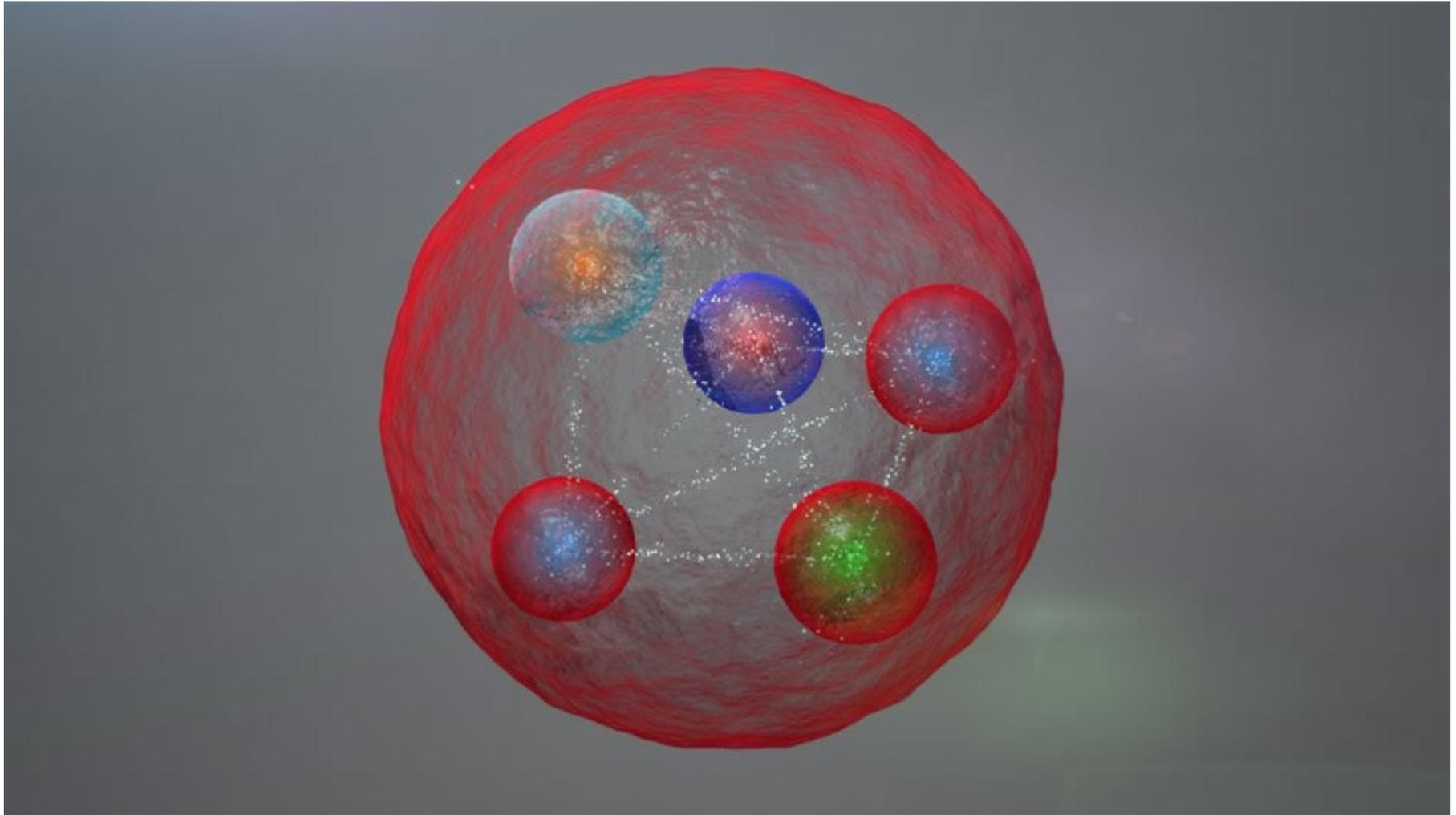
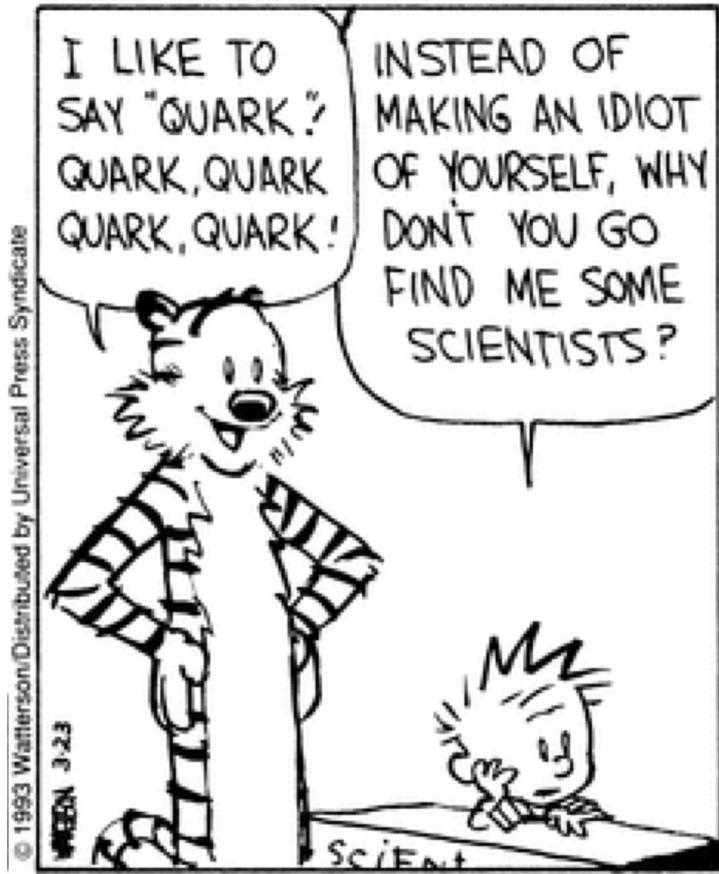


Il misterioso Pentaquark



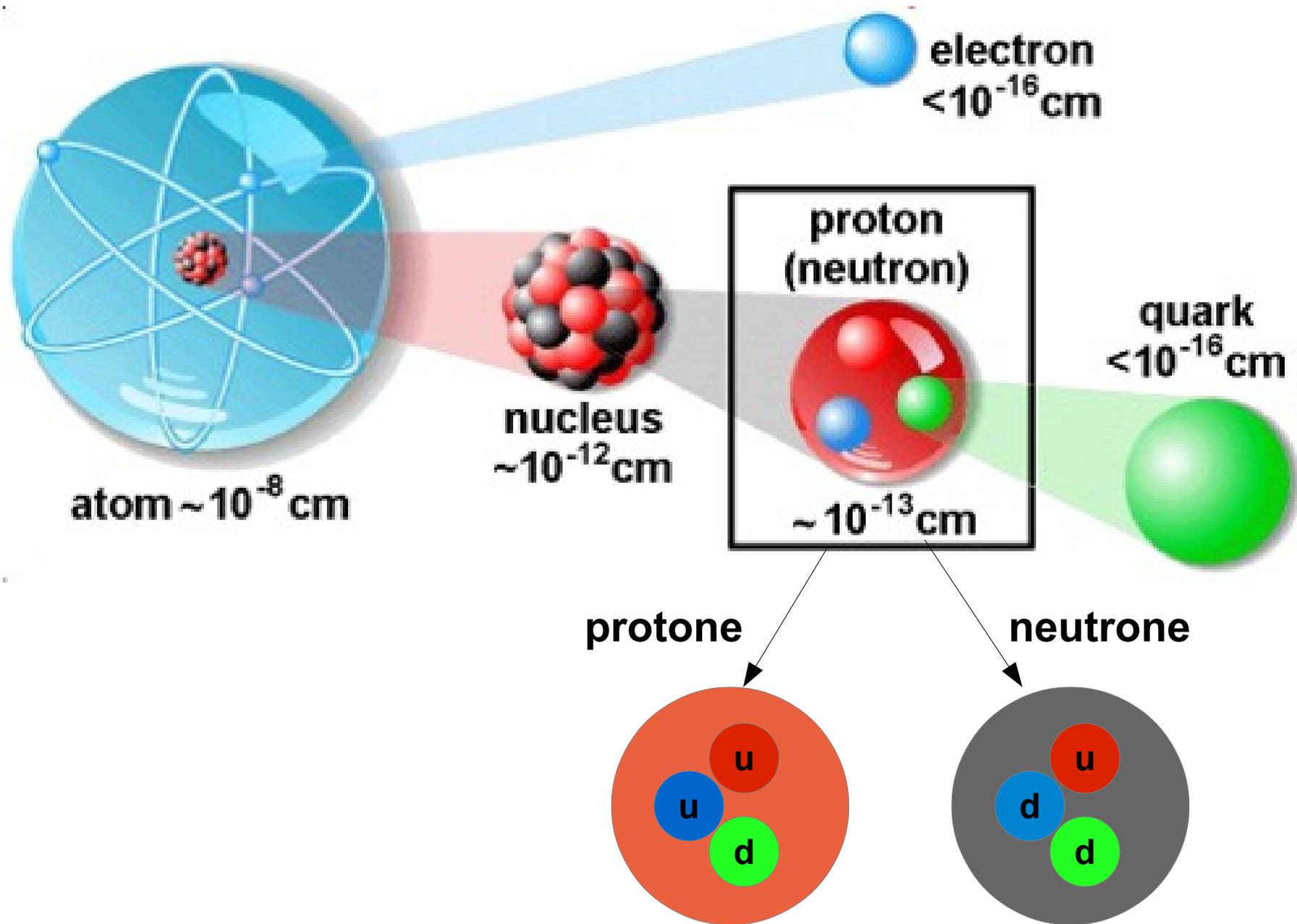
PENTA-QUARK ?

