Personal Impressions from the EPS HEP conference in Vienna

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CLICdp Monthly Meeting - 3 August 2015

Outline

Disclaimer: personally selected material, not a conference review, just what I saw and thought was interesting

Covering:

- **start up of LHC Run2: accelerator, detector performance and first results**
- **continued analysis of LHC Run1 data: new results and hints of new physics**
- **neutrino astrophysics**
- **possible future colliders**
- **specific feedback and questions relating to CLICdp**

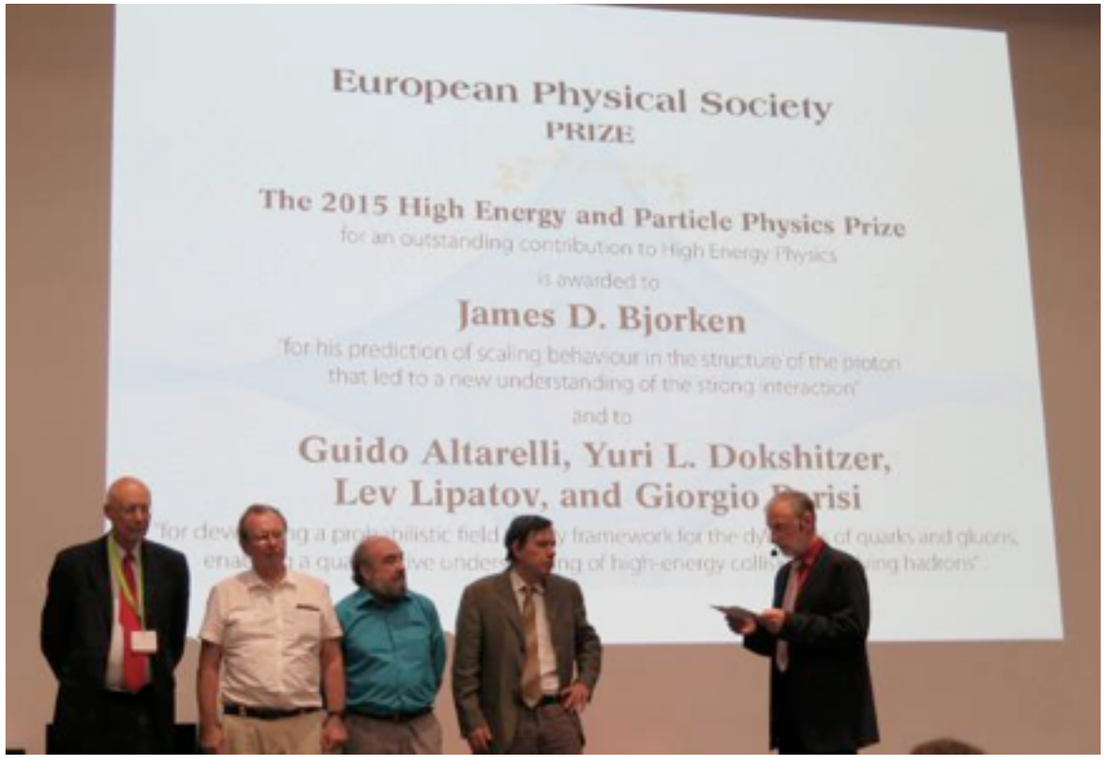
2015 High Energy and Particle Physics Prize

The 2015 High Energy and Particle Physics Prize, for an outstanding contribution to High Energy Physics, is awarded to

James D. Bjorken for his prediction of scaling behaviour in the structure of the proton that led to a new understanding of the strong interaction

and to

Guido Altarelli, Yuri L. Dokshitzer, Lev Lipatov, and Giorgio Parisi for developing a probabilistic field theory framework for the dynamics of quarks and gluons, enabling a quantitative understanding of high-energy collisions involving hadrons.



Yuri Dokshitzer: "You never know where things will lead"

Other prizes:

http://eps-hepp.web.cern.ch/eps-hepp/

LHC Run2 Start Up: Accelerators

Run1

- a success

LS1

- a success

Run2 start up

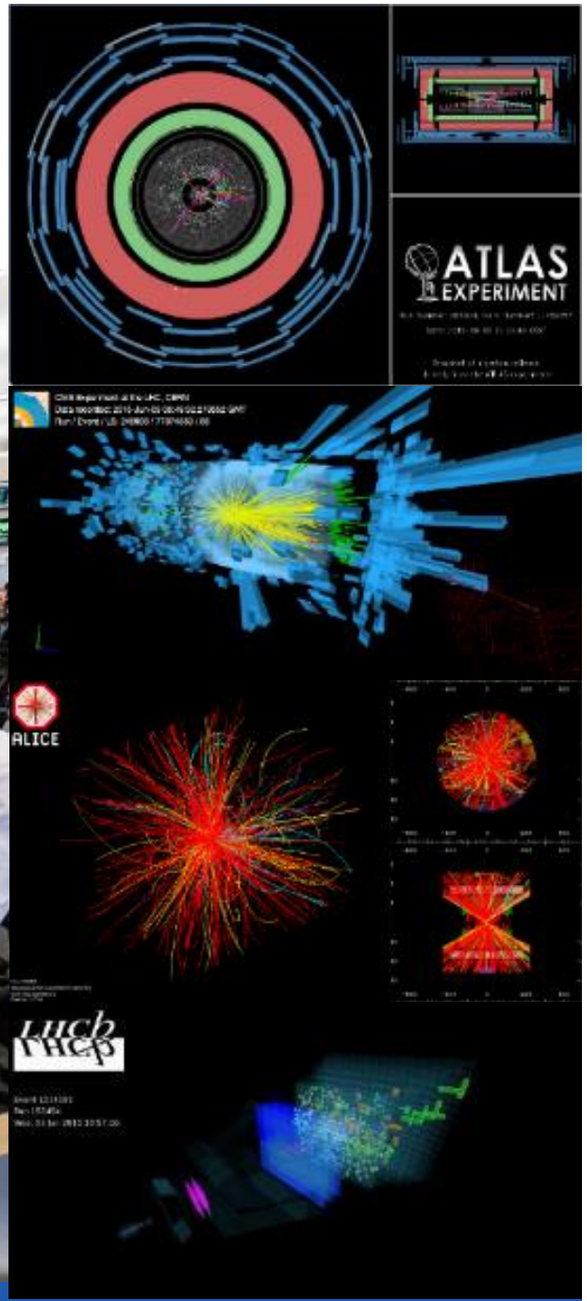
- a success

LHC 2015 plan:

- pp at 13 TeV
- 25 ns
- max pile up 50
- 5-8 fb^{-1}
- no $\sqrt{s}$ increase

LHC experiments are back in business at a new record energy 13 TeV

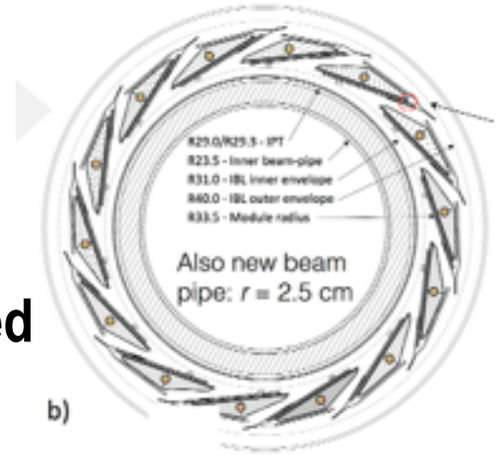
3rd June 2015



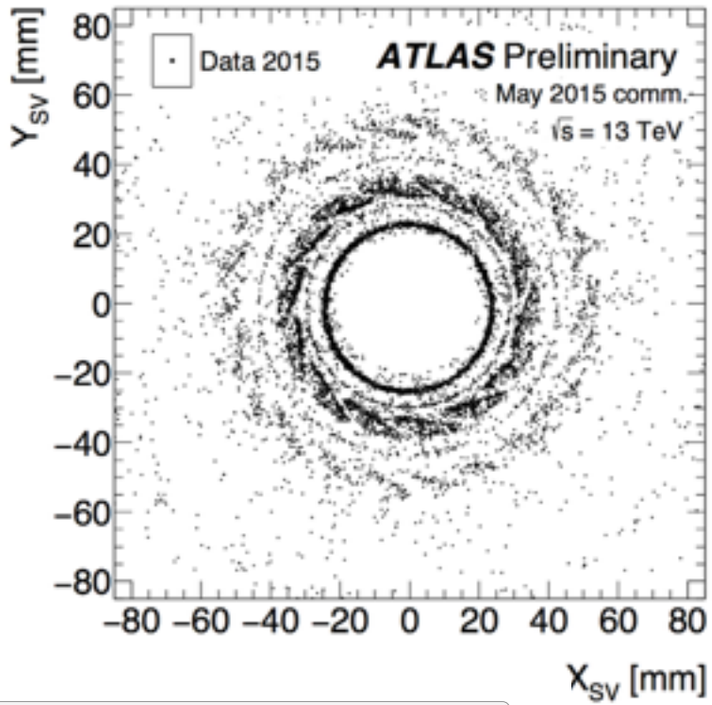
LHC Run2 Start Up: ATLAS

New insertable B layer (IBL):

