

LHC Luminosity Monitor Status

R. Miyamoto (BNL)

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On behalf of

H. S. Matis, A. Ratti, W. C. Turner (LBNL)

E. Bravin (CERN)

Also thanks to S. M. White (BNL)

What's new since CM15 ?

- Everything has been installed and no hardware change.
- 2010 data (counting mode) analyzed and good agreements with measurements of ATLAS and CMS.
- Testing and switching to the pulse height mode due to a high multiplicity (up to 10).
 - Better correlation to the experiments than the counting.
 - Minor bugs in the expert application found and fixed.
 - Adjusting parameters (offset, timing, filtering ...)
- LAFS started developing operator display for CCC.

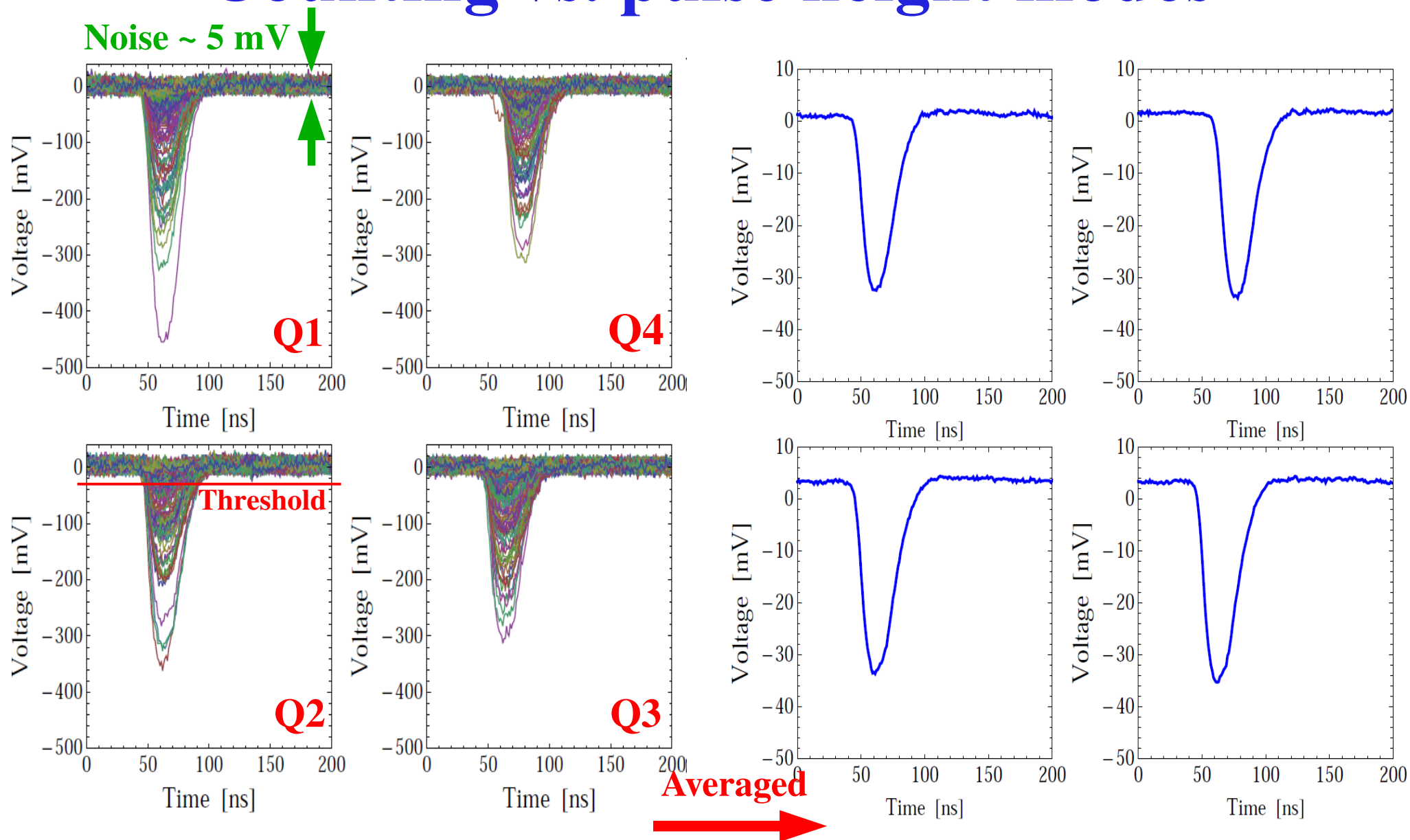
LHC and BRAN parameters

	2010	2011	Nominal design
Beam energy [TeV]	3.5	3.5	7
Luminosity [$\text{cm}^{-2}\text{s}^{-1}$]	2E32	2E33	1E34
Bunches/beam	368	1404	2808
Bunch intensity	1E11	1.2E11	1.15E11
Emittance [μm]	2.5	2.5	3.75
Beta* [m]	3.5	1.5	0.55
multiplicity	< 4	~10	~20
BRAN acceptance [%]	~5	~5	~10

Quadrant area [mm^2]	1600
Plate gap [mm]	1
Number of gaps	6
Gas type	Ar (94%) + N2 (6%)
Gas pressure [atm,absolute]	6
Bias voltage [kV]	1.2
E/p [V/mm-atm]	200
e ⁻ drift speed [mm/ns]	0.045
RMS noise [mV]	~5

- Counting mode in 2010
- Testing and switching to the pulse height mode

Counting vs. pulse height modes

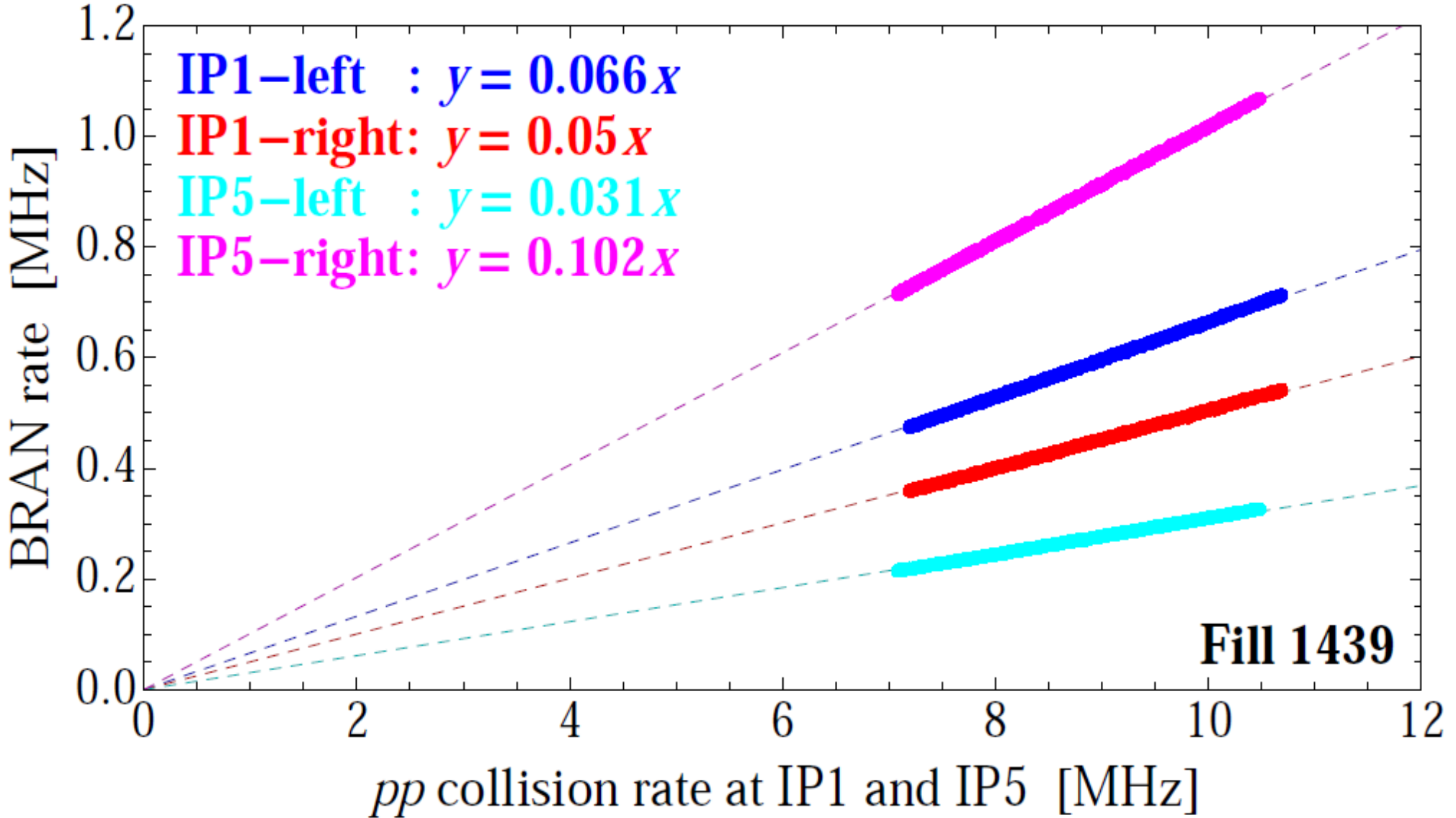


One pulse MAY include products from more than one pp collision

- ~20 for the nominal design → must use the pulse height
- ~3 in 2010 → counting mode still effective

