

# LHC Status; Review of the past 6 months

RRB, CERN, 29<sup>th</sup> October 2012

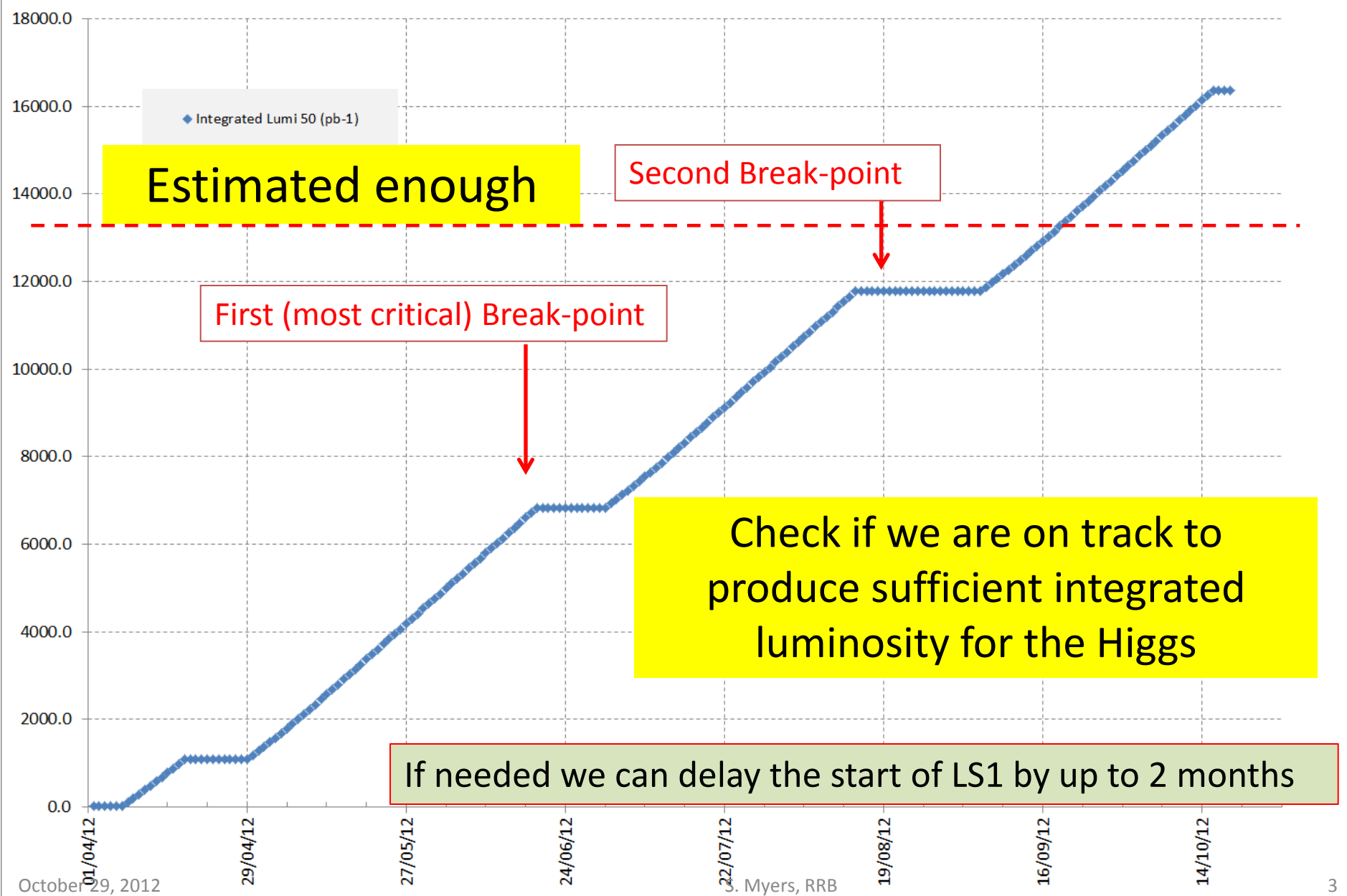
Steve Myers

(On behalf of the LHC team)

# 2012 Priorities

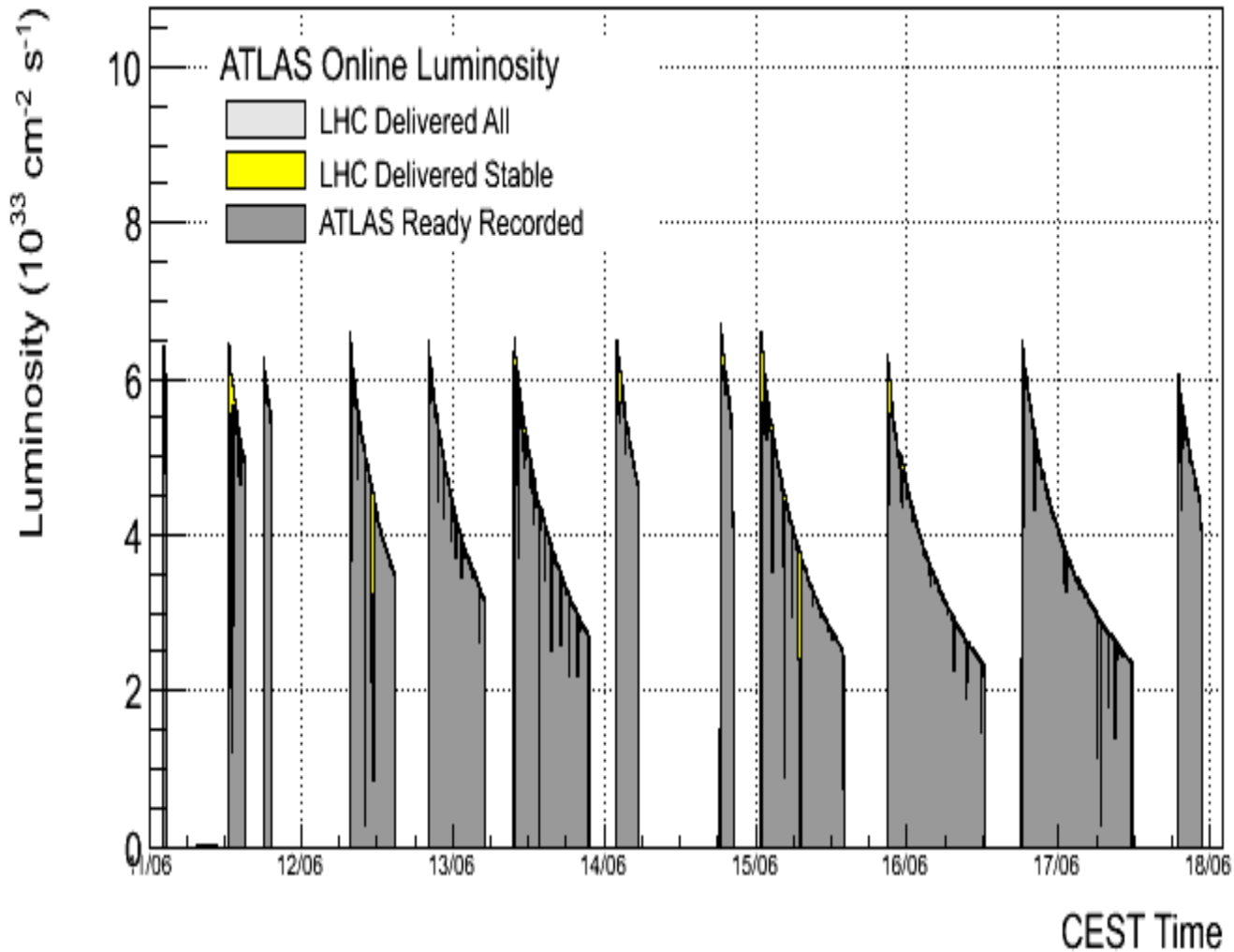
1. The LHC machine **must** produce enough integrated luminosity to allow ATLAS and CMS to **independently** discover the Higgs before the start of LS1.
2. We must also prepare for the proton-lead ion run at the end of the year.
3. We must (in 2012) do the necessary machine experiments to allow high energy, useful high luminosity running after LS1.