Qualcuno ha parlato di QUARK ?



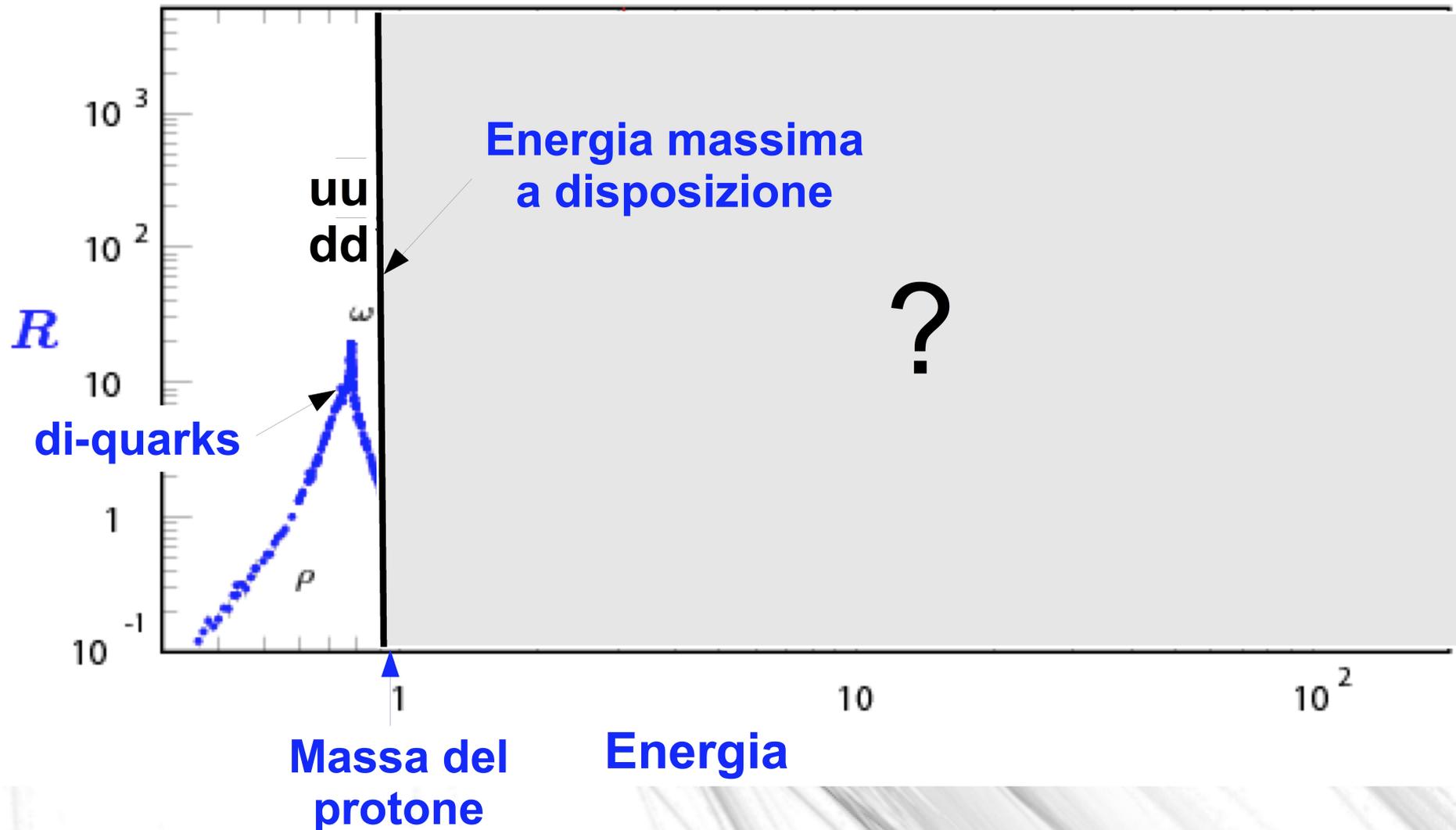


PESO: 85 KG
QUARKS: 99.98 %

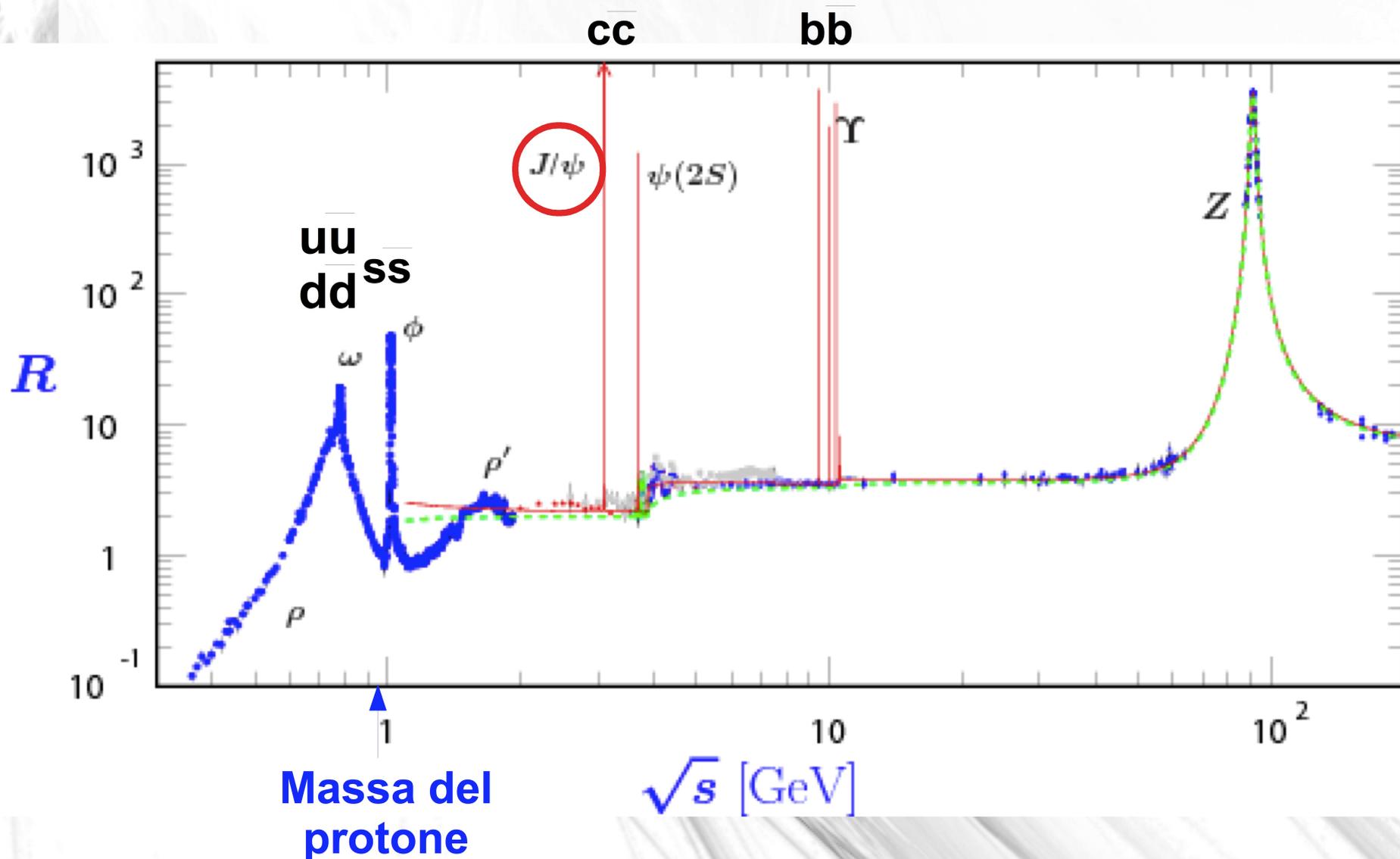


2 TIPI DI QUARKS: “up” e “down”

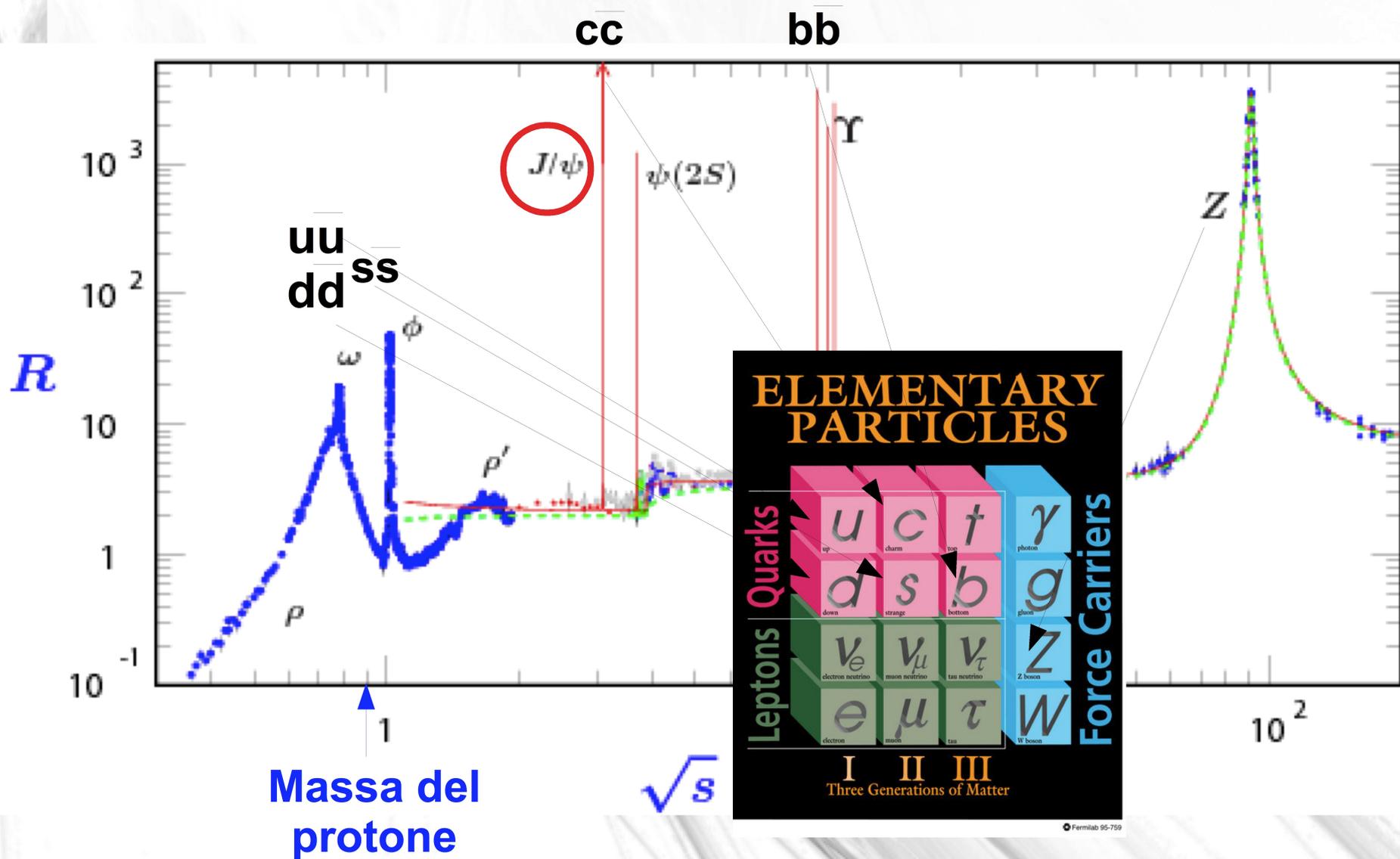
Come si vedono le particelle: 2-quarks



Aumentando l'energia(massa) :
nuovi e piu' pesanti quarks...

