

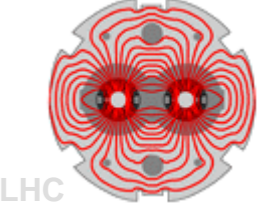
Emittance Preservation MD 3 - Preliminary Results

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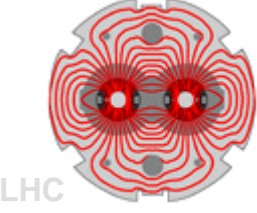
MD Goals



- o Noise effect, 50 Hz lines
 - o Transverse damper effect
 - o Wire scanner photomultiplier saturation
 - o Comparison with experiment data and LHCb SMOG
-
- o Also from beta-beating team: optics through the ramp
 - To be analyzed

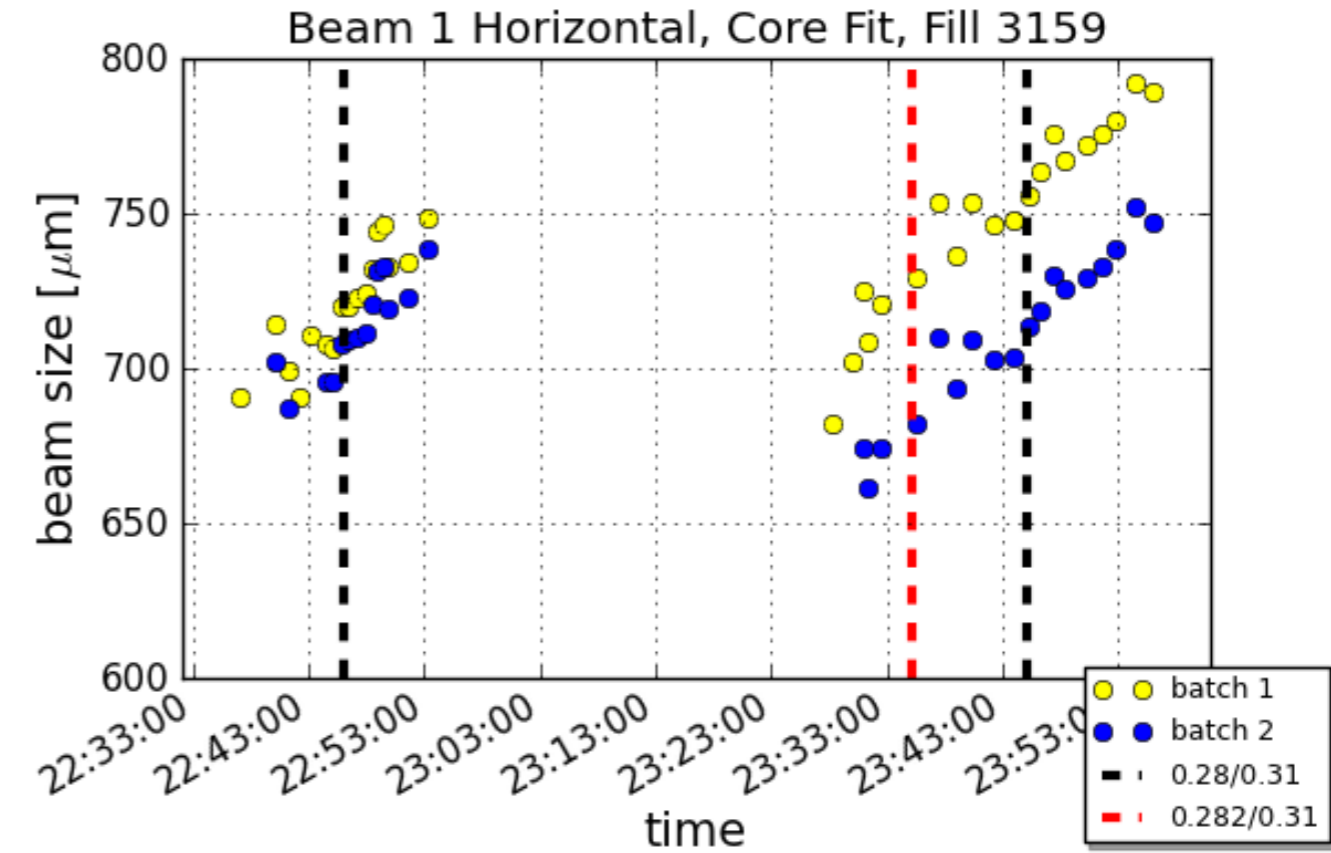


Programme

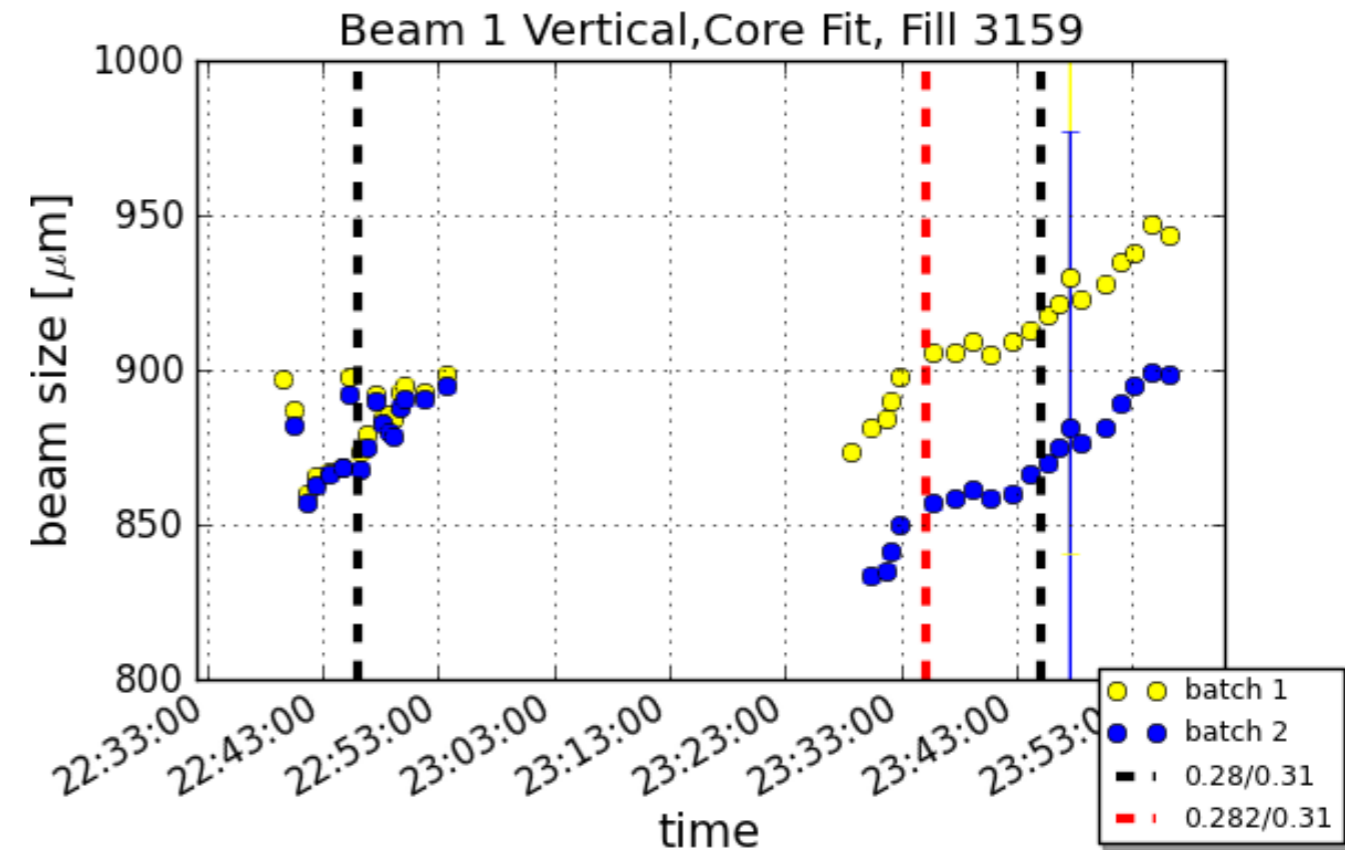


- o Injection:
 - Check 50 Hz noise line
 - Check PM saturation
- o Ramp:
 - With different damper gains and longitudinal blow-up
- o Flattop:
 - Check PM saturation
- o Collision:
 - Take ATLAS/CMS luminosity data
 - Take ATLAS/CMS luminous region data
 - Inject SMOG at LHCb Velo for beam size measurements
- o Instrumentation
 - Wire scanner always
 - Emittances averaged over 6 bunches of one batch
 - Errors include fitting error (used core fit), beta function error and error from averaging
 - Beta function from k-modulation
 - BSRT at injection and squeeze (to be analyzed)

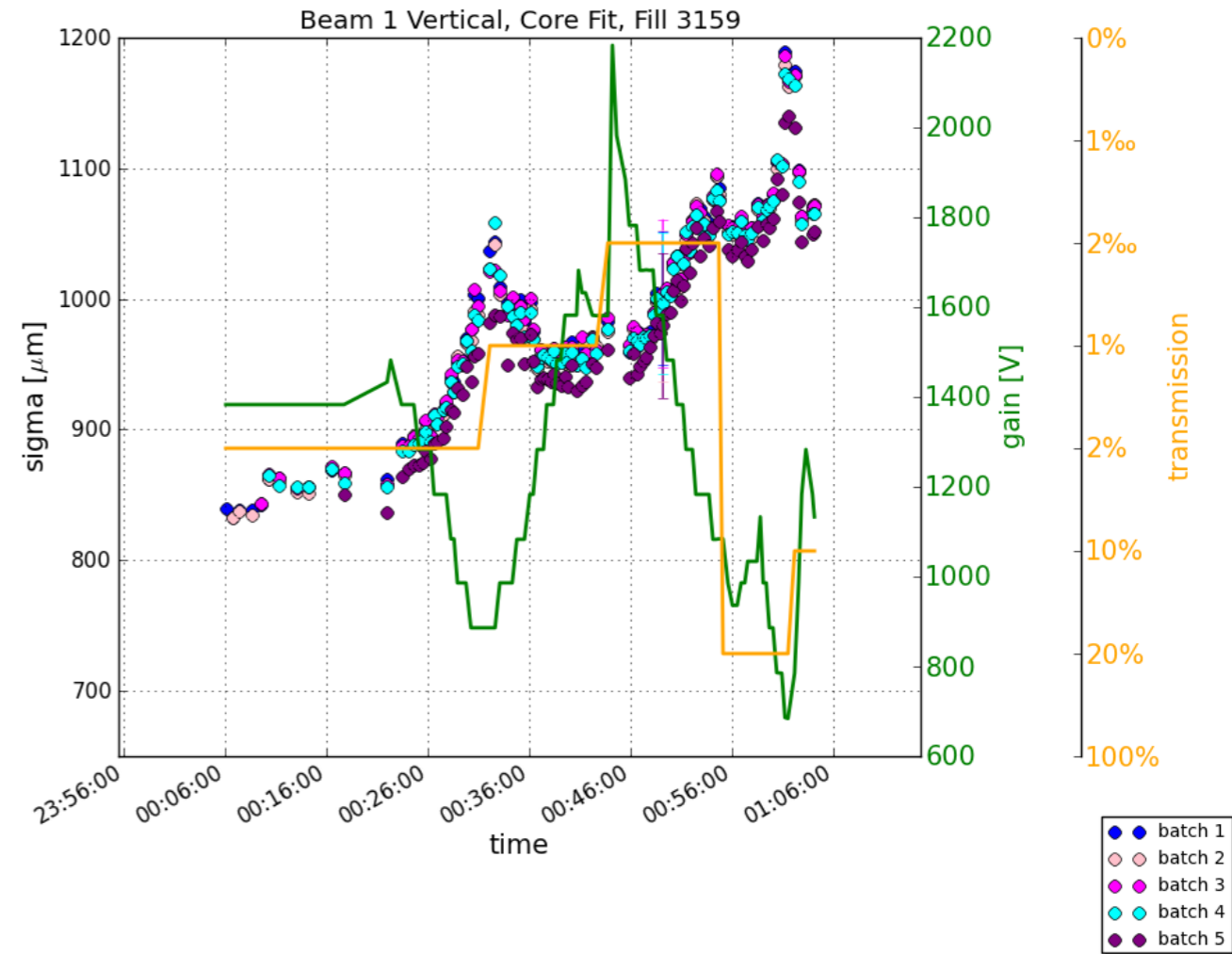
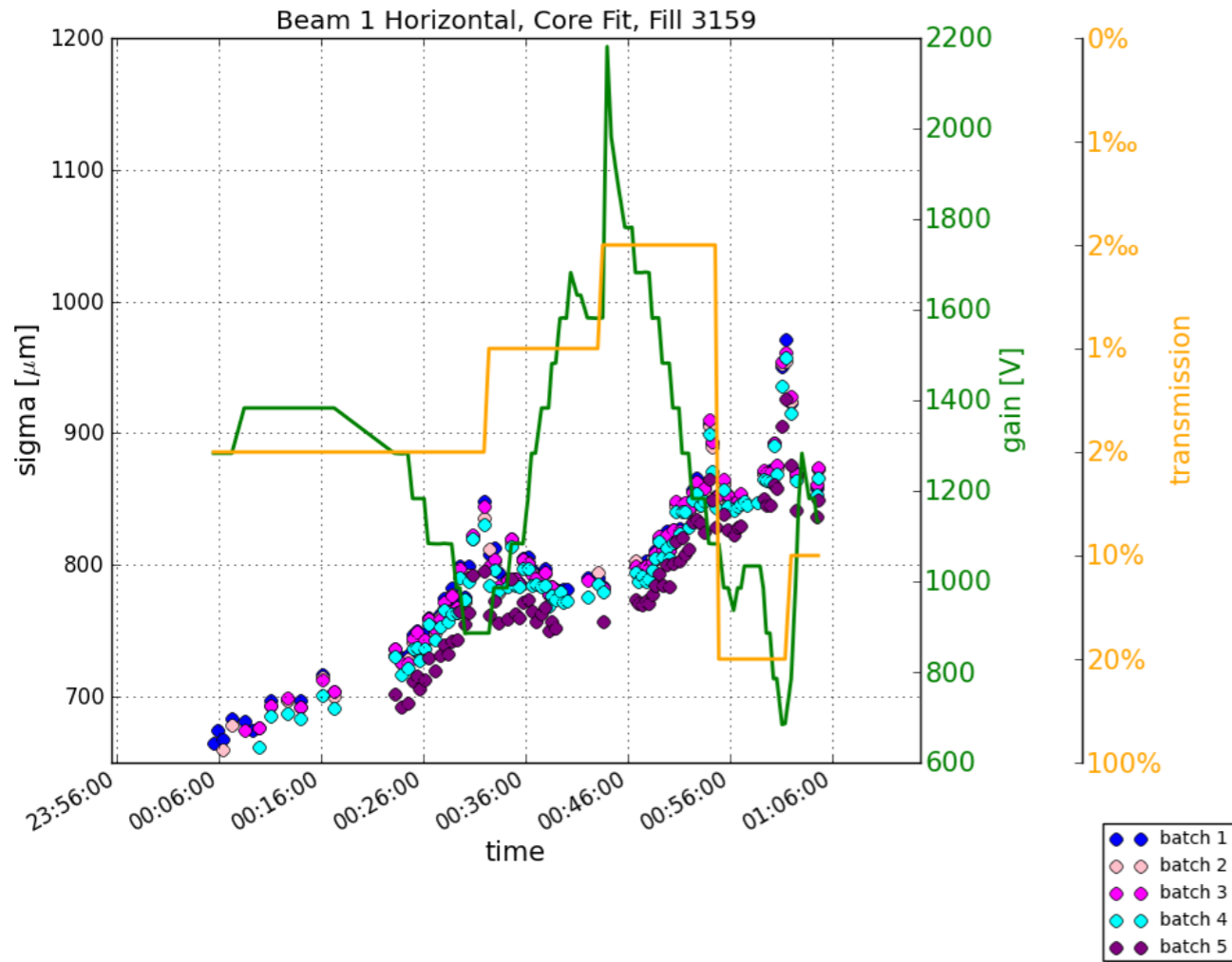
- o Inject 2 x 6 nominal 50 ns bunches
- o Intensity: 1.3×10^{11} ppb
- o Fillnumber 3159
 - Trim tune to 0.28/0.31 (50 Hz line)
 - Unexpected beam dump, re-injection
 - Move tune to 0.282/0.31
 - Tune back to 0.28/0.31



- o **What is going on in the vertical plane?**
 - Only changed horizontal tune!
- o **horizontal plane not clear yet**
 - IBS anyways



