Barrel pixel dynamic inefficiency at PU 12

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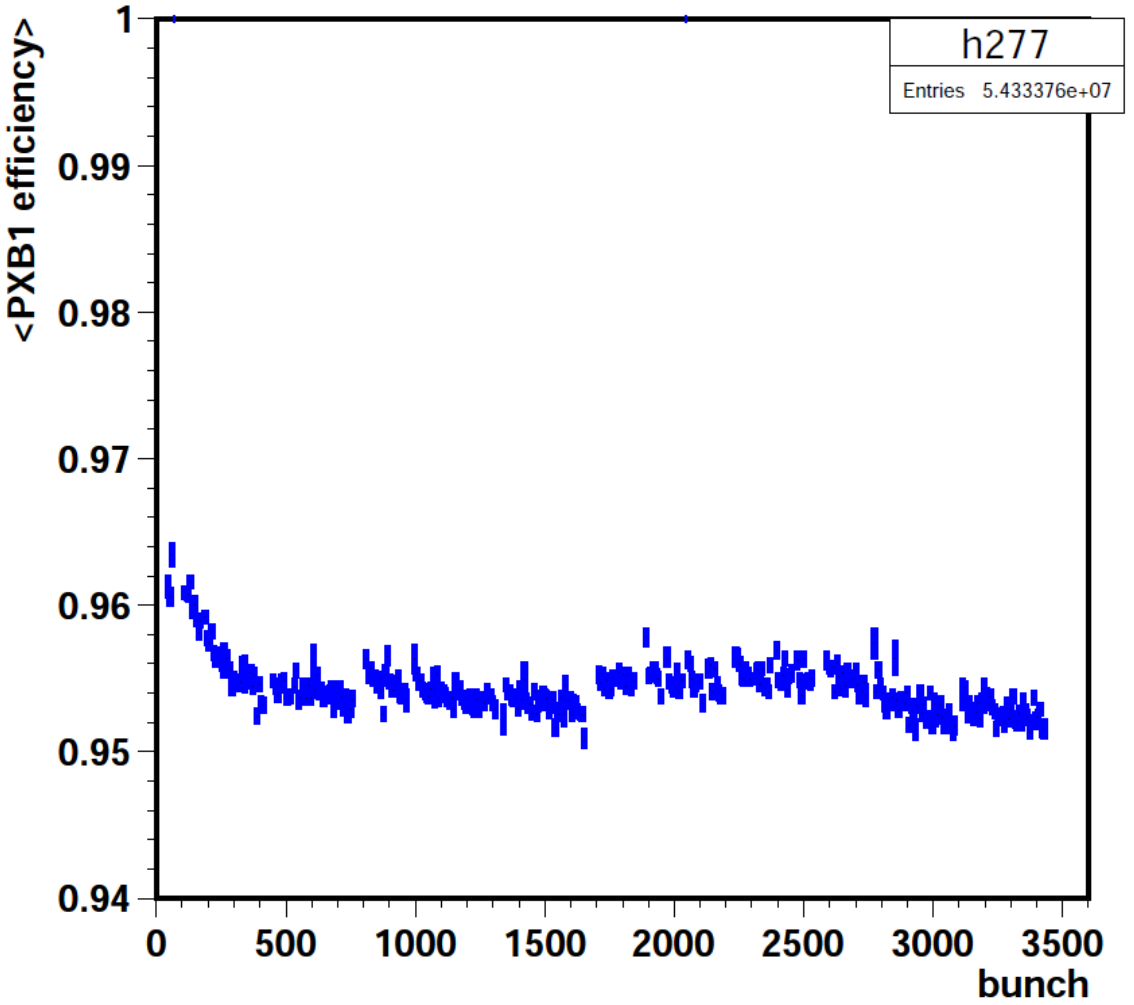
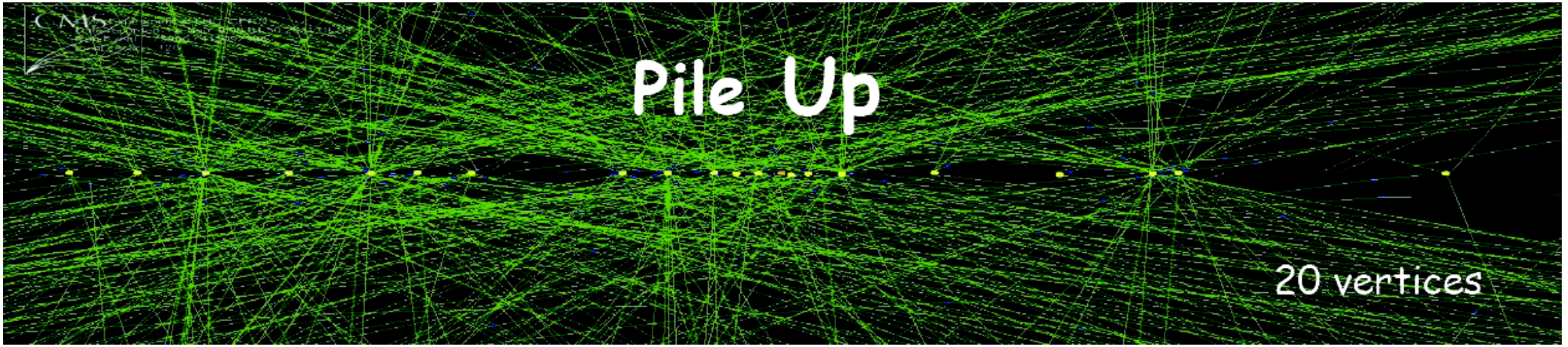
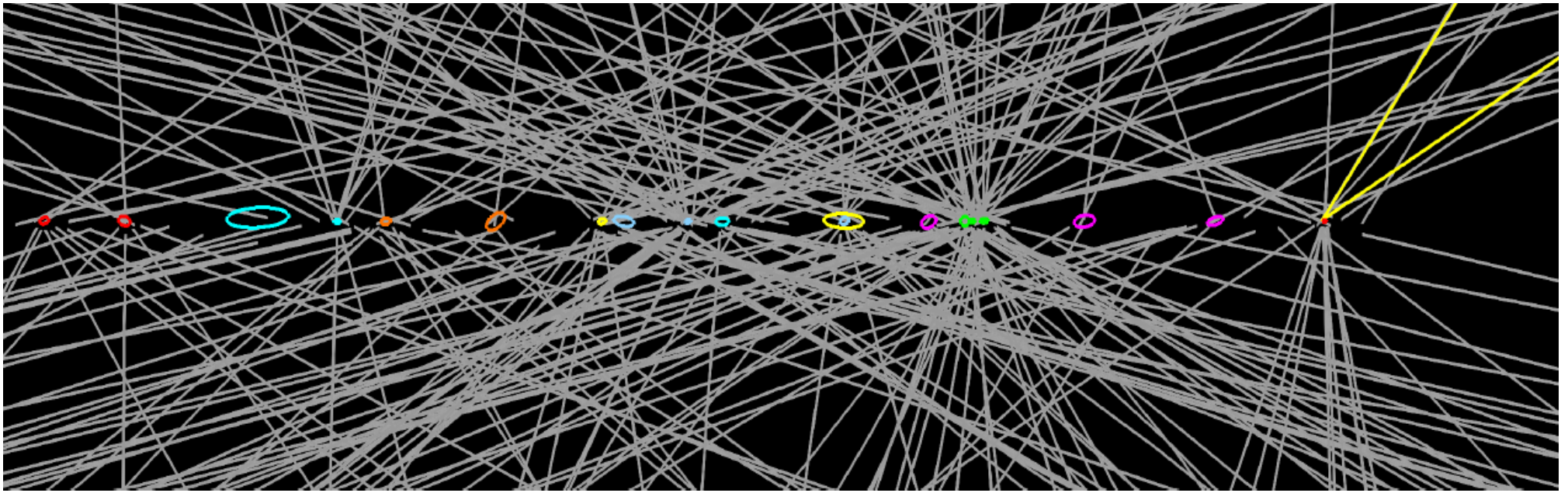
CMS Pixel DPG 22.9.2011