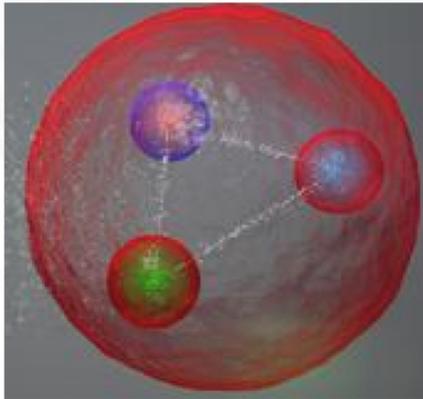


Capire e Classificare



Nell'Universo i quarks si trovano **solo** in due combinazioni possibili:

3-quarks (barioni)



2-quarks (mesoni)



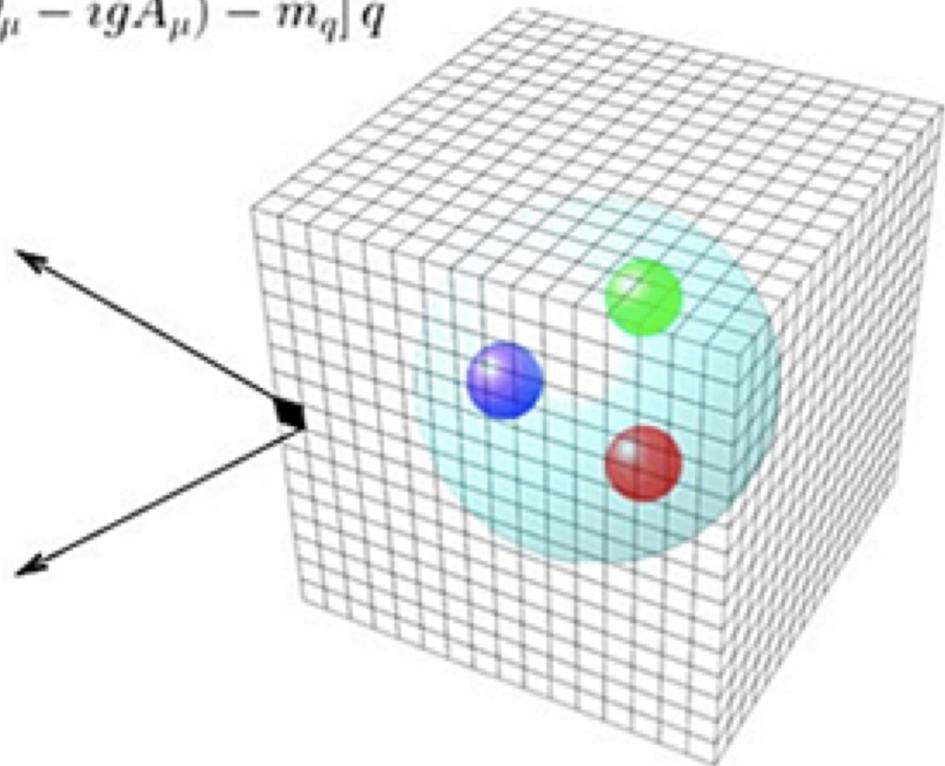
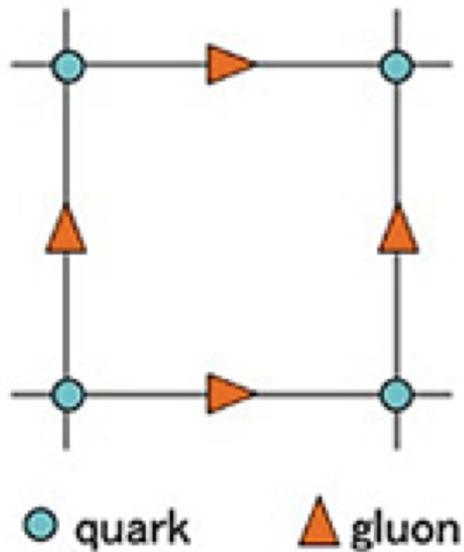
(in effetti $1q + 1 \text{ anti-}q$)

PERCHE' ?
E' PROPRIO SICURO ?