# 2012 Measured vs Predicted Integrated Luminosity

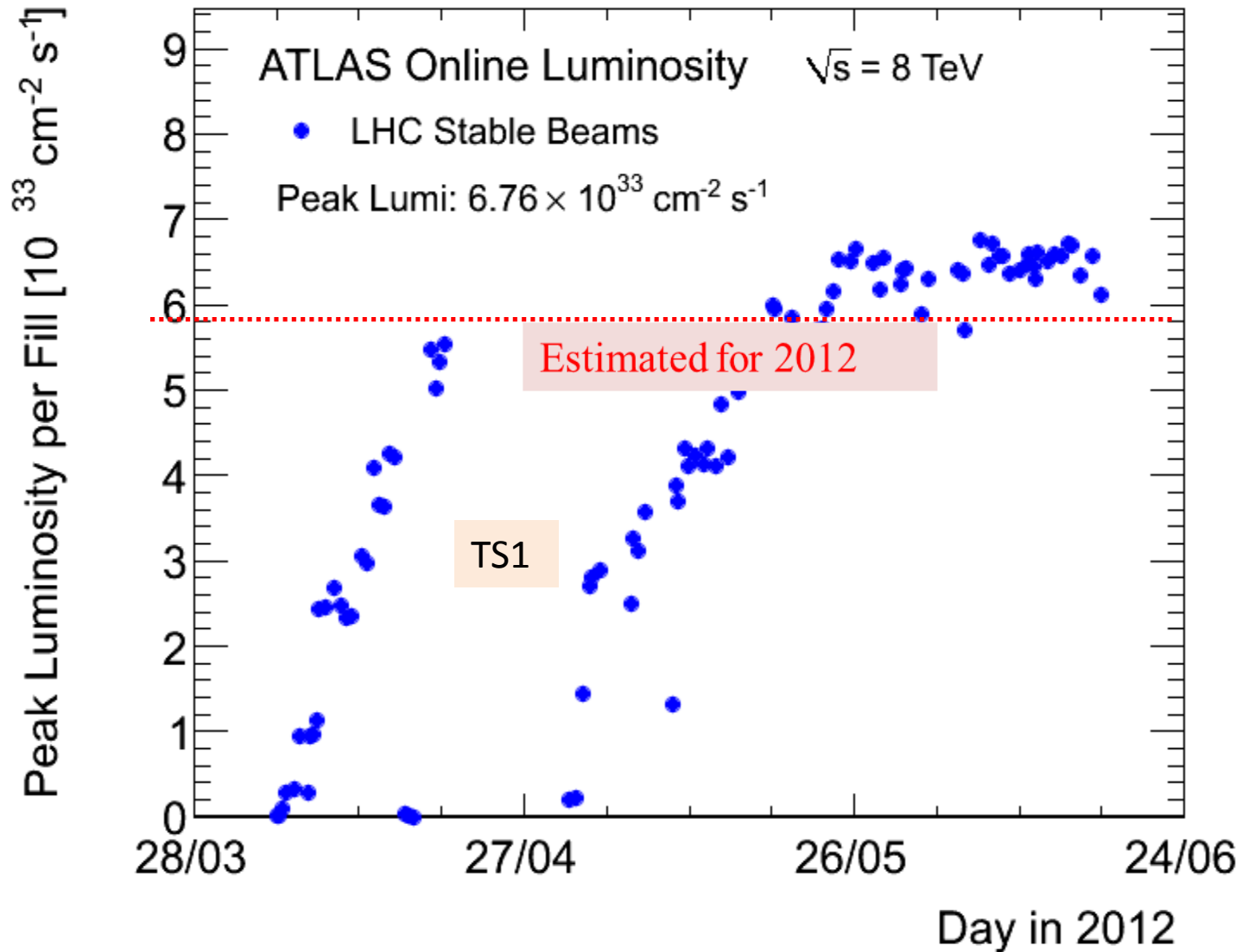


# Performance in 2012

# 7 Days of production ( $1.35\text{fb}^{-1}$ ) (June 10—16, 2012)

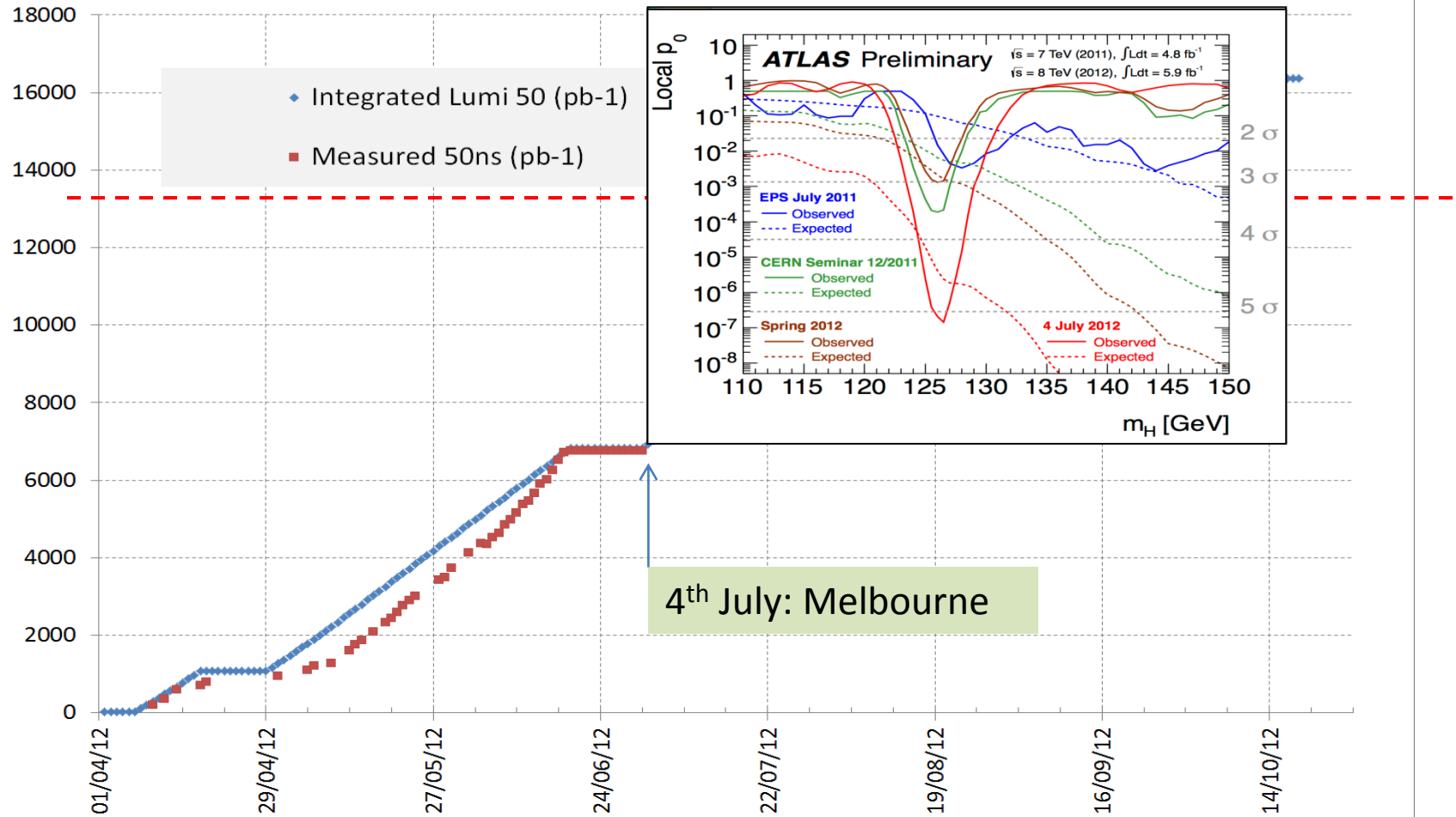


# Peak Luminosity (end June 2012)

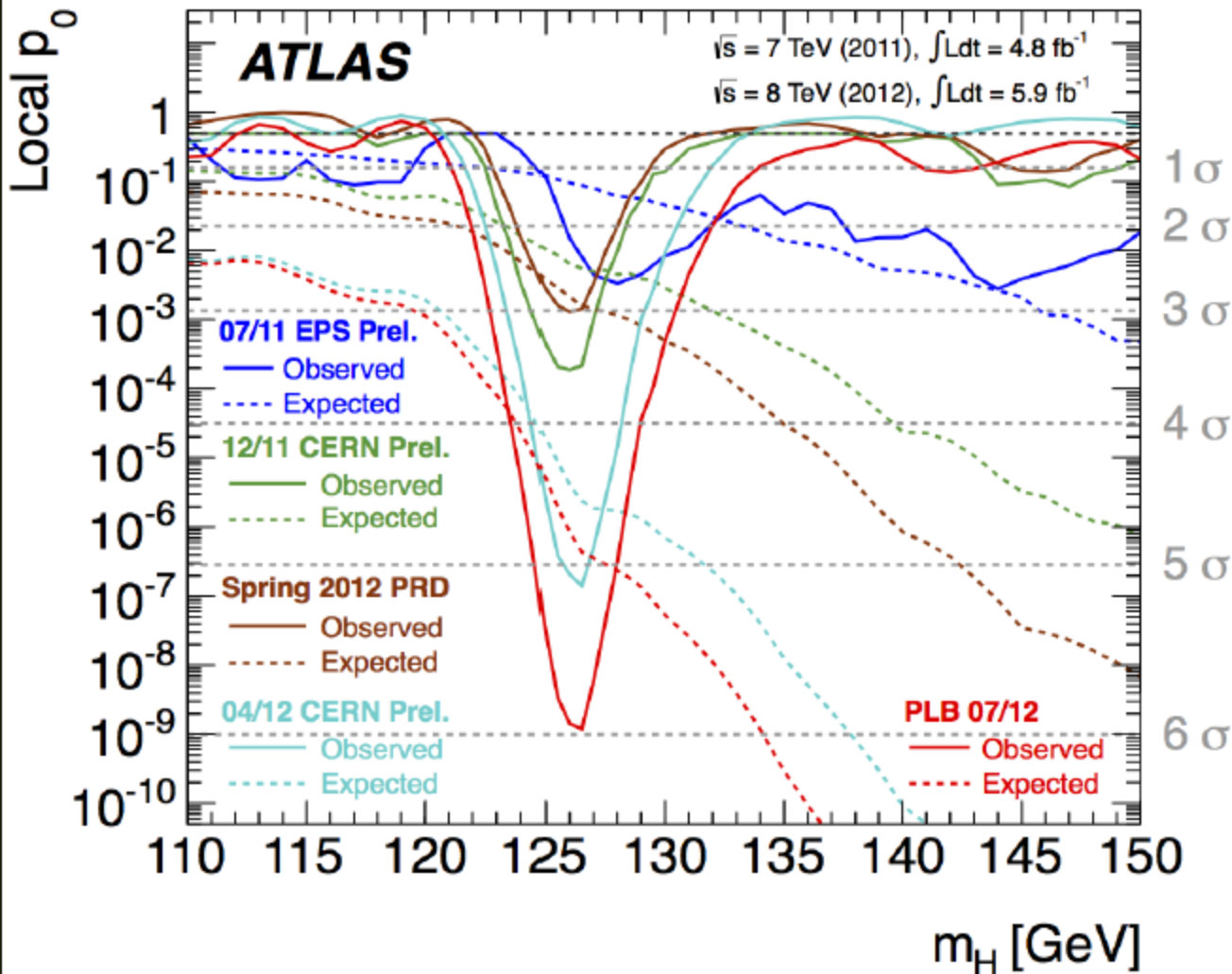


# With Respect to estimates

## 2012 Measured vs Predicted Integrated Luminosity



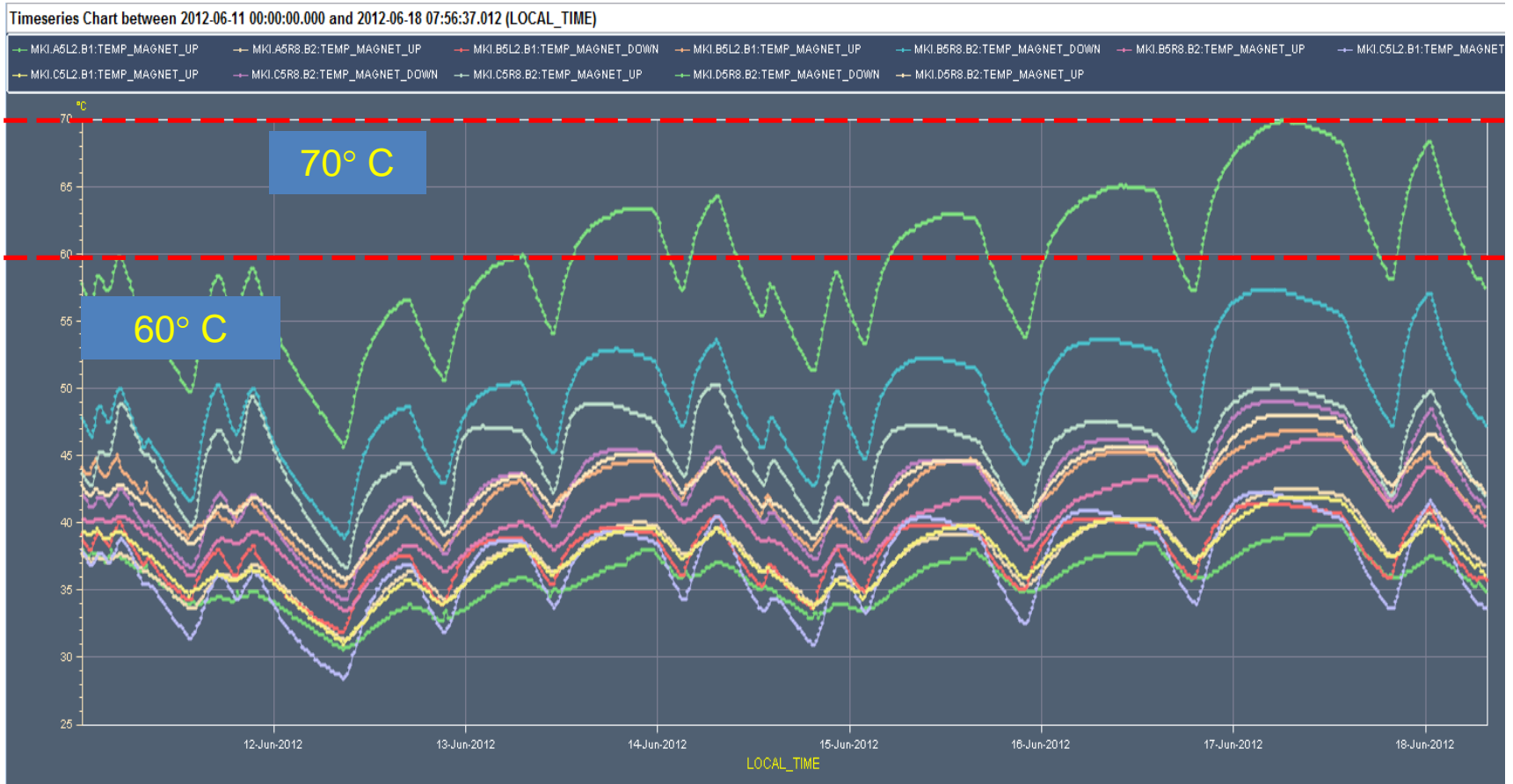
# Evolution of the excess with time



Significance increase from 4<sup>th</sup> July to now from including 2012 data for  $H \rightarrow WW^*$  search



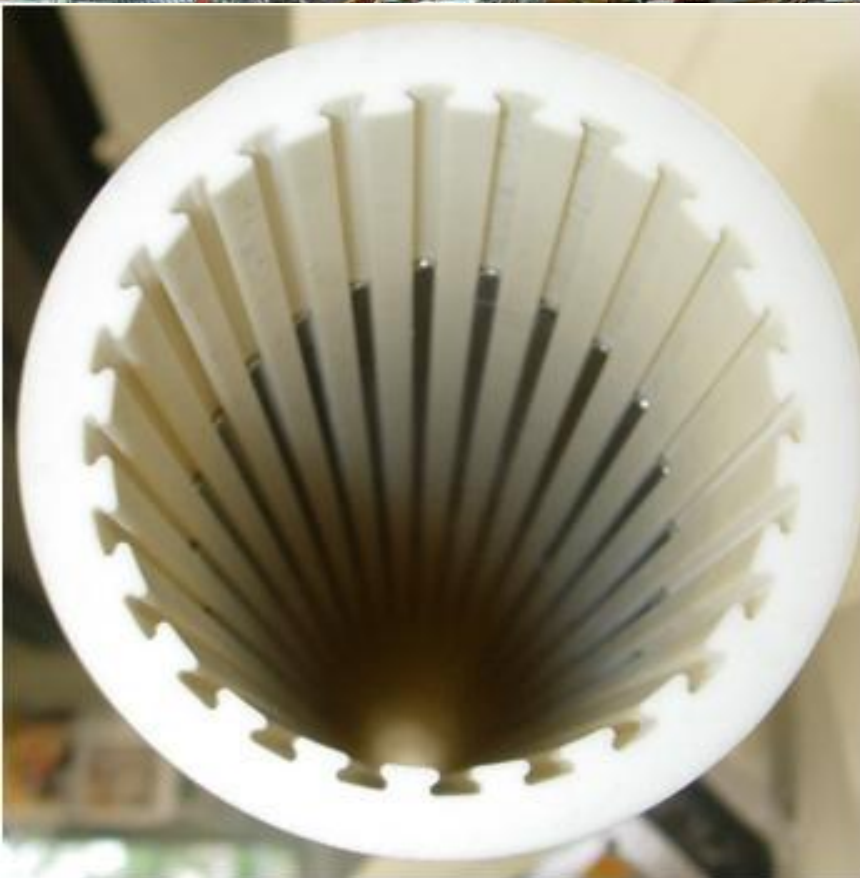
# Injection kicker MKI temperatures



All time record temperatures

# Injection Kicker MKI

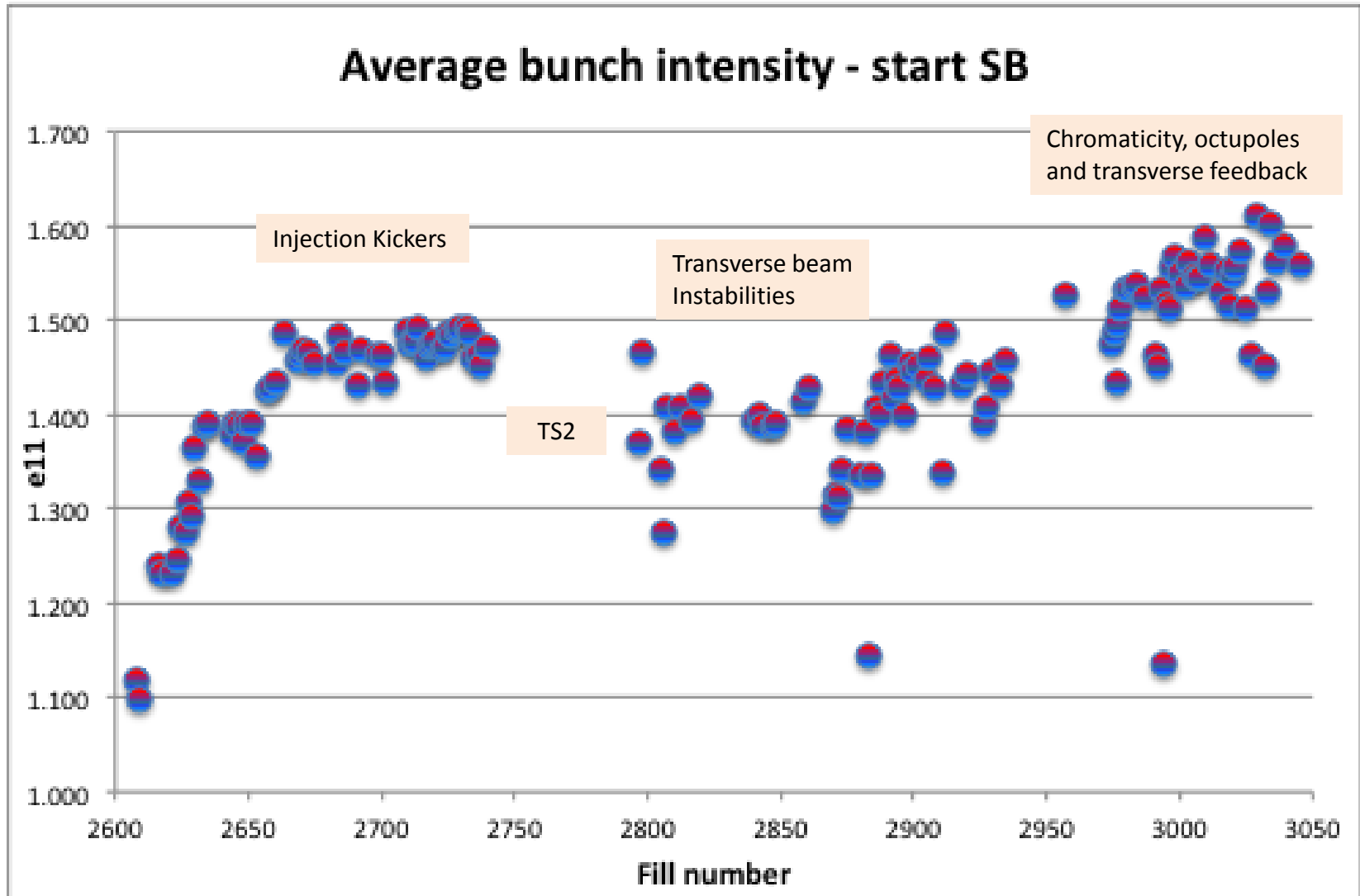
Bake-out jackets removed in TS2,  
(only) gave a 5° C gain in measured temperature  
new MKI-8D with more stripes in TS3



