News from CERN

- CERN Membership
- Fixed Target
- LHC

R. Heuer

88th Plenary ECFA,
Thursday, 25th November 2010

News from CERN

Fixed Target

Delivered PoT after end of proton run:

CNGS achieved (expected) 4.02 (3.83) 10^{19}

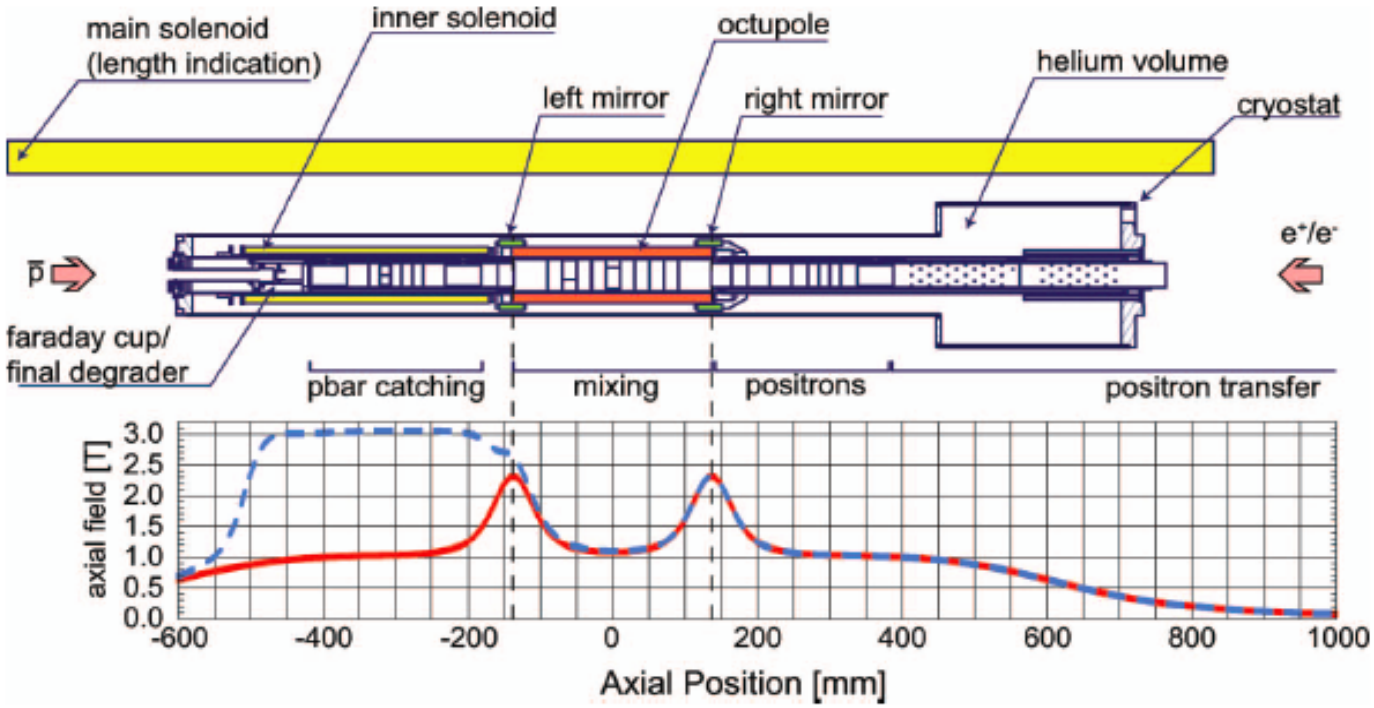
nTOF achieved (expected) 1.19 (0.9) 10^{19}

ALPHA

Antimatter studies at the AD

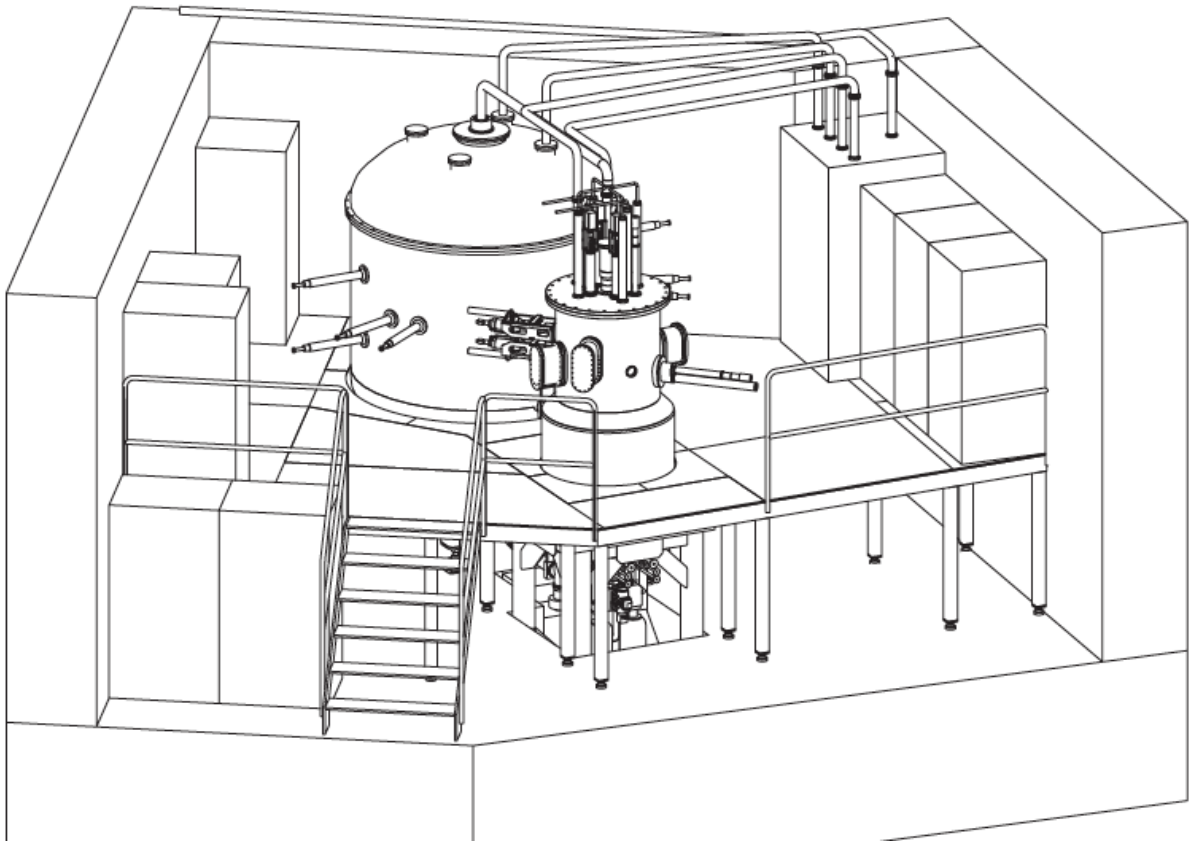
- 4 experiments (ALPHA, ATRAP, ASACUSA, AEGIS)
- First results of anti-H production and trapping published

38 anti H confined for the first time in a wall-free trap



CLOUD experiment

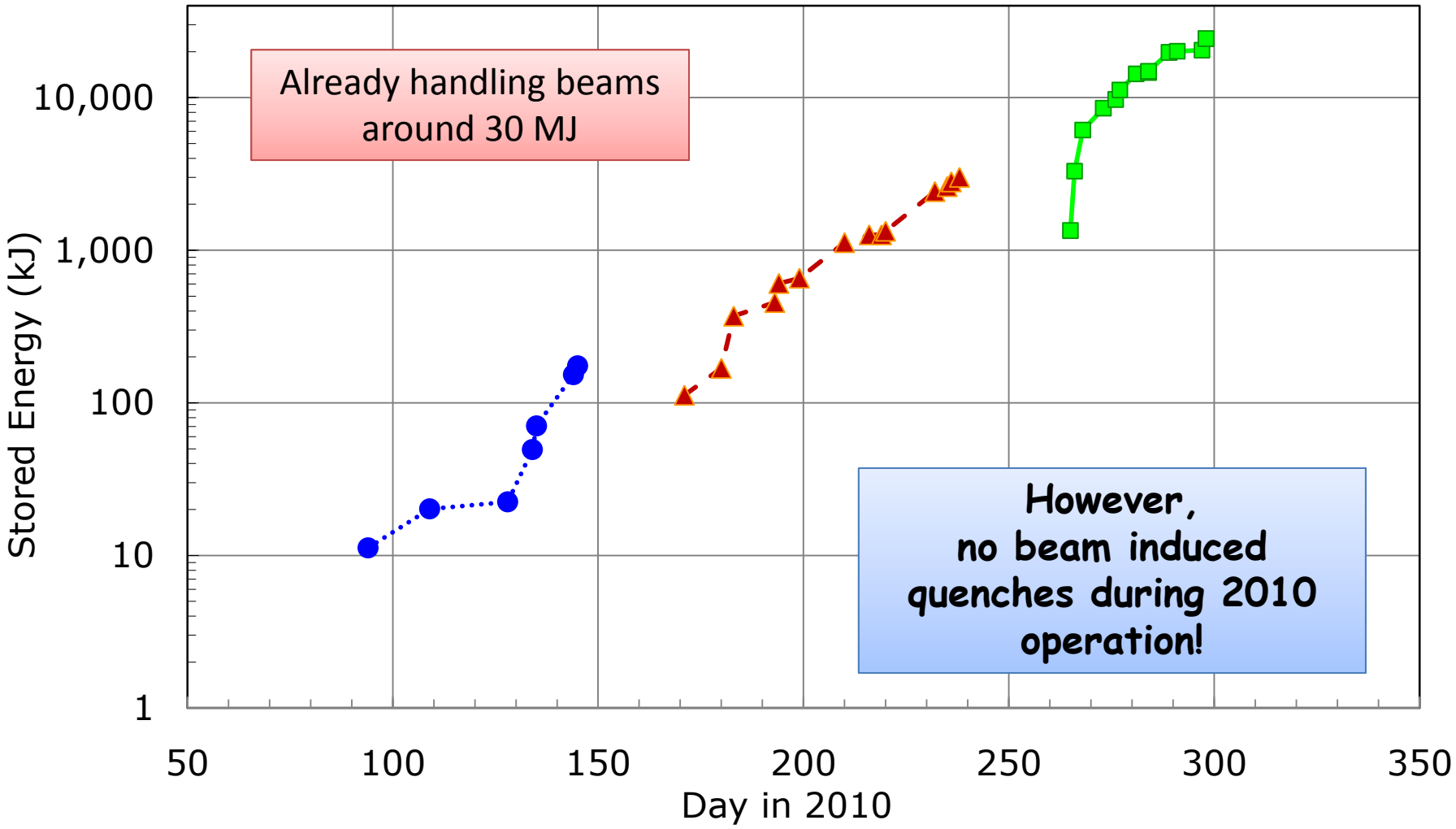
- A unique facility: an high volume chamber with precision controlled environmental parameters **and** a particle beam



