ISTITUTO NAZIONALE DI FISICA NUCLEARE

CONSIGLIO DIRETTIVO

DELIBERAZIONE N. 12438

Il Consiglio Direttivo dell'Istituto Nazionale di Fisica Nucleare, riunito in Roma il giorno 26 luglio 2012 alla presenza di n. 33 dei suoi componenti su un totale di n. 34;

- premesso che, in base all'art. 2 del proprio Statuto, l'Istituto Nazionale di Fisica Nucleare, promuove, coordina ed effettua la ricerca scientifica nel campo della fisica nucleare, subnucleare, astroparticellare e delle interazioni fondamentali, nonché la ricerca e lo sviluppo tecnologico pertinenti all'attività in tali settori, prevedendo forme di sinergia con altri enti di ricerca e il mondo dell'impresa;

- premesso che, in base ai propri compiti istituzionali, l'Istituto Nazionale di Fisica Nucleare promuove e partecipa a collaborazioni, stipula convenzioni e contratti in materia di studio, ricerca e servizi, con Enti, Società ed imprese pubbliche e private, promuove il trasferimento delle conoscenze e delle tecnologie acquisite, promuove e provvede alla formazione scientifica e alla diffusione della cultura nei settori istituzionali;

- premesso che la Sincrotrone Trieste S.C.p.A., società di interesse nazionale ai sensi della legge 19 ottobre 1999, n. 370, nell'ambito del migliore utilizzo scientifico e tecnologico del proprio Laboratorio Elettra e con l'obiettivo di stimolare iniziative e programmi inerenti la realizzazione dei propri compiti istituzionali, promuove la collaborazione con soggetti di ricerca italiani ed internazionali, pubblici e privati mediante l'utilizzo di risorse comuni anche sulla base dello sviluppo e dell'utilizzo della radiazione di sincrotrone prodotta da anelli di accumulazione e da laser ad elettroni liberi (Free Electron Lasers - FEL);

- vista la deliberazione n. 10329, adottata dal Consiglio Direttivo in data 26 ottobre 2007, con la quale veniva approvato lo schema di Convenzione Quadro tra l'INFN e la Sincrotrone Trieste per regolare i rapporti di collaborazione relativamente a programmi e progetti di ricerca e sviluppo cui partecipino la ST e le Sezioni ed i Laboratori dell'INFN, anche nell'ambito di collaborazioni con altri enti nazionali ed esteri o di progetti internazionali della UE o di altri organismi internazionali, in particolare nel campo della fisica e dello sviluppo di macchine acceleratrici o parti di esse;

- preso atto che la Convenzione Quadro approvata con la citata deliberazione n. 10329 è stata poi sottoscritta il 5 dicembre 2007;

- visto l'art. 2 della Convenzione sopracitata secondo cui le Parti possano sottoscrivere specifici accordi attuativi per la realizzazione di progetti comuni e la disciplina di ogni ulteriore aspetto rispetto a quanto definito nella Convenzione stessa;

- vista la deliberazione n. 11968 adottata dal Consiglio Direttivo in data 26 luglio 2011 con la quale veniva approvato lo schema di Accordo di Collaborazione tra l'INFN e la Sincrotrone Trieste per attivare una collaborazione per realizzare la partecipazione italiana alla progettazione e alla costruzione delle infrastrutture di ricerca europee per l'analisi fine della materia;

- preso atto che l'Accordo approvato con la citata deliberazione n. 11968 è stato poi sottoscritto in data 5 ottobre 2011;

- premesso che European Spallation Source (ESS) è un progetto europeo per la realizzazione di una infrastruttura scientifica di ricerca multidisciplinare, che svolgerà attività nell'ambito delle scienze della vita, scienze dei materiali, dell'energia e delle scienze del clima, in conformità con le raccomandazioni dell'Organizzazione per la Cooperazione Economica e lo Sviluppo (OCSE) per le sorgenti di neutroni in tutto il mondo, con sede a Lund (Svezia);

- premesso che in data 3 febbraio 2012 diversi Paesi europei, tra i quali il governo italiano, hanno firmato un Memorandum of Understanding avente ad oggetto la partecipazione alla fase Design Update, alla costruzione e al funzionamento di ESS e nel quale è previsto che le attività di ricerca e sviluppo relative alla fase Design Update di ESS saranno condotte da ESS AB e dagli enti di ricerca qualificati a livello internazionale principalmente nei Paesi partecipanti al progetto ESS;

- premesso che la realizzazione dell'infrastruttura ESS è attualmente nella fase di aggiornamento di progettazione 2010-2013 e gli aspetti tecnici di macchina e delle linee sperimentali sono nella fase di definizione e che l'INFN ha contribuito nel 2011 alla revisione della progettazione di ESS e alla definizione del Conceptual Design Report che costituirà le basi del Technical Design Report di ESS, la cui finalizzazione è prevista entro la fine del 2012;

- premesso che la realizzazione e la gestione del progetto ESS sono state affidate alla società pubblica di diritto svedese, partecipata dai governi della Svezia e della Danimarca, ESS AB;

- considerato che per il Progetto ESS alla Sincrotrone Trieste è stato assegnato dal MIUR il ruolo di capofila nell'erogazione dei fondi relativi alle attività da svolgersi nel 2011;

- premesso che Il "Decreto Ministeriale per il riparto del Fondo ordinario per gli enti e le istituzioni di ricerca per l'anno 2011", prevede assegnazioni straordinarie di importo complessivo pari a € 14.069.242,00, per sostenere attività derivanti da accordi internazionali, tra le quali è prevista una somma di € 2.500.000,00 da destinarsi alla realizzazione del progetto ESS;

- ritenuto di dover sottoscrivere un apposito Accordo Attuativo per regolare i rapporti tra le Parti nell'attribuzione del finanziamento relativo alle attività svolte dall'INFN per l'anno 2011, consentire il prosieguo delle attività nonchè assicurare il rispetto degli impegni assunti dal Governo italiano con la sottoscrizione della Convenzione del 3 febbraio 2012;

- vista la proposta formulata dal Direttore dei Laboratori Nazionali del Sud con nota del 16 luglio 2012, prot. n. 1702;

- premesso che lo schema di Accordo Attuativo di cui alla presente deliberazione non comporta alcun onere finanziario per l'INFN e che l'entrata prevista per l'Istituto, pari a complessivi euro 447.475,00, verrà accertata tra le entrate dell'Istituto con apposite deliberazioni del Consiglio Direttivo;

- su proposta della Giunta Esecutiva;

- con n. 33 voti a favore;

DELIBERA

Di approvare lo schema di "Accordo Attuativo tra l'Istituto Nazionale di Fisica Nucleare e la Sincrotrone Trieste S.C.p.A.", allegato e che fa parte integrante della presente deliberazione; il Presidente, o persona da lui delegata, è autorizzato a negoziarlo e firmarlo.

ACCORDO ATTUATIVO

tra

Sincrotrone Trieste S.C.p.A., di seguito denominata “**ST**”, con sede in Trieste, S.S. 14 - km 163,5 in AREA Science Park, loc. Basovizza, Italia, C.F. e P.I. IT00697920320, in persona del suo legale rappresentante e Amministratore Delegato, prof. Alfonso Franciosi, nato a Roma il 14/07/1955, domiciliato per il presente atto presso la sede della società,

e

Istituto Nazionale di Fisica Nucleare, di seguito denominato “**INFN**”, con sede in Frascati (RM) via Enrico Fermi 40, C.F. e P.I.84001850589, rappresentata dal Presidente, Prof. Fernando Ferroni, nato a Roma il 12/01/1952, domiciliato per il presente atto presso la sede dell’Istituto

di seguito collettivamente indicate come “le Parti”

PREMESSO CHE

- Tra ST e INFN è stato firmato, il 05/12/2007 un accordo quadro per regolare i rapporti di collaborazione relativamente a programmi e progetti di ricerca e sviluppo cui partecipino ST e le Sezioni ed i Laboratori di INFN, anche nell’ambito di collaborazioni con altri enti nazionali ed esteri o di progetti internazionali della UE o di altri organismi internazionali, in particolare nel campo della fisica e dello sviluppo di macchine acceleratrici o parti di esse;
- L’art. 2 dell'accordo sopracitato prevede che le Parti possano sottoscrivere specifici accordi attuativi per la disciplina di ogni ulteriore aspetto eccedente le obbligazioni

generali fissate nell'accordo quadro stesso, in particolare in relazione alla realizzazione di specifici progetti comuni;

- In data 05/10/2011 ST e INFN hanno firmato un successivo accordo di collaborazione in cui viene ribadita la disponibilità delle Parti a collaborare per realizzare la partecipazione italiana alla progettazione e alla costruzione delle infrastrutture di ricerca europee per l'analisi fine della materia;
- European Spallation Source (ESS) è un progetto europeo per la realizzazione di una infrastruttura scientifica di ricerca multidisciplinare, che svolgerà attività nell'ambito delle scienze della vita, scienze dei materiali, dell'energia e delle scienze del clima, in conformità con le raccomandazioni dell'Organizzazione per la Cooperazione Economica e lo Sviluppo (OCSE) per le sorgenti di neutroni in tutto il mondo, con sede a Lund (Svezia);
- La realizzazione e la gestione del progetto ESS sono state affidate alla società pubblica di diritto svedese, partecipata dai governi della Svezia e della Danimarca, ESS AB;
- In data 3 febbraio 2012 diversi Paesi europei, tra i quali il governo italiano, hanno firmato un Memorandum of Understanding avente ad oggetto la partecipazione alla fase Design Update, alla costruzione e al funzionamento di ESS e nel quale è previsto che le attività di ricerca e sviluppo relative alla fase Design Update di ESS saranno condotte da ESS AB e dagli enti di ricerca qualificati a livello internazionale principalmente nei Paesi partecipanti al progetto ESS;
- Attualmente la realizzazione dell'infrastruttura ESS è nella fase di aggiornamento di progettazione 2010-2013 e gli aspetti tecnici di macchina e delle linee sperimentali sono nella fase di definizione;

- INFN ha contribuito nel 2011 alla revisione della progettazione di ESS e alla definizione del Conceptual Design Report che costituirà le basi del Technical Design Report di ESS, la cui finalizzazione è prevista entro la fine del 2012;
- ESS AB e INFN hanno convenuto che INFN svolgerà sotto la propria esclusiva responsabilità le attività connesse al Work Package 6 definite nel documento "*Annex 1 - Project Specification for ESS Accelerator Design Update Project*" (di seguito "Annex 1"), in allegato sub 1, come unità di lavoro WU1 - Management and TDR, WU2 - Proton source and Low Energy Beam Transport, WU5 - Drift Tube Linac di cui alle pagine da 18 a 22 del citato documento Annex 1;
- Il "Decreto Ministeriale per il riparto del Fondo ordinario per gli enti e le istituzioni di ricerca per l'anno 2011", firmato dal Ministro dell'Istruzione Università e Ricerca il 28.11.2011, prevede assegnazioni straordinarie di importo complessivo pari a € 14.069.242,00 (euro quattordicimilionisessantanovemiladuecentoquarantadue/00), per sostenere attività derivanti da accordi internazionali relativi ai progetti realizzati da Sincrotrone Trieste S.C.p.A. (ST), che sono state attribuite per il tramite del Consorzio per l'Area di ricerca scientifica e tecnologica di Trieste, tra le quali è prevista una somma di € 2.500.000,00 (Euro duemilionicinquecentomila/00) da destinarsi alla realizzazione del progetto ESS;
- Quanto sopra rappresenta ad oggi il quadro di riferimento in cui si inserisce il presente Accordo Attuativo tra ST e INFN relativo al contributo italiano in-kind alla realizzazione dell'infrastruttura europea European Spallation Source;
- ESS AB e ST hanno firmato in data 24 febbraio 2012 un Memorandum of Understanding avente ad oggetto la definizione degli elementi di base della collaborazione tecnica tra ESS AB e ST e di eventuali contributi in natura al progetto ESS;

Tutto ciò premesso facente parte integrante dell'Accordo,

TRA LE PARTI SI CONVIENE E SI STIPULA QUANTO SEGUE

ARTICOLO 1

Oggetto

1. Allo scopo di rafforzare il ruolo italiano in ESS e di coprire una prima voce prevista di contributo italiano in-kind al programma medesimo, ST corrisponderà a INFN, secondo le modalità e le tempistiche indicate al successivo articolo 2, un contributo complessivo dell'ammontare di € 447.475,00 (euro quattrocentoquarantasettemilaquattrocento-settantacinque/00) a parziale copertura dei costi per lo svolgimento delle attività e la realizzazione della strumentazione previste per l'anno 2011 di cui alla tabella 1 (*Table 1*) del documento "*Annex 2*" (di seguito "Annex 2"), in allegato sub 2, a valere sugli importi assegnati a ST per la realizzazione del progetto ESS sul Fondo ordinario per gli enti e le istituzioni di ricerca per l'anno 2011 di cui al Decreto Ministeriale del 28.11.2011 citato in premessa.
2. INFN si impegna a completare le attività e realizzare la strumentazione previste per l'anno 2011 di cui alla tabella 1 (*Table 1*) del documento Annex 2, in allegato sub 2, sotto la propria esclusiva responsabilità e a utilizzare le somme di cui al precedente comma per le finalità espressamente indicate.
3. Lo svolgimento delle attività e la realizzazione della strumentazione previste per l'anno 2012 di cui alla tabella 3 (*Table 3*) del documento Annex 2, in allegato sub 2, saranno realizzate da INFN e non rientrano nell'ambito delle attività finanziate ai sensi del presente Accordo.
4. Nella tabella 2 (*Table 2*) del documento Annex 2, in allegato sub 2, le Parti individuano

su base annuale i costi stimati, comprensivi dei costi di personale, per la realizzazione delle attività necessarie alla realizzazione del Work Package 6, unità di lavoro WU1 WU2 e WU5 di cui alle pagine da 18 a 22 del documento Annex 1, in allegato sub 1.