- **fourth pixel layer 3.3 cm from beam**
- **planar and 3D silicon**
- **successfully inserted**
- **simulation material description validated with interaction vertices**
- **improves impact parameter resolution significantly**



Hadronic interaction vertices



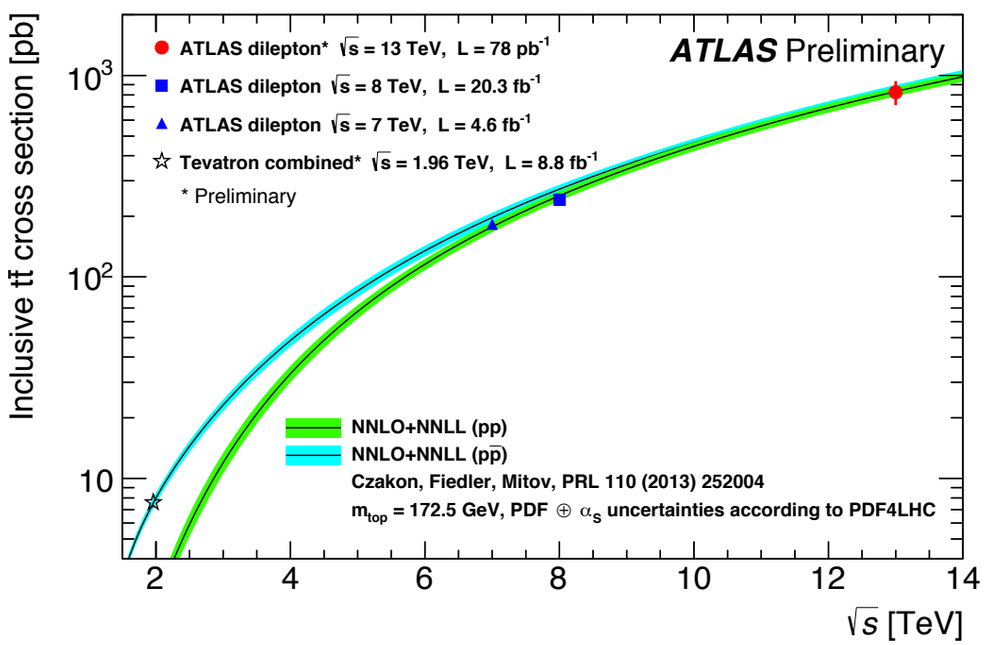
New data matches well with 13 TeV MC

- **no need to reproduce simulation**

Early physics:

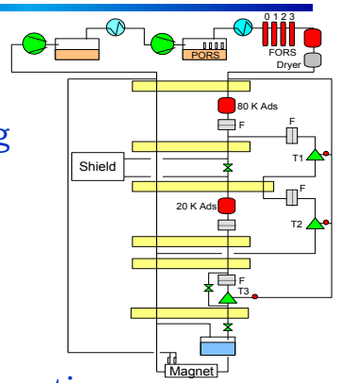
- **J/Ψ, W, Z in agreement with expectations**
- **tt production agrees with SM**
- **'ridge' in long-range two-charged-particle angular correlations confirmed at 13 TeV**

σ_{tt} (13 TeV) = 825 ± 49 (stat) ± 60 (syst) ± 83 (lumi) pb



LHC Run2 Start Up: CMS

Magnet Cryogenics



- The restart of the CMS magnet after LS1 was more complicated than anticipated due to problems with the cryogenic system in providing liquid Helium.
- Inefficiencies of the oil separation system of the compressors for the warm Helium required several interventions and delayed the start of routine operation of the cryogenic system.
- Currently the magnet can be operated, but the continuous up-time is still limited by the performance of the cryogenic system requiring more frequent maintenance than usual.
- A comprehensive program to re-establish its nominal performance is underway. These recovery activities for the cryogenic system will be synchronized with the accelerator schedule in order to run for adequately long periods.
- A consolidation and repair program is being organized for the next short technical stops and the long TS at the end of the year.

B=0 21.7 pb^{-1}

61.8 pb^{-1}

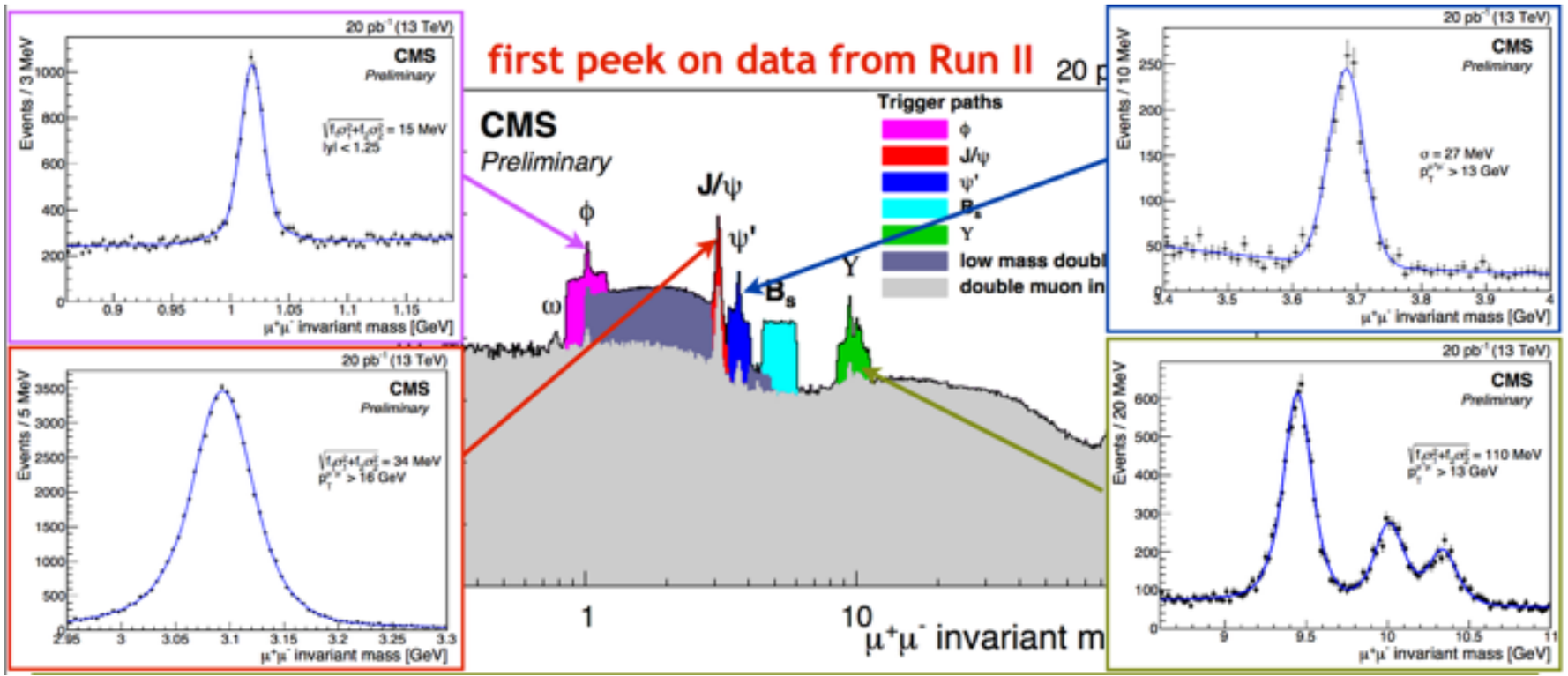
Borras - First Run2 results from CMS

Krätschmer - Quarkonium and heavy flavour production in Run1 and first results with 13 TeV data at CMS