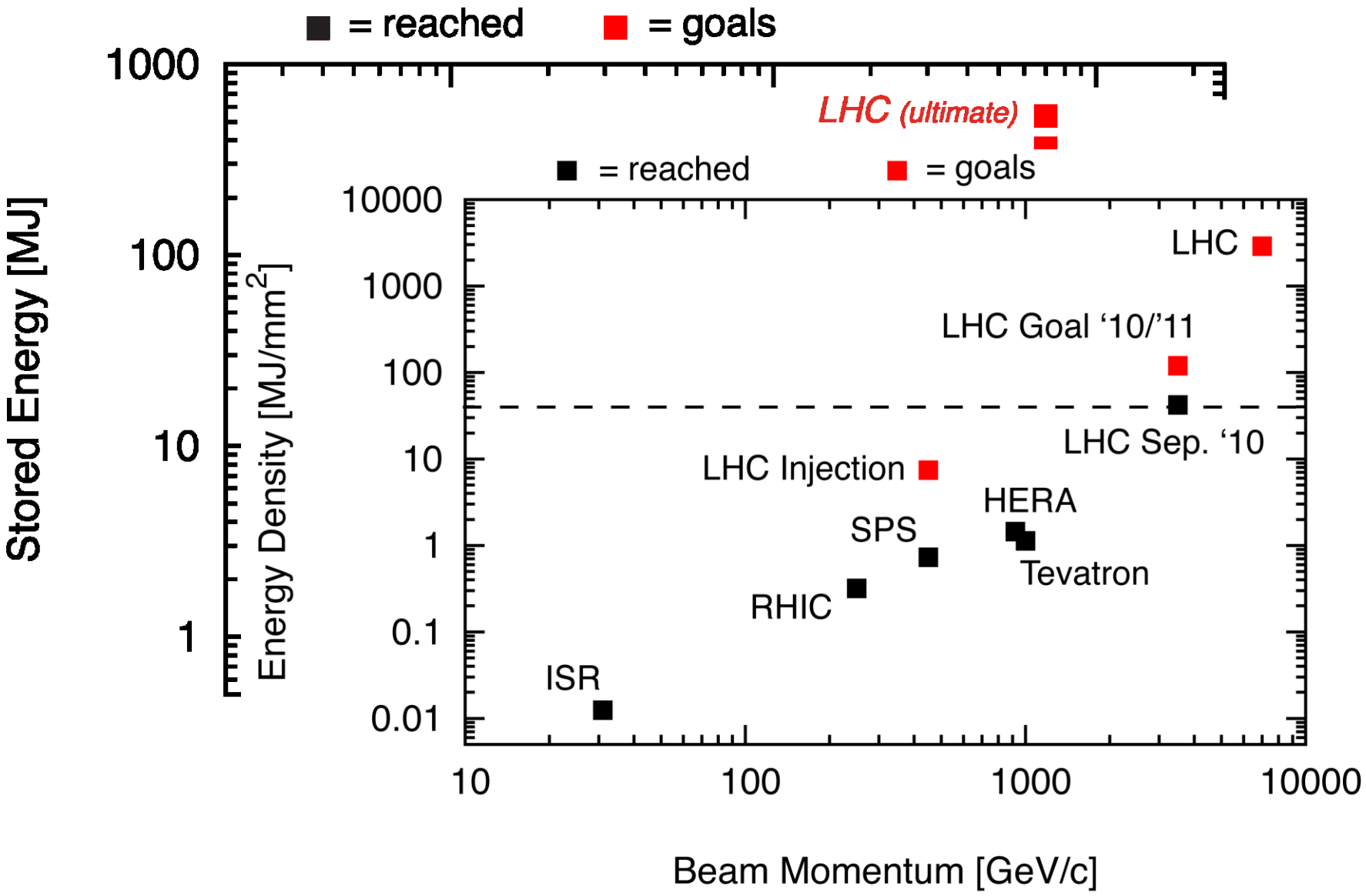
News from CERN

LHC

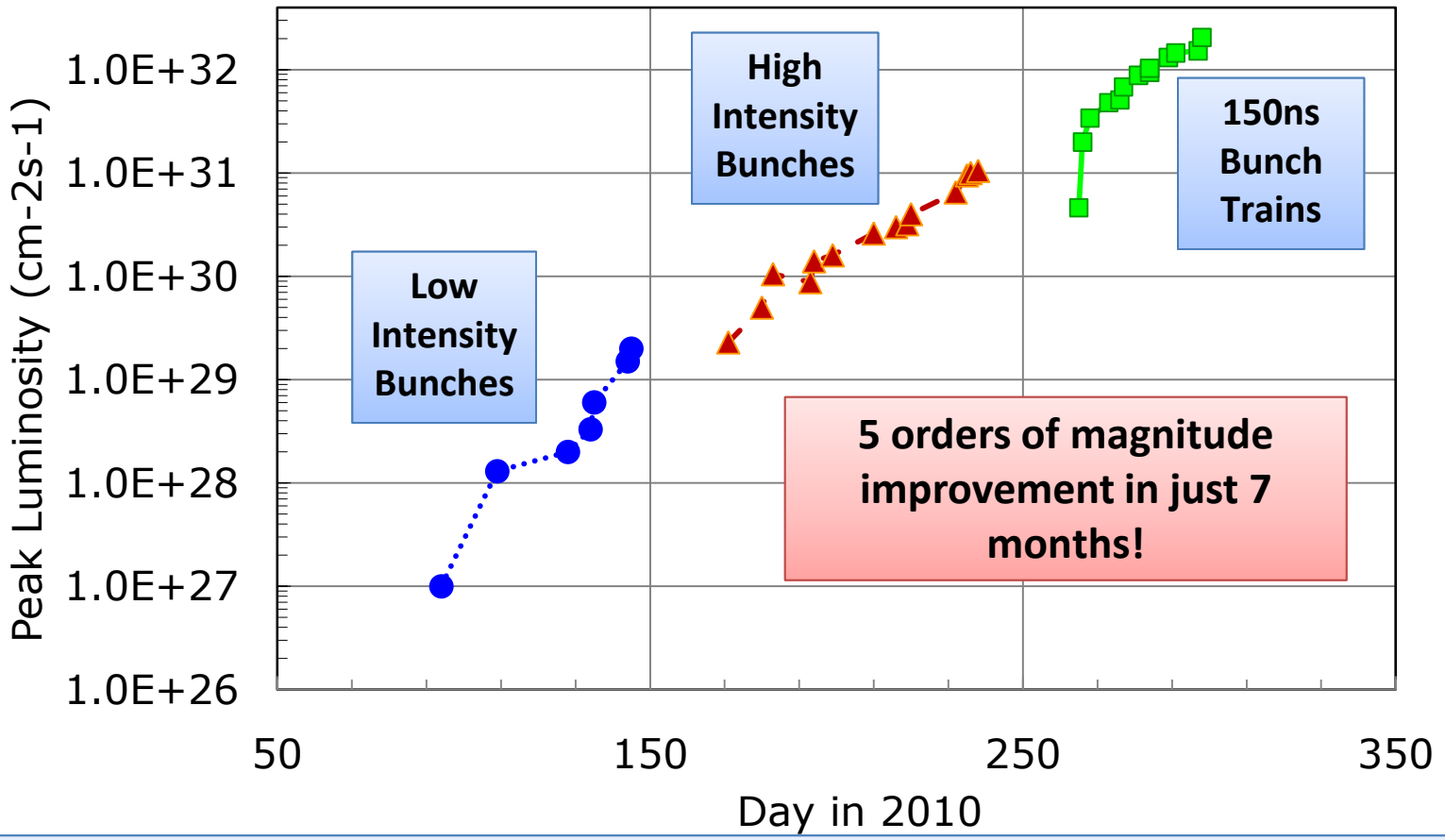
Increasing Stored Energy in the Beam



Stored Energy in the LHC

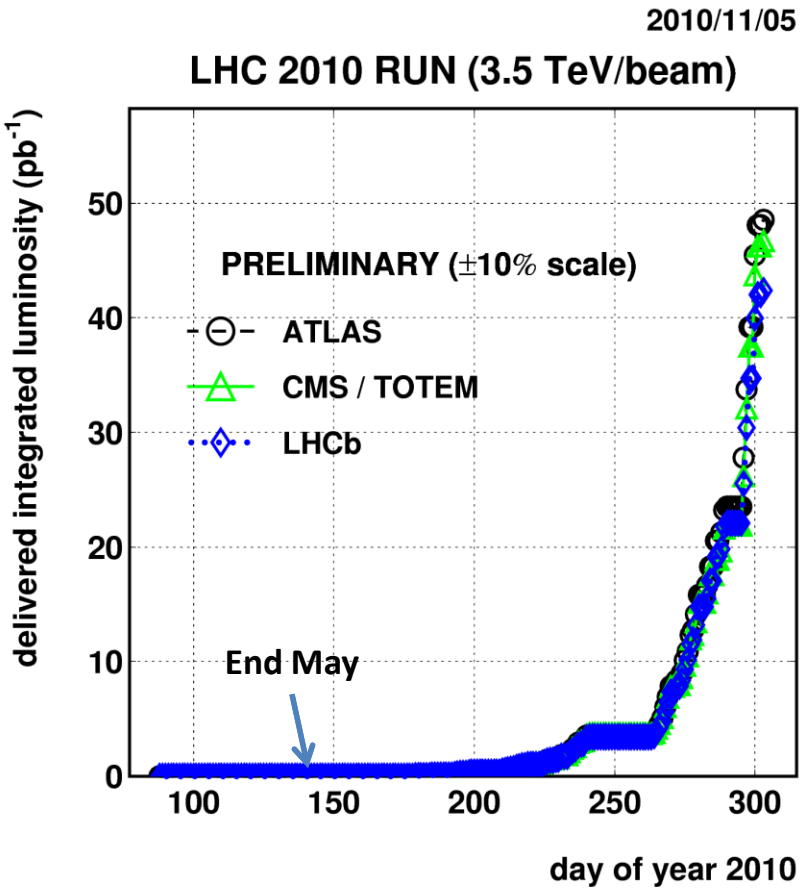


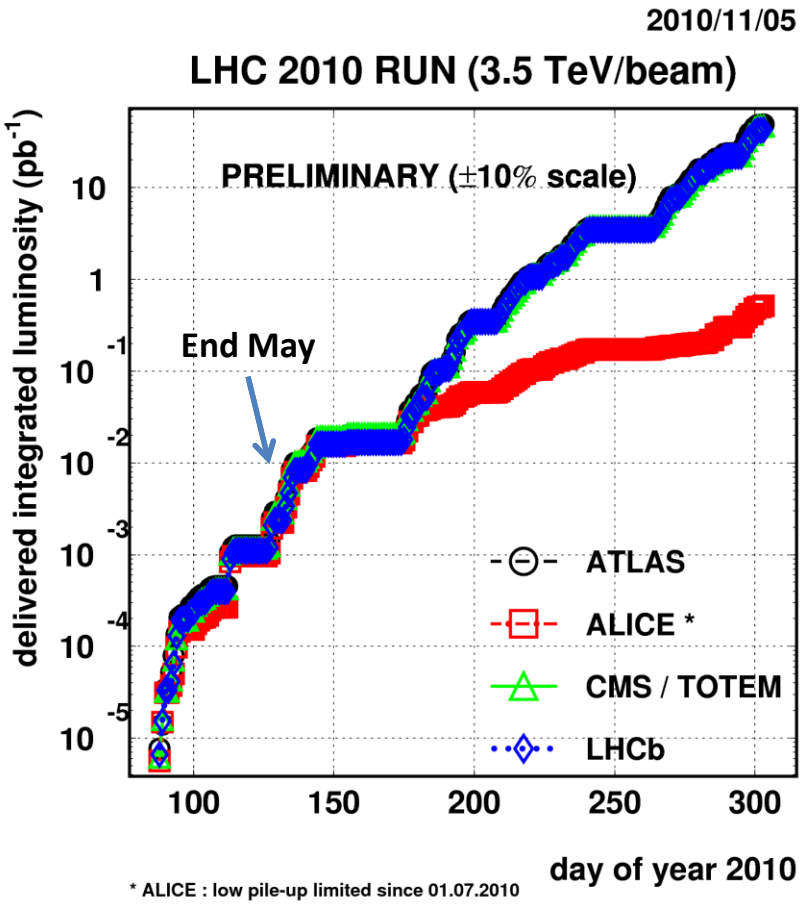
LHC Proton Run 2010



At each change in the operating conditions of the machine a concentrated period of Machine development was used to set-up the new scheme, establish the collimation and machine protection and qualify it.

