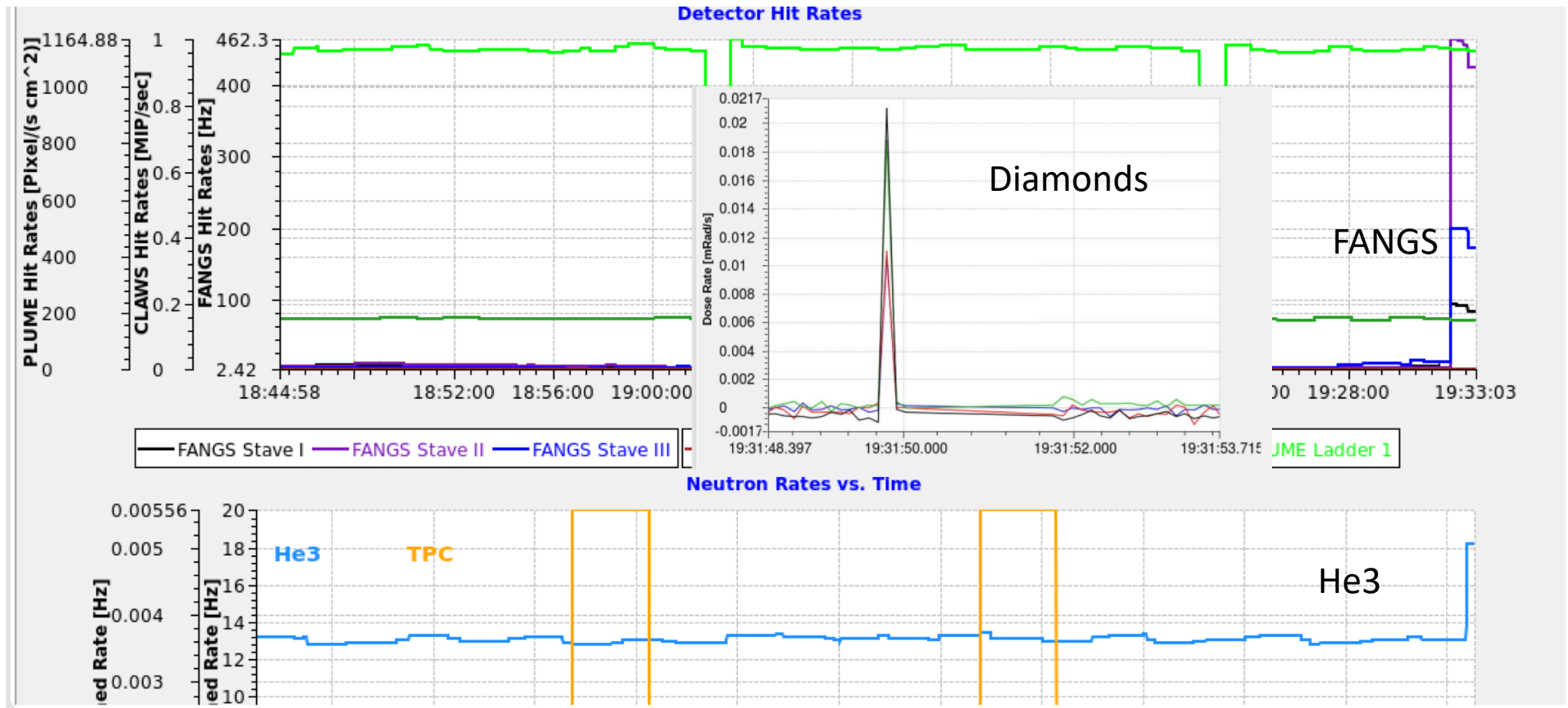




# Machine Commissioning

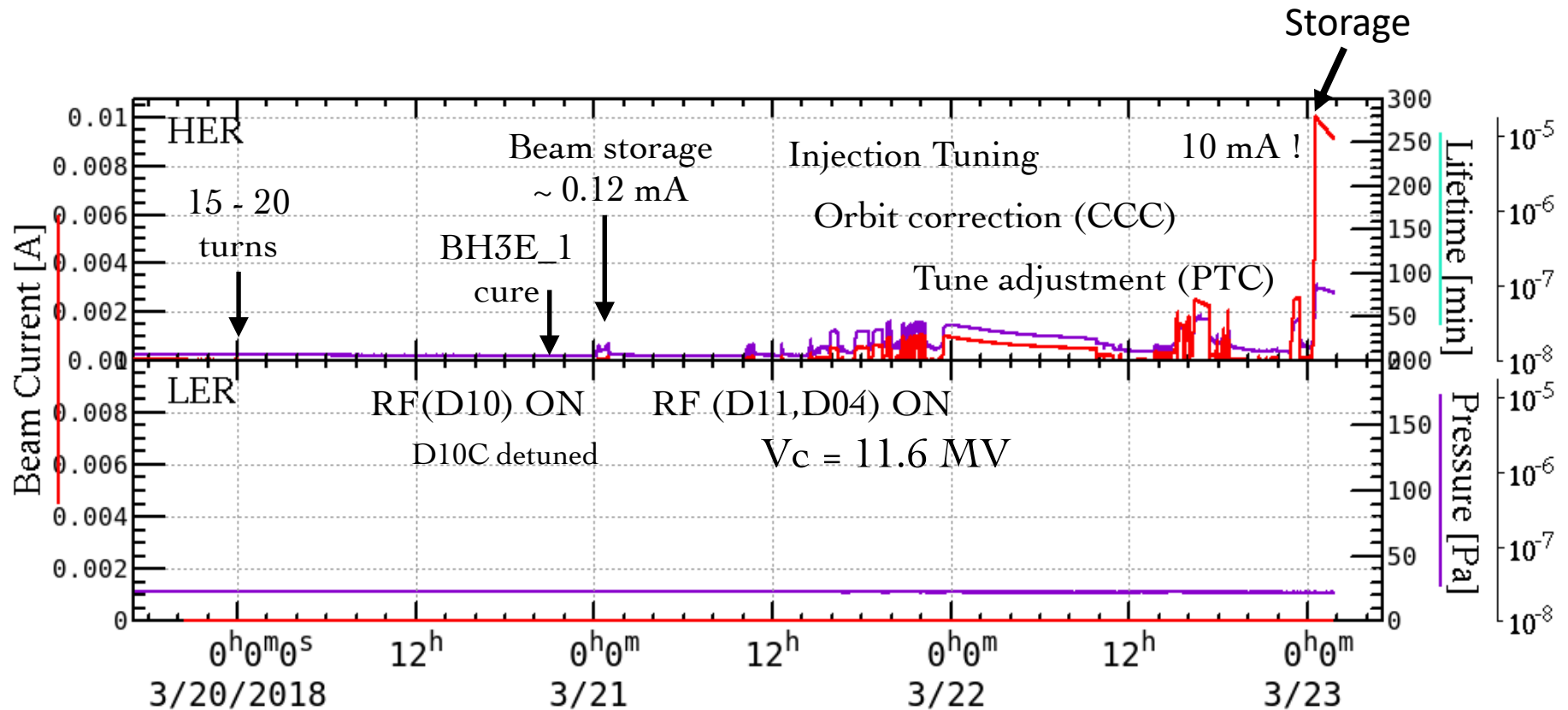
# Phase 2 Start

19<sup>th</sup> March 2018 at 19h31 → First electron injection into HER detected by BEAST



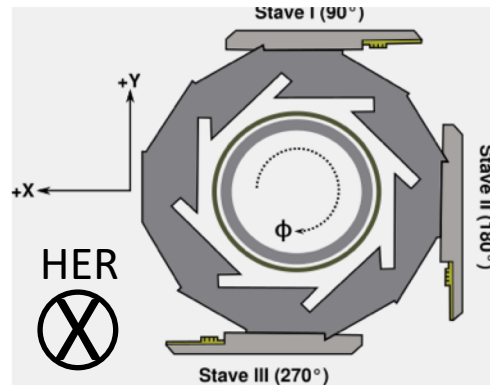
CLAWS, PLUME, TPCs followed shortly after