- Sep 2011 data
- Efficiency vs bunch

Pile up September 2011

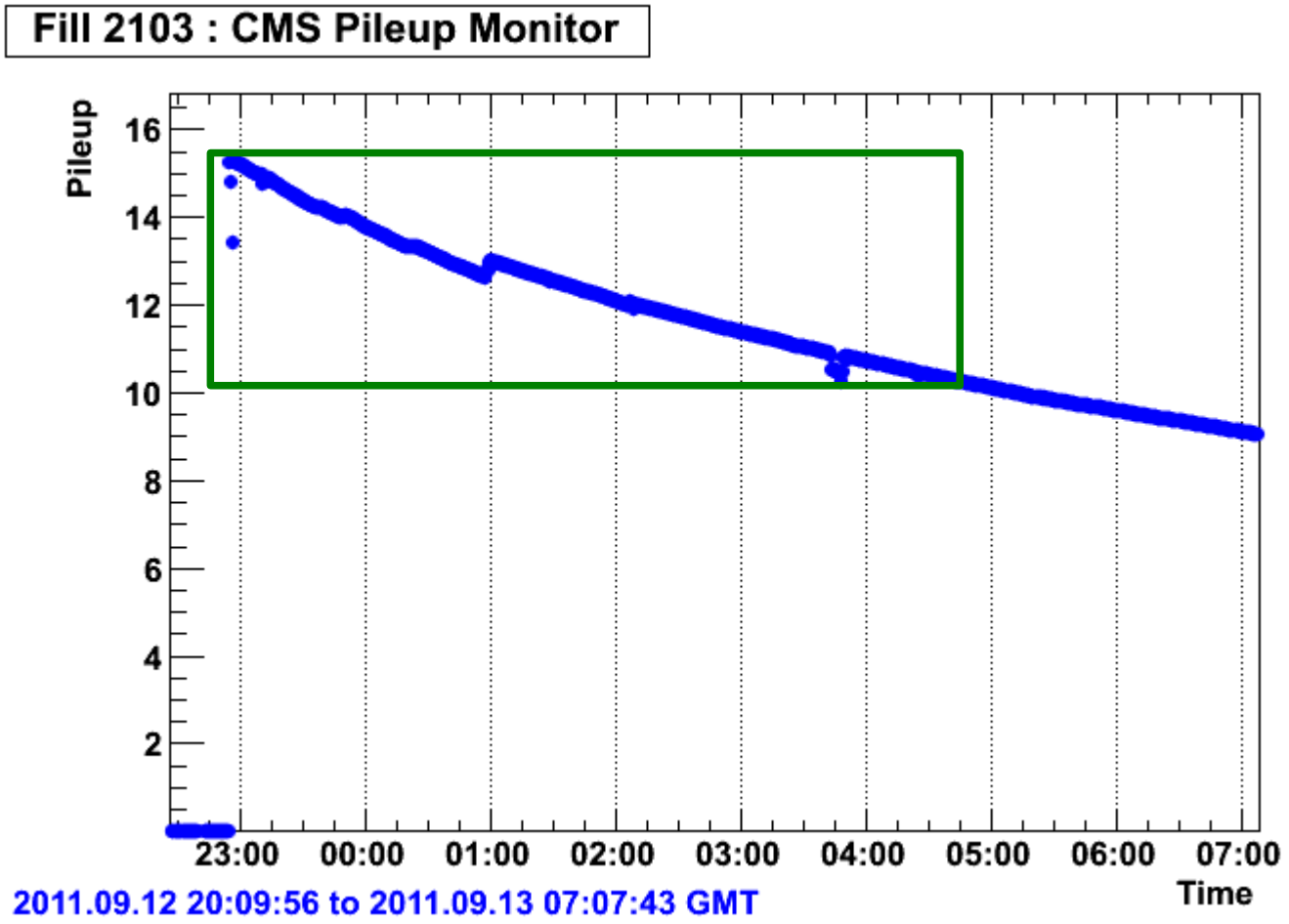




Data

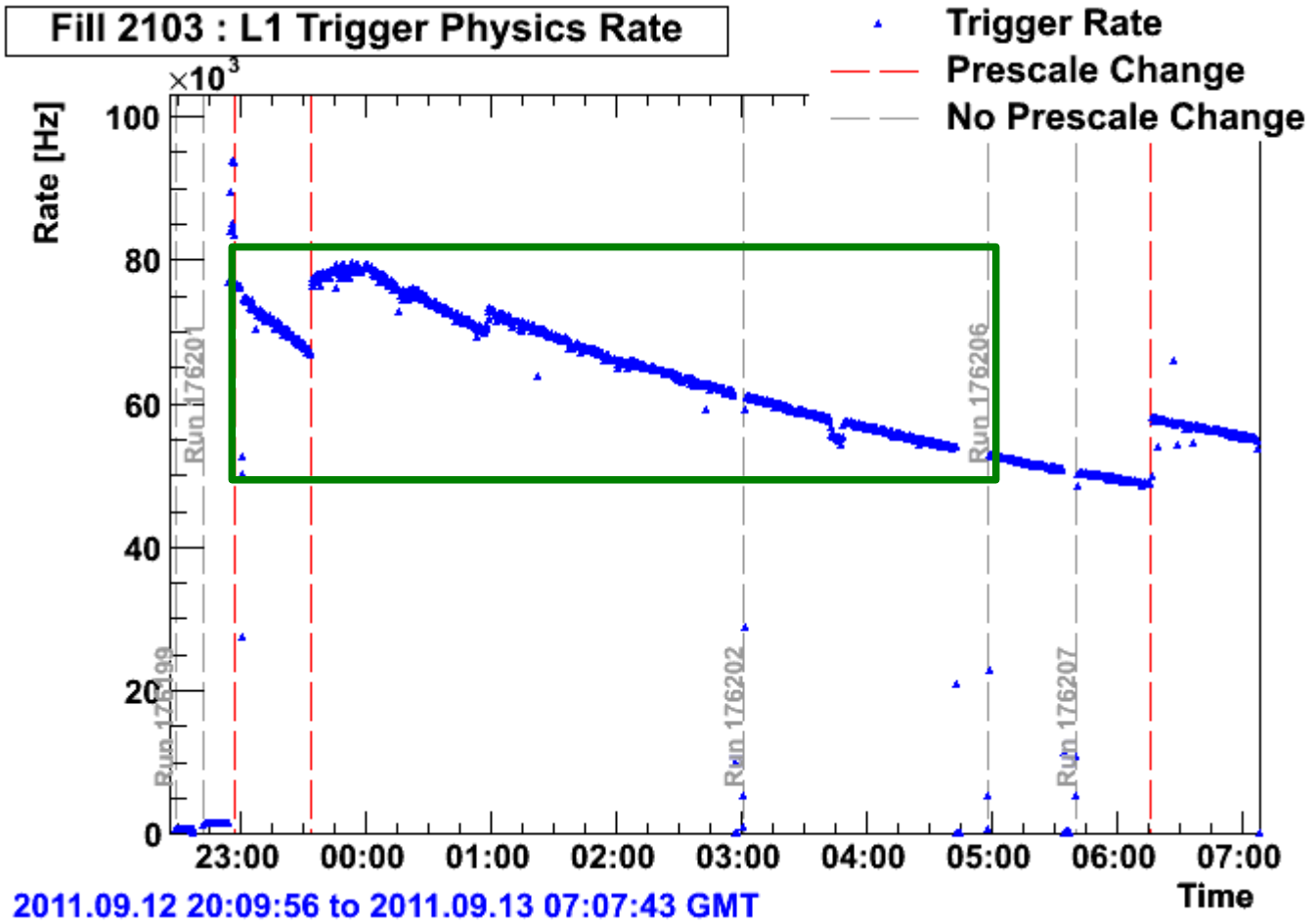
- Sep 2011, early parts of fills 2092, 2093, 2094, 2101, 2103, 2104
  - 50 ns spacing, 1380 bunches, 1317 colliding
  - β* 1 m, L_{peak} $3.2 \cdot 10^{33}$, starting pile up 15, <PU> 12
- The pixel ROC efficiency may be affected by the history of the previous 156 or more bunch crossings (L1 latency or RO token):
  - data losses when Time Stamp or Data buffers are full,
  - data loss due to double column reset after a readout.
  - Study the pixel barrel efficiency as function of bunch number.
- Use hits on tracks (`HitPattern`) on AOD.
- SingleMu/AOD/PromptReco-v1