5. INFN si impegna a fornire a ST tutta la documentazione necessaria ai fini della rendicontazione dei costi sostenuti per l'ammontare trasferito per la realizzazione delle attività oggetto del presente Accordo e una relazione tecnico-scientifica finale sulla realizzazione delle attività medesime debitamente approvata da ESS AB entro 30 giorni dalla data di fine dell'attività fissata convenzionalmente al 31 dicembre 2012.
6. Entro il termine fissato al precedente comma 5, INFN si impegna, altresì, a produrre a ST una dichiarazione di ESS AB con la quale ESS AB medesima riconosce le attività e la strumentazione realizzata nell'ambito del presente Accordo come contributo in natura (in-kind) del governo italiano alla realizzazione del progetto ESS per un valore complessivo pari al contributo di € 447.475,00 (euro quattrocentoquarantasettemila-quattrocentosettantacinque/00) erogato da ST a INFN ai sensi del precedente comma 1.
7. Nel caso in cui INFN non adempia alle obbligazioni sopra indicate, ST potrà sospendere le erogazioni in favore di INFN, ovvero potrà chiedere la restituzione delle somme già erogate. In tale ipotesi, INFN, si impegna a restituire le somme ricevute a fronte della mera richiesta scritta di ST e a concordare con ST le azioni necessarie per adeguare le attività intraprese da INFN, alle obbligazioni assunte con il presente Accordo. Qualora non fosse possibile raggiungere alcun accordo, ST, previo assenso del MIUR, potrà destinare le somme non corrisposte a INFN, ad altre attività nell'ambito del progetto ESS o di iniziative collegate.

ARTICOLO 2

Modalità di erogazione

1. ST corrisponderà l'importo complessivo di € 447.475,00 (euro quattrocentoquaranta-

settemilaquattrocentosettantacinque/00) di cui all'art. 1 secondo le seguenti tempistiche e modalità:

- € 200.000,00 (euro duecentomila/00) entro 30 giorni dalla data della firma del presente Accordo;
- € 200.000,00 (euro duecentomila/00) entro 30 giorni dalla comunicazione di INFN di avvenuta stipula tra INFN e ESS AB di un accordo formale per la realizzazione delle attività previste per il Work Package 6, unità di lavoro WU1 WU2 e WU5 di cui alle pagine da 18 a 22 del documento Annex 1, in allegato sub 1;
- € 47.475,00 (euro quarantasettemilaquattrocentosettantacinque/00) entro 30 giorni dalla presentazione da parte dei INFN della relazione tecnico scientifica e della dichiarazione dei ESS AB di cui rispettivamente ai commi 5 e 6 dell'art. 1.

ARTICOLO 3

Comunicazioni

1. Qualsiasi comunicazione tra le Parti concernente il presente Accordo dovrà essere effettuata con raccomandata con avviso di ricevimento a:

Sincrotrone Trieste S.C.p.A.	**INFN**
S.S. 14 - km 163,5 in Area Science Park	Via Enrico Fermi 40,
34149 – Trieste	00044 - Frascati (Roma)
Alla c.a. del prof. Alfonso Franciosi	Alla c.a. _______________

ARTICOLO 4

Disposizioni conclusive

1. I documenti Annex 1 e Annex 2, rispettivamente allegati sub 1 e 2, formano parte integrante del presente Accordo.

2. Qualsiasi modifica al presente Accordo dovrà essere concordata per iscritto fra le Parti ed entrerà in vigore fra le medesime solo dopo la relativa sottoscrizione da parte di entrambe.

3. Per le parti non espressamente disciplinate dal presente Accordo le Parti rinviano alle disposizioni previste nell'accordo quadro di cui in premessa in quanto applicabili.

ARTICOLO 5

Risoluzione delle controversie

1. Le Parti concordano di definire amichevolmente qualsiasi controversia che possa derivare dal presente Accordo. Nel caso in cui tale definizione amichevole non possa essere raggiunta, ogni eventuale vertenza che sorgesse fra le Parti relativamente alla validità, interpretazione od esecuzione dell'Accordo sarà di competenza esclusiva dell'Autorità Giudiziaria del foro di Trieste.

Letto, approvato e sottoscritto:

Trieste, _______________	Frascati, _______________
Sincrotrone Trieste S.C.p.A.	Istituto Nazionale di Fisica Nucleare
____________________________	____________________________
Prof. Alfonso Franciosi	Prof. Fernando Ferroni
Amministratore Delegato	*Presidente*

Prepared (also subject responsible if other)		No.		
Mats Lindroos				
Approved	Checked	Date	Rev	Reference
		2012-01-23	1.26	

Project Specification for ESS Accelerator Design Update Project

Enclosures

Time Schedule – including WBS, deliverables, and costs

Abstract

This document describes the proposal for an open and collaborative project to complete the ESS baseline, and is an invitation to European partner countries and their best competence laboratories, to join and form the necessary core group of technical knowledge to validate and reach the necessary consensus for the design review.

The ESS Accelerator Design Update (ADU) will be prepared within a pan-European collaboration with the goal of producing, by the end of 2012, a Technical Design Report with full cost (to completion) for the Accelerator. The Design Update will build upon the preliminary work already performed within the ESS- Bilbao and the ESS- Scandinavia initiatives. The Technical Project Plan (TPP) contains seven major Work Packages proposed to be lead by different partner institutions, working with other collaborating institutes. Each Work Package will contain several Work Units, with leadership distributed among all participants. A few work unit leaders will be part of the Lund staff in order to start as soon as possible the team building effort, which is necessary for the operation of the future facility.

A potential project organization for the design phase is also sketched in the proposal. A central team, technically solid, with a strong leadership is required to fulfil project objectives. A collaboration board of partner institute representatives is also proposed.

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Contents

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1 Project Goal, Strategies and Stakeholders

1.1 Project Background

See ESS Programme Plan.

1.2 Project Goal

The ADU operates within the pan-European ESS collaboration with the primary goal of producing a Technical Design Report for the accelerator, including full cost to completion, by the end of 2012.

Underlying accelerator technologies have evolved, and considerable experience has been gained, since the basic ESS design proposal was originally completed in 2002. Two multi-megawatt accelerator based spallation sources have been constructed: the SNS in the U.S. and J-PARC in Japan. New European and International accelerator projects are under construction, such as IFMIF/EVEDA, SPIRAL-2, and LINAC-4. Thus it is necessary to review and enhance the original ESS design, through the Accelerator Design Update (ADU) project.

The ADU is building on the preliminary work already performed within the ESS-Bilbao and the ESS- Scandinavia initiatives, taking advantage of latest acquired knowledge and synergies with other on-going projects to make modifications that will improve the facility reliability, reduce costs and reduce project overall risks. The delivery of a consolidated TDR, complete with corresponding project planning, construction schedules and cost estimates, will enable the detail engineering and construction phase of ESS to be launched.

The ADU project consists of seven major Work Packages lead by different partner institutions. Each Work Package contains multiple Work Units, with leadership distributed among multiple participating institutions. Some Work Unit leaders are part of the Lund staff, enabling the team building effort that is necessary for future facility operation to begin.

The Work Package leaders are responsible for the following objectives:

1. Deliver a Technical Design Report (TDR) by the end of 2012.
2. Estimate the accelerator cost with a precision better than 20%, in most cases.
3. Provide a readiness to construct. That is, describe a safe baseline design with technical choices that will enable an immediate 2013 start on the generation of engineering design specifications, detailed drawings, and the construction of "late prototypes".
4. Assure a viable critical path to commissioning and operation. That is, begin work on "early prototypes" that need to be completed before the end of 2012, and on other prototypes that must be started immediately, but which will not be completed by the end of 2012.
5. Work with the lead institution directorate to manage and monitor Work Package performance, if necessary resolving conflicts between partner institutions through the Collaboration Board, which has the ultimate responsibility for deliverables.
6. Take into account energy budgets and sustainability.

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1.2.1 Objectives of each Work Package

1.2.1.1 WP1: Management Coordination

The development and construction of a project of the magnitude of the ESS requires the effort and collaboration of many countries, institutions, laboratories and companies all over the world. Due to this complexity, the implementation of a good organisation is critical. Therefore, it is necessary to remark that during the design update phase, high levels of project management, technological coordination, system engineering and quality assurance and configuration control will be needed to achieve a complete and coherent consolidated design in agreement with the specified needs. This Work Package will deal with all these project management related activities.

1.2.1.2 WP2: Accelerator Science

This Work Package will be in charge of Beam Physics, Control Systems, Beam Instrumentation, and RF Modelling with the aim to identify and perform high-priority analyses and simulations that will be critical to determining the most suitable parameters in terms of performance, reliability and feasibility. Activities in this Work Package will support and will be integrated with Physics design efforts at all ESS collaborating and other partner institutions.

1.2.1.3 WP3: Infrastructure Services

As of January 2012, the Infrastructure Services work package is part of the Infrastructure Design Update Project and no longer part of the Accelerator Design Update Project

The overall objective of this Work Package is to perform the design and specification of all infrastructure facilities and services, including HVAC (Heating, Ventilation & Air Conditioning), cryogenics system, and supply of cooling water, electricity, and networking. ESS will be a climate-neutral and sustainable facility and this Work Package will work closely with the ESS energy team.

1.2.1.4 WP4: Spoke Cavities

This Work Package will address the engineering design of the complete spoke cryomodules which will compose the intermediate energy section of the ESS Superconducting Accelerator, based on multi-gap superconducting spoke resonators at 352 MHz.

The detailed design of the spoke cryomodule includes the cavity and the couplers. Early prototyping will be included in this work to validate part of the cavity and power couplers design and to justify the cavity design gradients. Two spoke cavity prototypes and power couplers will be constructed and tested.

1.2.1.5 WP5: Elliptical Cavities

The main objective of this Work Package is to provide the engineering design of the fully equipped cryomodules for both medium and high beta elliptical cavity sections of the ESS Accelerator operating at 2 K with an accelerating field of about 15 MV/m. The design should be carried out in close collaboration with the SPL development of a prototype cryomodule housing several high beta elliptical cavities. Several components, namely cavities, fundamental power couplers and fast frequency tuners are considered to be critical, therefore prototypes will be fabricated for each of them and tested.

1.2.1.6 WP6: Front End and Normal Conducting Accelerator

This Work Package will be responsible for the design of the elements of the front-end up to the warm-to-cold transition (proton source, beam transport system, radio frequency quadrupole and drift tube accelerators). Different European laboratories contain the competences necessary to take the responsibility of the design, construction and integration of the whole NC part of the Accelerator. Existing equipment will provide a valuable test for the Ion Source. This test will be followed by a whole injector (source, low energy beam transport and RFQ) reliability test lasting about three months. The NC Accelerator design study would take advantage of this experiment and the experience of the design of similar Accelerators LINAC4, TRASCO and IPHI RFQ.

1.2.1.7 WP7: HEBT, NC Magnets and Power Supplies

This Work package is concerned with the design of a HEBT system which functionalities include transport to the main target, to a commissioning beam dump, to an optional future target station, and a collimation section after the Accelerator. Also included in the scenario are considerations about bringing the HEBT into operation, i.e. a steering and a focusing concept. In addition to the above general design of the HEBT, this Work Package will also define standards for the normal conducting magnets, the corresponding power supplies, beam dumps and collimators for the whole Accelerator. Power supply studies addressing sustainability over a 10 year period are included.