# HER Commissioning

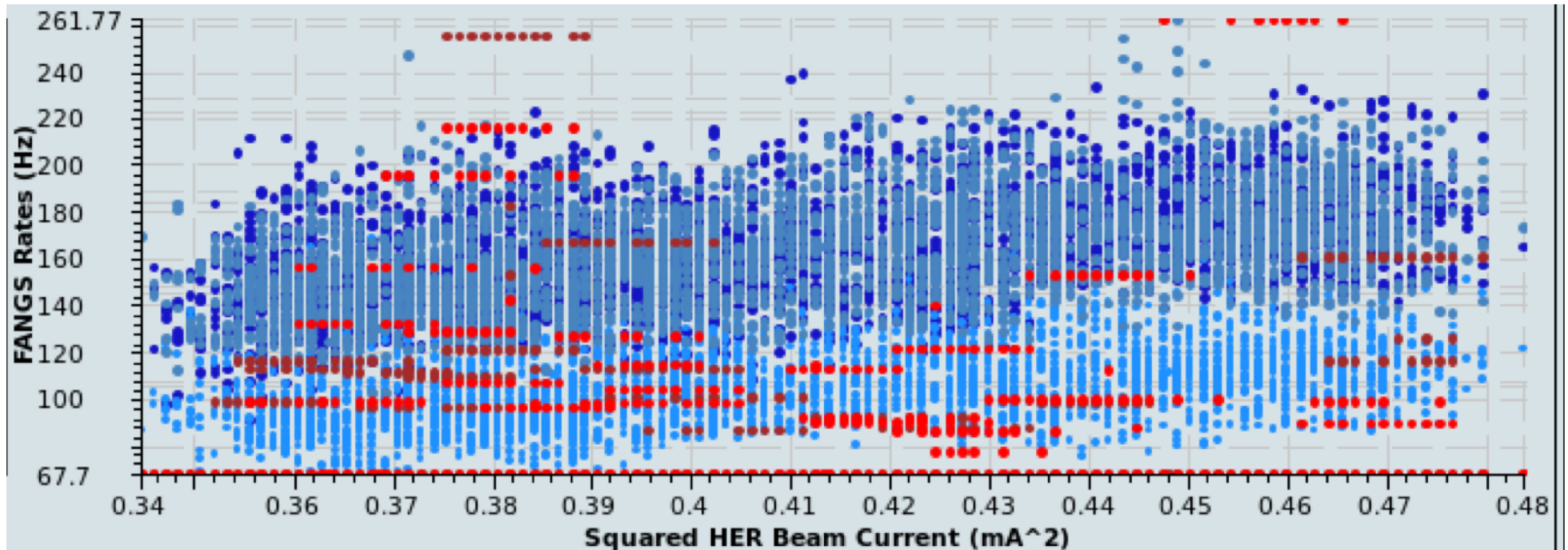


- Abort check, injection tuning, orbit correction, feedback system adjustment,...
- Same strategy followed for LER commissioning