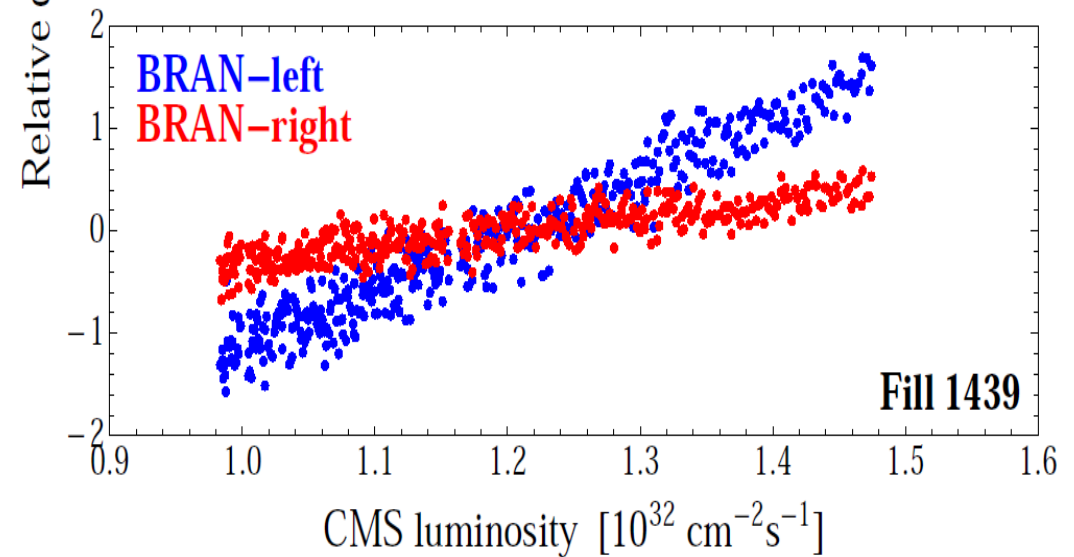
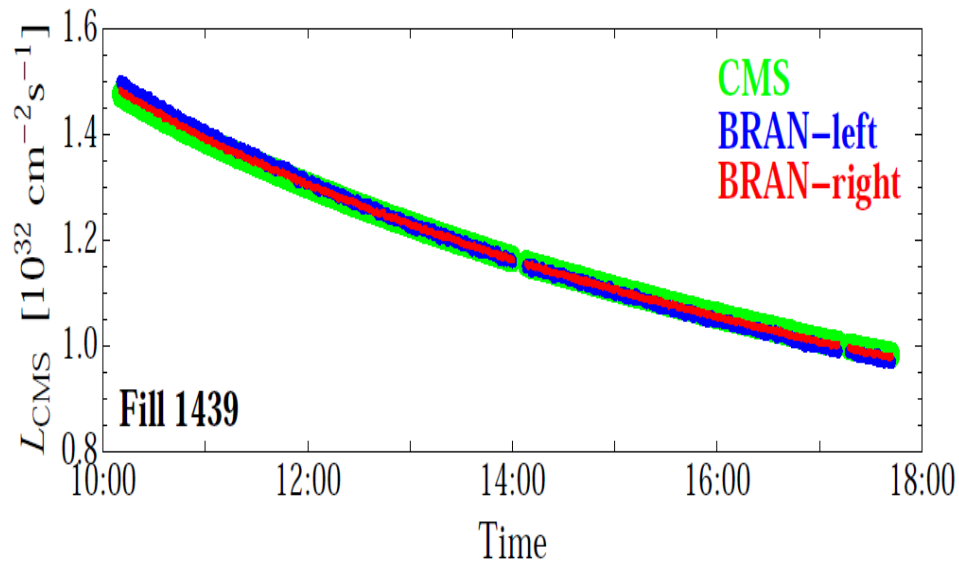
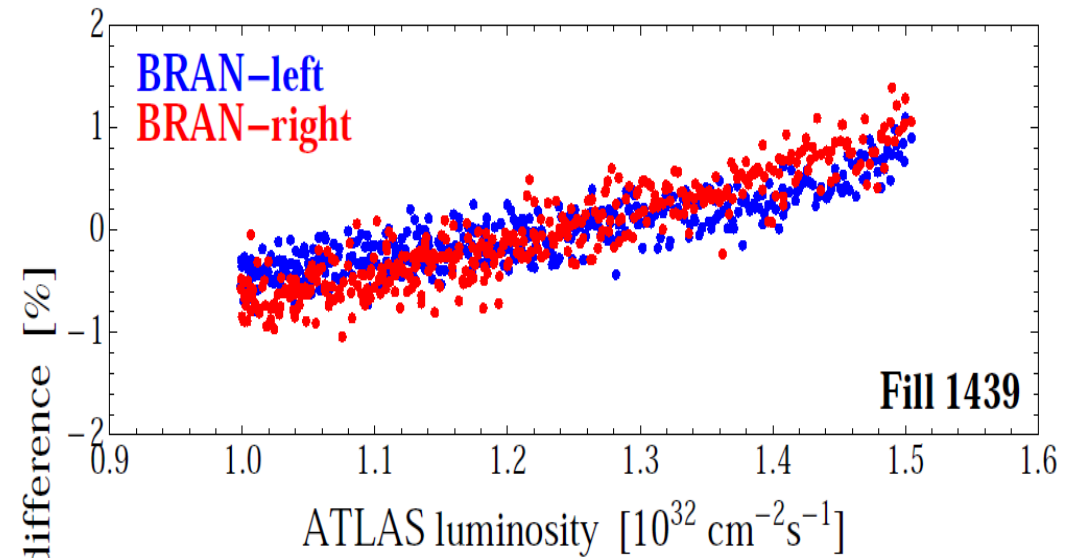
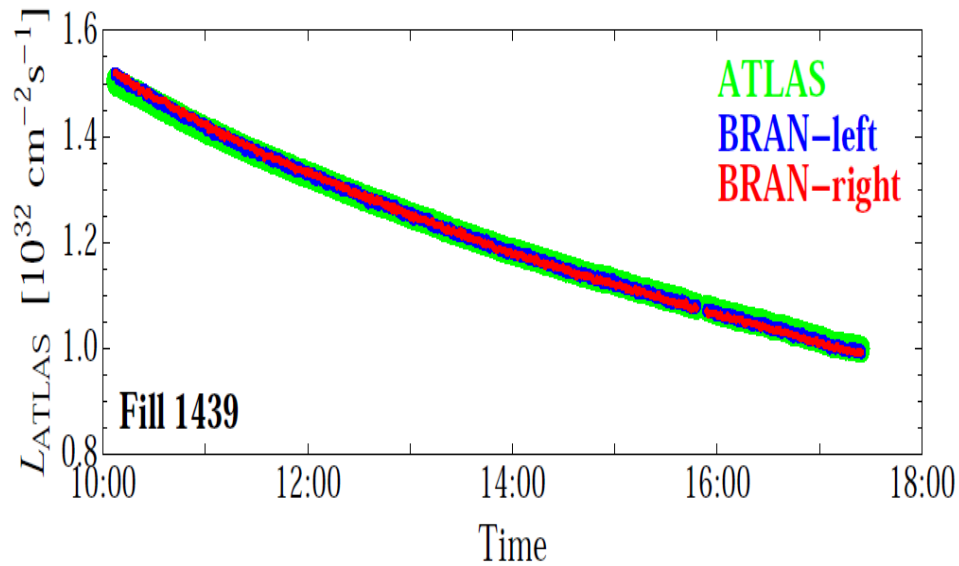
Data from 2010 in Counting Mode

Collision rate vs. BRAN rate



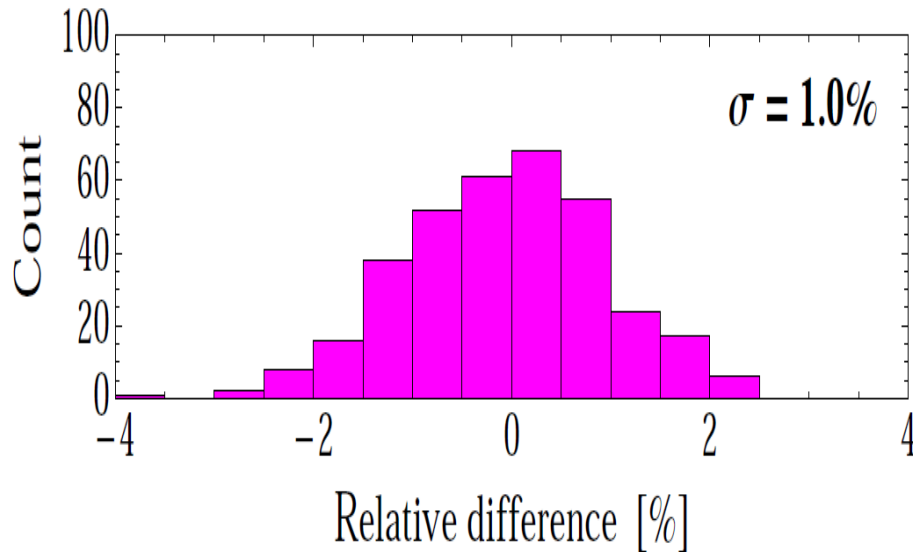
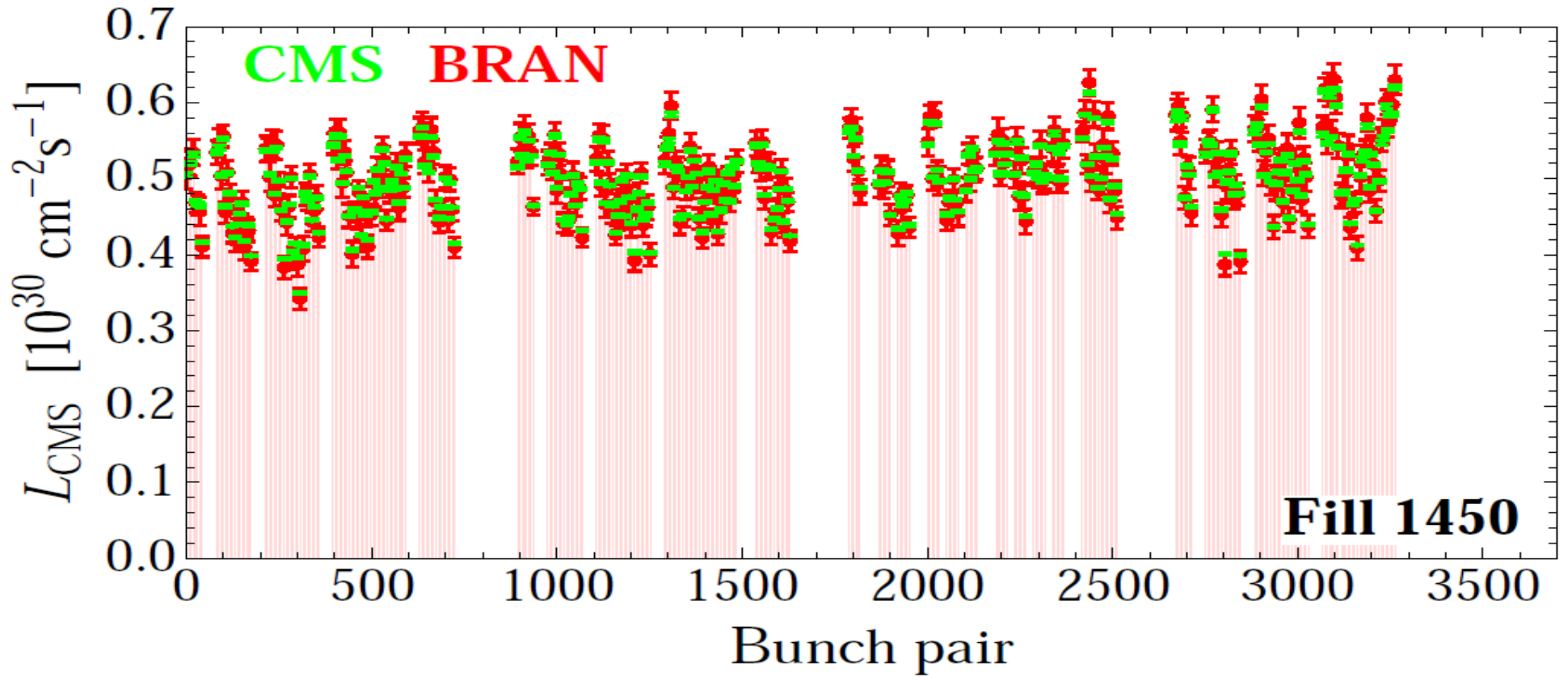
- Data is for 295 bunch collisions and $L \sim 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$.
- Our simulation predicted $\sim 5\%$ acceptance.