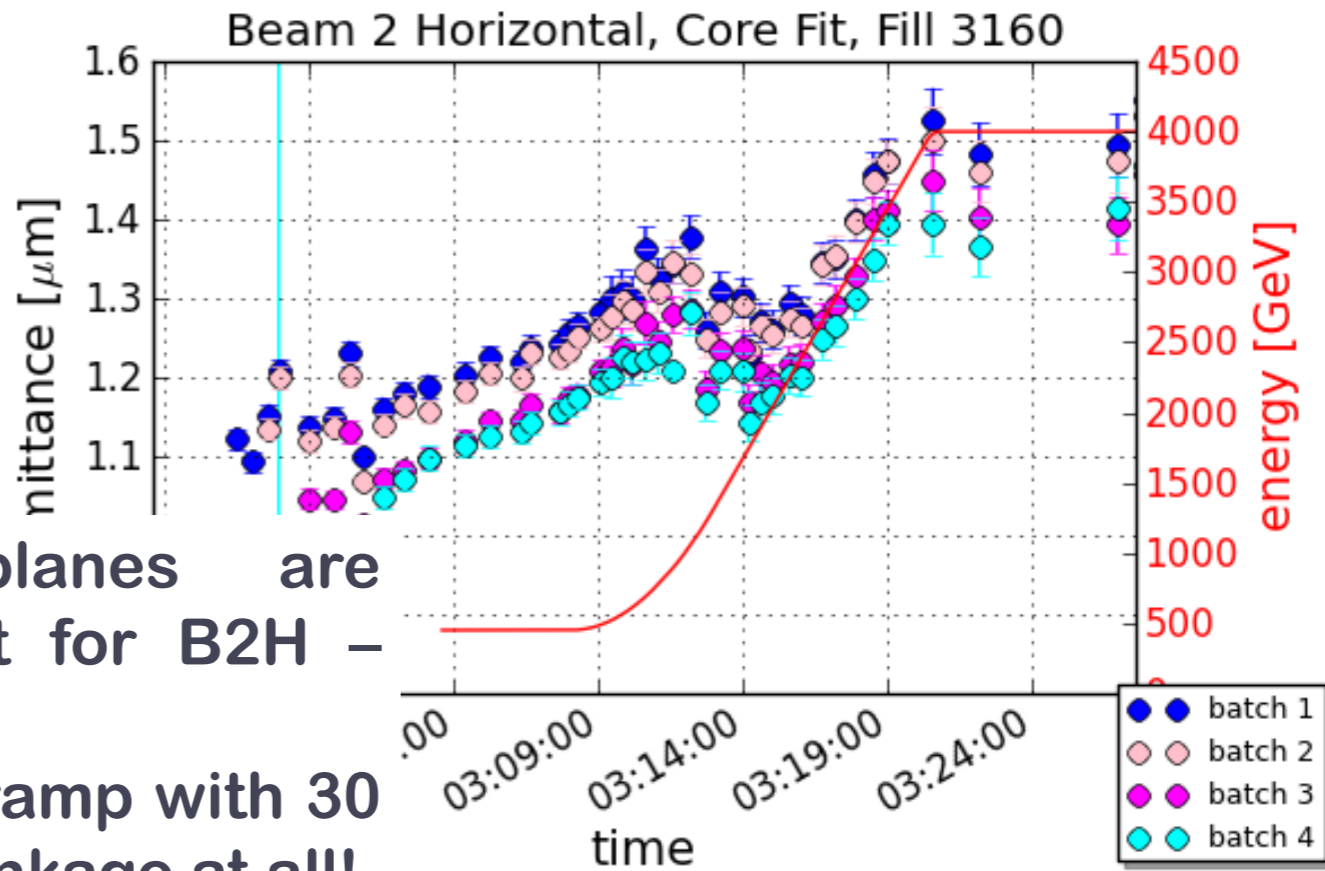
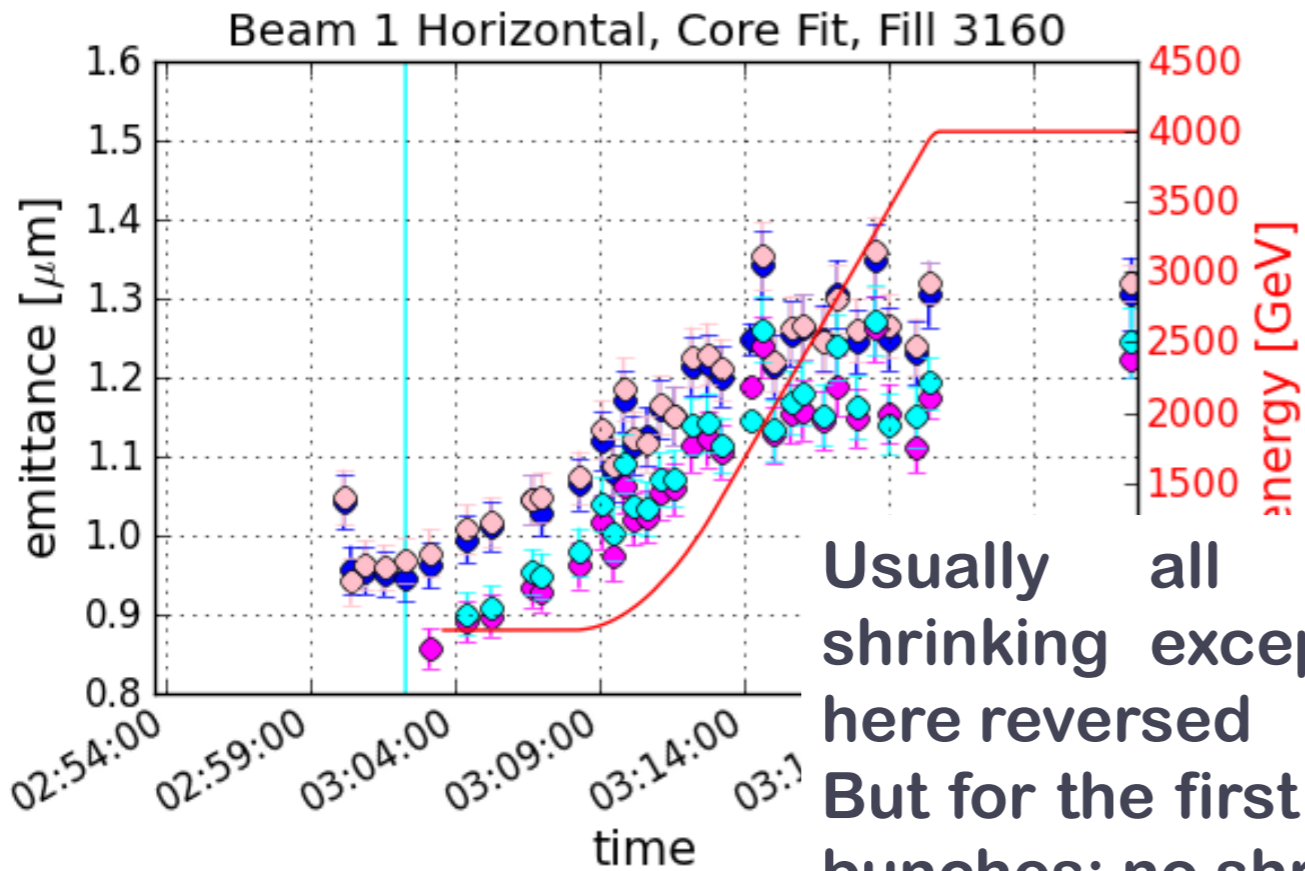
- o Inject 5 x 6 nominal 50 ns bunches
 - Change filters and voltage of wire scanners



- Horizontal plane: emittance growth due to IBS
- BUT: vertical plane also growing
- **Clearly filter and gain selection have an influence on the beam size**
- Preliminary: best working point for ramp: **low transmission + high voltage**

- o Re-inject 5 x 6 nominal 50 ns bunches
 - Unexpected beam dump after ramp
 - Due to beam loss in point 4 during wire scan → **WS threshold changed to 3.6×10^{12}**
 - **Beam dump still under investigation (beam size, wire thickness, change of system?)**
- o Lower intensity: 1.0×10^{11} ppb
- o Fillnumber 3160
- o Re-inject 4 x 6 nominal 50 ns bunches
 - Still very high losses in point 4 during wire scans!!!

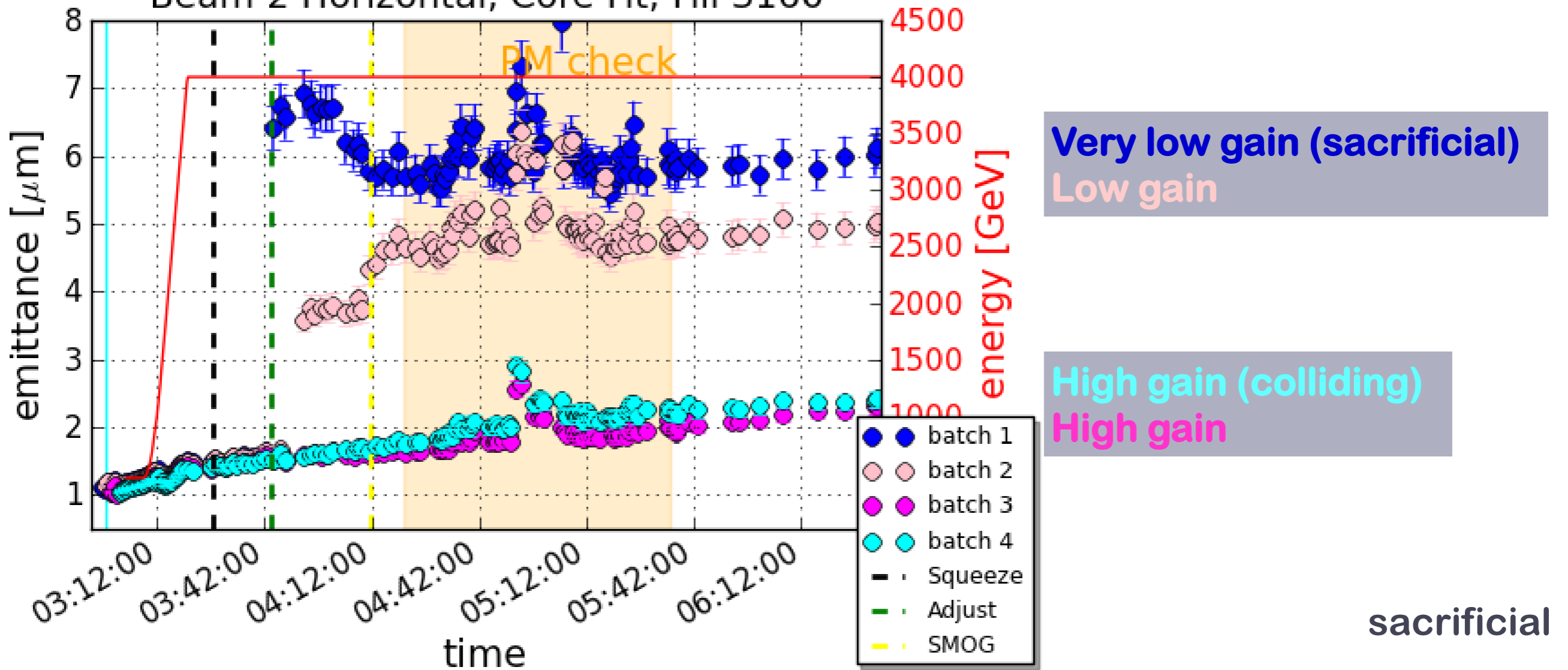
Optics?
Transverse instabilities due to short bunch lengths?



Usually all planes are shrinking except for B2H – here reversed
 But for the first ramp with 30 bunches: no shrinkage at all!

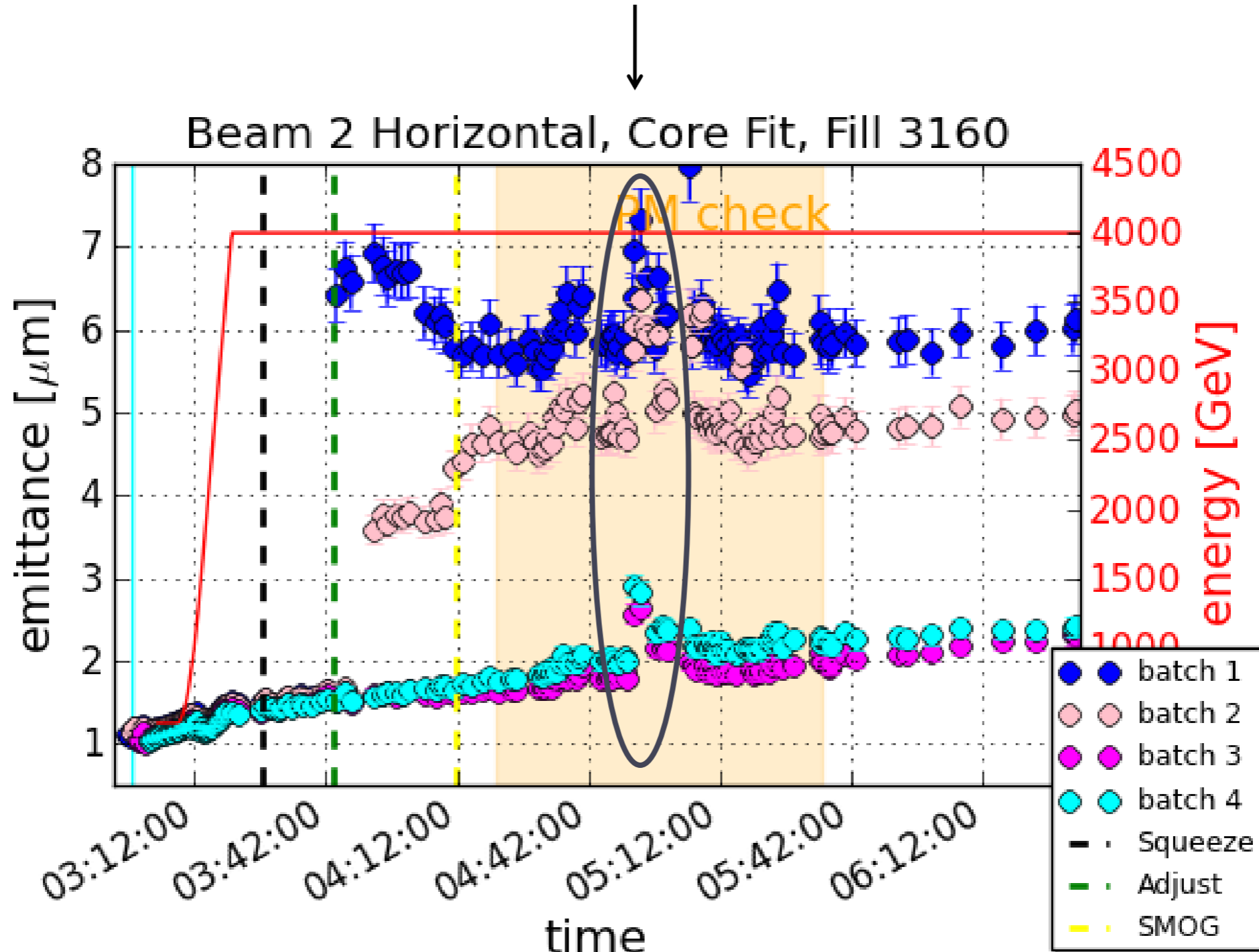
- o Large blow-up for low gain bunches
- o Colliding and non-colliding high gain bunches look good

Beam 2 Horizontal, Core Fit, Fill 3160



- o All other planes look the same, except B1H

- o filter and gain selection have an influence on the emittance
 - Changes the normalized emittance up to $1 \mu\text{m}$!



- o Best settings are still under investigation

- o Convoluted emittance:
 - Used measured beta from k-modulation at $\beta^* = 0.6\text{m}$ for wire scanners
 - Only batch 4 (average over 6 bunches) are colliding

	Wire Scan	From ATLAS Luminosity	From CMS Luminosity
ϵ_L [μm]	1.39 +/- 0.04	1.60 +/- 0.24	1.80 +/- 0.27

- Luminosity: β^* error of 15 %, crossing angle error 15 μrad

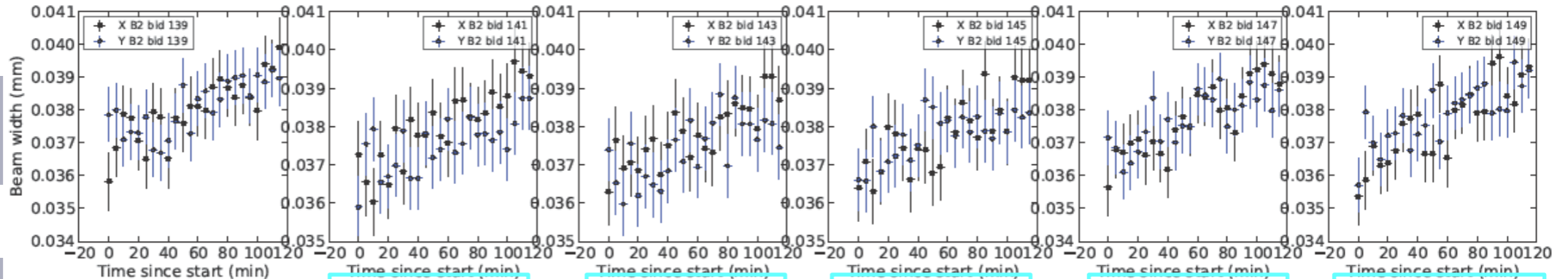
- o Emittances from wire scans significantly smaller than emittances from luminosity
 - Also large difference between ATLAS and CMS
 - **Also unknown error on wire scanner measurements due to PM saturation**
 - **Emittances measured approx. too small**
- o To be checked: luminous region (no data at peak luminosity)
 - Bunch-by-bunch beam sizes of colliding bunches in IP1 and IP5

- o Work still in progress
- o LHCb could measure all bunches, no collisions in IP8

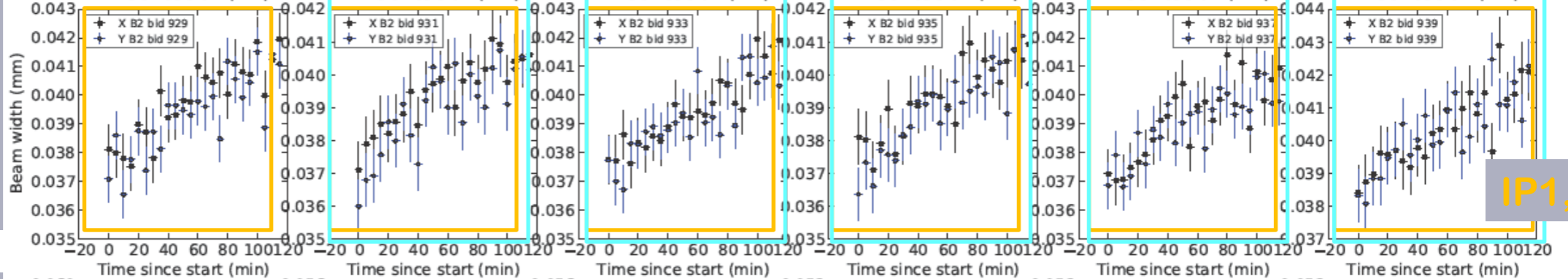
Colin Barschel

Beam 2:

High gain (no collisions)