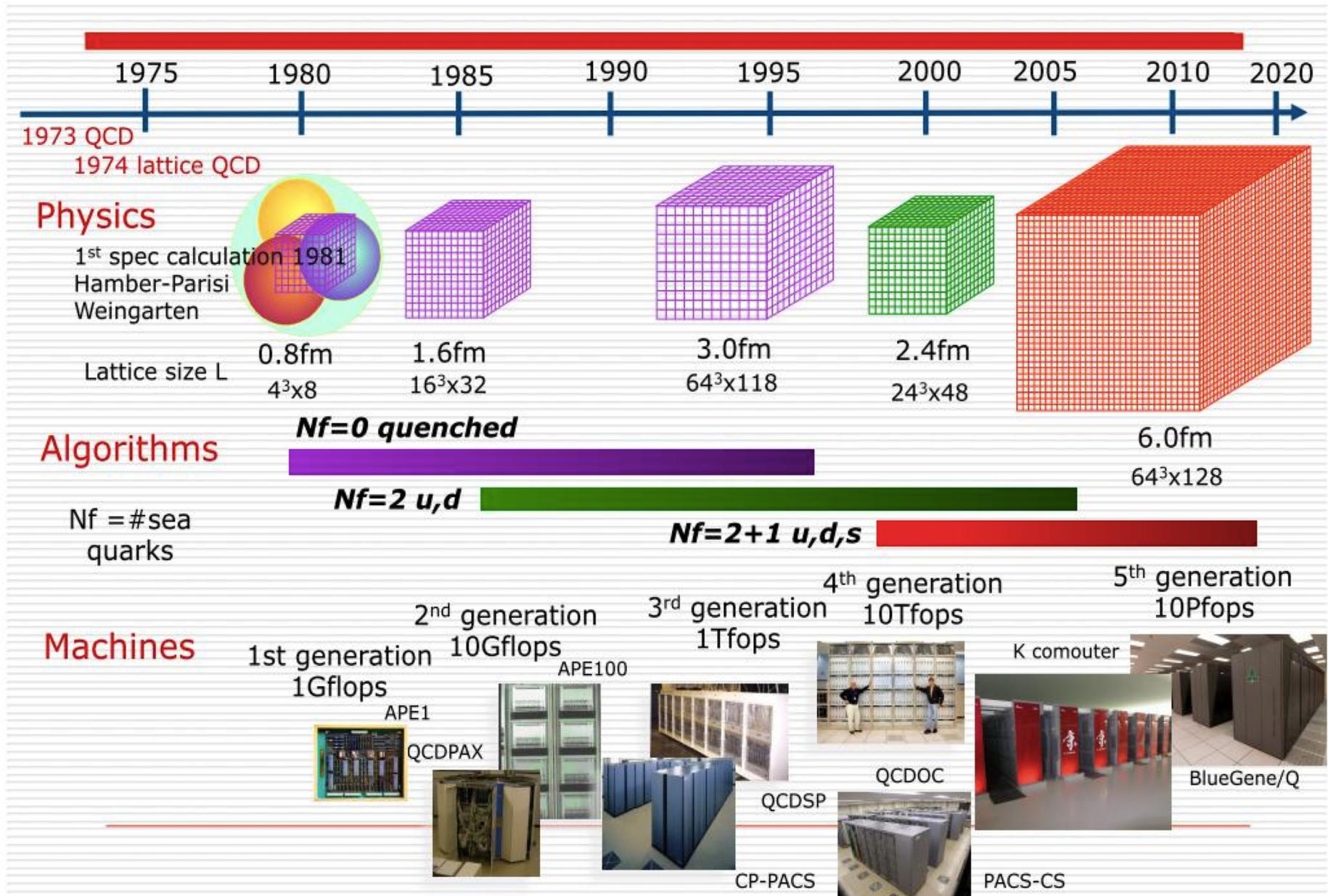
La forza che lega i quarks: QCD

QCD Lagrangian

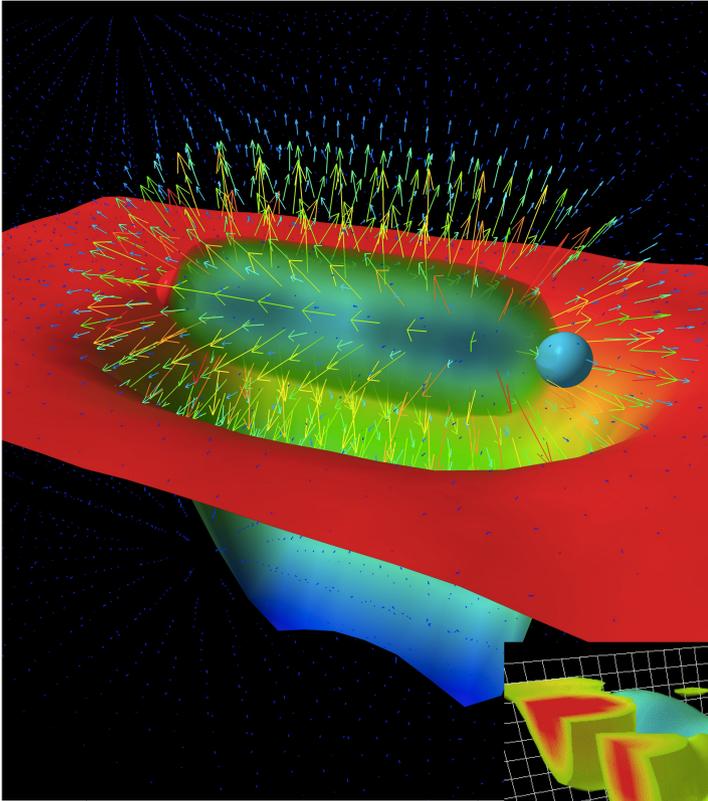
$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} + \sum_{q=u,d,s,c,b,t} \bar{q} [i\gamma^\mu(\partial_\mu - igA_\mu) - m_q] q$$



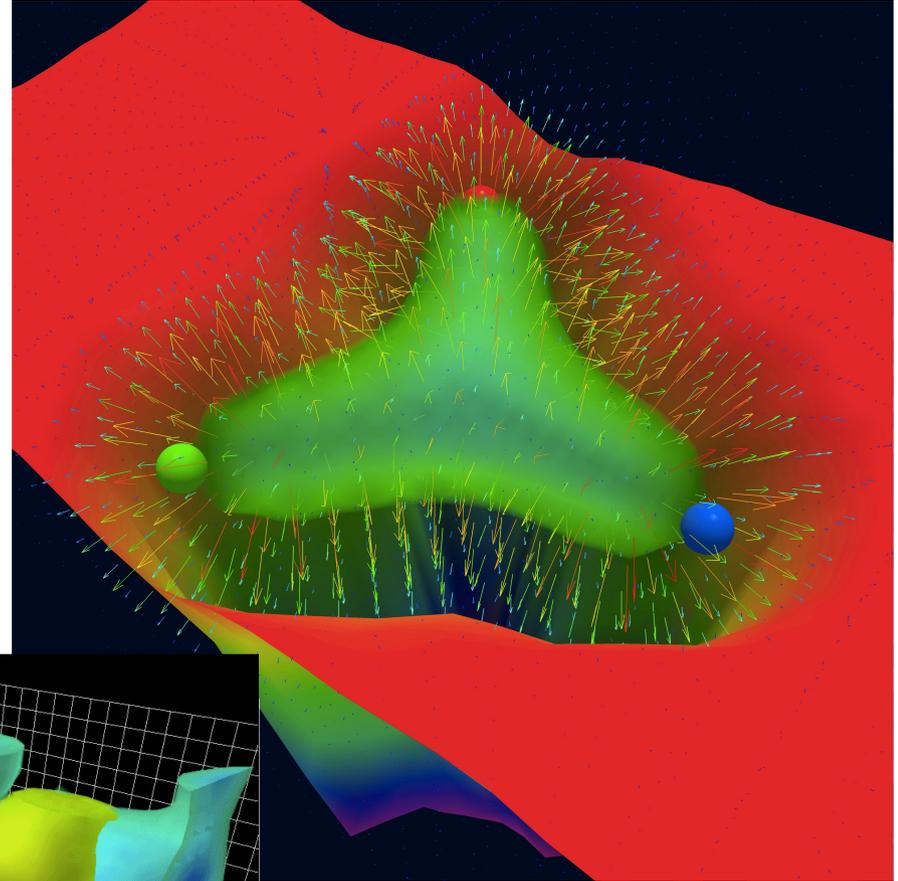
40 anni di studi di QCD con i computers



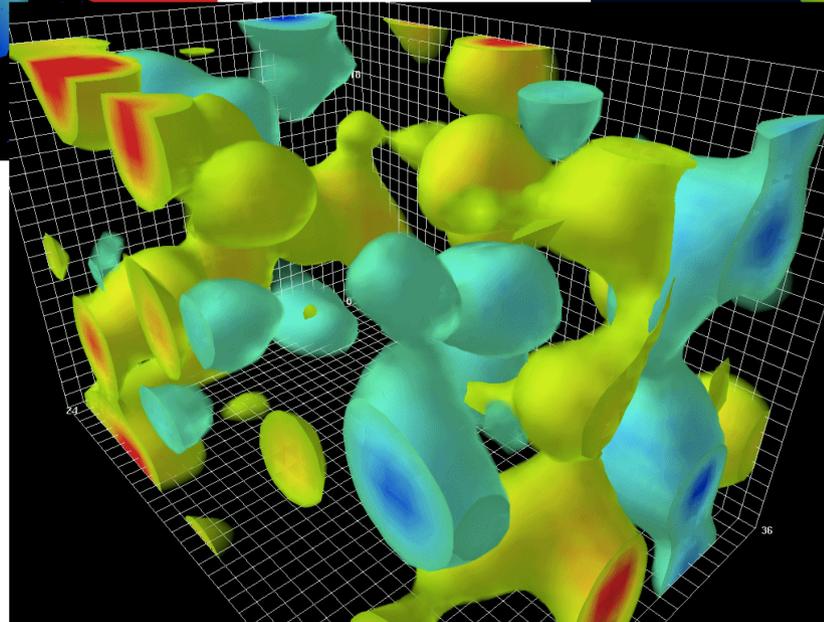
“Guardare” dentro le particelle con il computer