1.2.1.8 WP8: Radio Frequency Systems

The RF system for the ESS accelerator is defined as the system that converts AC line power to RF power at either 352 or 704 MHz to be supplied to the RF accelerating cavity couplers. Therefore, the RF system is bound by the AC conventional power lines on one side, and the waveguide power couplers on the accelerating cavities on the other side

The purpose of the Accelerator Design Update (ADU) in WP8 is to produce

- *A technical design report (TDR)*
- *A cost estimate*
- *A construction plan*

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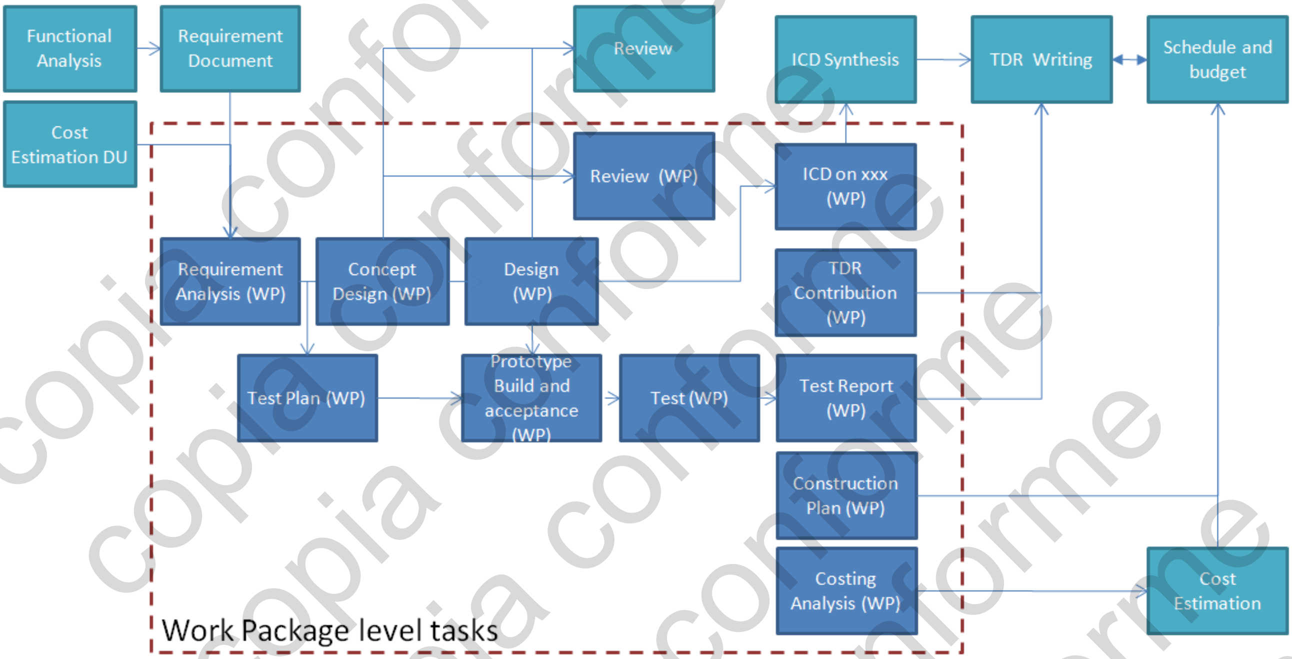
1.3 Strategies

The project will follow a common sequence of activities for the most of the work units' deliveries. The main steps of this are

- Functional analysis and requirements
- Requirement analysis
- Concept design and review
- Design (ICDs and Technical Reports)
- Prototype and test



1.4 Connections to other Projects or Assignments

The ESS Accelerator Design Update project will deliver a detailed Technical Design Report (TDR) to be used by later projects in the ESS Program.

The projects are;

- Accelerator Prepare to Build project(P2B)
- Target Design Update project
- Instrument Design Update project
- Infrastructure and facilities project

When these projects start it will be necessary to have a close contact and dialogue on technical issues and dependencies between tasks in the projects.

The projects may also need to use the same competencies and by this create resource allocation issues.

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1.5 Project Stakeholders

Preliminary list of high-level major stakeholders:

- Neutron users
- ESS AB
- STC (Steering Committee)
- EU (European Union)
- Host states
- Member states
- Skåne region
- Collaboration institutes
- Other institutes

To be detailed in separate ESS Programme Stakeholder Analysis

1.5.1 List of participants

The ESS Accelerator Design project will be addressed as ESS a joint European effort in which several countries from all over the world will contribute with the best of their technical and scientific resources in a collaborative project. The list of participating institutes in the collaboration is as follows:

- Aarhus University (DK)
- CEA Saclay (FR)
- University of Lund (SE)
- CNRS Orsay (FR)
- *ESS- Bilbao (ES)?*
- INFN (IT)
- Uppsala University (SE)

The assignment of responsibilities for Work Units within each Work Package goes in parallel with discussions with potential partners in an iterative process of merging tasks and partners

Also participating, as part of the work packages, are other institutes:

- Argonne (USA)
- ASTEC (UK)
- BNL (USA)
- CERN (CH/FR)
- Cockcroft Institute (UK)
- DESY (GE)
- ESS- Bilbao (ES)
- Fermilab (USA)
- JLab (USA)
- John Adams Institute (UK)
- Laval University (CAN)
- Maribor Univ. (SI)
- Tech. Univ Darmstadt (GE)
- Technical University of Lisbon (PT)
- TRIUMF (Canada)
- Oslo University (NO)
- Rostock Univ (GE)
- SLAC (USA)
- SNS (USA)

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- Stockholm Univ (SE)
- Soltan Institute (PL)

2 Project Scope

2.1 Scope Description

2.1.1 WP1: Management Coordination (M. Lindroos, ESS)

1) Coordinate the technical, scientific, financial and administrative activities of the collaboration with ultimate responsibility for cost control.

2) Integrate all ESS accelerator activities into a single coherent project.

3) Assure smooth transition between design and construction phase

3) Establish and maintain Accelerator parameter lists.

The development and construction of a project of the magnitude of the ESS requires the effort and collaboration of many countries, institutions, laboratories and companies all over the EU and around the world. Due to this complexity, the implementation of a good organisation is critical. Therefore, it is necessary to remark that during the updating phase, high levels of project management, technological coordination, systems engineering and quality assurance and configuration control will be needed to achieve a complete and coherent consolidated design in agreement with the specified needs.

The proposed organization for this project is based on the development by means of in-kind contributions, organized in technology related tasks, of a large number of entities. This work organisation is suitable for this kind of projects, but for an optimal efficiency it is necessary to provide a technically strong and well resourced *Accelerator Management Team* with the ultimate responsibility and coordination control. For managing the collaboration and for purposes of coordination and control, two more bodies are foreseen: the *Accelerator Collaboration Board* and the *Technical Board*. A description of the roles of these three bodies is given in the "organisational structure and overall project management" section

The roles of the ADU Management Team are as follows:

2.1.1.1 System engineering (R. Duperrier, Saclay)

Requirements management and interface control. Verification of the appropriate integration of the Accelerator subsystems as a whole and check the coherence and compatibility of the components requirements. Technical validation and functional analysis and synthesis, concept review and baselining. Critical analysis of each subsystem as their design evolve, identifying any implication for any other subsystem. Identification of R&D needs

- Requirements and interface activities
- Validation and tests
- R&D and prototyping priorities set up
- Concept review

2.1.1.2 TDR editing (M. Lindroos, ESS)

Communication among the different workgroups, contact with the Collaboration Board, responsibility over financial management, risk management, publications and dissemination.

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- Final design report
- Cost estimation
- Accelerator construction work plan

2.1.1.3 Review organisation (S.Gysin ESS AB, C. Oyón, SPRI)

Planning and control of objectives, scope, schedule, costs. Responsibility over the collection, edition and publication of the generated communication and reports. Continuous identification of the high priority activities with the aim of identifying the critical aspects and accordingly suiting the project planning to the actual needs of the project. Assure the coherence with the other ESS systems design update projects. Organisation of internal reviews

2.1.1.4 Planning and documentation (S.Gysin, ESS)

This work unit consist of regular follow-ups on the budget and schedule, establishing and maintaining a communication plan, regular risk analysis and mitigation, and planning for the P2B and Construction projects.

2.1.2 WP2: Accelerator Science (S. Peggs, ESS)

The 5 Work Units within the Accelerator Science Work Package –Management, Beam Physics, Control Systems, Beam Instrumentation, and RF Modelling – will work with other Work Packages, with all ESS Divisions, and with the ESS Project Management team, to describe an ESS Accelerator baseline. This Work Package will work especially closely with the Management Coordination Work Package to identify and perform high-priority analyses and simulations that will be critical to determining the most suitable parameters in terms of performance, reliability and feasibility.

The baseline design will be accompanied by the smallest possible set of potential design variants, consistent with R&D and prototyping efforts that will extend beyond the 2012 Work Package completion milestone, when the Technical Design Report will be delivered. Work Package 2 activities will support and will be integrated with Physics design efforts at all ESS collaborating and other partner institutions.

2.1.2.1 Work Unit 2.1: Management (S. Peggs, ESS)

The following are the management tasks pertaining to the work done in WP2:

- Meetings planning
- Progress monitoring
- Contributions to the parameter lists.
- Definition of prototyping requirements
- TDR writing
- PBS description
- WBS description for construction phase
- Cost estimation for WP2

2.1.2.2 Work Unit 2.2: Beam physics (H. Danared, ESS)

This Work Unit will perform detailed studies of beam dynamics and lattice layout issues for the ESS Accelerator. It will develop end-to-end lattice layouts and a Relational Database Management System amenable to efficient and robust project-wide configuration control. Different, consistent views (formats) of lattice layouts will be made available to the spectrum of users in other Work Packages at all ESS collaborating institutions. Steps in defining the basic layout of the Accelerator include:

- Single-particle longitudinal modelling producing a baseline layout which defines the number of superconducting cavities and cryomodules, the synchronous phases and the cavity gradients
- Single-particle transverse modelling giving a baseline for the magnet lattice, transverse focusing and the rms beam size
- Interaction with other work packages, in particular WP6 on beam parameters and interfaces between normal conducting and superconducting accelerator and WP8 on beam parameters and interfaces between the accelerator and the HEBT
- Studies in close collaboration with the HEBT Work Package on the design of an optimized accelerator/target interface, possibly including a chicane or dog-leg system to ameliorate back-streaming neutrons and gammas

Detailed modelling and three-dimensional multi-particle simulations with space charge are required to get a more complete understanding of emittances, acceptances, losses and other factors determining the performance of the accelerator. Tasks in this category include:

- Three-dimensional simulations investigating longitudinal acceptance
- Studying effects of functional loss of cavities or cryomodules and investigating schemes for compensating such losses by redistribution of cavity gradients in the accelerator
- Simulation of halo growth and determination of machine settings minimizing halo size in contrast to rms beam size
- Investigation of requirements on beam instrumentation to set specifications on sensitivity, resolution, etc.
- Code benchmarking and development

In a real accelerator, all beam and hardware parameters will be subject to errors or uncertainties. The study of such errors and their effect on the proton beam as well as strategies for their mitigation are an important part of the design work. Sensitivity to such errors will be used as input to hardware specifications. Examples of error studies concern:

- Longitudinal errors and reduction of longitudinal acceptance resulting from static or dynamic errors in cavity gradients and phases
- Transverse errors, transverse acceptance and halo growth resulting from static or dynamic errors in cavity gradients and phases (through effect on rf defocusing) and quadrupole currents, misalignment of cavities and, most importantly, misalignment of quadrupole magnets
- Magnetic-field errors, such as higher multipole components of quadrupole magnets
- Sensitivity to higher-order modes in accelerating cavities
- Sensitivity to fluctuations in beam current
- Feasibility of control loops to compensate for dynamic errors in beam or hardware parameters

Non-linearities in the beam dynamics as well as the intrinsic distribution of particles from the ion source make beam collimation necessary in order to manage beam losses and to concentrate the losses to specific points in the accelerator. Collimation can be performed transversally by introducing physical apertures, preferably in several stages, and longitudinally by adjusting cavity

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parameters such that the longudinal acceptance has minima at selected positions down the accelerator:

- Design of longitudinal collimation
- Design of transverse collimation

Although the tasks above refer to the baseline design with 50 mA, 14 Hz and 5 MW, it is important to foresee consequences on accelerator layout and beam dynamics for different upgrade scenarios. For the time being, three upgrade scenarios are considered, consisting of an increase of the beam current to 75 mA while other main parameters are constant, the addition of a second target station which implies interleaving of pulses at 40 Hz and a short-pulse target which requires an H– accelerator:

- 75 mA upgrade study
- Second target station upgrade study
- Short-pulse option upgrade study

2.1.2.3 Work Unit 2.3: Control systems (G. Trahern, ESS)

This Work Unit is partially defined in the “ESS Control System Study” document (hereafter referred to as CL/CSS) that became available on March 31, 2010. This document includes a preliminary integration strategy from consoles to equipment control access points.