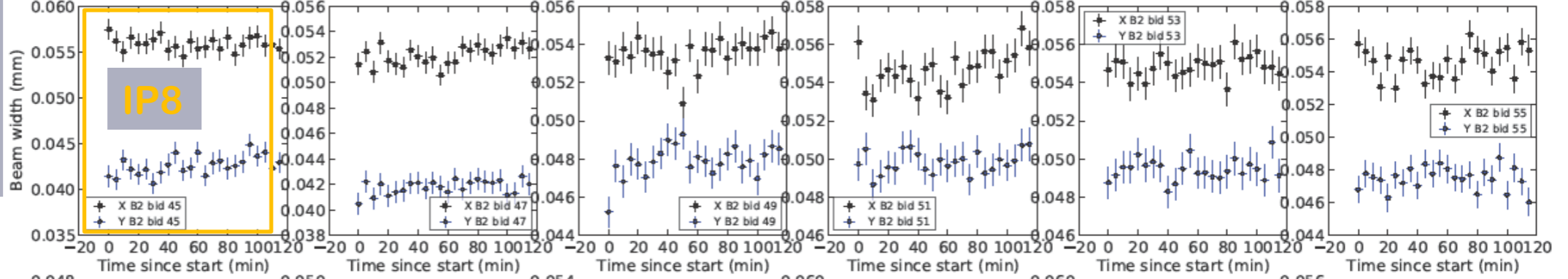


High gain (long range collisions IP1,2,5) (head-on collisions IP1,5)

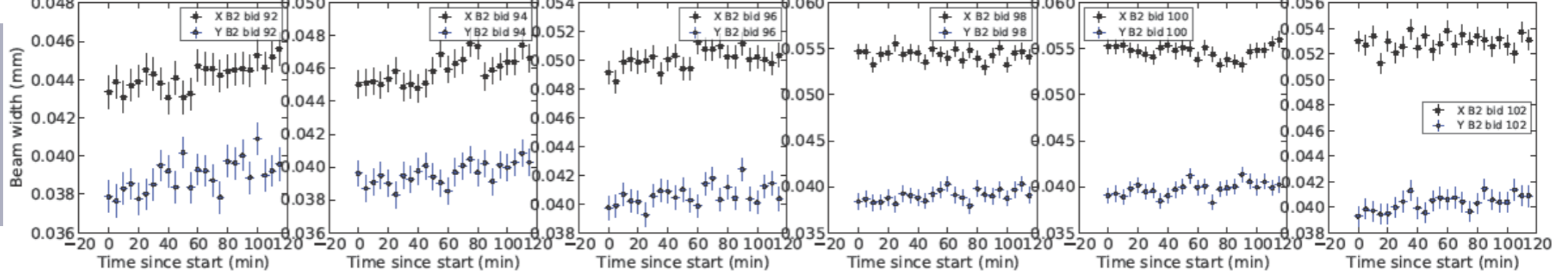


IP1,2,5

Very low gain (sacrificial, long range collisions IP1,5,8)



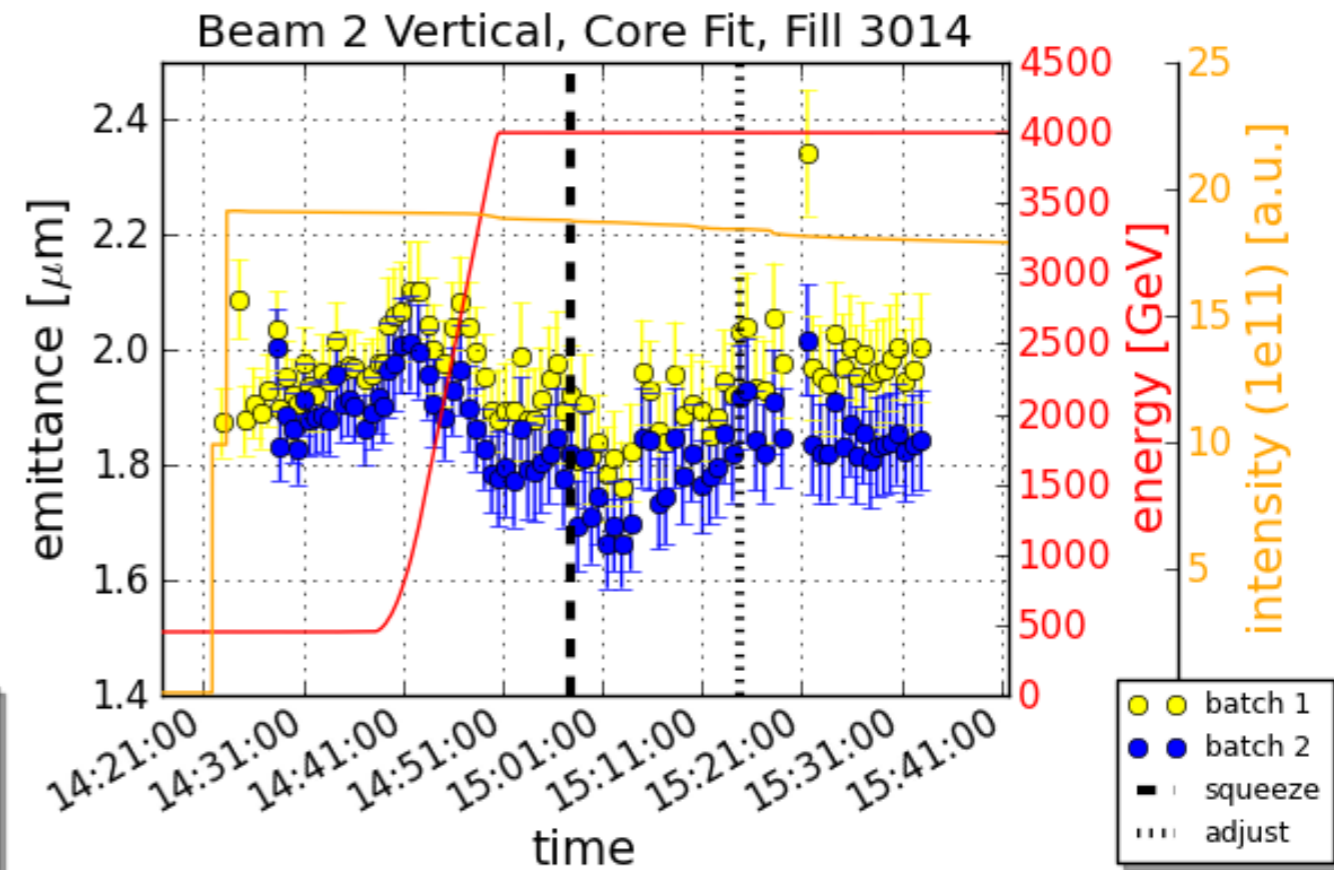
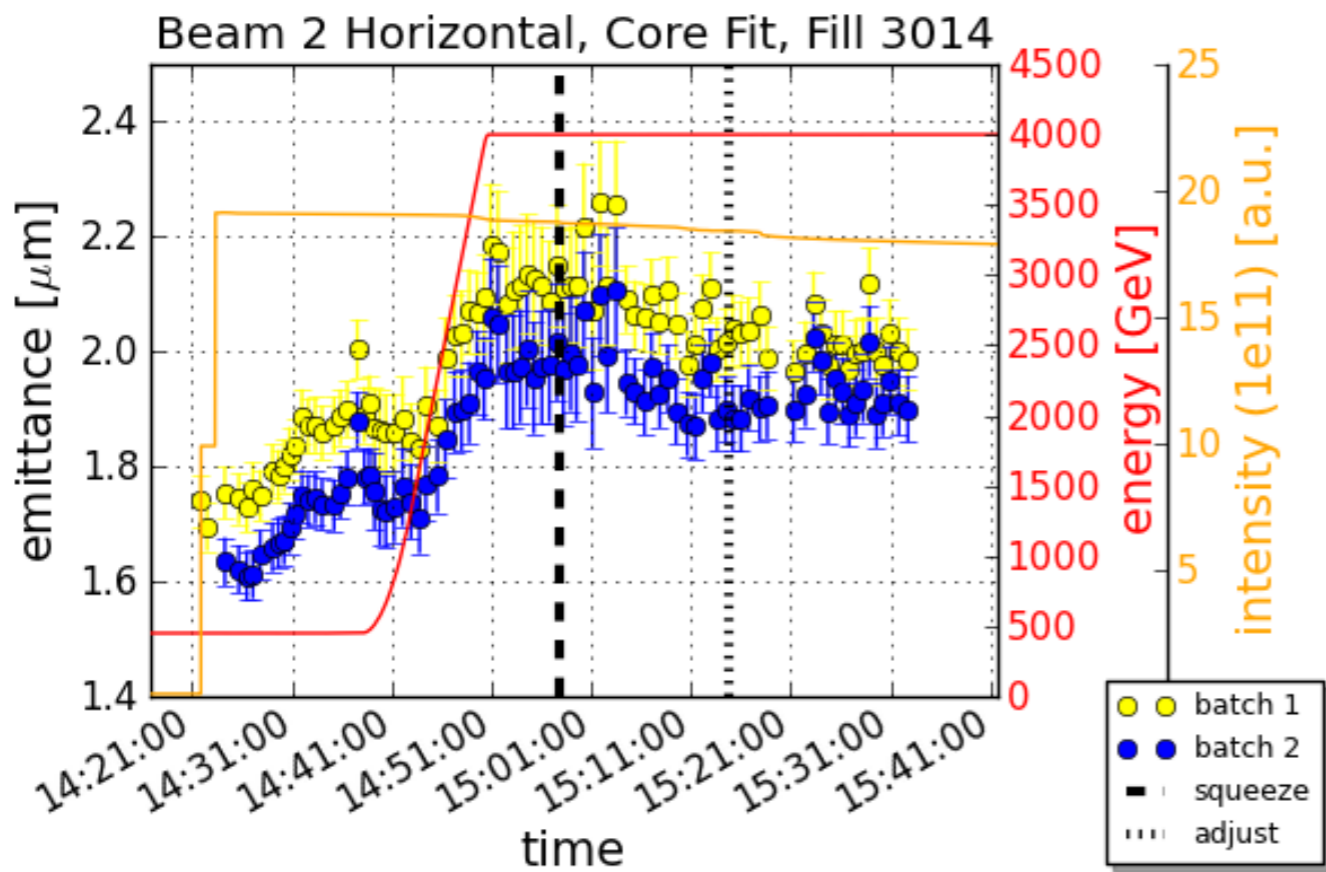
Low gain (long range collisions IP1,5)



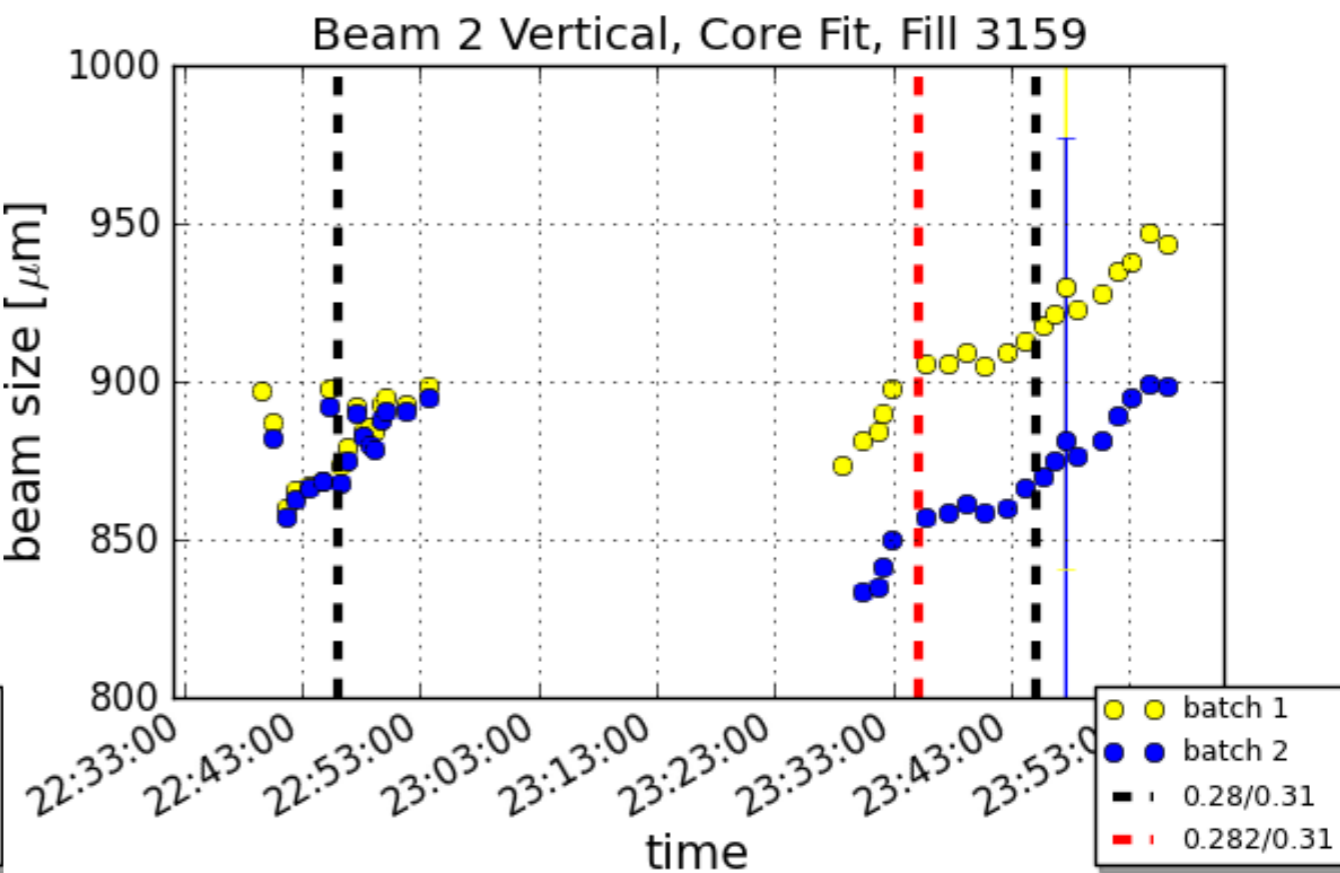
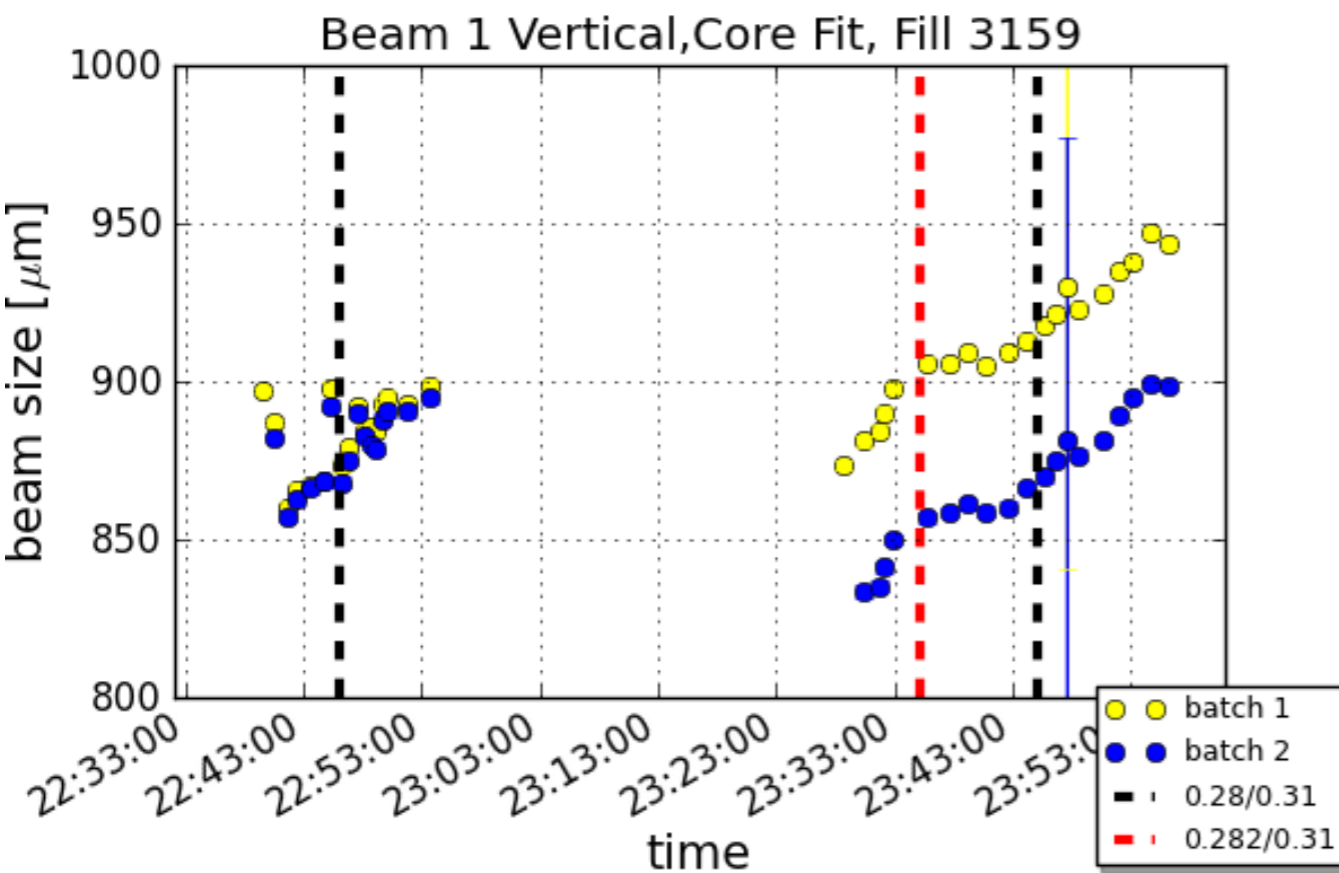
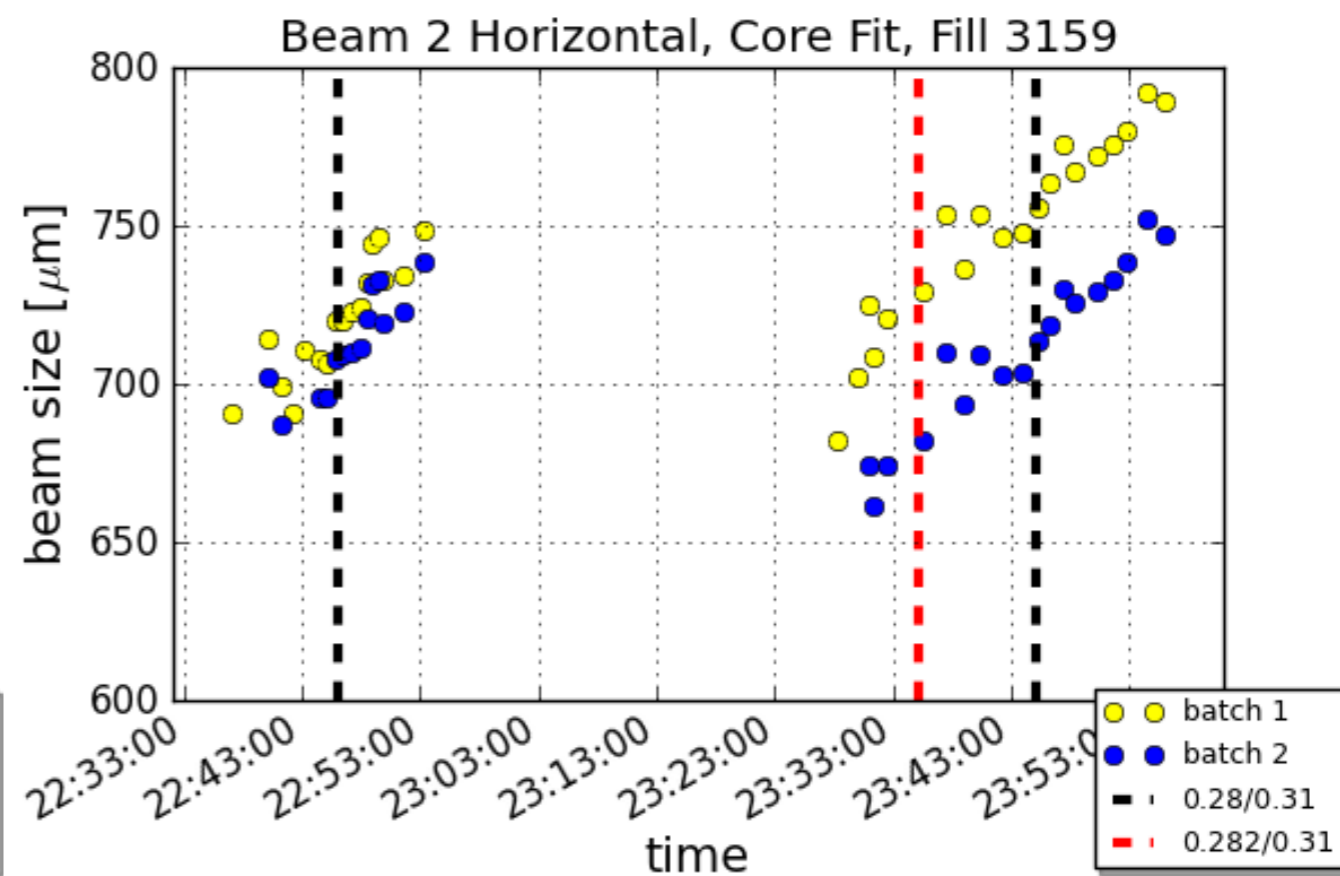
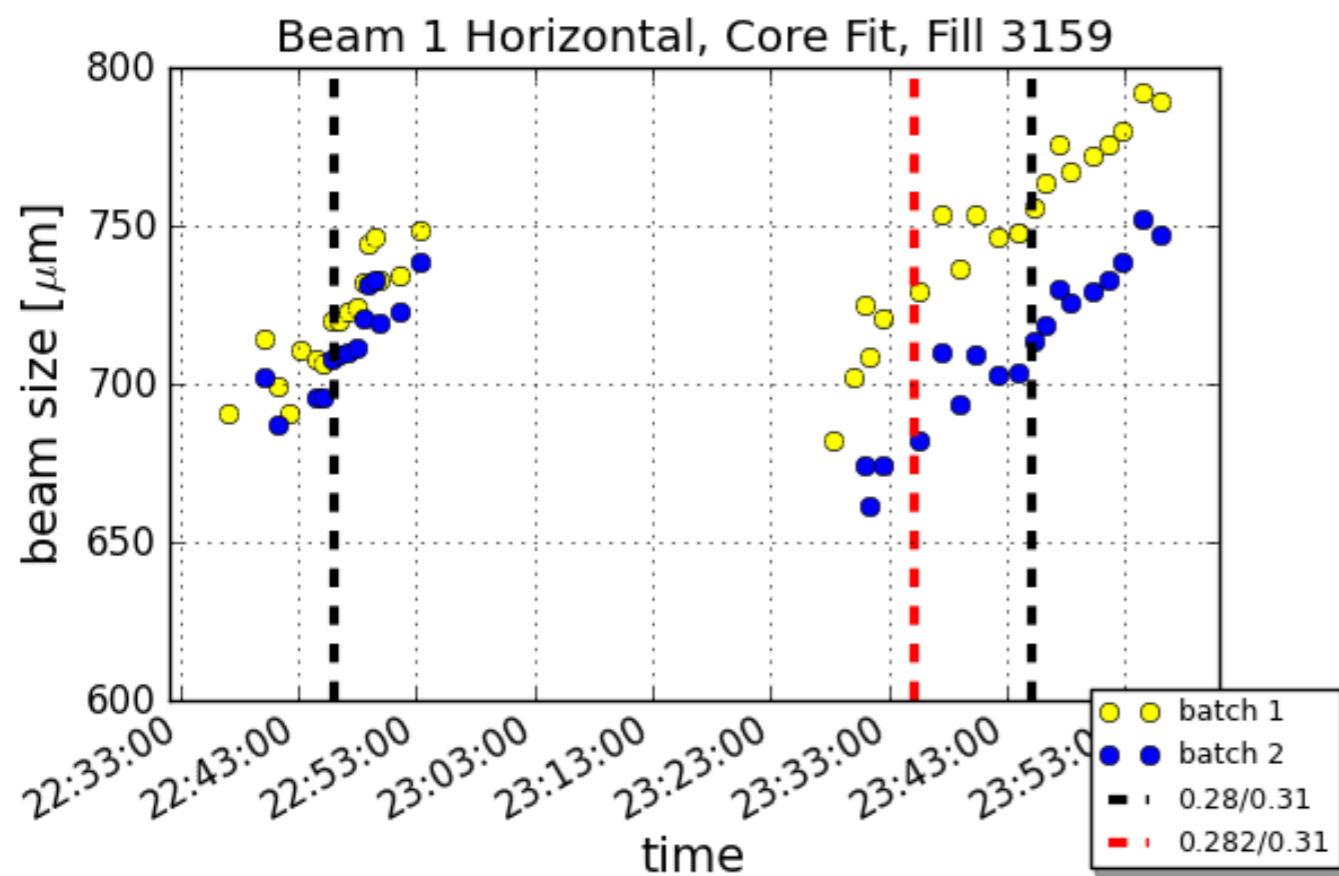
**THANKS TO EXPERIMENTS FOR
SMOG DATA AND BUNCH-BY-BUNCH
LUMINOUS REGION. VERY EFFICIENT
COLLABORATION.**