pile up



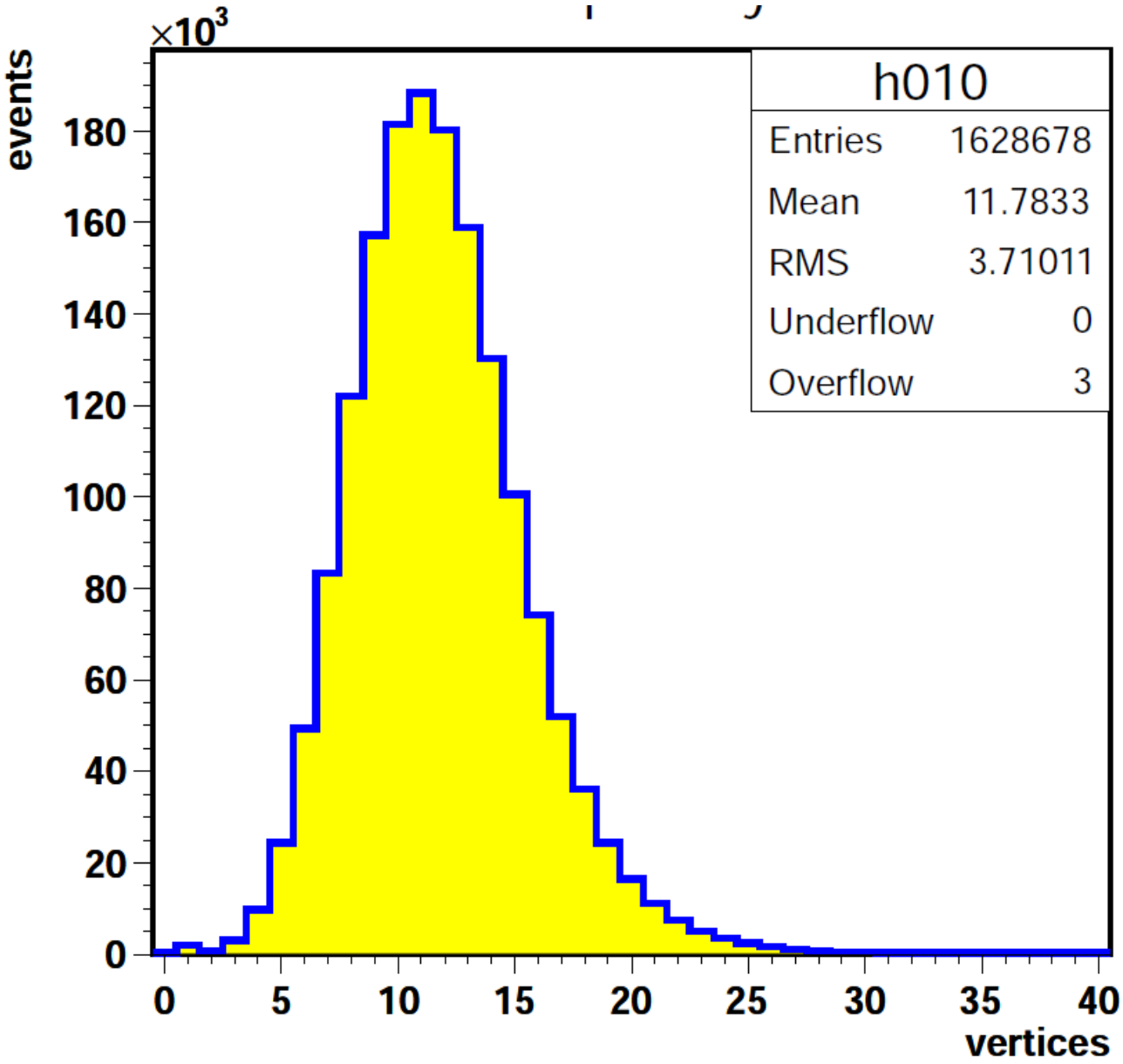
- Example fill 2103:
  - initial pile up 15.5
  - initial period down to pile up 10 used here.

CMS L1 trigger rate



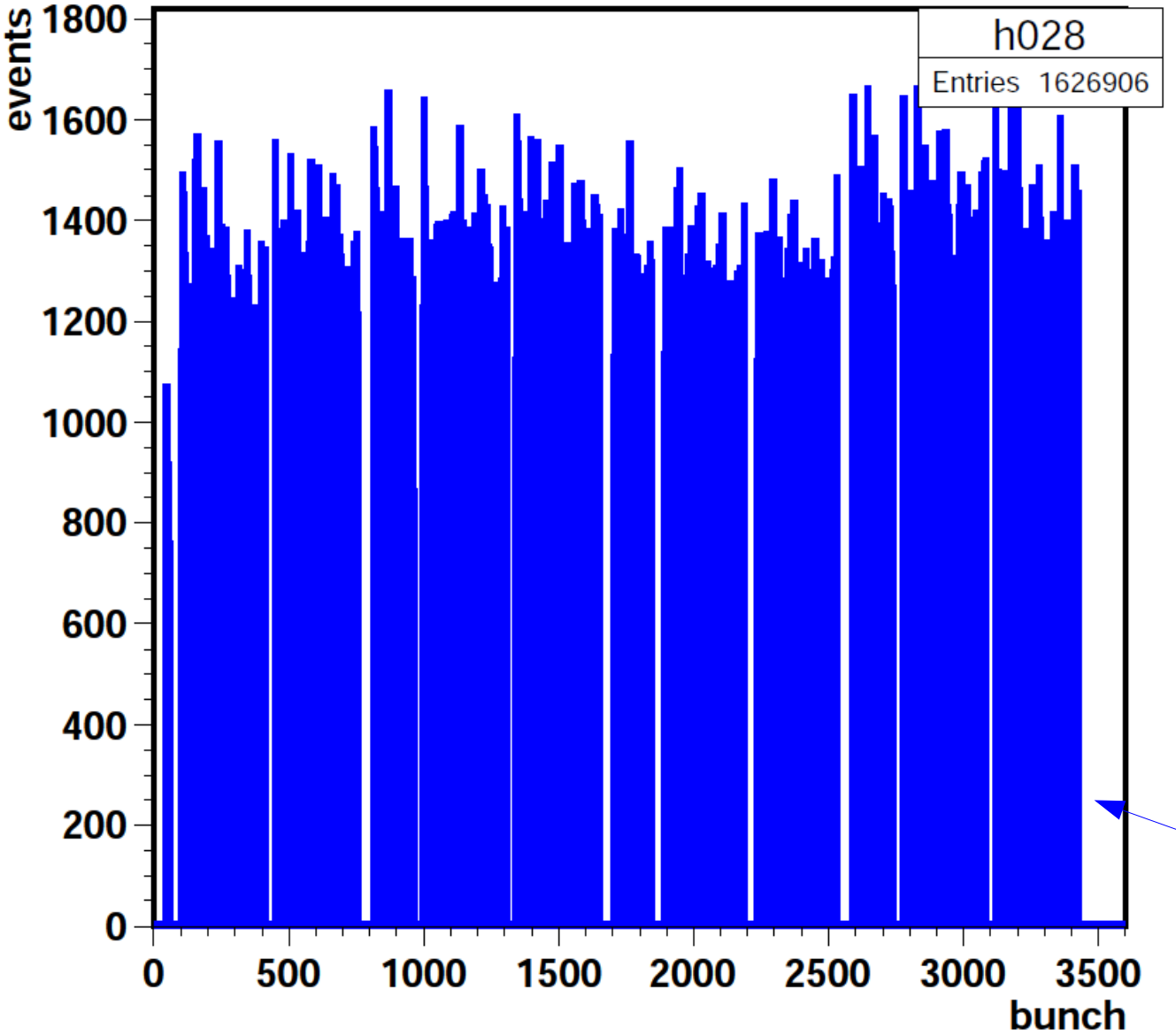
- Example fill 2103:
  - L1 trigger rate 80..50 kHz.
  - initial 2 runs in this fill used here.