2010 Proton Run





Excellent Performance of the LHC and its Injectors.

Stepping up of the number of bunches went smoothly and safely – good control over the machine parameters

Reproducibility of the machine was good – eg <100μm in collimator positioning wrt. orbit over several weeks.

Good Surprises …

Can Routinely inject accelerate and collide beams with a normalized emittance much smaller than nominal.

(LHC Design ε_n = 3.75μm ~2.2 routinely achieved at the start of physics.

Single beam lifetime very high >>100h – excellent vacuum

Lifetime in collisions still very good, at around 25hours

- in spite of the large beam-beam tune shift (approaching 0.02)
- Luminosity lifetime around 10-15 hours coming mainly from emittance growth.

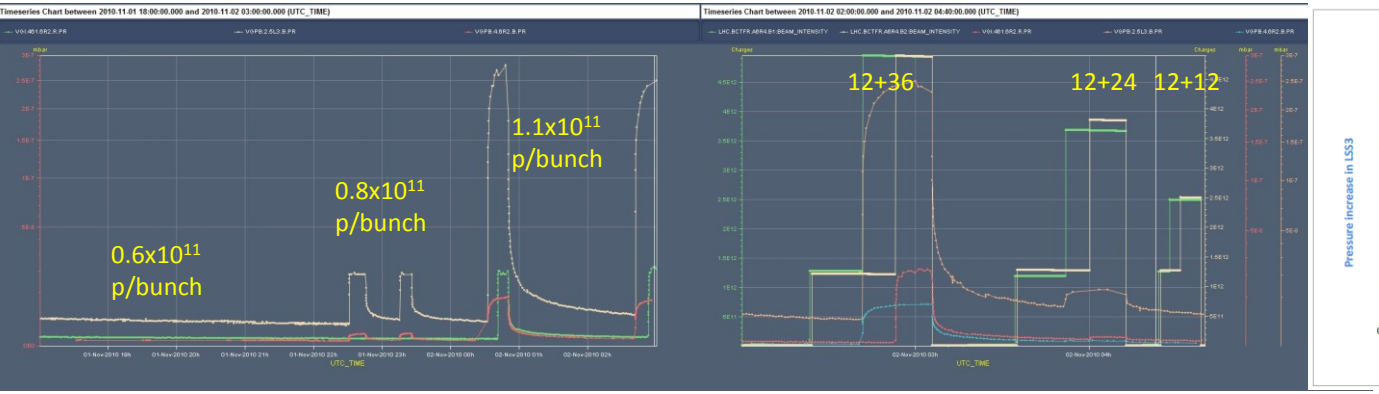
Measurements of the aperture in the inner triplets show that we have more space than we thought

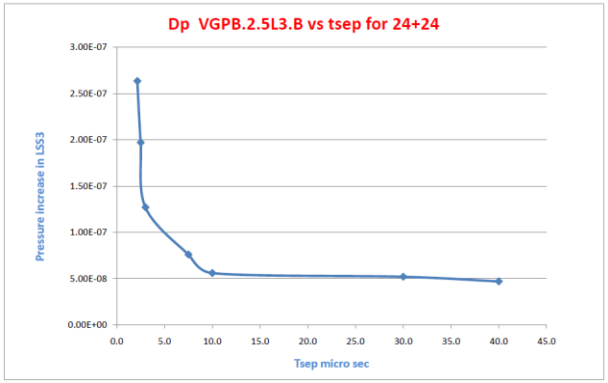
- Better alignment of of components, well controlled beta-beating (<20%), excellent orbit control and stability
- More margin – either to squeeze further, or increase the crossing angle.

… all opens new possibilities for the future …

Electron Cloud Studies

- **Systematic measurements of pressure rise in the straight sections and heat load in the arcs for different filling patterns to provide input for simulations and guide predictions:**
  - **Dependence on bunch intensity**
  - **Dependence on bunch train length**
  - **Dependence on bunch train spacing**
- **Comparison between pressure rise before and after scrubbing run with 12+36 bunches at 450 GeV (-> reduction by ~1 decade in ~3 days)**



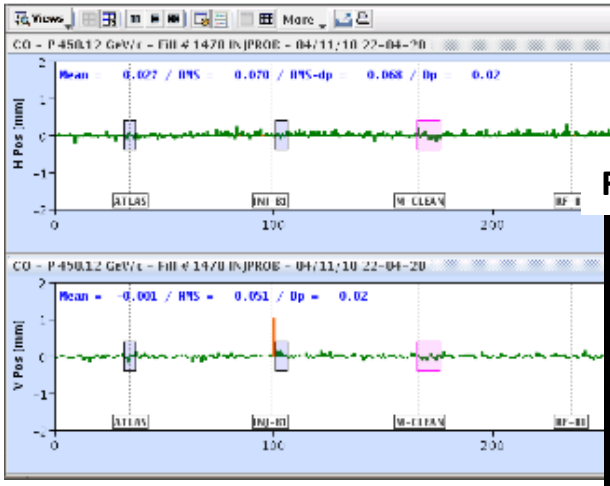


Important input for discussions concerning the strategy for 2011.

Changeover to Ions

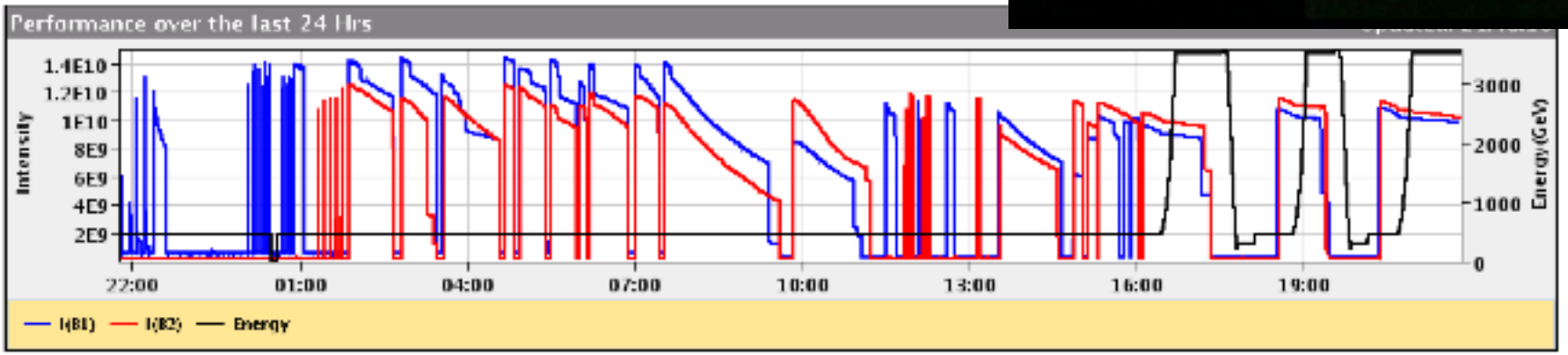
Thursday 4th November – Switched from Proton to $^{208}Pb^{82+}$

Circulating beam quickly established: identical magnetic machine.



First ever Synchrotron light from Nuclei

First 24 hours



Beam1 : injection and capture

Beam2: injection and capture

Optics Checks, Beam Instrumentation & Collimation

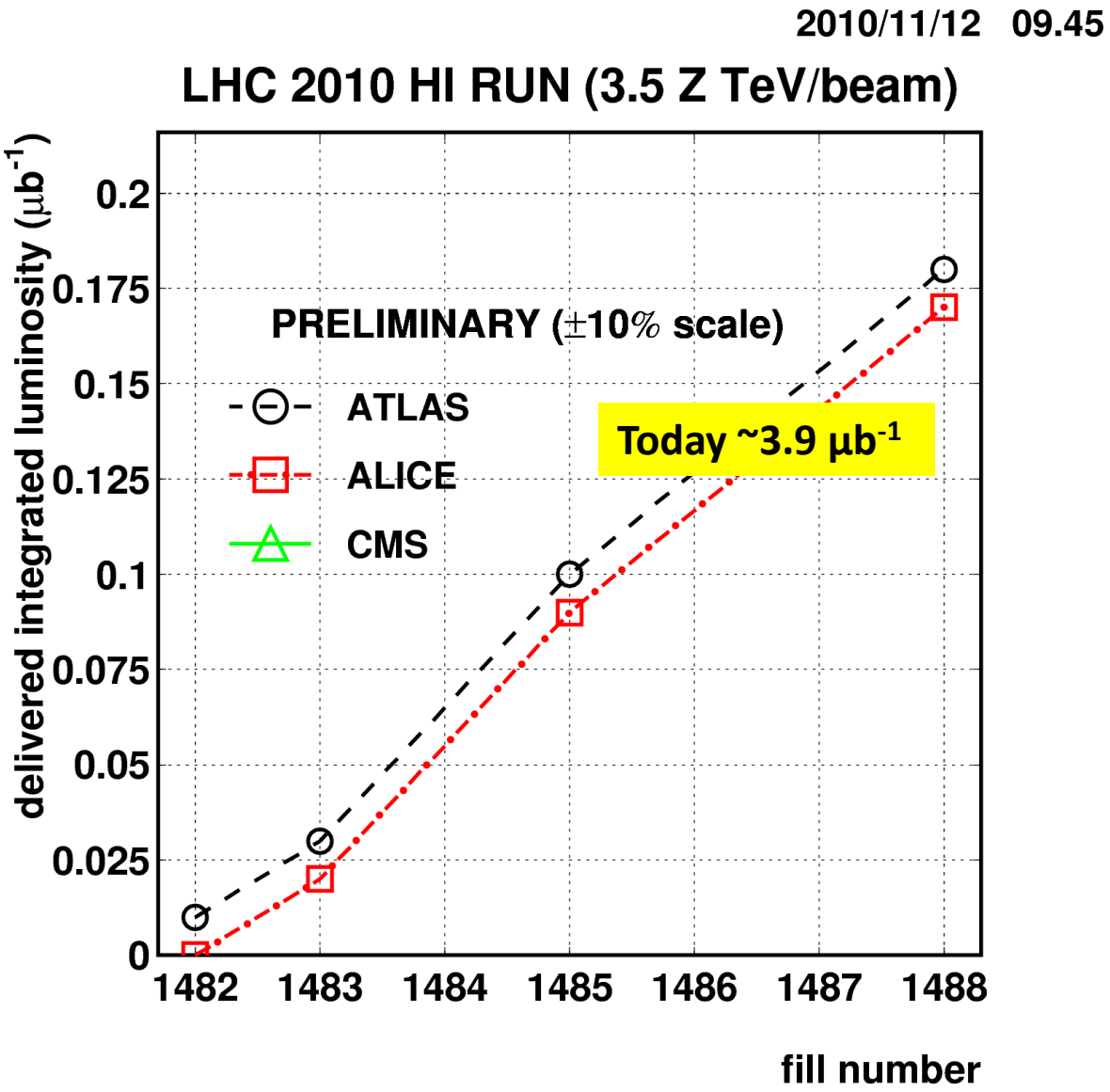
First ramp, collimation at high energy and squeeze

Heavy Ion Run 2010

Presently still in the period of increasing the performance.