# Some Issues after TS2

(after 4 July)

# Bunch intensities

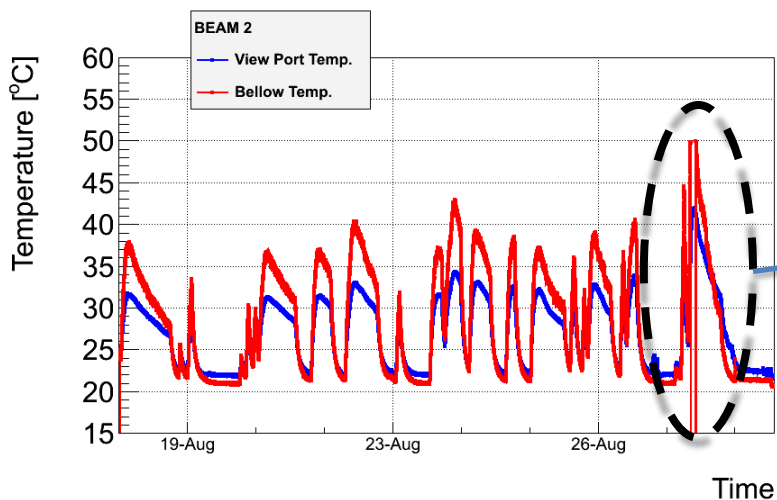
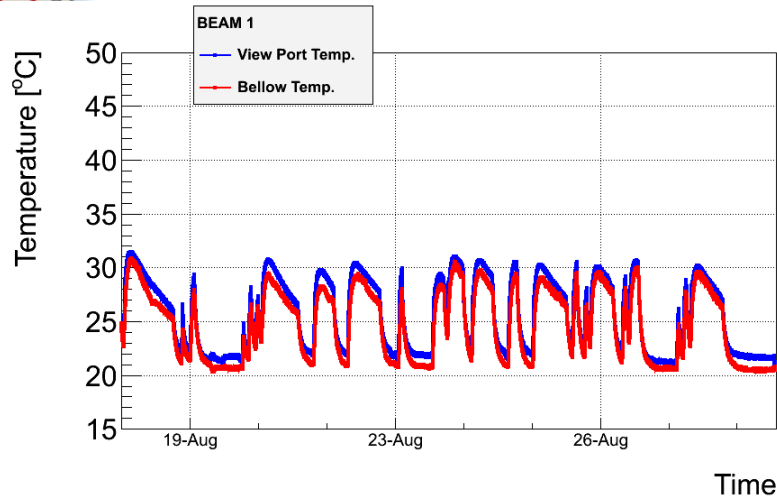
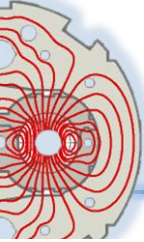


Up to an average bunch intensity of  $1.69e^{11}$  ppb at 450 GeV

# Pushing the Bunch Intensity

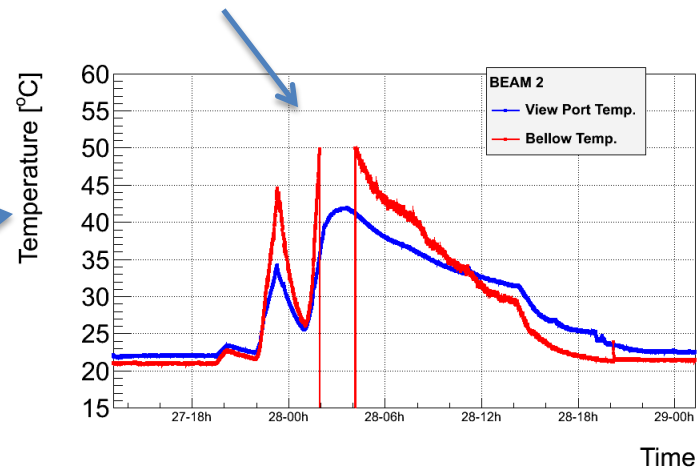
- Event Pile up
- Electromagnetic beam instabilities
  - Octupoles, beam feedback gain, increased chromaticity
- Beam Induced Heating (HOM)
  - Injection kickers, synchrotron light mirrors
- Radiation to Electronics (SEUs)
- Event Pile Up

The bunch intensity is now at 1.6 times design at 4TeV/bunch

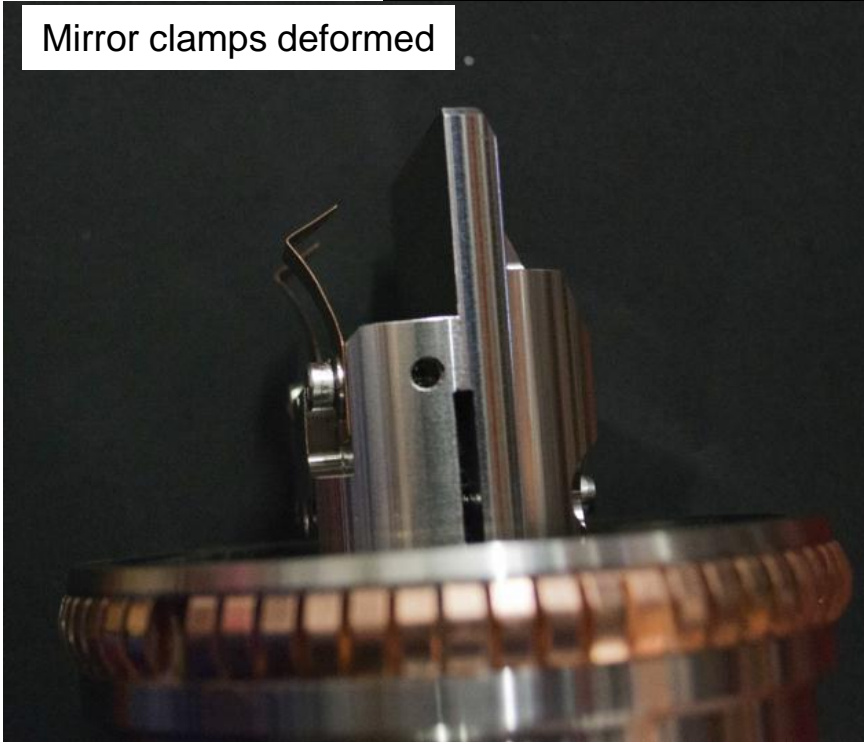


- Observed movements of the mirrors extracting the synch. light as a result of beam induced trapped modes. Deterioration in week 34 and in particular on 28/8 for B2
- Indications of permanent deformation of the system holding the mirror
- Potential risk: mirror falling on beam and/or on underlying glass window port

## Last two fills



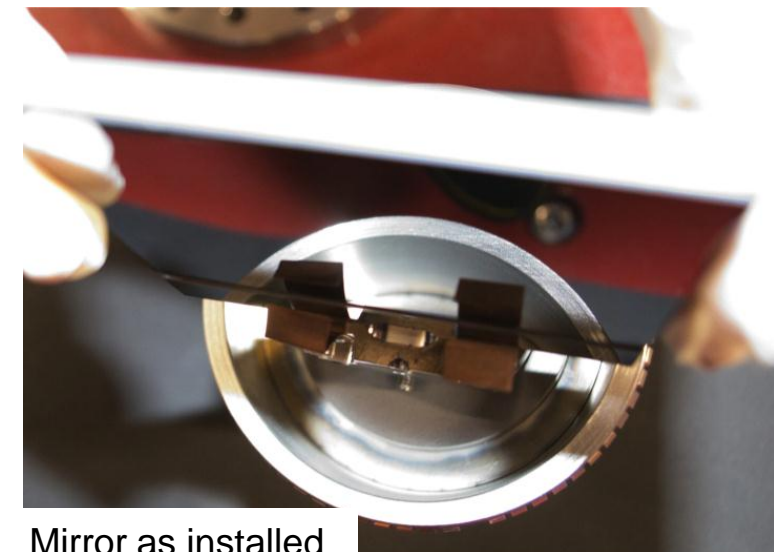
Mirror clamps deformed



# Findings

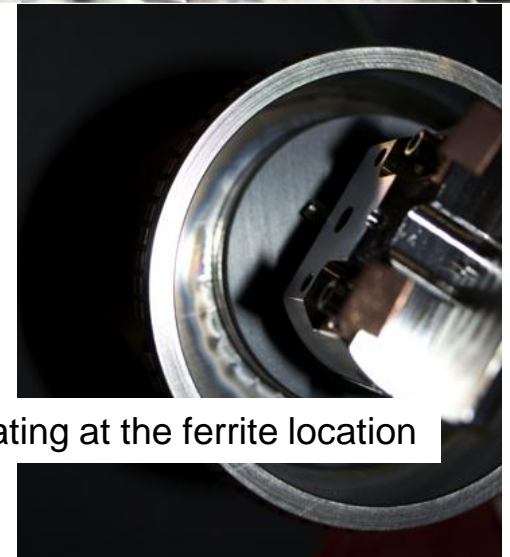


Mirror damaged by heat



Mirror as installed

October 29, 2012



Traces of heating at the ferrite location

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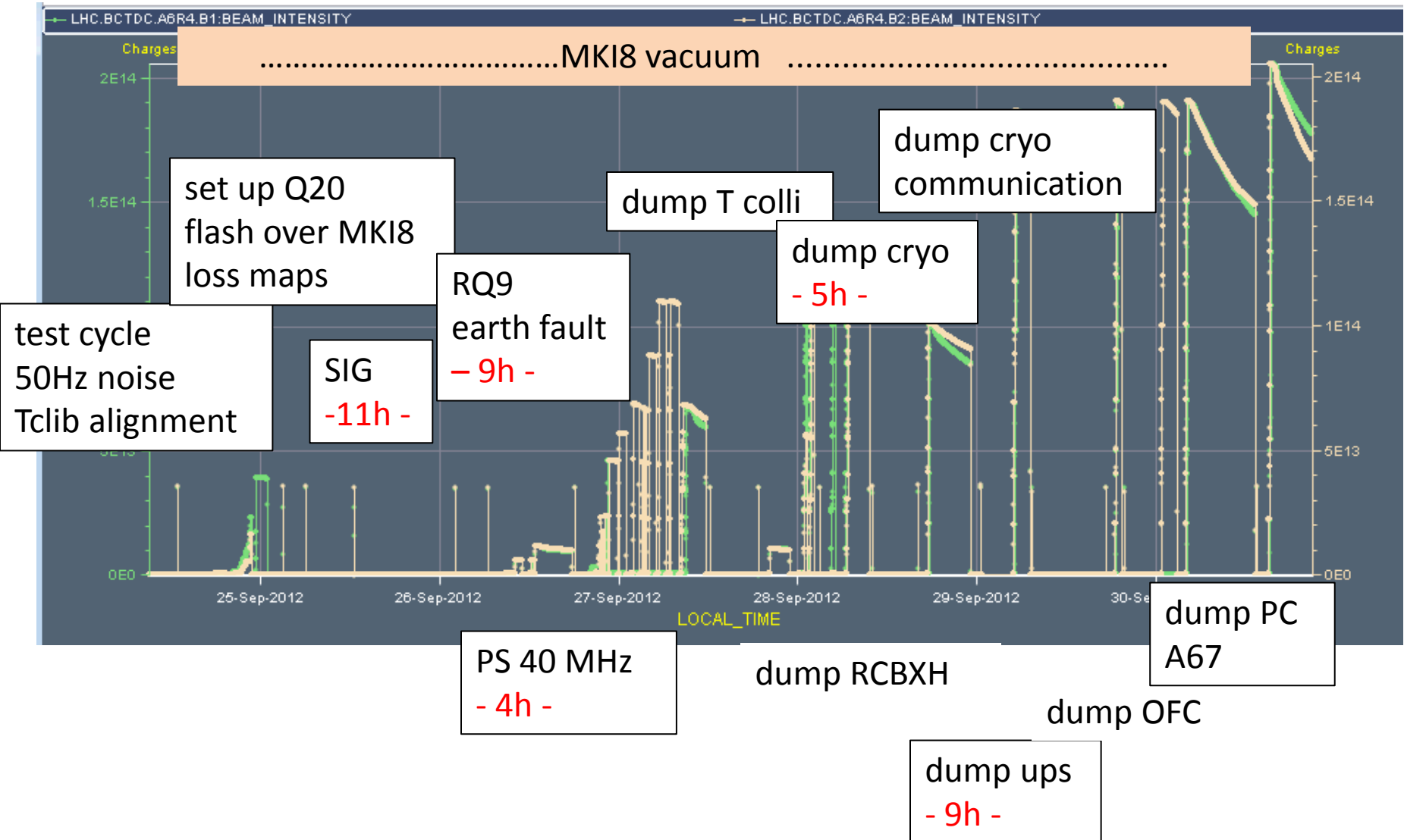
# Up to the Minute Status (after TS3)