pile up vertices



- Mean number of CMS reconstructed vertices in this sample is 11.8

Bunch pattern fill 1718

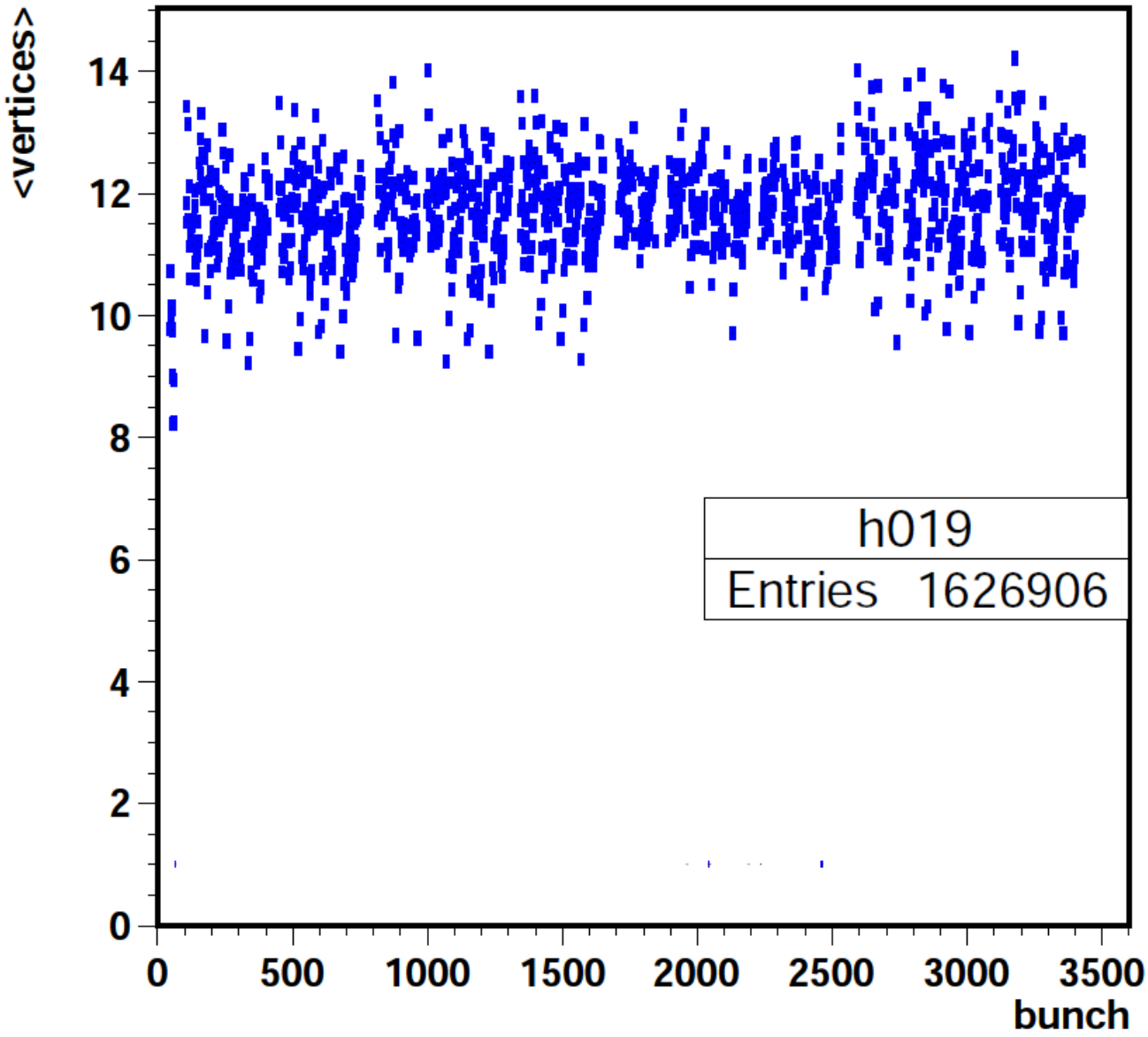


- LHC:
  - 26'659 m
  - 89 us / turn
  - space for 3564 bunches at 25 ns.
- Sep 2011:
  - kicker gap at end of fill pattern:
  - last filled bunch 3426
  - first filled bunch 45
  - **gap: 182 bunches = 4.5 µs.**