# Before Orbit Tuning



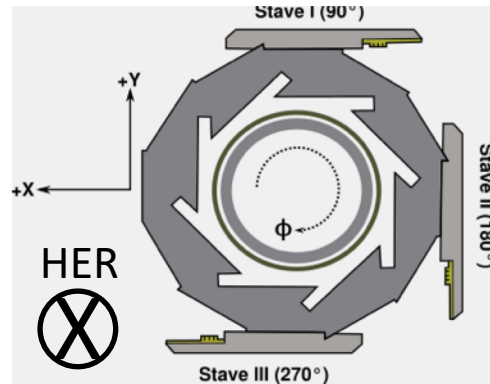
Center of the ring



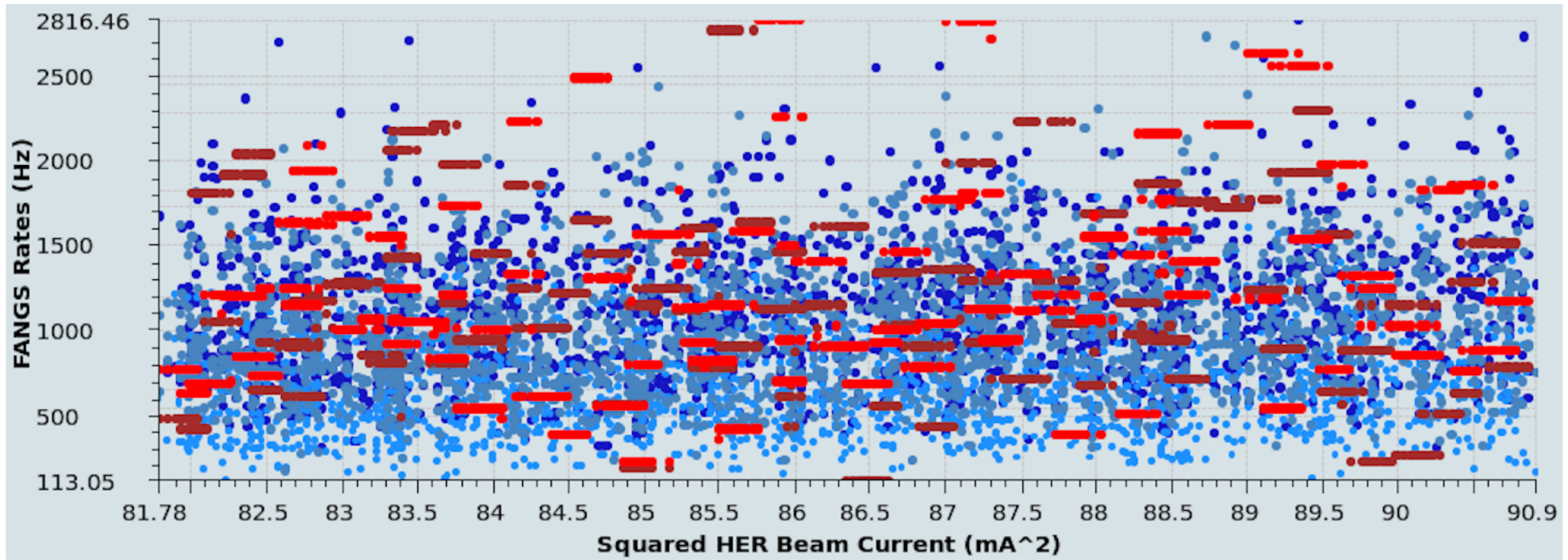


# After Orbit Tuning

BEAST is a useful tool for machine optimization

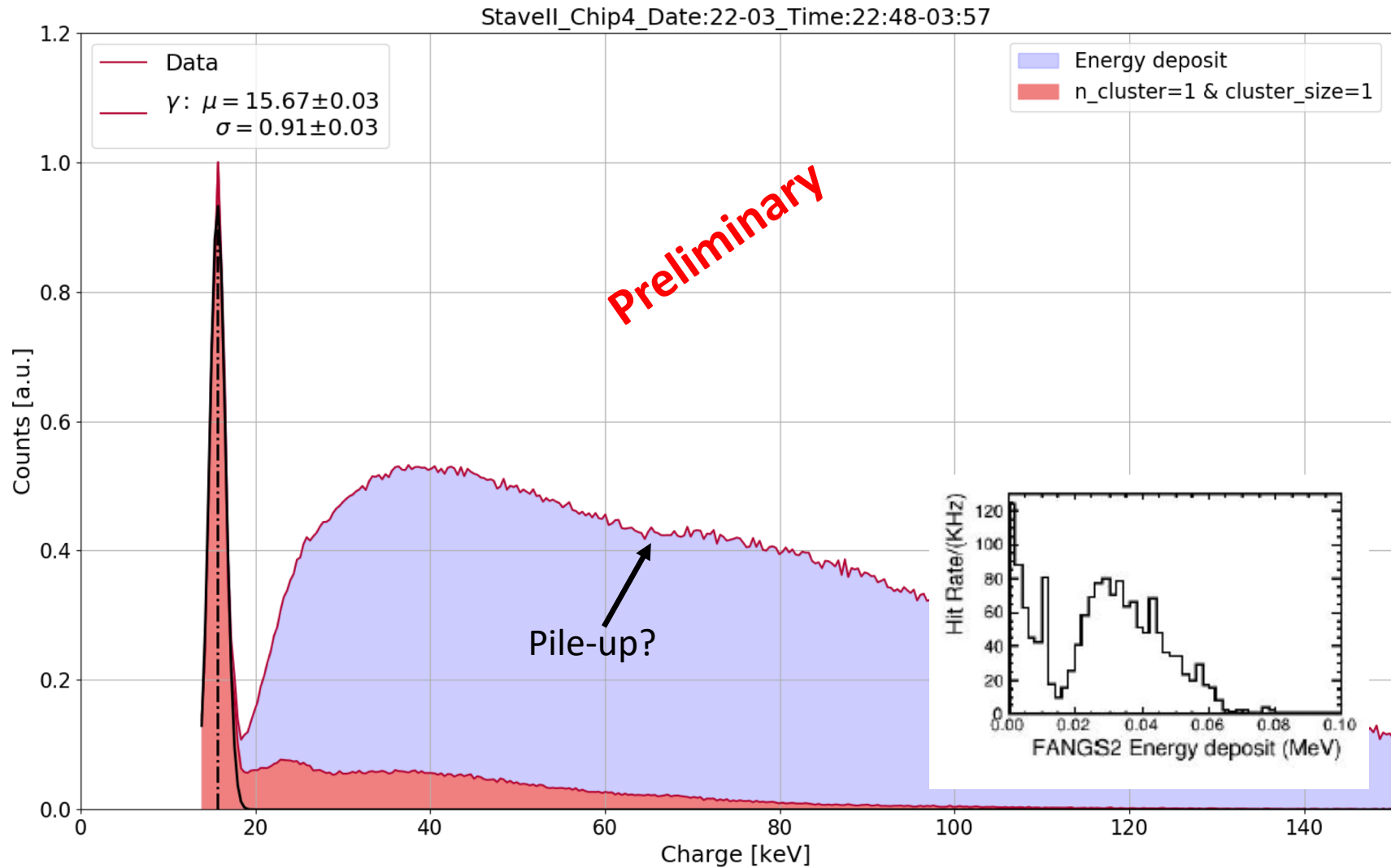


Center of the ring



# First Hints of SR

First hints of SR in the horizontal plane



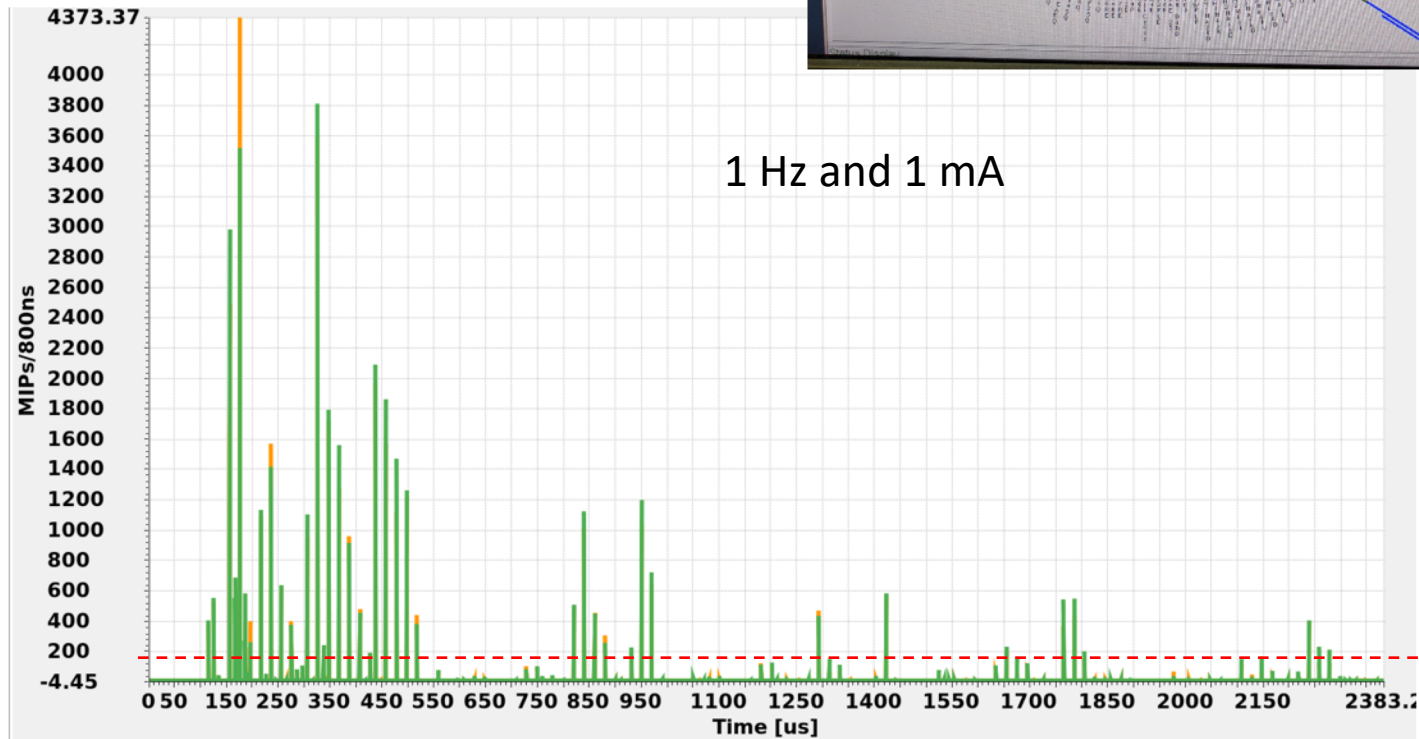
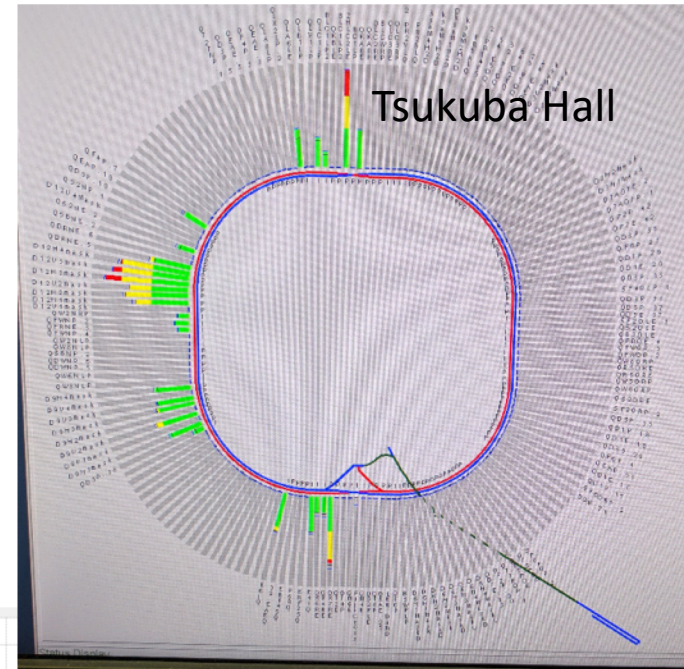
# BEAST Detector Summary

- *All* BEAST detectors are operational and participating in machine commissioning
- BEAST well time aligned when detecting backgrounds
- Absolute particle rates to be understood (x-check between systems)
- Integrated doses are mild (few rad) [not quite, see next slides]
- Particle rates with stable beam storage are small
- Problem\* → **Injection...**