Assumptions include:

- EPICS implementation of a 3-layer architecture
- Deferred specification of the upper (user interface) layer
- Linux operating system in the middle (services) layer
- A standard “Controls Box” defining the boundary interface between the control system and the lower (equipment) layer will be implemented, prototyped, and made available to all Linac sub-systems well before the end of 2012
- Broad use of a Relational Database Management System (RDBMS) as well as other information control systems, consistent with the Beam Physics Work Unit
- A distributed ESS Controls development environment, to collect and standardize sub-system controls and software development

This Work Unit will provide prototype Control Boxes (CL/CSS 3.2) to ESS collaborating institutions working on ESS Work Packages. The development of the Control Box and its methodology will be ongoing during the project. The availability of Control Boxes will:

- Enable rapid deployment of a useful (equipment level) controls environment
- Administer consistency between sub-systems
- Minimize throw-away hardware and software development
- Encourage and enable the rapid maturation of the Controls Box implementation through feedback from engineering subgroups

This Work Unit will collaborate with WP8 regarding fast Low Level RF (LLRF) controls (where interfaces with the Linac control system are recognized) as well as Master Clock timing signal generation and distribution.

An early deliverable is a document defining the Naming Convention and its scope for the naming of devices, signals and equipment. In addition we will develop software that can be used by the ESS collaboration to implement the naming scheme as sub-systems mature.

The Naming Convention will be defined as this Work Unit investigates and initiates collaboration with other projects, e.g., SNS, XFEL, ITER, SPIRAL 2 & FRIB. The scope of these collaborations can and should evolve beyond the mode of 'lessons learned' and include ESS systems development.

This Work Unit will collaborate with other members of ESS to produce a design document for the scientific and technical computing environment for the Linac Division. The control room software and frameworks described in CL/CSS 3.5-3.7 can provide guidance for this design. The scope of this environment shall include software used for modelling of the Linac, engineering sub-system prototyping, and control room applications as well as the support systems and personnel required for a fully robust research laboratory.

A specification document for the Control System will be produced by this Work Unit in two parts: a prototype specification document to be included in the conceptual design report (CDR) and a final document to be included in the design update report (TDR). The prototype specification will provide a sufficiently detailed proposal for the Control System so that a detailed review of it should allow the final report to be written with confidence. One deliverable of this effort in tandem with the project management developments should be a Work Breakdown Structure (WBS) for the Control System design.

This Work Unit will also establish the relationship of Linac and Target controls and will also define its role with respect to the Machine Protection System (MPS).

2.1.2.4 Work Unit 2.4: Beam instrumentation (A. Jansson, ESS)

This Work Unit will design and prototype accelerator beam diagnostic instrumentation, including beam loss monitors, beam current monitors, beam position monitors, transverse and longitudinal beam profile monitors, emittance scanners, and a time-of-flight measurement system. It will:

Interface with the Beam Physics Work Unit, and with the Spoke, Elliptical, Front End, and HEBT Work Packages, to specify the beam instrumentation needs in each part of the accelerator, and determine the relative priority of each system (e.g. essential for machine protection, or useful for performance optimization)

- Develop a minimum set of different beam instrumentation designs for each function
- Participate in cryomodule design and prototype testing to the extent the accelerator design requires some instruments to be located inside the cryostat.
- Interact with the HEBT Work Package and with the ESS Target Division to design instrumentation for beam observation on the target, and for beam-on-target tuning
- Work with the Control Systems Work Unit to provisionally define instrumentation data acquisition interface standards.

2.1.3 WP3: Infrastructure Services (J. Eguia, Tekniker)

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As of January, 2012, Work Package 3 has moved to the Infrastructure Design Update project, and is no longer part of the Accelerator Design Update.

2.1.4 WP4: Spoke superconducting accelerator (S. Bousson, Orsay)

The Work Package 4 (WP4) of the ESS Technical Design Report (TDR) will address the engineering design of the complete spoke cryomodules which will compose the intermediate energy section of the ESS Superconducting Accelerator. This section is covering the energy range between ~50 MeV and ~200 MeV, and will be based on multi-gap superconducting spoke resonators at 352 MHz. The overall specifications of the spoke accelerator will be provided by the accelerator design team (input and output energy, cavity beta and number of accelerating gaps).

The aim of this WP is to performed in 2 years (2011-2012) a detailed design of the spoke cryomodule: it includes the cavity (for the 2 b), the power coupler, the cold tuning system (mechanical and piezo), the cryomodule vacuum tank, the cryogenics and magnetic shields, the cavity supporting system and alignment, the cryo-fluid circuitry, the cryogenic valve box and the assembly toolings.

Spoke cavities are under development in several laboratories worldwide, but up to now none of them have effectively accelerated any beams. The first part of the work will consist of a detailed analysis of the spoke cavities performances state-of-the-art in order to establish the ESS spoke accelerator operating values (accelerating fields, cryogenic consumption, temperature operating point,…).

The work will be performed having in mind the objective of fulfilling all requirements for producing a complete TDR: for the whole ESS spoke accelerator, a Working Breakdown Structure (WBS), a Product Breakdown Structure (PBS) will be defined, and a cost estimate at 20% will be calculated.

Early prototyping will be included in this work to validate part of the cavity and power couplers design and to justify the cavity design gradients. Two spoke cavity prototypes and 2 power couplers will be constructed and partially tested.

2.1.4.1 Work Unit 4.1: Project management and TDR (S. Bousson, Orsay)

This WU is dedicated to the WP management and the non-technical work that is required for fulfilling the requirements of a TDR:

- Overall management of the WP : planning meetings and progress monitoring
- Preparation of the PBS of the spoke accelerator section
- Preparation of the WBS of the spoke accelerator section for the construction
- Define and fill a parameter list for the spoke accelerator section for a better exchange between the accelerator design group (beam dynamics), the RF WP and the engineering design of the spoke accelerator elements
- Organize the TDR writing work
- Define the prototyping requirements, strategy and cost for the project phase between the TDR and construction.
- Perform the spoke accelerator costing from the PBS and WBS

2.1.4.2 Work Unit 4.2: Cavities

The main activities within this WU are to establish a state of the art for the spoke cavity design and performances, in particular looking at the recent developments in this field for the EURISOL and HINS projects. This will be used to address two main questions:

- what cavity performance (Eacc) should be taken as the design goal
- address a pros and cons comparison between operation at 4.2 K and 2 K

RF Engineering design of the different spoke cavities (for all required beta), and if possible comparison of the results with several electromagnetic codes

- Mechanical design of the cavity
- Helium tank
- Stiffening system
- Cold tuning system

During this study, one of the main goal will be to minimize the dynamic lorentz forces detuning. All technical choices should be done and justified by the positive impact on this key parameter for a pulsed machine.

Specify what preparation and conditioning procedure should be performed in order to reach the design performances of the spoke cryomodule:

- Procedures for the cavities:
  - Chemical etching requirements for the cavities (standard BCP or electro-polishing)
  - Cavity cleaning procedure (H degazing, in-situ baking, high pressure water rinsing)
  - Requirements for cavity assembly in clean room
  - Special processing procedure during individual cavity testing (He processing)
- Power coupler preparation
  - Procedure for power coupler cleaning and assembly
  - Power coupler conditioning (with high RF power)
- Requirements for cryomodule assembly (clean room)

2.1.4.3 Cold tuning system (N. Gandalfo, Orsay)

The aim of this Work Unit is to develop the cold tuning system (CTS) for the spoke cavities. The CTS is a device required to in-situ (inside the Cryomodule) adjusts the cavity resonant frequency to the nominal value. For the spoke cavities, two options for the cold tuning system will be considered:

- A “classical” CTS based on a mechanical deformation of the cavity length to adjust the frequency. Such systems have already been developed for single-spoke resonator for the Eurisol project.
- A novel concept for superconducting cavities, based on a niobium plunger inserted inside the cavity volume. This new scheme has been developed for the Spiral-2 project on the high energy quarter wave resonators.

Both systems will be envisaged and studied from a conceptual point of view. One solution will be then chosen and studied into details to perform a complete engineering design of the CTS for the spoke cavities.

2.1.4.4 Power coupler (E. Rampnoux, Orsay)

- Precise the technical specifications:
  - Required transmitted RF power
  - Needs for adjustable or variable coupling
- Power coupler RF design, taking into account:
  - Ceramic window geometry and number

- Cooling requirements

2.1.4.5 Cryomodule (G. Rouillé, Orsay)

- Perform the mechanical and cryogenic design study of the module (could be for 4.2 K or 2K, depending on the WU 3 conclusions). Assess the cryogenic performances of the module. This work will be done in 2 phases:
  - Conceptual design, in order to start the work before having all precise data from the others WU
  - Detailed engineering design
- Cold box design for the cryo-fluids exchange with the module
- Magnetic shielding design
- Vacuum system
- Study and define the alignment procedure
- Particularly study the module required cooling time in order to assess the need for a cavity baking (avoid 100 K effect)
- Perform the conceptual design study of the assembly tooling

2.1.4.6 Superconducting magnets (G. Rouillé, Orsay)

If the focusing elements are chosen to be cold, the integration of the superconducting magnets (developed in WP5) in the spoke cryomodules will be addressed in this WU. It will take into account the mechanical integration, the study of the supporting and alignment systems and the integration of the power supply feed through for the magnets.

2.1.4.7 Prototypes and tests (G. Olry, Orsay)

With the given timeframe, the possibilities for prototyping and testing are limited. The prototyping should concentrate on the fabrication and test of 2 cavity prototypes (one for each b), and 2 power couplers.

- Cavity prototyping outcomes:
  - Assess the fabrication procedure, and evaluate the tuning procedure, check the capability of reaching the desired frequency, evaluate the major difficulties during fabrication.
  - Assess the preparation procedure (chemistry, baking, clean room assembly)
  - Test in vertical cryostat (at 4K and 2K) and assess the cavity performances (accelerating field, Lorentz forces detuning coefficient, dissipated power) at the two temperatures.
- Power couplers outcomes:
  - Assess the fabrication procedure, evaluate the major difficulties during fabrication.
  - Measure the couplers main parameters (f, S-parameters...)
  - Assess the preparation procedure (cleaning, clean room assembly)
  - Depending on the availability of a 352 MHz RF power station and conditioning test bench, a coupler conditioning with the necessary RF power (2 or 4 times the nominal power) could be envisaged to assess the overall coupler performances.

2.1.5 WP5: Elliptical Superconducting Accelerator (G. Devanz, Saclay)

The ESS proton accelerator consists of a room temperature low energy part up to the transition energy. Beyond this point the acceleration contains superconducting (SC) structures. The first SC section consists in two families of spoke cavities modules, then from 200 MeV two families of 704 MHz elliptical SC cavities, grouped into 8-cavity cryomodules. The first 5 modules host 8 beta=0.7 5-cell cavities each (medium beta) and the 14 last module host 8 beta=0.9 5-cell cavities each (high beta).

The main objective of the WP5 of the design update phase is to provide the engineering design of the fully equipped cryomodules for both medium and high beta elliptical cavity sections of the ESS accelerator operating at 2K with an accelerating field of 15 MV/m.

The cryomodule design will include all aspects, including the valve box, internal Helium distribution, thermal shielding, the cavity alignment and supporting systems. The design should be carried out in close collaboration with the SPL development of a prototype cryomodule housing 8 beta=1 elliptical cavities. In order to guaranty the performance of the cavities in terms of accelerating gradient in long cryomodules, the cavity string is assembled in a large clean room to prevent field emission operation. It is then transported to an assembly area where it is inserted in the vacuum vessel. The whole assembly sequence requires large tooling equipment which will be studied in conjunction with the cryomodule design. The high and medium beta ESS elliptical modules should be sharing the same design, the prototyping effort will therefore be concentrated on the high beta module in the next phase of the project.

WP 5 will provide the drawings of the 704 MHz superconducting elliptical cavities, helium tanks, power couplers, high order mode couplers, frequency tuners, magnetic shielding. At the end of the design update study, CAD models of fully equipped modules will be produced. Several components, namely cavities, fundamental power couplers and fast frequency tuners are considered as critical, therefore prototypes will be fabricated for each of them, and tested after the design update phase. Similar objects have been developed for SNS and during the last decade in European Framework Programs in several laboratories. The feasibility of components of the same type, at the same operating frequency has been demonstrated, and their performance goals already met experimentally, however with small statistics.

WP5 will provide the following for the elliptical part of the accelerator by the end of 2012:

- A technical design report (TDR)
- A cost estimate within 20%
- A construction plan

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2.1.5.1 Management and TDR (G. Devanz, Saclay)

WP management, planning of the design update follow-up and construction phase, including PBS and WBS.

TDR write-up and costing coordination.

2.1.5.2 Medium beta cavities (G. Devanz, Saclay)

RF and mechanical study of the medium beta elliptical cavities and helium tank.

RF and mechanical design of the HOM dampers according to the damping specifications provided by WP2.

Design of the magnetic shield of the medium beta cavity.

Write-up of TDR section on medium beta elliptical cavities, including costing.

2.1.5.3 Cold tuning system (G. Devanz, Saclay)

Mechanical design of a cold tuning system for the elliptical cavities.

Write-up of TDR section on the cold tuning system, including costing.

2.1.5.4 High beta cavities (J. Plouin, Saclay)

RF and mechanical study of the high beta elliptical cavities with its helium vessel.

RF and mechanical design of the HOM couplers according to the damping specifications provided by WP2.

Design of the magnetic shield of the high beta cavity.

Design and fabrication of the RF tuning bench.