2 quarks



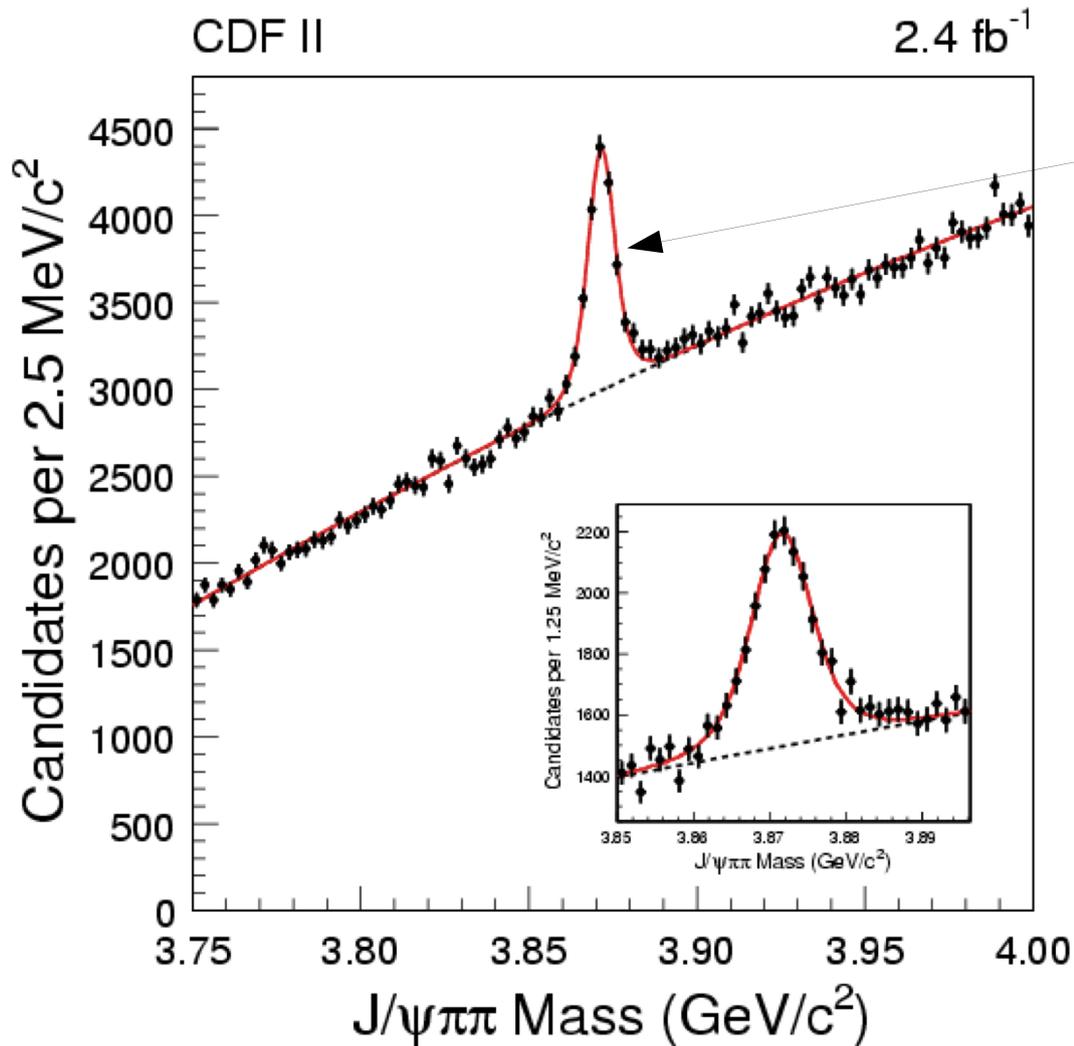
3 quarks



~~1 quark~~

Ma non tutto e' ancora stato capito

Esempio $X(3872)$



Particella contenente quarks - ma non rientra nei nostri schemi. (e non e' nemmeno un pentaquark)

$$2+3 = 5 ?$$

Molti fisici teorici ritengono che debbano esistere dei penta-quarks

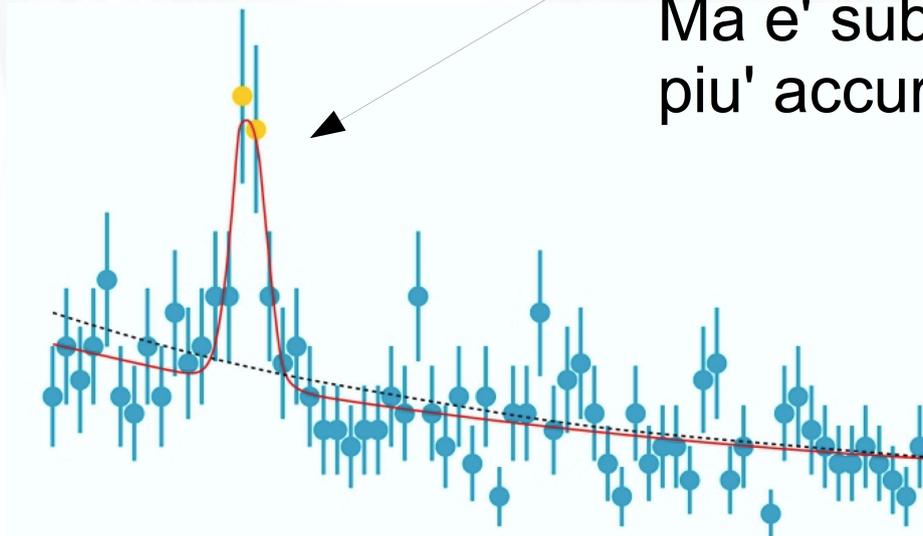
A partire da Murray Gell-Mann,
ideatore dei quarks
Premio Nobel 1969



Ma in mezzo secolo, nessuno li ha visti.
(a parte una parentesi)

2003: False partenze: il theta+

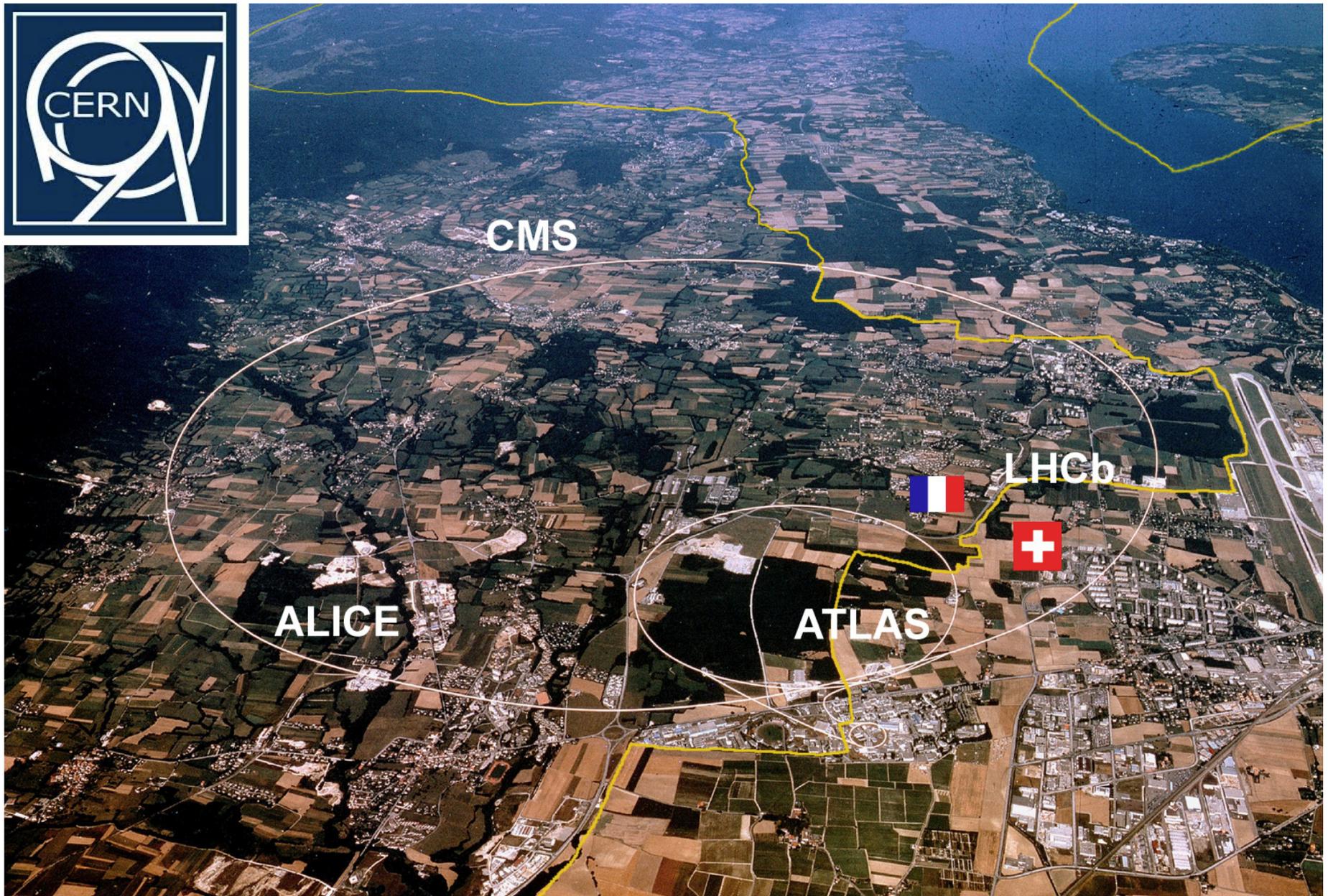
Avvistato nel 2003 – per un attimo sembro' di aver trovato un pentaquark. Ma e' subito scomparso dopo misure piu' accurate.