Luminosity: BRANs vs. Experiments



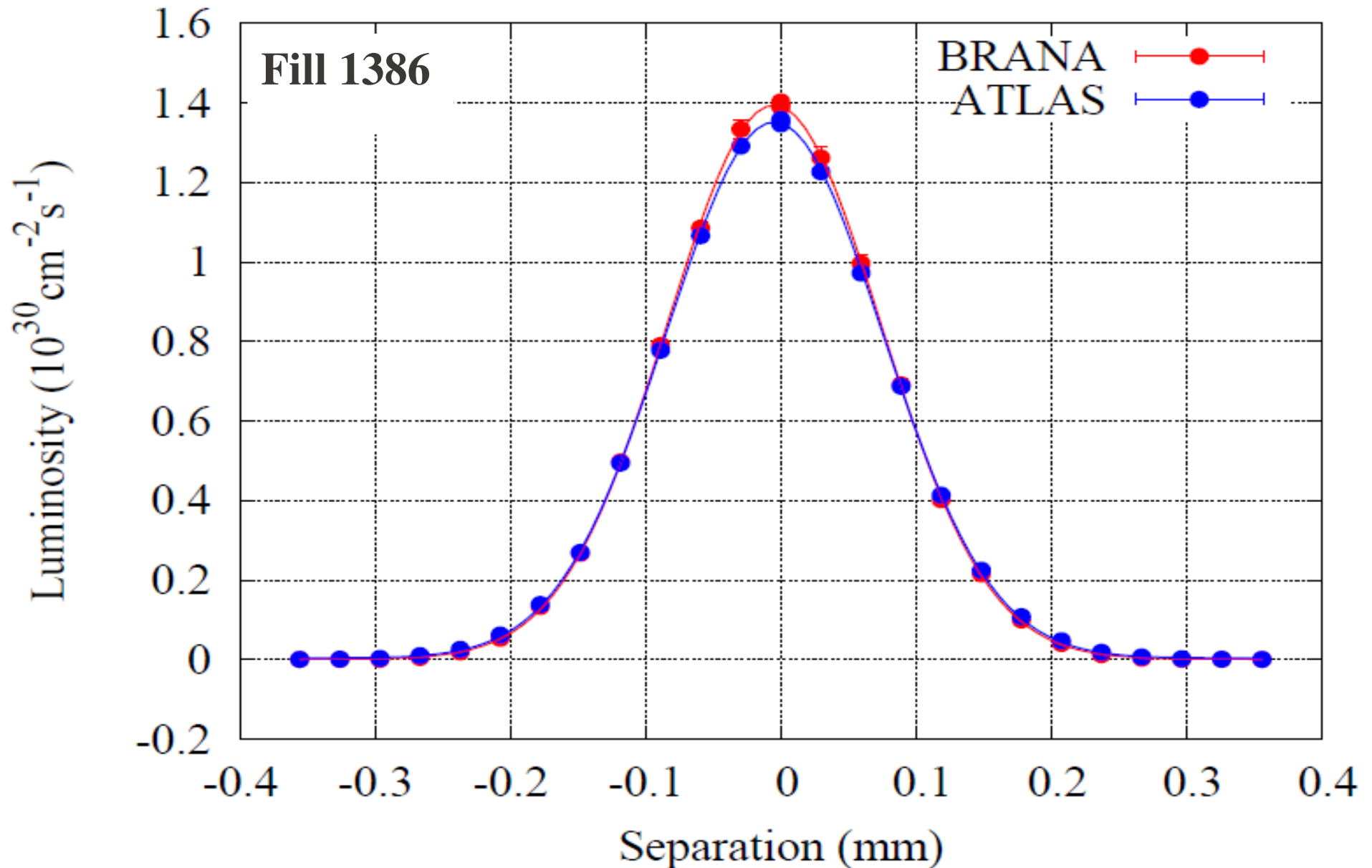
Systematic difference is about $\pm 1\%$

Bunch-by-bunch luminosity



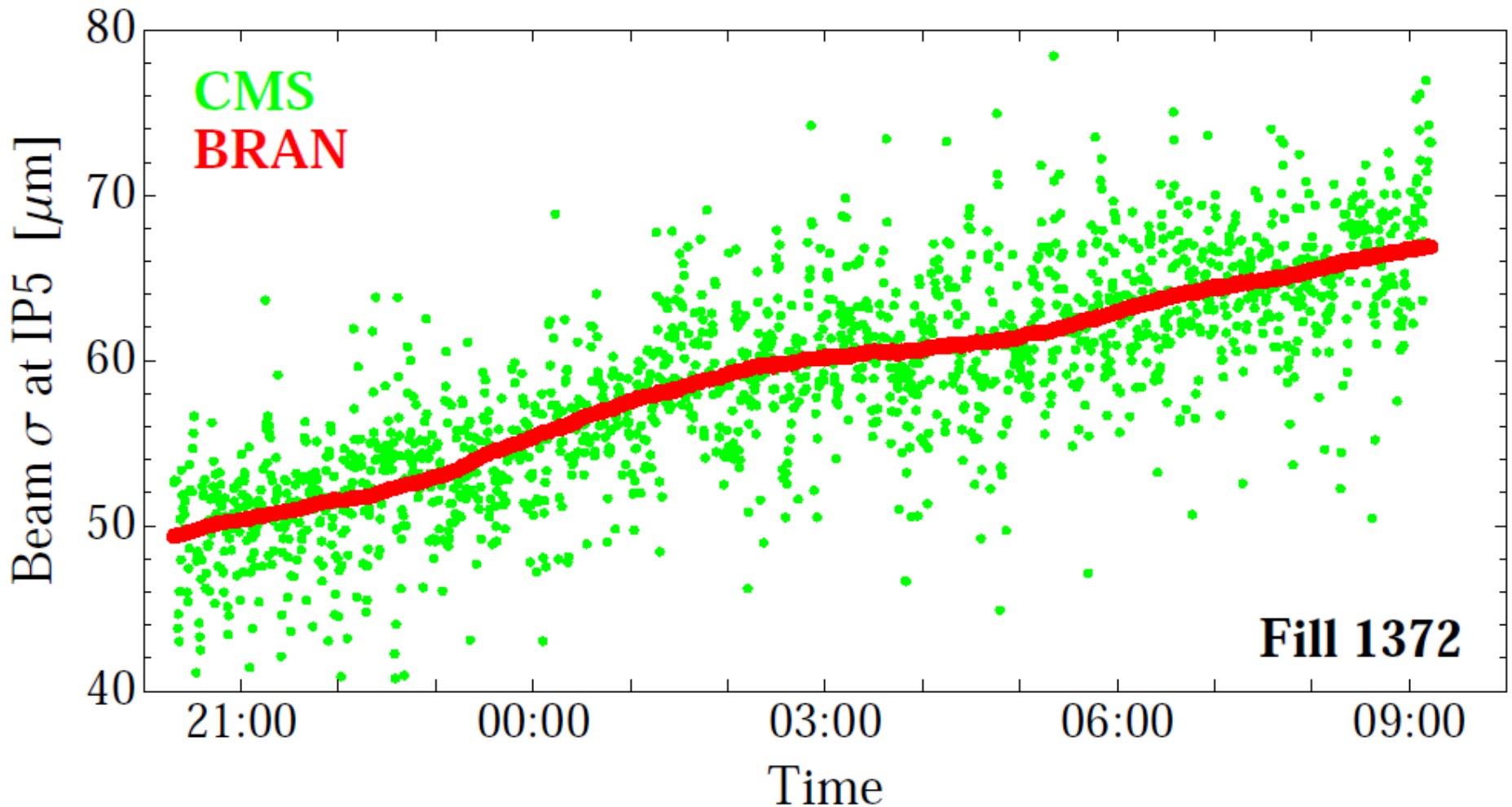
- ~1% discrepancy for bunch-by-bunch measurement.
- The discrepancy seems to come from the systematic.