During TS3

- Installed new design injection kicker
- Replaced BSRT with new design

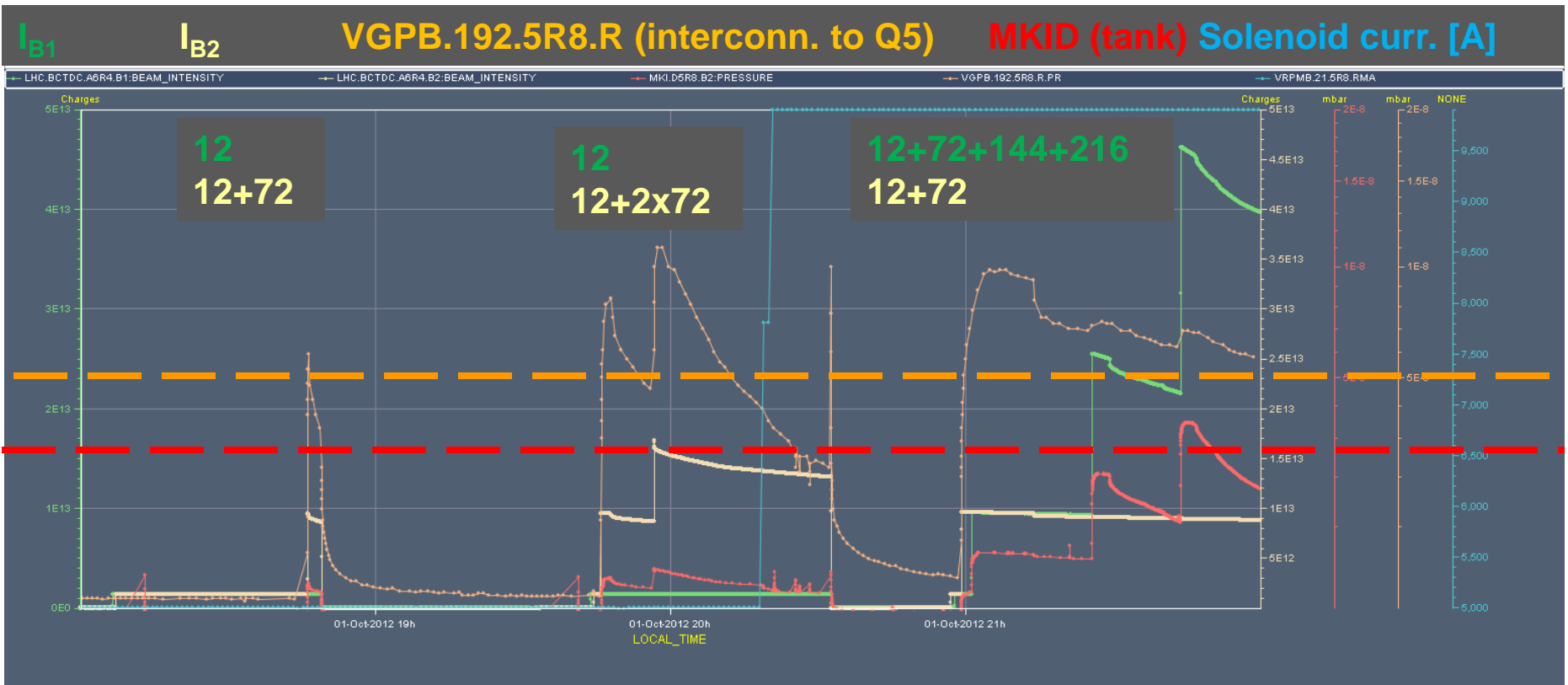


# Resume of a tough week (1<sup>st</sup> week after TS3)



# 25 ns test: MKI8

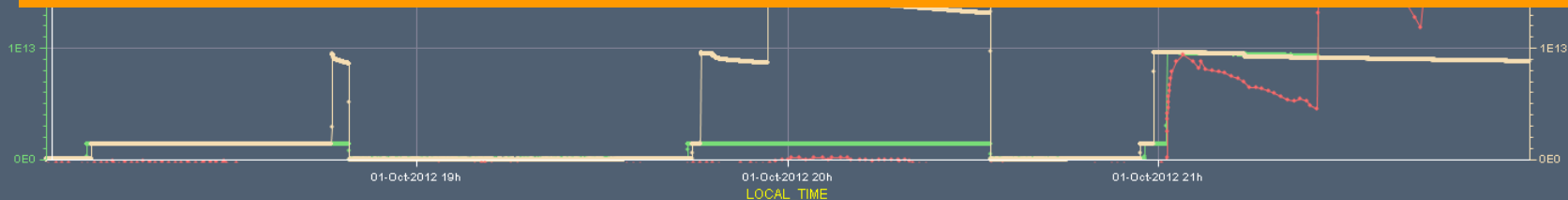
- Hit (new) interlock on **interconnect pressure** after 1 or 2 72 bunch trains. No significant decrease unless losses. No effect of **solenoid**.
- Hit interlock on **MKID pressure** when injecting B1 (444 bunches)



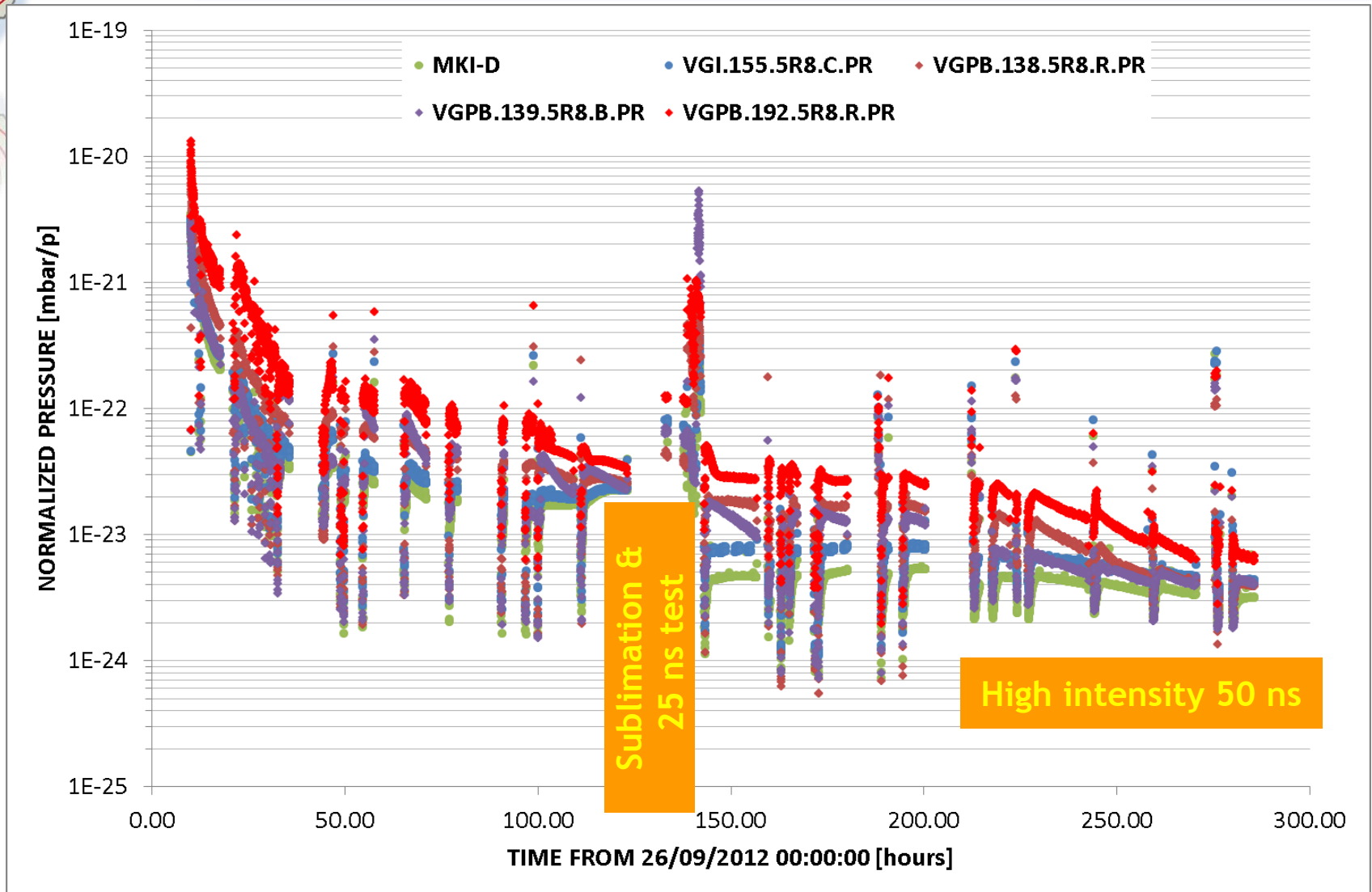
# 25 ns test: MKI2

- Hit interlock on **interconnect pressure** after with 444 bunches on B1. **Interlock added after TS3**

- In the present conditions the scrubbing run cannot be performed efficiently without an increase of the vacuum thresholds in particular at the interconnects (new)
- Considered too risky for the operation of the injection kickers
- LMC decision to postpone the scrubbing run