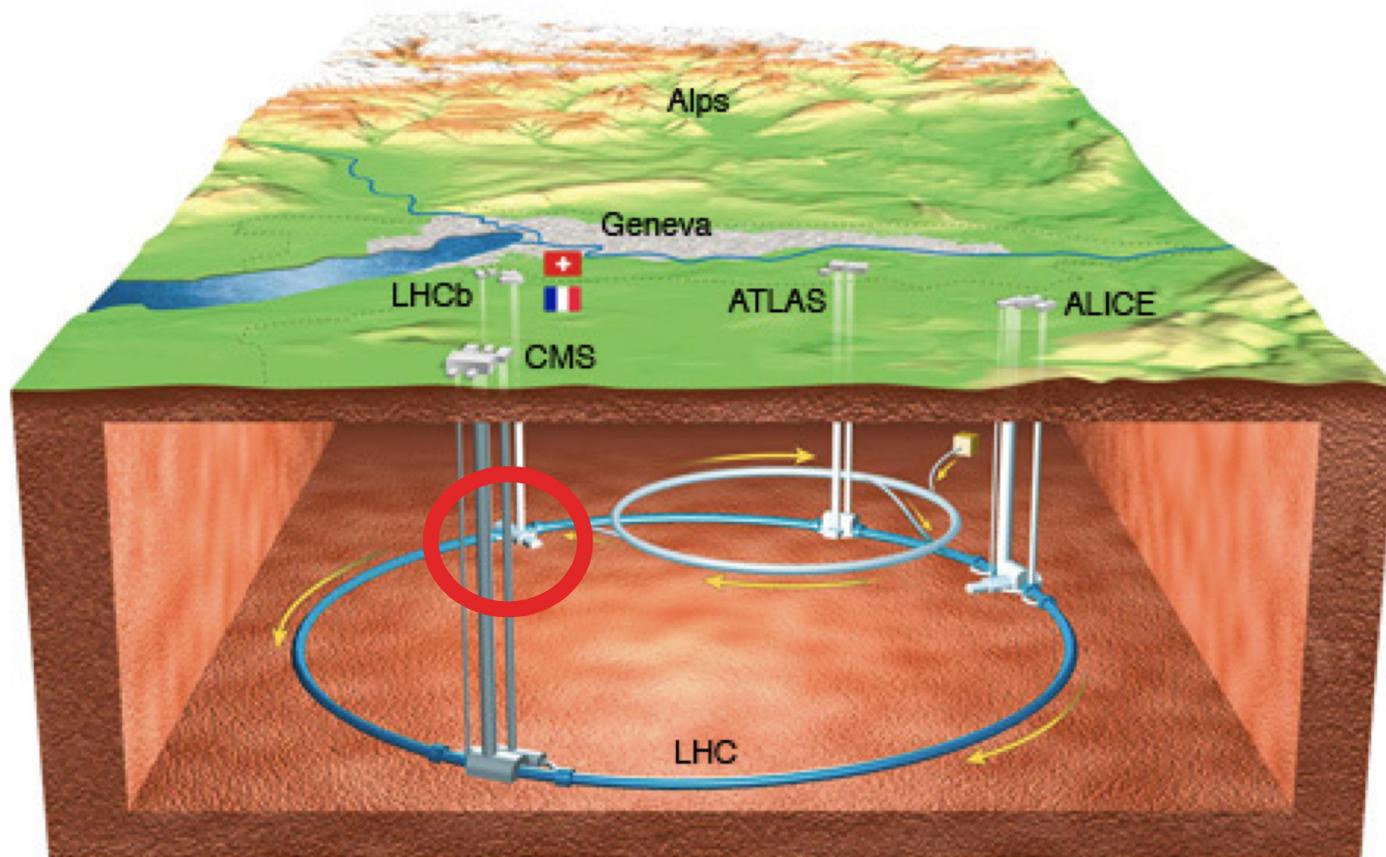


1.5 GeV

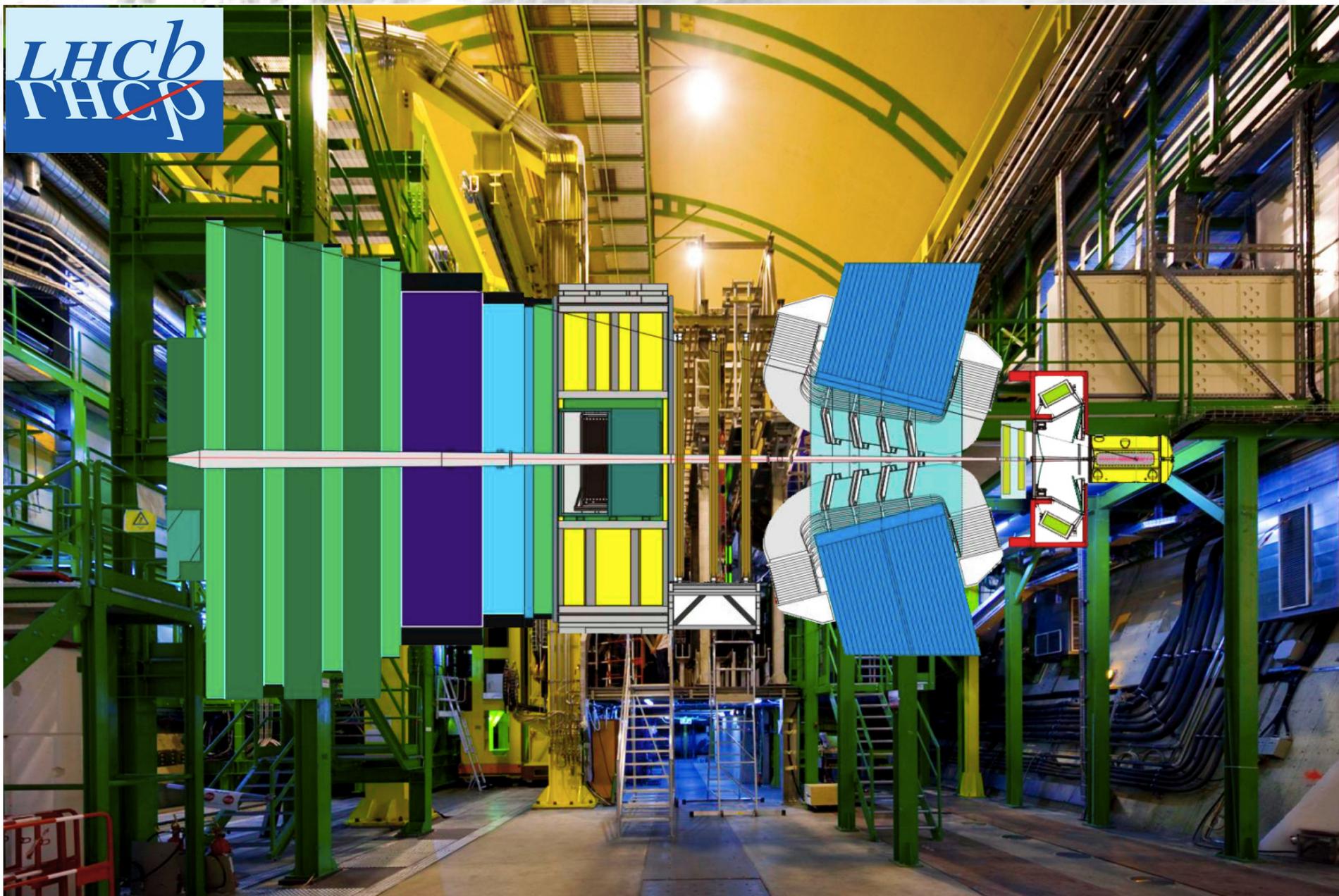
Nel 2006 si e' concluso che era solo una fluttuazione casuale.
Allora niente pentaquarks ?