4 physics fills so far:

2x2 bunches
5x5 bunches (4 crossings)
17x17 bunches (16 crossings)
69x69 bunches (66 crossings)

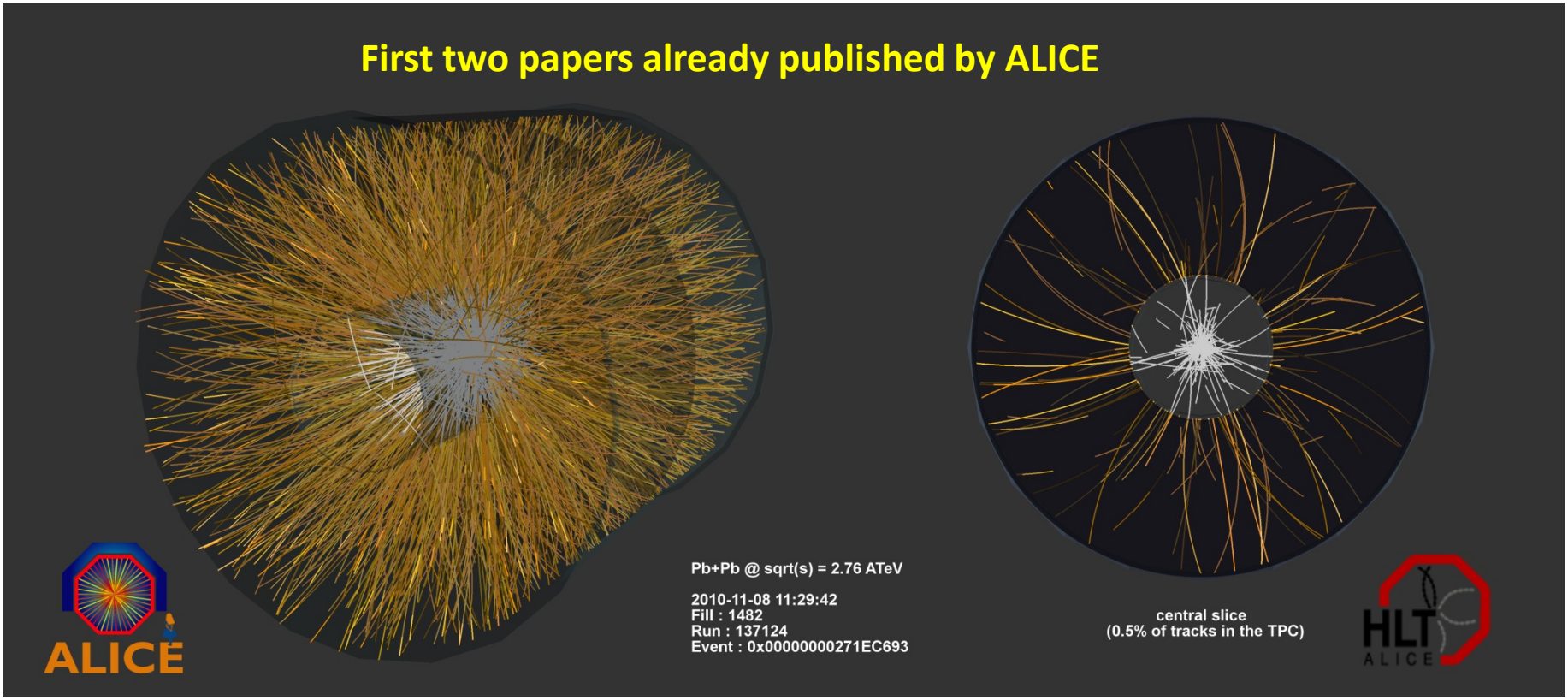


Heavy Ion Run

Monday 9th November: First Stable Beams 2x2 bunches ions.
Tuesday 10th November: Physics with 17x17 bunches of ions.
Thursday 12th November: Physics with 69x69 bunches

Luminosity performance ~$2 \times 10^{+23}$ cm^{-2} s^{-1} per bunch crossing

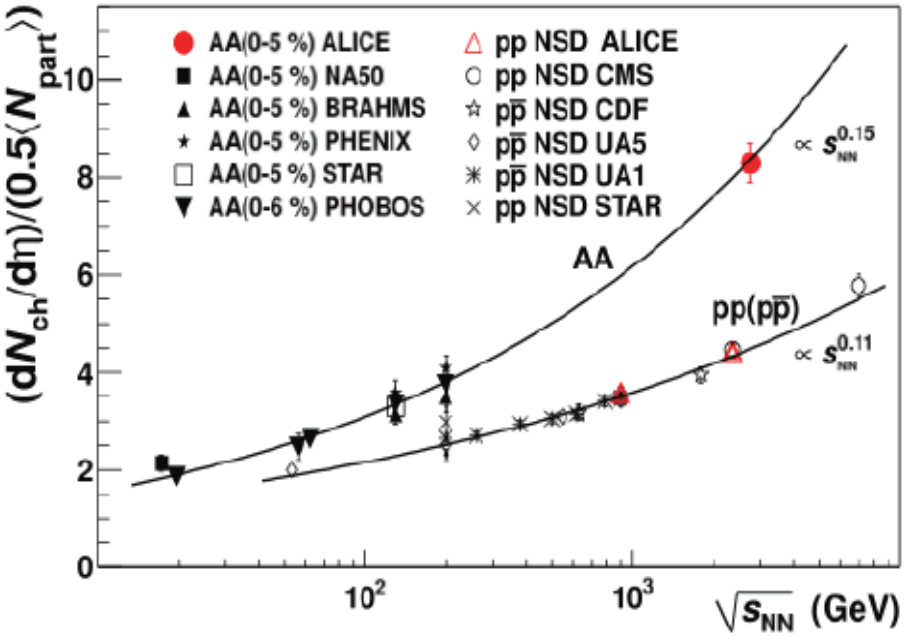
First two papers already published by ALICE

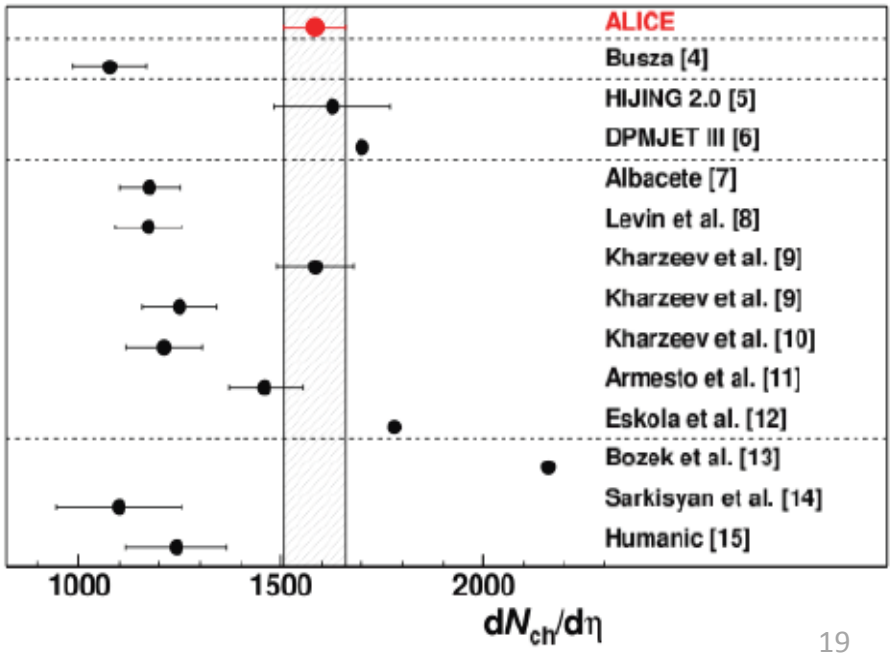


Charged Particle Multiplicity

- Charged Particle Multiplicity
  - ~ 2.2 x RHIC
  - higher than all phenomenological extrapolations based on lower energies (1000 – 1300)
  - well in the range of most event generator predictions

$$\mathrm{d}N_{\mathrm{ch}}/\mathrm{d}\eta = 1584 \pm 4\ (stat.) \pm 76\ (syst.)$$