BACK-UP

- o From previous measurements: puzzling effects
 - Vertical plane growing at injection
 - Emittance shrinkage during the ramp
 - Emittance from luminosity larger than from wire scanners

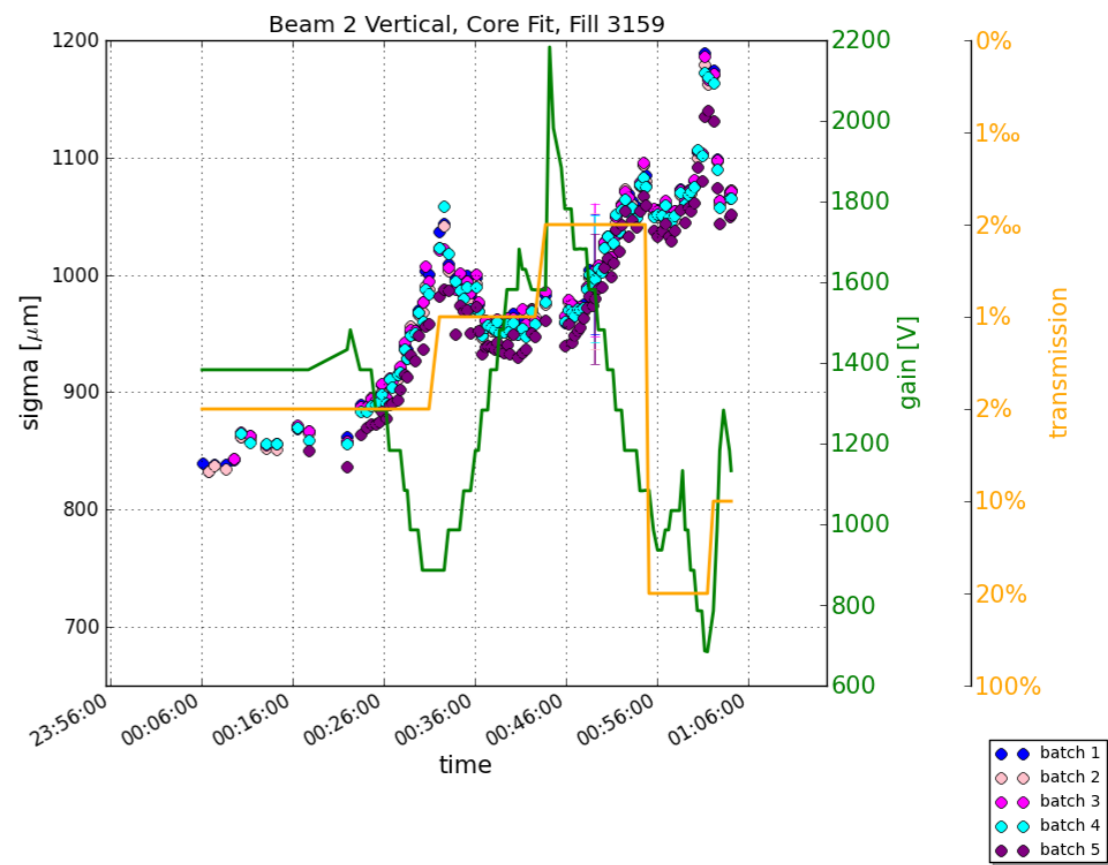
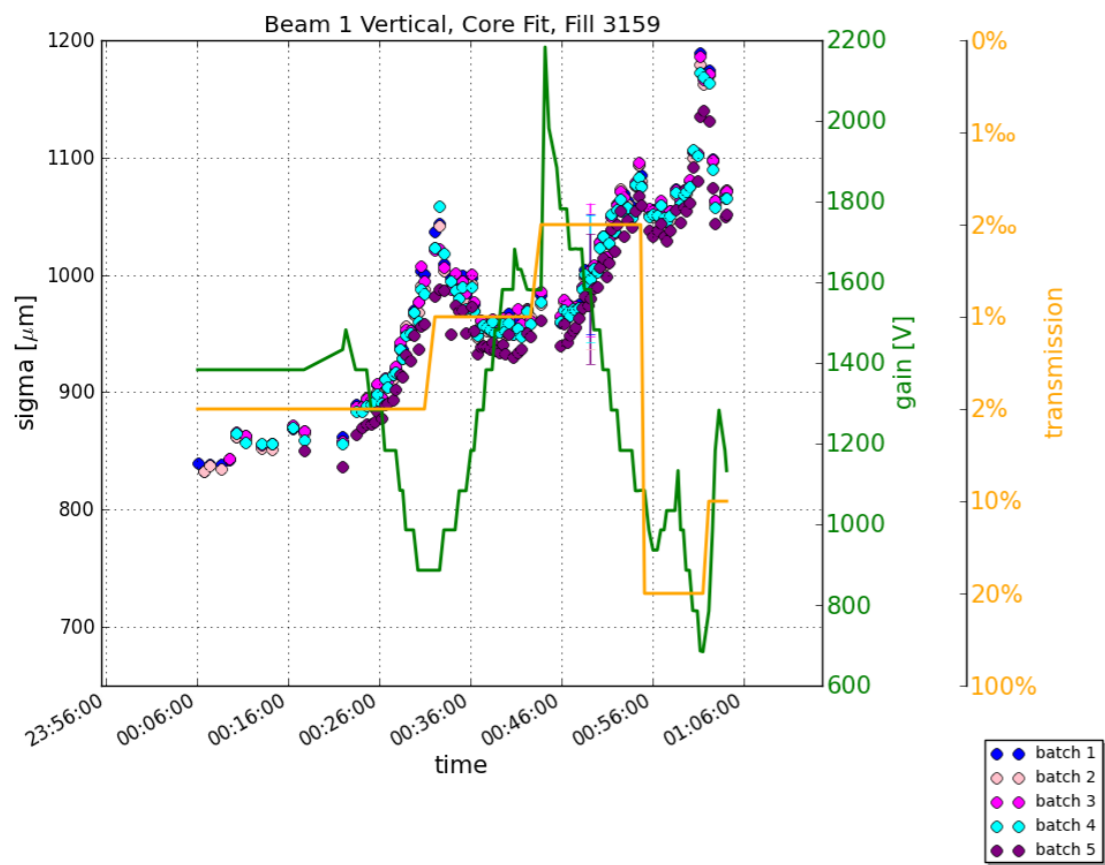
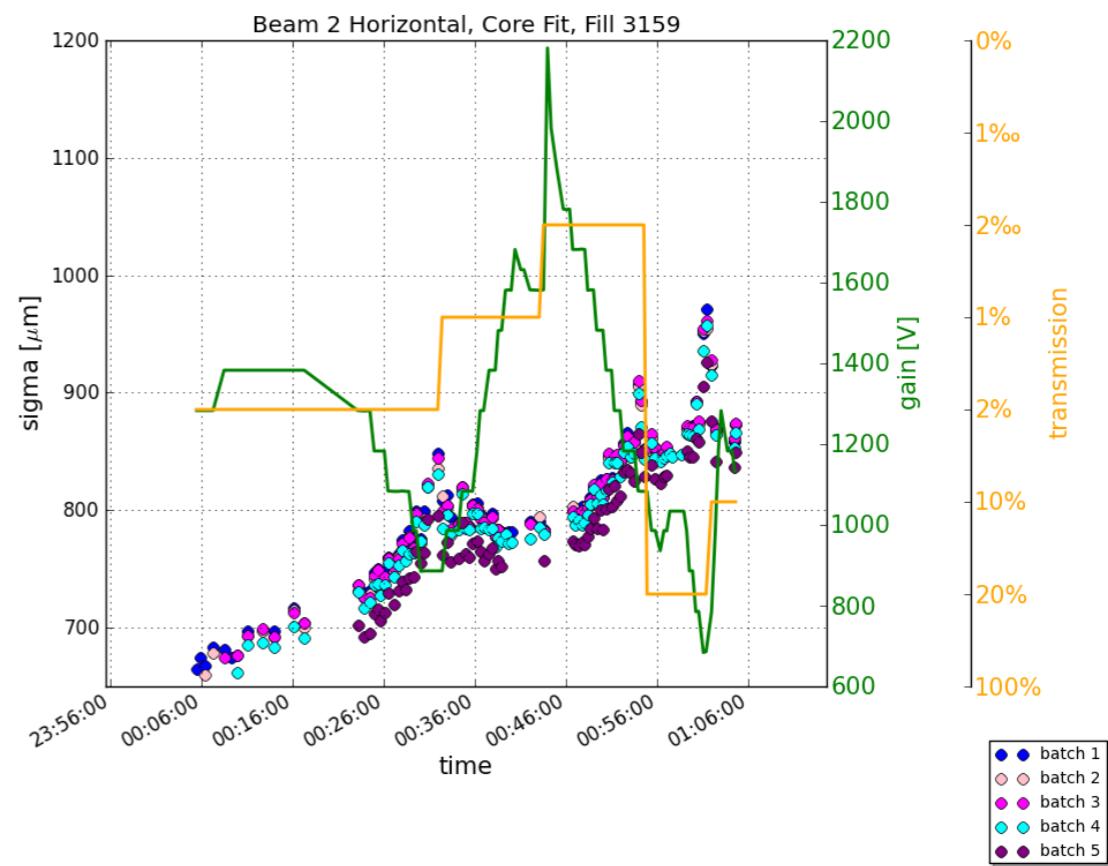
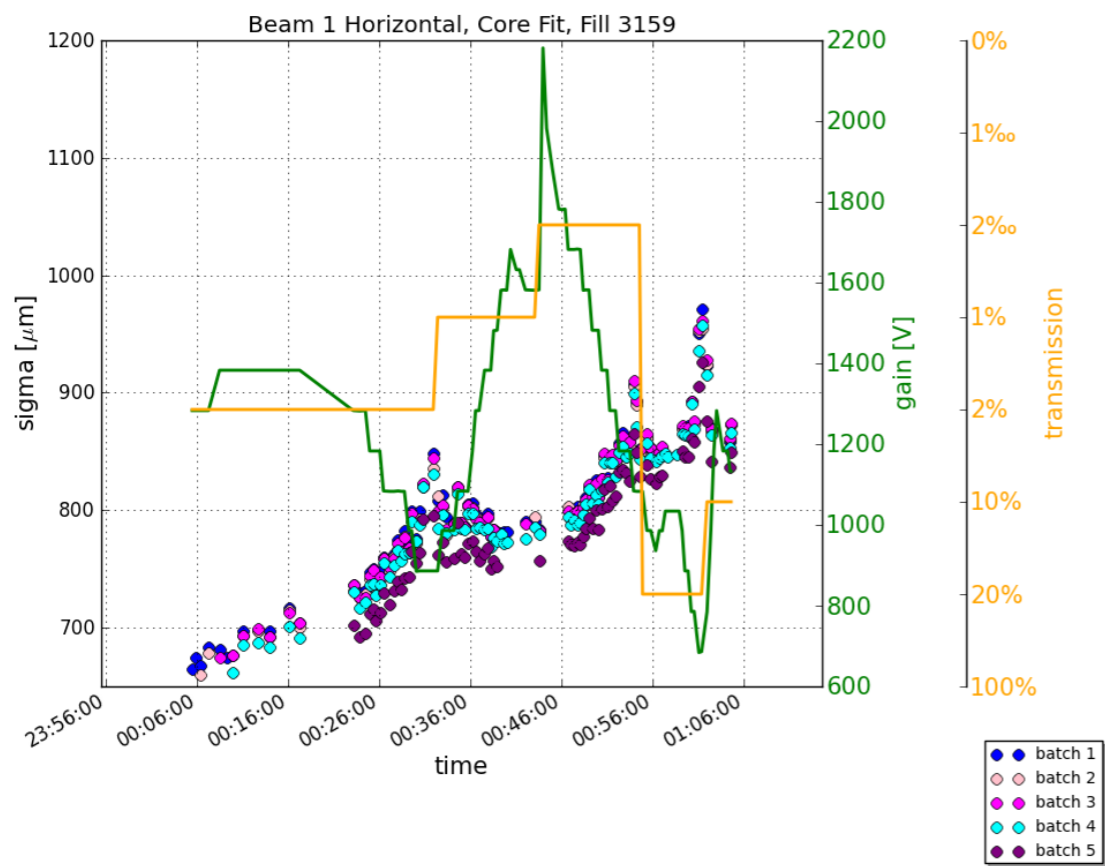
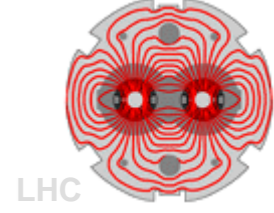