II Large Hadron Collider





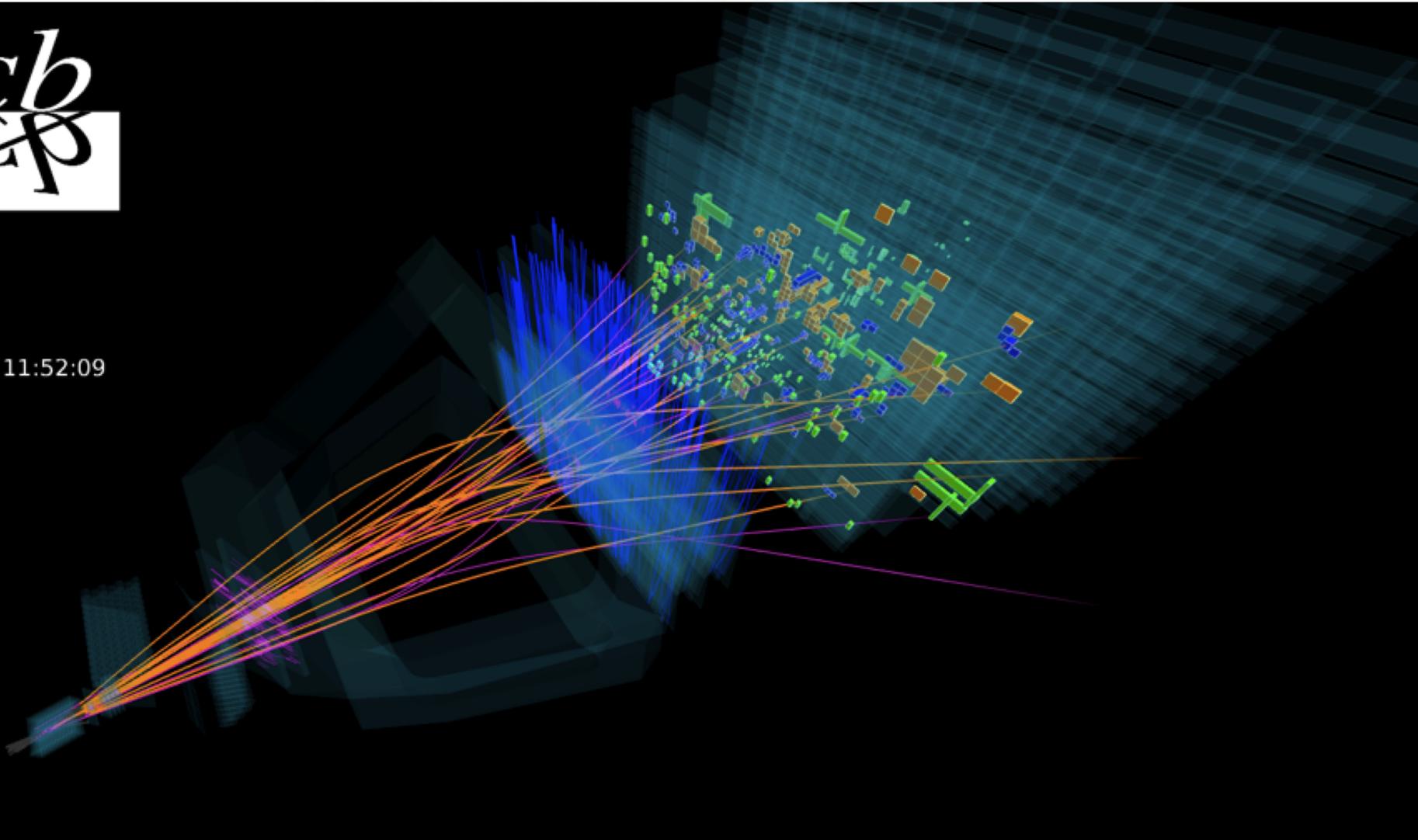




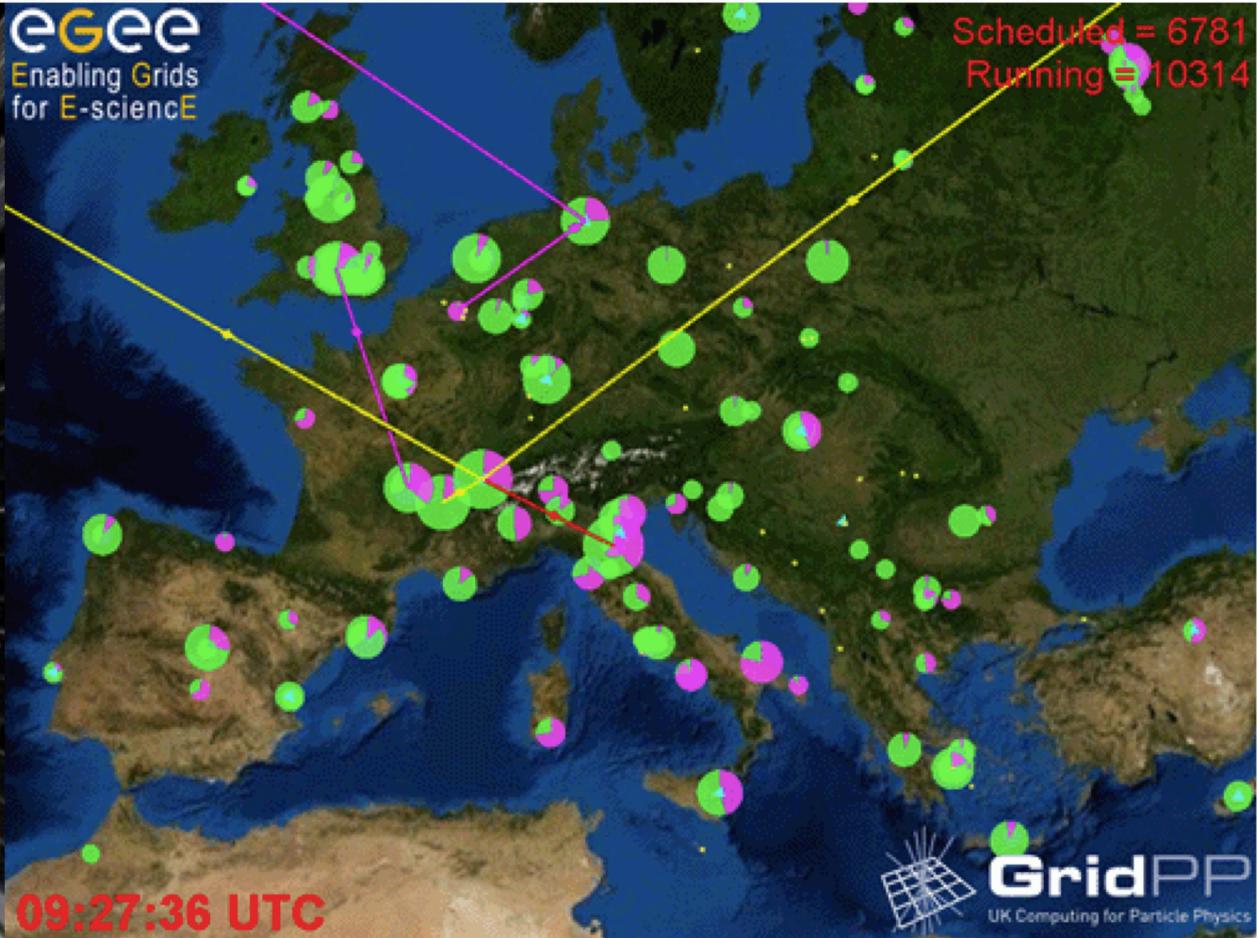
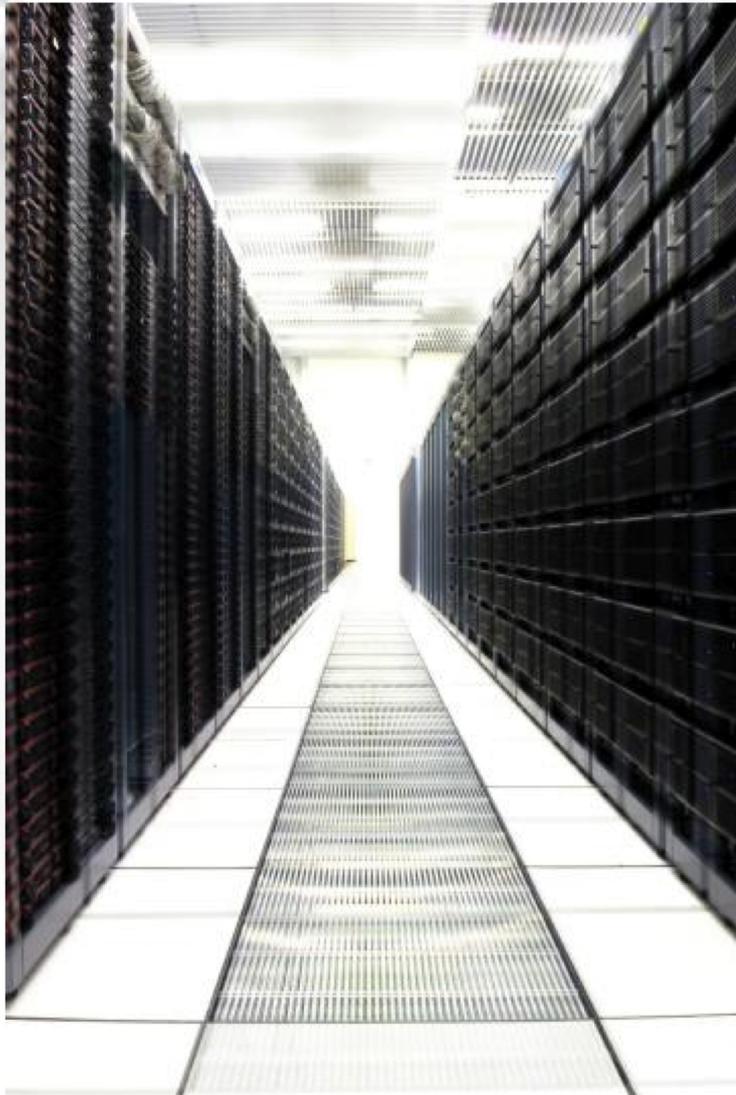
SHOWTIME



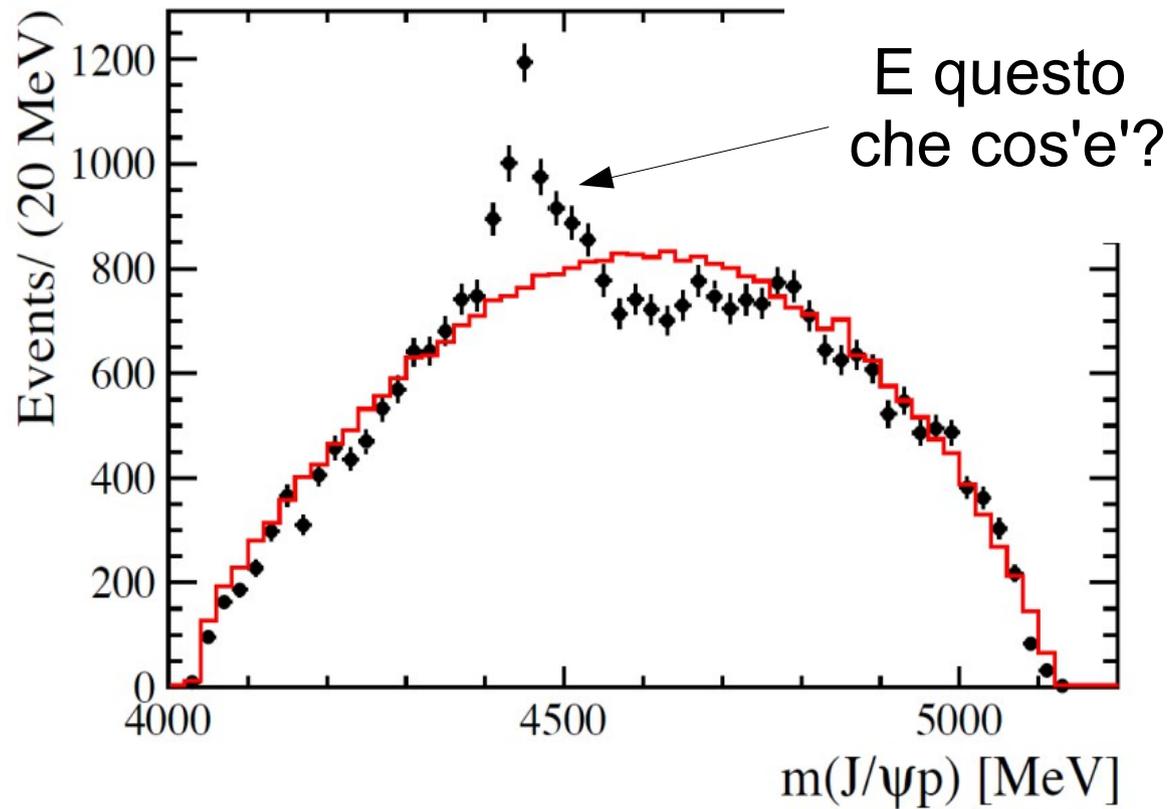
Event 41383468
Run 153460
Wed, 03 Jun 2015 11:52:09