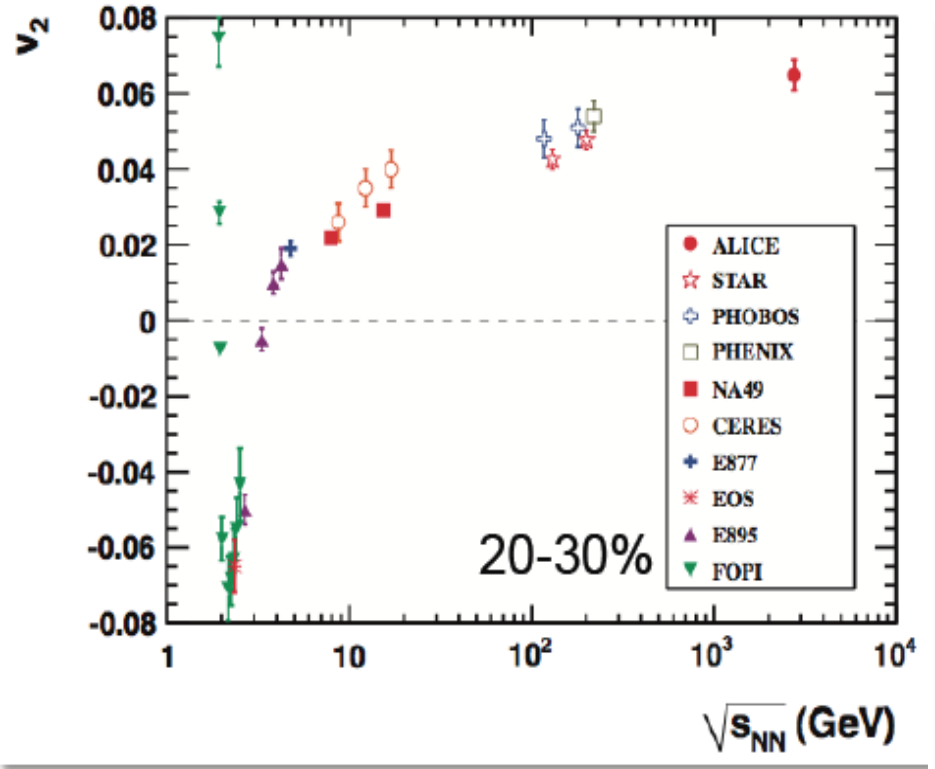




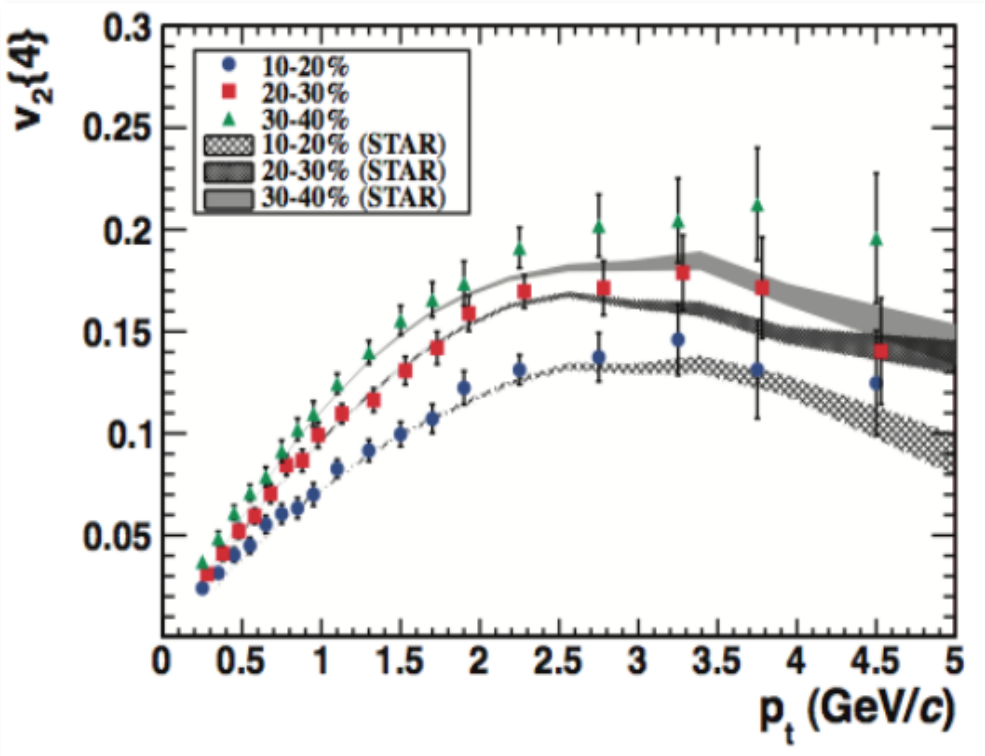
http://xxx.lanl.gov/abs/1011.3916

Elliptic Flow

- Hydrodynamic predictions 'spot on'
  - differential flow very similar to RHIC => QGP is still an 'ideal liquid'
  - average flow is higher because $\langle p_T \rangle$ increases from RHIC to LHC



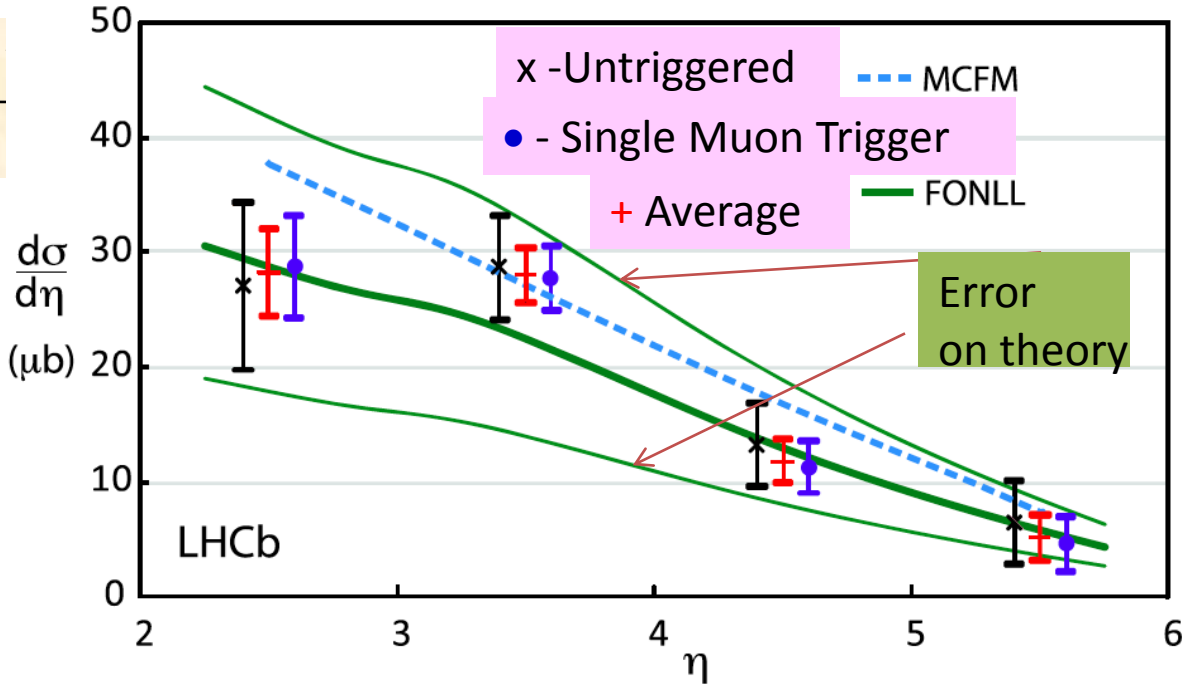
http://xxx.lanl.gov/abs/1011.3914



Very large $b\bar{b}$ and $c\bar{c}$ cross-sections at LHC → Good prospects for many exciting measurements

- *Measure $\sigma(pp \to bbX)$ using $b \to \overline{D^0} X \mu^- \nu$, $D^0 \to K^- \pi^+$, ~280 events*

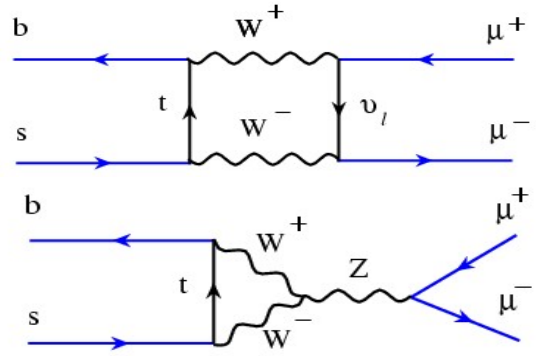
$$\sigma = \frac{\#\text{ of detected } D^0\mu^- \ \&\ \bar{D}^0\mu}{L \text{ x efficiency x } 2}$$

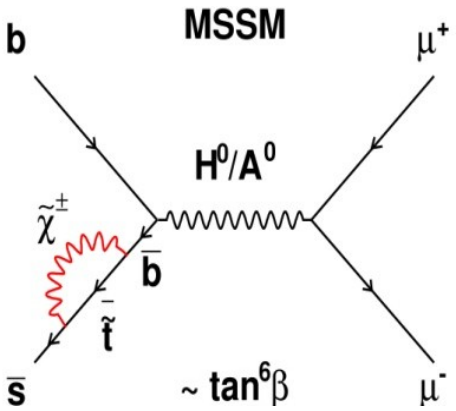


- ***In $2<\eta<6$, $(75.3 \pm 5.4 \pm 13.0)$ μb LEP frag***
- *In $2<\eta<6$, 89.6 μb Tevatron frag*
- ***Also measured charm cross-section, ~20x b***

Search for $B_s \rightarrow \mu\mu$ decay

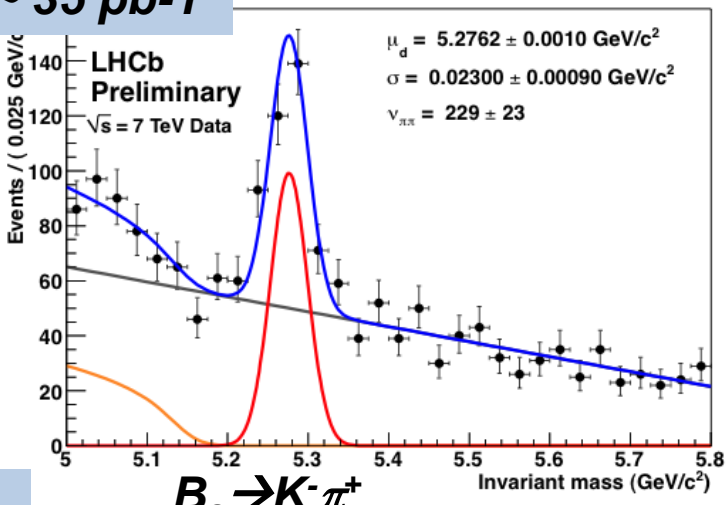
- *Super rare decay in SM with well predicted* $BR(B_s \rightarrow \mu\mu) = (3.2\pm0.2)\times10^{-9}$
  $BR(B_d \rightarrow \mu\mu) = (1.1\pm0.1)\times10^{-10}$
- *Sensitive to NP, in particular new scalars*
  In MSSM: $BR \propto \tan^6\beta / M^4_A$





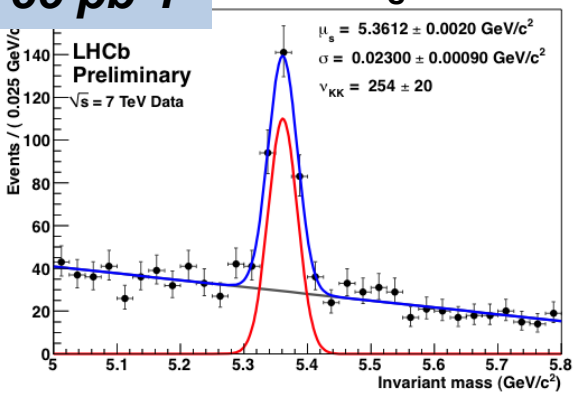
~ 35 pb-1

$B^0 \rightarrow \pi^+\pi^-$



~ 35 pb-1

$B_s \rightarrow K^-\pi^+$



Main control channels:
$B \rightarrow \pi\pi$, $B_s \rightarrow K\pi$

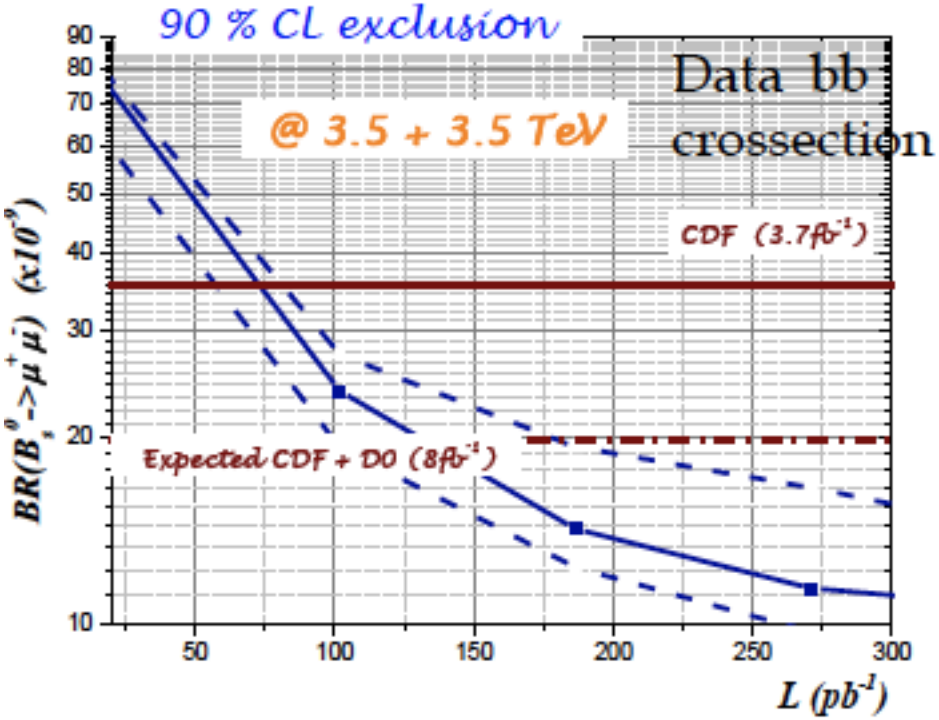
Observed yields:

229±23 ev. for $B^0 \rightarrow \pi\pi$ *with BR ~* $5 \cdot 10^{-6}$

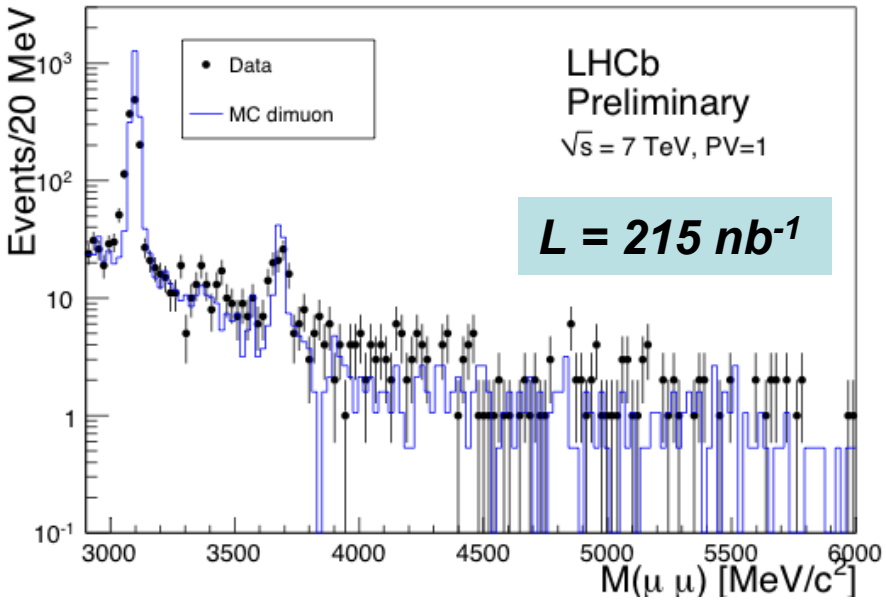
254±20 ev. for $B_s \rightarrow K\pi$ *with BR ~* $3 \cdot 10^{-5}$

$B_s \rightarrow \mu\mu$

For the SM prediction LHCb expects 10 signal events in 1 fb^{-1}



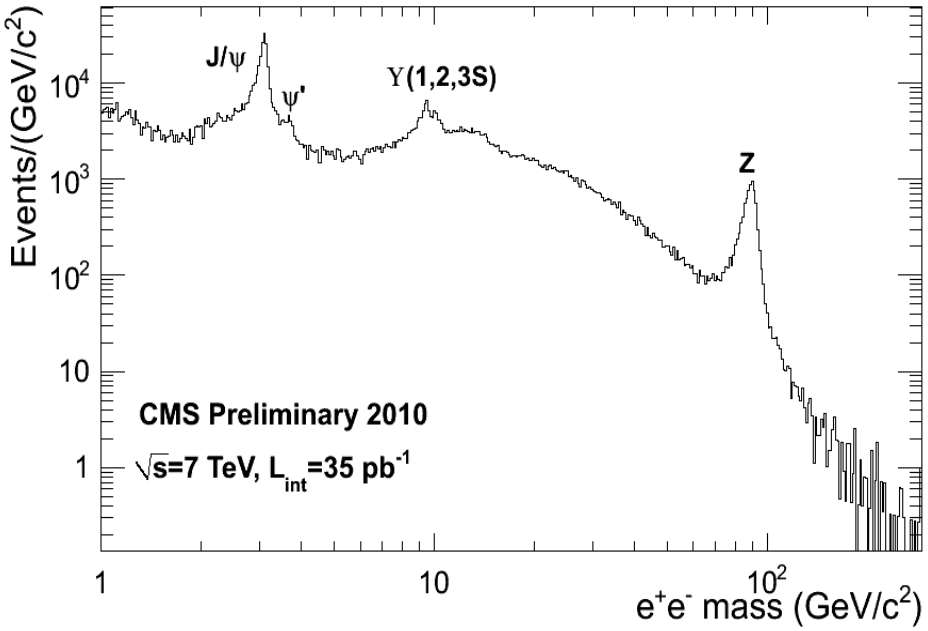
Background expected from MC is in good agreement with data

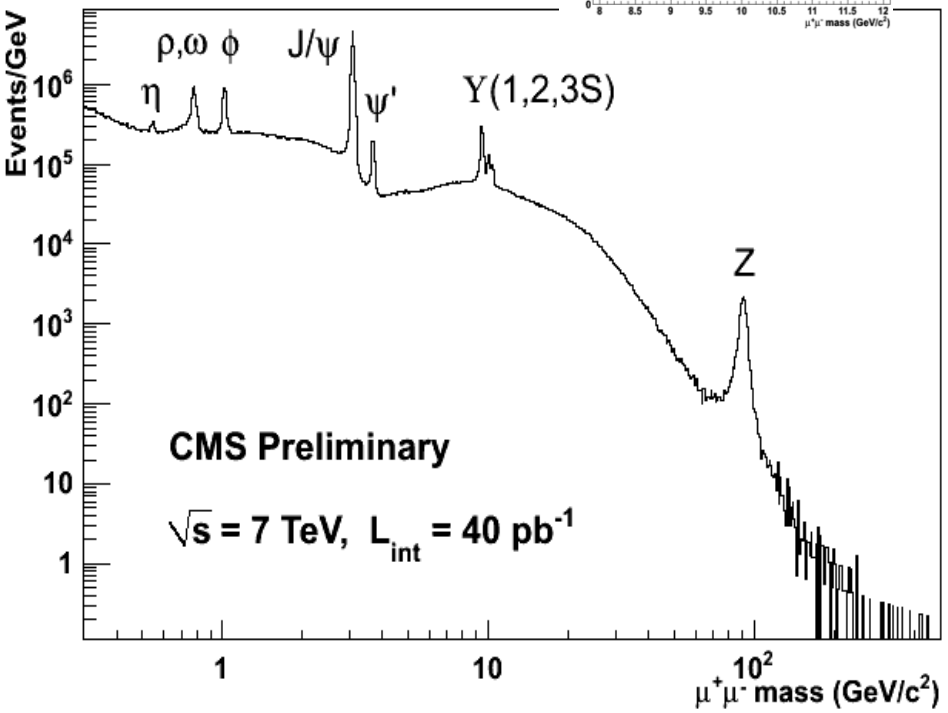


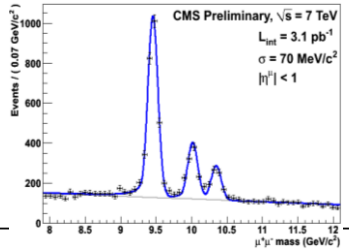
Very interesting sensitivity possible even with 40 pb^{-1} !!!

With L ~ 1 fb^{-1} exclusion of SM enhancement up to BR($B_s \rightarrow \mu\mu$) ~ 7×10^{-9}

The Standard Model at 7TeV







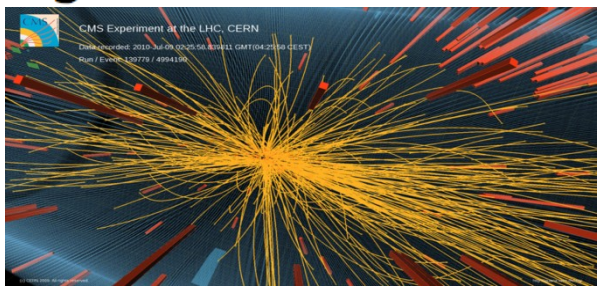
The “ridge”: the first surprising result from LHC

High Energy Physics - Experiment arXiv:1009.4122v1 [hep-ex]

Observation of Long-Range Near-Side Angular Correlations in Proton-Proton Collisions at the LHC

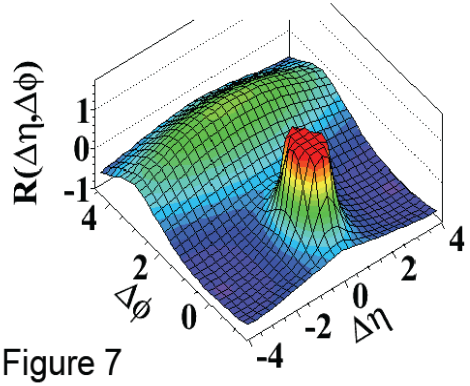
CMS Collaboration

(Submitted on 21 Sep 2010) **JHEP Sep. 27**



MinBias

(b) MinBias, 1.0GeV/c<p_T<3.0GeV/c



high multiplicity (N>110)

(d) N>110, 1.0GeV/c<p_T<3.0GeV/c

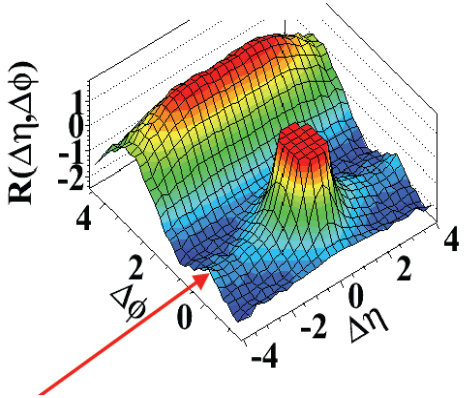
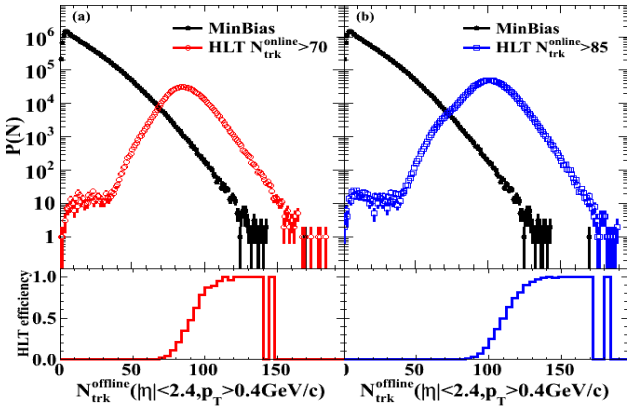
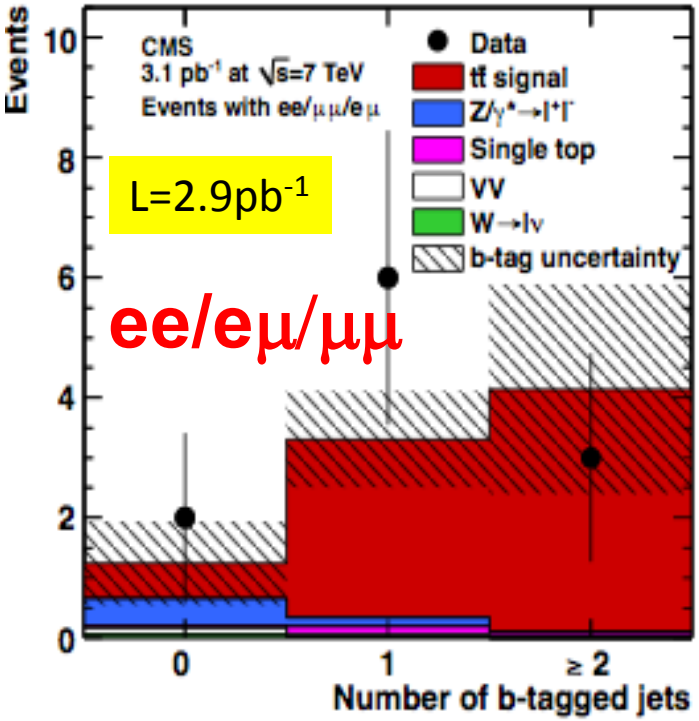