- o Already checked:
 - Wire scanner calibration
 - Collimator setting
 - Optics at injection, flattop and squeeze (so far linear interpolation for the ramp)

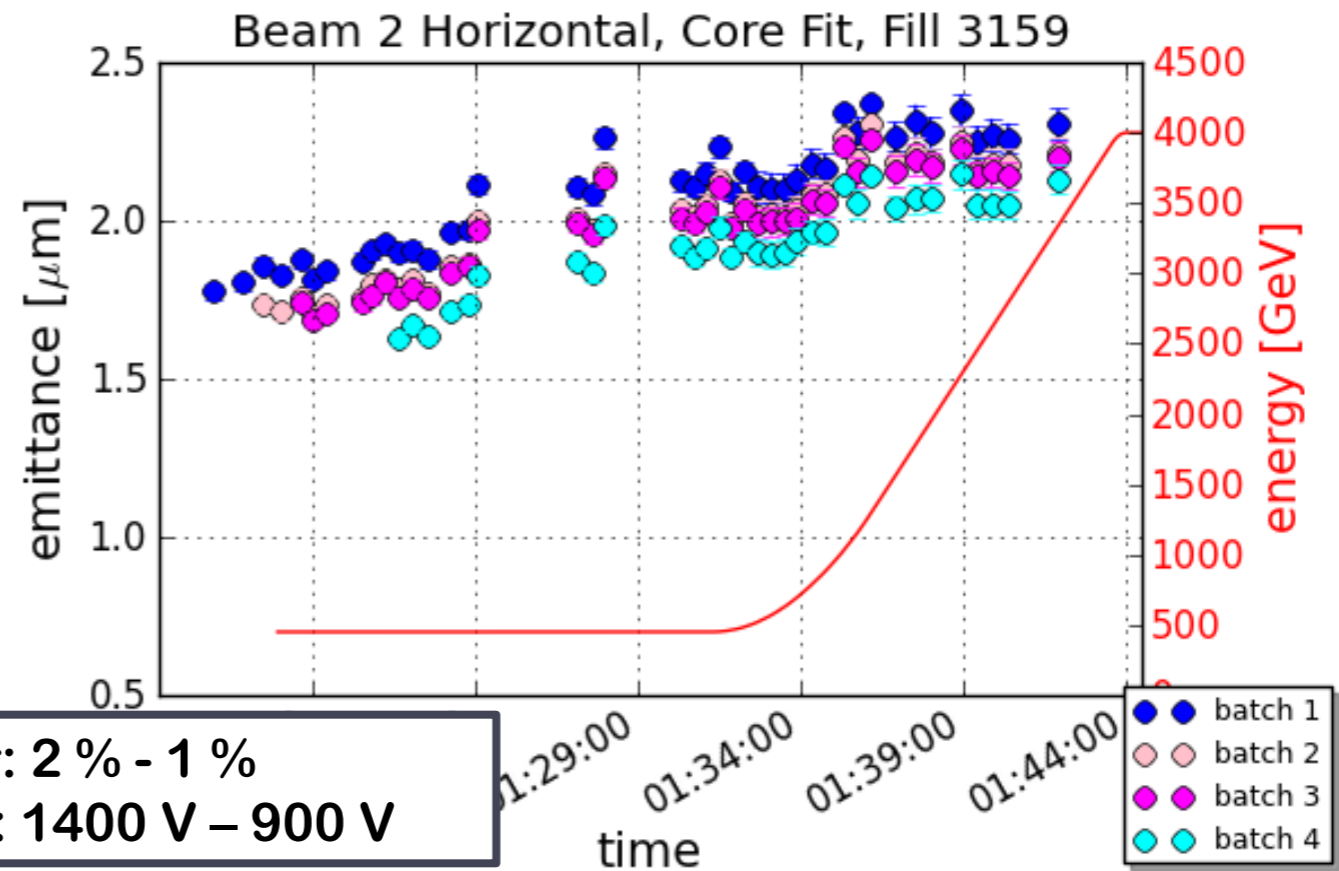
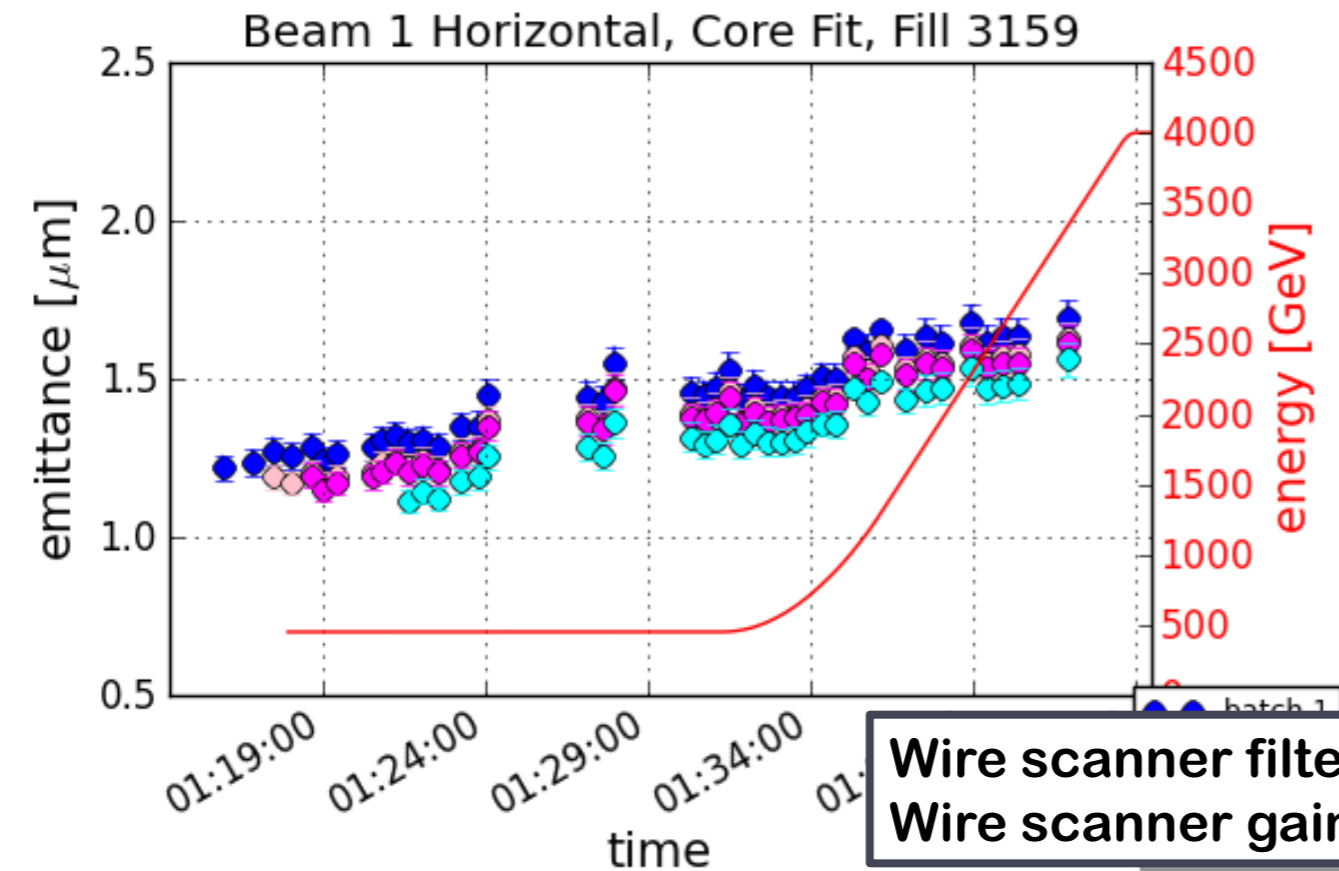




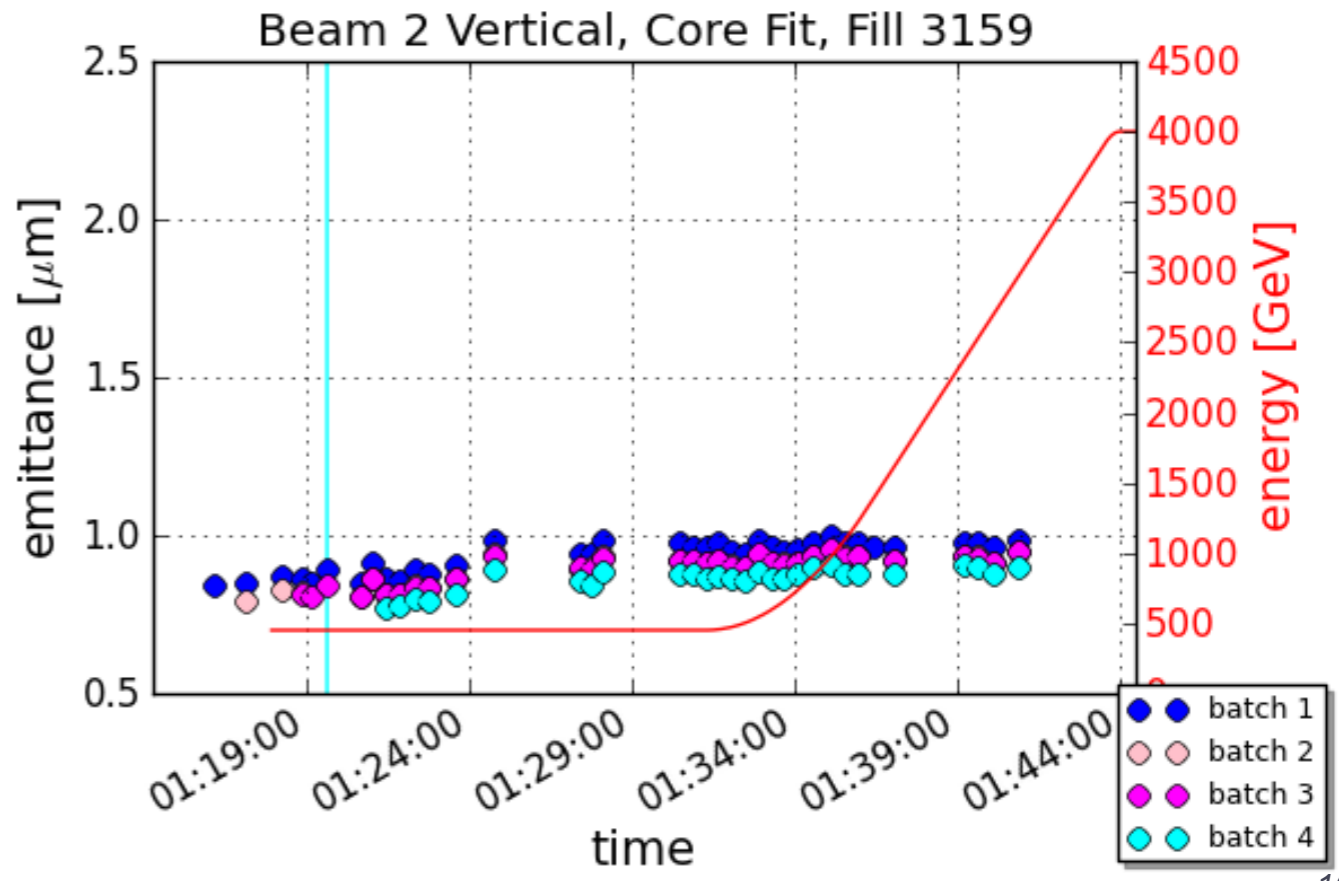
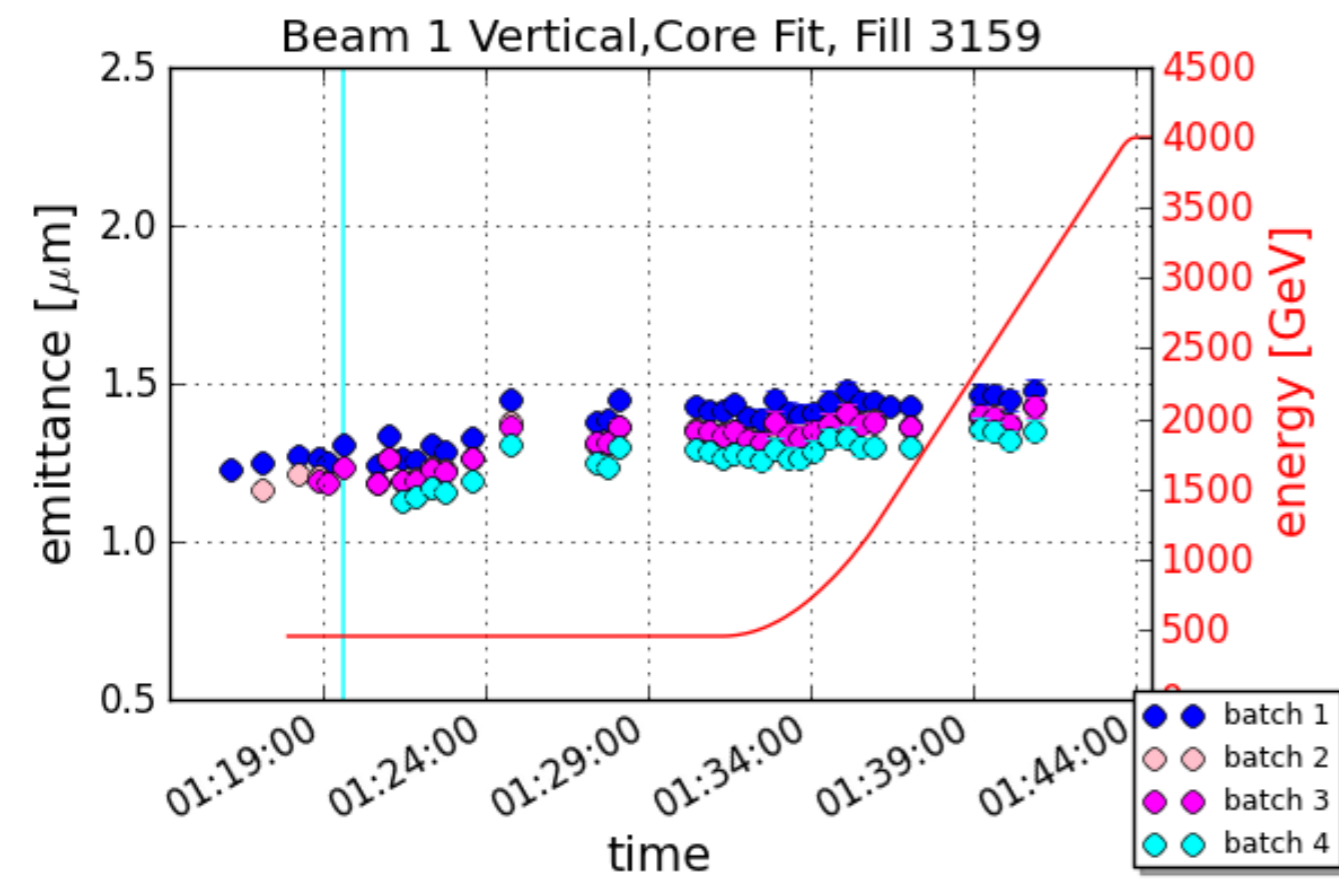
PM Saturation at 450 GeV – All Planes