Profile measurements: BRAN vs. ATLAS



Courtesy of S. White

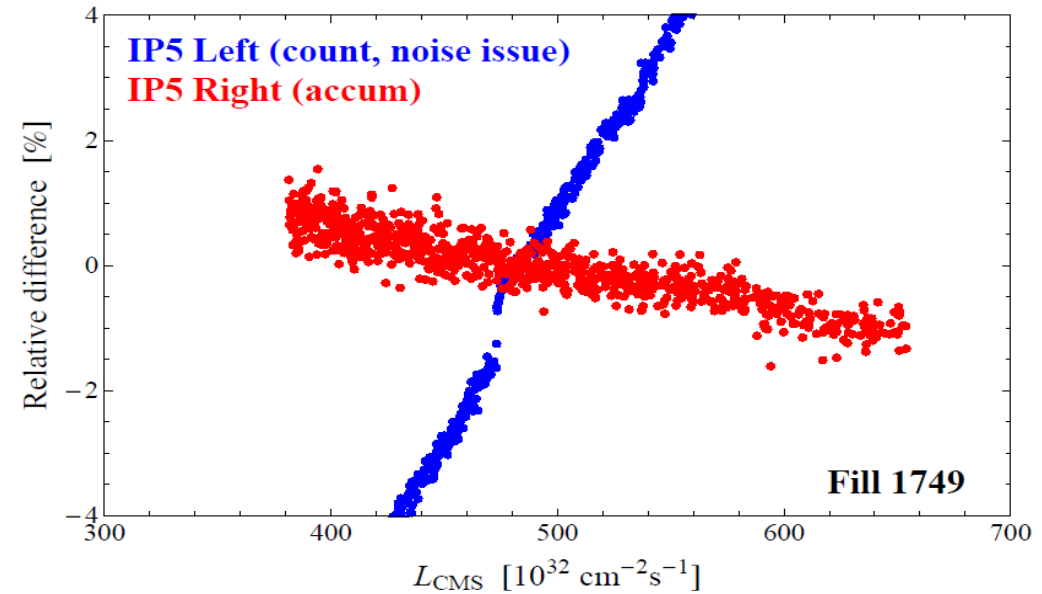
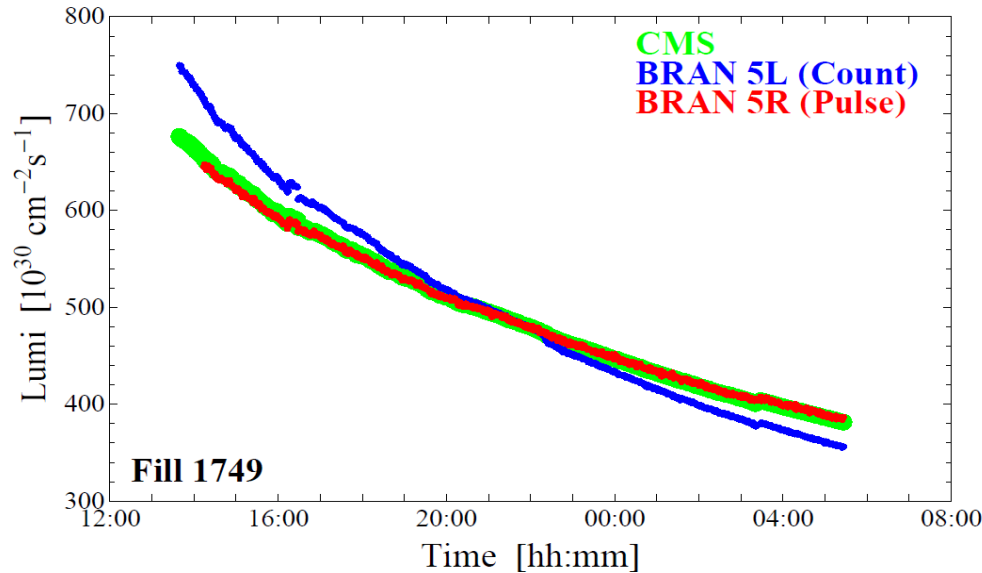
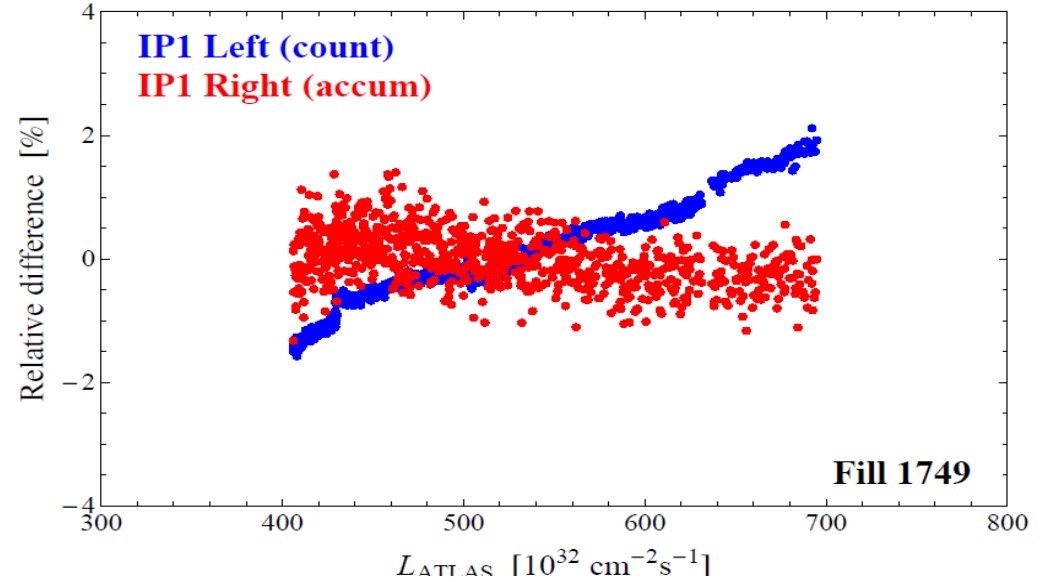
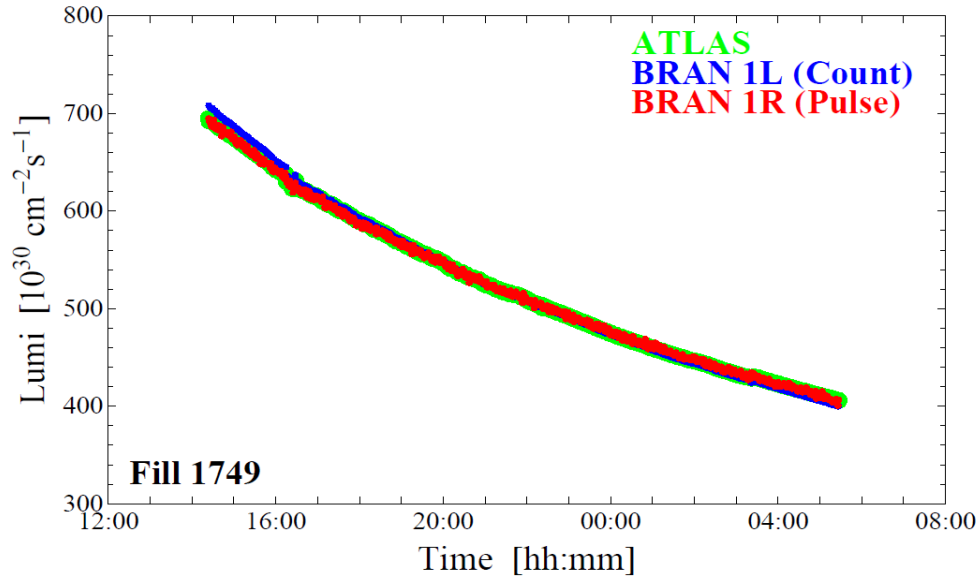
Evolution of interaction area at IP5



- The interaction area (converted to the beam size) from the luminosity of the BRAN and the luminous region measurement of CMS.
- Bunch-by-bunch measurement also available.
- Implemented into operator display.

