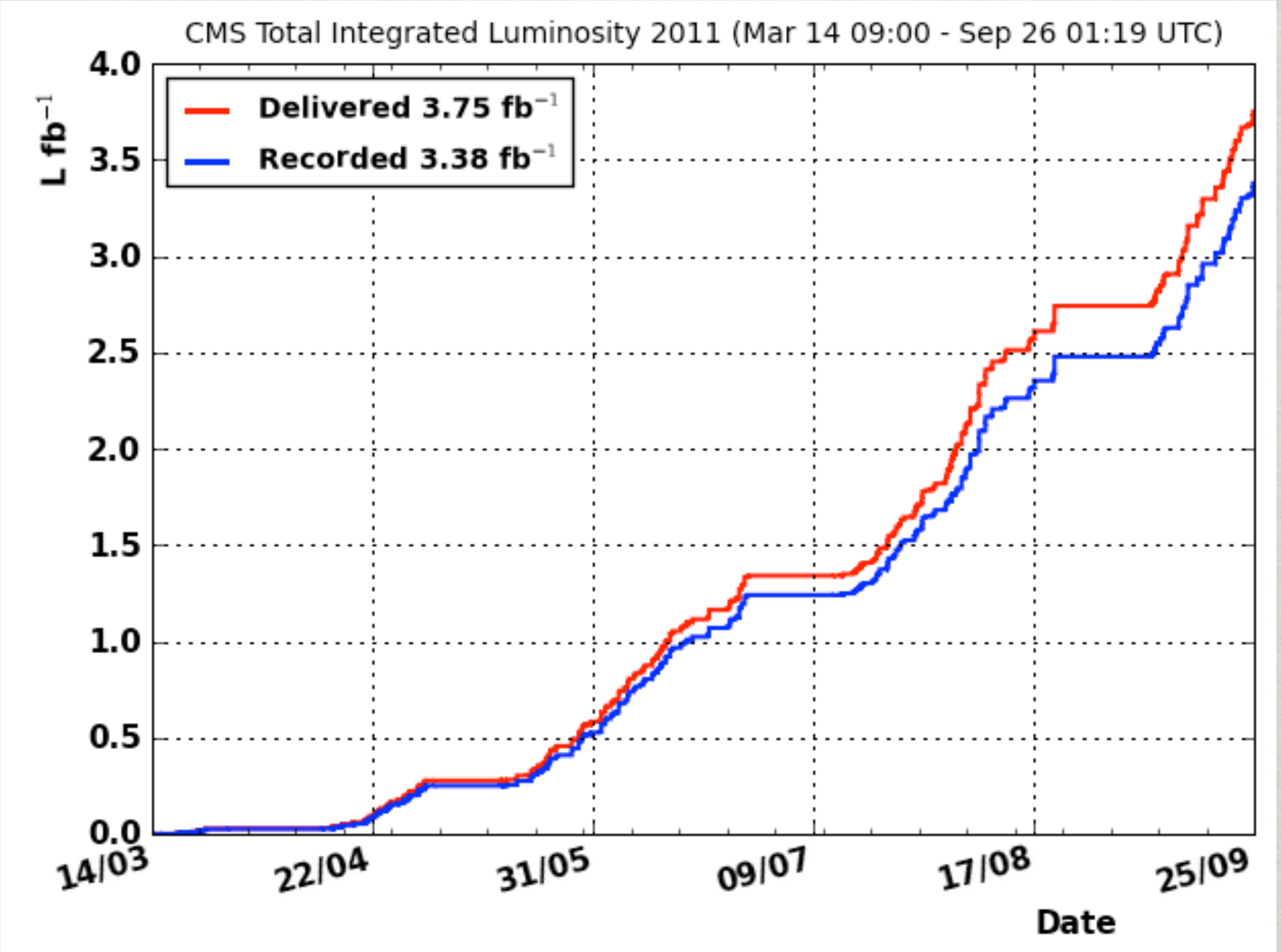
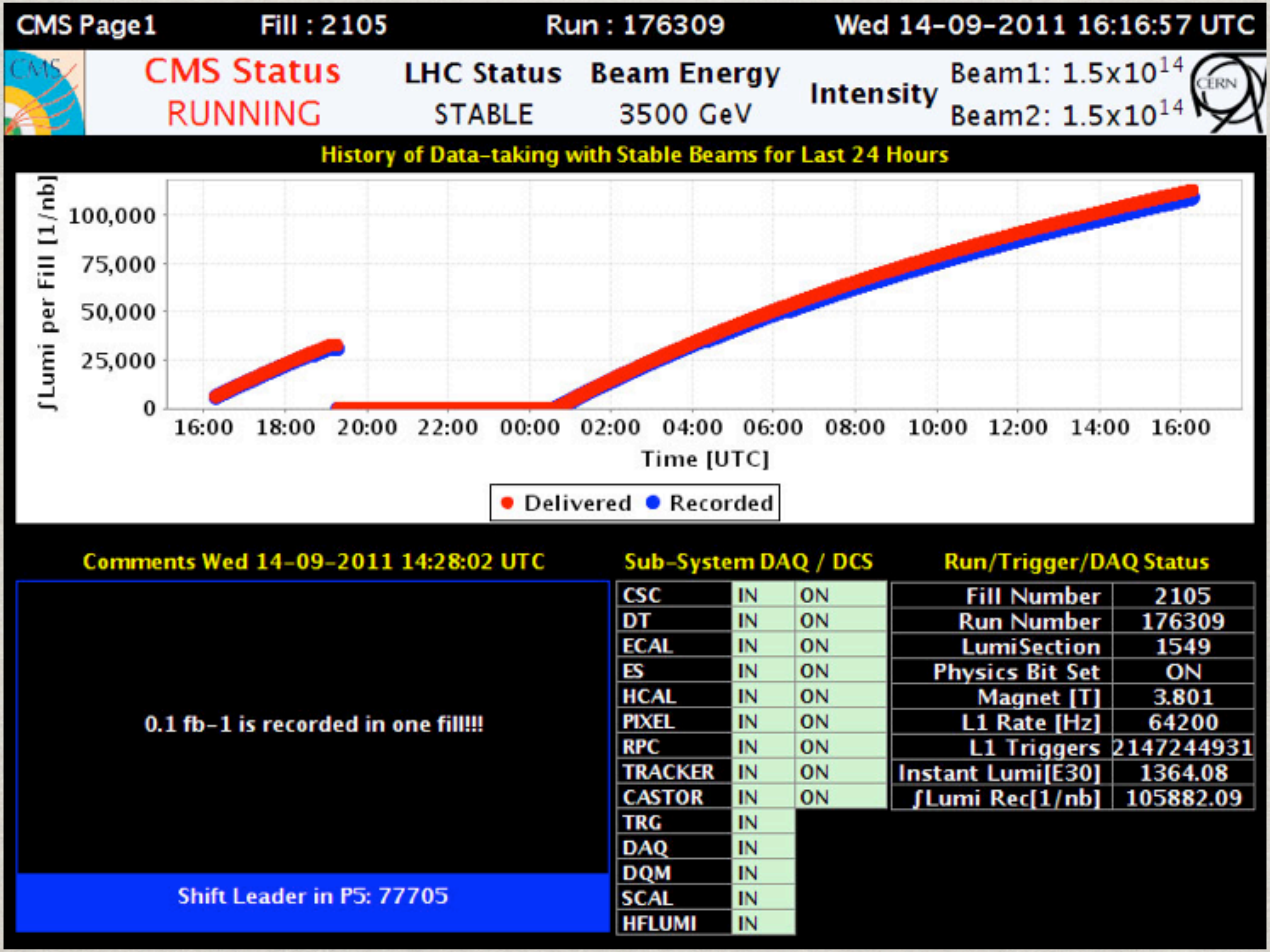
CMS Status

Kevin Lannon
on behalf of
the CMS collaboration

LHC Data is Pouring In!

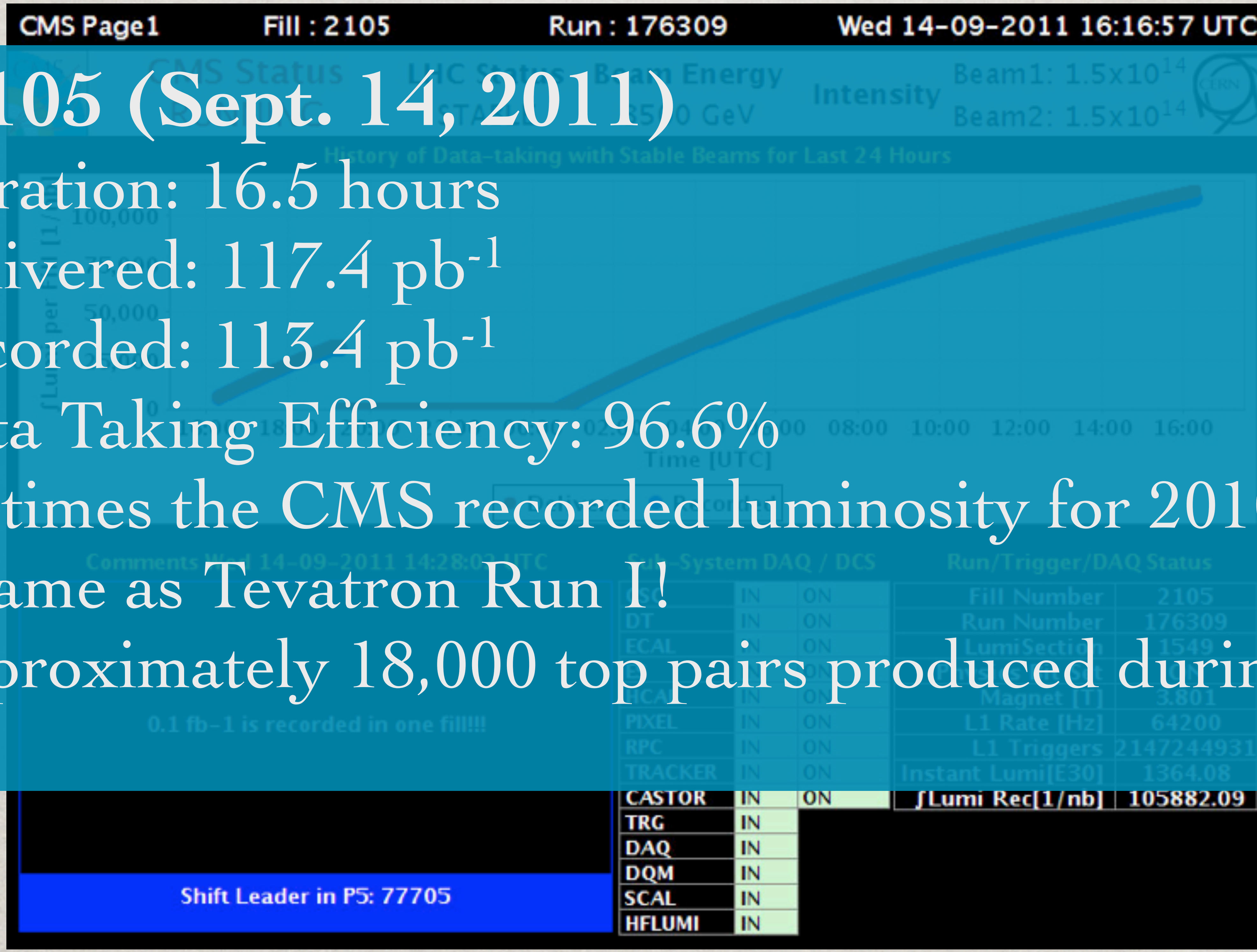


Record Fill!



CMS Page1
Fill : 2105
Run : 176309
Wed 14-09-2011 16:16:57 UTC
CMS Status
RUNNING
LHC Status
STABLE
Beam Energy
3500 GeV
Intensity
Beam1: 1.5x10^14
Beam2: 1.5x10^14
CERN
History of Data-taking with Stable Beams for Last 24 Hours
∫Lumi per Fill [1/nb]
100,000
75,000
50,000
25,000
0
16:00 18:00 20:00 22:00 00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00
Time [UTC]
Delivered
Recorded
Comments Wed 14-09-2011 14:28:02 UTC
0.1 fb-1 is recorded in one fill!!!
Shift Leader in P5: 77705
Sub-System DAQ / DCS
CSC IN ON
DT IN ON
ECAL IN ON
ES IN ON
HCAL IN ON
PIXEL IN ON
RPC IN ON
TRACKER IN ON
CASTOR IN ON
TRG IN
DAQ IN
DQM IN
SCAL IN
HFLUMI IN
Run/Trigger/DAQ Status
Fill Number 2105
Run Number 176309
LumiSection 1549
Physics Bit Set ON
Magnet [T] 3.801
L1 Rate [Hz] 64200
L1 Triggers 2147244931
Instant Lumi[E30] 1364.08
∫Lumi Rec[1/nb] 105882.09