\*during the first week

# Injection Noise

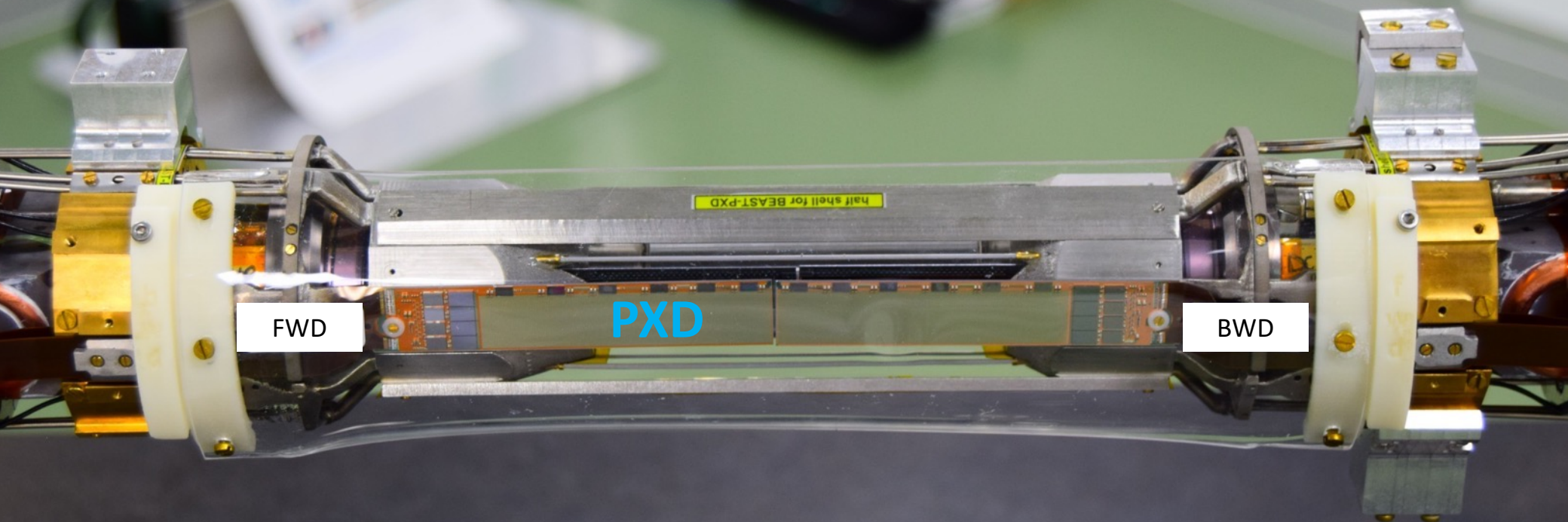
- Newly injected bunches showed severe losses in Tsukuba Hall
- (True for both HER and LER)