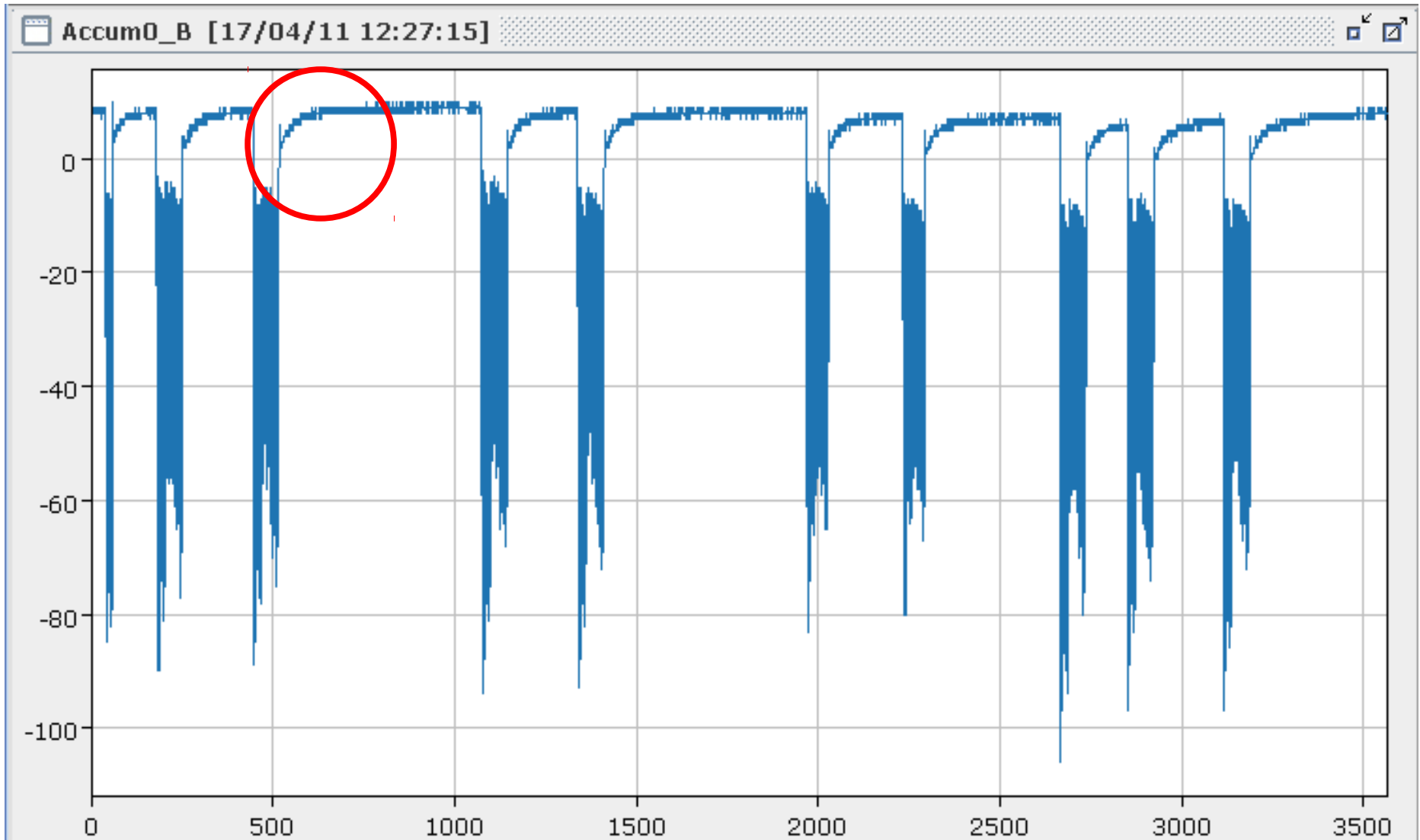
Commissioning of Pulse Height Mode

Luminosity: counting vs. pulse height



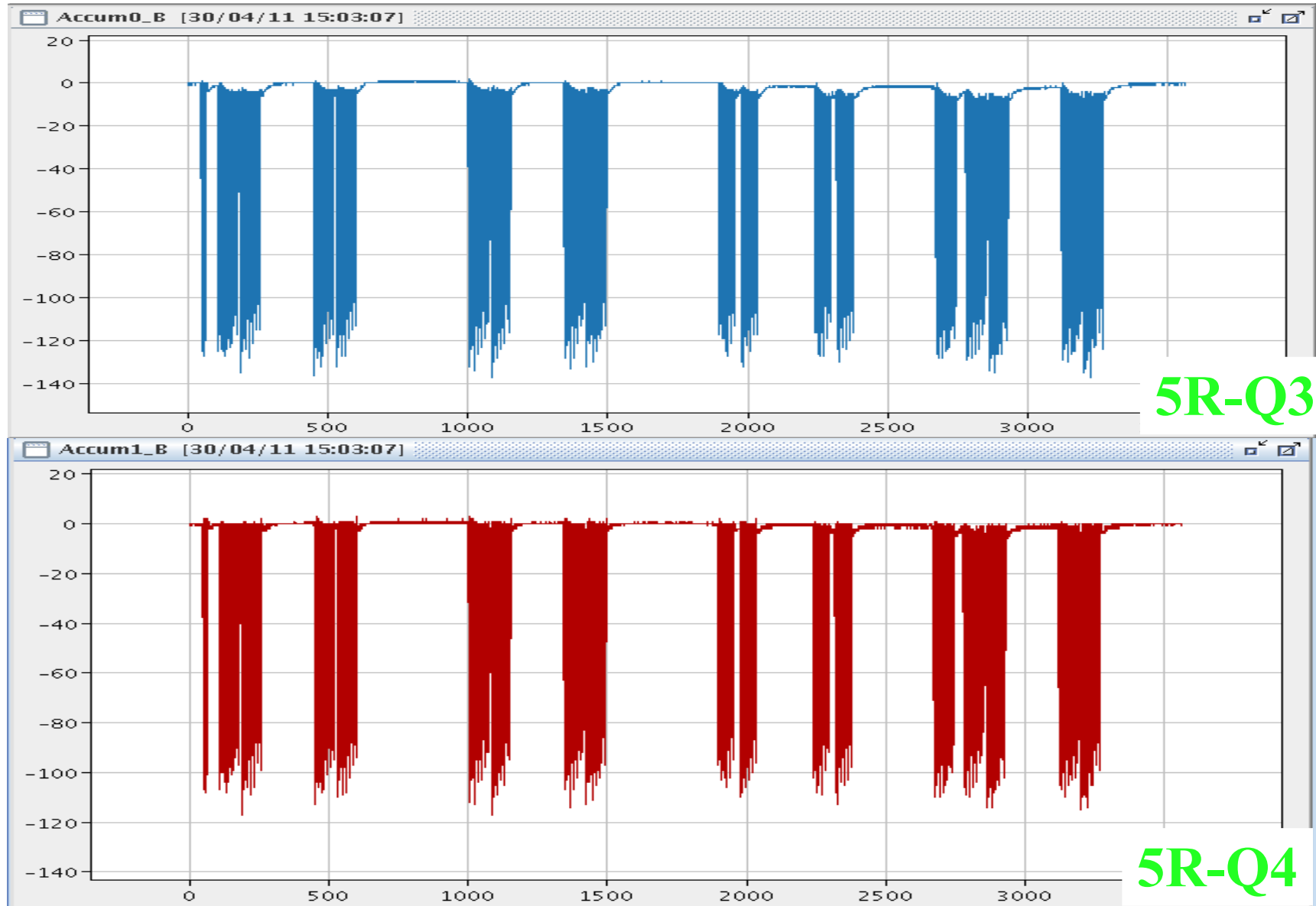
- 1R and 5R on pulse height mode, 1L and 5L on counting mode.
- Total lumi from the pulse height mode agrees well with experiments.
- Should increase the averaging time from 1 sec.

Baseline shift due to AC coupling



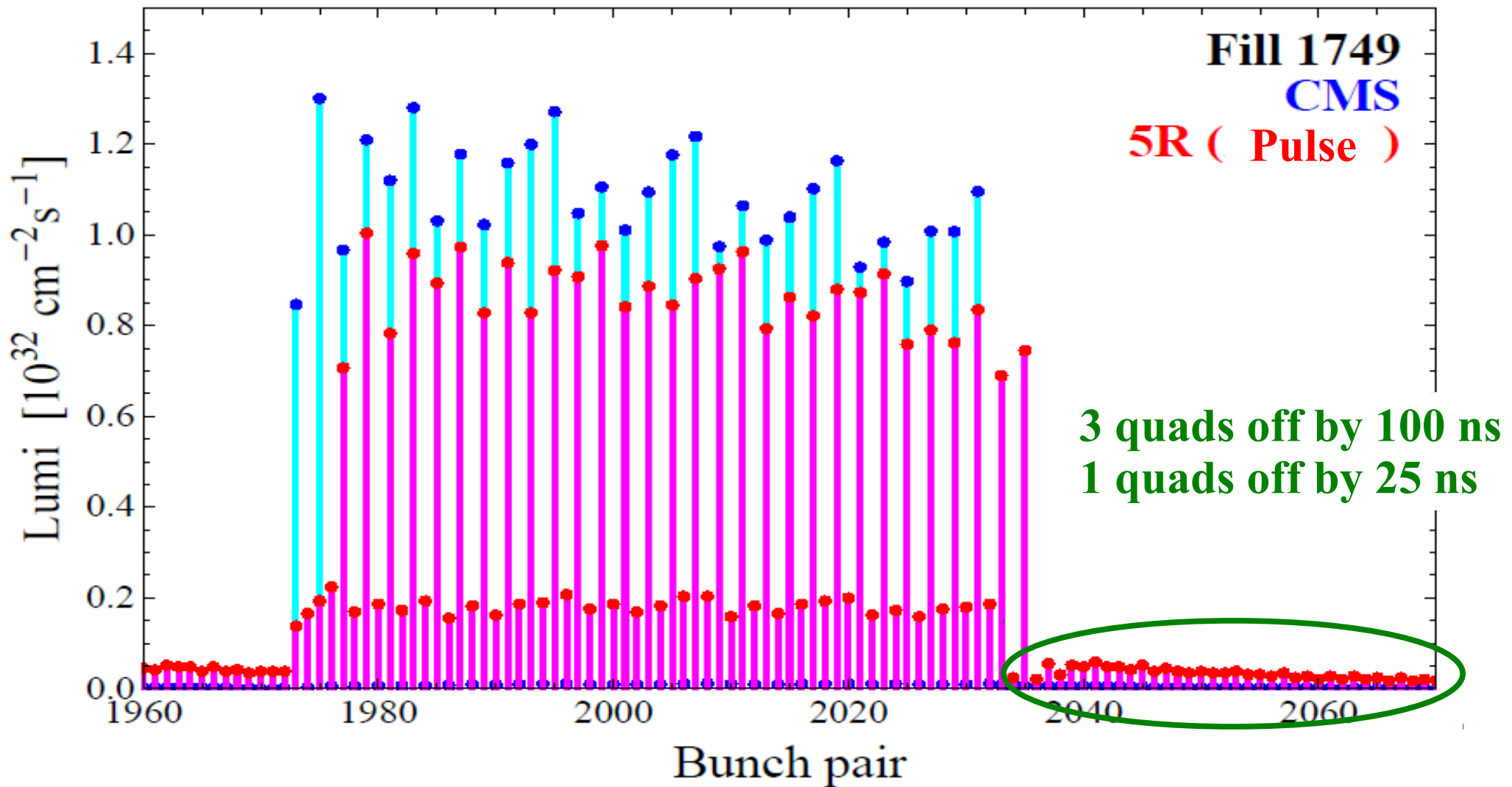
- Less of an issue for the counting mode.
- Depends on the signal strength.