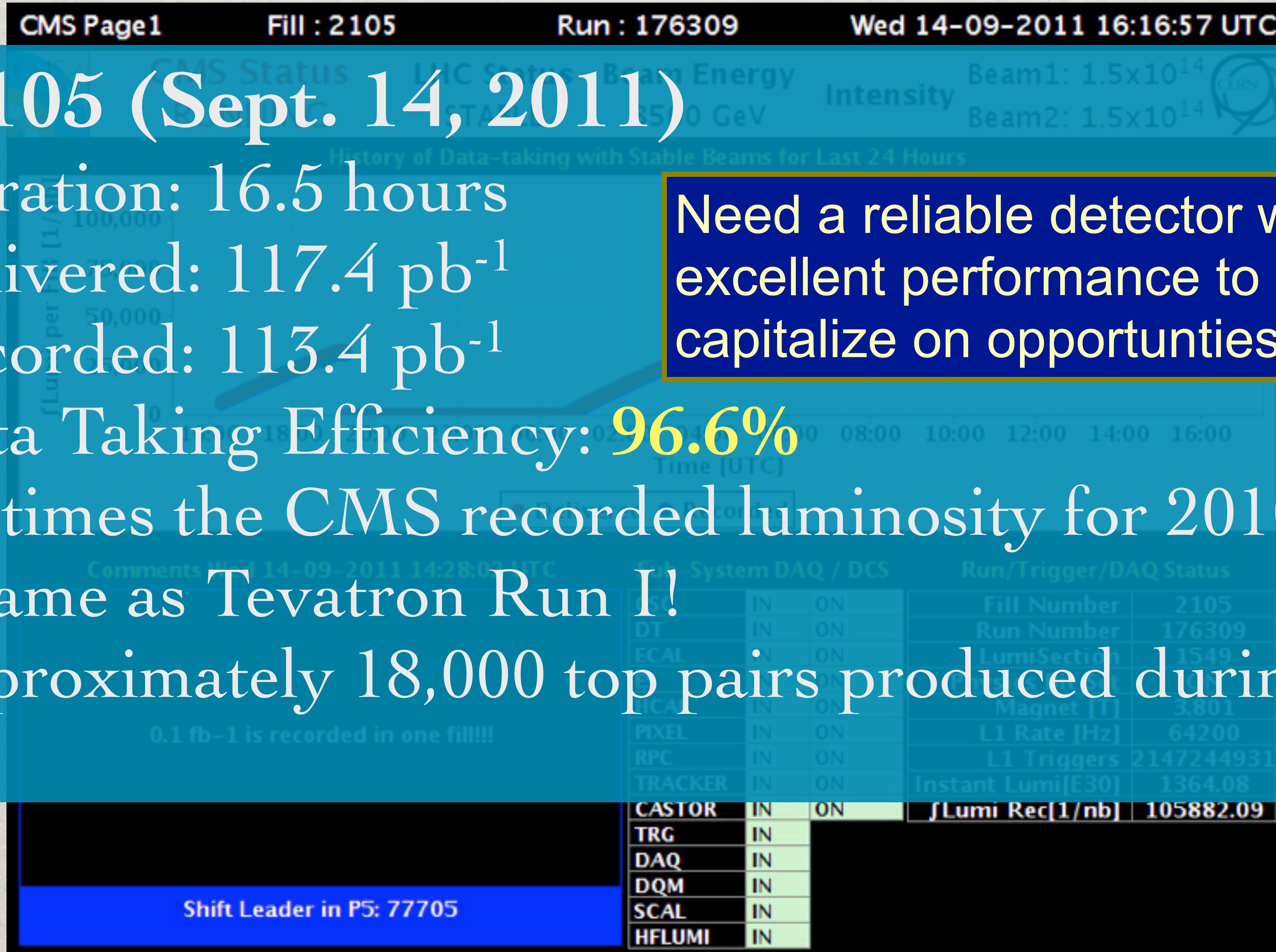
Record Fill!



Fill 2105 (Sept. 14, 2011)

- Duration: 16.5 hours
- Delivered: 117.4 pb^{-1}
- Recorded: 113.4 pb^{-1}
- Data Taking Efficiency: 96.6%
- 2.6 times the CMS recorded luminosity for 2010
- ~ Same as Tevatron Run I!
- Approximately 18,000 top pairs produced during this fill!

Record Fill!



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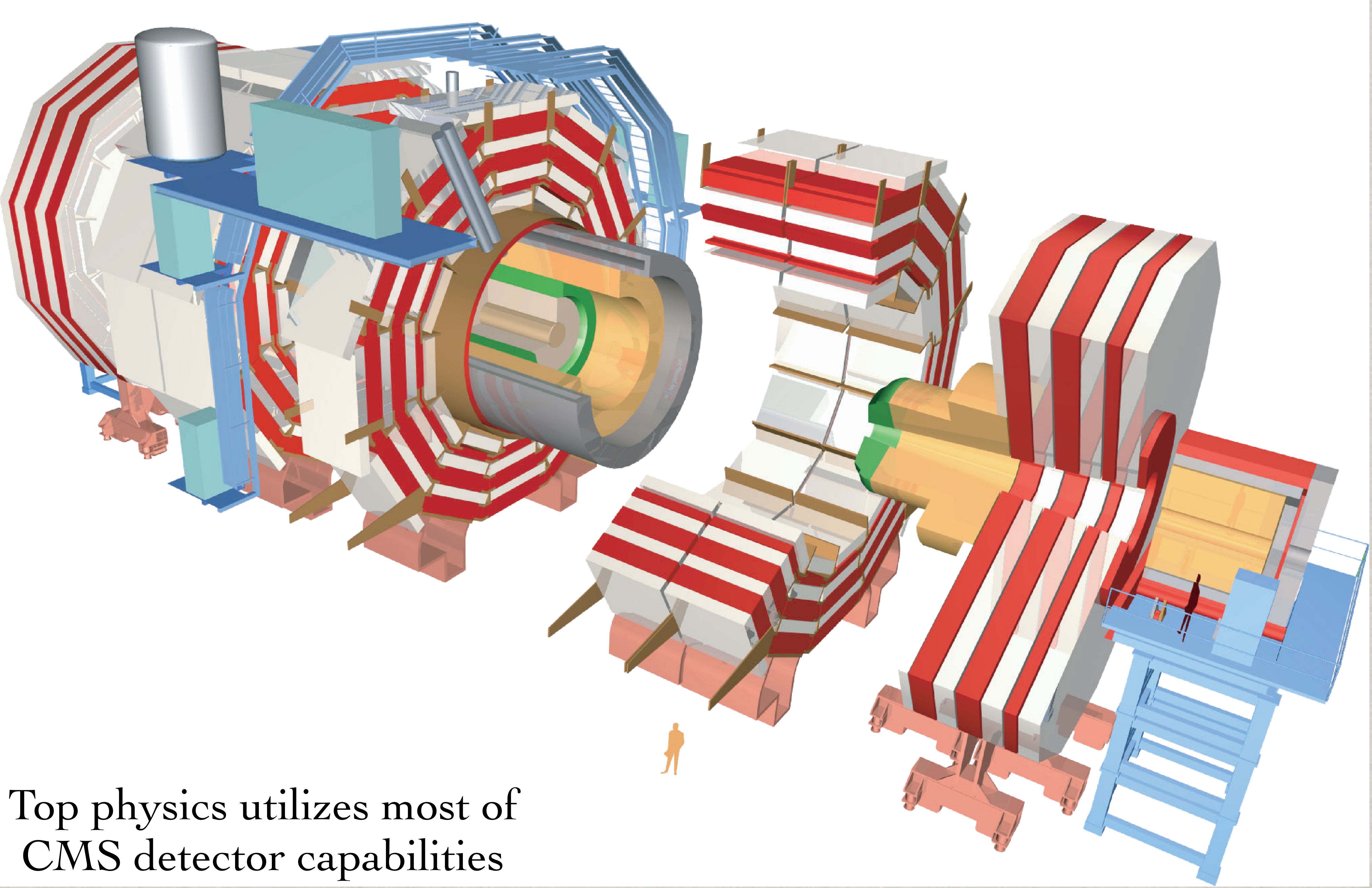
Need a reliable detector with excellent performance to capitalize on opportunties like this!

Detector

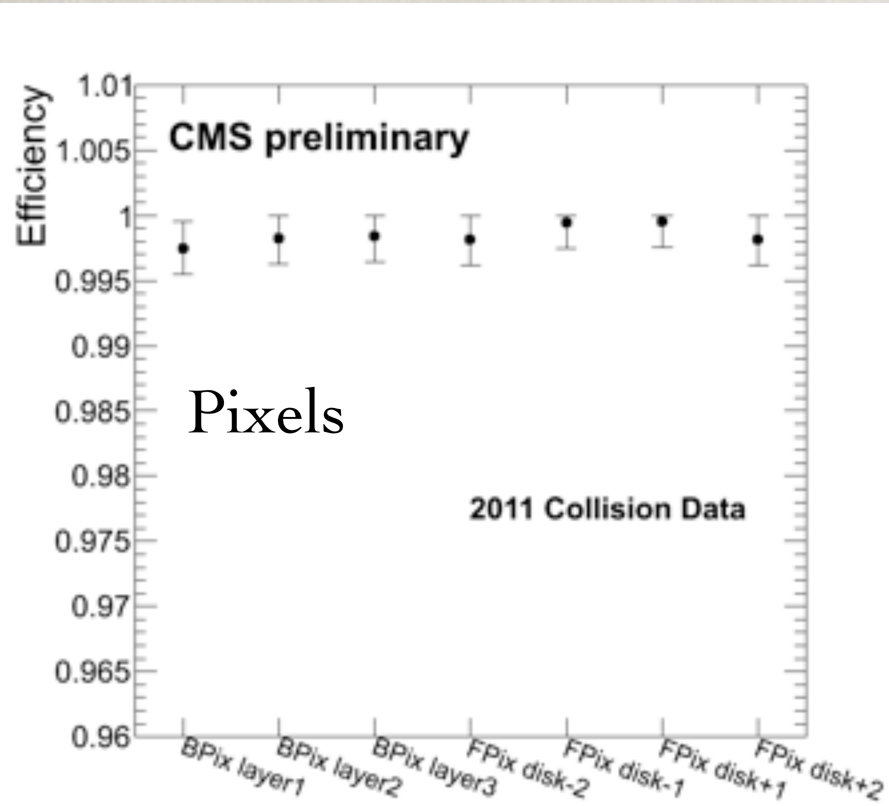
CMS Detector



Top physics utilizes most of CMS detector capabilities

Tracker

Both cover $|\eta| < 2.5$

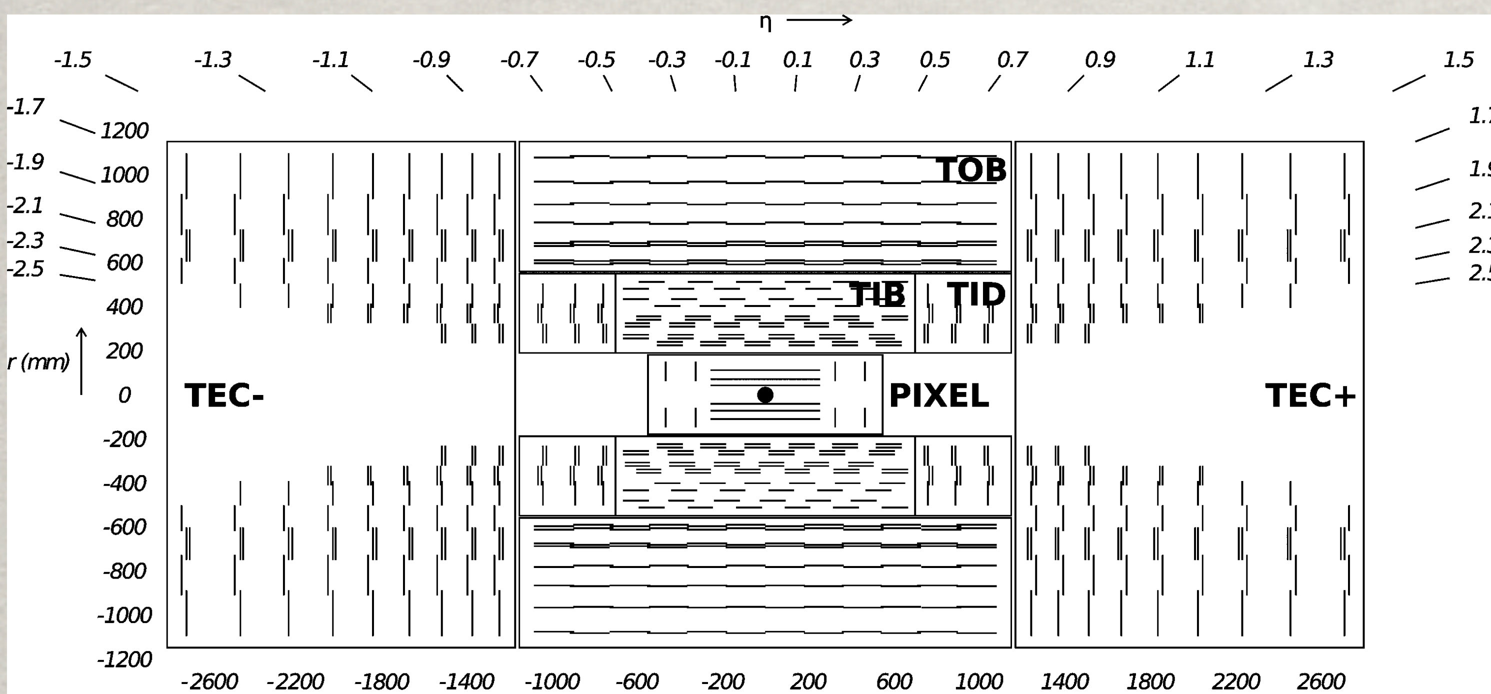


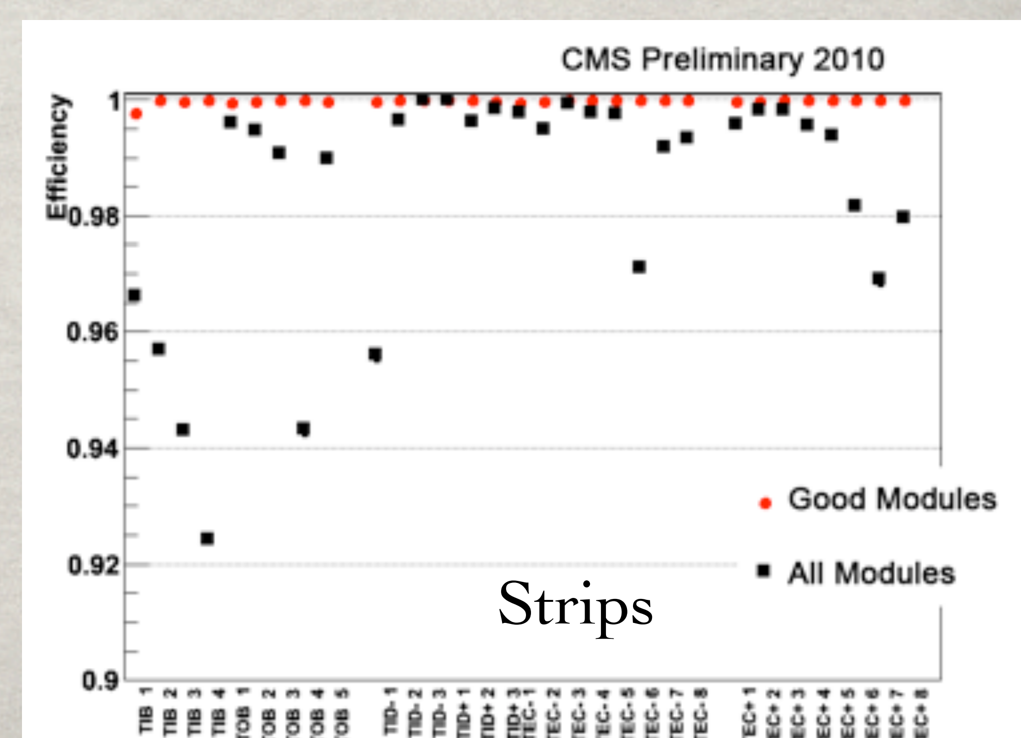
Pixel detector:

Number of channels: 66M
Sensor size: 100 μm × 150 μm (~1 m^2 total area)
Hit resolution: 11.2 μm (trans.), 26.8 μm (long.)