Data taking commenced

Rediscovering the SM

Tuned MC describes data well



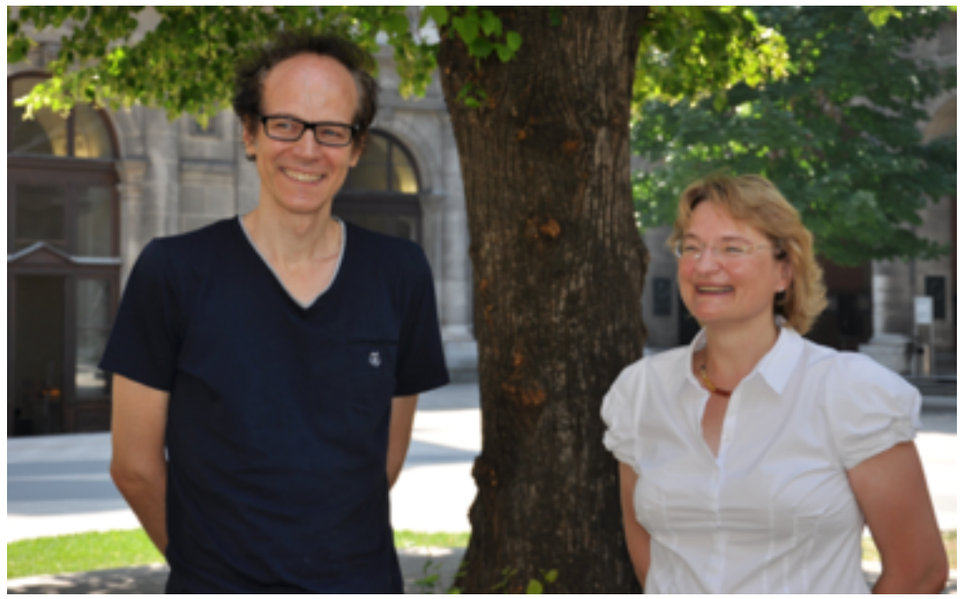
Words of wisdom

From the conference daily newsletter:

Andreas Hoecker and Kerstin Borras give advice for young physicists:

KB: Work on all aspects of physics if possible – detector, data analysis, but always keep in mind the physics goals of the experiment you are working on. Teamwork is very important, as is communicating clearly within the team.

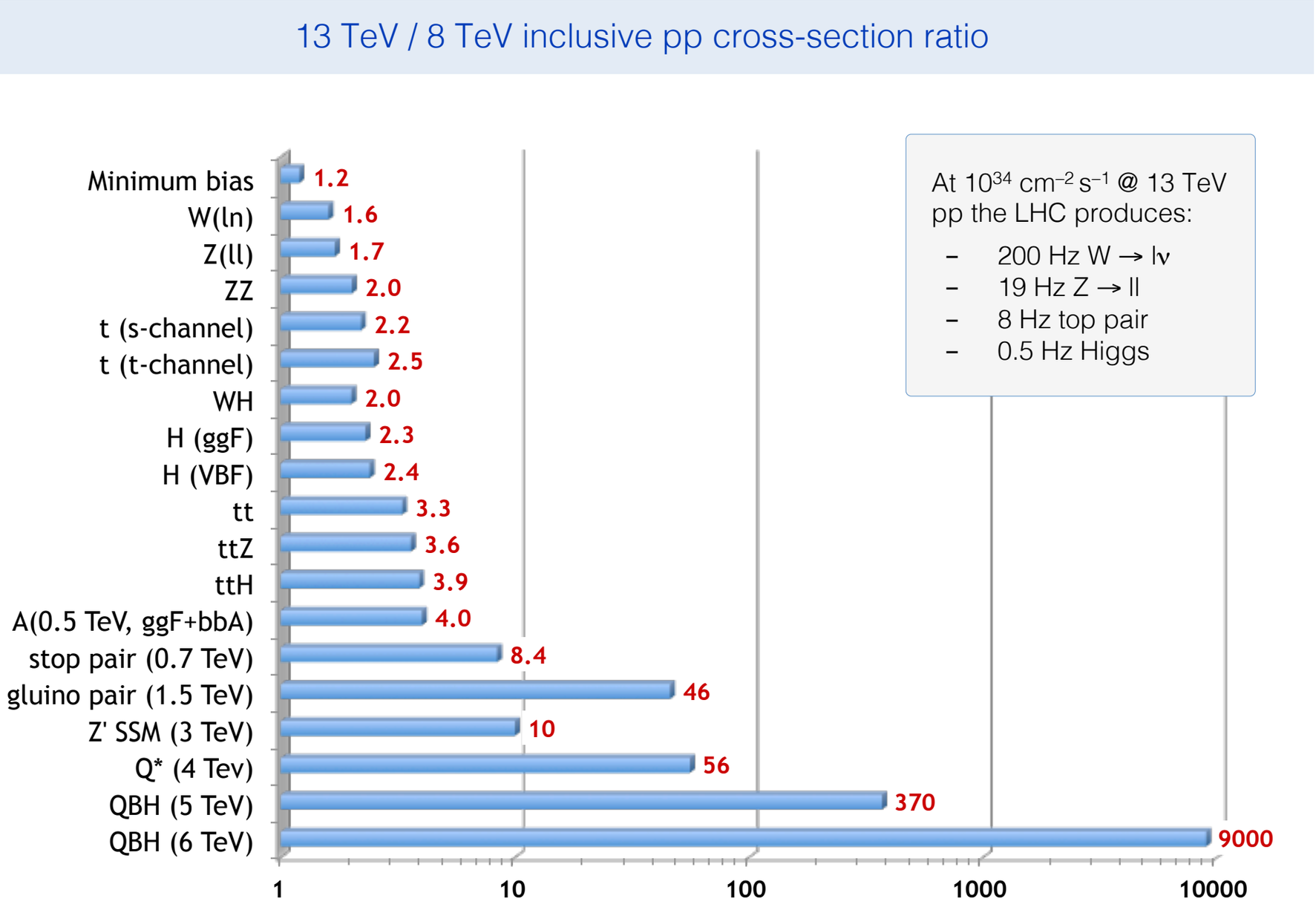
AH: Be ambitious and persevering. Find the most difficult topic that is important for the experiment and be creative. Creativity is the most important part and one that makes your work a happy one.



LHC Run2: Prospects

The Stirling Plot

demonstrates increased discovery potential of Run2 wrt. Run1



New results from LHC Run1 data

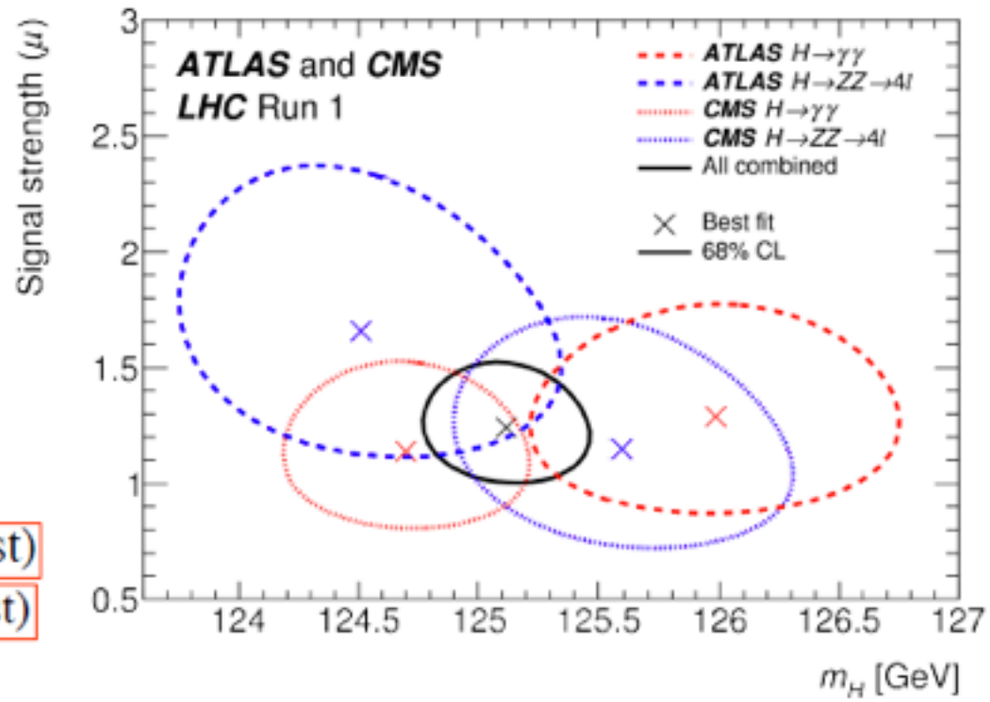
Hoecker: "Run1 is not over yet: high-quality, extremely well understood data sample for precision measurements"