After the adjustments



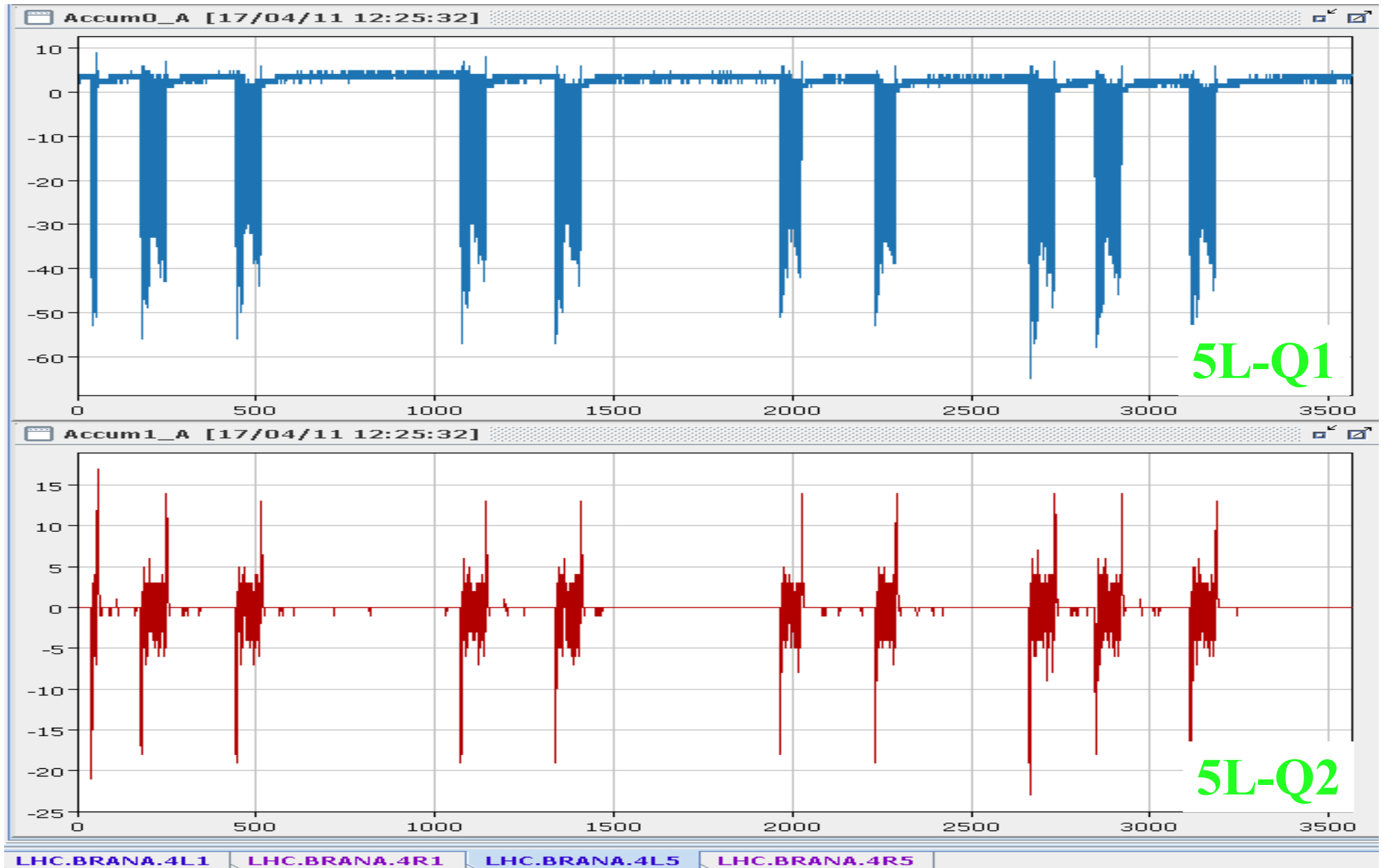
- We adjust offset, timing, deconvolution, and gain.
- Some channels are harder to adjust than others ...

Bunch-by-bunch lumi by pulse height mode



- Synchronization among quads will be fixed.
- ~5% “leak” into the empty spots. Pulse height mode is more sensitive to adjustments/calibration than the counting mode.

IP5L-Q2 has a bad connection ?

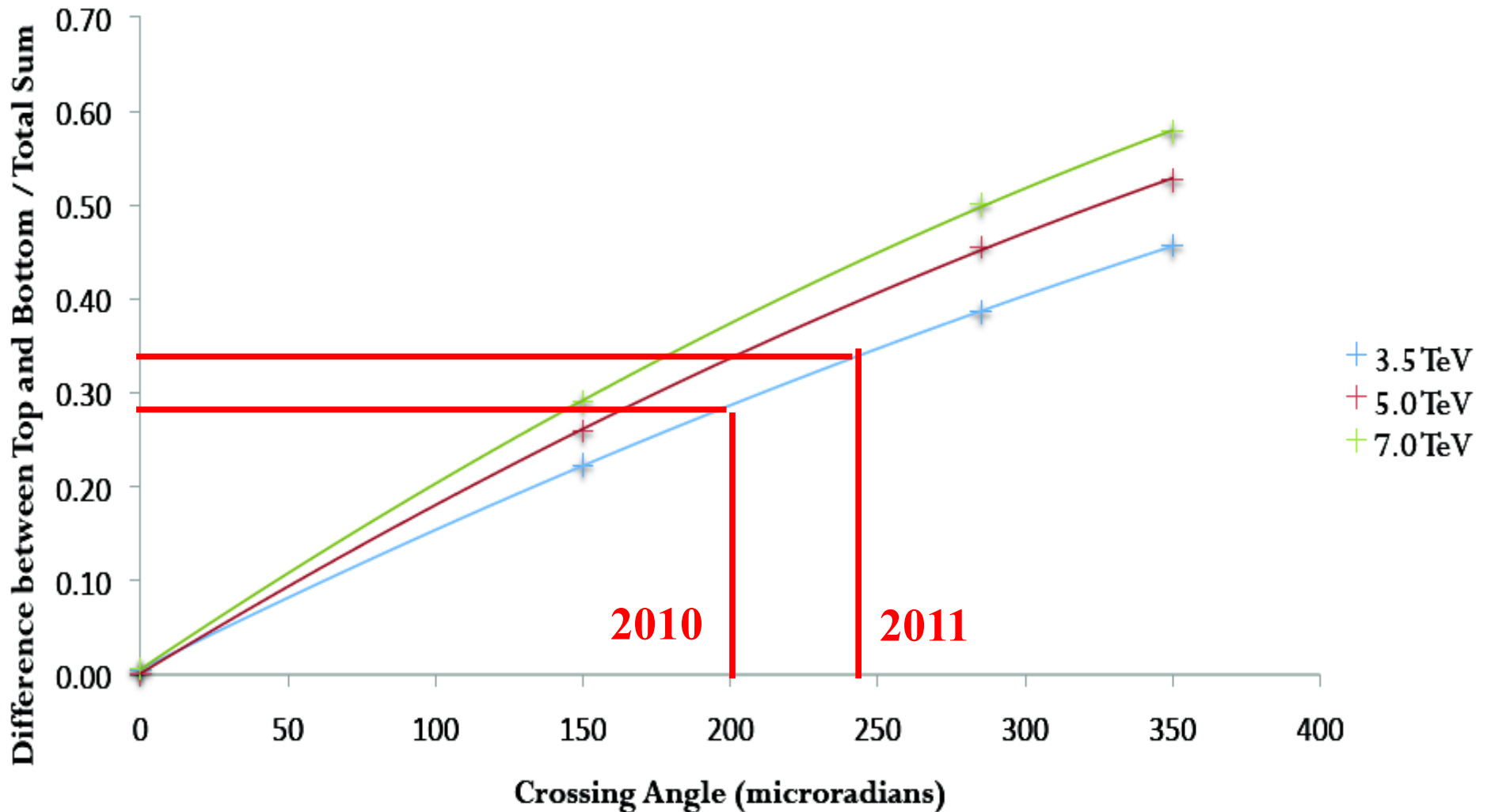


Fixed after re-connecting the cable out of the shaper ??