Strip detectors:

Number of channels: 9.6M
Strip pitch: 80-183 μm (~210 m^2 total area)
Hit resolution: 16 - 40 μm





ECAL

Barrel (EB)

$|\eta|<1.479$

- 61,200 $PbWO_4$ crystals
- 2.2 cm × 2.2 cm on face
- 0.0174 × 0.0174 in η × ϕ
- 25.8 X_0 deep

Endcap (EE)

$1.479 < |\eta| < 3.0$

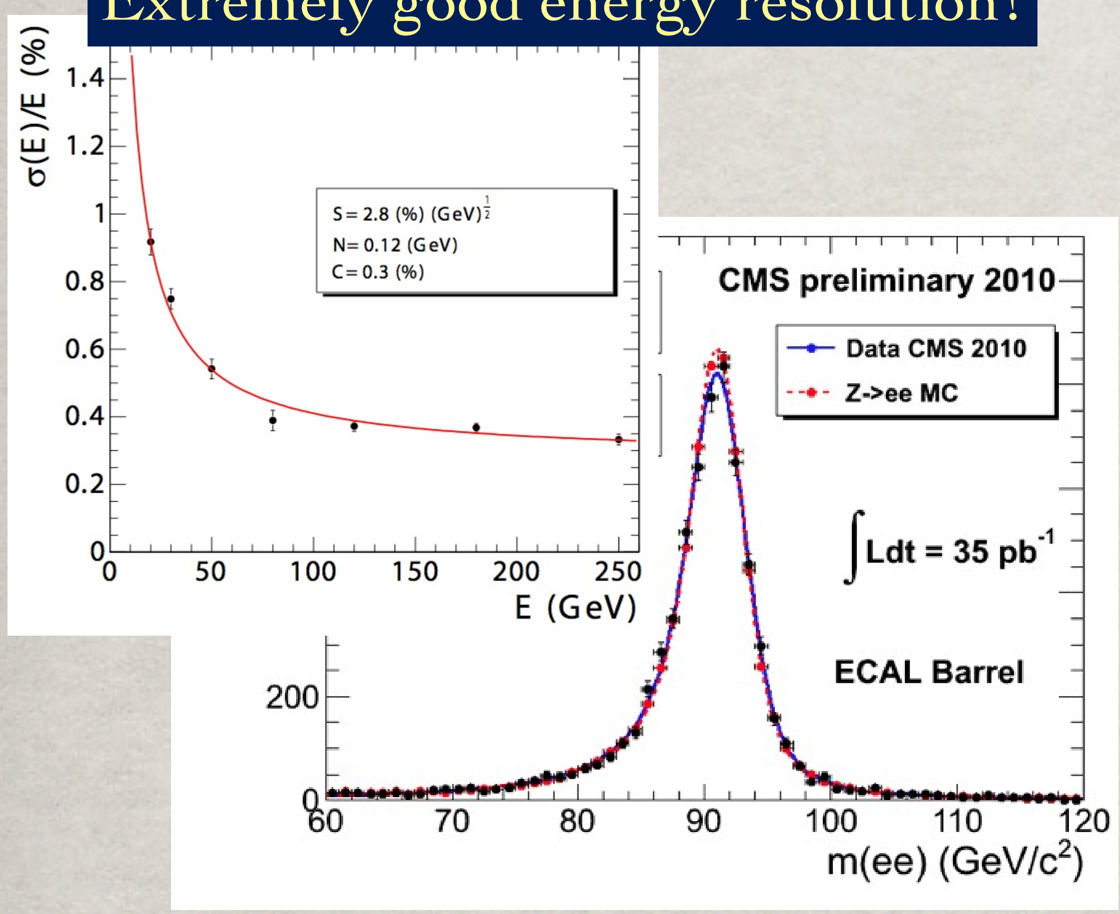
- 14,648 $PbWO_4$ crystals
- 2.86 cm × 2.86 cm on face
- 24.7 X_0 deep

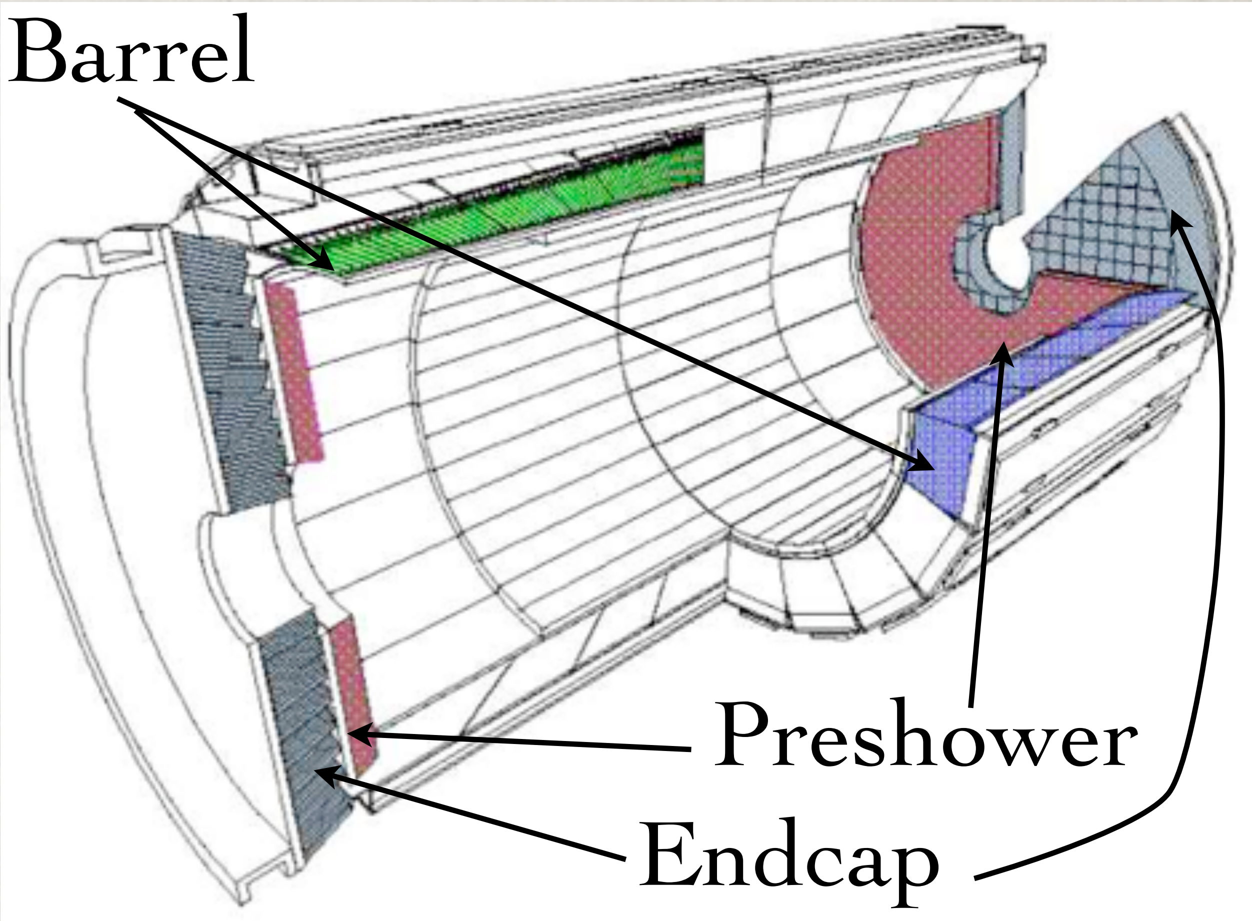
Preshower: (ES)

$1.653 < |\eta| < 2.6$

- 137,000 readout channels
- Alternating Si/Pb layers:
- 20 cm thick (~3 X_0)

Extremely good energy resolution!





$$\left(\frac{\sigma}{E}\right)^2 = \left(\frac{2.8\%}{\sqrt{E}}\right)^2 + \left(\frac{0.12}{E}\right)^2 + (0.3\%)^2$$

HCAL

Barrel (HB)

$|\eta|<1.3$

- 0.087×0.087 in $\eta \times \phi$
- $5.8\ \lambda_I$ (in middle) to
- $10.6\ \lambda_I$ (at end)

Endcap (HE)

$1.3 < |\eta| < 3.0$

- 0.087×0.087 in $\eta \times \phi$
- 0.17×0.17 in $\eta \times \phi$
- (for $|\eta| > 1.6$)
- $\sim 10\ \lambda_I$

Forward (HF)

$3.0 < |\eta| < 5.0$

- $\sim 10\ \lambda_I$

Outer (HO)

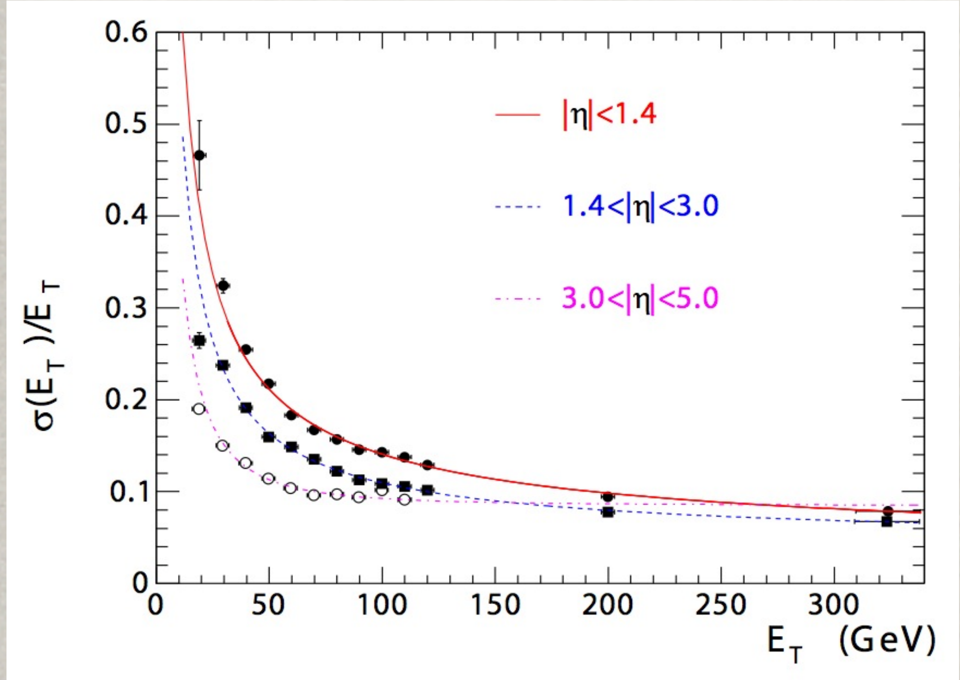
$|\eta|<1.3$

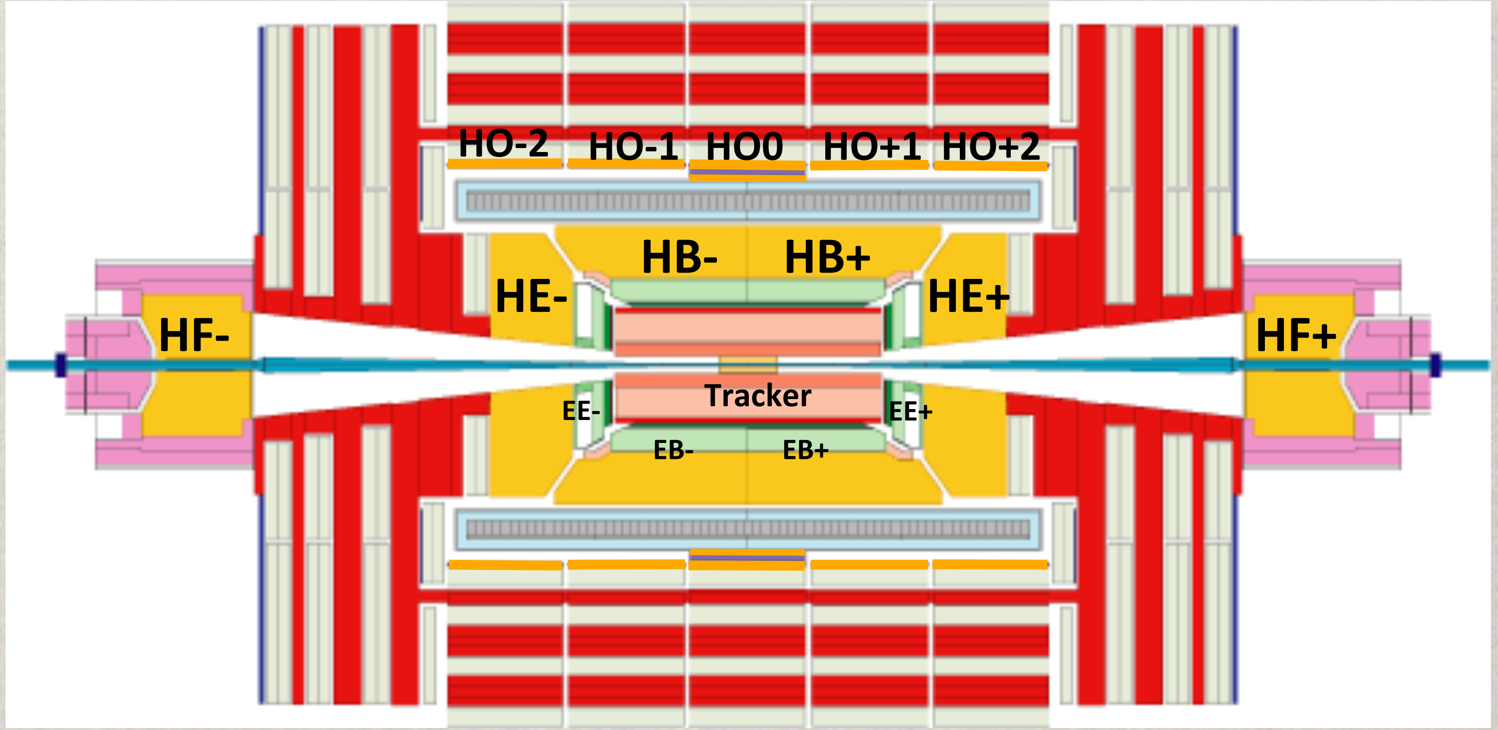
- Outside solenoid
- Ensure sufficient depth