Zeppenfeld - Highlights from EPS HEP 2015

HIGGS MASS

The SM does not predict the Higgs boson mass: we need to measure it

Given a mass, we can make predictions* for the production cross section and decay rates



Higgs mass measurements (GeV):

ATLAS: 125.36 ± 0.37 (stat) ± 0.18 (syst)
CMS: 125.02 ± 0.27 (stat) ± 0.15 (syst)

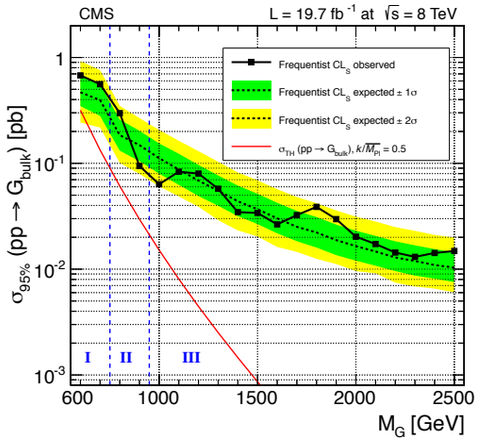
LHC combination:
125.09 ± 0.21 (stat) ± 0.11 (syst)

Precision measurement: <0.2%

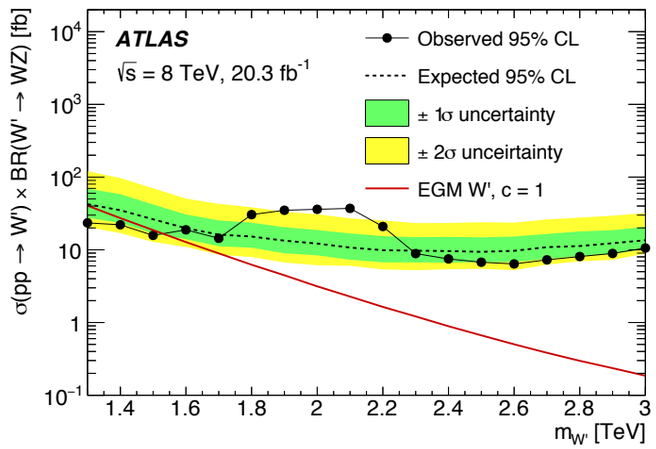
*a lot of progress by theory community, LHCXSWG. Improvements continue…

New results from LHC Run1 data

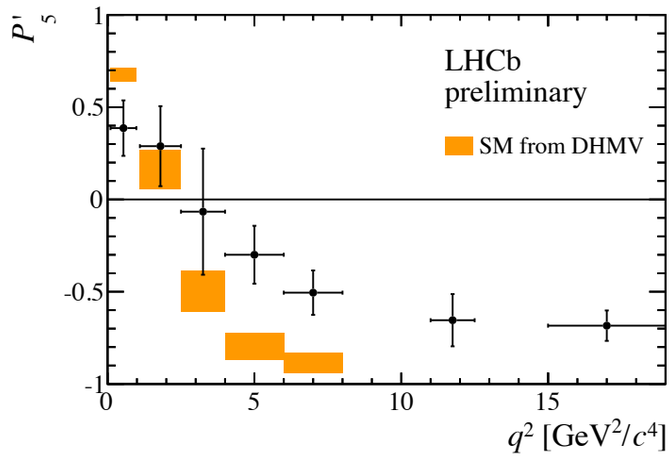
Are we already seeing New Physics?



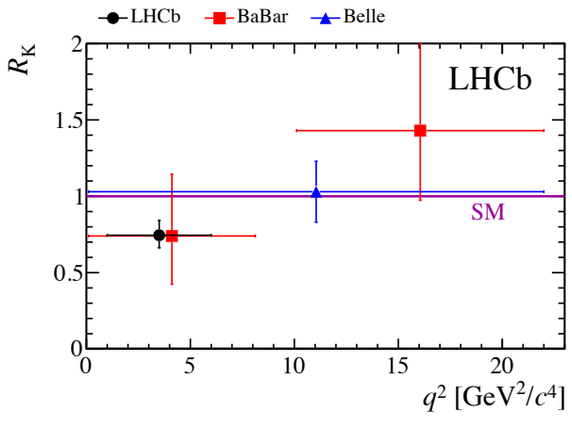
Excess at 2 TeV [CMS, JHEP 08 (2014) 174]



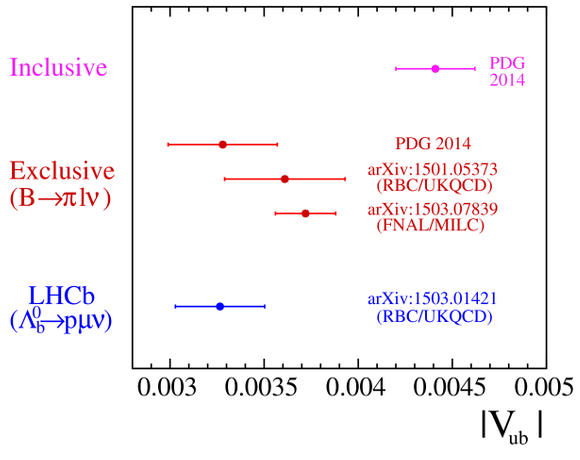
Excess at 2 TeV [Atlas, arXiv:1506.00962]



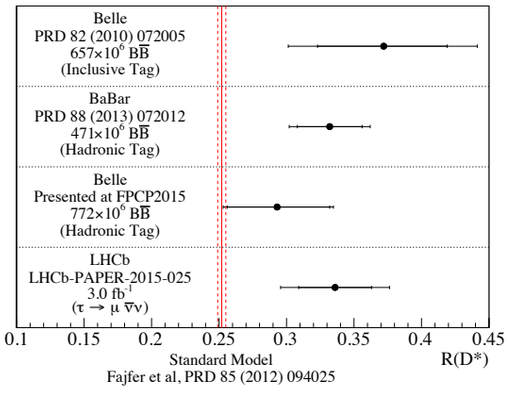
P_5' in $B \to K^* \mu^+ \mu^-$ [LHCb-CONF-2015-002]



Lepton universality [Phys. Rev. Lett. 113 (2014) 151601]



V_{ub} puzzle [Nature Physics 3415 (2015)]



$B \to D^* \tau \nu$ [arXiv:1504.06339]

There's a handful of intriguing 3–4σ anomalies

Pentaquarks and Tetraquarks

$$\Lambda_b \to J/\psi K^- p$$

Dalitz plot shows an unusual feature

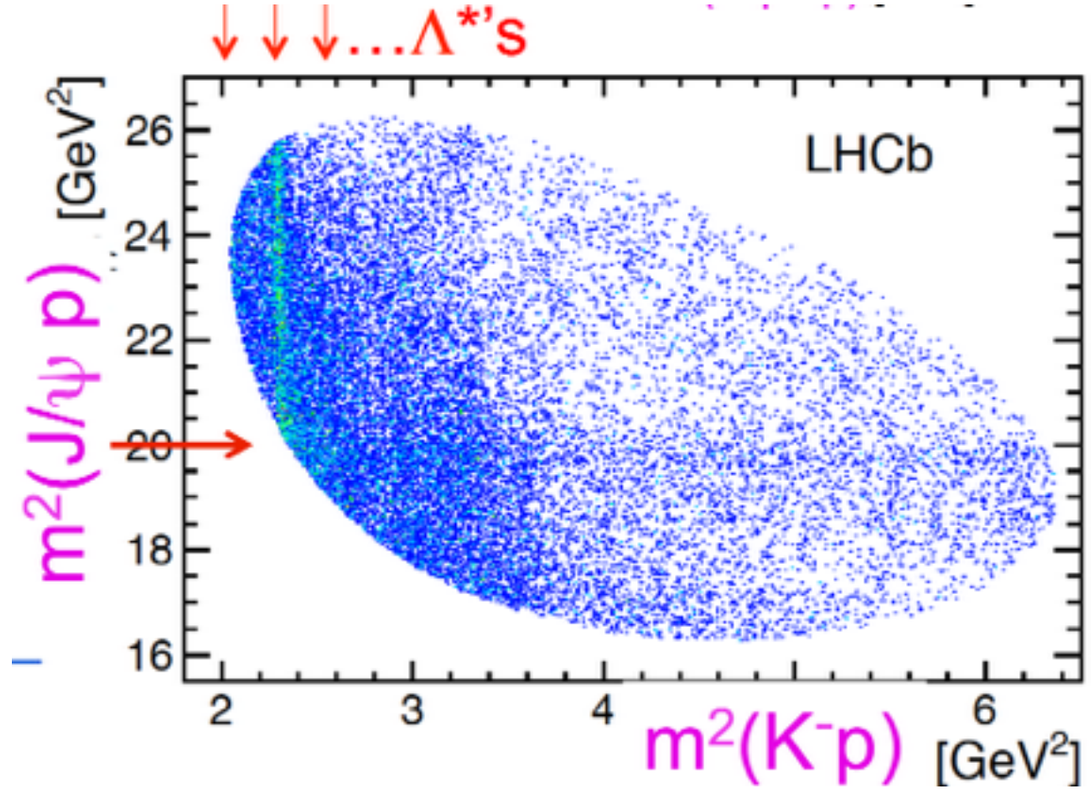
Projection fits require 2 pentaquark resonances