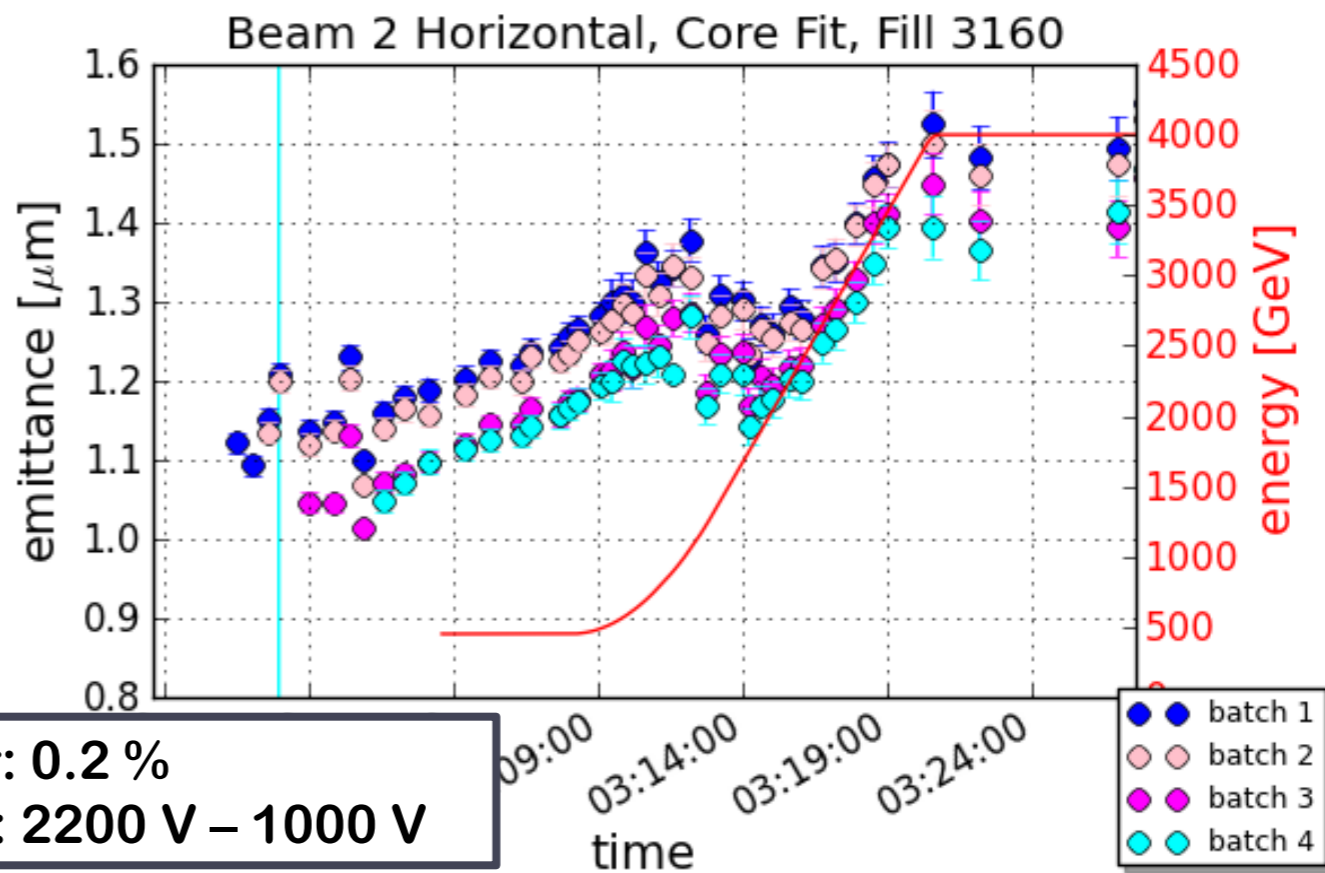
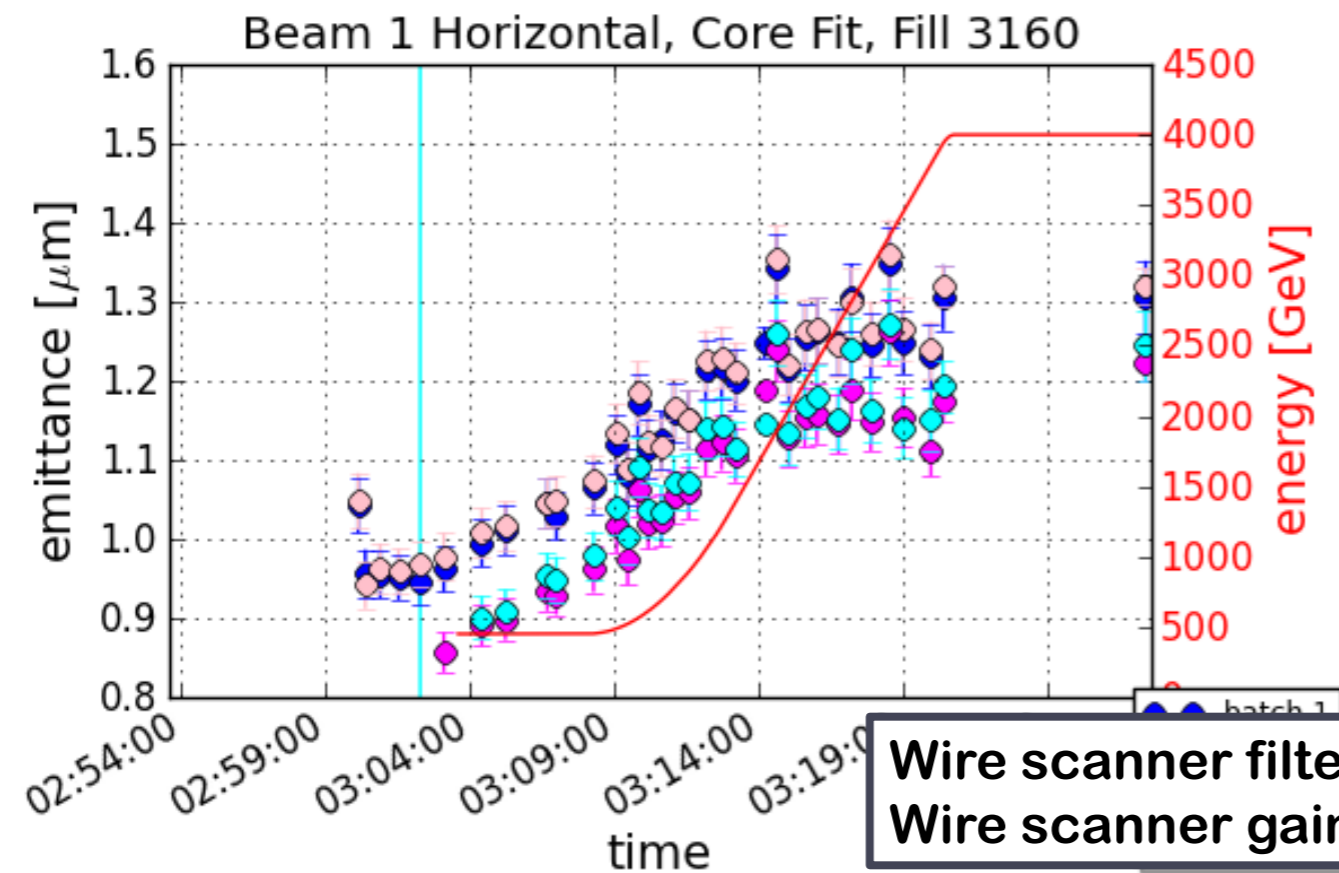
First Ramp – All Planes



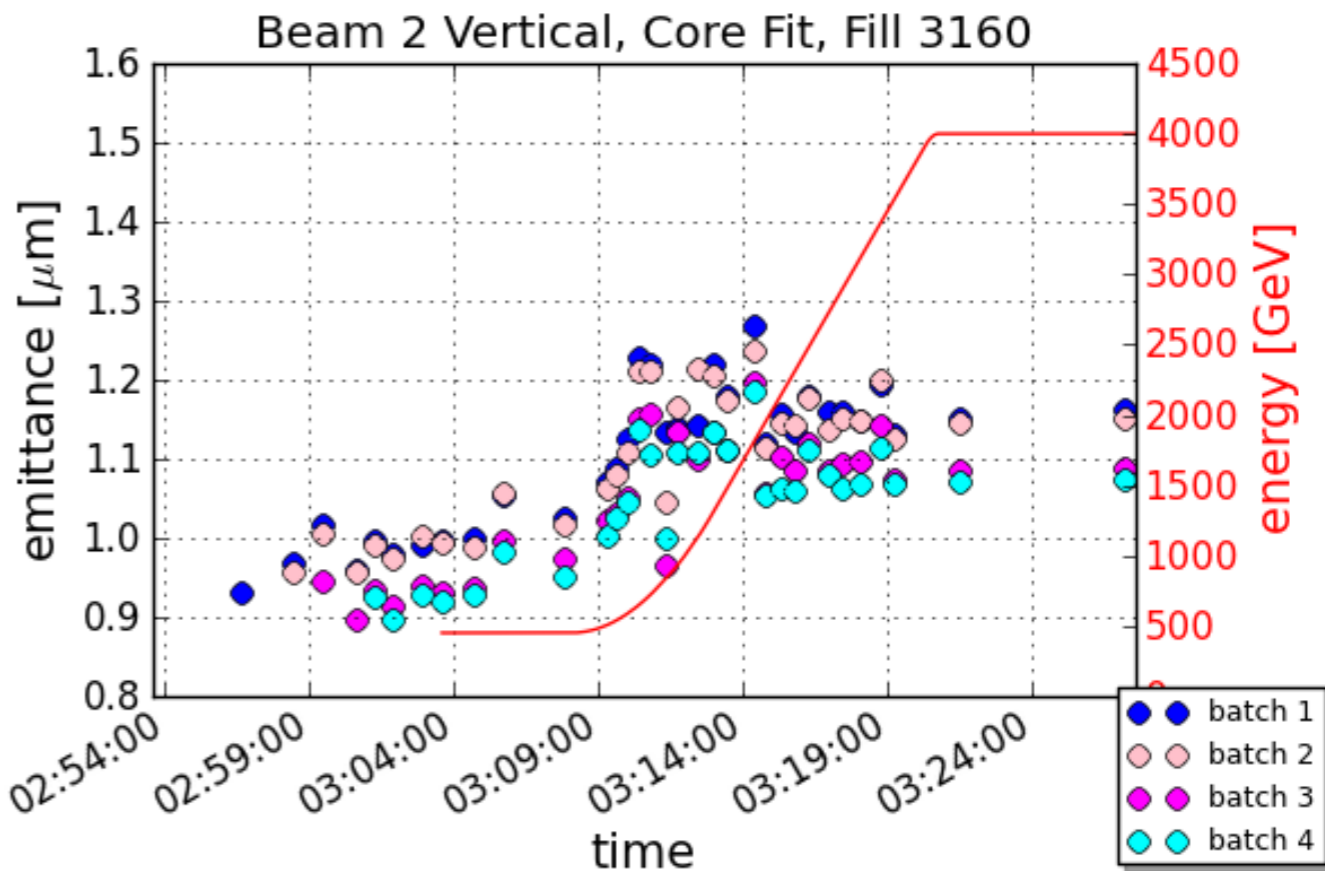
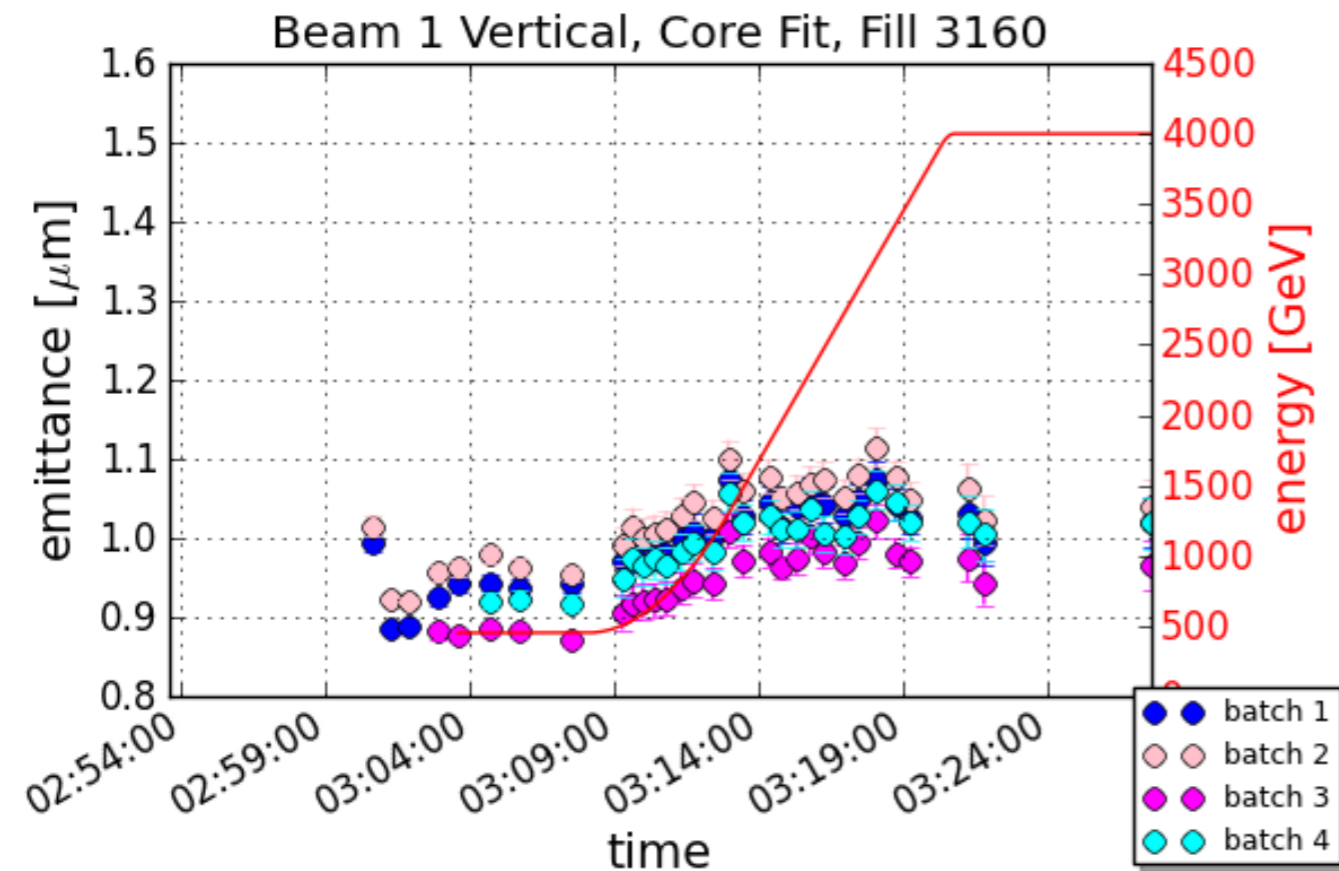
Wire scanner filter: 2 % - 1 %
Wire scanner gain: 1400 V – 900 V