Jet angular resolution (E_T > 100 GeV):

σ_ϕ = 20 mrad; σ_θ = 30 mrad

ECAL + HCAL Resolution





K. Lannon

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Muon Systems

Drift Tubes (DT)

$|\eta| < 0.8$ (full coverage); $0.8 < |\eta| < 1.2$ (overlap with CSC)

4 tracking stations measure trajectory in r-ϕ and r-z

Cathode Strip Chambers (CSC)

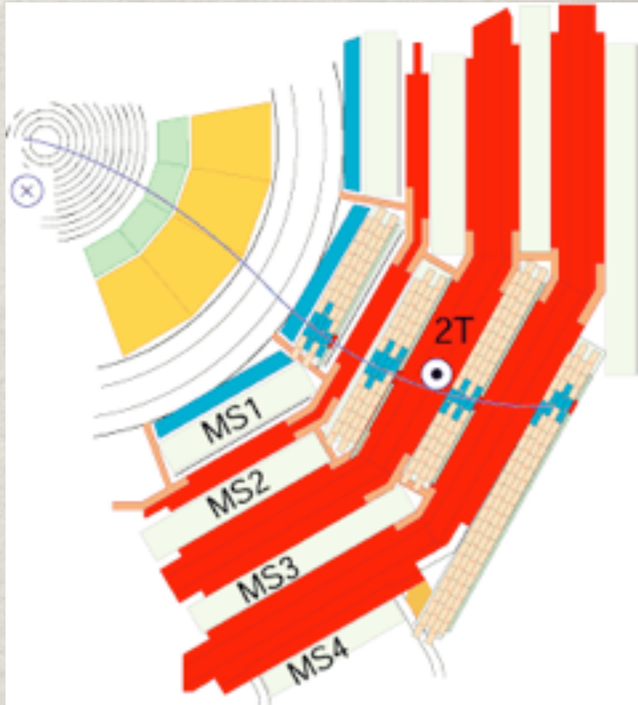
$1.2 < |\eta| < 2.4$ (full coverage); $0.8 < |\eta| < 1.2$ (overlap with DT)

3-4 tracking stations

Resistive Plate Chambers (RPC)

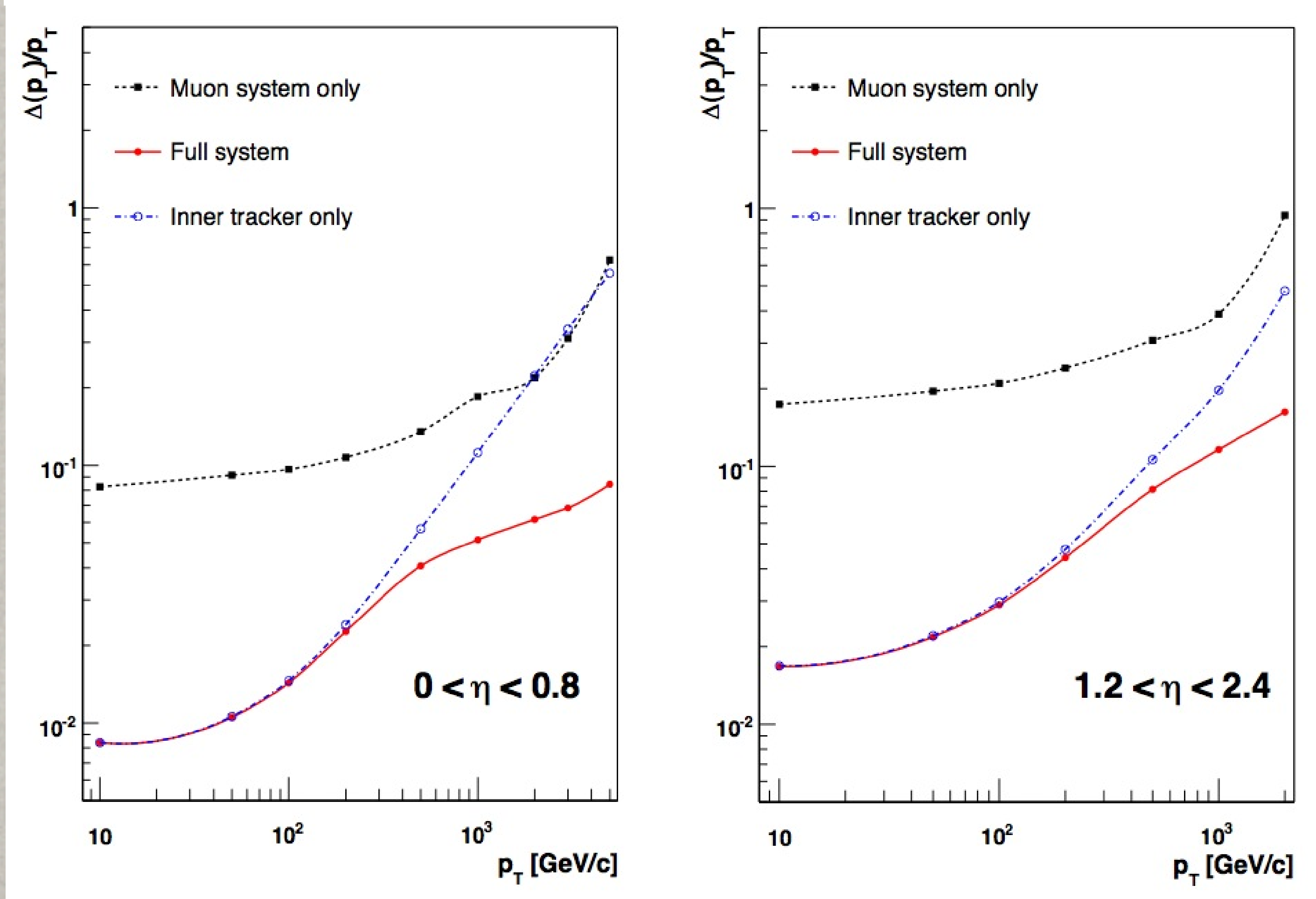
$|\eta| < 1.6$; 6 layers in barrel; 3 layers in endcap

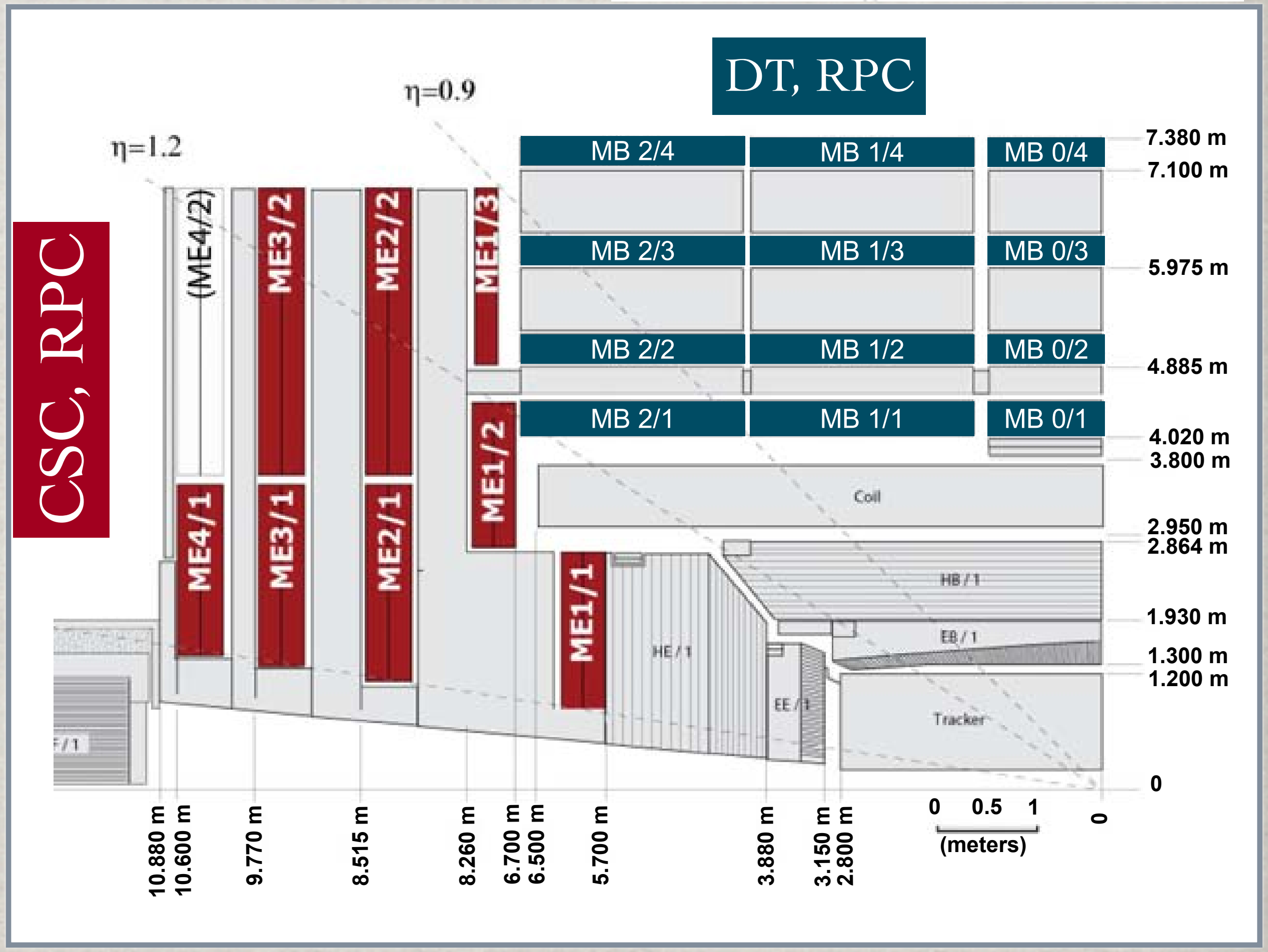
Provide fast timing information



$> 10\ \lambda_I$ (first station) to $> 20\ \lambda_I$ (last station): low punch-through

Standalone momentum measurement, plus combined with tracker





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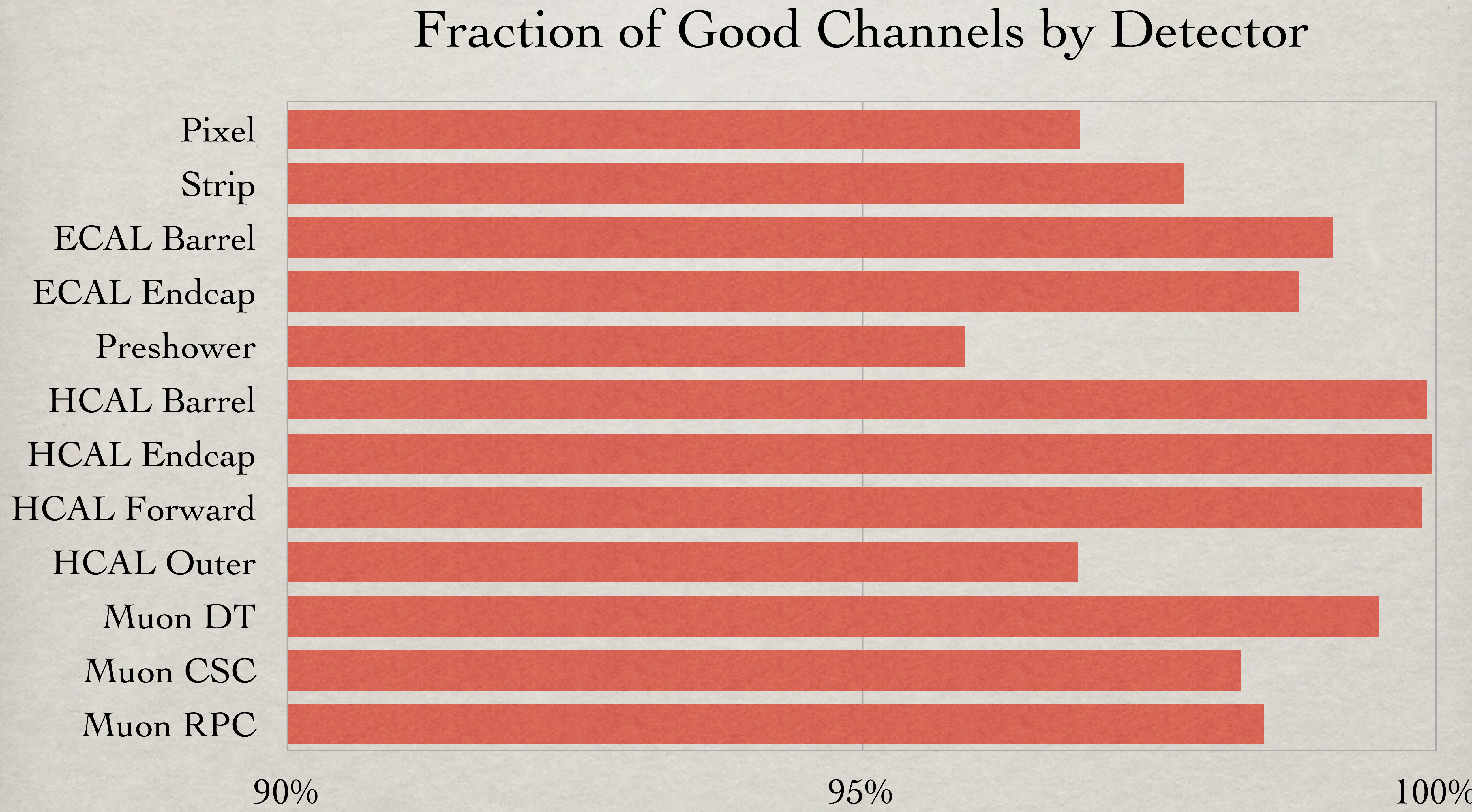
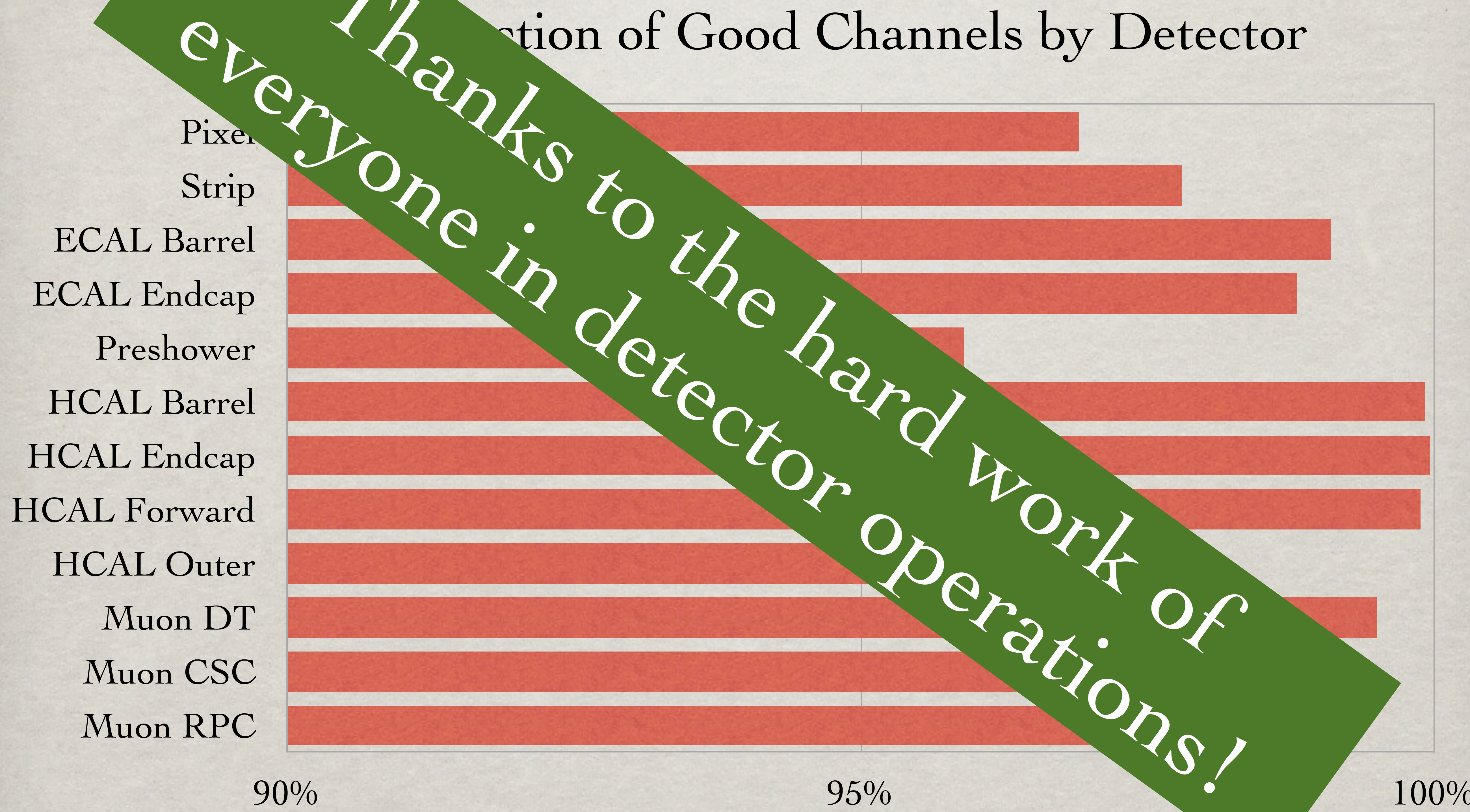
CMS Detector Works Well