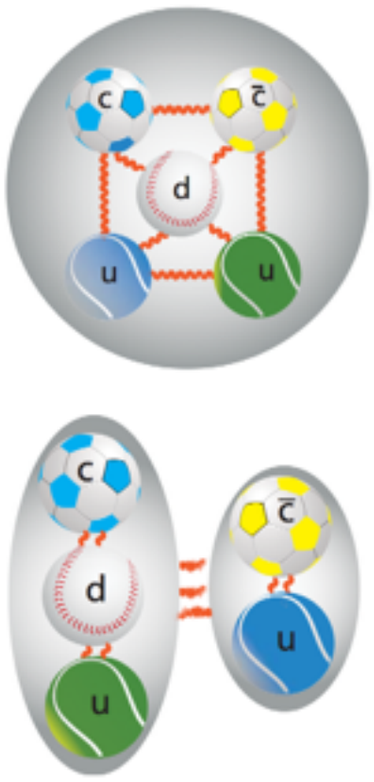
Huge significances: 12 and 9 sigma

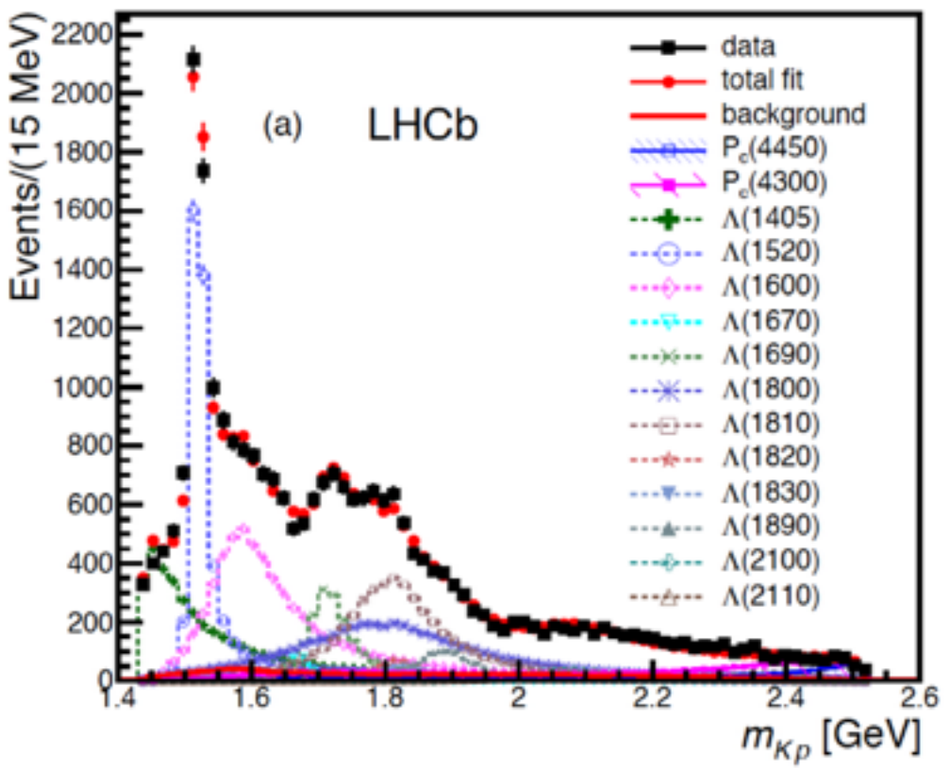
Tightly bound model slightly favoured over molecular model

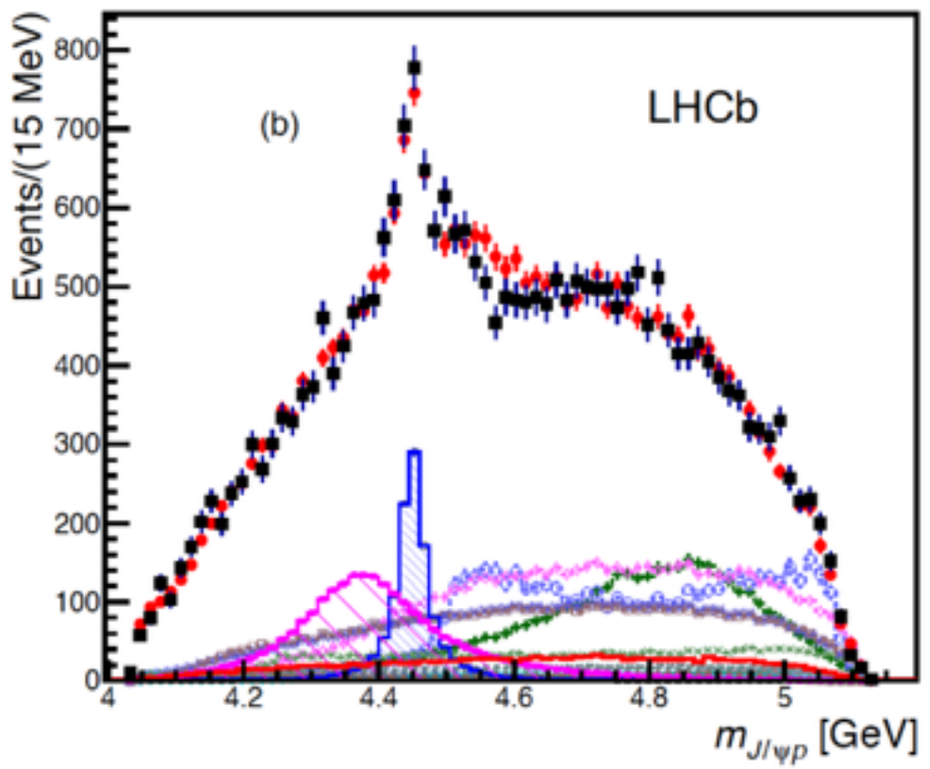
Tetraquark $Z^+(4430)$ appears to be viable