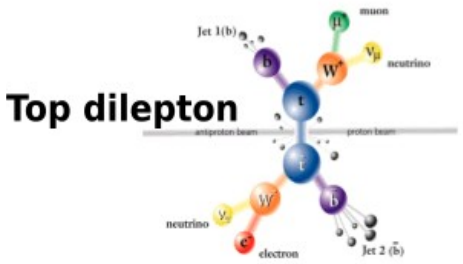
Figure 7



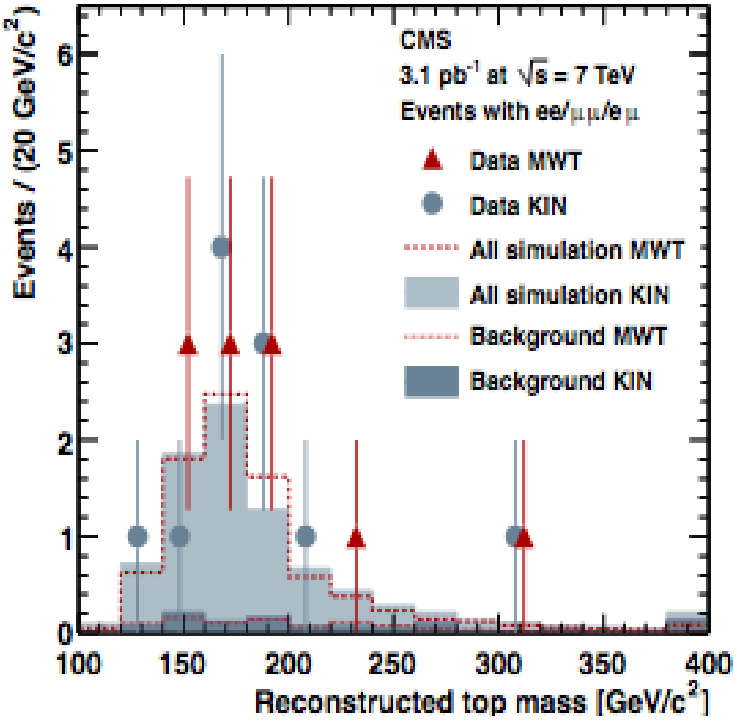
Top: dileptons+jets

- Full selection applied: Z-bosonVeto, |M(ll)-M(Z)|>15 GeV
- MET >30 (20) GeV in ee,μμ, (eμ); N(jets)≥2





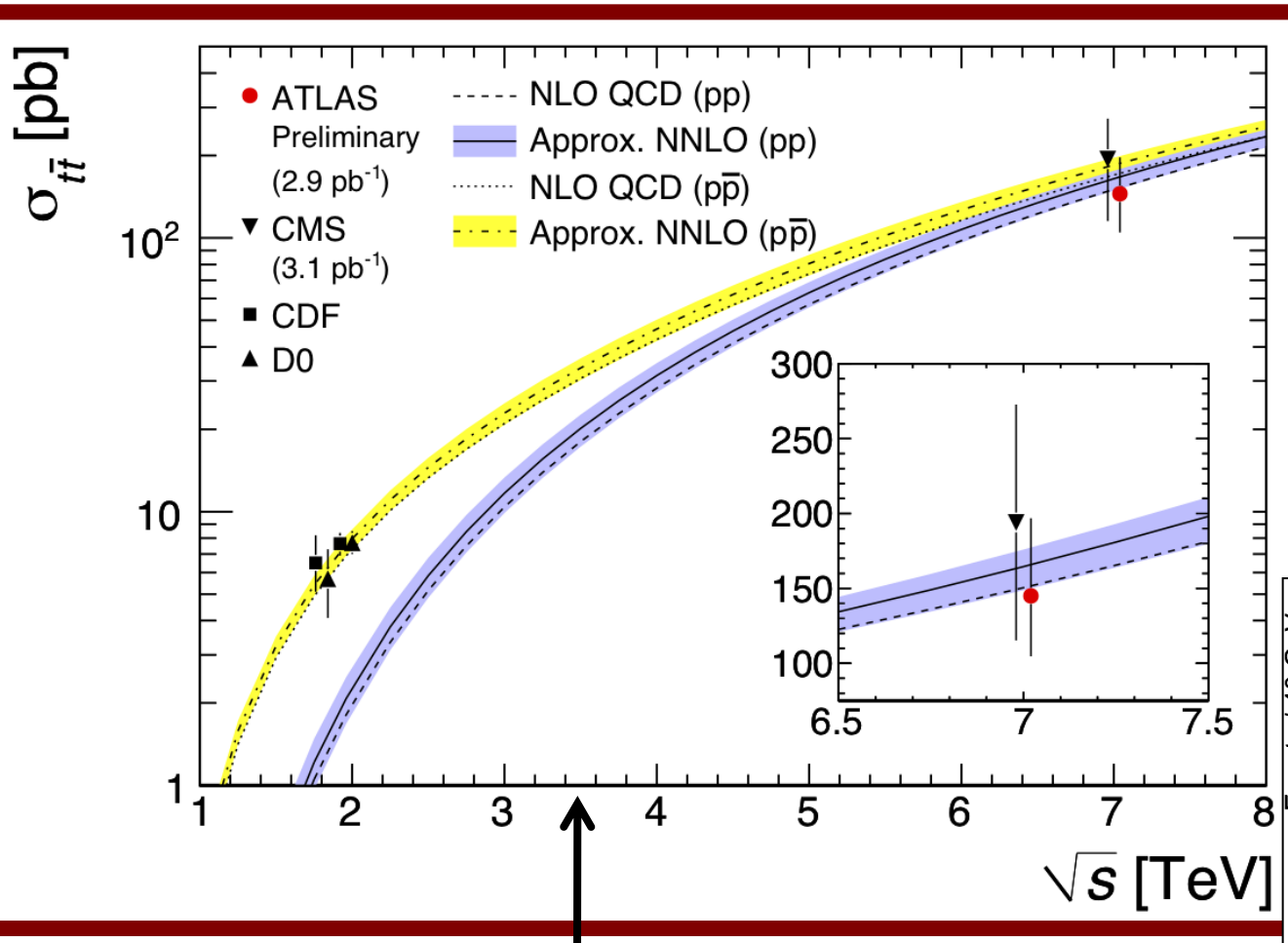
Submitted to PL-B
arXiv:1010.5994

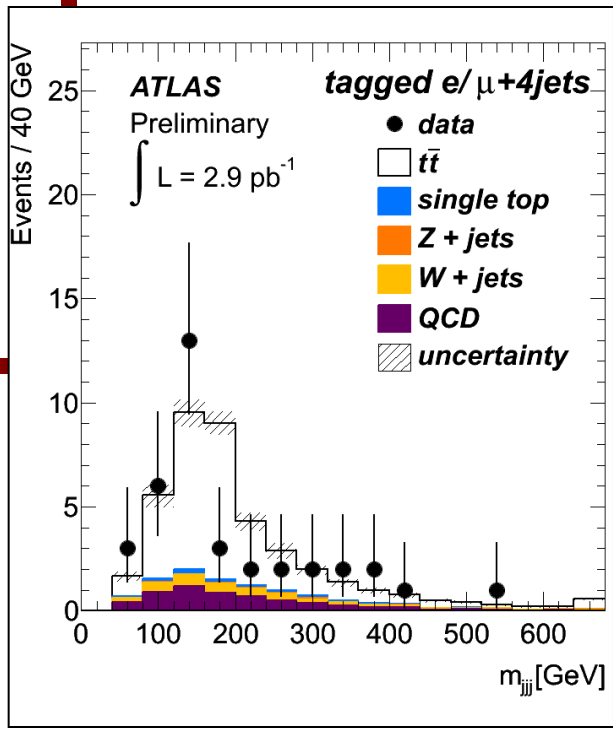


First top cross section measurement at LHC.

$\sigma(pp \rightarrow t^{-}t) = 194 \pm 72(stat.) \pm 24(syst.) \pm 21(lumi.)$ pb. Consistent with NLO prediction of 157.5 (+23.2 −24.4) pb for a top quark mass of $m_t = 172.5$ GeV/c^2

Top-quark cross-section



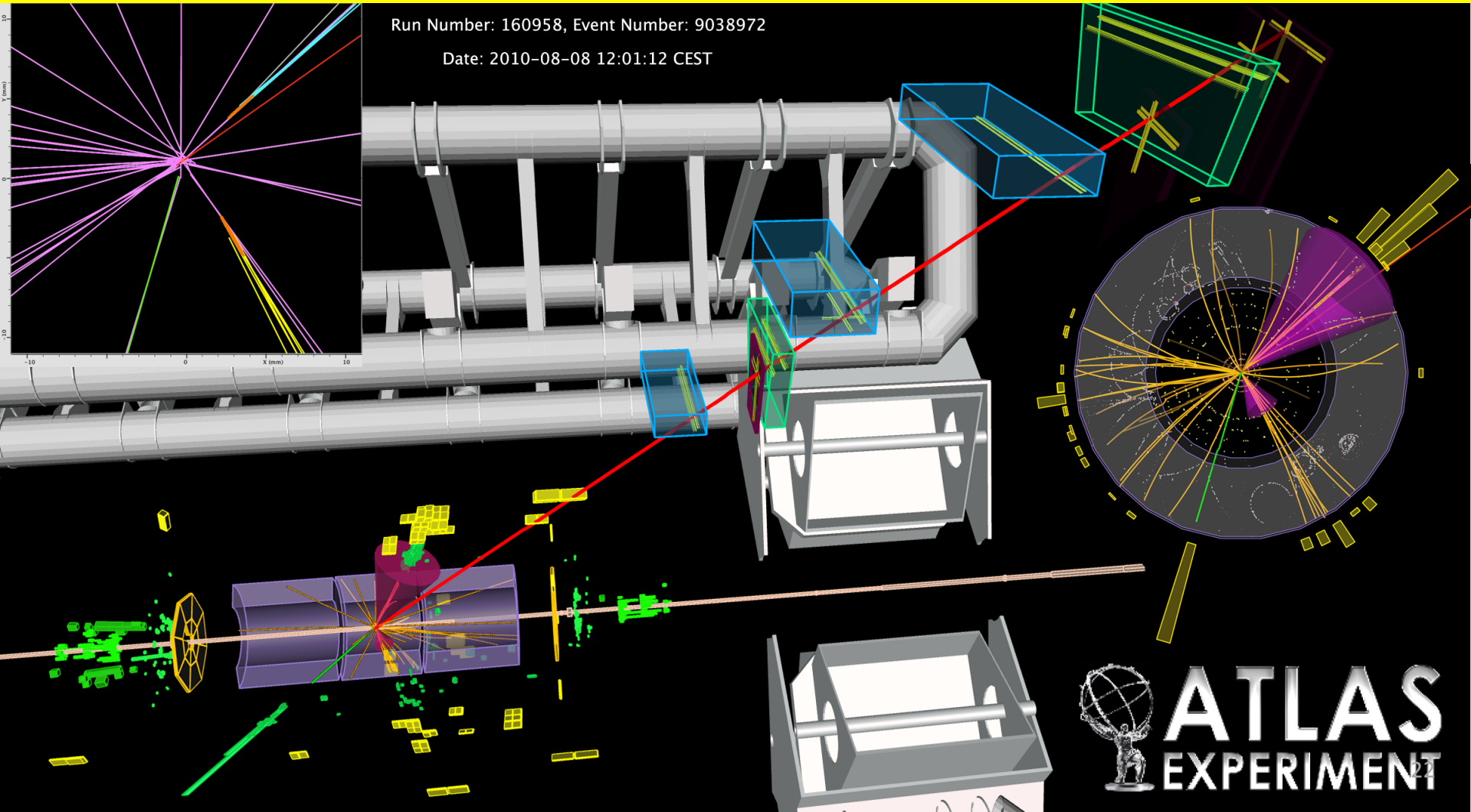


Smaller ATLAS error due to the fact that all channels (lepton-lepton + lepton-jet) are combined
(CMS: lepton-lepton channel only)

