Advanced Virgo: preliminary cost and manpower plan

VIR-002A-09

The Virgo collaboration

30/01/2009

Introduction

This document gives a cost and manpower estimate for the Advanced Virgo project. It refers to the project as it is described in the Advanced Virgo Preliminary Design[1]. The data presented here are a preliminary estimate. The release of the Final Design document is foreseen for May 2009; at that point, a more precise time, cost and manpower plan will be available.

The main project milestones are:

- July 2009 Project start
- July 2011 Shutdown of Virgo+ for Advanced Virgo installation
- Dec. 2013 Finish of assembly and integration
- July 2014 First one-hour long continuously controlled operation ("lock")

Subsystem overview

This section gives an overview over the Advanced Virgo organizational breakdown in subsystems.

VAC

The VAC subsystem concerns all the modifications to the vacuum pipes and tower vacuum chambers. The main tasks of VAC will be: the upgrades of the vacuum system needed to meet the AdV sensitivity target, the replacement of the vacuum links in the central area (compliant with the larger beam and the modified optical scheme)), the realization of the vacuum chamber for the new signal recycling tower and the modifications of the chambers for the injection and detection towers, the installation of the clean air flux in each tower, the works for the displacement of the towers in the central area

SAT

The SAT subsystem concerns all the modifications to the existing superattenuators (SA) and the construction of the signal recycling one. The main task of SAT are: the construction of the superattenuator for the signal recycling mirror, the upgrade of the short SA (injection, detection, mode cleaner), the change of the inverted pendulum legs, the implementation of the tilt control and all the modifications to the inertial damping, the upgrade of the filter 0 on the long towers, the upgrades of the SA sensors, actuators and electronics.

PAY

The PAY subsystem concerns the realization of the SA payload (marionette -test mass-RM). The main tasks of PAY are: the design and realization of the new steering stage and of the new reference mass compliant with the AdV test mass geometry, the realization of the monolithic payload, the sensing/actuation for local controls.

MIR

The MIR subsystem concerns the procurement and preparation of the AdV test masses and spares. The main tasks of MIR are: the realization of the substrates

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[1] Advanced Virgo Preliminary Design; the Virgo Collaboration, 2008: https://pub3.ego-gw.it/codifier/includes/showTmpFile.php?doc=2110&calledFile=VIR-089A-08.pdf

(including spares) and the coatings with the best available optical and mechanical features.

TCS
The TCS subsystem concerns the design and installation of the new thermal compensation system compliant with the AdV power and sensitivity. The system must correct thermal effects in the input and end test masses. TCS dedicated sensors, to monitor the radius of curvature of all test masses and the wavefront distortion of the input test masses, are part of this subsystem as well.

PSL
The PSL subsystem concerns the installation of the new power stabilized laser, able to provide a power of about 200 W.

INJ
The INJ subsystem concerns all the modifications of the injection system to make it compliant with AdV. The main tasks of INJ are: the design of the optical layout downstream the laser bench, the input optics (EOM and RF modulation, Faraday isolator, polarizers, mechanics), the injection bench (mechanics, mode matching telescope, adaptive mode matching system), input mode cleaner (optics and mechanics).

DET
The DET subsystem concerns all the modifications to the detection benches, with the related optics, and to the photodiodes. The main tasks of DET are: the photodiodes and their acoustic isolation, the new output mode cleaner, the output optics.

OSD
The OSD (Optical Simulation and Design) subsystem concerns the finalization of the optical design and the coordination of the optical simulation efforts.

ISC
The ISC subsystem (Interferometer Sensing and Control) concerns the preparation of the complete control strategy (lock acquisition, robust steady state control, alignment). The main tasks of ISC are: the preparation of the lock acquisition, including radiation pressure effects; the definition of the steady state control, including a noise budget of the predictable control noise; the definition of the alignment scheme; the mitigation of the parametric instabilities.

DAQ
The DAQ subsystem concerns the electronics and software related to the control of the ITF. The main tasks of DAQ are the modifications to the electronics, the replacement of obsolete systems (including workstations and computer networks), the upgrade of control loops (hardware, software and algorithms), automation, timing, data conversion, environment monitoring and control. Front end electronics can be excluded in all cases where a strong interaction with a given external system is required. DAQ system shall give specifications for any piece of hardware and software involved in the operation of AdV.