Center of the ring



FWD

PXD

BWD

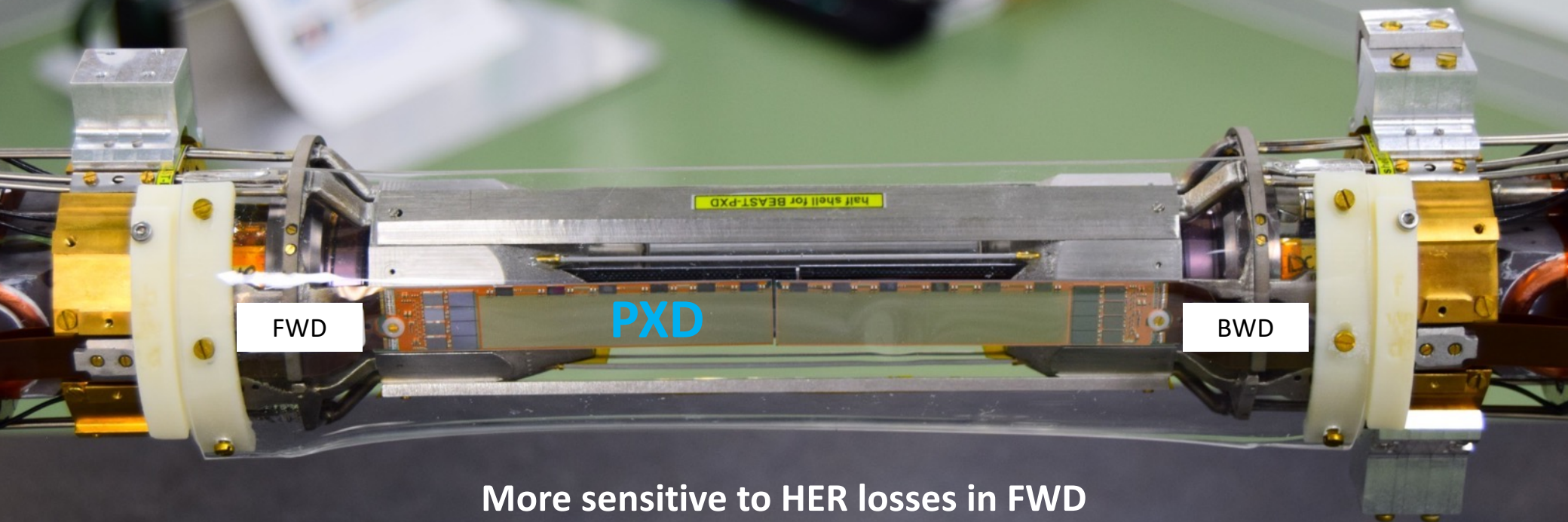
half shell for BEAST-PXD

Backward  
4 Diamonds

5 Hz, 1394 bunches, 10 mA  
 $\dot{D} \sim 1 \text{ mRad/s}$   
(TID (6d)  $\sim 2.5 \text{ rad}$ )



Center of the ring



More sensitive to HER losses in FWD

Forward  
4 Diamonds

5 Hz, 1394 bunches, 10 mA  
 $\dot{D} \sim 7$  mRad/s  
(TID (2d)  $\sim 13$  rad)

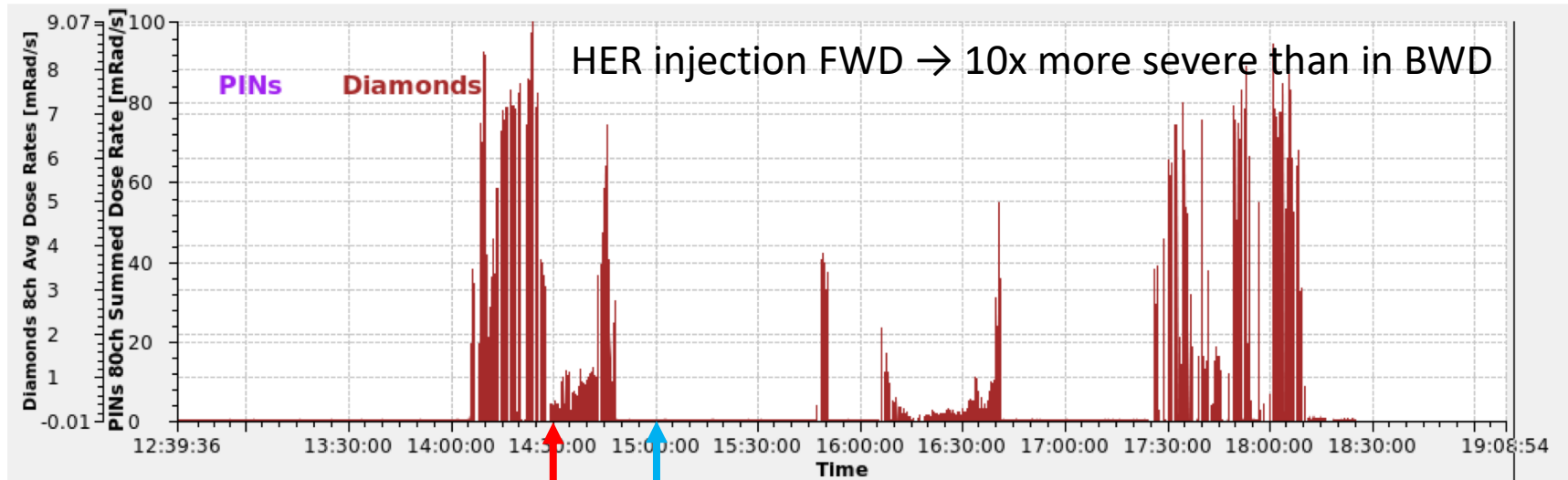
Backward  
4 Diamonds

5 Hz, 1394 bunches, 10 mA  
 $\dot{D} \sim 1$  mRad/s  
(TID (6d)  $\sim 2.5$  rad)



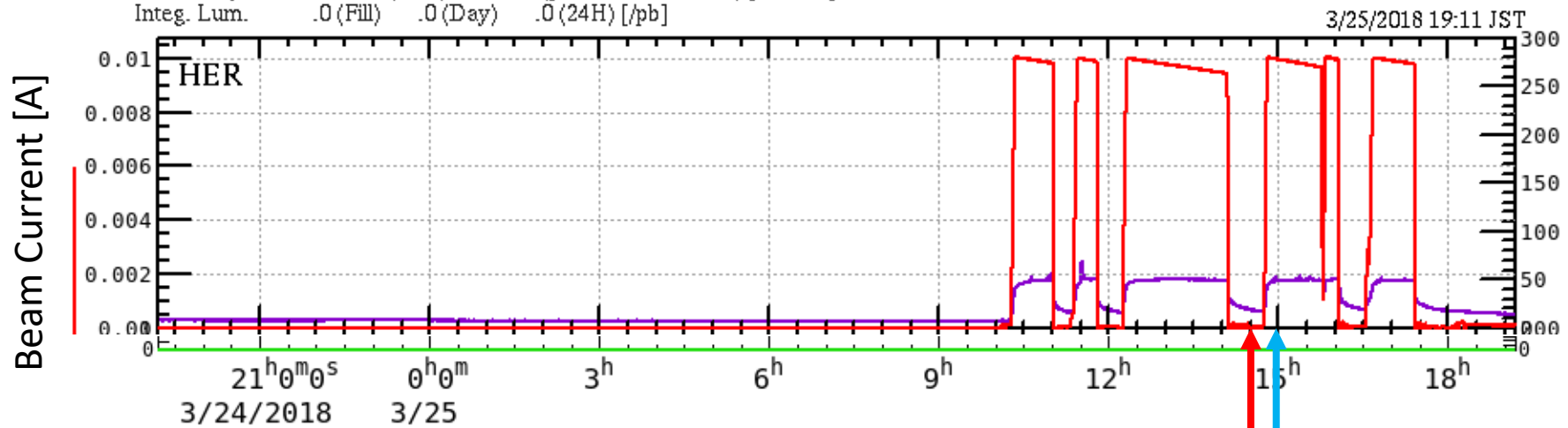
# Injection Noise

Dominating TID term: Injection



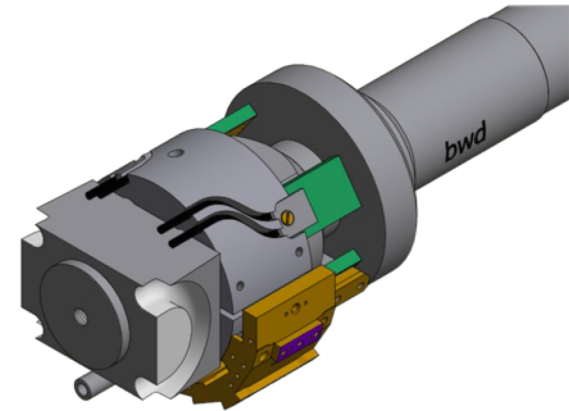