Write-up of TDR section on high beta elliptical cavities, including costing.

2.1.5.5 Power coupler (G. Devanz, Saclay)

RF and mechanical design of the 1.2 MW, high duty cycle power couplers. It will be compatible with the upgrade of ESS, within the limit of 10% duty cycle.

RF and mechanical design of the coupler conditioning bench.

Write-up of TDR section on power couplers, including costing.

2.1.5.6 Medium beta cryomodule (W. Hees, ESS)

Note: As of January 2012, this work unit is in the process of replanning.

The work is concentrated on the high beta cryomodule. The medium beta cryomodule will share the same mechanical and cryogenic design, assembly and alignment methods.

Mechanical design of the medium beta cryomodule. This phase takes into account the assembly phase of the cavity string inside the modules, vacuum and cryogenic sectorisation, mechanical and thermal loading of the system, alignment, and integration of the instrumentation and superconducting quadrupoles.

Cryogenic and vacuum design of the modules. This includes the detailed design of the valve box and vacuum systems.

Mechanical design of the clean room cavity string assembly tools.

Mechanical design of cryomodule assembly tools.

Write-up of the TDR section on elliptical cavities cryomodules including costing.

2.1.5.7 High beta cryomodule (W. Hees, ESS)

Note: As of January 2012, this work unit is delayed and in the process of replanning.

The work is concentrated on the high beta cryomodule.

Mechanical design of the high beta cryomodule. This phase takes into account the assembly phase of the cavity string inside the modules, vacuum and cryogenic sectorisation, mechanical and thermal loading of the system, alignment, and integration of the instrumentation and superconducting quadrupoles.

Cryogenic and vacuum design of the modules. This includes the detailed design of the valve box and vacuum systems.

Mechanical design of the clean room cavity string assembly tools.

Mechanical design of cryomodule assembly tools.

Write-up of the TDR section on elliptical cavities cryomodules including costing.

2.1.5.8 Superconducting magnets (M. Bruchon, Saclay)

Magnetic and mechanical design of the two types of SC quadrupoles.

Write-up of TDR section on SC quadrupoles.

2.1.5.9 Prototypes and tests (G. Devanz, Saclay)

Note: As of January 2012, this work unit is in the process of replanning.

Design and Fabrication of the coupler test box

Fabrication of a pair of 1.2 MW power couplers

Design and fabrication of a room temperature tuning bench for elliptical cavities equipped with the interface parts for the high beta cavities.

Design and fabrication of the tools required to perform the chemical etching of the cavity and clean room preparation.

Fabrication and preparation of two high beta cavity prototypes. In order to build these prototypes during the design update phase, they will not be equipped with HOM couplers

2.1.6 WP6: Normal conducting accelerator (S. Gammino, Catania)

Design of the elements of the front-end up to the warm-cold transition (proton source, LEBT, RFQ, NC accelerator and chopper section).

In principle the competences necessary to take the responsibility of the design, construction and integration of the whole NC part of the accelerator, from the high current proton source to the normal conducting DTL up to 50 MeV, exist in different laboratories, in particular at INFN and at CEA.

A strong synergy between these two institutions and ESS-Bilbao, with possible contributions from others, may permit to fulfil the requested update of the design for the Front End and NC accelerator and to set the basis for the construction of the above-mentioned components.

For some of these components the construction of prototype could be convenient in principle, for some others the experience gained by the research teams involved in the project may permit to skip the construction. In particular for the Ion Source and LEBT the existing equipment may provide a valuable test bench but the construction of an 'on-going prototype' is to be considered in the following, or immediately following a 3-month tests of Ion source and RFQ.

This 'long run' experience will put in evidence any possible criticality and will permit to optimize the design of these components.

The design study of RFQ-MEBT-DTL can take advantage from the experience on the design of a similar accelerator (LINAC4), from the experience of the TRASCO and IPHI RFQ, and of the DTL prototype built by INFN-LNL and CERN. The MEBT line, matching the RFQ beam into the DTL, very important for the performances of the entire accelerator, would be designed to ensure phase advance matching between RFQ and DTL; such matching is space charge independent at first approximation.

General remarks

The major challenge of this part of the accelerator is the preparation of a high quality beam, with a pulse well defined in time, a short emittance and a minimized halo, so that the beam losses throughout the high energy part of the accelerator could be limited and the overall ESS reliability be maximized. In order to prepare a high quality beam, not only the source extractor design, the RFQ modulation and the first cells of DTL are relevant, but also the LEBT and MEBT with their chopping systems, the necessary diagnostics, steerers and collimators.

Beam dynamics aspects related to the choice of the focussing period, steering dipoles location and possible beam position monitor integration must be properly studied and addressed in the TDR.

The possibility to take into account future upgrading of the project at this early stage is to be evaluated, especially for what concerns the civil engineering design. Some areas should be over-dimensioned and in this sense the area that will host the Front-End should take in consideration the possibility to modify the injector in future, e.g. with a more complex MEBT.

The WP6 will be organized as it follows: the Working Unit 1 will take care of the Planning of the activities, the Working Unit 2 of the source and LEBT, the Working Unit 3 of the RFQ, the Working Unit 4 of the MEBT and finally the Working Unit 5 will take care of the Accelerator.

2.1.6.1 Management and TDR (S. Gammino, Catania)

The activities are essentially the coordination of the work of all the other WUs and the communication with the other WPs, in order to ensure the consistency of the WP6 work with the project plan.

The coordination duties also include the organization of WP internal steering meetings, the setting up of proper reviewing, the reporting to the project management and the distribution of the information within the WP as well as to the other work packages running in parallel.

This WU is in charge of the coordination and harmonization of the physical design and beam dynamics of the initial part of the accelerator, defines and manage the internal interfaces between WUs.

This WU coordinates the writing of the technical design report (TDR) for the parts of interest, including the technical drawings of each component and a full cost analysis with a precision better than 20%, and a construction plan.

This WU also supports the organization of WP activity review and workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the WP.

2.1.6.2 Proton source and Low Energy Beam Transport (L. Celona, Saclay)

INFN-LNS (Catania) and CEA-Saclay may be able to contribute to the design of the injector part (the proton source and the LEBT) in close collaboration. The high current proton source will be based on the know-how acquired during the design phase and the construction phase and commissioning of the sources named TRIPS and VIS at INFN-LNS and of the SILHI source at CEA-Saclay, but surely some remarkable improvements are to be developed because of the high current at a relatively low extraction voltage. A new extraction system has to be developed for a pulsed beam of about 60 mA with a quite low emittance as required by the following RFQ. An option for larger current will be considered.

A new design of the magnetic field profile is essential and the microwave injection system will be deeply revised according to the recent experience gained with the VIS source. A new idea to enhance the electric field in the plasma chamber will be tested in order to get higher ionization rates. Further studies about brightness optimization are mandatory, which can be carried out either at CEA and at INFN-LNS.

A series of tests will be carried out in the 1st year concerning the possible use of different frequency than 2.45 GHz, that is the standard frequency used up to now for similar sources.

The LEBT from the source extractor to the RFQ entrance must take into account different and competitive requests as it should be as short as possible and it should permit to allocate the necessary diagnostics and the low energy chopper. These achievements are to be obtained for a low energy beam with a power of about 5 kW and the optimum matching with the RFQ must be guaranteed. A remarkable R&D is available from the studies carried out at Saclay and at Catania, in particular some of the considerations which are valid for the IFMIF project may be exported for ESS Accelerator LEBT.

2.1.6.3 Radio Frequency Quadrupole (B. Pottin, Saclay)

The design, construction and commissioning of the RFQ may be under the responsibility of CEA, Saclay, in close collaboration with INFN-LNL. In spite of the fact that a remarkable know-how is available in terms of RFQs designed for high intensity beams (IPHI, TRASCO, EVEDA), it seems imaginable to review these designs after a period of tests of pulsed mode operation at the IPHI RFQ, tailored to ESS parameters, with particular attention to the long term reliability (e.g. 3 months) with a duty factor of 14Hz and 2.9 ms pulse length.

An acceptance of 0.25π mm mrad can be considered at this stage, but this item needs to be studied along with the reliability and the power dissipation, to be optimized. As for the construction of the RFQ, industrial experiences are available in France and in Italy.

The existing effort for prototyping and realizing structures on the above mentioned projects can be directly reused for the TDR and none major specific prototype is identified for ESS.

It must be remarked that a few differences exist for these projects and a unique choice is needed for ESS; in particular, RFQ could be four vanes without PILs and coupling cell, very similar to Linac4.

2.1.6.4 Medium Energy Beam Transport (I. Bustinduy, Bilbao)

This part is under the responsibility of ESS Bilbao, in cooperation with other institutions. The design of the MEBT could be simplified in a first phase, by considering a system as the one suggested by INFN-LNL and CEA people. A short MEBT line could be possible, with diagnostics and electromagnetic quads. For the future upgrading, fast chopper may be taken in consideration.

The matching between RFQ and DTL is probably a crucial point for beam halo formation. The ramping of the RFQ and DTL voltage (increasing in the last RFQ part and first DTL part) should make possible to match the longitudinal and transverse phase advance per meter, and to get a space charge independent matching.

2.1.6.5 Drift Tube Linac (A. Pisent, Legnaro)

As for the DTL (accelerating the beam between 3 and 50 MeV), the design of LINAC4 may be a relevant basis. INFN-LNL team has already designed an accelerator with very similar performances and a common prototype tank approximately 1 m long has been prototyped by Italian industry, together with CERN Linac4 team (prototype for Linac4 and SPES driver). The collaboration with CERN team is to be encouraged and the DTL may be built on the basis of this R&D. If we look in details to the different parameters of the Linac4 and ESS DTL, there is an evident similarity concerning pulse current, gradient, injection energy; some differences exist for output energy and duty cycle only. For this reason, there is no need of prototyping for NC Accelerator, but a careful analysis of the optimum design, adapted to the ESS parameters, is necessary. Particularly, the beam dynamics studies and the RF design, plus the preliminary mechanical studies necessary to use the already developed DTL structures to the ESS duty cycle, will be the major activity during the TDR preparation phase. “Design of the elements of the front-end up to the warm-cold transition (proton source, LEBT, RFQ, NC accelerator and chopper section).”

In principle the competences necessary to take the responsibility of the design, construction and integration of the whole NC part of the accelerator, from the high current proton source to the normal conducting DTL up to 50 MeV, exist in different laboratories, in particular at INFN and at CEA.

A strong synergy between these two institutions and ESS-Bilbao, with possible contributions from others, may permit to fulfil the requested update of the design for the Front End and NC accelerator and to set the basis for the construction of the above mentioned components.

For some of these components the construction of prototype could be convenient in principle, for some others the experience gained by the research teams involved in the project may permit to skip the construction. In particular for the Ion Source and LEBT the existing equipment may provide a valuable test bench but the construction of an ‘on-going prototype’ is to be considered in the following, or immediately following a 3-month tests of Ion source and RFQ.

This ‘long run’ experience will put in evidence any possible criticality and will permit to optimize the design of these components.

The design study of RFQ-MEBT-DTL can take advantage from the experience on the design of a similar accelerator (LINAC4), from the experience of the TRASCO and IPHI RFQ, and of the DTL prototype built by INFN-LNL and CERN. The MEBT line, matching the RFQ beam into the DTL, very important for the performances of the entire accelerator, would be designed to ensure phase advance matching between RFQ and DTL; such matching is space charge independent at first approximation.

2.1.7 WP7: HEBT, NC Magnets and Power Supplies (S. Pape-Møller, Aarhus)

Work Package 7 is concerned with the design of the High-Energy Beam Transport, in particular beam optics, in collaboration with WP2. The design should fulfil the different functionalities of the HEBT, and interface to the exit of the accelerator and input to the targets and beam dump. The functionalities include transport to the main target (vertical/horizontal), to a commissioning beam dump, to an optional future target station, and a collimation section after the accelerator. Also included in the scenario are considerations about bringing the HEBT into operation, i.e. a steering and a focusing concept.

In addition to the above general design of the HEBT, the Work Package should also define standards for all normal conducting magnets and the corresponding power supplies. In particular studies taking sustainability over a 10 year period are included.

2.1.7.1 Management and TDR (S. Pape-Møller, Aarhus)

This work unit consist of the WP management and non-technical work, in particular writing the TDR.

- Meetings, planning
- Progress monitoring
- Definition of parameters list
- TDR writing
- PBS description
- WBS description for construction phase
- Cost estimation

2.1.7.2 High-Energy Beam Transport (S. Pape-Møller, Aarhus)

This work unit is designing the high-energy beam transport from accelerator output to targets. It includes the following main points

- Beam transport and expander design
- Upgrade transport systems
- Collimation systems design
- HEBT Mechanical systems

2.1.7.3 Normal conducting magnets (S. Pape-Møller, Aarhus)

This work unit establishes standards for all normal conducting magnets. Conceptual designs will be provided for all magnets. Radiation hardness will be included whenever needed. Sustainability issues will be included already at this stage.