50ns_1380b+1small_1318_39_1296_144bpi13inj.txt

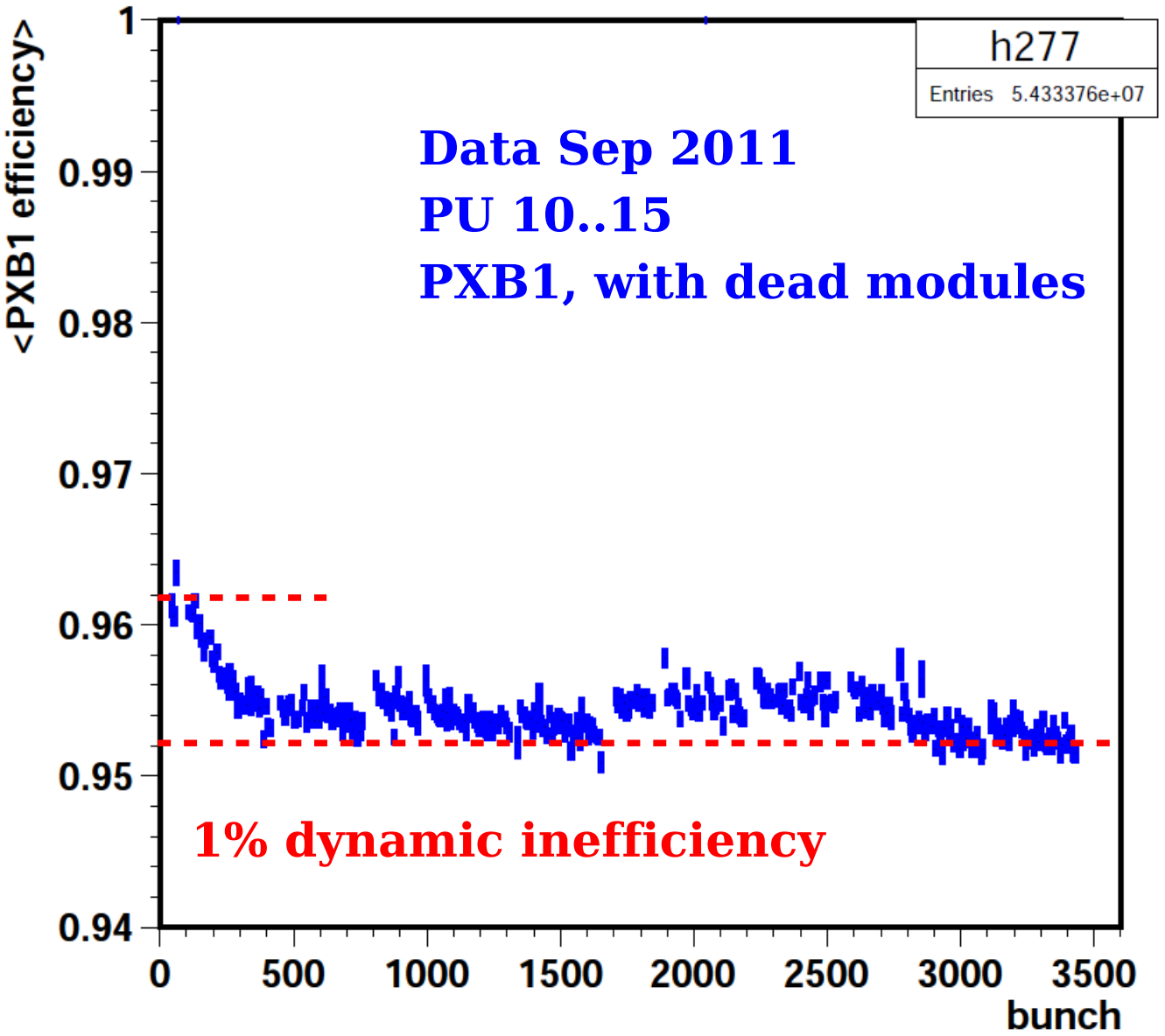
http://lpc.web.cern.ch/lpc/fillingschemes.htm

pile up per bunch



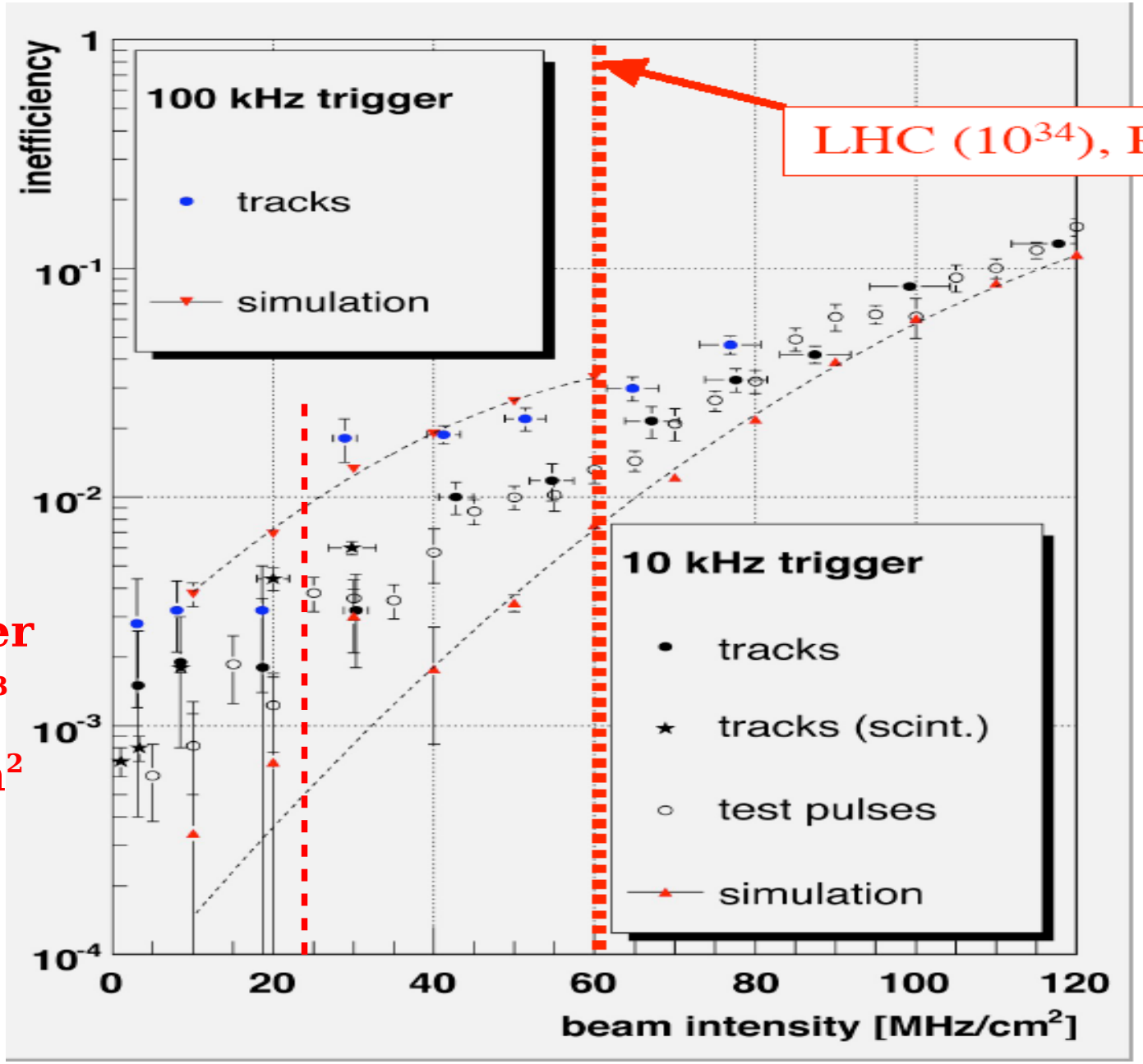
- mean number of primary vertices per bunch.
- early parts of Sep 2011 lumi fills.
- Variation from 9 to 14 on the mean pile up per bunch.