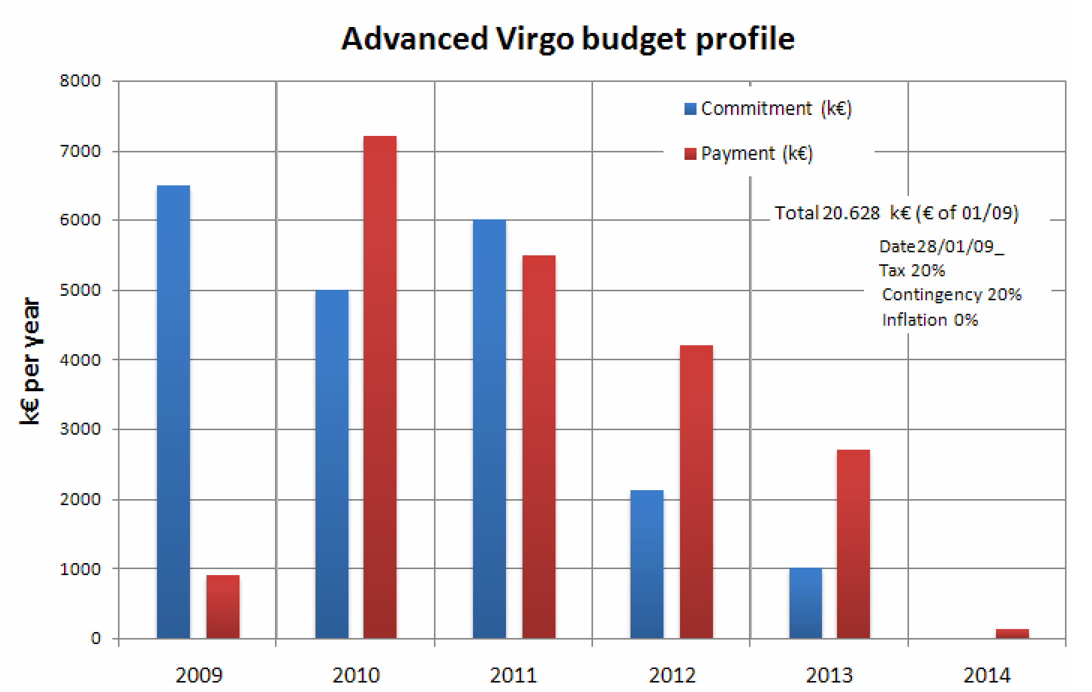
IME
The IME subsystem (Infrastructure Modifications for Environmental noise reduction) concerns all the hard works aimed to reduce the level of anthropogenic noise into