- Technology analysis
- Costing study
- Conceptual design of all normal conducting magnets including:
  - SC accelerator quadrupoles
  - SC accelerator steerers
  - LEBT magnets (solenoids+steerers)
  - MEBT quadrupole
  - MEBT steerers
  - HEBT quadrupoles
  - HEBT steerers
  - HEBT dipoles
  - HEBT octupoles
  - HEBT duodecapoles

2.1.7.4 Power supplies (S. Pape-Møller, Aarhus)

This work unit establishes standards for all normal conducting magnets. Conceptual designs will be provided for all magnets. Sustainability issues will be incorporated already during this phase.

- Technology analysis
- Costing study
- Conceptual design of power supplies for all normal conducting magnets including:
  - SC accelerator quadrupoles
  - SC accelerator steerers
  - LEBT magnets (solenoids+steerers)
  - MEBT quadrupole
  - MEBT steerers
  - HEBT quadrupoles
  - HEBT steerers
  - HEBT dipoles
  - HEBT octupoles
  - HEBT duodecapoles

2.1.7.5 Normal magnet/diagnostic prototypes (S. Pape-Møller, Aarhus)

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A prototype for a combined quadrupole/steerer/diagnostics section to operate in the warm interface sections between cryostats of the accelerator will be designed, built and tested.

2.1.8 WP8: Radio Frequency systems (D.McGinnis, ESS)

The RF system for the ESS linac is defined as the system that converts AC line power to RF power at either 352 or 704 MHz to be supplied to the RF accelerating cavity couplers. Therefore, the RF system is bound by the AC conventional power lines on one side, and the waveguide power couplers on the accelerating cavities on the other side.

The purpose of the Accelerator Design Update (ADU) in WP8 is to produce

- A technical design report (TDR)
- A cost estimate
- A construction plan

for the RF systems for the ESS linac.

2.1.8.1 Coordination of WP8 (ESS-AB)

The work in ADU WP8 flows from system design to subsystem design to gallery integration. WU8.1 will coordinate the documentation, reviews and milestones for these work units. All reviews of units in WP8 will be organized by WP8.1. All documents from the WP8 subsystems will be collected and organized in this unit. All milestones for WP8 will be tracked only in this work unit with the other work units in WP8 contributing to the completion of the milestones.

2.1.8.2 RF System Design

This work will cover the requirements, design and specifications of the RF systems of the ESS linac. It will describe the topologies of the chosen design for the different parts, and give input for the design of the subsystems. The RF systems are defined as all high frequency systems in the Linac, except the systems for the ion source. The RF systems starts and ends at the ports of the accelerating structures: RFQ, DTL, spoke and elliptical cavities.

2.1.8.3 LLRF Control System

The LLRF control system is defined as that controlling and maintaining of the amplitude and phase stability of the accelerating fields in pulse mode for all the RF cavities along the accelerator.

2.1.8.4 Master Oscillator

The master oscillator will be responsible for generating both the reference phase for the RF systems, as well as the master clock for the control system. By having both these time references derived from the same oscillator, they will be phase locked to each other.

2.1.8.5 Phase Reference Distribution

The phase reference distribution takes the RF signal(s) from the master oscillator and distributes them to the separate RF systems. The system starts at the output of the master oscillator and ends at the inputs of the LLRF systems.

2.1.8.6 352 MHz Spoke Cavity Power

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This work unit will address the 352 MHz RF power systems for the spoke cavities. The 352 MHz Spoke Cavities operate at lower power levels than the rest of the accelerator. To use the same type of RF system as the high power sections of the accelerator would be inefficient. This section will include both the RF power sources and RF power source modulators for the spoke cavities. This work unit will also address the driver amplifiers that are need to bring the RF power level to an appropriate level for the final amplifier.

2.1.8.7 High Power Klystrons

Most of the cavities will require power levels that exceed 500kW. The most efficient power source at these frequencies and power levels will be klystrons. This work unit will discuss the high power klystron power sources both for 352 MHz and 704 MHz.

2.1.8.8 High Power Klystron Modulators

The klystrons require pulsed power to energize. The conventional AC power is converted into pulse power with a modulator or a pulsed power convertor. For klystrons, these modulators will have to operate at fairly high voltages and stored energy.

2.1.8.9 RF Distribution

This subtask describes the system used to distribute RF power from the output of the power sources to the various cavities used to accelerate the beam. The RF Power Distribution is taken to mean all components from the output of the power source to the cavity couplers.

2.1.8.10 RF Equipment Gallery

The RF power gallery for the ESS accelerator will contain a wide array of systems ranging from low-level RF control to high power RF sources such as klystrons. The power sources and modulators will require a large amount of supporting infrastructure such as cooling water, AC power. The RF distribution systems will be comprised of complex system of waveguide components. All of these systems will have to be integrated

2.2 Deliverables

The main deliverables from the ESS Accelerator Design Update project are:

- A Technical Design Report (TDR) describing the Accelerator design
- First schedule for the Accelerator build
- First budget for the Accelerator build
- Test facilities
- Prototype equipment

Detailed list of deliverables is in the project schedule enclosure and described in the Scope Description

2.3 Quality Objectives

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To ensure the project implemented within the schedule and the project outcome delivered according to the quality standard specified in the project requirements in terms of reliability, usability and fault density.

2.4 Internal Requirements

Internal requirements are:

- Development of project management framework and processes
- Prepare the organizations (ESS) capability to build the Accelerator by building competence and organization
- Build a strong collaboration for the coming phases of the program
- Contribute to the development of a ESS Management System

2.5 Intellectual Property Rights

In principle ESS AB has no interest in owning any rights or patent that may spring from the Design Update project. Although ESS will need the right of use for any project result for the lifetime of the ESS.

To be detailed, contract negotiations are on-going.

3 Project Procurement

3.1 Project Procurement Strategy

The project will use the ESS AB purchasing resources and procedures as they are developed. In the meanwhile purchase tasks in the project will be performed by the responsible Work Package in collaboration with the DU Project Management.

To be detailed with ESS purchasing process and principles

4 Project Quality Plan

4.1 Project Quality Framework

4.1.1 Audits

The Project may be audited by a program external body if this is deemed necessary by the sponsor/steering committee or the ESS Management Team.

4.1.2 Assessments

The project will mainly be assessed at the project tollgates, these are described in the ESS Project Framework. These assessments are made by the project sponsor supported by the Steering Committee. Prior to a tollgate assessment a corresponding project milestone review is done by the project.

4.1.3 Reviews

The project will use two main types of reviews:

4.1.3.1 Work Package review

The progress and approach of each of the developing work packages will be reviewed by the program. This review will focus on the technical feasibility of the solutions selected in the WPs.

4.1.3.2 TDR Review

Parallel to the TDR Writing work packages running reviews of the TDR content will be made. This review is focusing on the ability of the accelerator design to fulfil the requirements.

4.2 Operative Processes and Project Support Activities used in the Project

The project will use the following ESS AB processes/procedures:

- Purchasing
- Communication
- Change management
- Quality Management
  - Quality Verification Model
  - Acceptance Procedure
  - Control of Non-Conforming Products
  - Handling of Changed Requirements
- Safety Management
- Permissions management
- Document handling

5 Project Schedule

5.1 Time-Schedule (detailed schedule in enclosure to this document)

5.1.1.1 Major milestones and phases

- *Planning Phase* - Project specification finished in its first main version. High-level requirements and functional specifications. Contracts negotiated and signed (completed April, 2011)
- *Mile Stone 1: Project Kick-off* - Decision to Establish the Project and Start Project Execution (completed March, 2011)
- *Establishment Phase* – Requirement analysis, conceptual design, design reviews, selection of contractors.
- *Mile Stone 2: First iteration of major deliverables:*
  - *Conceptual Design report revision 2011* – A snapshot of the current design alternatives and parameters (completed December, 2011)
  -
  - *Costing – first draft* - a very preliminary costing with emphasis on the to top 10 cost items (completed December 2011)
  - *Construction Plan – first draft* – establish the major milestones and tasks of construction, focusing on the critical path (completed December 2011)
- *Realization Phase1* – Detailed design, design reviews, prototype builds, ICDs
- *Mile Stone 2.1: Second iteration of deliverables*
  - First draft of TDR,
  - Second iteration of costing
  - Second iteration on construction plan

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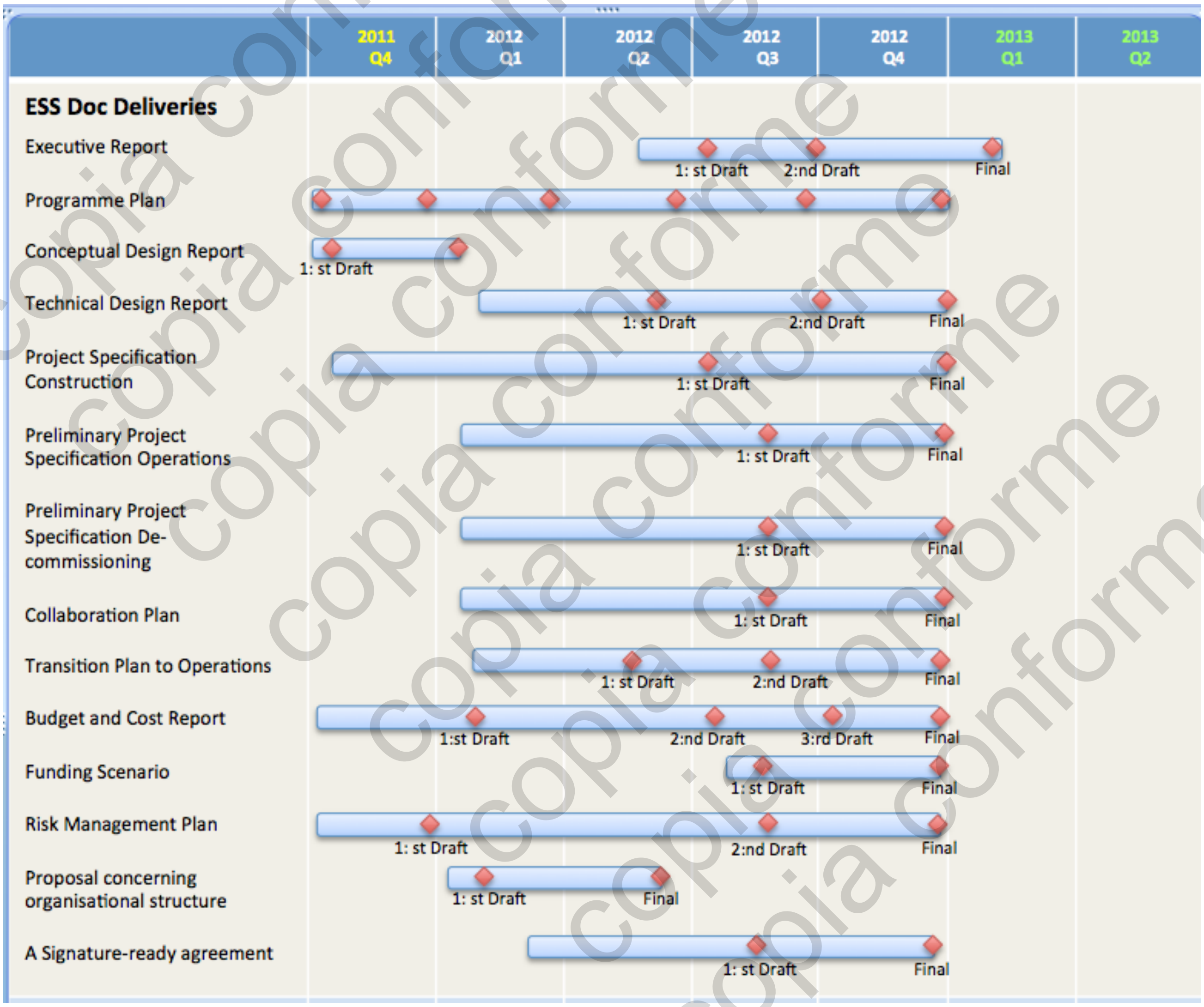
- *Realization Phase2* – Detailed design, design reviews, prototype builds, ICDs, tests, TDR writing, schedule and budget for Accelerator project.
- *Mile Stone 3: Final iteration of deliverables*
  - Final TDR,
  - Costing within 20%
  - Construction plan
- *Mile Stone 4:* Decision to Hand Over Project Outcome – Planned for Q4 2012
- *Hand Over Phase* – Review of result, hand over of result to Accelerator project
- *Mile Stone 5:* Decision to start project conclusion – Planned for Q1 2013
- *Conclusion Phase* – Close the project



5.2 Work Packages

Work Packages are listed in the project schedule enclosure and described in “Project Scope”

6 Project Budget and Financial Reporting

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6.1 Financial Strategies

To be detailed, contract negotiations are on-going.

6.2 Financial Constraints

To be detailed, contract negotiations are on-going.