Pixel barrel layer 1 efficiency



- Efficiency = (tracks with hit in PXB1) / (tracks through PXB1 – z-gaps)
  - z-gaps taken out,
  - dead or bad modules **not taken out.**
- Mu sample, PromptReco, AOD.
- $p_t > 0.75$, primary.
- Peak efficiency 96.2%.
- Dynamic inefficiency -1%.

Pixel ROC inefficiency



Sep 2011
70 kHz trigger
L_{avg} = 2.5·10^{33}
≃ 25 MHz/cm^2
at 4.4 cm

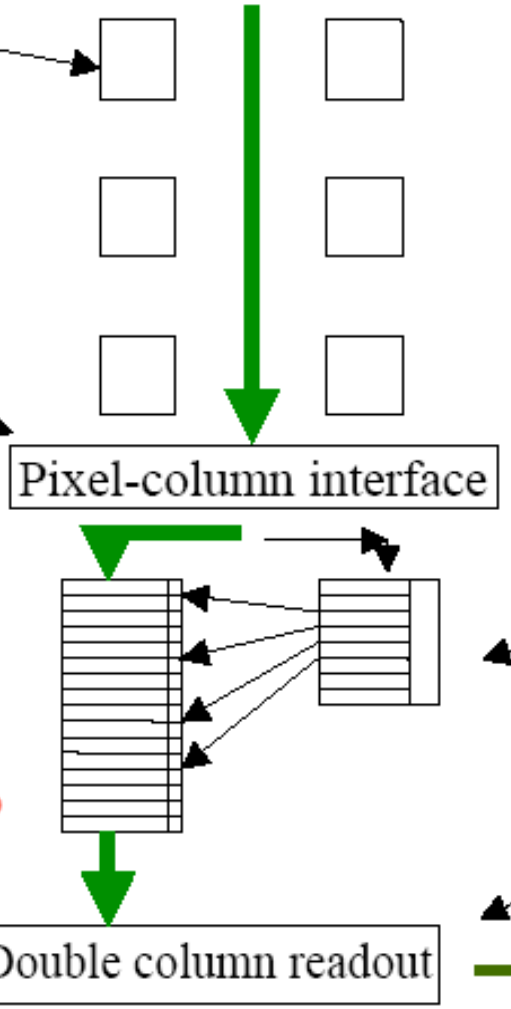
PSI high rate test beam 2005

Data loss mechanisms

Present PSI46 readout chip simulated at LHC design luminosity

Pixel busy:
0.04% / 0.08% / 0.21%
pixel insensitiv until hit transferred to data buffer (column drain mechanism)

Double column busy:
0.004% / 0.02% / 0.25%
Column drain transfers hits from pixel to data buffer. Maximum 3 pending column drains requests accepted