Stone - Pentaquarks and tetraquarks at LHCb





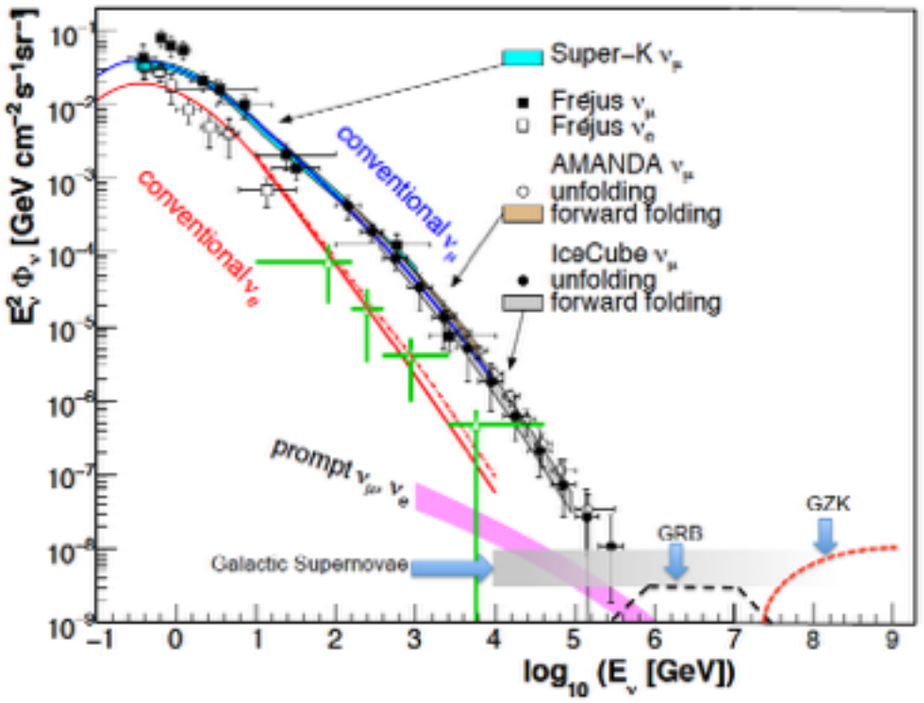


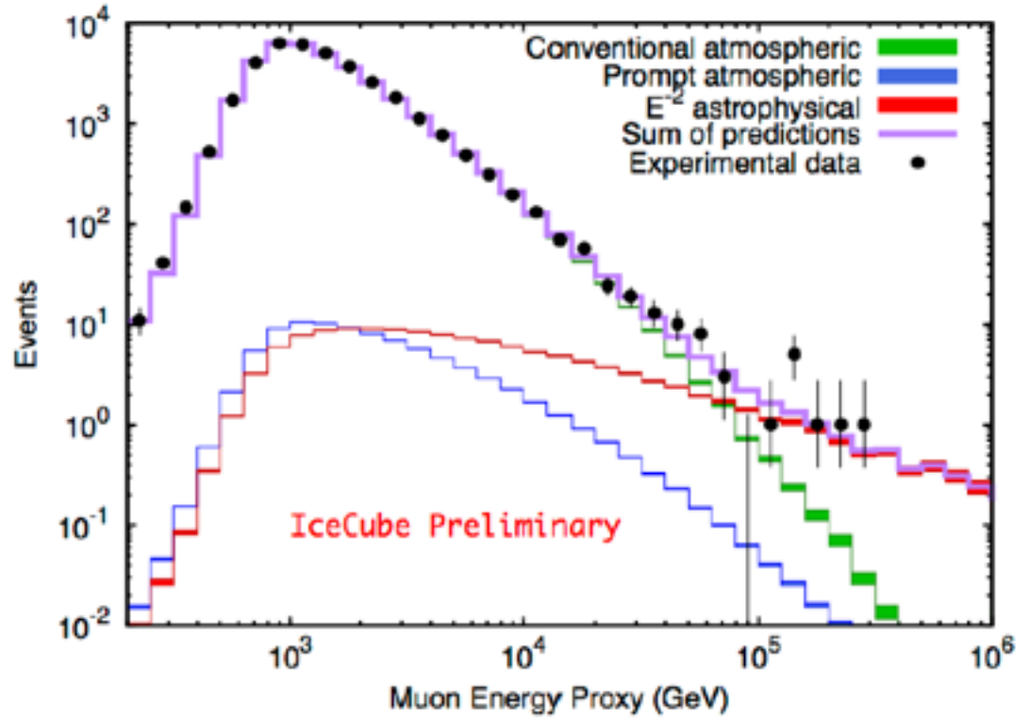


Neutrino Astrophysics: IceCube

Above 100 TeV, atmospheric neutrinos disappear, only cosmic neutrinos

Cosmic neutrinos confirmed in 2 years of IceCube data at 3.7 sigma





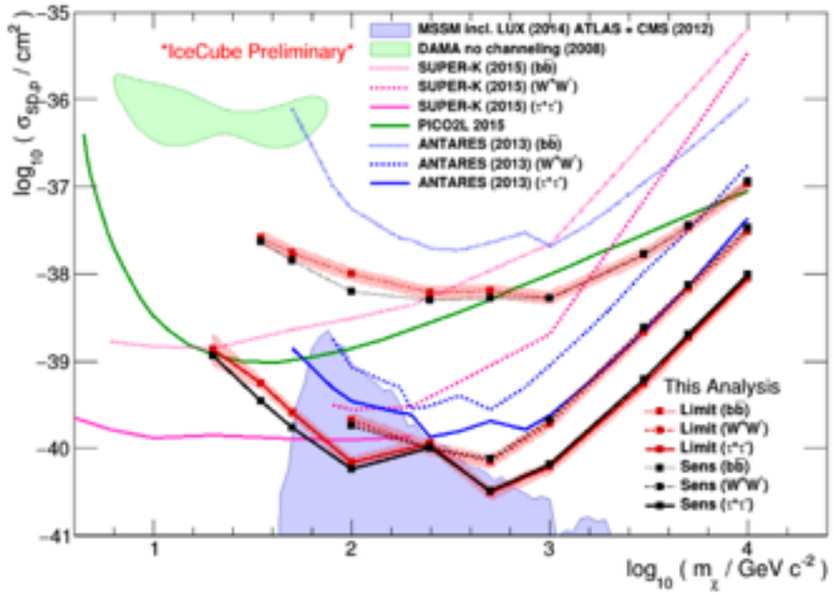
Dark Matter:

WIMP capture and annihilation in the Sun

Produces neutrinos which could be observed on Earth

Nothing seen in one year of IceCube data

Halzen: "I'm too old for limits, I want to see a signal!"



Future circular colliders

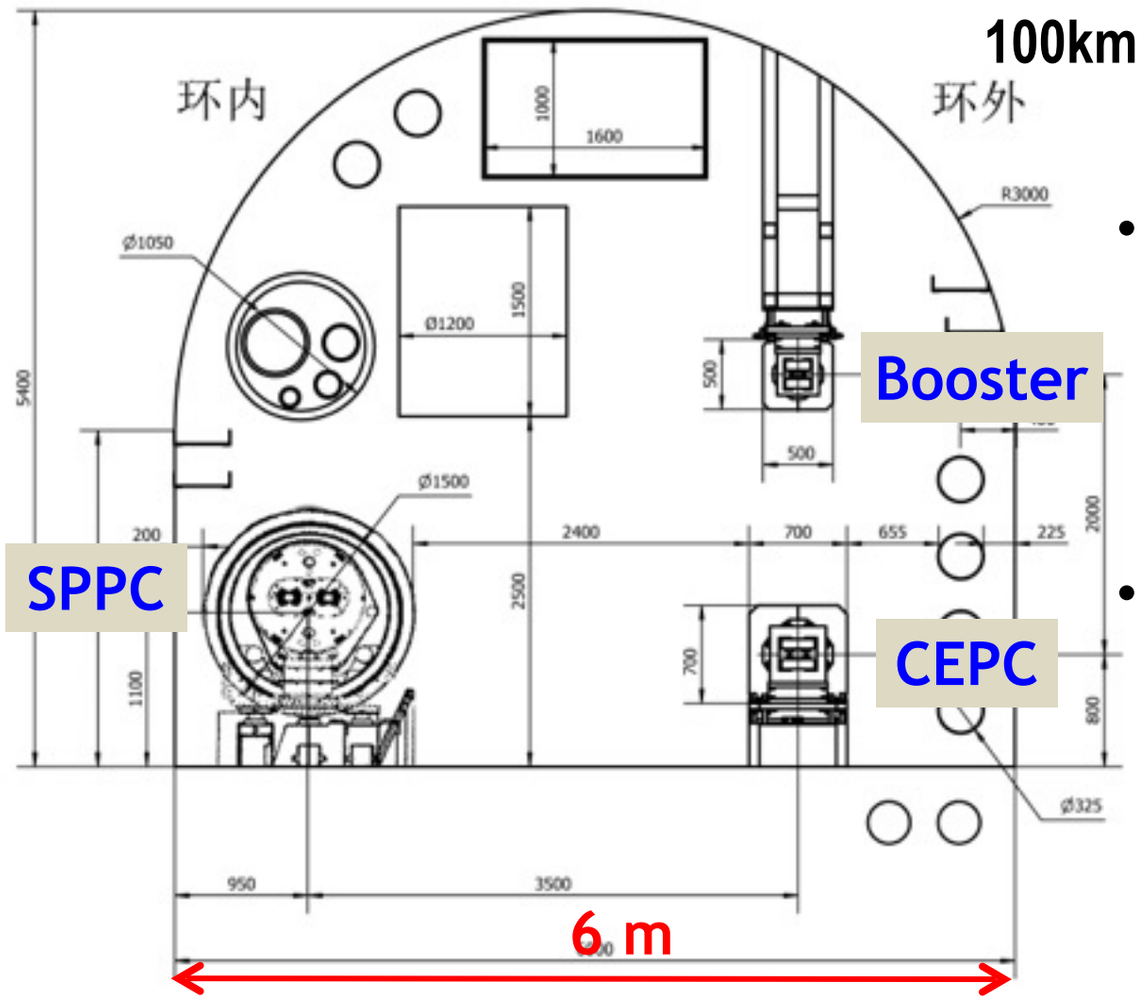
Future **C**ircular Colliders and R&D

CERN **C**hina **C**hicago

Weiren **C**hou

LHC: Last hadron collider?