CM Detector Works Well



Thanks to the hard work of everyone in detector operations!

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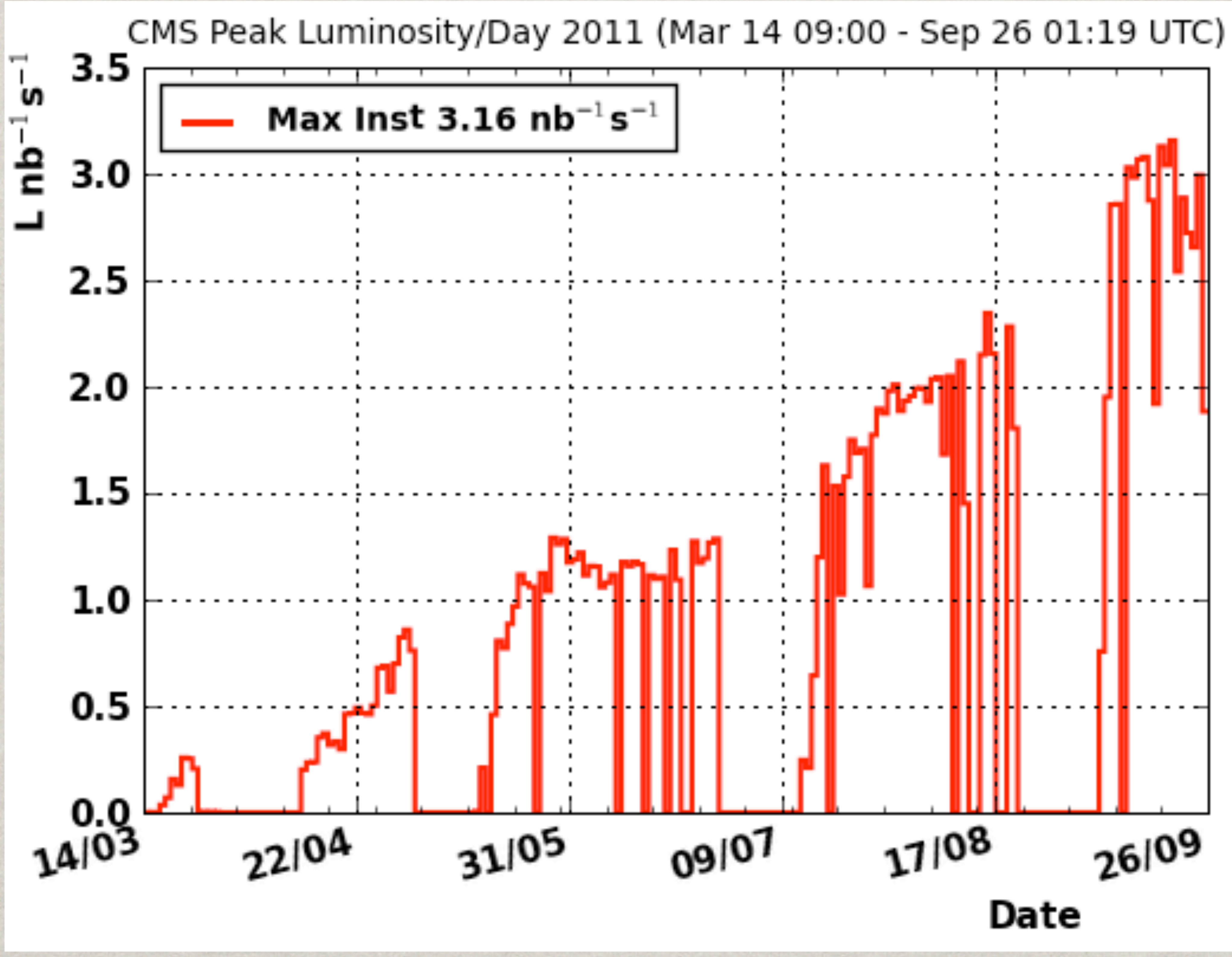
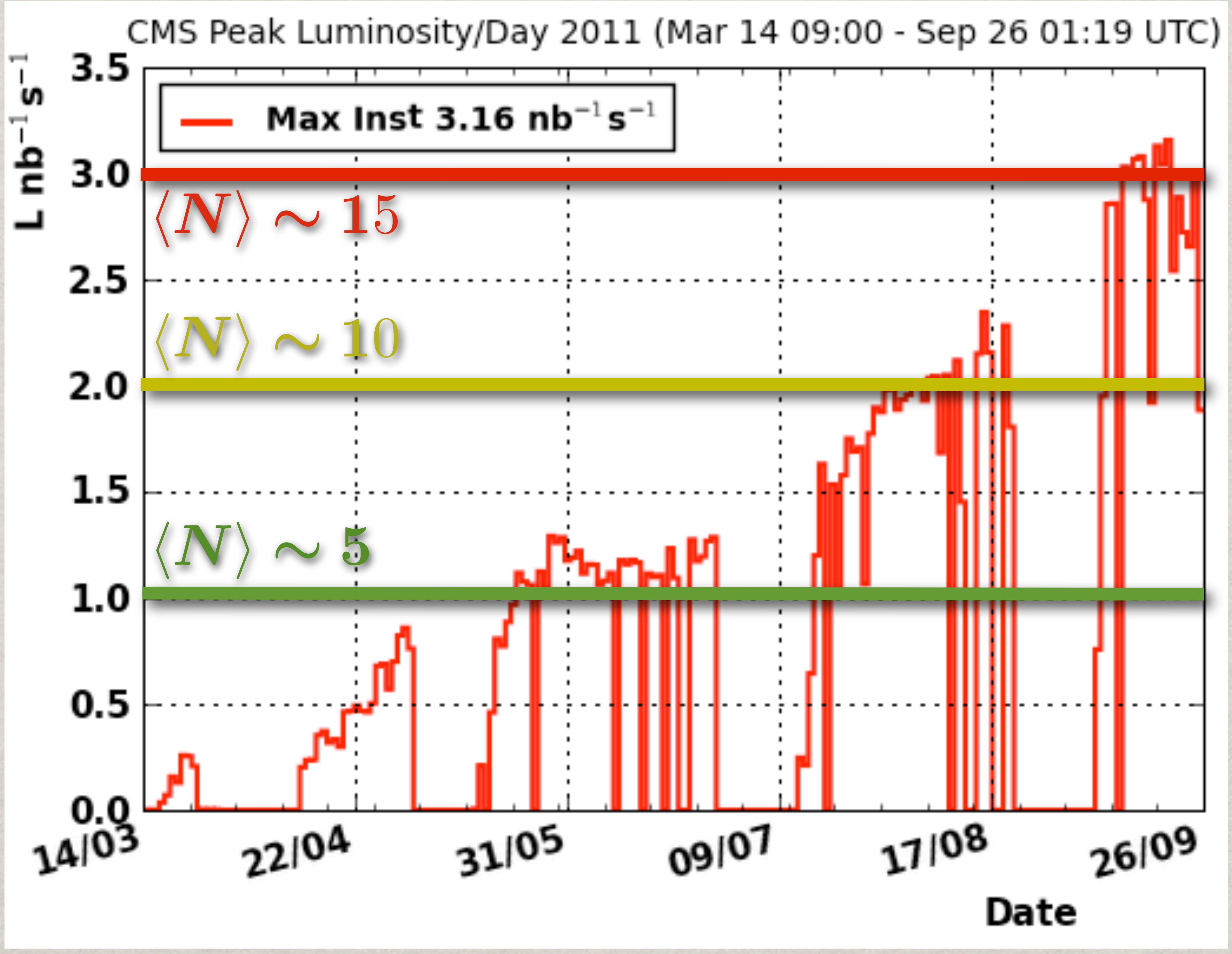
Trigger and DAQ