Timestamp Buffer full:
0 / 0.001% / 0.17%

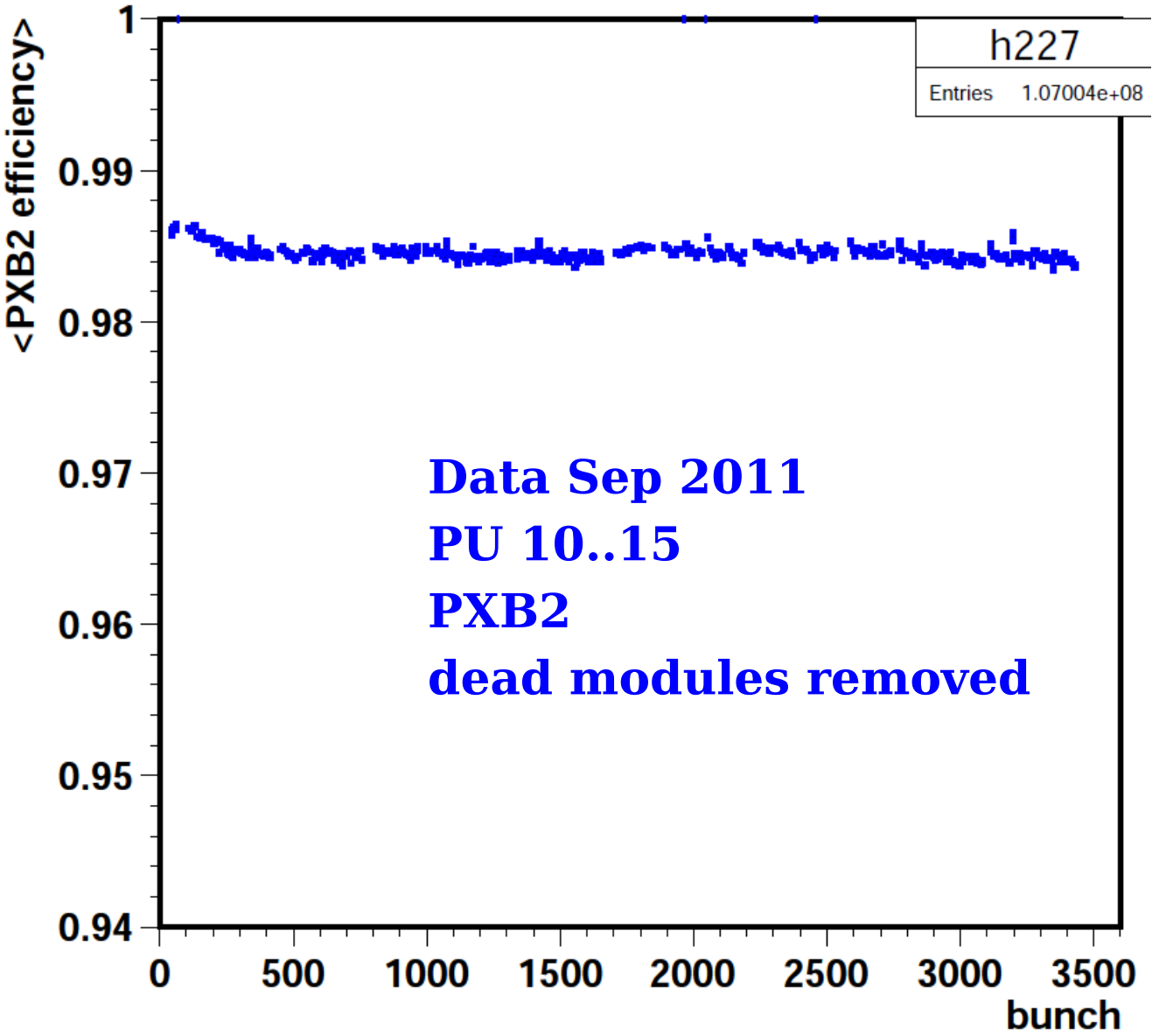
Data Buffer full:
0.07% / 0.08% / 0.17%

Readout and double column reset:
0.7% / 1% / 3.0%
for 100kHz L1 trigger rate

- 1xLHC: $10^{34}cm^{-2}s^{-1}$
- 11 cm / 7 cm / 4 cm layer
- total data loss @ 100kHz L1A:
  - 0.8%
  - 1.2%
  - 3.8%

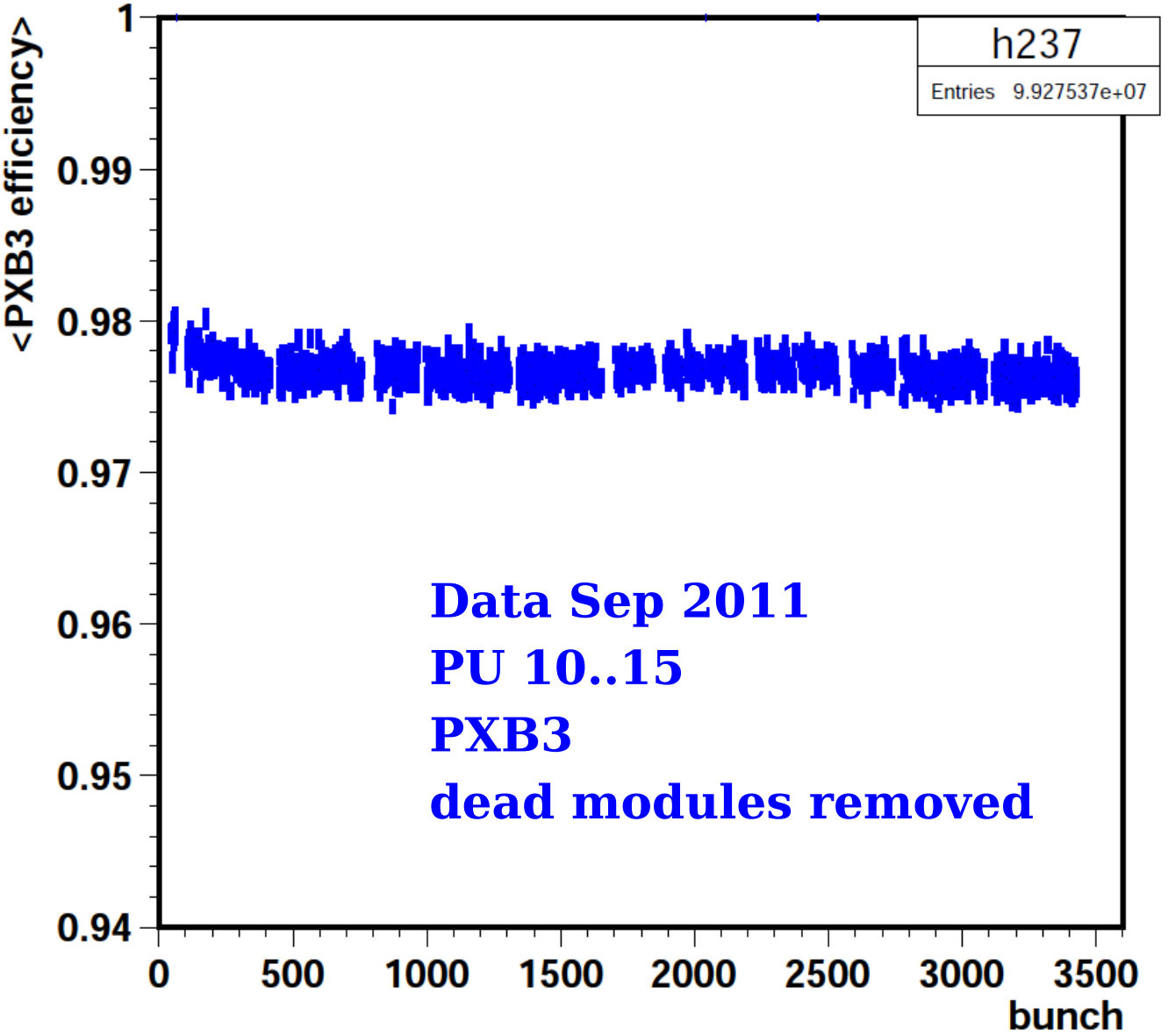
H.C. Kaestli, CMS Tracker upgrade workshop Feb 2007
http://indico.cern.ch/conferenceDisplay.py?confId=12094

Pixel barrel layer 2 efficiency



- Efficiency = (tracks with hit in PXB2) / (tracks through PXB2 – z-gaps – dead modules)
  - z-gaps taken out,
  - dead or bad modules **are taken out.**
- Hit in PXB1 required.
- SingleMu sample, PromptReco, AOD.
- Top efficiency is 98.6%.
- Dynamic inefficiency: about -0.2%.

Pixel barrel layer 3 efficiency



- Efficiency as for layer 2
  - z-gaps taken out
  - **known** dead or bad modules **are taken out.**
- Hit in PXB1 or PXB2 required.
- Mean efficiency is 98.7%.
- Dynamic degradation: at most -0.1%.

Summary

- Dynamic inefficiency in PXB1 at 2.5 10^{33} (<PU> 12) is about -1%
- Similar studies on March 2011 data (with PU 5-6) gave -0.5%
- PXB2 dynamic inefficiency is about -0.2 at PU 12.
- Does it agree with simulation?