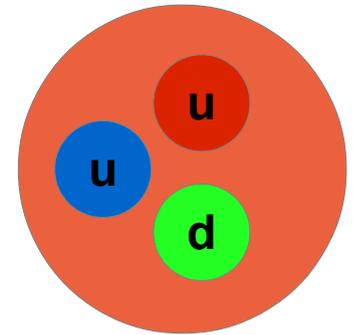
Computers... CERN GRID



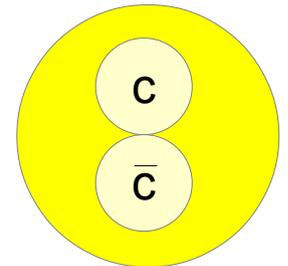
Risultati inattesi



protone

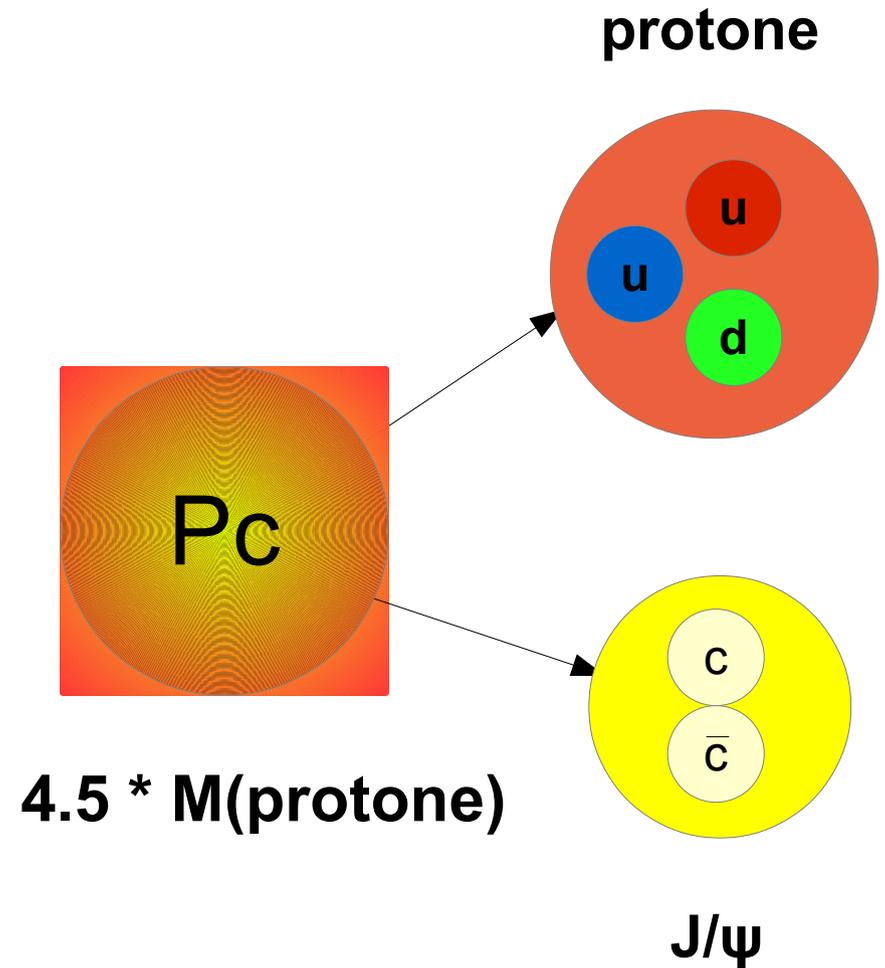
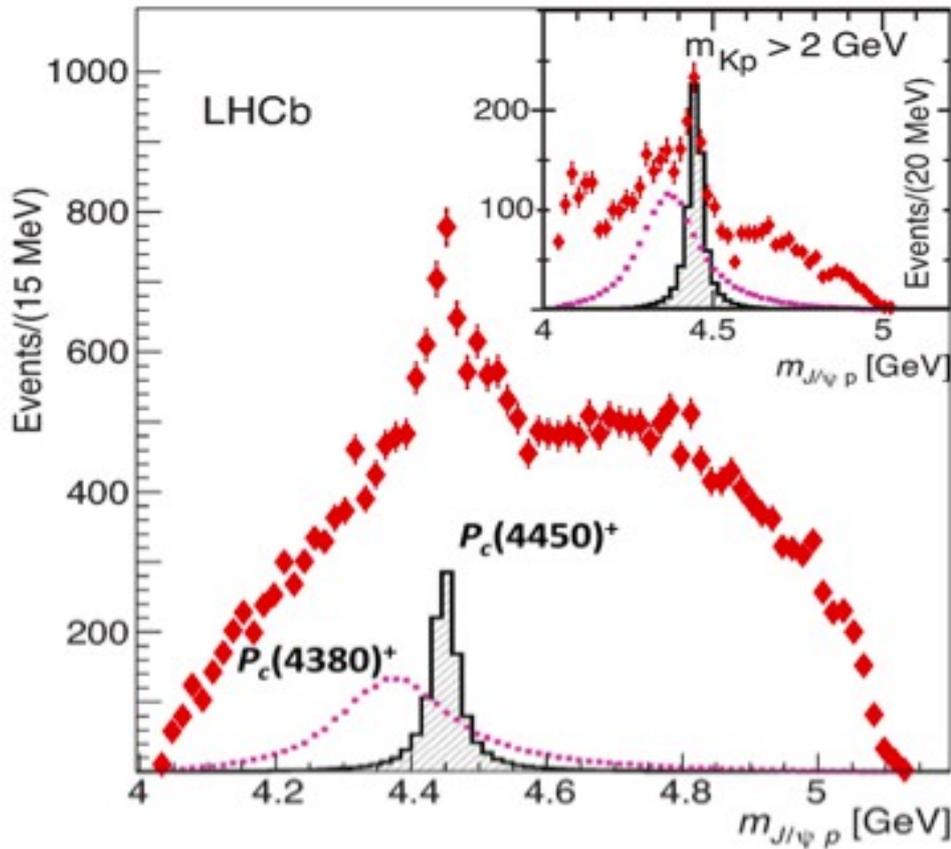


+



J/ψ

E' un pentaquark: $(uud) + (c\bar{c})$?



Publicato: 12 Agosto 2015

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Observation of $J/\psi p$ Resonances Consistent with Pentaquark States in $\Lambda_b^0 \rightarrow J/\psi K^- p$ Decays

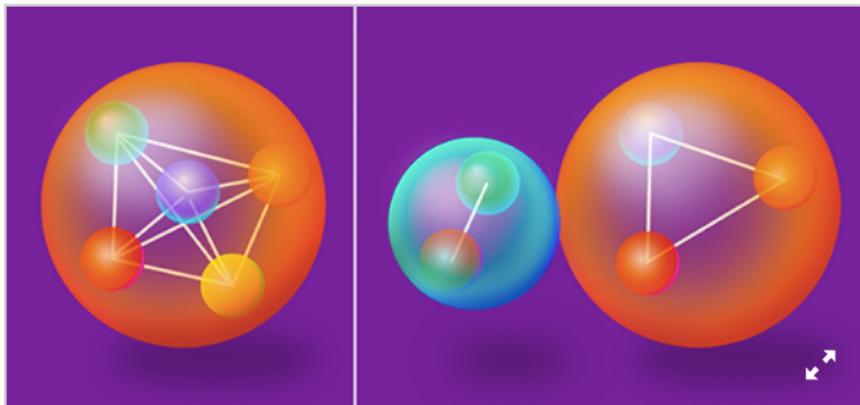
R. Aaij *et al.* (LHCb Collaboration)
Phys. Rev. Lett. **115**, 072001 – Published 12 August 2015



Viewpoint: Elusive Pentaquark Comes into View

Kenneth Hicks, Department of Physics and Astronomy, Ohio University, Athens, OH 45701, US
August 12, 2015 • *Physics* 8, 77

A new type of particle containing five quarks has been observed by the LHCb experiment.



APS/Carin Cain

Figure 1: Researchers running the LHCb experiment have discovered a new type of particle containing five quarks, called a pentaquark. The figure indicates two possibilities for the pentaquark's internal structure. At left, all five particles are tightly bound ... [Show more](#)

Ma... sono proprio 5 quarks ?

Ma come stanno insieme ?

Esistono altri tipi di pentaquarks ?

Riusciamo a capire la QCD ?

“PROVANDO E RIPROVANDO”

Motto dell'Accademia del Cimento dal 1657



**Buona visita alla
Notte dei Ricercatori Toscana!**