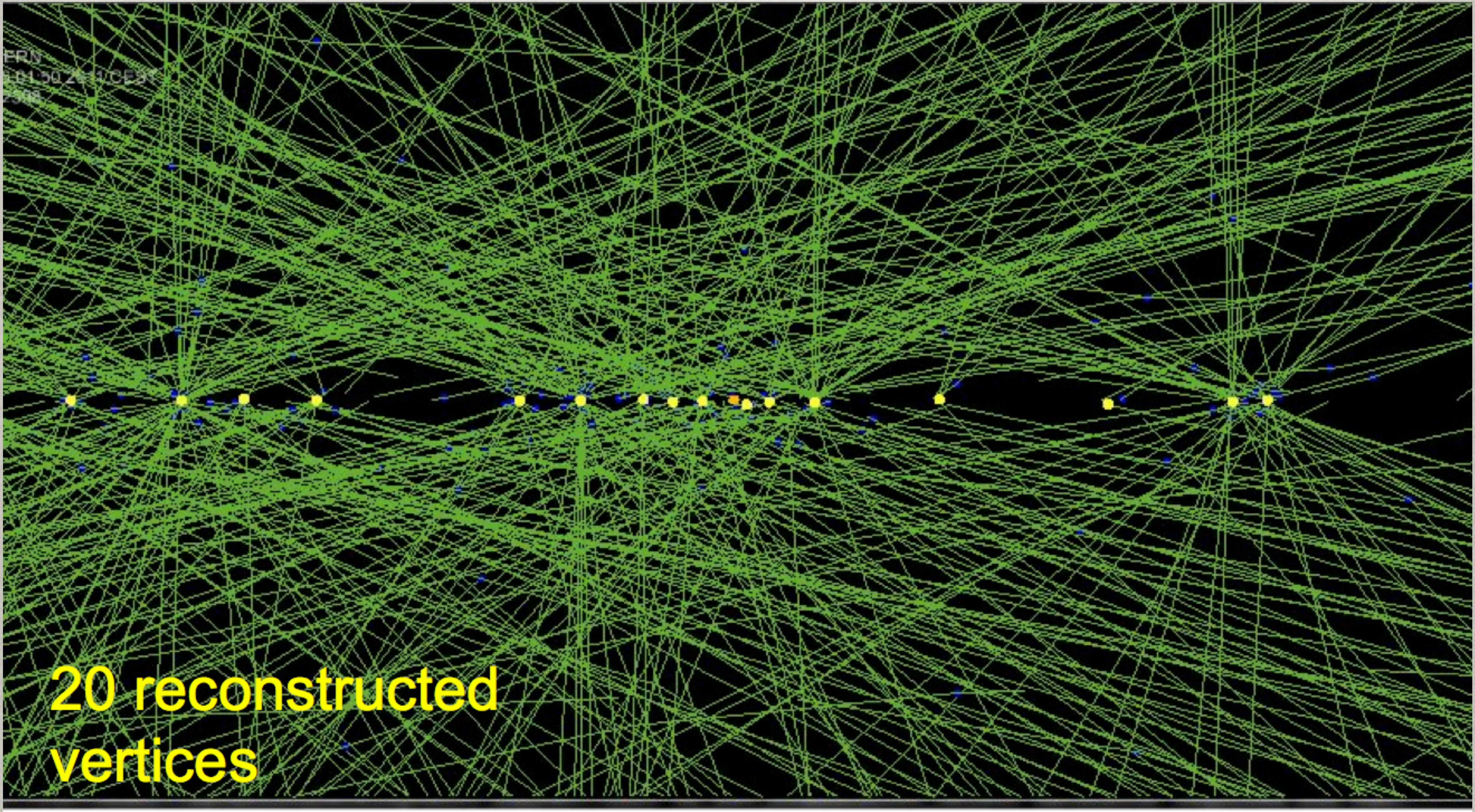
Luminosity Evolution



Luminosity Evolution



Pileup



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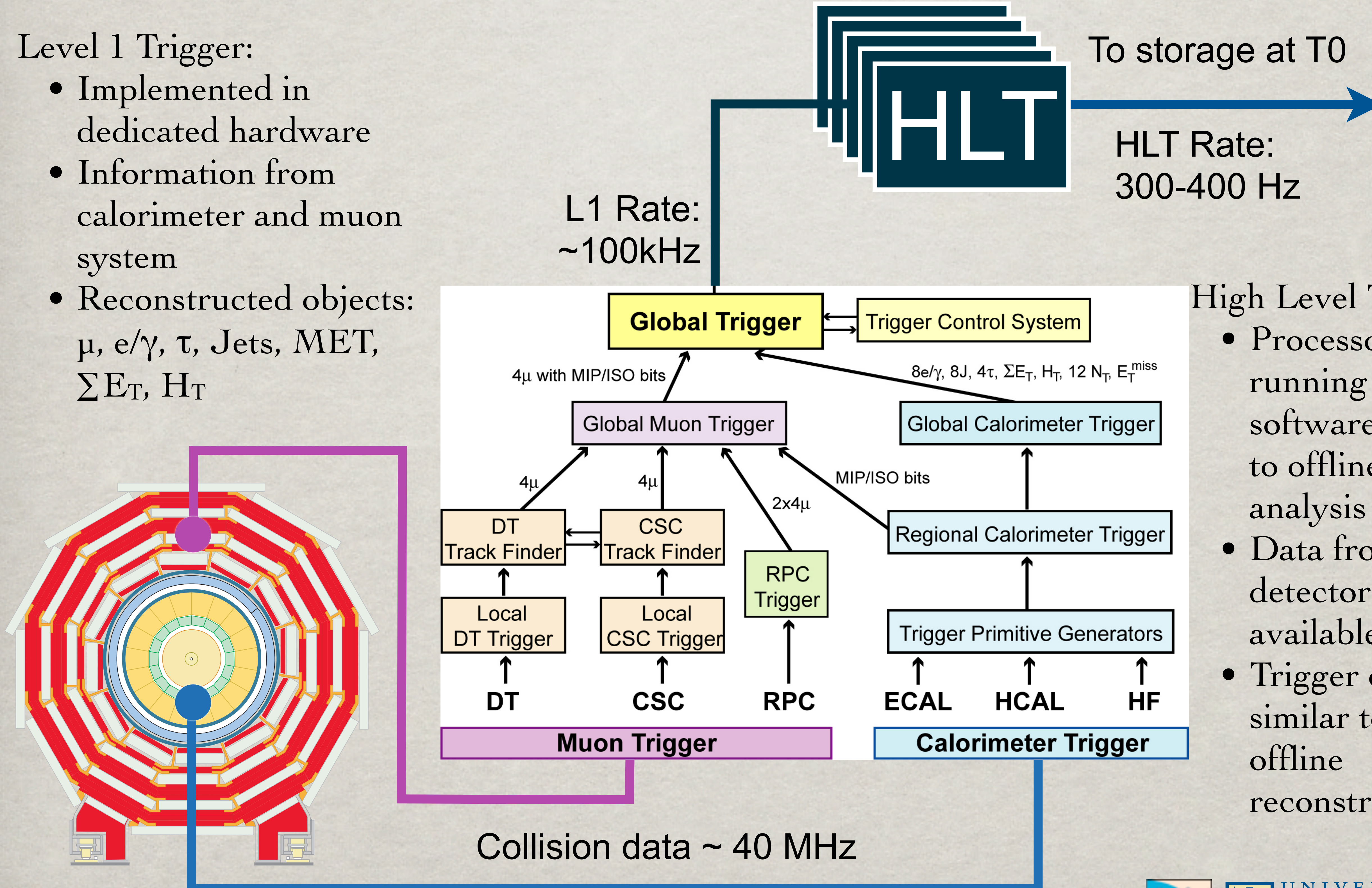
Trigger Overview

Level 1 Trigger:

- Implemented in dedicated hardware
- Information from calorimeter and muon system
- Reconstructed objects: μ, e/γ, τ, Jets, MET, $\sum E_T$, H_T

High Level Trigger:

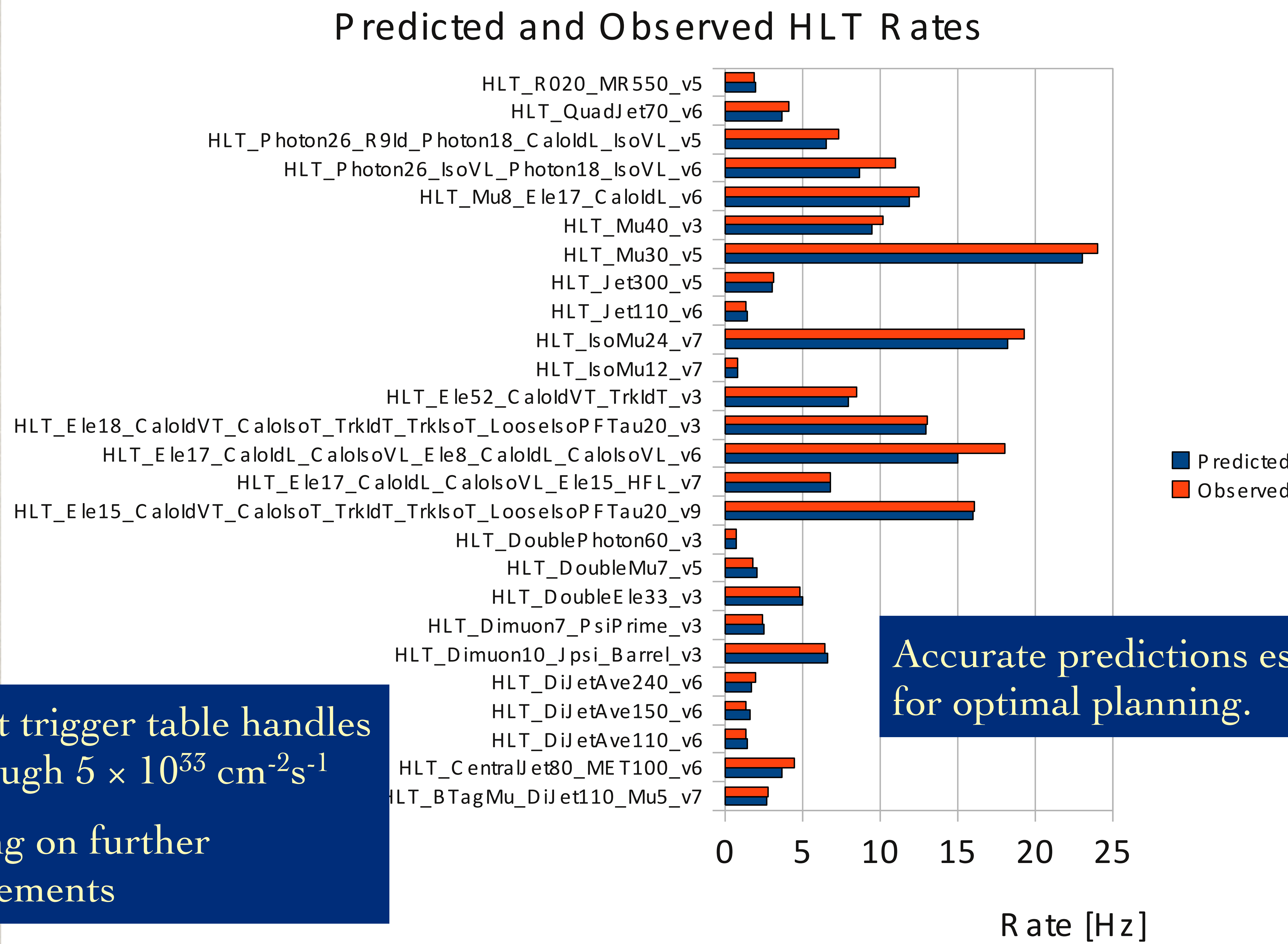
- Processor farm running software similar to offline analysis
- Data from all detectors available
- Trigger object similar to offline reconstruction



Top Trigger Strategies

- Take advantage of all objects in top quark signature to maximize acceptance: leptons, jets, MET
- L1 Triggers: Single/Double μ, e/γ, Quad Jet
- HLT Triggers:
  - Single e, μ, Double lepton
  - e/μ/τ + jets (+MET) (Different numbers of jets)
  - Multijet triggers (4-6 jets)
- As luminosity increases, make adjustments to control rates:
  - Increase thresholds
  - Improve ID/iso
  - Combine more objects

Trigger Rate Predictions

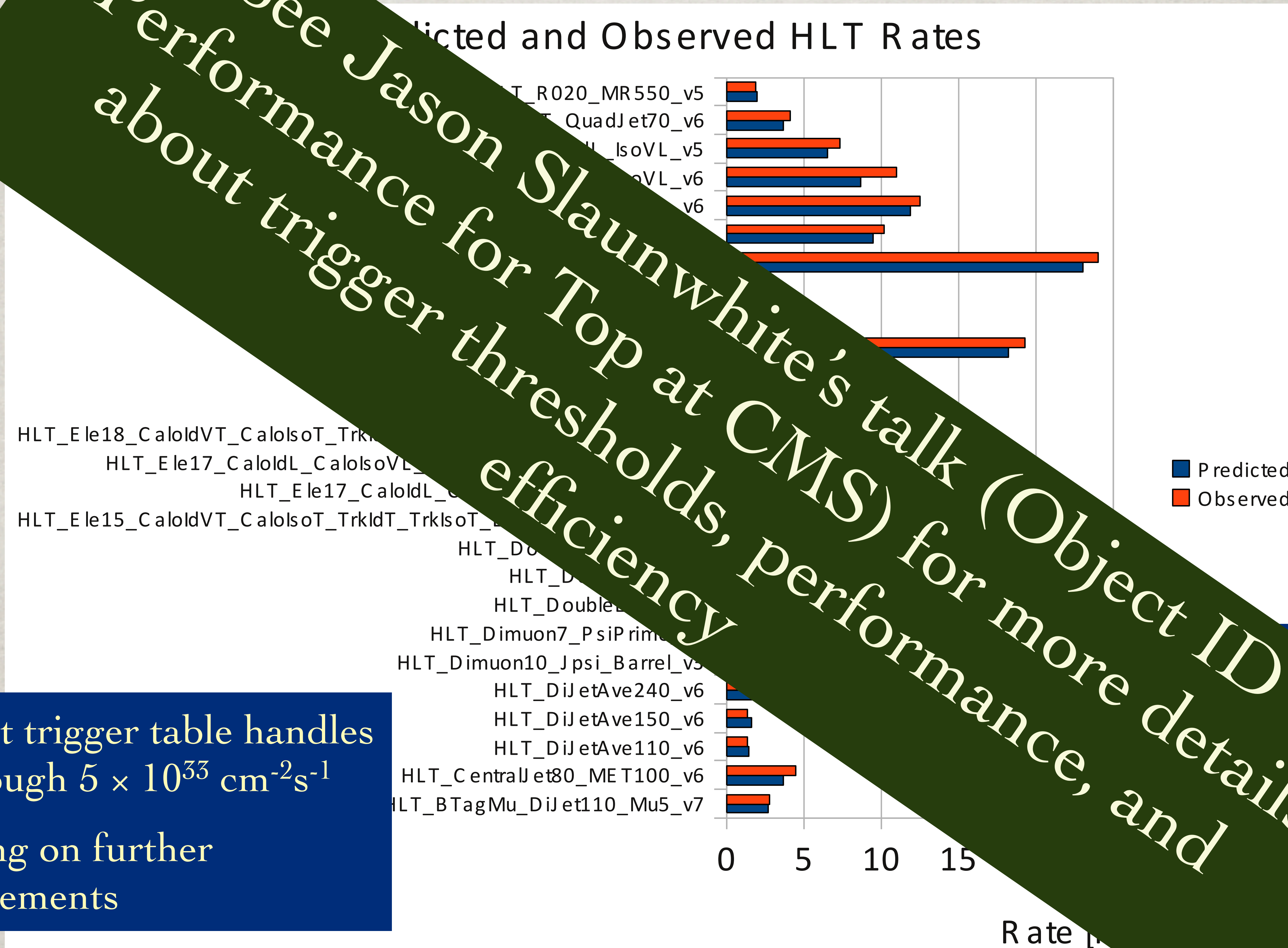


Accurate predictions essential for optimal planning.