A gold-plated tt → bev bμv candidate

$p_T(\mu)$= 51 GeV $p_T(e)$=66 GeV p_T (b-tagged jets) = 174, 45 GeV E_T^{miss} = 113 GeV,
Secondary vertices:
-- distance from primary vertex: 4mm, 3.9 mm
-- vertex mass : ~2 GeV, ~ 4 GeV

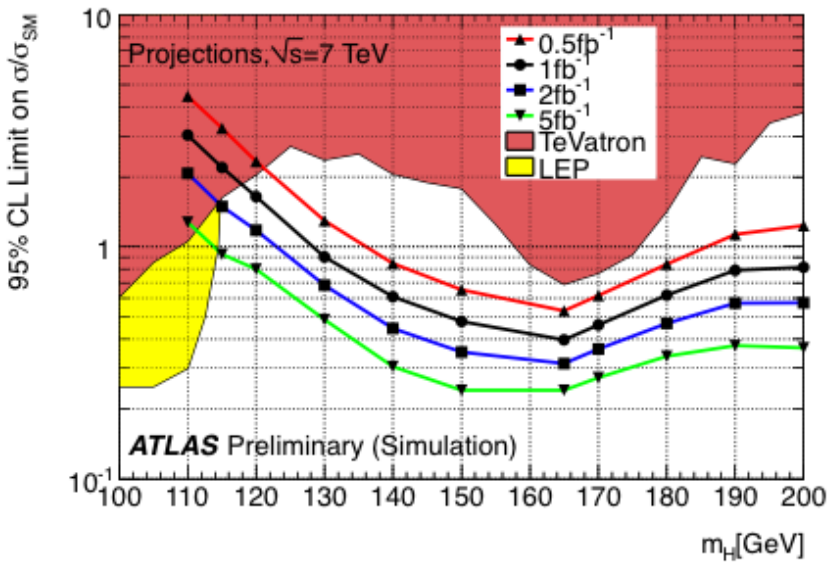
Event purity > 96%

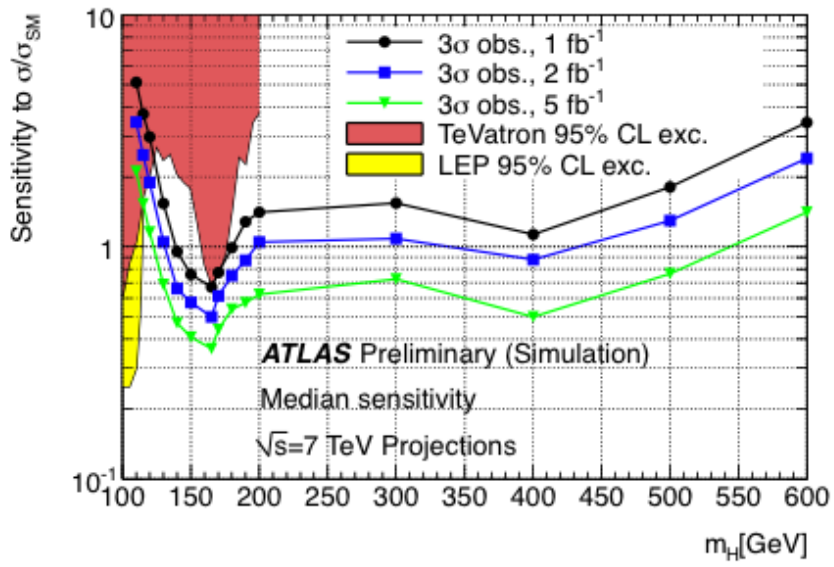


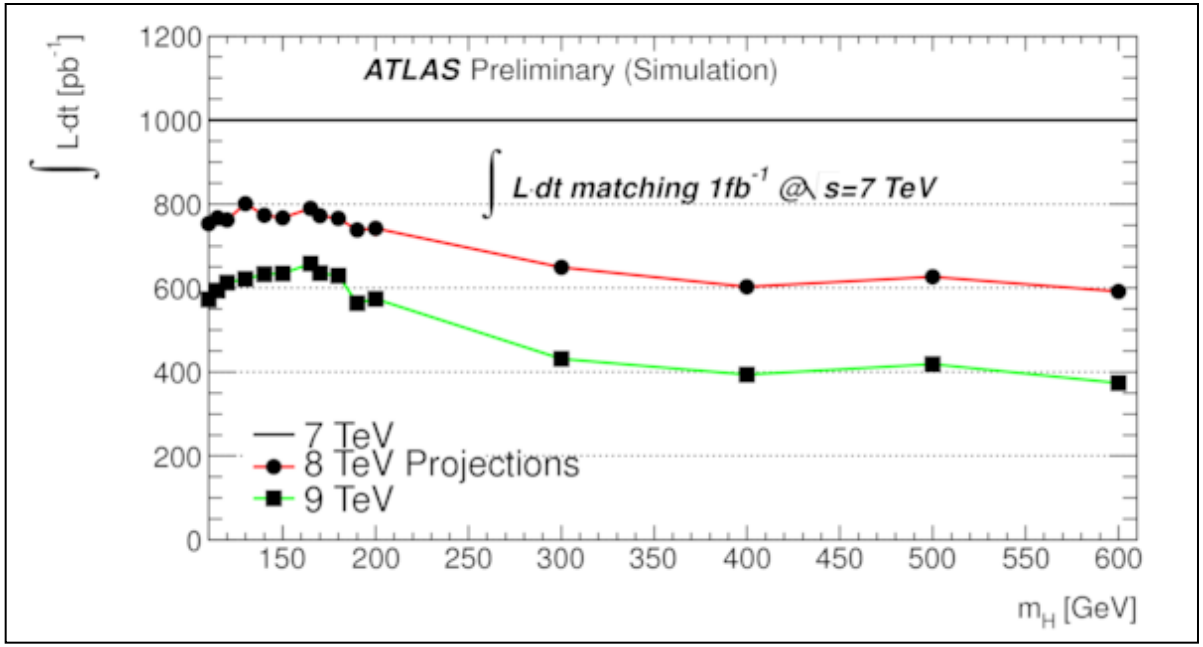
Summary as of today

- Experiments enthusiastically following the exceptional machine progression
- Standard Model particle zoo completed with the observation of the “european” top quark
- Grid Computing keeping the pace smoothly
- A steady flow of physics results streaming out
- Ready for more and the first unexpected results are around the corner. . . !

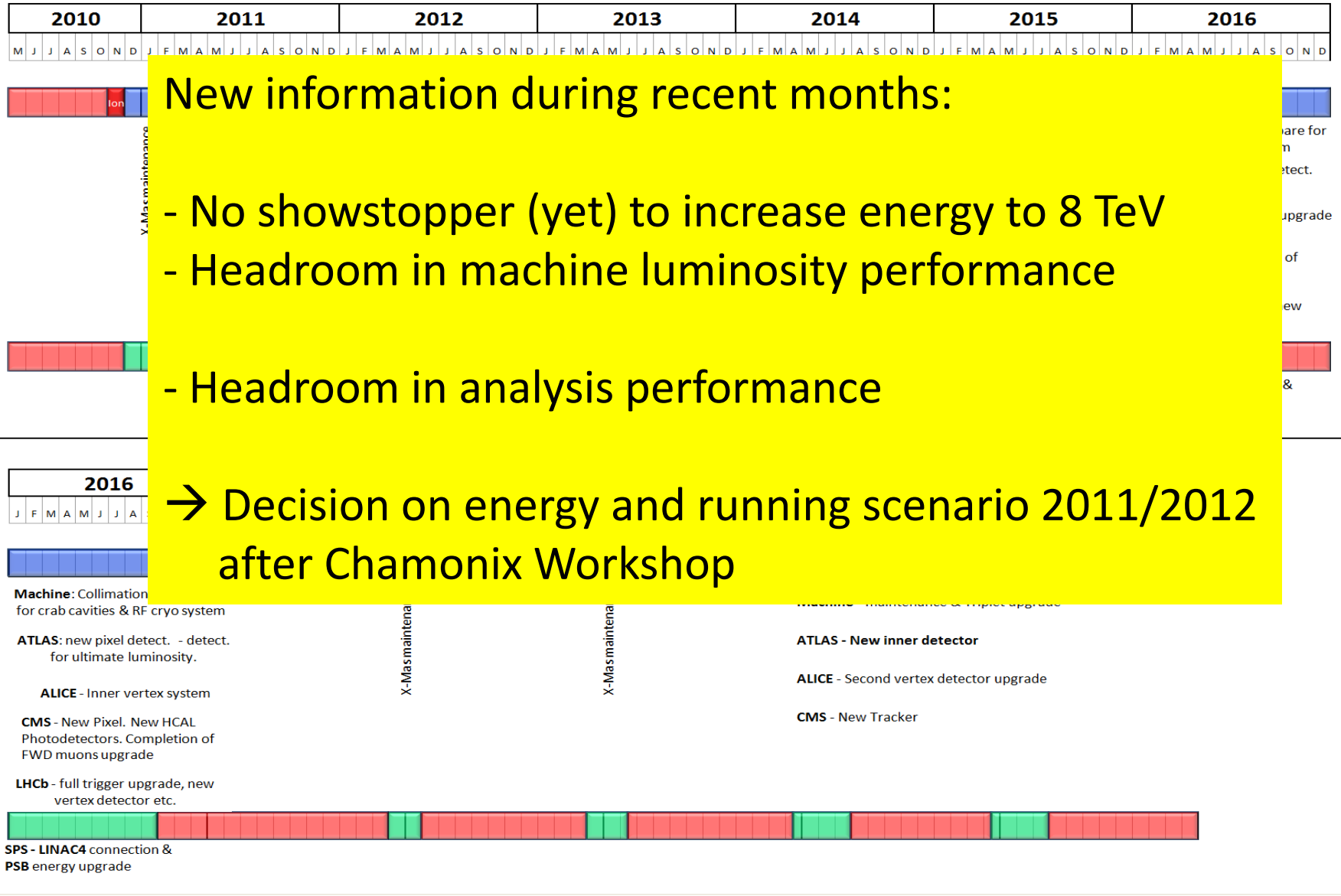
Higgs sensitivities







The 10 year technical Plan



New information during recent months:

- No showstopper (yet) to increase energy to 8 TeV
- Headroom in machine luminosity performance

- Headroom in analysis performance

→ Decision on energy and running scenario 2011/2012 after Chamonix Workshop