Second Ramp – All Planes

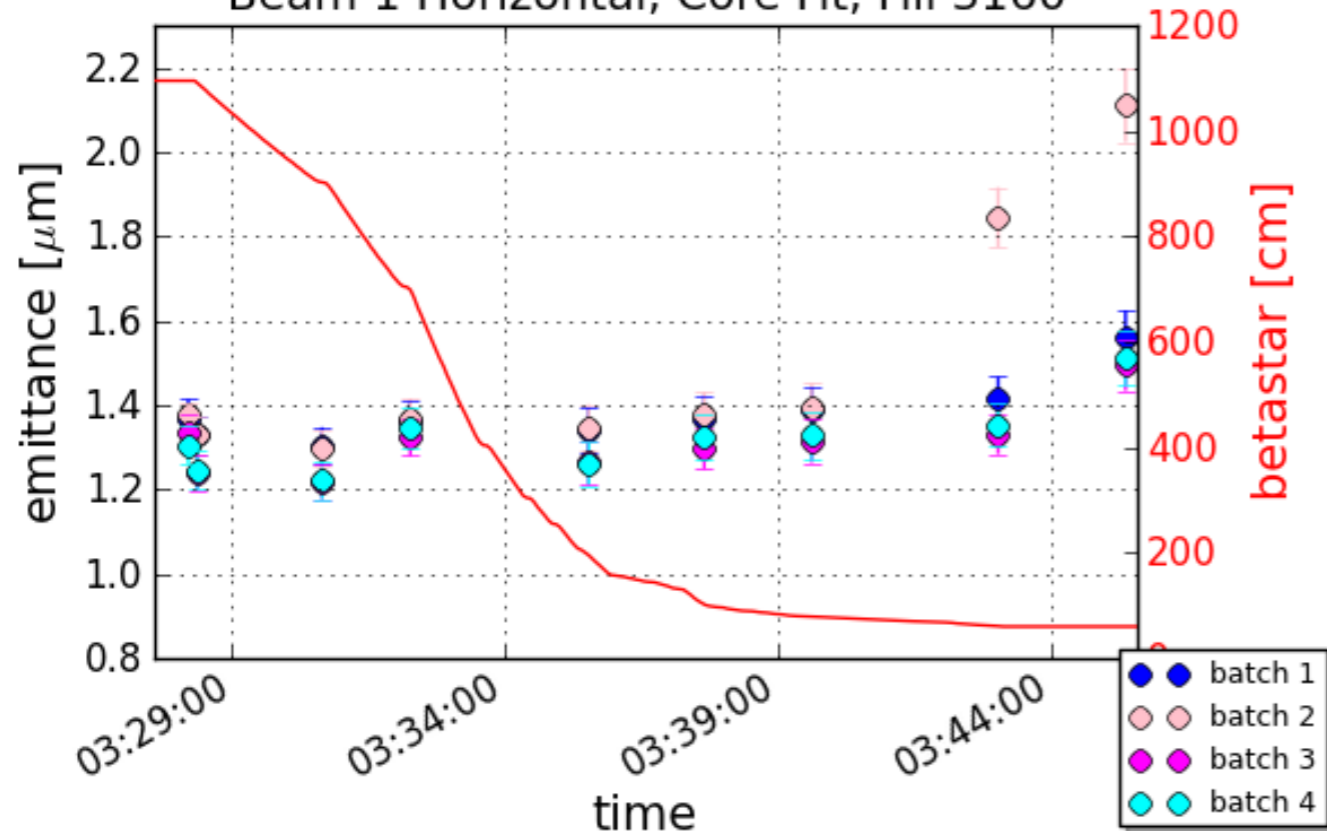


Wire scanner filter: 0.2 %
Wire scanner gain: 2200 V – 1000 V

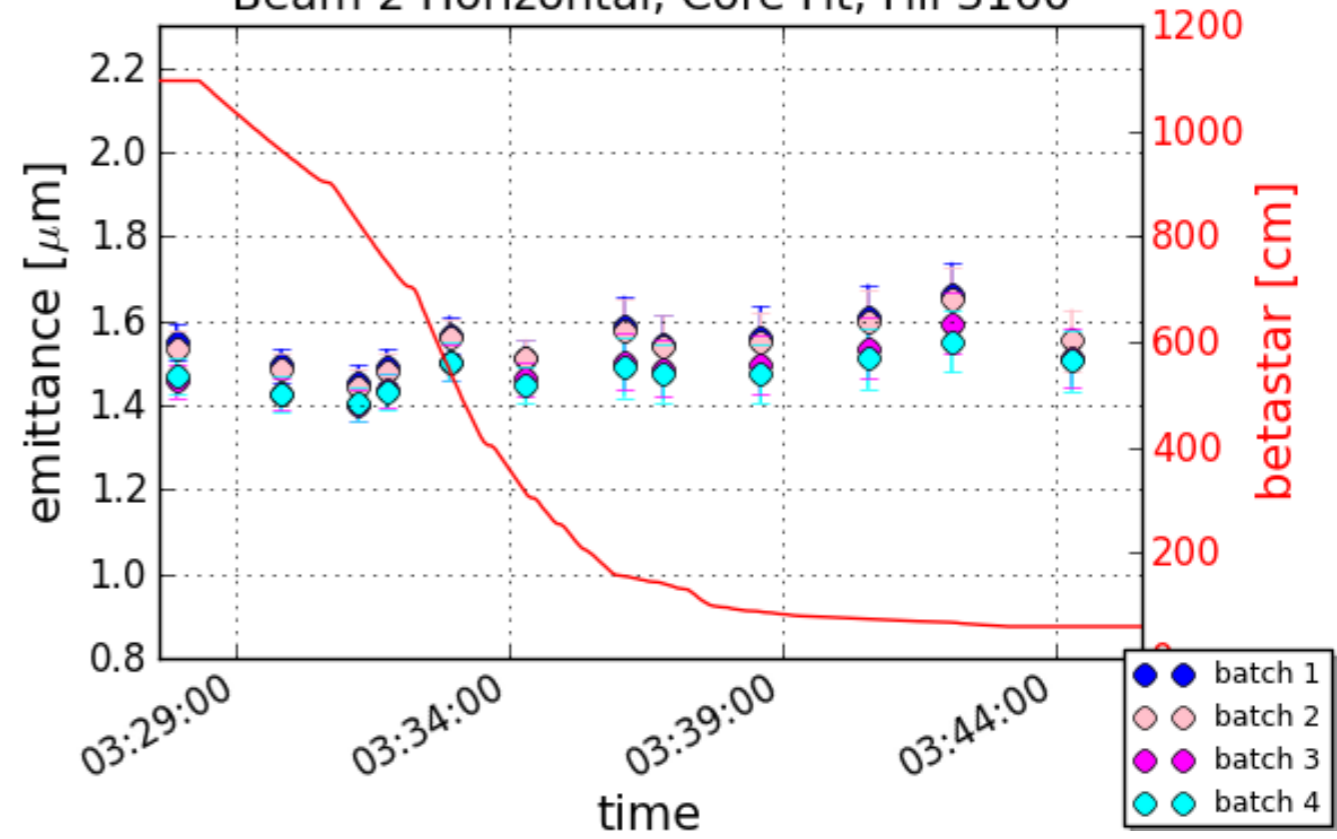


The Squeeze

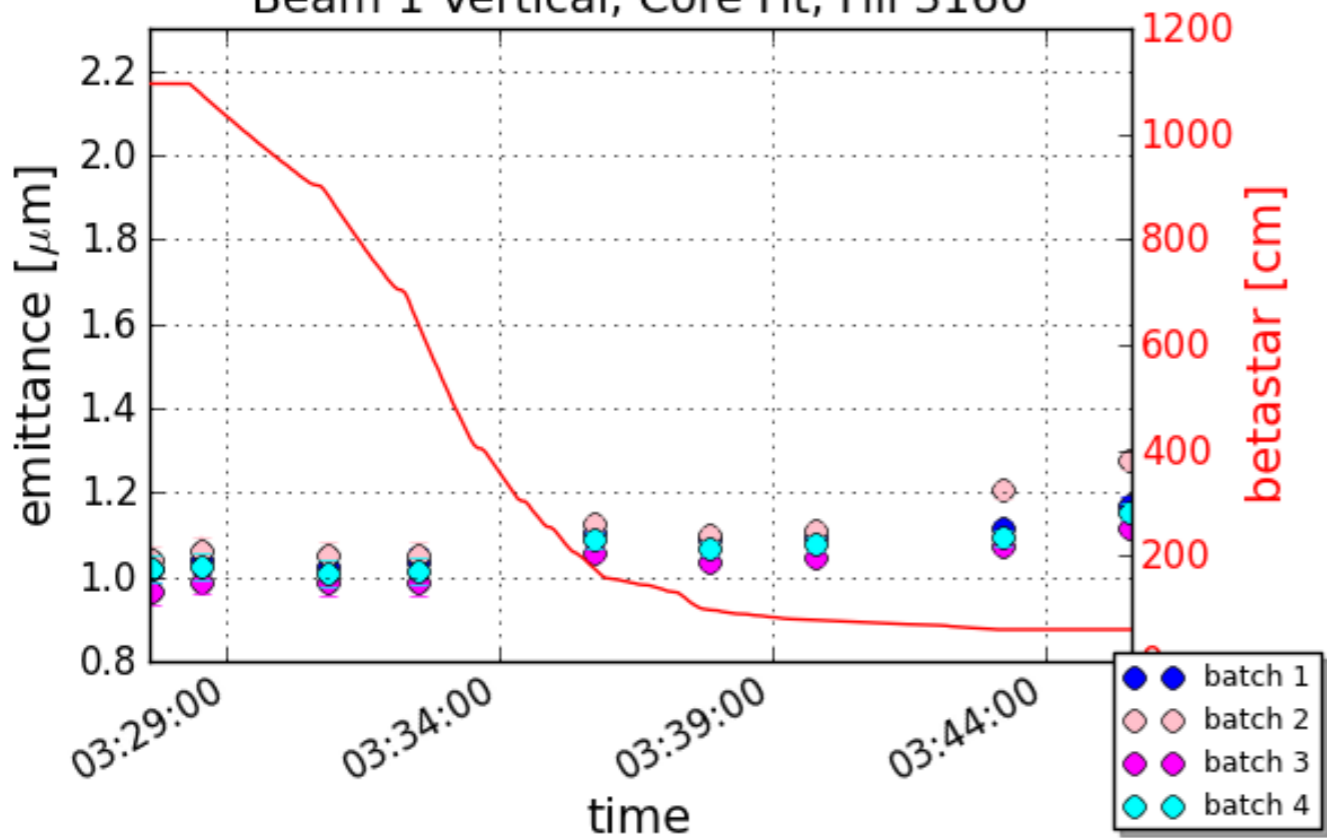
Beam 1 Horizontal, Core Fit, Fill 3160



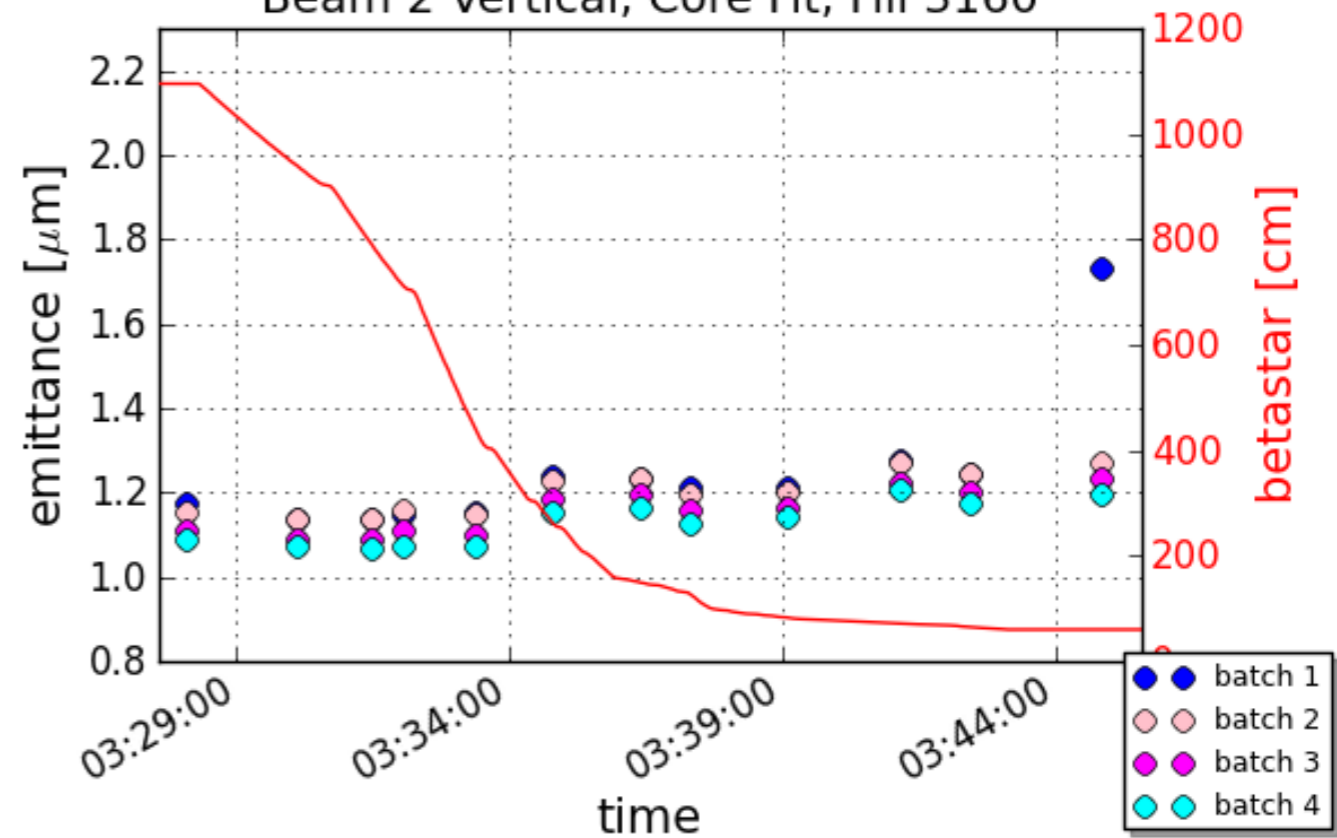
Beam 2 Horizontal, Core Fit, Fill 3160



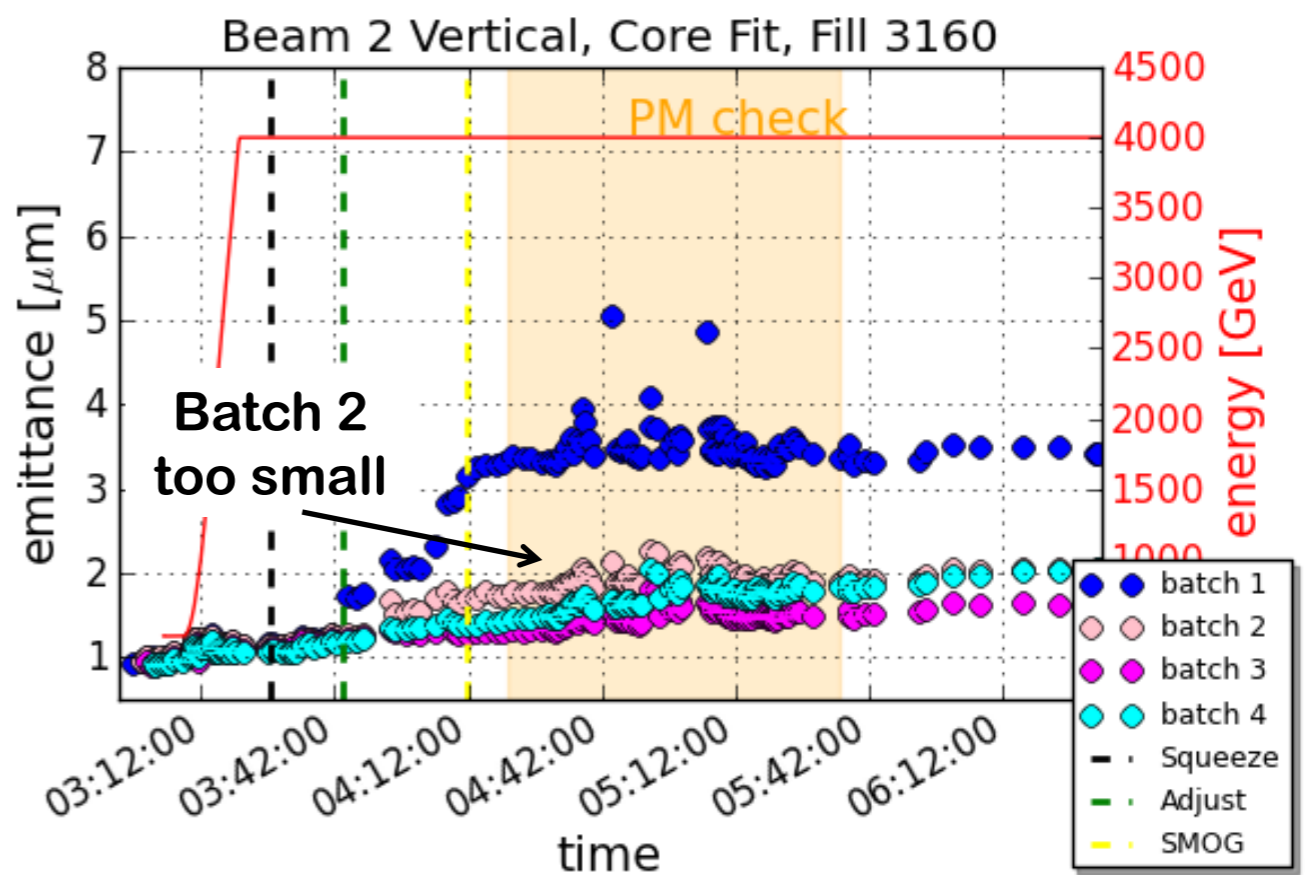
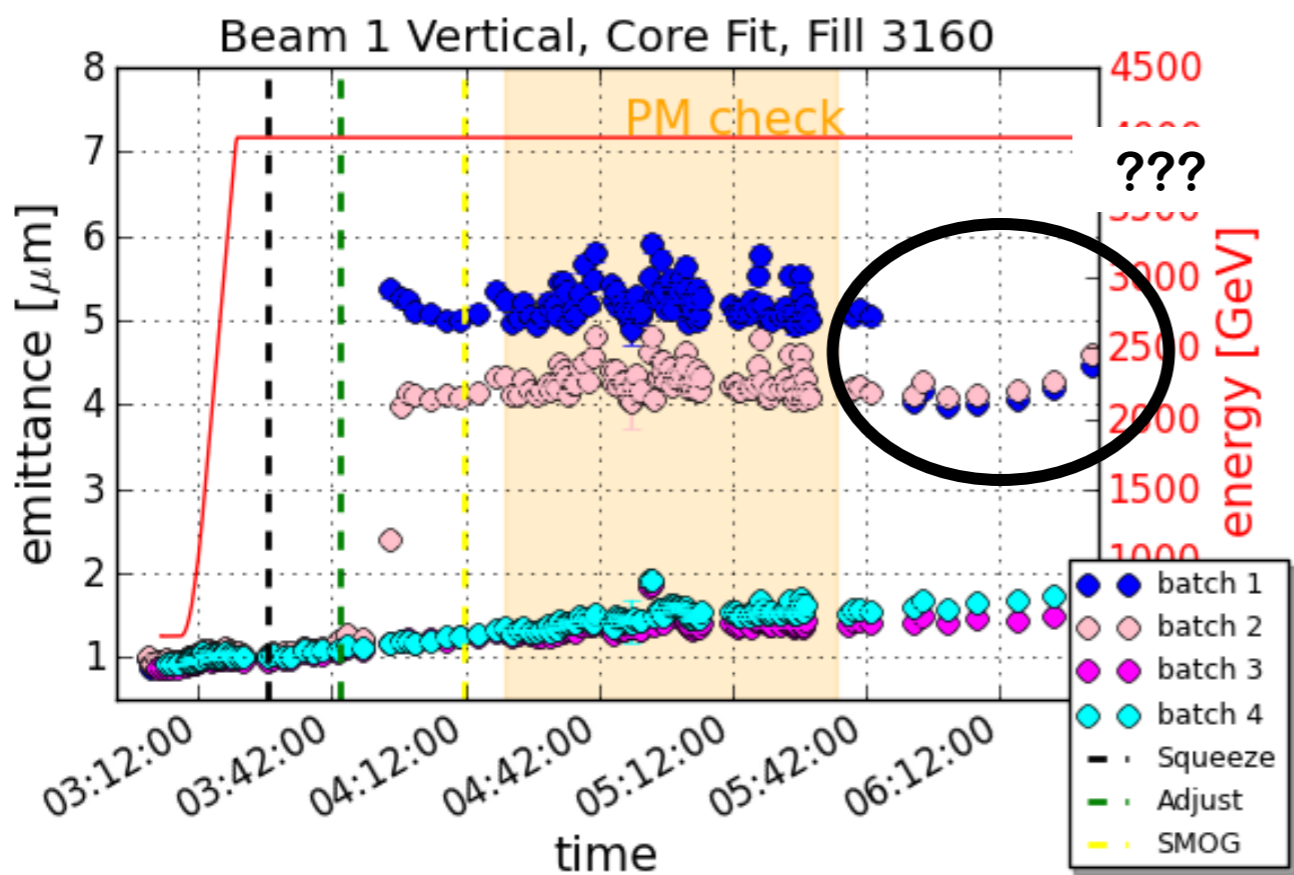
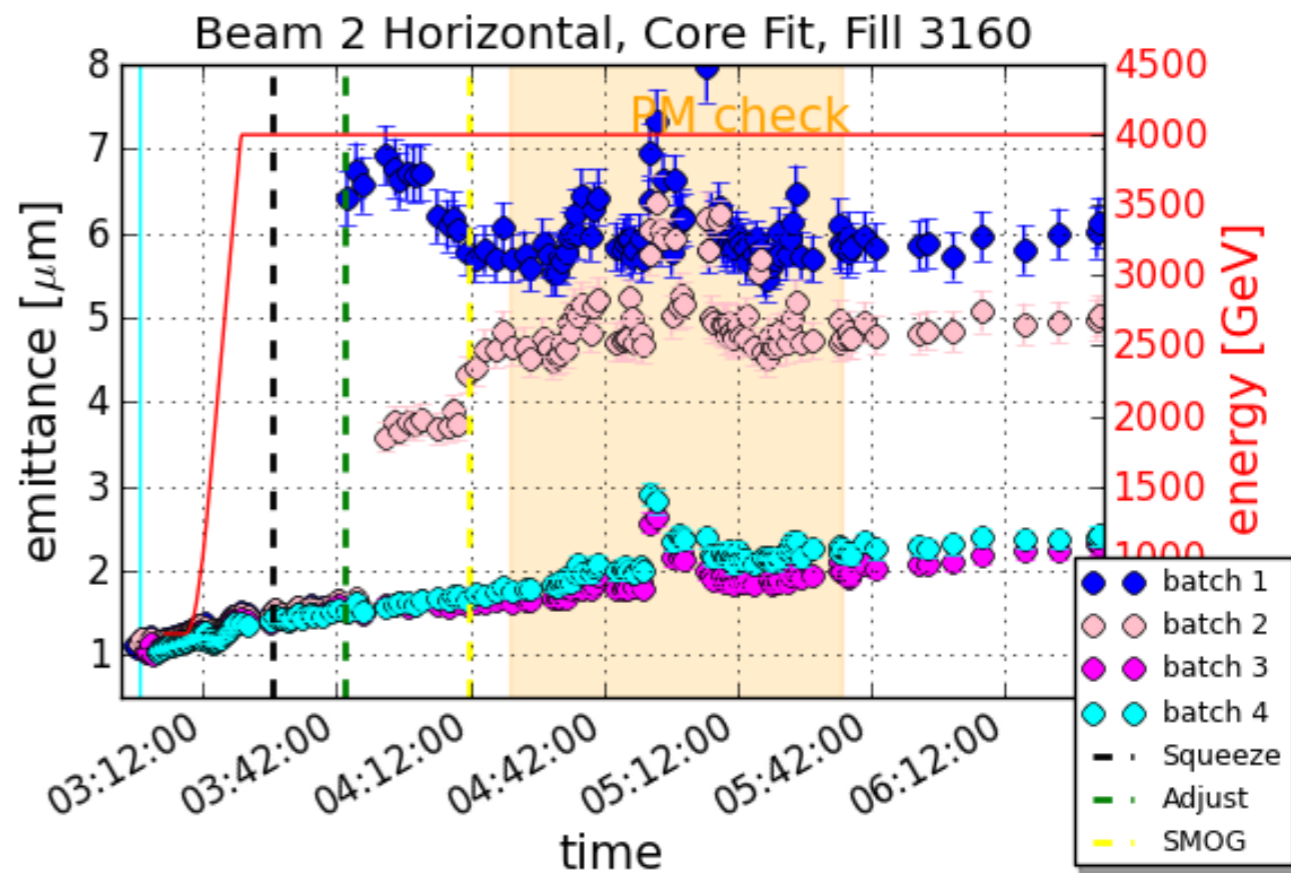
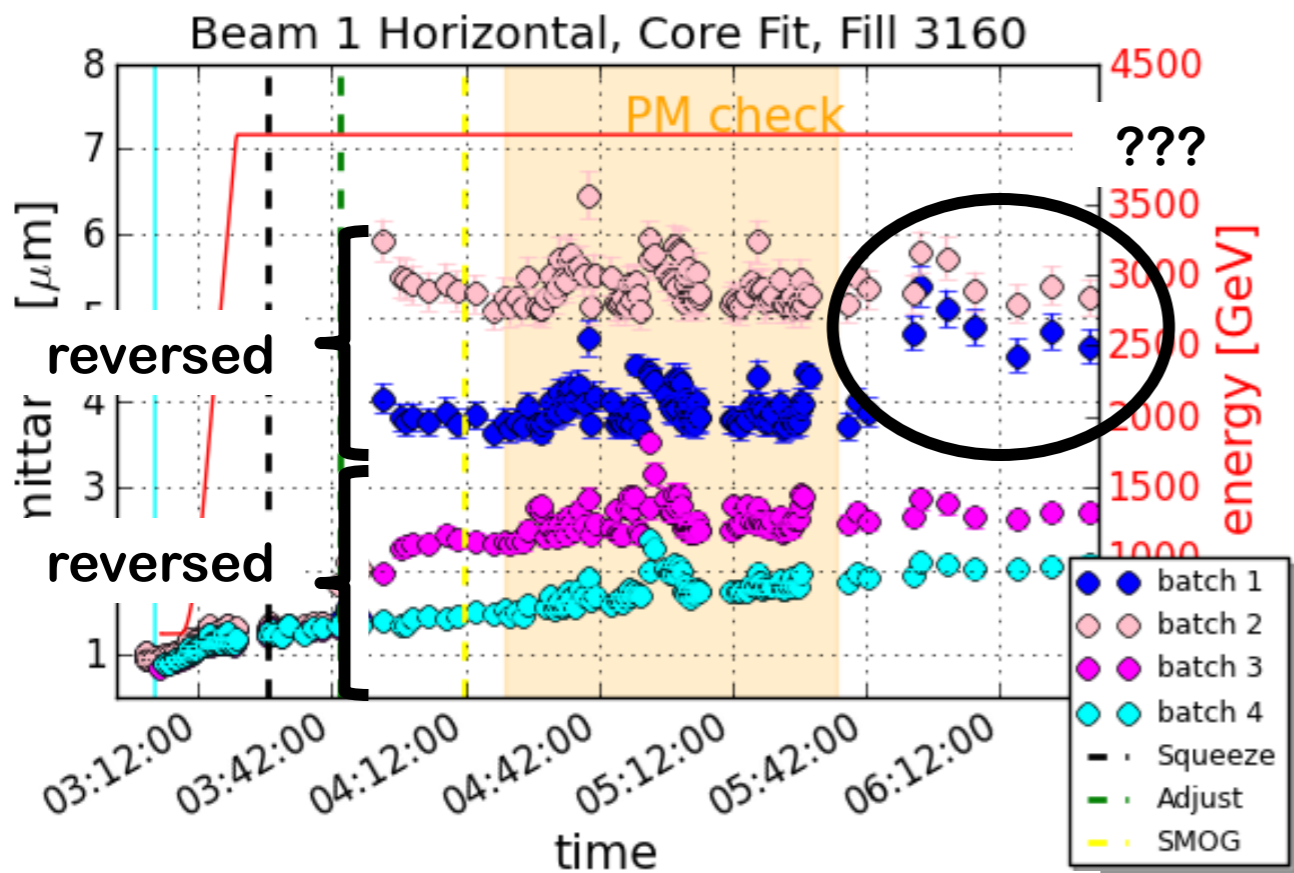
Beam 1 Vertical, Core Fit, Fill 3160