50km: Gvmt funded
100km: Gvmt funded + business sponsored



- ***e+e-* collider** (CEPC and FCC-ee)
  1. Power consumption
  2. Heat load in the cold region (HOM heating)
  3. Dynamic aperture
- ***pp* collider** (FCC-hh and SPPC):
  1. SC magnet
  2. Heat load in the cold region (SR heating)
  3. Machine protection

→ Common concern

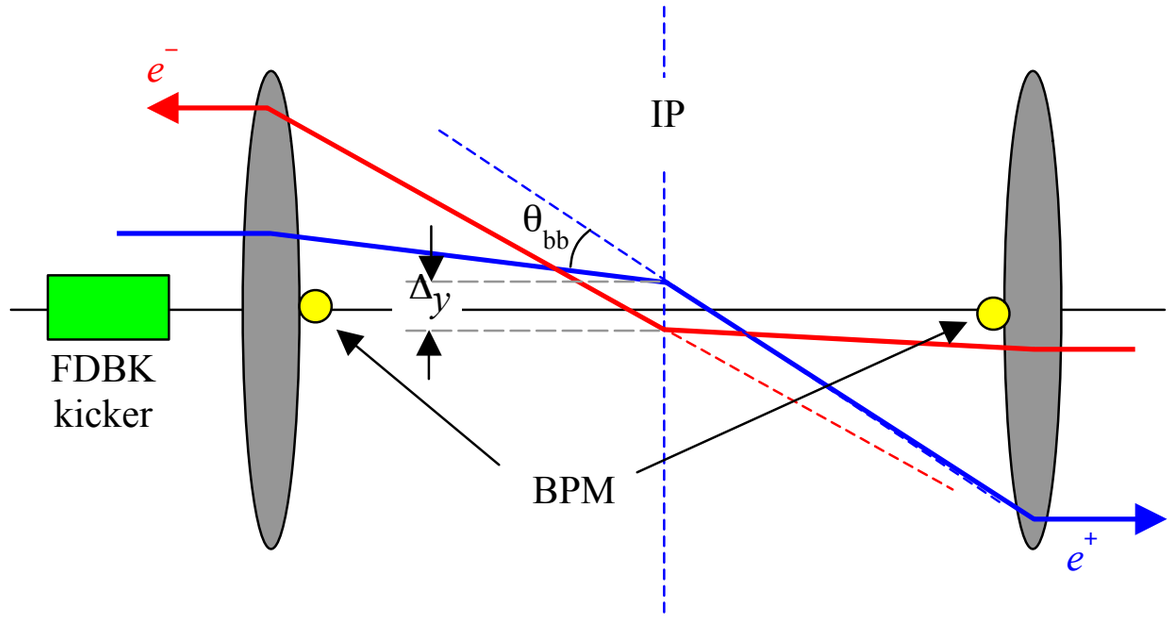
Future linear colliders

- **Linear colliders**
  - ILC
  - CLIC
- **Linacs in**
  - XFEL and LCLC-II
  - ESS
  - PIP-II

Seryi - Future linear colliders

FONT for ILC - also necessary for CLIC?

- Use the strong beam-beam deflection kick for keeping beams in collision
- Sub-nm offsets at IP cause well detectable offsets (micron scale) a few meters downstream



ILC operating scenario: arXiv:1506.07830v1
20 years then possible upgrate to 1 TeV
From plenary:
Q: "Feasibility of ILC options?"
A: "All feasible. 1 TeV the hardest - cost. Options should be discussed as a second priority, need to get it going first."

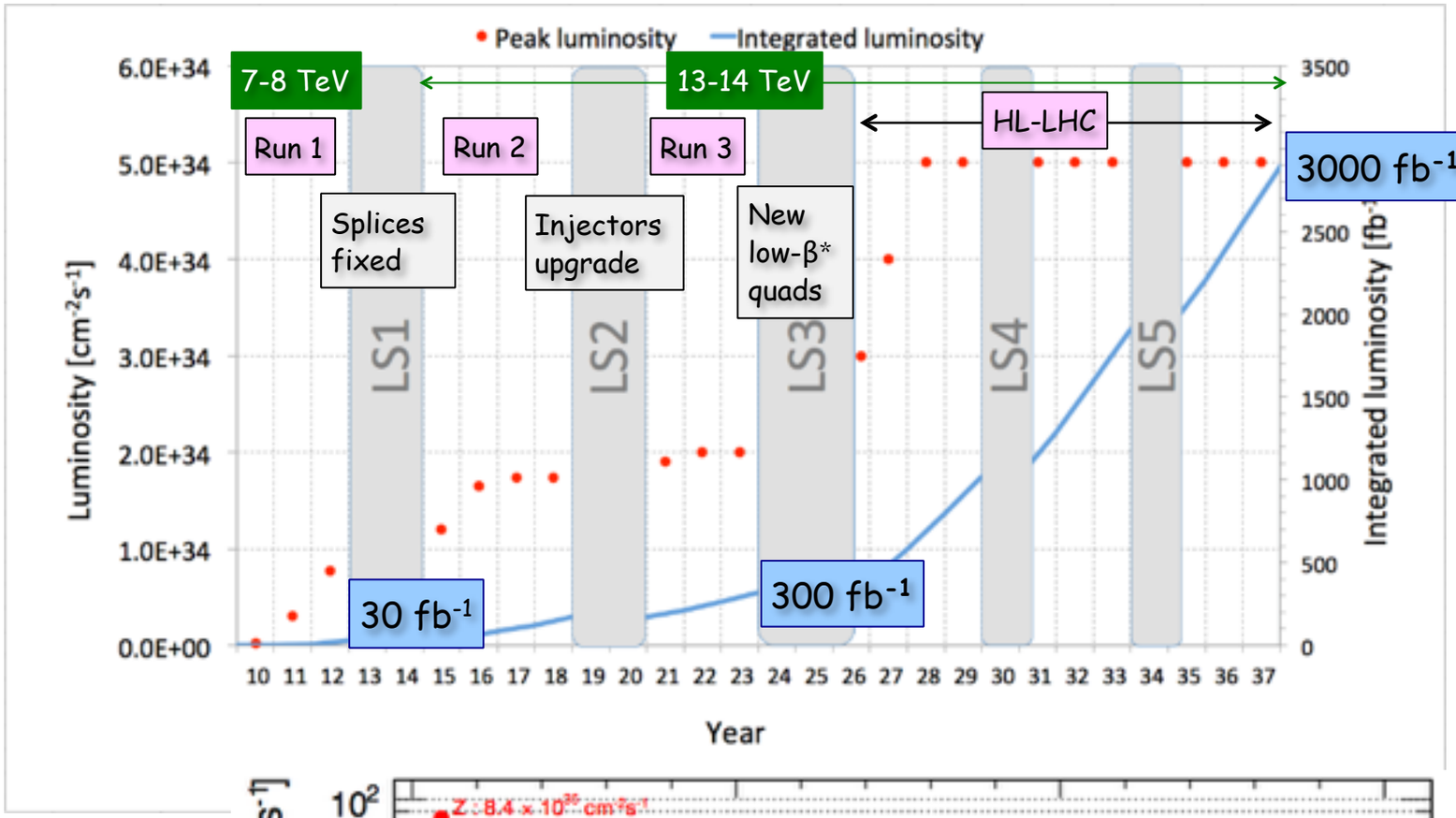
Stage	ILC500			ILC500 LumiUP		
$\sqrt{s}$ [GeV]	500	350	250	500	350	250
$\mathcal{L}$ [fb^{-1}]	500	200	500	3500	-	1500
time [a]	3.7	1.3	3.1	7.5	-	3.1

Dürig - Higgs programme at the ILC

Outlook: physics prospects at high-E colliders

“the disturbing success of the SM”