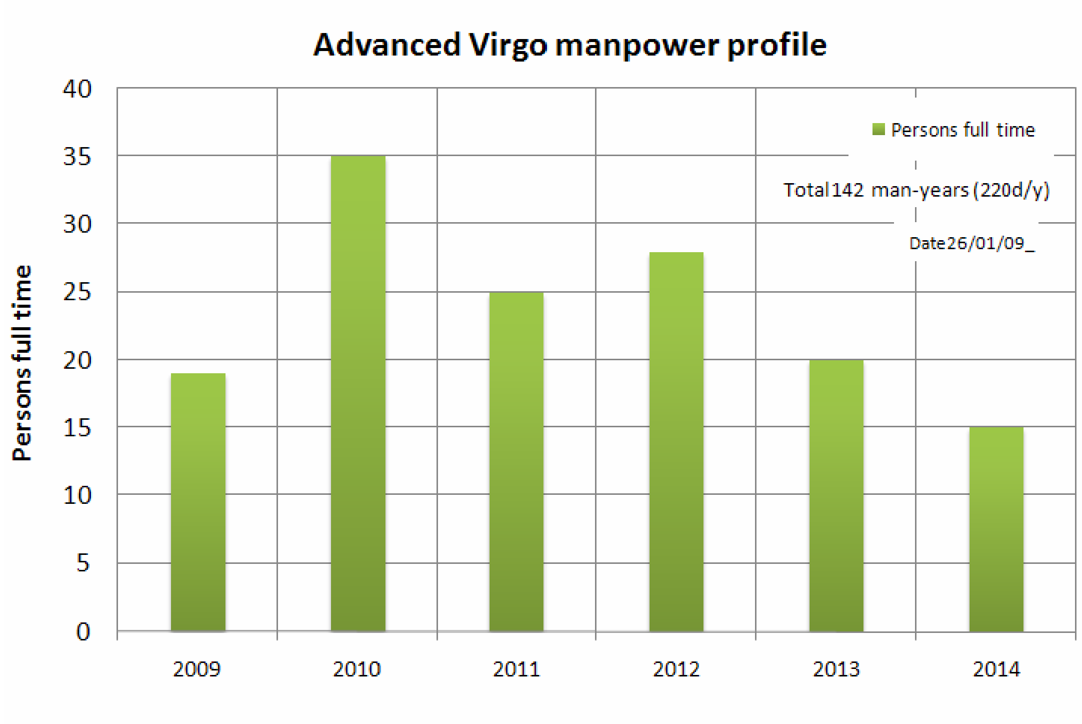
the experimental buildings. The main tasks of IME will be: the replacement of the machines with more silent ones and, if needed, their displacement out of the experimental halls. The subsystem will also be involved in minor tasks such as the support in the realization of the eventual infrastructural works needed for the installation of the deliverables of the other subsystems.

Cost and manpower overview

The following graphs show the commitment and spending profile for the Advanced Virgo construction and installation phase. All costs include 20% VAT. *The total contingency of 20% is also included; it has been calculated from contingencies for the individual subsystems ranging from 10 to 40% depending upon the proportion of industrial offers received at that point in time.* An estimate of costs for computing is still missing. All costs are in k€ of 2009, not taking into account inflation. As usual, salaries are not included; they are covered by the budget of the individual laboratories.

The manpower profile was estimated taking into account the duration of each construction and installation task and the number of required people associated to it. 220 working days per year were assumed.




Advanced Virgo manpower profile
Persons full time
40
35
30
25
20
15
10
5
0
Persons full time
Total 142 man-years (220d/y)
Date 26/01/09_
2009
2010
2011
2012
2013
2014

Distribution of cost over the subsystems

The following table shows the distribution of costs in k€ (with tax) over the various subsystems and the main tasks therein:

Advanced Virgo investment budget	**20628**
Contingency	**3438**
MIR	**5184**
Substrates Fabrication	1884
Substrates Polishing	1980
Coatings	960
Metrology upgrades	360
PAY	**645**
Payload prototyping	84
External production	492
Payload preparation and assembly	69
TCS	**304**
CO2 laser projector construction	132
ring heater construction	46
Viewports	18
Sensing construction+installation	108
SAT	**1639**
Monolithic Inverted Pendula	90
PZT Actuators	63
Tilt-Meters	84
Filter Zero upgrades	30
Suspension electronics maintenance & upgrade	231
SR construction	425
Short SAs upgrade (MC,IB,DB) construction	617
VAC	**4350**
Control system	360
Tower displacement	300
Larger links	942
LN2 plants	240
Cryotraps	1092
Vacuum equipment	684
Tower height increase	516
UHV clean flux	216
IME	**1596**
HVAC air handler relocation	708
HVAC air distribution	240
Electronics relocation	228
Halls acoustic damping	210
Support works to the other SS	210

ISC	**300**
Calva	300
DET	**600**
Suspended detection bench	
Output mode cleaner	
External detection bench	
End benches	
Extra bench for pick-up beam	
Quadrant diodes	
Photodiode readout	
Beam imaging system	
Scanning Fabry-Perot's	
Phase cameras	
PSL	**780**
Power laser	600
Laser stabilization	120
Pre-mode-cleaner	60
INJ	**799**
EOM construction	48
Input beam control, monitoring, characterization	79
Input mode cleaner	180
UHV and in-air Faraday isolators	144
Reference cavity upgrade	24
INJ assembly	324
DAQ	**993**
Control electronics	378
Environmental sensing	210
Local control	216
Electronics infrastructure	189