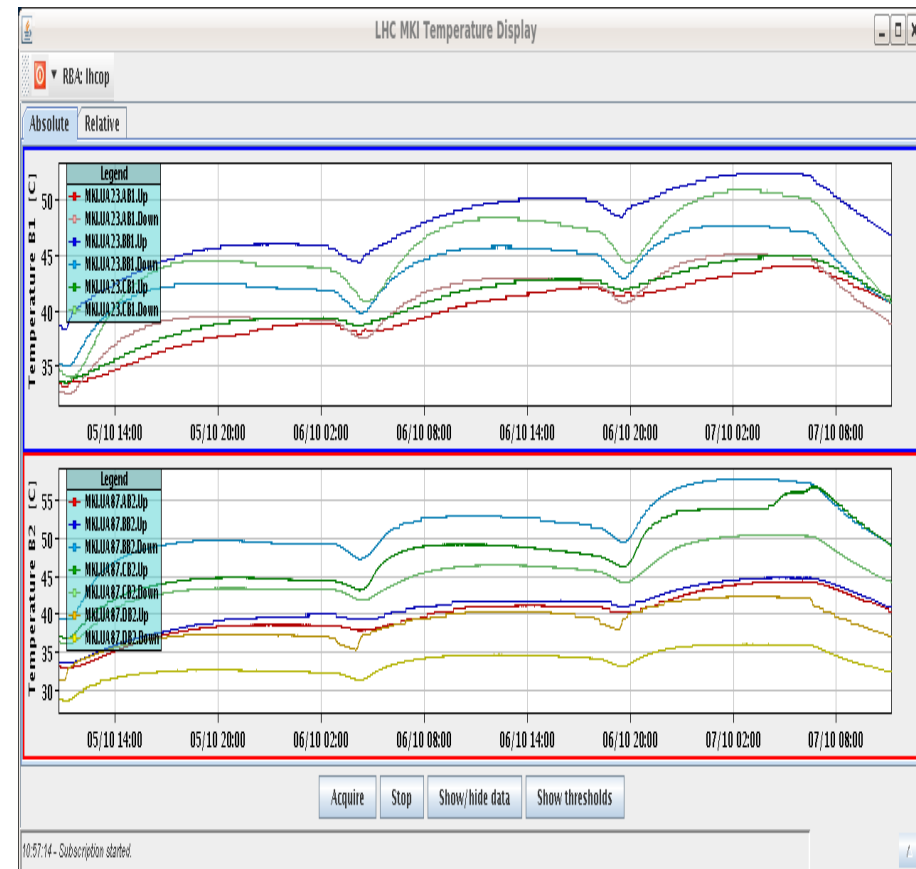


# After TS3: vacuum conditioning

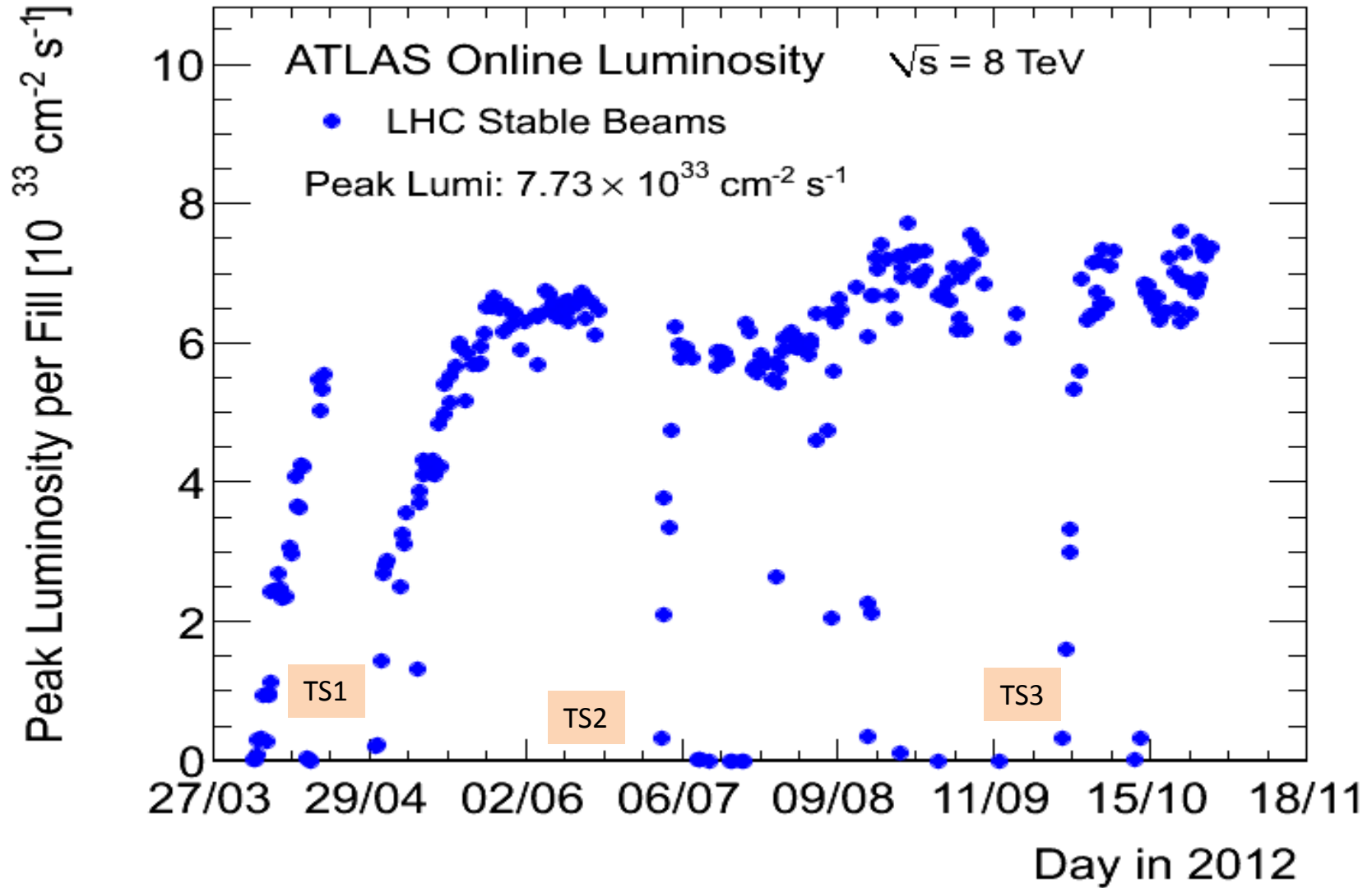


# New Injection Kicker Design successful

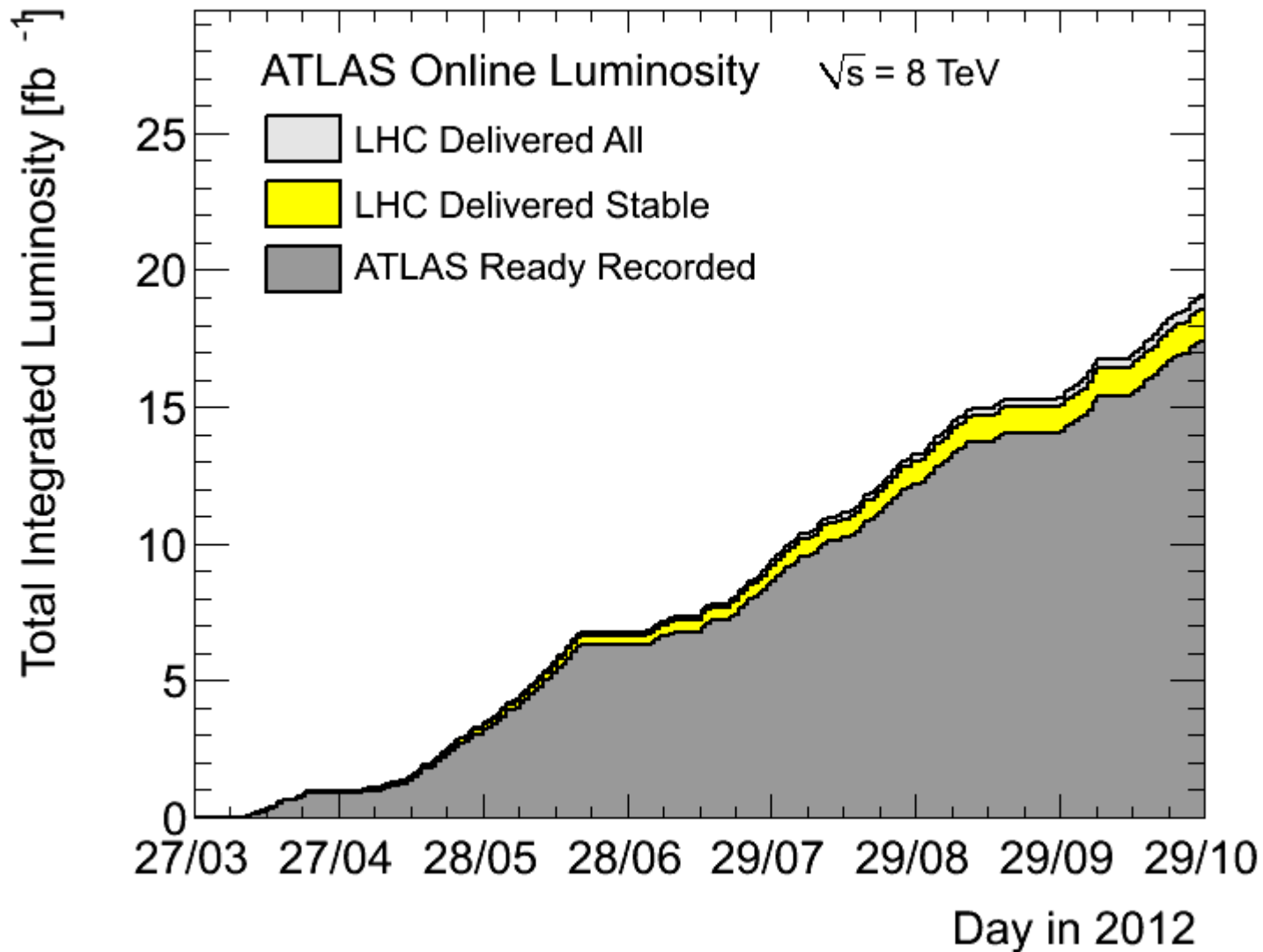
- Clear reduction of the temperature on MKI8D (now has lowest temperature of all 8 injection kickers)