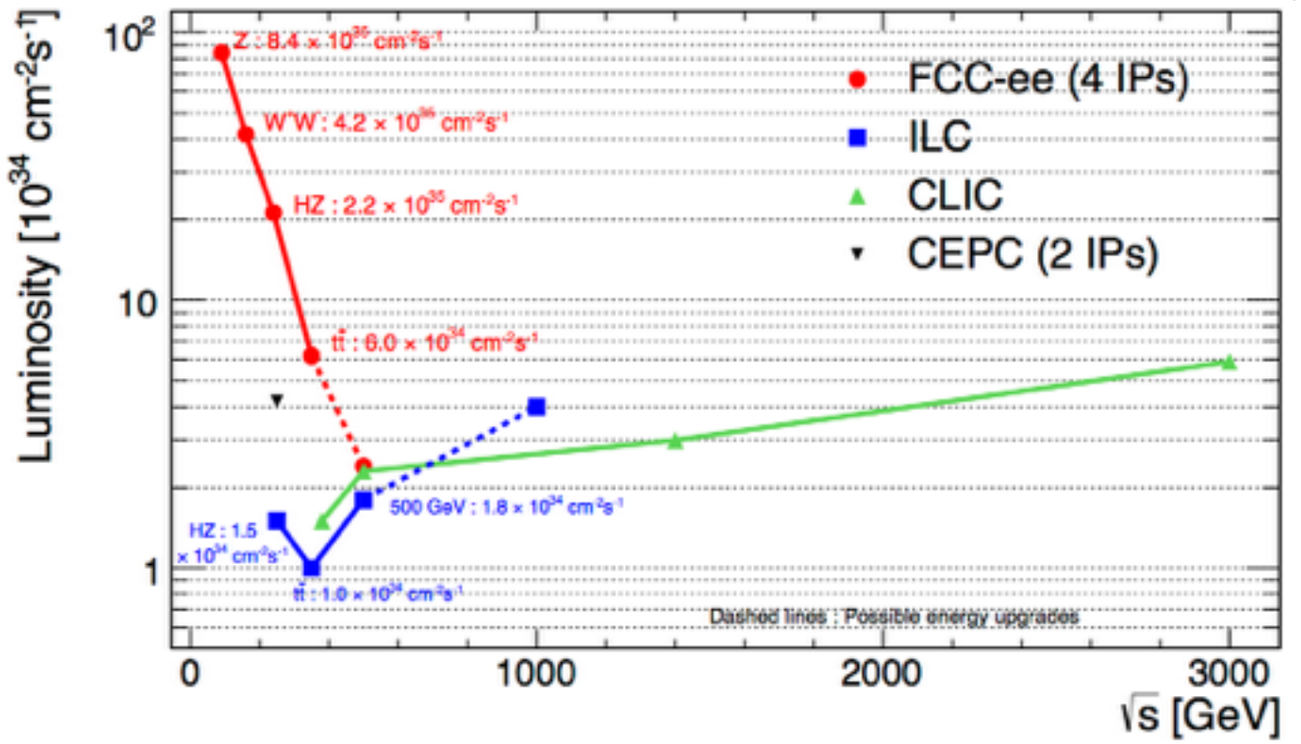
Near and medium term future = LHC and HL-LHC



“synergy between e+e- and pp machines”

Possible future e+e- colliders: centre of mass energy read vs luminosity

Any new physics seen at the LHC will be heavy (since nothing was seen so far). Therefore another machine will be necessary to see the full spectrum.



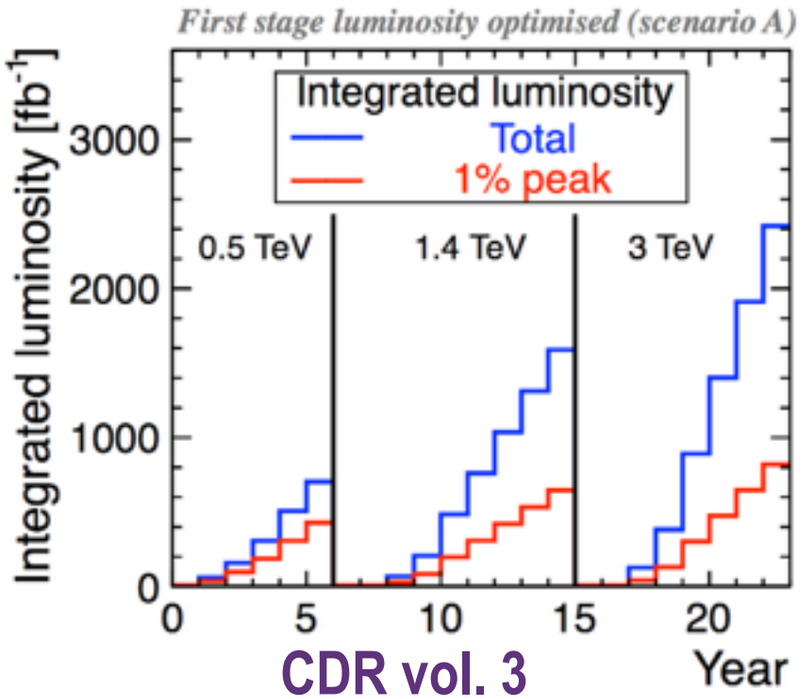
Comments and questions for CLICdp

Our clear staging scenario was appreciated

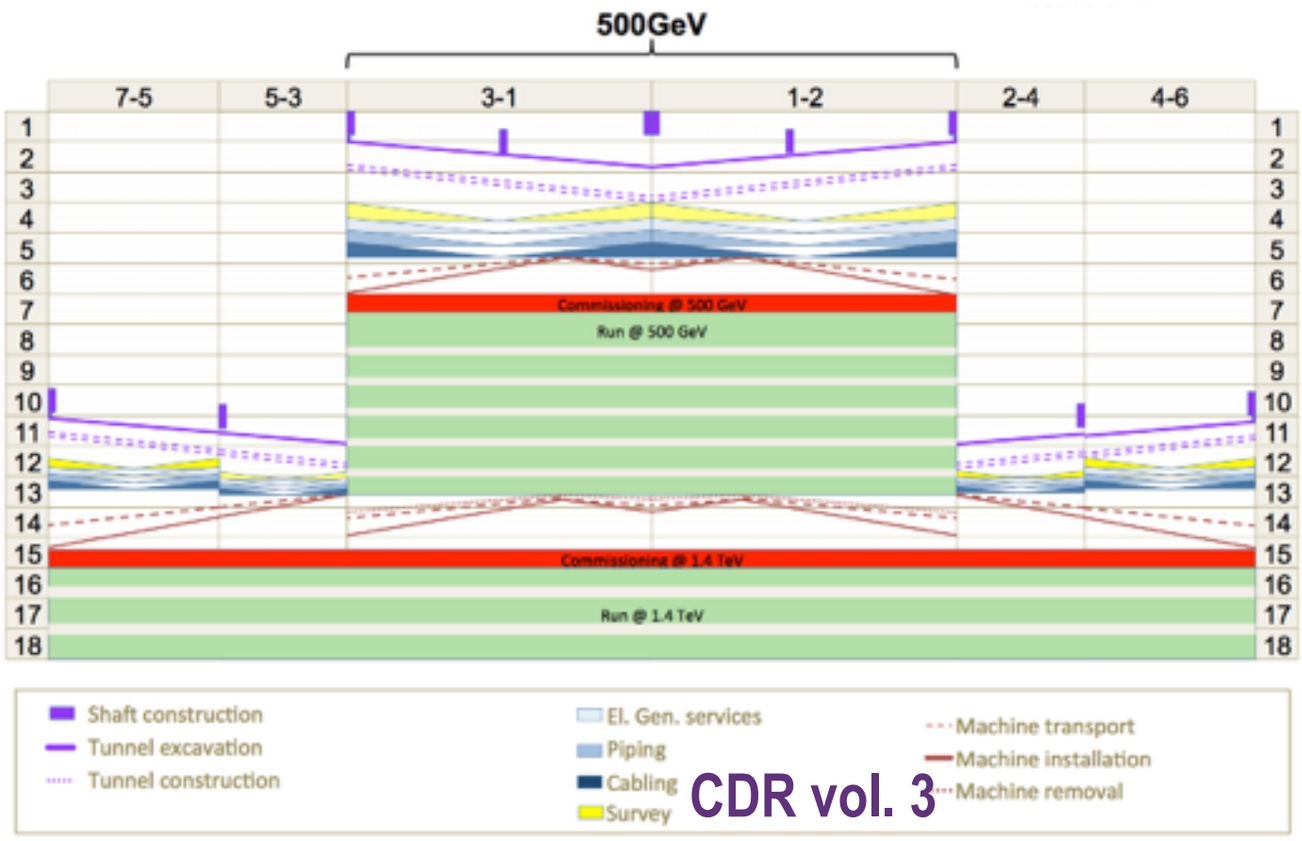
Question regarding construction timeline

Complementarity with hadron collider for BSM

Discussions regarding TPC for CLIC



CDR vol. 3



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Thanks for your help with the talk!