6.3 Project Budget

The total value of the project is calculated to 12,2 M€, excluding travel and administration costs. This is equivalent to about 95 FTE:s over 2 years.

Note that the cost of the project for ESS AB is only a part of this since the majority of the work and equipment will be paid for "in kind" by the participating institutes in the collaboration. The details of the in kind contributions are regulated in separate contracts.

See budget below:

ADU_1	Accelerator design update	189 968,6 hrs	10 259 513 €	1 985 000 €
ADU_1.1	Management	189 968,6 hrs	10 259 513 €	0 €
ADU_1.1.1	System Engineering	21 651,2 hrs	1 190 816 €	0 €
ADU_1.1.2	TDR editing	2 265 hrs	124 575 €	0 €
ADU_1.1.3	Review organisation	1 780,2 hrs	97 911 €	0 €
ADU_1.1.4	Planning and documentation	3 904 hrs	214 720 €	0 €
ADU_1.2	Accelerator science	13 702 hrs	753 610 €	0 €
ADU_1.2.1	Management and TDR contribution	50 914 hrs	2 787 070 €	0 €
ADU_1.2.2	Beam physics	2 212 hrs	121 660 €	0 €
ADU_1.2.3	Control systems	17 042 hrs	937 310 €	0 €
ADU_1.2.4	Beam Instrumentation	16 160 hrs	875 600 €	0 €
ADU_1.4	Spoke superconducting linac	15 500 hrs	852 500 €	530 000 €
ADU_1.4.1	Management and TDR	30 870 hrs	1 695 650 €	0 €
ADU_1.4.2	Cavities	2 600 hrs	143 000 €	0 €
ADU_1.4.3	Cold tuning system	5 391 hrs	296 505 €	0 €
ADU_1.4.4	Power coupler	1 767 hrs	97 185 €	0 €
ADU_1.4.5	Cryomodule	1 880 hrs	103 400 €	0 €
ADU_1.4.6	Superconducting magnets	7 506 hrs	410 630 €	0 €
ADU_1.4.7	Prototypes and tests	3 987 hrs	219 285 €	530 000 €
ADU_1.5	Elliptical superconducting linac	7 739 hrs	425 645 €	713 000 €
ADU_1.5.1	Management and TDR	34 632 hrs	1 879 900 €	0 €
ADU_1.5.2	Medium beta cavities	2 600 hrs	143 000 €	0 €
ADU_1.5.3	Cold tuning system	5 106 hrs	280 830 €	0 €
ADU_1.5.4	High beta cavities	808 hrs	44 440 €	0 €
ADU_1.5.5	Power coupler	5 993 hrs	306 955 €	0 €
ADU_1.5.6	Medium beta Cryomodule	4 236 hrs	232 980 €	0 €
ADU_1.5.7	High beta Cryomodule	3 480 hrs	191 400 €	0 €
ADU_1.5.8	Superconducting Magnets	5 540 hrs	302 500 €	0 €
ADU_1.5.9	Prototypes and tests	1 020 hrs	56 100 €	713 000 €
ADU_1.6	Normal conducting linac	5 849 hrs	321 695 €	0 €
ADU_1.6.1	Management and TDR	24 470,4 hrs	1 197 372 €	0 €

ADU_1.6.2	Proton source and Low Energy Beam Transport	2 608 hrs	143 440 €	0 €
ADU_1.6.3	Radio Frequency Quadrupole	6 941,4 hrs	348 777 €	0 €
ADU_1.6.4	Medium Energy Beam Transport	2 565 hrs	141 075 €	0 €
ADU_1.6.5	Drift Tube Linac	5 448 hrs	275 440 €	0 €
ADU_1.7	HEBT, NC Magnets and Power Supplies	6 908 hrs	288 640 €	742 000 €
ADU_1.7.1	Management and TDR	7 279 hrs	400 345 €	0 €
ADU_1.7.2	High Energy Beam Transport	3 040 hrs	167 200 €	0 €
ADU_1.7.3	Normal conducting magnets	2 519 hrs	138 545 €	336 000 €
ADU_1.7.4	Power supplies	640 hrs	35 200 €	294 000 €
ADU_1.7.5	Warm magnet/diagnostics prototype	600 hrs	33 000 €	112 000 €
ADU_1.8	Radio Frequency Systems	480 hrs	26 400 €	0 €
ADU_1.8.1	Coordination and communication	20 152 hrs	1 108 360 €	0 €
ADU_1.8.2	RF System Design	2 004 hrs	110 220 €	0 €
ADU_1.8.3	Low Level RF	2 400 hrs	132 000 €	0 €
ADU_1.8.4	Master Oscillator	2 250 hrs	123 750 €	0 €
ADU_1.8.5	Phase Reference Distribution	1 500 hrs	82 500 €	0 €
ADU_1.8.6	352 MHz Spoke Cavity Power	900 hrs	49 500 €	0 €
ADU_1.8.7	High Power Klystrons	2 100 hrs	115 500 €	0 €
ADU_1.8.8	High Power Klystrons Modulators	3 374 hrs	185 570 €	0 €
ADU_1.8.9	RF Distribution	3 374 hrs	185 570 €	0 €
ADU_1.8.10	RF Equipment Gallery	1 650 hrs	90 750 €	0 €

7 Project Organization

7.1 Resource and Competence Plans and Profiles

The project will be executed with resources from the collaborating institutes

- Planning indicates that about 85 FTEs (Full Time Estimates) per year will be needed for the 2 year duration of the project.
- Each WP Leader is responsible to staff the WP organization to the recourse need described in the scope and schedule (resource budget)
- The project uses the following resource types:
  - Project Manager
  - Reviewer
  - Work Package Leader
  - Work Unit Leader
  - Scientist
  - Technician
  - Engineer
  - Tester
  - Buyer
  - Contractor
  - Quality

7.2 Project forums

7.2.1 Accelerator Collaboration Board (ACB)

The ACB is responsible for all decisions dealing with the activity planning, all deliverables, arbitration of conflicts brought to it by the MB and the allocation of the resources.

7.2.2 Technical Board (TB)

The main task of the TB is to ensure the global coherence of the Design Project through continuous monitoring of the work and planning of all tasks, updating of reports and analysis of the results achieved during the implementation of the work. It will monitor the progress of each Work Package. The specifications of the facility, the layout and the evaluation of the costs will also be supervised by the TB.

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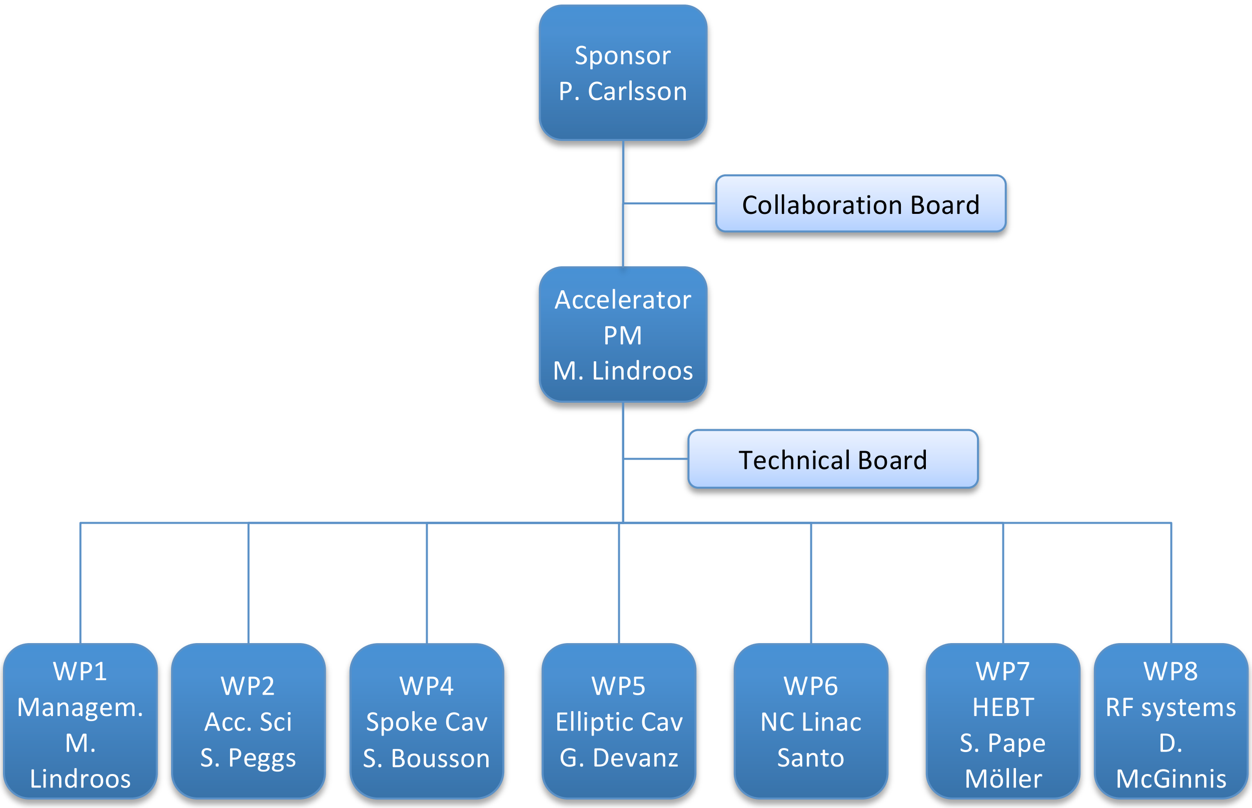
7.3 Project Organization



8 Project Risk Management

8.1 Risk List

Risk list has been compiled during the project planning work. The project Quality Function will maintain the Risk List during the project lifetime.

8.2 Risk analysis and risk response planning

The initial risk analysis was performed after the first compilation of the project budget. The risk analysis for ADU is done every quarter, and the risk analysis for the construction project was started as part of the first deliverable at the end of 2011.

8.3 Risk Monitoring and Control

Updates of the risk analysis will be performed every quarter or when the need arises. The outcome and mitigation strategy is presented to the Programme Division.

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9 Project Communications Plan

9.1 Communication solutions

The DU project will use a few alternate ways to communicate with stakeholders and in the way that documentation is maintained:

- Meetings – Physical or virtual meetings
- Mail – Mail will be a main channel of communication between project management, members, sponsor and stakeholders
- Alfresco Document Management System – Collaboration tool where information on the project will be stored – Project specification, schedules, meeting minutes, etc. This is an Alfresco database hosted by IDOM.

9.2 Document types

Type of documer	Author	Receipient	Distribution method	Storage	Timing
Work Package Status Reports	Work Package Leaders	ADU management	Presentation at TB meeting	Alfresco	Monthly
Project Status Reports	ADU management	Project Division	Meeting	Alfresco	Quarterly
Work progress reporting	Work Package Leaders	ADU management	Alfresco	Alfresco	Monthly
Deliverabel reports	Work Package Leaders	ADU management	Alfresco	Alfresco	Monthly
Interface Control	Work Package Leaders	ADU management/WPL	Alfresco	Alfresco	Monthly
Project Plan	ADU project management	Work Package Leaders, Project Division	Alfresco	Alfresco	Monthly
Decision Log	Technical Board	Technical Board members	Alfresco	Alfresco	as needed
Review reports	Work Package Leaders	Technical Board/AD management	Alfresco	Alfresco	as needed
Risk list	ADU project management	Work Package Leaders, Project Division	Alfresco	Alfresco	Quarterly
Budget	ADU management	Work Package Leaders, Project Division	Alfresco	Alfresco	as needed
Project Specification	ADU project management	ADU management, ESS stakeholders	Alfresco	Alfresco	as needed
Parameter List	Work Package Leaders	Techinical Board	Review at TB meeting	AD Webpage	as needed