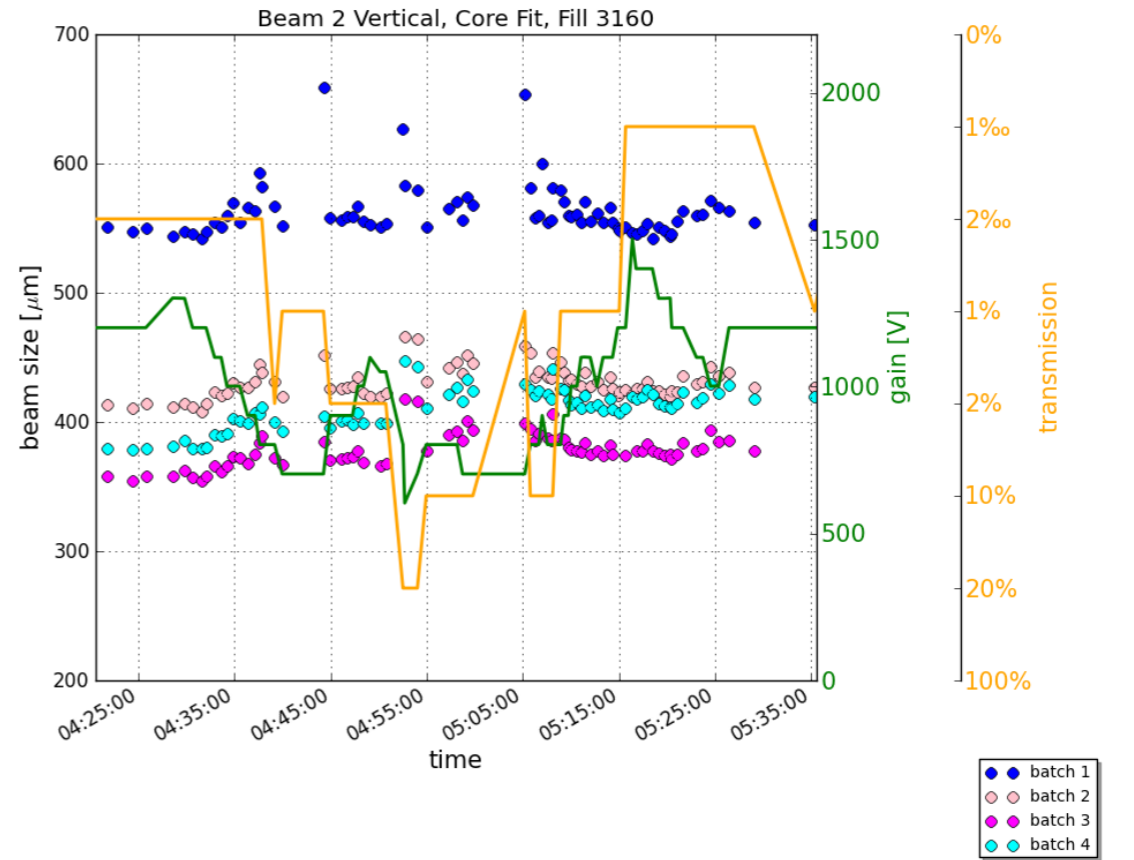
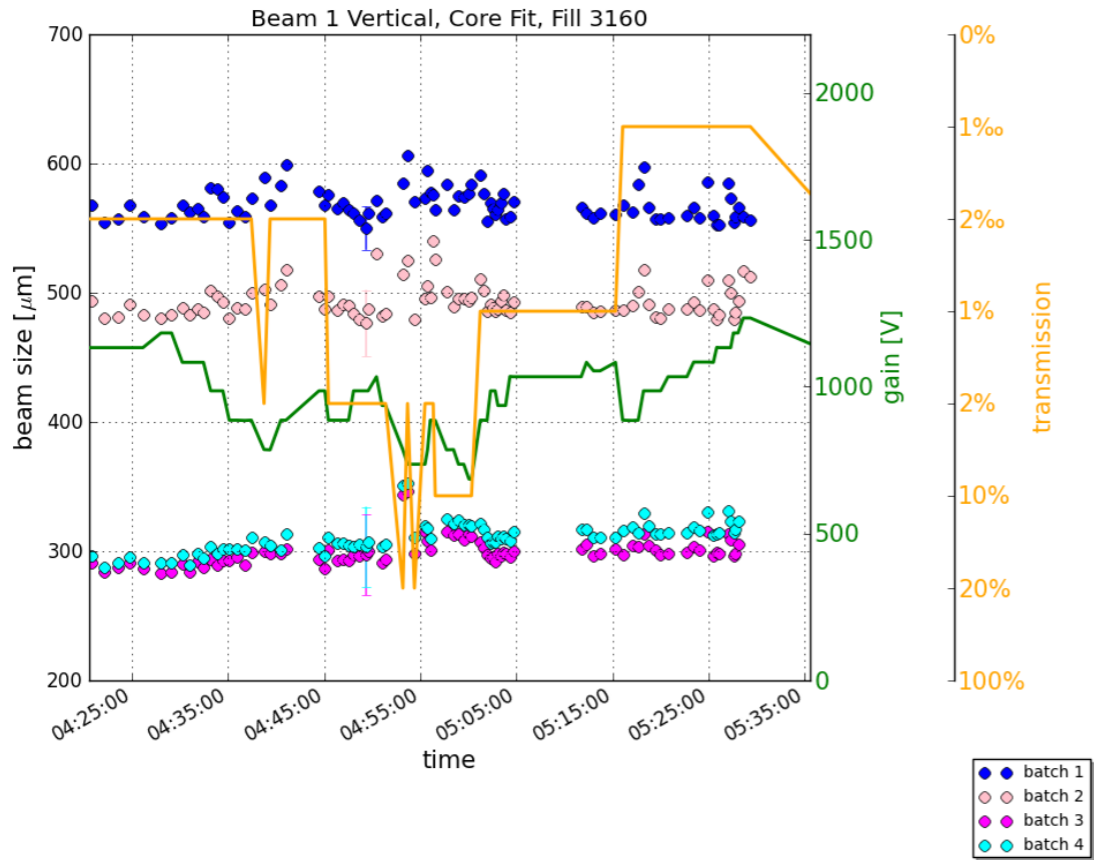
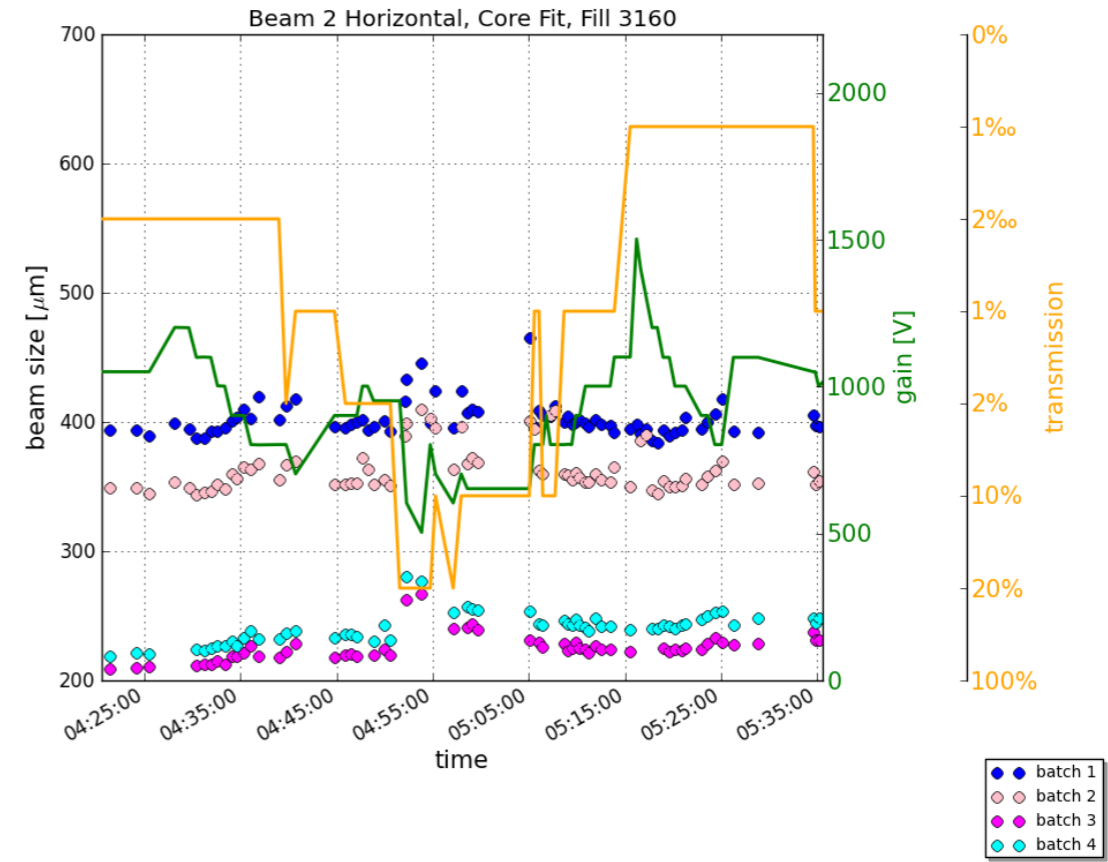
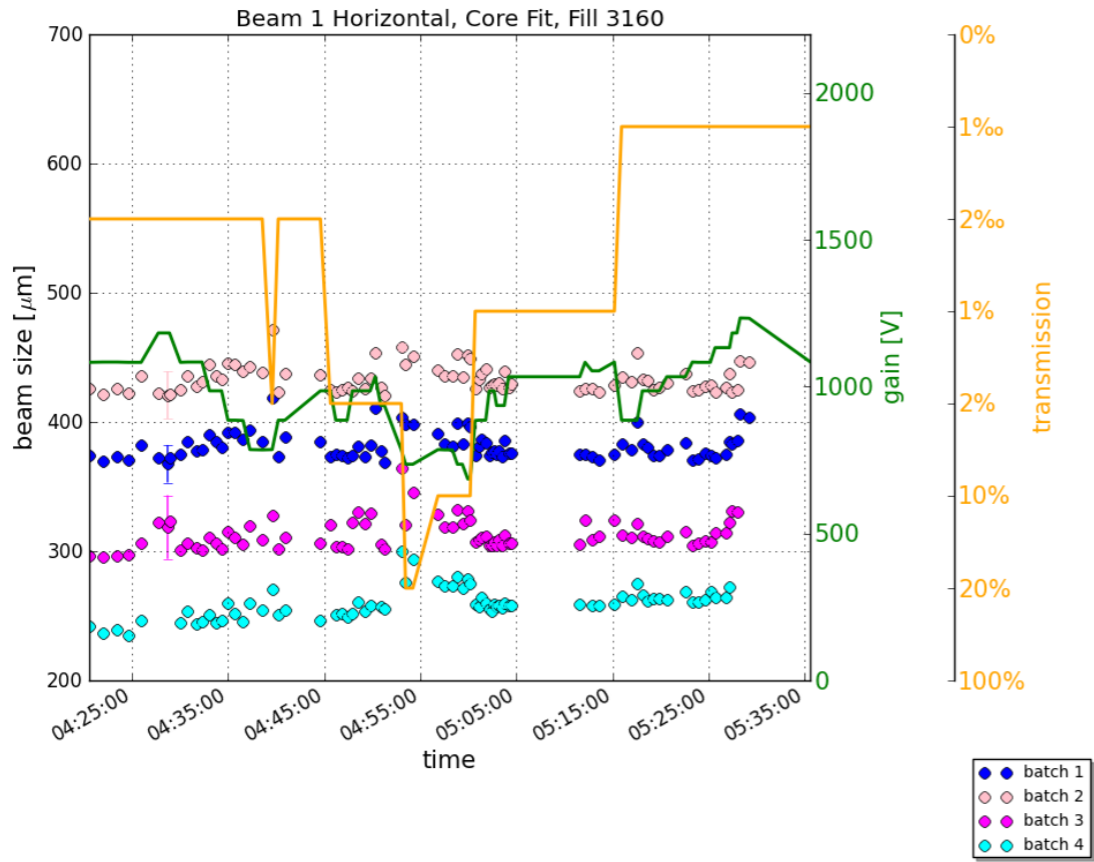
Beam 2 Vertical, Core Fit, Fill 3160



Damper Gain – All Planes



PM Saturation at 4 TeV – All Planes



Test Cycle with 12 Bunches

25.10.2012

- o Fill 3217
- o 2 x 6 nominal 50 ns bunches
- o Measured with wire scanners through the whole cycle
 - With 0.2 % transmission, only gain change (same settings as for fill 3160)