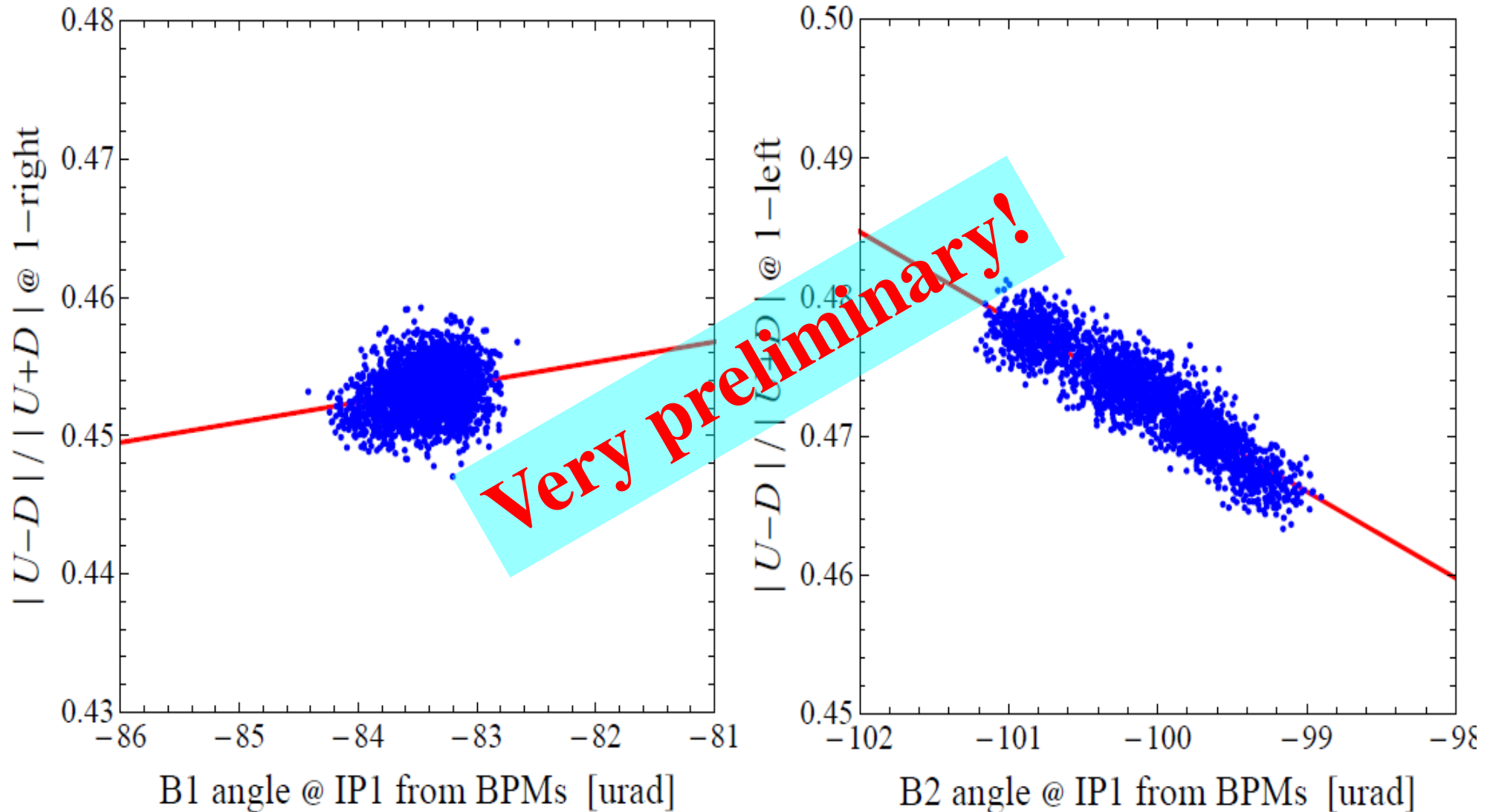
Crossing Angle and GUI

Crossing angle simulation

Normalised Difference Between Top and Bottom Quadrant Energy Deposition

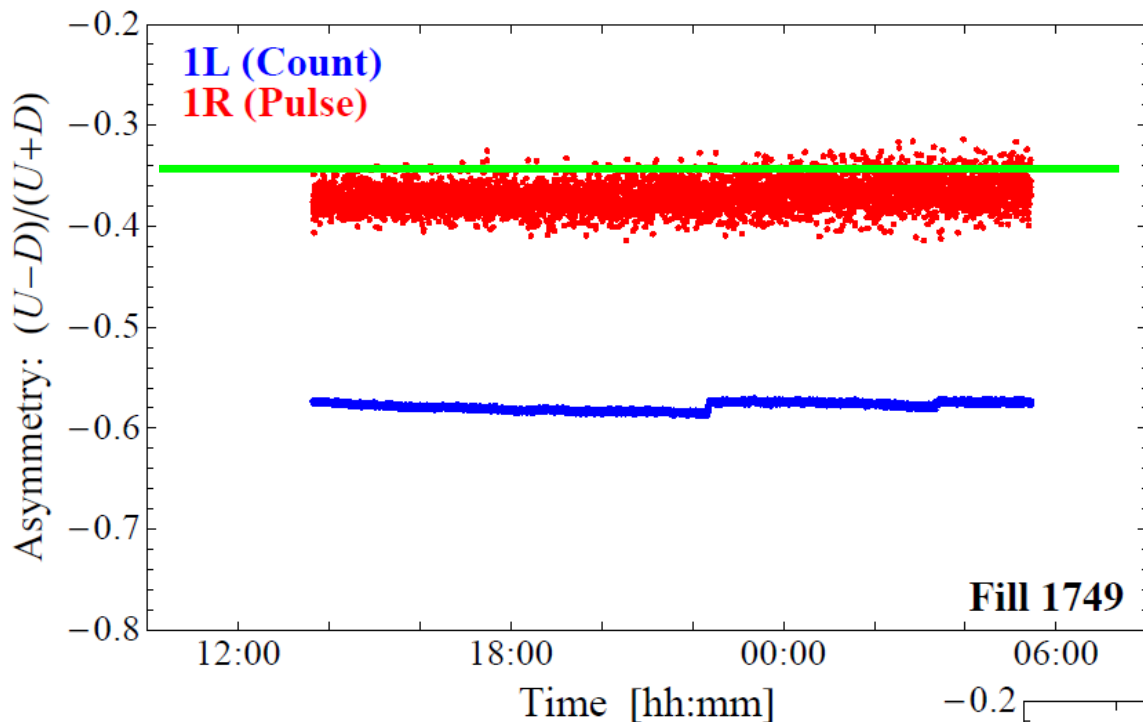


Asymmetry from the counting (2010)

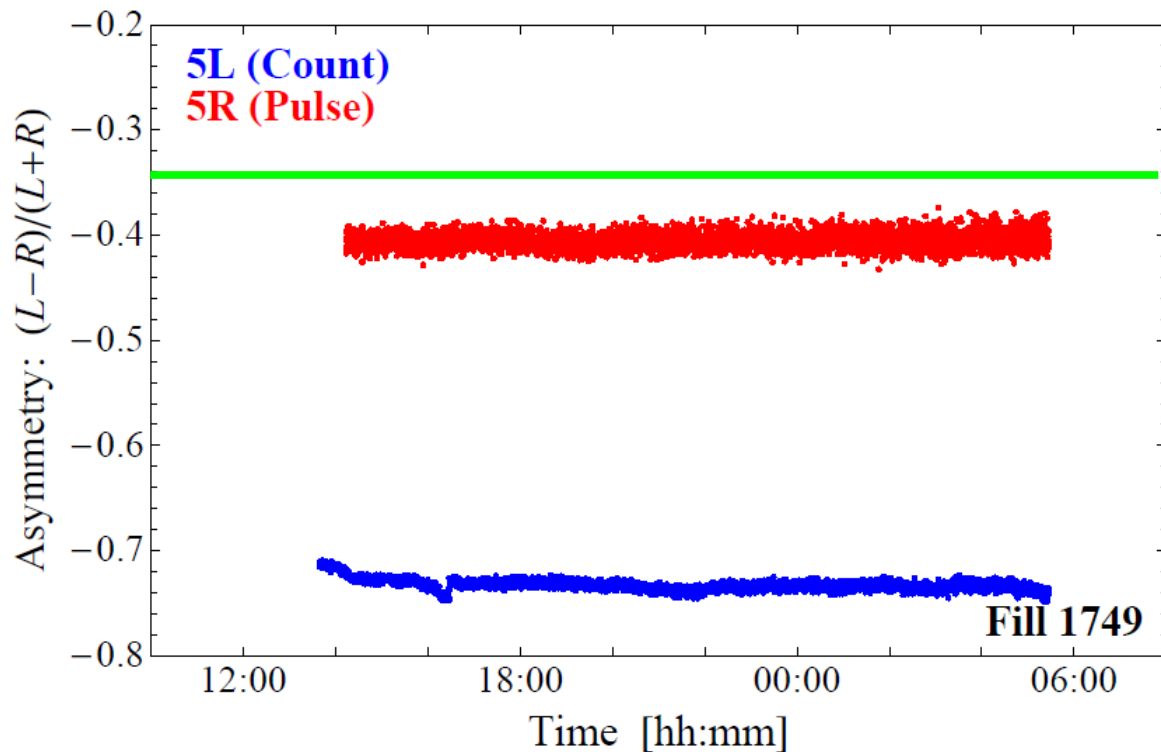


- The detector seems sensitive to the crossing angle but the asymmetry is ~50% off from the simulation.
- The measurement is sensitive to the calibration and threshold (for counting).

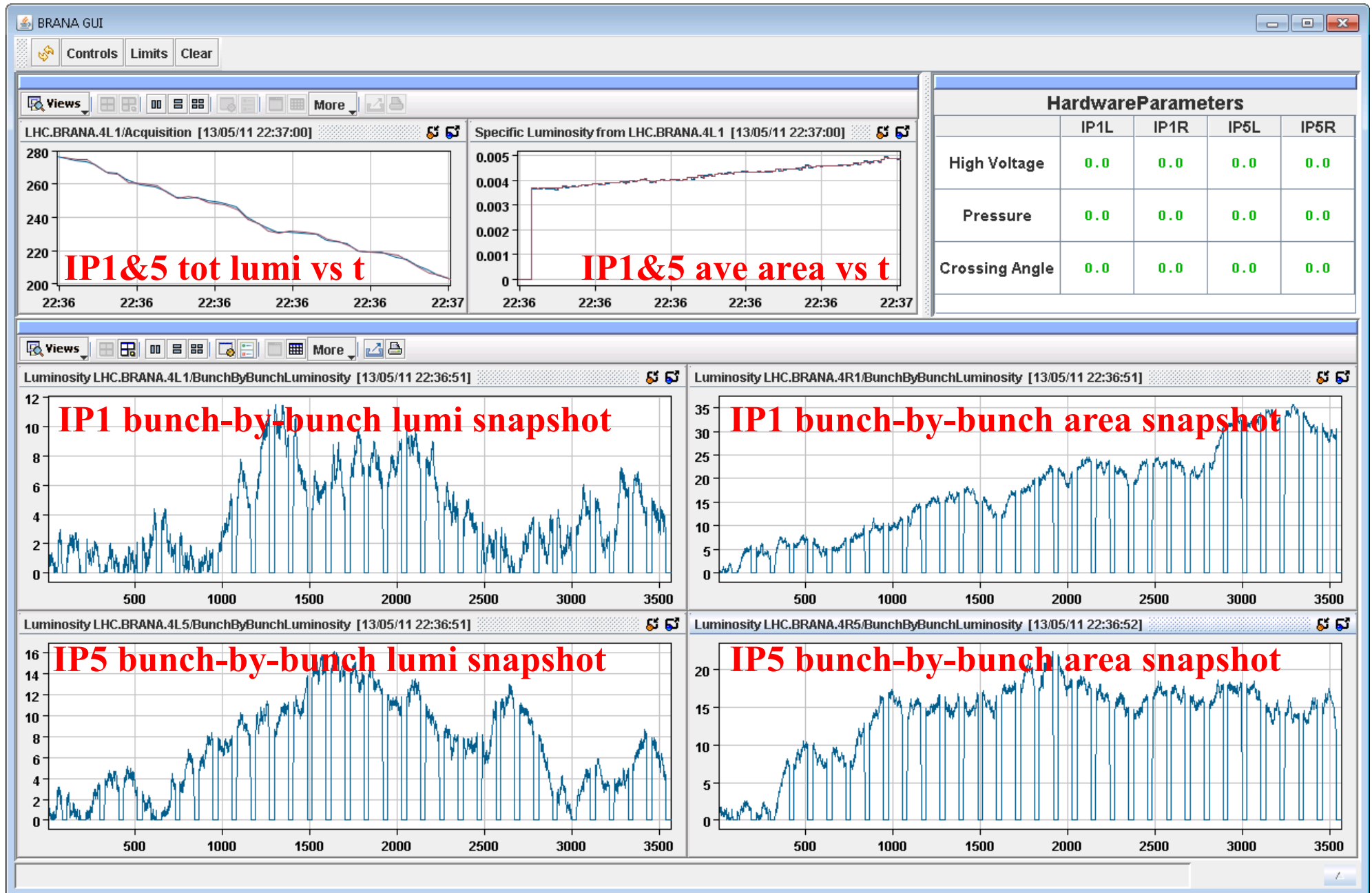
Crossing angle from pulse height (2011)



- We must use the pulse height for crossing angle measurements.
- Sensitive to the calibration.
Calibration adjustment ongoing.
- Labeling correct ??