Annex 2 Table 1

ADU_1.6	Normal conducting linac	03/01/11	31/12/12
ADU_1.6.1	Management and TDR	03/01/11	31/12/12
ADU_1.6.1.1	WP Management	03/01/11	31/12/12
ADU_1.6.1.2	Costing analysis	04/10/11	08/10/12
ADU_1.6.1.2.2	Costing estimate 1rst iteration	02/12/11	02/12/11
ADU_1.6.1.3	Construction Plan	05/10/11	08/10/12
ADU_1.6.1.3.1	Construction planing	05/10/11	08/10/12
ADU_1.6.1.3.2	Construction WBS first iteration	02/12/11	02/12/11
ADU_1.6.1.3.4	Construction plan final	08/10/12	08/10/12
ADU_1.6.2	Proton source and Low Energy Beam Transport	03/01/11	15/10/12
ADU_1.6.2.1	Proton source system	03/01/11	15/10/12
ADU_1.6.2.1.1	Magnetic system design	31/05/11	15/02/12
ADU_1.6.2.1.12	Mechanical design	03/01/11	28/01/11
ADU_1.6.2.1.13	Physics design	03/01/11	28/01/11
ADU_1.6.2.2	LEBT system	01/09/11	15/10/12
ADU_1.6.2.2.2	Mechanical LEBT design	15/10/11	02/05/12
ADU_1.6.2.2.5	Injector interfaces	01/09/11	04/10/12
ADU_1.6.2.2.7	Write Requirements Document	10/11/11	31/01/12
ADU_1.6.2.2.9	LEBT Chopper design	20/09/11	30/01/12
ADU_1.6.2.2.10	LEBT Solonoid design	20/09/11	14/02/12
ADU_1.6.3	Radio Frequency Quadrupole	03/10/11	21/08/12
ADU_1.6.3.1	Pole tips	03/10/11	03/04/12
ADU_1.6.3.1.1	Pole tips design	03/10/11	23/12/11
ADU_1.6.3.1.2	Review	26/12/11	30/12/11
ADU_1.6.3.2	RF design	10/10/11	22/06/12
ADU_1.6.3.2.1	RF cavity design	10/10/11	19/01/12
ADU_1.6.3.2.4	Tuner and pick up design	12/12/11	02/02/12
ADU_1.6.3.14	Decision to redesign RFQ	20/12/11	20/12/11
ADU_1.6.4	Medium Energy Beam Transport	03/10/11	24/09/12
ADU_1.6.4.1	Buncher cavity	03/10/11	01/08/12
ADU_1.6.4.1.1	RF buncher cavity design	03/10/11	19/01/12
ADU_1.6.4.4	Mechanical MEBT system	01/12/11	24/09/12
ADU_1.6.4.4.1	Optimization of diagnostics on MEBT	01/12/11	07/02/12
ADU_1.6.4.4.2	Mechanical MEBT design	01/12/11	26/06/12
ADU_1.6.4.5	RF Control for the Buncher	03/10/11	04/07/12
ADU_1.6.4.5.1	RF Control for the Buncher	03/10/11	20/06/12
ADU_1.6.4.6	Write requirements document	01/11/11	30/12/11
ADU_1.6.5	Drift Tube Linac	03/10/11	15/10/12
ADU_1.6.5.1	Physics design	03/10/11	01/10/12
ADU_1.6.5.1.1	Lattice design	03/10/11	28/02/12
ADU_1.6.5.1.12	Drift tube and tank design	30/11/11	28/02/12

Annex 2 Table 3

ADU_1.6	Normal conducting linac	03/01/11	31/12/12
ADU_1.6.1	Management and TDR	03/01/11	31/12/12
ADU_1.6.1.1	WP Management	03/01/11	31/12/12
ADU_1.6.1.2	Costing analysis	04/10/11	08/10/12
ADU_1.6.1.2.1	Costing analysis	04/10/11	08/10/12
ADU_1.6.1.2.3	Costing estimate 2nd iteration	17/05/12	17/05/12
ADU_1.6.1.2.4	Costing estimate final	08/10/12	08/10/12
ADU_1.6.1.3	Construction Plan	05/10/11	08/10/12
ADU_1.6.1.3.1	Construction planing	05/10/11	08/10/12
ADU_1.6.1.3.3	Construction plan draft	17/05/12	17/05/12
ADU_1.6.1.3.4	Construction plan final	08/10/12	08/10/12
ADU_1.6.1.4	TDR	08/02/12	15/10/12
ADU_1.6.1.4.1	TDR writing	08/02/12	15/10/12
ADU_1.6.1.4.2	TDR first draft	20/04/12	20/04/12
ADU_1.6.1.4.3	TDR second draft	17/08/12	17/08/12
ADU_1.6.1.4.4	TDR final document	15/10/12	15/10/12
ADU_1.6.2	Proton source and Low Energy Beam Transport	03/01/11	15/10/12
ADU_1.6.2.1	Proton source system	03/01/11	15/10/12
ADU_1.6.2.1.1	Magnetic system design	31/05/11	15/02/12
ADU_1.6.2.1.3	Magnetic system report	16/02/12	22/02/12
ADU_1.6.2.1.4	RF system design	29/02/12	30/04/12
ADU_1.6.2.1.6	RF system design report	01/05/12	07/05/12
ADU_1.6.2.1.7	HV system design	20/02/12	19/05/12
ADU_1.6.2.1.9	HV system design report	19/05/12	19/05/12
ADU_1.6.2.1.10	ICD for the proton source	01/03/12	31/07/12
ADU_1.6.2.1.11	ICD for the proton source report	15/10/12	15/10/12
ADU_1.6.2.1.14	Mechanical and Physics Design Drawings	01/03/12	01/03/12
ADU_1.6.2.2	LEBT system	01/09/11	15/10/12
ADU_1.6.2.2.1	Optimization of diagnostics on LEBT	20/03/12	28/05/12
ADU_1.6.2.2.2	Mechanical LEBT design	15/10/11	02/05/12
ADU_1.6.2.2.4	Mechanical LEBT design report	02/05/12	02/05/12
ADU_1.6.2.2.5	Injector interfaces	01/09/11	04/10/12
ADU_1.6.2.2.6	ICD for the LEBT system	15/10/12	15/10/12
ADU_1.6.2.2.7	Write Requirements Document	10/11/11	31/01/12
ADU_1.6.2.2.8	Requirements Document (LEBT)	31/01/12	01/02/12
ADU_1.6.2.2.9	LEBT Chopper design	20/09/11	30/01/12
ADU_1.6.2.2.10	LEBT Solonoid design	20/09/11	14/02/12
ADU_1.6.2.3	Funding available	31/01/12	31/01/12
ADU_1.6.2.4	Review (Proton Source and LEBT)	14/05/12	30/05/12
ADU_1.6.2.5	Review (Proton Source and LEBT) report	31/05/12	31/05/12
ADU_1.6.3	Radio Frequency Quadrupole	03/10/11	21/08/12
ADU_1.6.3.1	Pole tips	03/10/11	03/04/12
ADU_1.6.3.1.3	Pole tips design report	01/02/12	03/04/12

ADU_1.6.3.2	RF design	10/10/11	22/06/12
ADU_1.6.3.2.1	RF cavity design	10/10/11	19/01/12
ADU_1.6.3.2.2	Review	20/01/12	26/01/12
ADU_1.6.3.2.3	RF cavity design report	26/01/12	26/01/12
ADU_1.6.3.2.4	Tuner and pick up design	12/12/11	02/02/12
ADU_1.6.3.2.5	Review	03/02/12	07/02/12
ADU_1.6.3.2.6	Tuner and pick up design report	07/02/12	07/02/12
ADU_1.6.3.2.7	Power coupler design	20/01/12	24/05/12
ADU_1.6.3.2.8	Review	25/05/12	31/05/12
ADU_1.6.3.2.9	Power coupler design report	22/06/12	22/06/12
ADU_1.6.3.3	Cooling system	02/07/12	25/07/12
ADU_1.6.3.3.1	Cooling generation system design	02/07/12	11/07/12
ADU_1.6.3.3.2	Cavity cooling pipe network	11/07/12	20/07/12
ADU_1.6.3.3.3	Regulation loop design	11/07/12	20/07/12
ADU_1.6.3.3.4	Review	20/07/12	25/07/12
ADU_1.6.3.3.5	Cooling system design report	25/07/12	25/07/12
ADU_1.6.3.4	Cavity conceptual mechanical design	22/06/12	29/06/12
ADU_1.6.3.5	Review	02/07/12	04/07/12
ADU_1.6.3.6	Cavity conceptual mechanical design report	04/07/12	04/07/12
ADU_1.6.3.7	RFQ interfaces	30/07/12	21/08/12
ADU_1.6.3.8	ICD for the RFQ	21/08/12	21/08/12
ADU_1.6.3.10	Review 1	04/04/12	13/04/12
ADU_1.6.3.11	Review 1 report	13/04/12	13/04/12
ADU_1.6.3.12	Review 2	25/07/12	31/07/12
ADU_1.6.3.13	Review 2 report	31/07/12	31/07/12
ADU_1.6.4	Medium Energy Beam Transport	03/10/11	24/09/12
ADU_1.6.4.1	Buncher cavity	03/10/11	01/08/12
ADU_1.6.4.1.1	RF buncher cavity design	03/10/11	19/01/12
ADU_1.6.4.1.2	Review	20/01/12	09/02/12
ADU_1.6.4.1.3	RF buncher cavity design report	09/02/12	09/02/12
ADU_1.6.4.1.4	Tuner design	23/01/12	08/06/12
ADU_1.6.4.1.5	Review	11/06/12	13/06/12
ADU_1.6.4.1.6	Tuner design report	13/06/12	13/06/12
ADU_1.6.4.1.7	Power coupler design	23/01/12	27/07/12
ADU_1.6.4.1.8	Review	30/07/12	01/08/12
ADU_1.6.4.1.9	Power coupler design report	01/08/12	01/08/12
ADU_1.6.4.2	Buncher Cooling system	23/01/12	13/07/12
ADU_1.6.4.2.1	Cooling system design	23/01/12	25/05/12
ADU_1.6.4.2.2	Review	28/05/12	30/05/12
ADU_1.6.4.2.3	Cooling system design report	30/05/12	30/05/12
ADU_1.6.4.2.4	Cavity conceptual mechanical design	07/05/12	13/07/12
ADU_1.6.4.2.4.1	Cavity conceptual mechanical design	07/05/12	15/06/12
ADU_1.6.4.2.4.2	Review	18/06/12	18/06/12
ADU_1.6.4.2.4.3	Cavity conceptual mechanical design report	13/07/12	13/07/12
ADU_1.6.4.3	RF buncher interfaces	23/04/12	06/09/12
ADU_1.6.4.3.1	ICD for the RF buncher	23/04/12	06/09/12

ADU_1.6.4.3.2	ICD for the RF buncher report	06/09/12	06/09/12
ADU_1.6.4.4	Mechanical MEBT system	01/12/11	24/09/12
ADU_1.6.4.4.1	Optimization of diagnostics on MEBT	01/12/11	07/02/12
ADU_1.6.4.4.2	Mechanical MEBT design	01/12/11	26/06/12
ADU_1.6.4.4.3	Review	27/06/12	17/07/12
ADU_1.6.4.4.4	Mechanical MEBT design report	17/07/12	17/07/12
ADU_1.6.4.4.5	MEBT system interfaces	27/06/12	24/09/12
ADU_1.6.4.4.6	ICD for the MEBT system	24/09/12	24/09/12
ADU_1.6.4.5	RF Control for the Buncher	03/10/11	04/07/12
ADU_1.6.4.5.1	RF Control for the Buncher	03/10/11	20/06/12
ADU_1.6.4.5.2	Review	21/06/12	04/07/12
ADU_1.6.4.5.3	RF Control for the Buncher – report	04/07/12	04/07/12
ADU_1.6.4.7	Requirements document	01/01/12	01/01/12
ADU_1.6.4.8	Quadropole design	02/01/12	31/03/12
ADU_1.6.4.9	Study of optimal MEBT choppers	02/01/12	30/06/12
ADU_1.6.5	Drift Tube Linac	03/10/11	15/10/12
ADU_1.6.5.1	Physics design	03/10/11	01/10/12
ADU_1.6.5.1.1	Lattice design	03/10/11	28/02/12
ADU_1.6.5.1.2	Review (Physics design, Drift Tube, and tank design)	29/02/12	06/03/12
ADU_1.6.5.1.3	Lattice design report	06/03/12	06/03/12
ADU_1.6.5.1.4	Post coupler and tuner design	29/02/12	24/09/12
ADU_1.6.5.1.5	Review	25/09/12	01/10/12
ADU_1.6.5.1.6	Post coupler and tuner design report	01/10/12	01/10/12
ADU_1.6.5.1.7	Power coupler design	29/02/12	23/08/12
ADU_1.6.5.1.8	Review	24/08/12	30/08/12
ADU_1.6.5.1.9	Power coupler design report	30/08/12	30/08/12
ADU_1.6.5.1.12	Drift tube and tank design	30/11/11	28/02/12
ADU_1.6.5.2	Cooling system	06/02/12	06/09/12
ADU_1.6.5.2.1	Cooling system design	29/02/12	20/08/12
ADU_1.6.5.2.2	Review	31/08/12	06/09/12
ADU_1.6.5.2.3	Cooling system design report	06/09/12	06/09/12
ADU_1.6.5.2.4	Resonance Control	06/02/12	30/08/12
ADU_1.6.5.3	Magnetic system	22/02/12	01/03/12
ADU_1.6.5.3.1	Quadrupole design	22/02/12	29/02/12
ADU_1.6.5.3.2	Review	01/03/12	01/03/12
ADU_1.6.5.3.3	Quadrupole design report	01/03/12	01/03/12
ADU_1.6.5.4	DTLs interfaces	30/01/12	15/10/12
ADU_1.6.5.4.1	DTLs interfaces	07/03/12	01/10/12
ADU_1.6.5.4.2	ICD for the DTLs	15/10/12	15/10/12
ADU_1.6.5.4.4	Write requirements for diagnostics	30/01/12	16/04/12
ADU_1.6.5.4.5	Requirements document for diagnostics	17/04/12	17/04/12