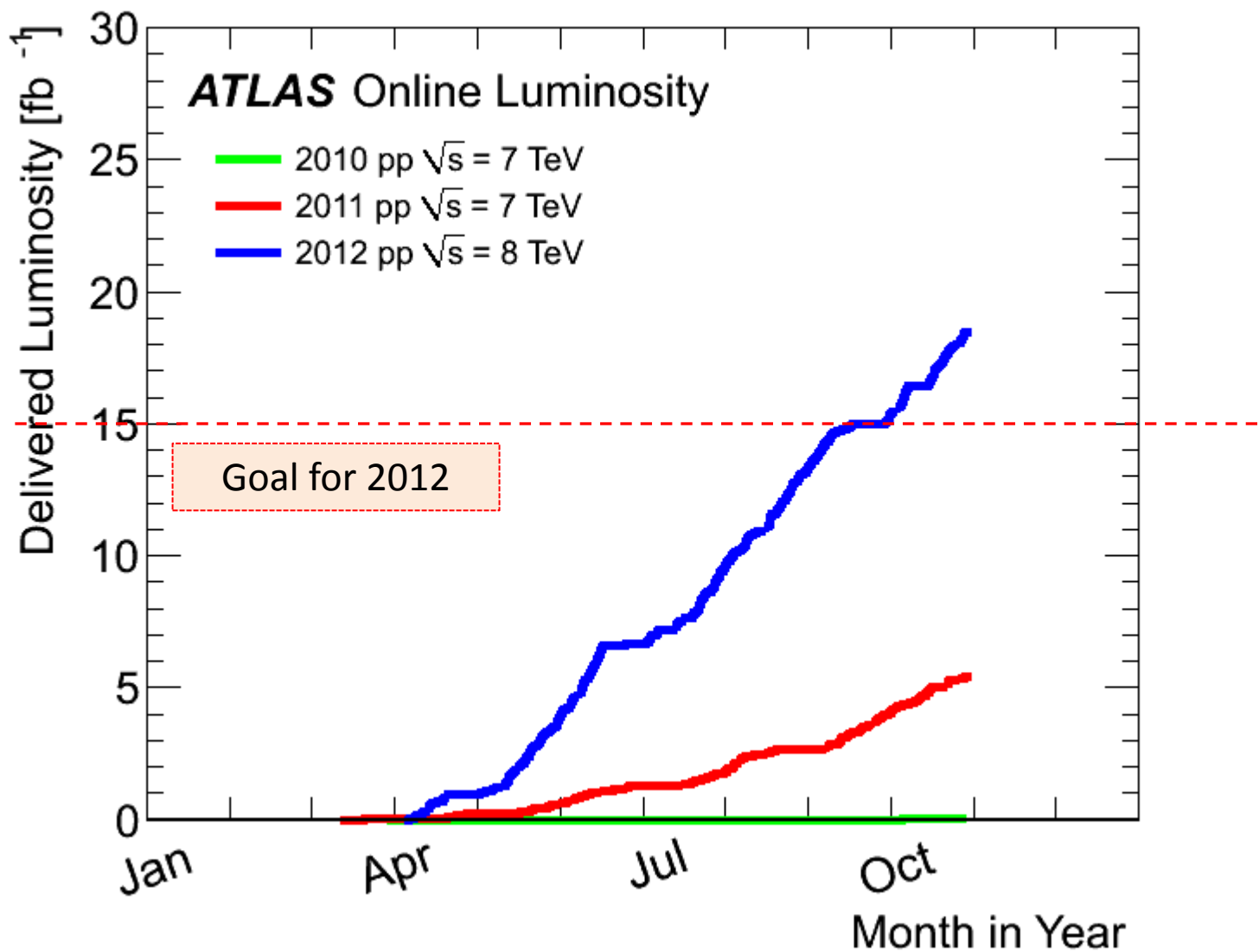
# Getting Back after TS3



# Integrated from ATLAS (18.6fb<sup>-1</sup>)



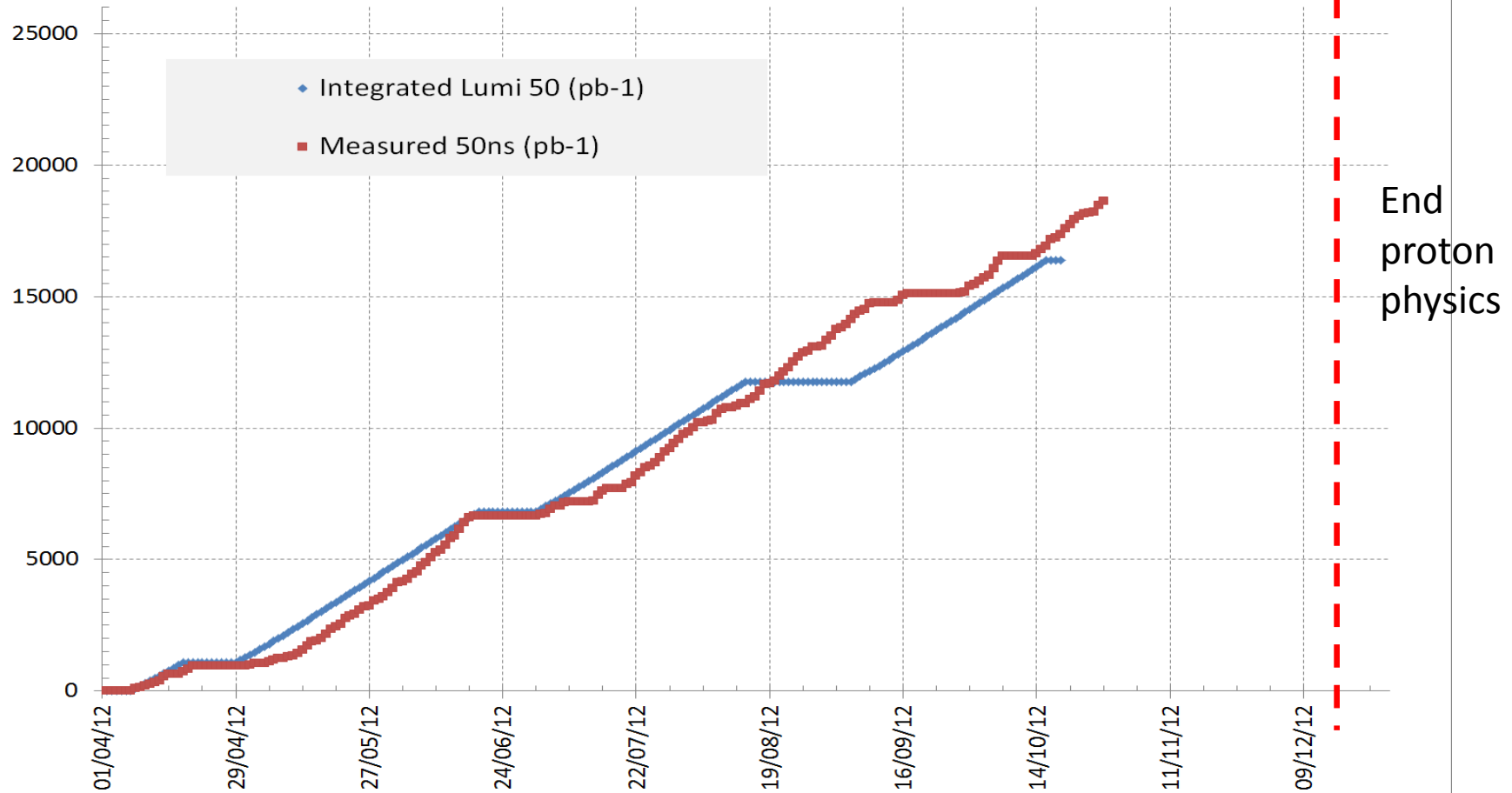
# Evolution of Integrated Luminosity





# Where we are today wrt Predictions

2012 Measured vs Predicted Integrated Luminosity

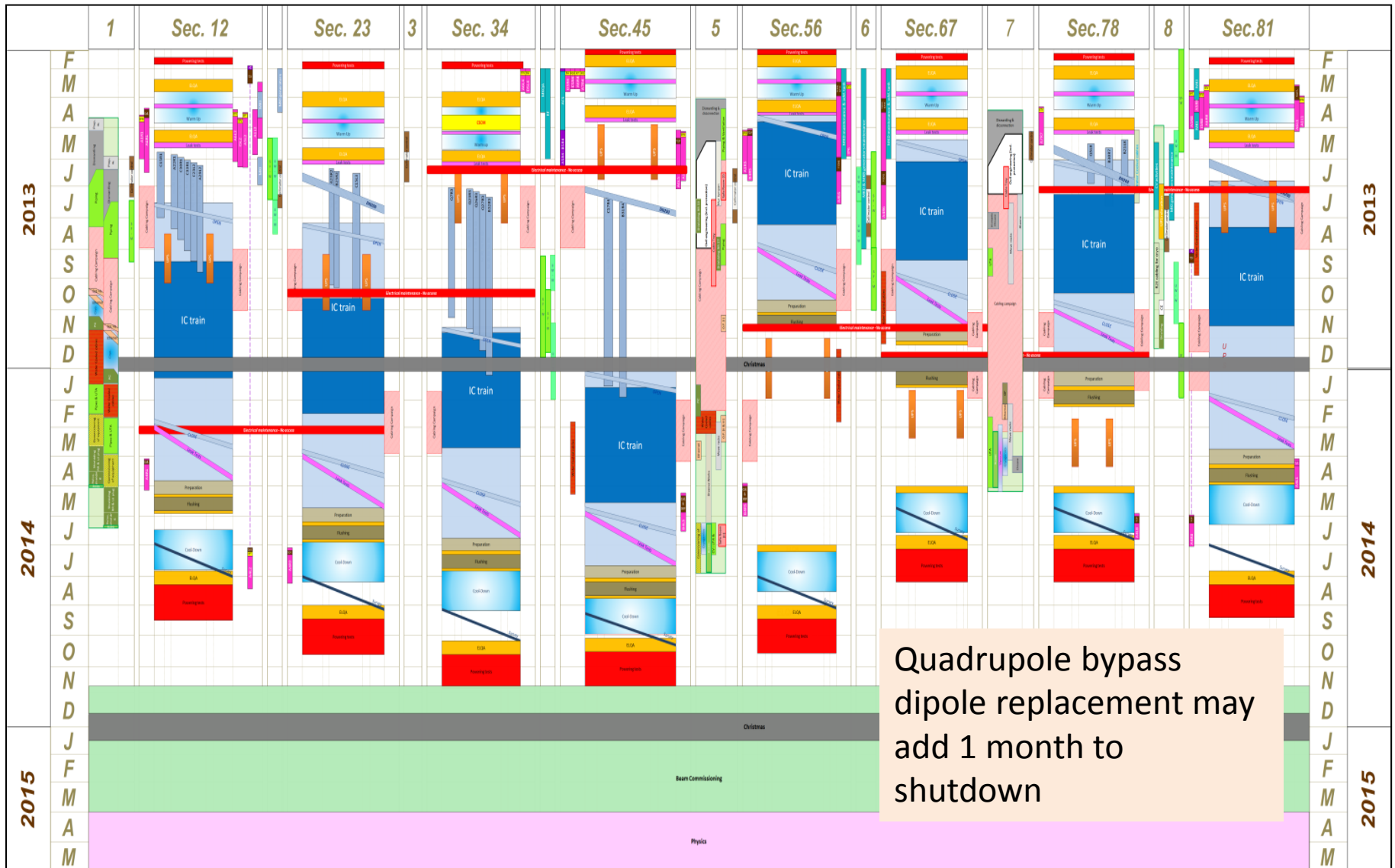


# LS1 then operation around 7TeV/beam

## LS1 Work

- Repair defectuous interconnects
- Consolidate all interconnects with new design
- Finish off pressure release valves (DN200)
- Bring all necessary equipment up to the level needed for 7TeV/beam

# Linear schedule



EDMS 1227656 (rev1.0, July 26th, 2012)

October 29, 2012  
No contingency

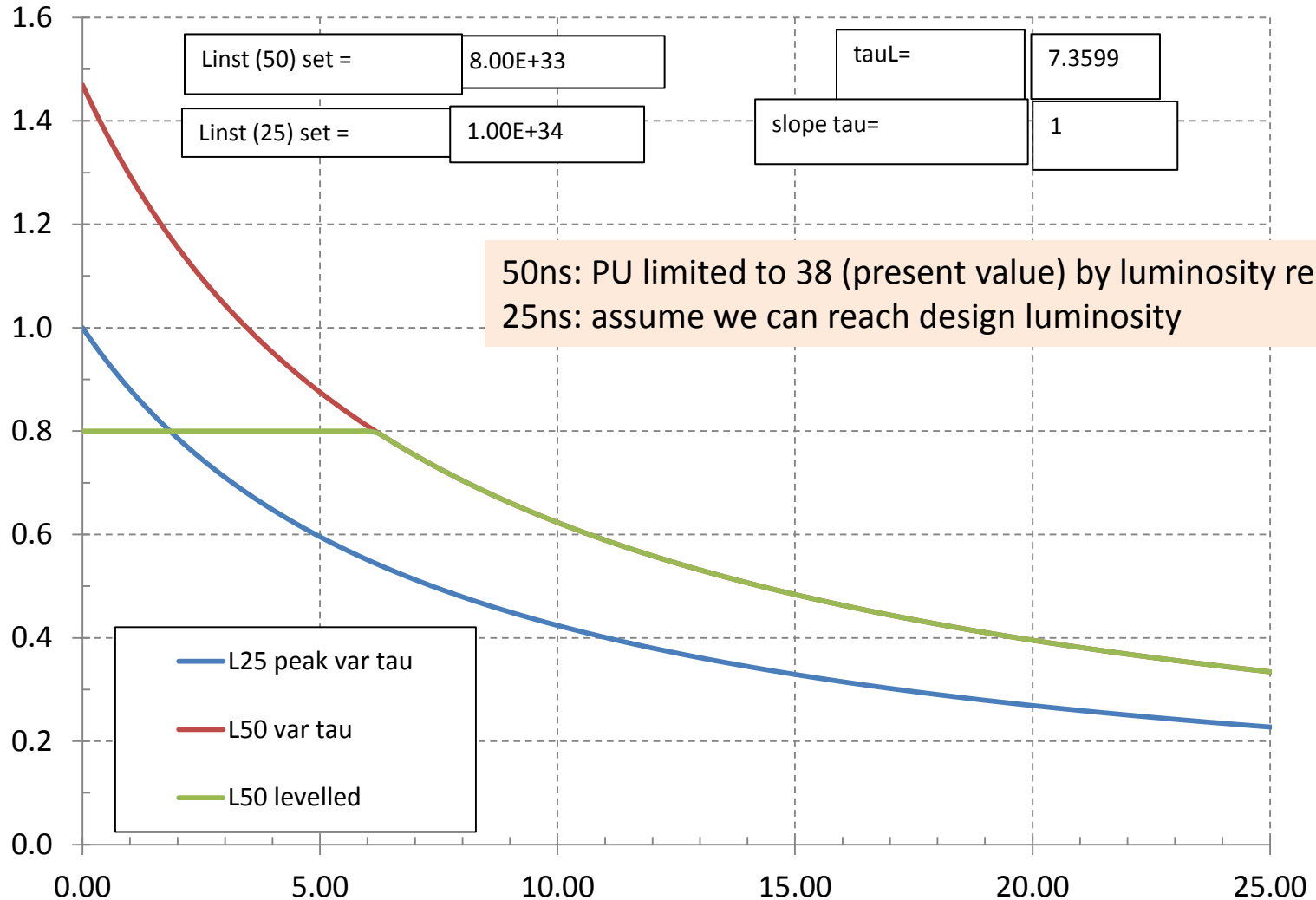
S. Myers, RRB

# To be done before the end of 2012

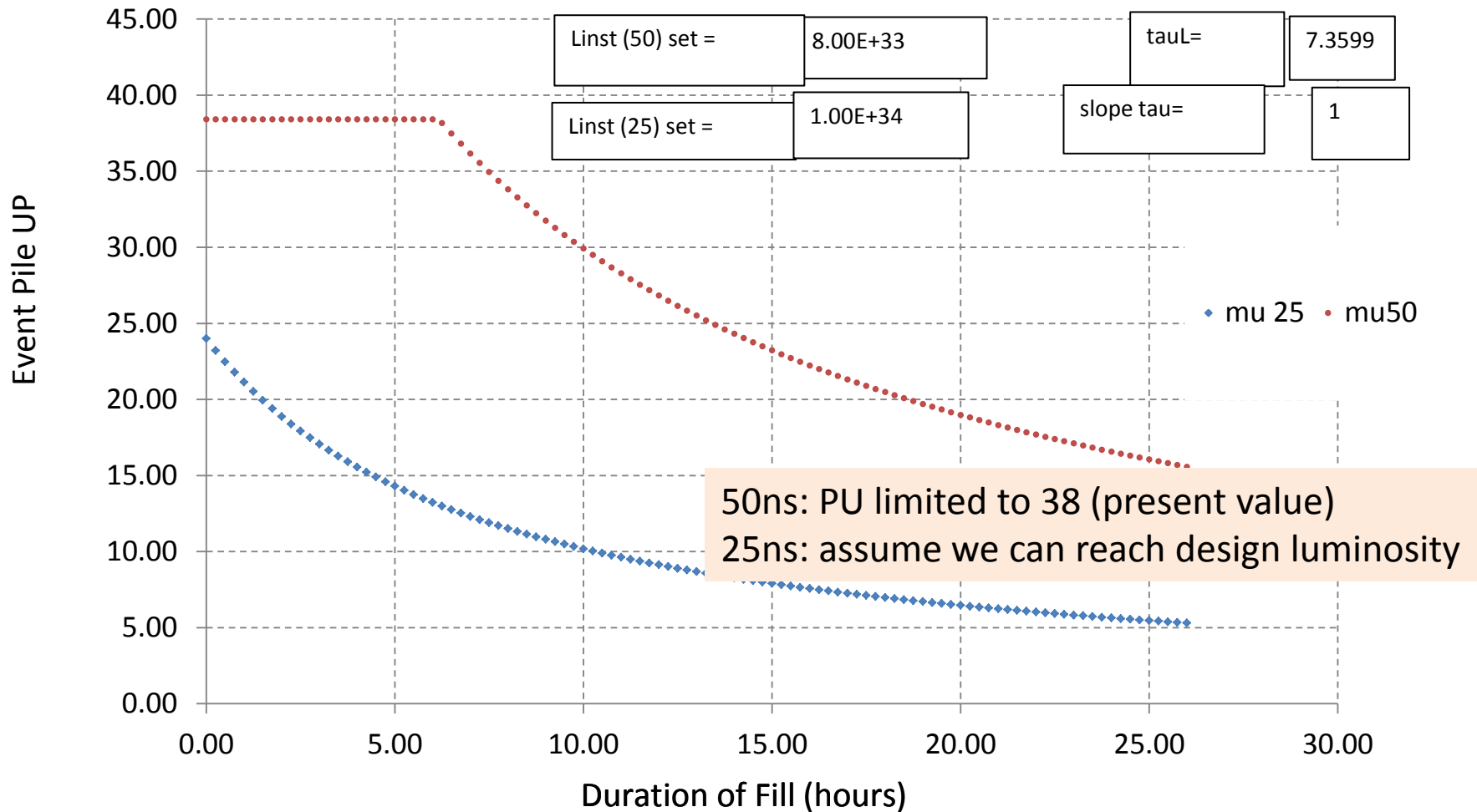
- Produce Integrated Luminosity
- 25 ns tests
  - Electron cloud and vacuum (scrubbing) New MKI8
  - Crossing angle, aperture, beam-beam, min  $\beta^*$
  - Maximum pile up? Will need some physics running
  - UFOs
  - HOM heating
- Comparison 25 vs 50 ns
  - $\beta^*$  levelling testing Well advanced in MD

# Comparing pile up and integrated luminosity for 25ns and 50ns with levelling

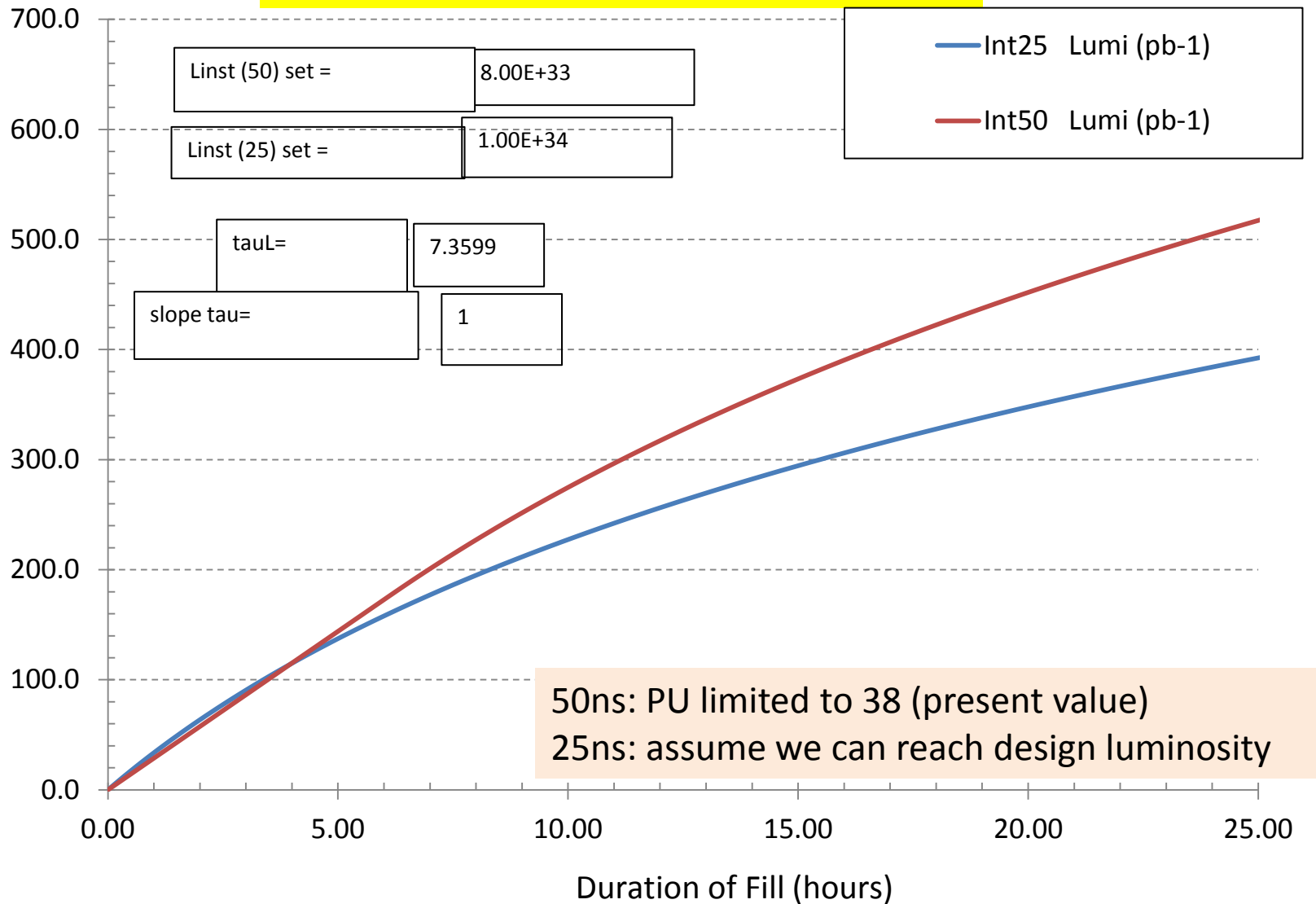
# Peak Luminosities (E34)