GUI development ongoing

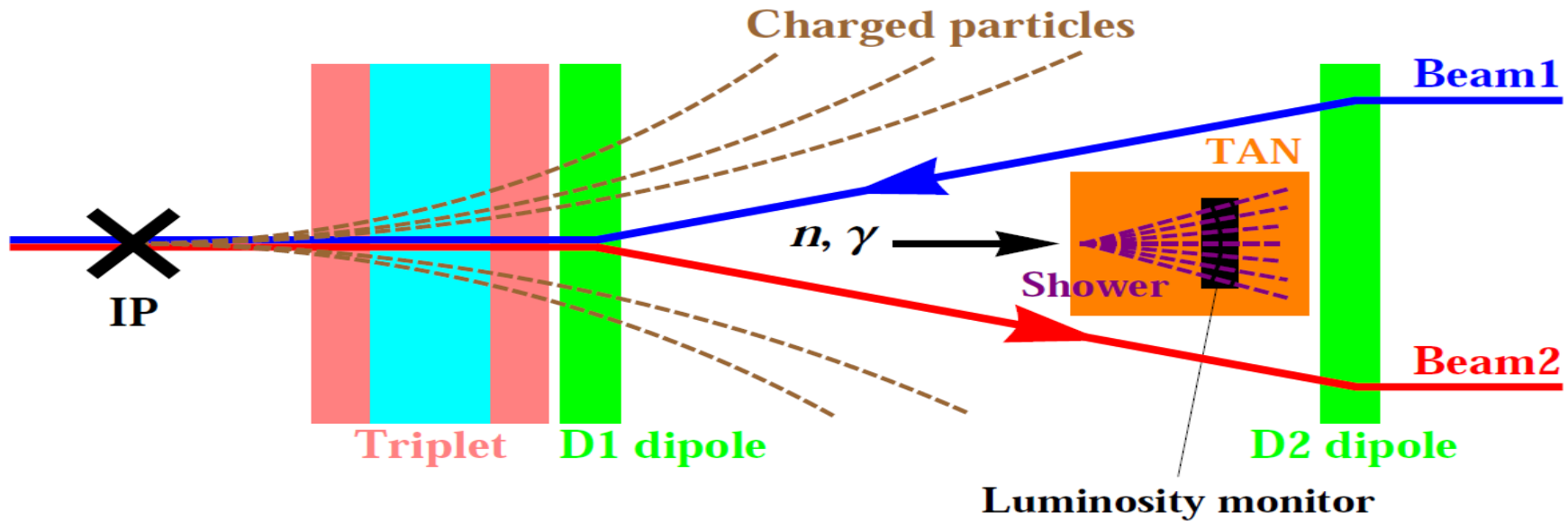


Summary

- All the components of LHC luminosity monitors have been installed and there is no recent hardware change.
- 2010 data from the counting mode agreed with measurements of ATLAS and CMS on 1% level (specification).
- Commissioning pulse height mode:
 - Pulse height mode is showing better correlations to the experiments than the counting in the condition of early 2011 run.
 - Pulse height mode is more sensitive to the calibrations of various parameters (offset, timing, filtering ...). Adjustments of the calibrations ongoing to improve accuracy of the detectors.
- GUI development ongoing and will be available in CCC.

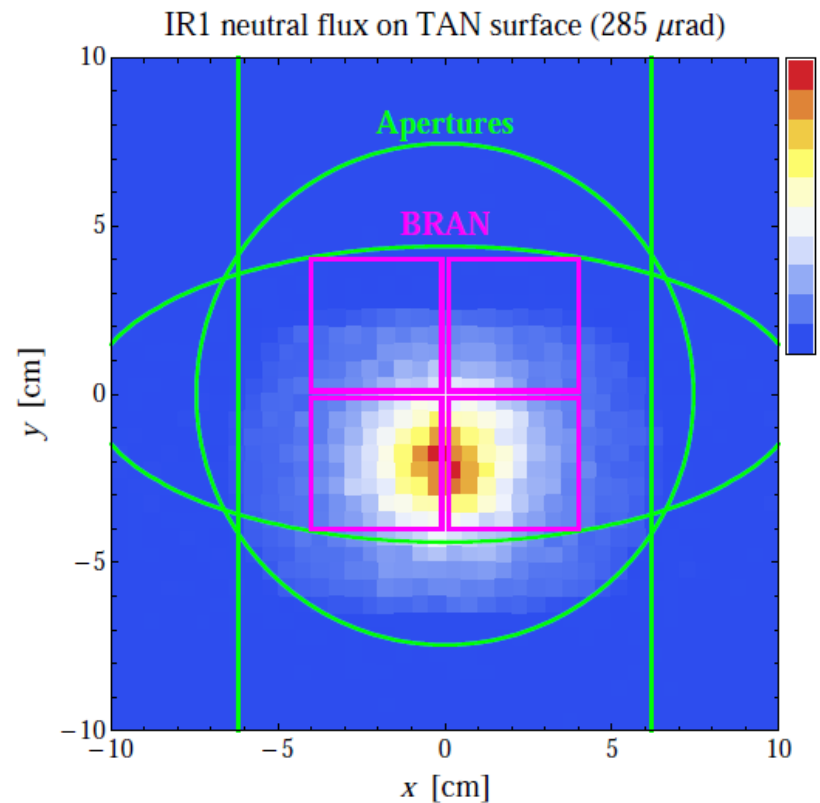
Backup Slides

BRAN luminosity monitor concept

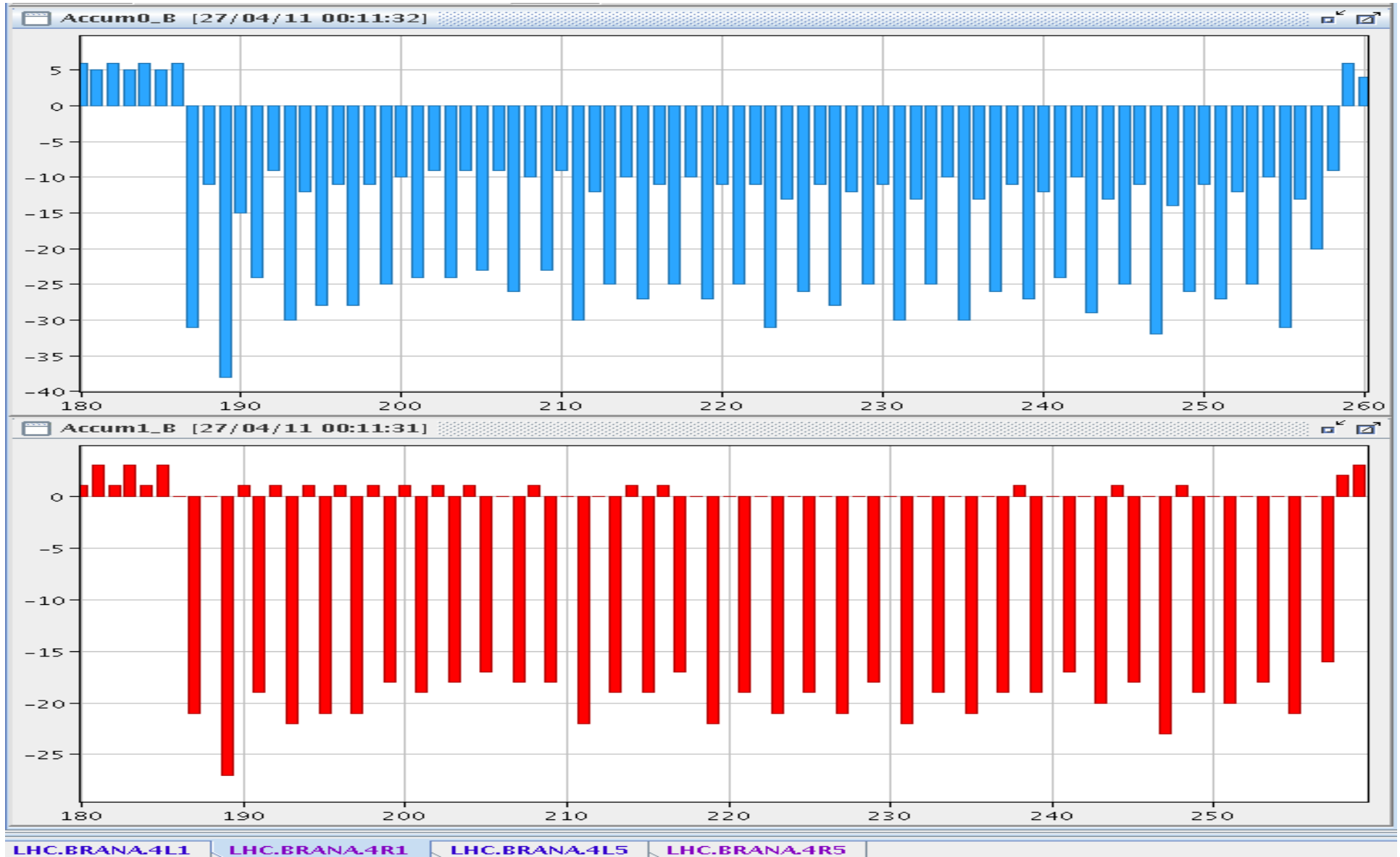


BRAN (Beam RATE Neutrals):

- Argon gas (+6% N₂) ionization chamber.
- Measures **bunch-by-bunch** (40 MHz)
 - average flux (*pulse height mode*, high lumi).
 - rate (*counting mode*, low and medium lumi)
- Withstands the **extreme radiation** (~1 GGy/y)
- Quadrant structure
 - sensitive to the **crossing angle**.
- Precision goal: **1%** relative measurements



Need “deconvolution” for 50 ns



- Implemented from the beginning. Turned on for 1R and 5R (on the pulse height)
- Again, not an issue for the counting mode (as long as not too large).
- Must be adjusted while 50 ns.