Current trigger table handles up through 5×10^{33} cm^{-2}s^{-1}

Working on further improvements

Tr[...]r Rate Predictions

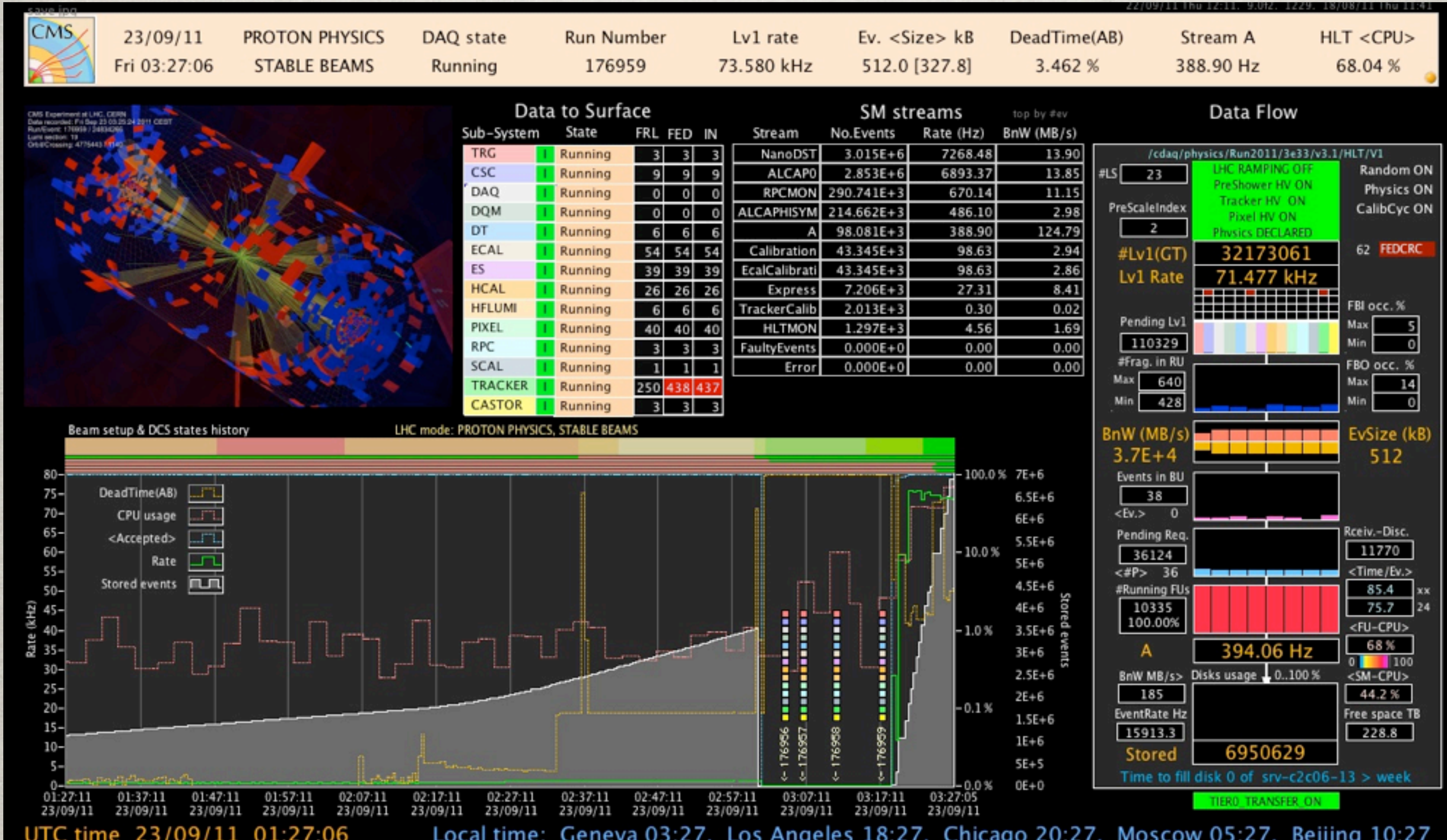


See Jason Slaunwhite's talk (Object ID Performance for Top at CMS) for more details about trigger thresholds, performance, and efficiency

Current trigger table handles up through 5×10^{33} cm^{-2}s^{-1}

Working on further improvements

DAQ at High Lumi



Inst Lumi = 2.8×10^{33} cm^{-2}s^{-1}

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Extrapolation to Higher Lumi

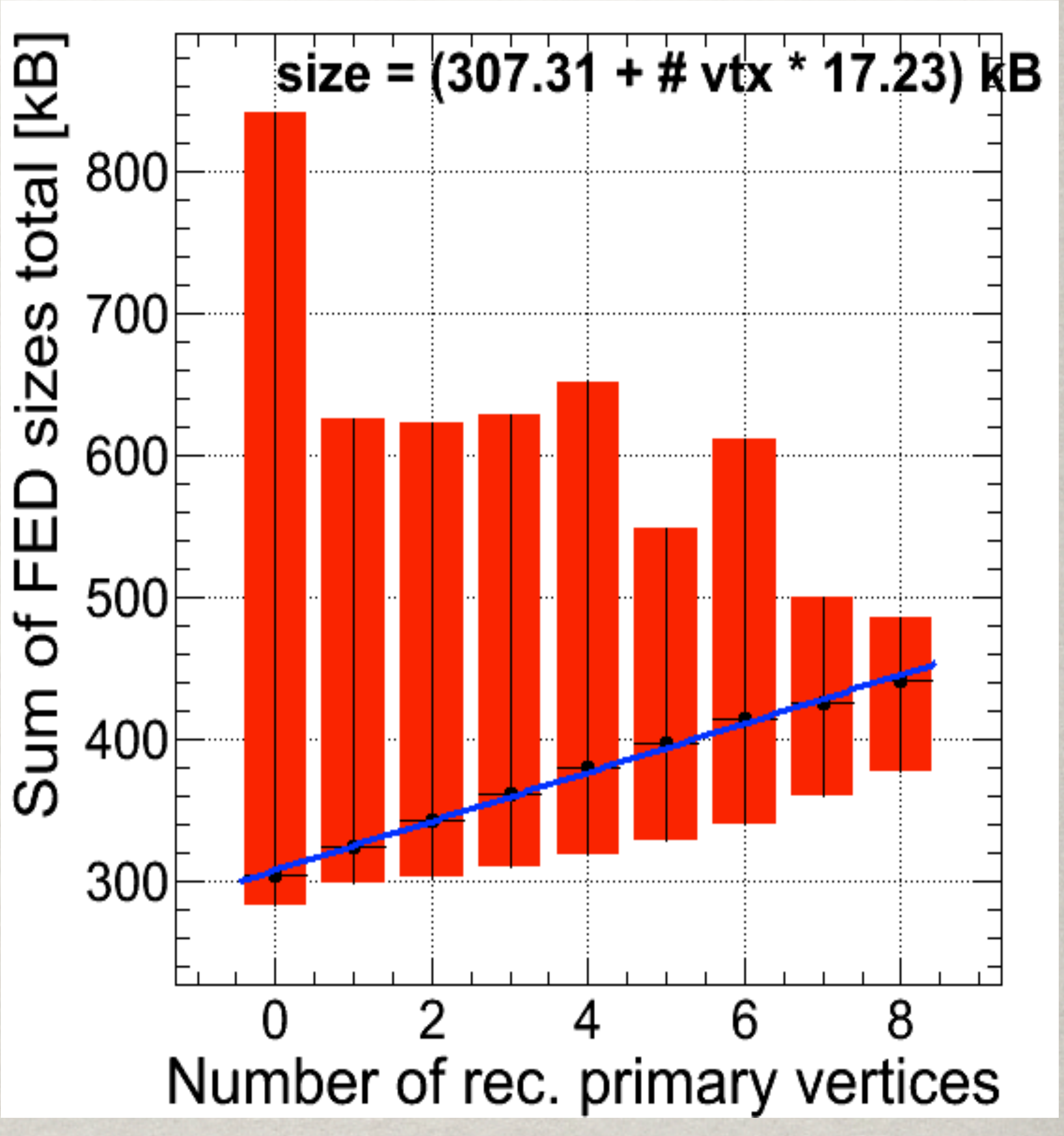
- DAQ Limitations
  - Max event size must remain < 1 MB

Extrapolation looks fine for expected luminosity

  - No single FED exceeding 2kB/evt @ 100 Hz

Tested with tracker in HI running

- No problems foreseen



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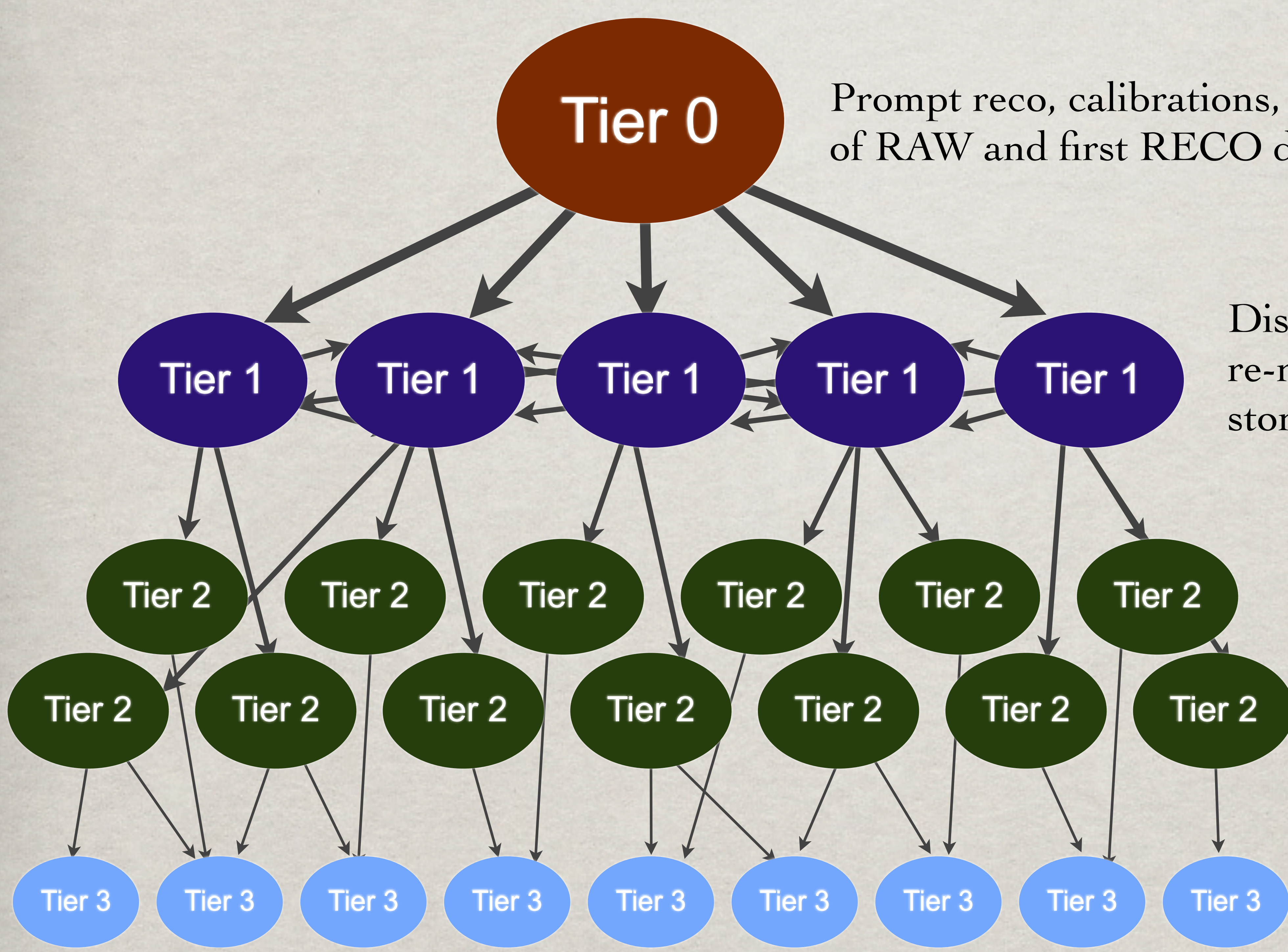
Offline and Computing

CMS Computing Model



Prompt reco, calibrations, copy of RAW and first RECO data

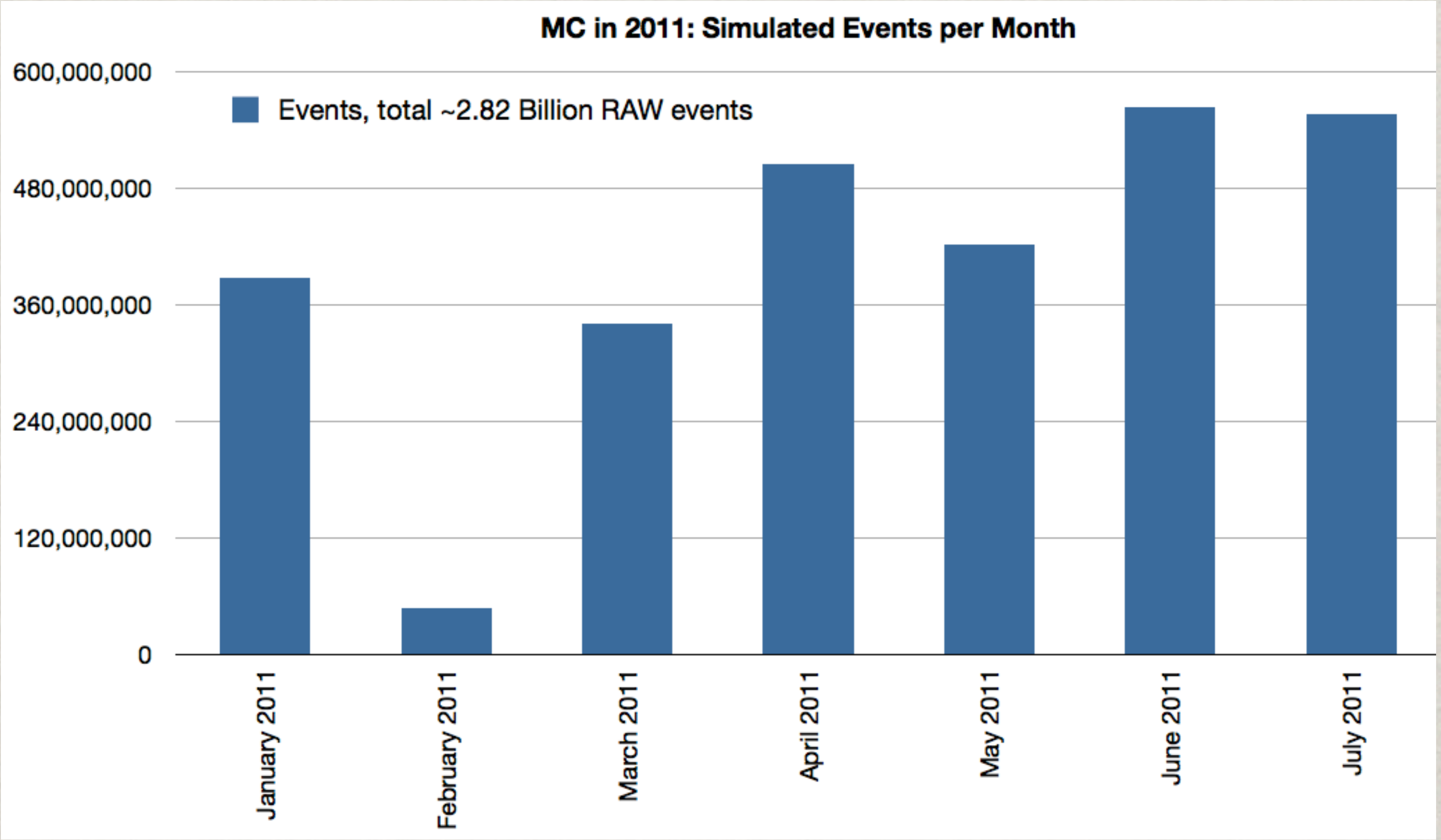
Distribute RECO/AOD, re-reco, generation/ storage of SIM