# Event Pile Up (During Fill)

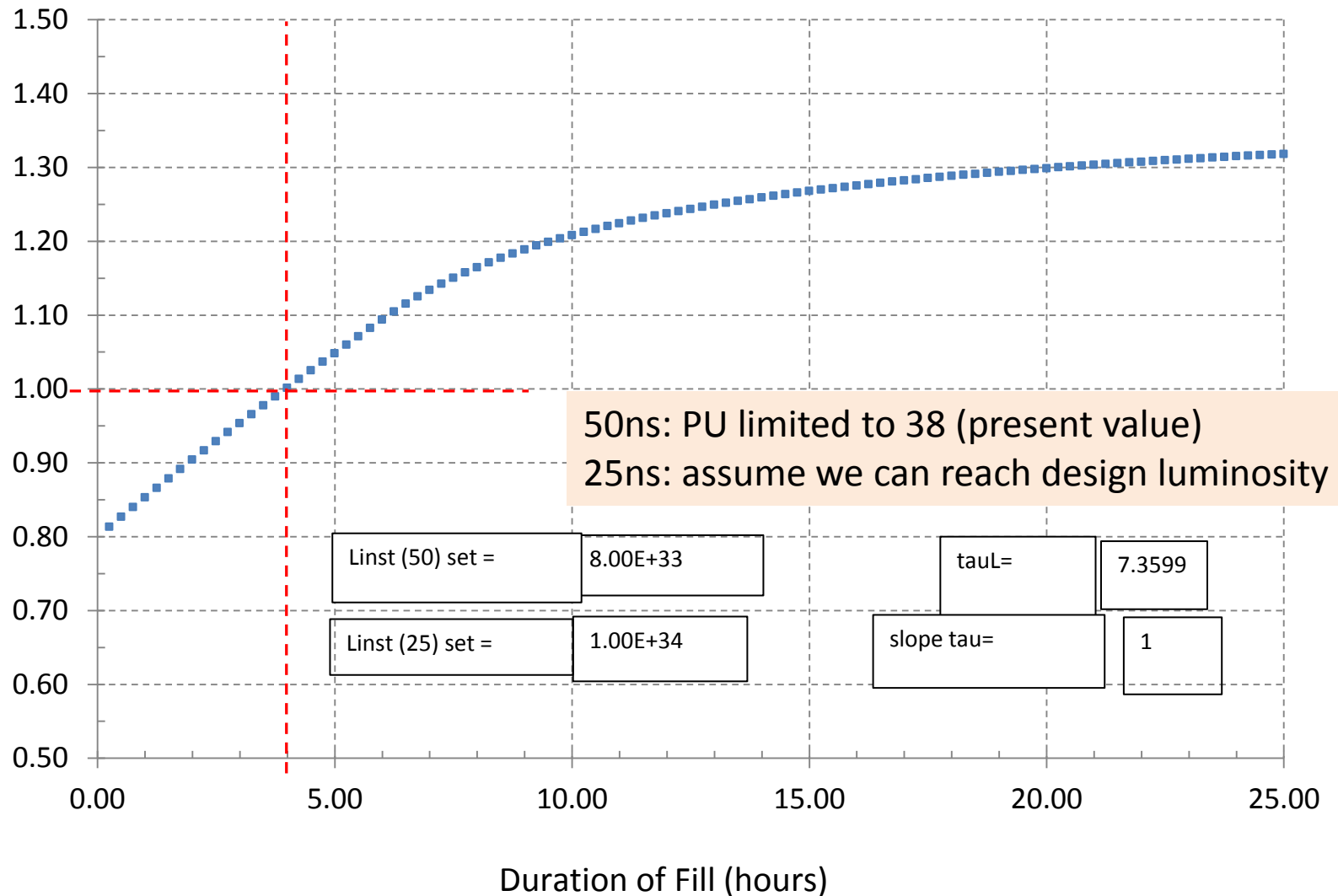


# Integrated Luminosity

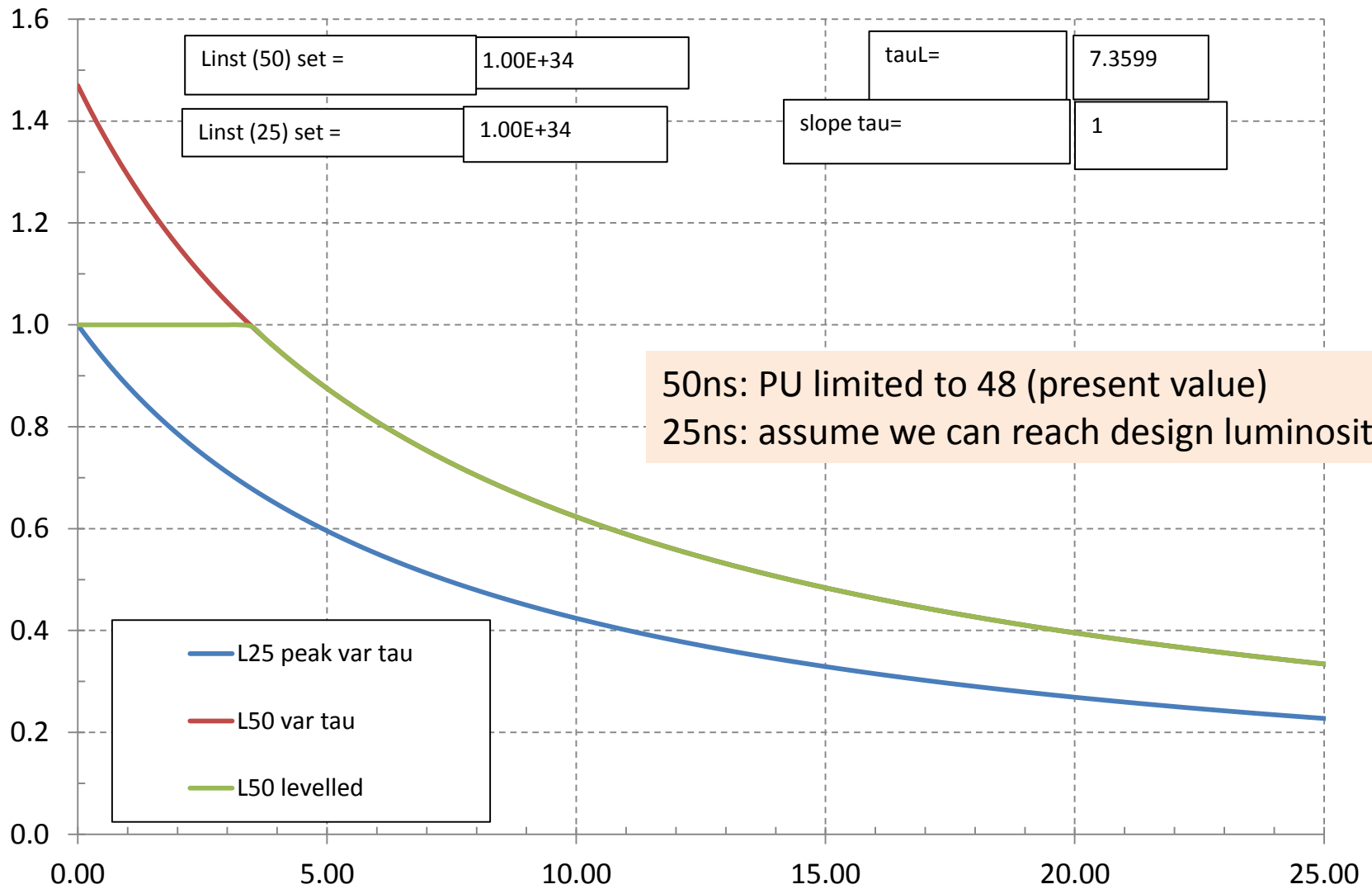




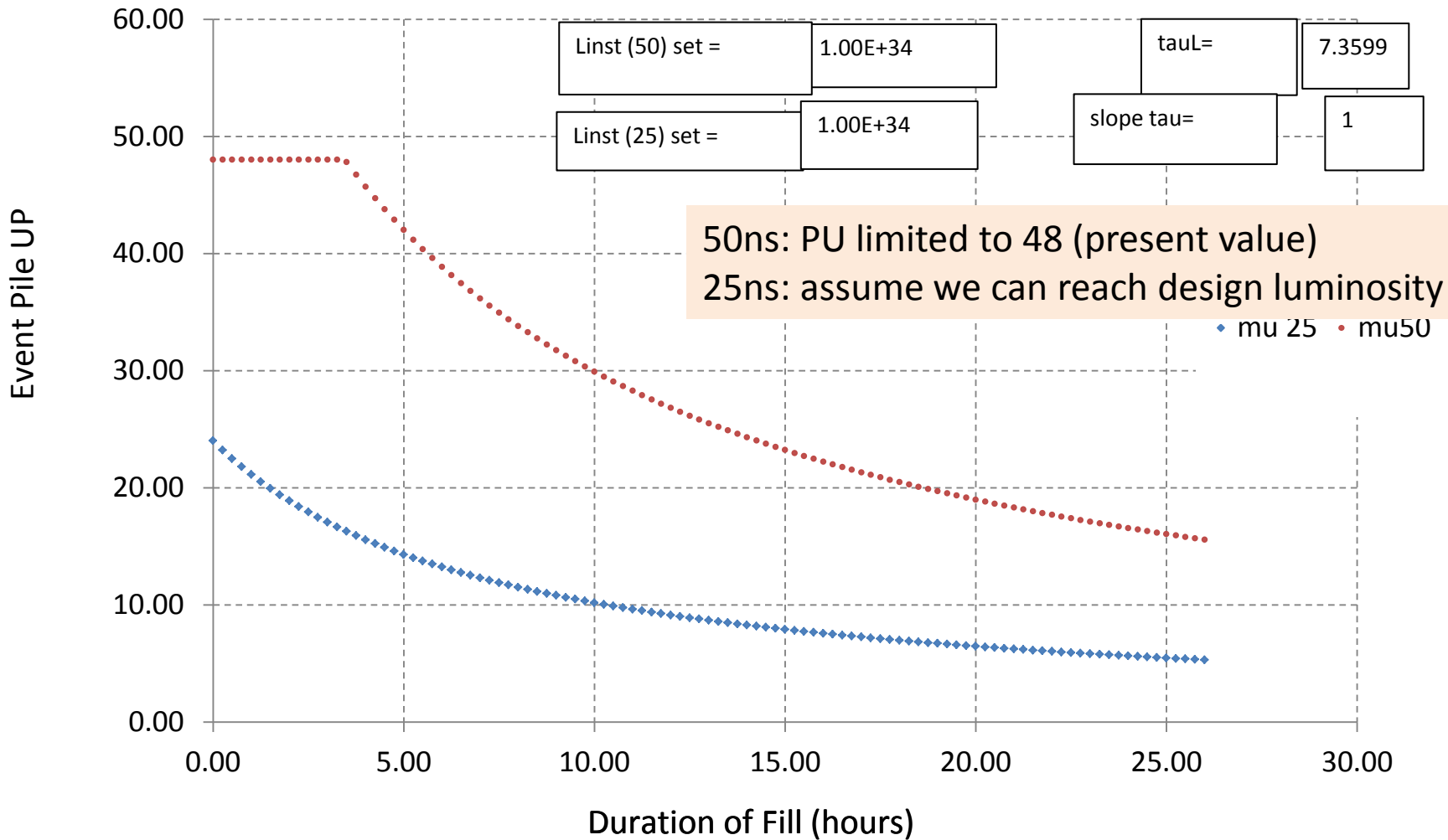
# Integrated Ratio 50 to 25 ns



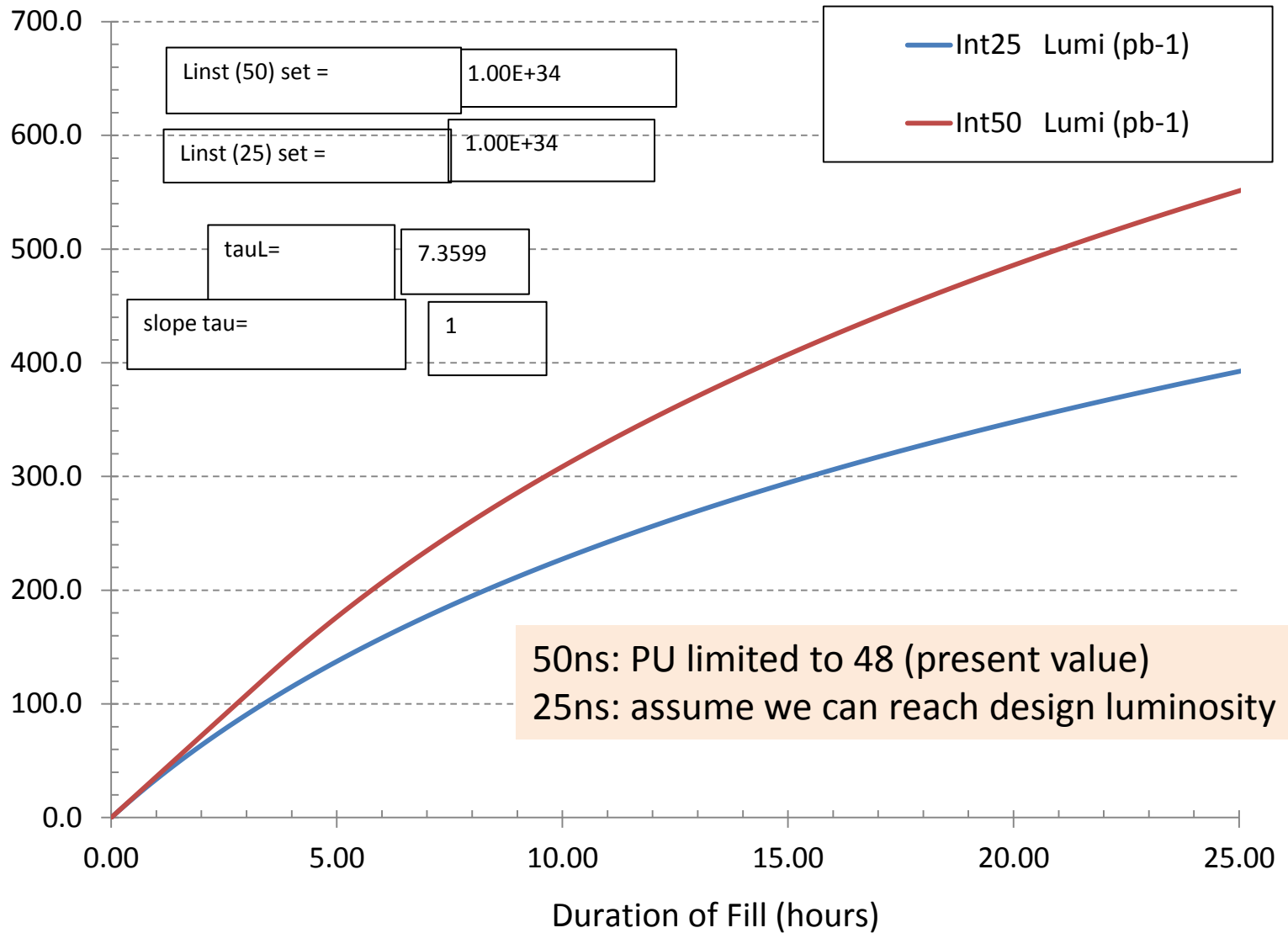
# Peak Luminosities (E34)



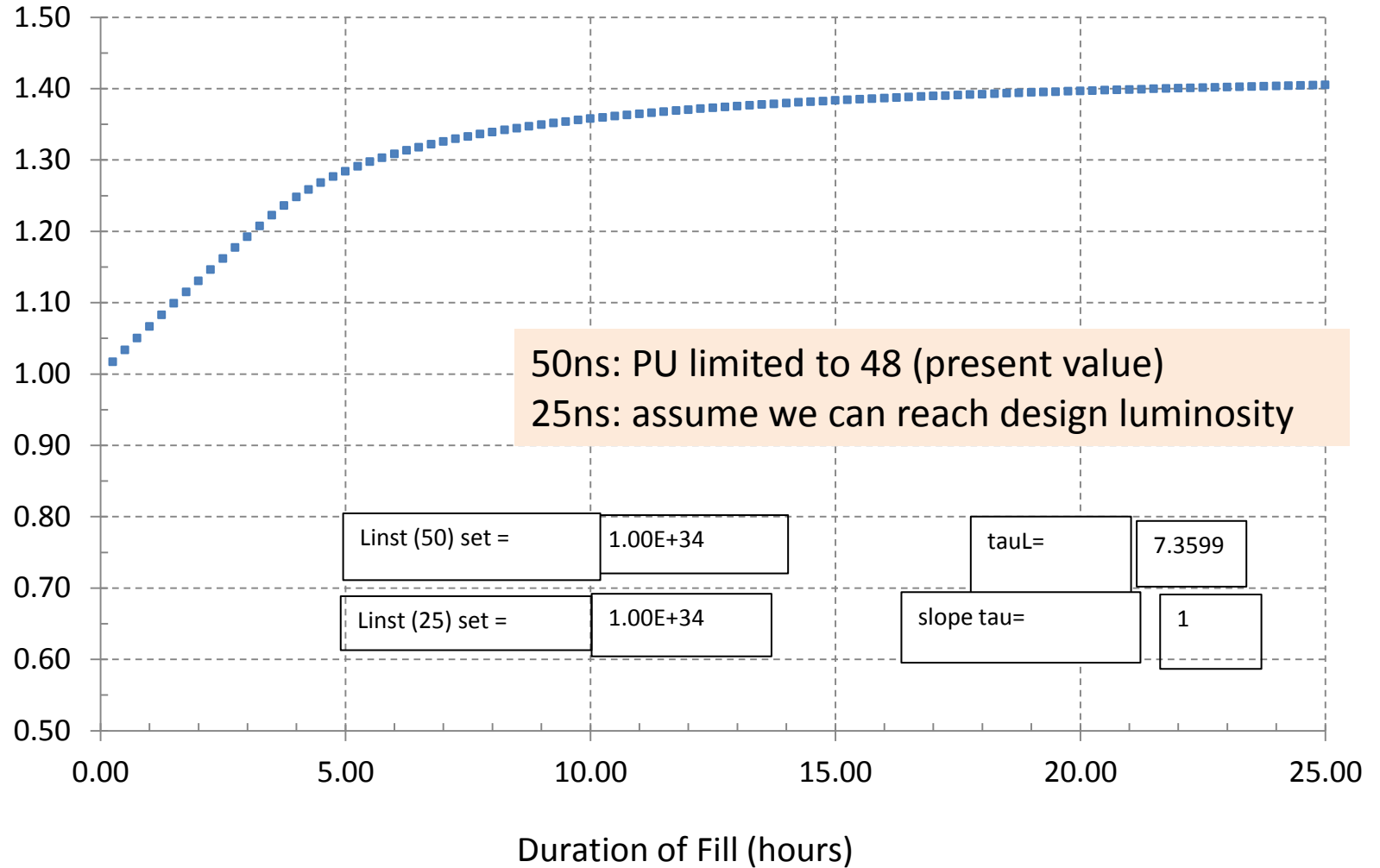
# Event Pile Up (During Fill)



# Integrated Luminosity



# Integrated Ratio 50 to 25 ns



# Summary

- Integrated luminosity goal for 2012 exceeded
  - $\cong$  6 weeks proton physics to go:
  - for physics production we will continue with 50ns
- Proton-lead run in excellent shape (some published results already)
- LS1 plans in good shape (? Quadrupole diodes)
- Operation after LS1
  - 25ns: injector brightness, e-cloud, HOM, beam-beam related, UFOs
  - 50ns:  $\beta^*$  levelling (maximum permissible pile up)

Thank you

# SPARES

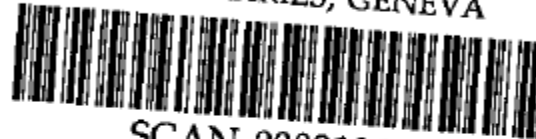


# LHC 1

ps

LEP/LIBRARY

CERN LIBRARIES, GENEVA



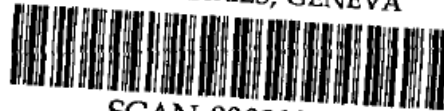
SCAN-0008106

LEP Note 440

11.4.1983

PRELIMINARY PERFORMANCE ESTIMATES FOR A LEP PROTON COLLIDER

S. Myers and W. Schnell



## PRELIMINARY PERFORMANCE ESTIMATES FOR A LEP PROTON COLLIDER

S. Myers and W. Schnell

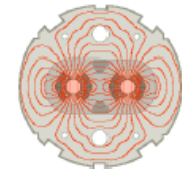
1. Introduction

This analysis was stimulated by news from the United States where very large  $p\bar{p}$  and  $pp$  colliders are actively being studied at the moment. Indeed, a first look at the basic performance limitations of possible  $p\bar{p}$  or  $pp$  rings in the LEP tunnel seems overdue, however far off in the future a possible start of such a p-LEP project may yet be in time. What we shall discuss is, in fact, rather obvious, but such a discussion has, to the best of our knowledge, not been presented so far.

We shall not address any detailed design questions but shall give basic equations and make a few plausible assumptions for the purpose of illustration. Thus, we shall assume throughout that the maximum energy per beam is 8 TeV (corresponding to a little over 9 T bending field in very advanced superconducting magnets) and that injection is at 0.4 TeV. The ring circumference is, of course that of LEP, namely 26,659 m. It should be clear from this requirement of "Ten Tesla Magnets" alone that such a project is not for the near future and that it should not be attempted before the technology is ready.



# The LHC Life cycle



- 1983: Preliminary Performance Estimates for the LHC (S.Myers and W. Schnell, 11<sup>th</sup> April 1983)
  - 1984: Kick off meeting to discuss ideas for an accelerator to collide particles at very high energy
  - 1996: Final decision for the LHC, the most complex scientific instrument ever constructed
  - 10 September 2008: Start of commissioning with beam
  - 19 September 2008: Series of beam instabilities and damage
  - 19 November 2009: Resumption of beam operation
  - December 2009: First collisions at 2.38 TeV
- Today, successful operation, providing millions of particle collisions for the LHC experiments
- About 2035: The LHC physics programme to be finished ?

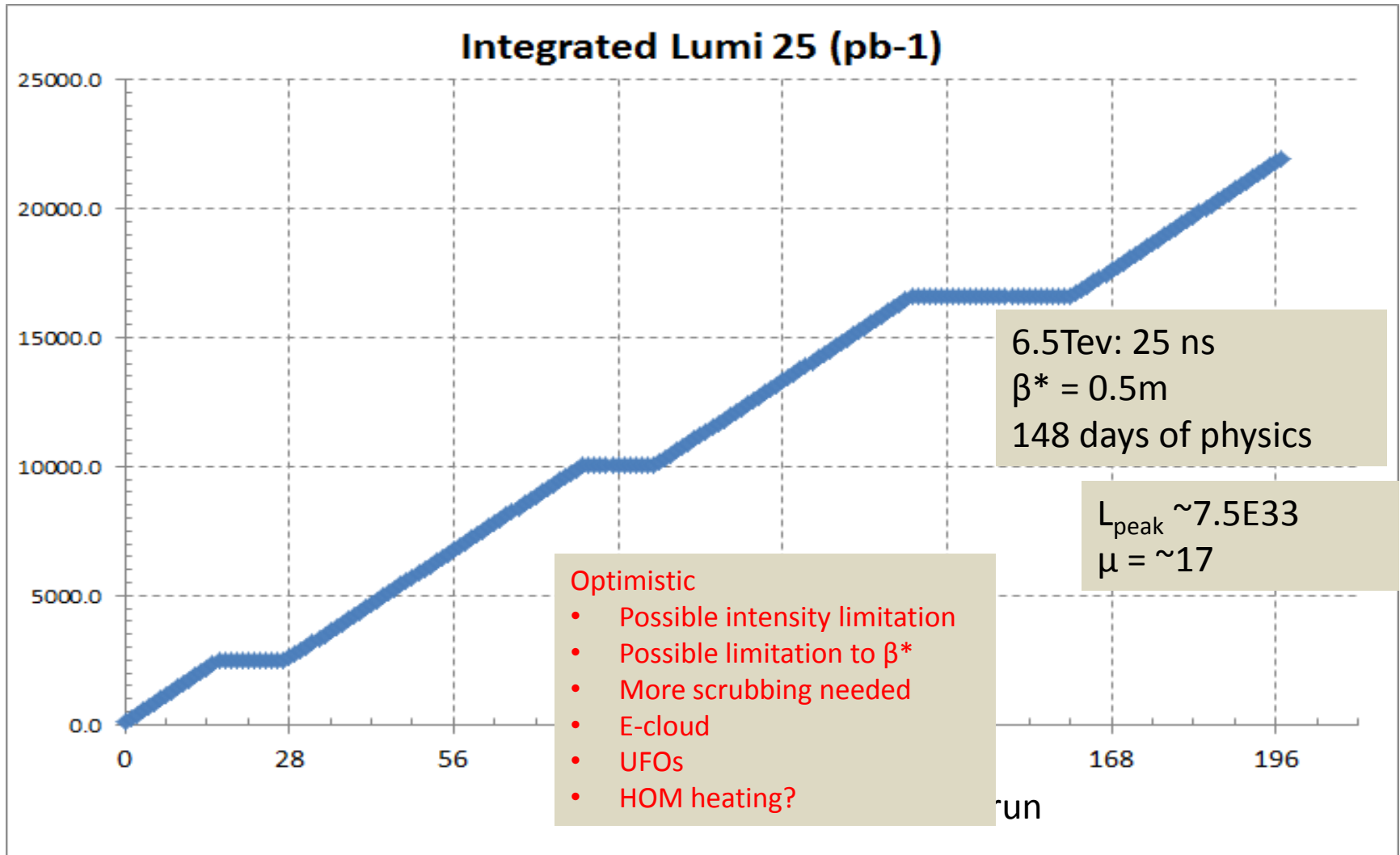
**A >50 Years Adventure**

# Then operation at 6.5TeV per beam

## Assumptions

- $E=6.5\text{TeV}$
- $\beta^* = 0.5\text{m}$
- All other conditions as in 2012 i.e. no improvement (yet ??) in injector brightness, LHC availability same etc

# 6.5TeV: 25ns



# 6.5TeV per beam with 50ns