Simulation, user data access/analysis

User data analysis

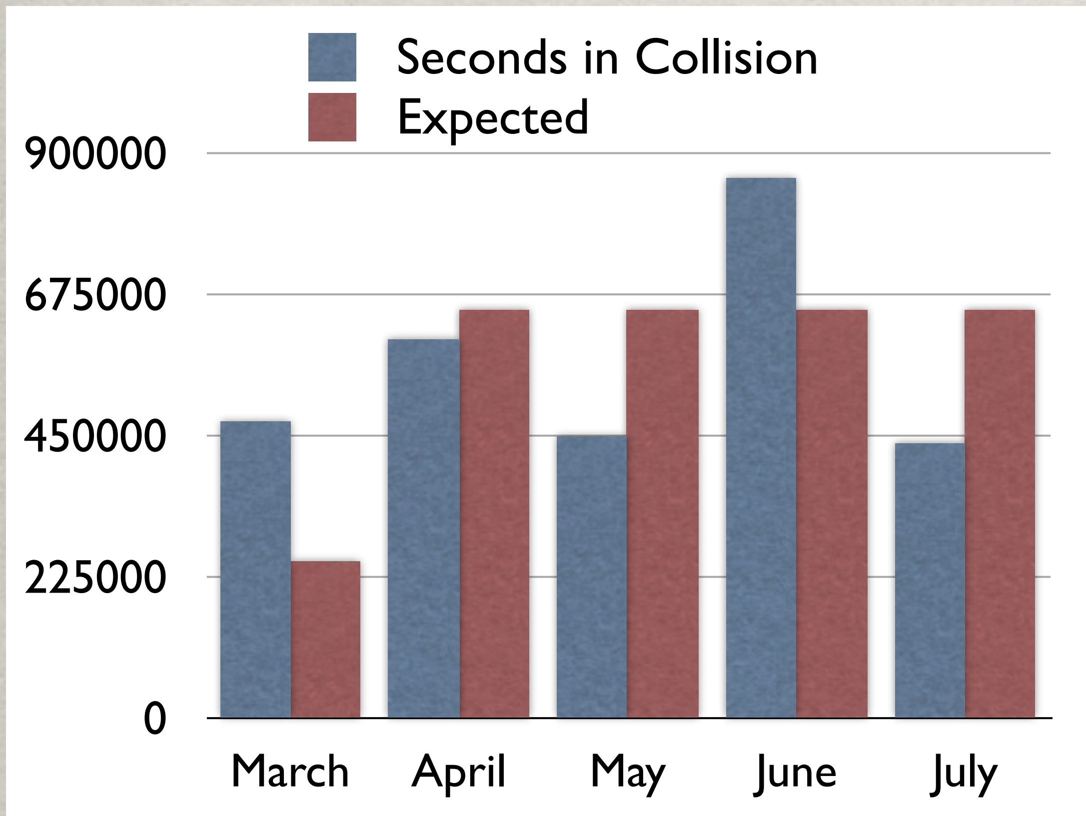
CMS Computing in 2011

- Expecting to process > 2 billion events!
  - Becoming resource limited
  - Fewer re-recos; rely more on prompt reco
- Simulated > 2.8 billion MC events so far!



Event Size and CPU

- Event sizes in line with (or better than) expectations
- Time spent in collisions matches expectations
- Data volume OK

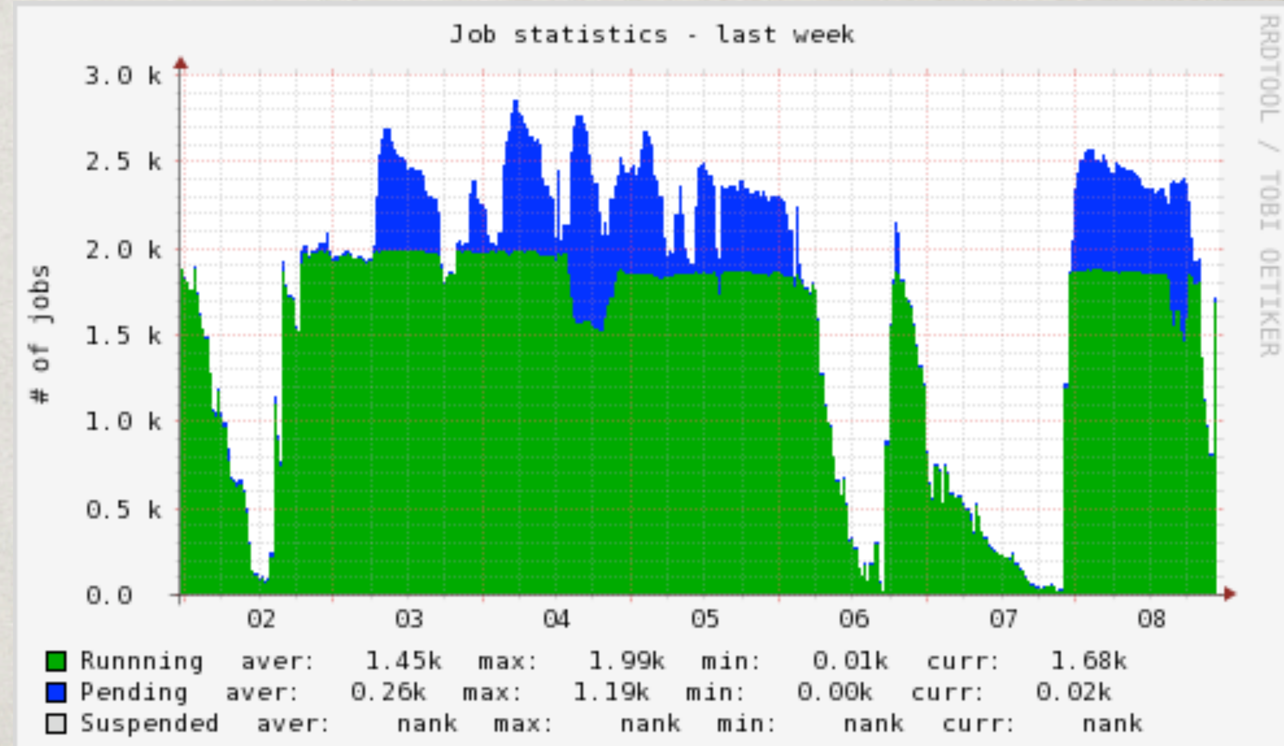


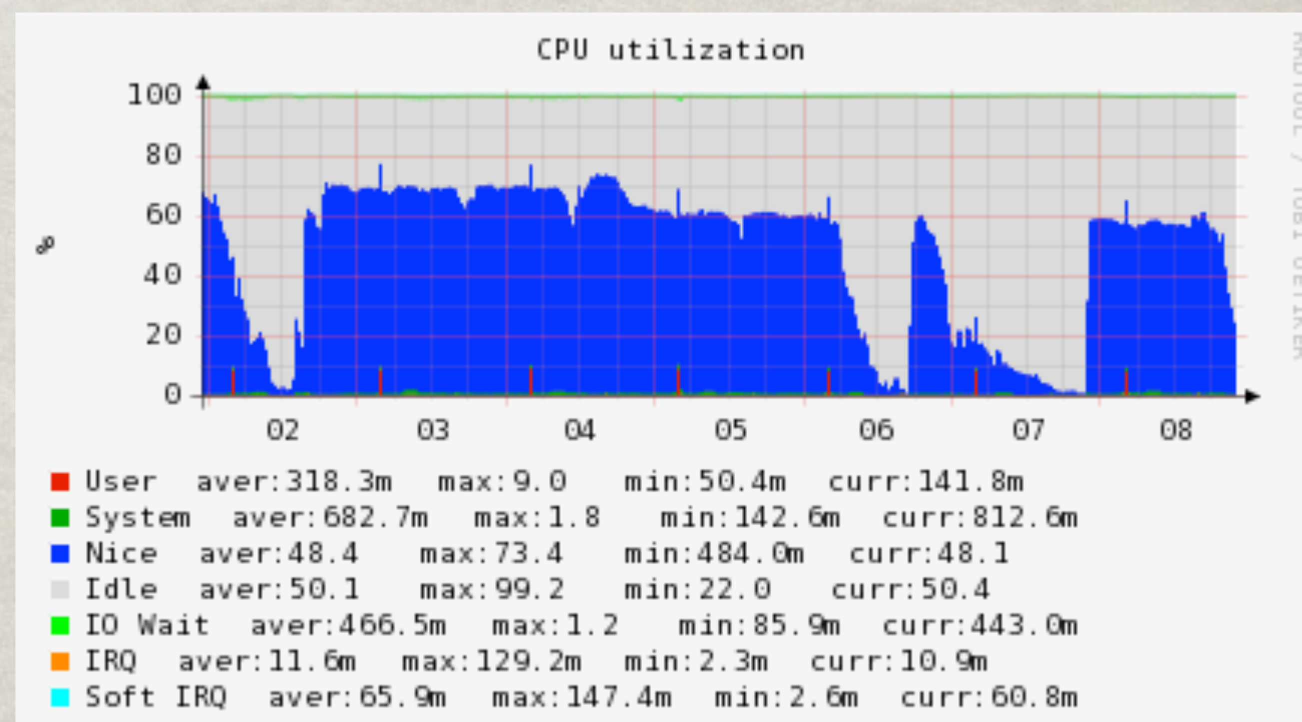
Tier	Size	Exp.
Data RAW	200 kB	390 kB
Data RECO	500 kB	530 kB
Data AOD	100 kB	200 kB
MC RECO	970 kB	600 kB
MC AOD	250 kB	265 kB

- As lumi continues to increase, challenges increase
  - For 10 pile-up
    - CPU increases by factor of ~2-3
    - RECO size increases by factor of ~2

Memory Usage

- Switch to 64-bit software and new ROOT ➔ Increased memory usage
- Preventing full utilization of available CPU resources
- Addressed in next CMSSW release (as well as CPU time improvements)
  - Coming soon!

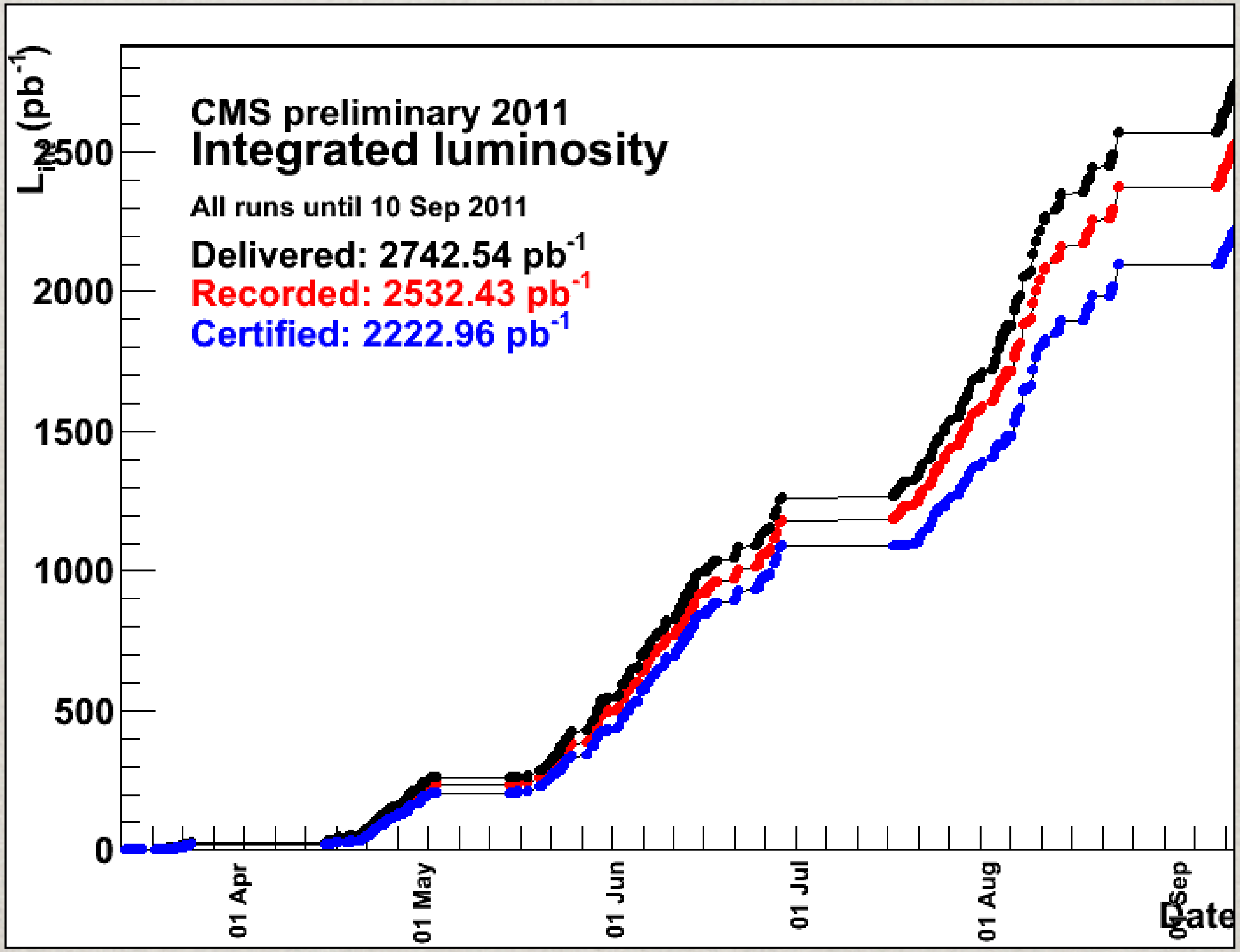




Prompt Validation

Data processed through propt reco and certified for analysis in ~ 1 week!

- ➡ 87.8% collected data certified good (all detector systems perfect)
- ➡ 93.4% certified good for muon physics (calorimeters not required)



Conclusions

- CMS detector, trigger, DAQ, and offline operating extremely well
- Collecting large volumes of high quality data that is certified and ready for analysis very quickly
- Growing top sample continues to provide exciting physics opportunities
- Talks during this workshop will highlight some of the current results and those coming in the near future
- Look forward to many great results over the next year!