HER	.000 [A]	1394 [bunches]	HER Optics Correction
LER	.000 [A]	1477 [bunches]	Linac Tuning
Luminosity	.000 (now)	.000 (peak in 24H @6:23) [/nb/sec]	
Integ. Lum.	.0 (Fill)	.0 (Day)	.0 (24H) [/pb]

Phase-2 started: 2018/03/19  
HER stored beam: 2018/03/21





# Integrated Doses



21.03.2018 (00:00 → 19:00):

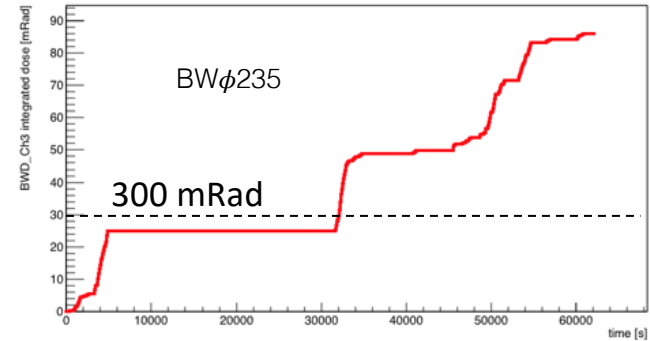
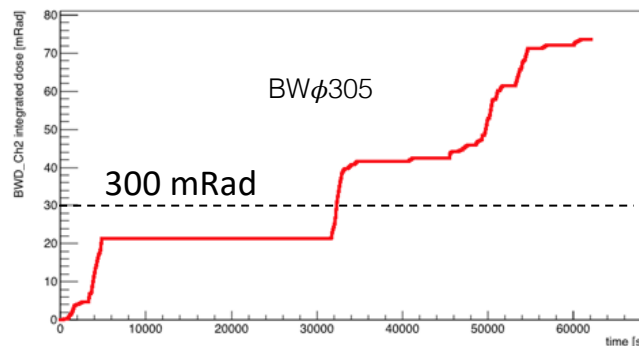
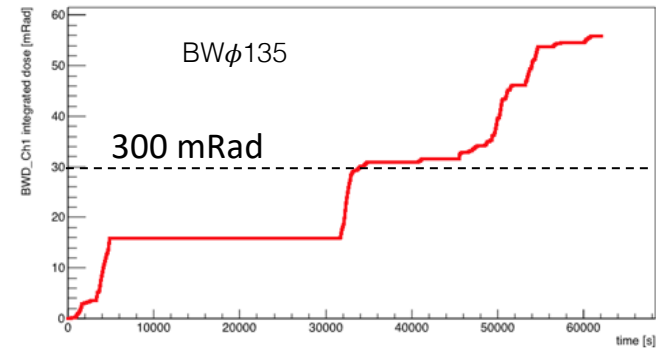
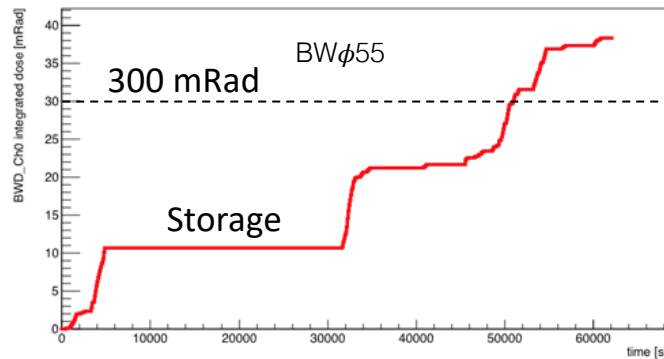
BW $\phi$ 55 = 383 mRad

BW $\phi$ 135 = 559 mRad

BW $\phi$ 235 = 737 mRad

BW $\phi$ 305 = 861 mRad

Doses accumulated mainly during HER injection



Asymmetry in the accumulated dose...

# Integrated Doses

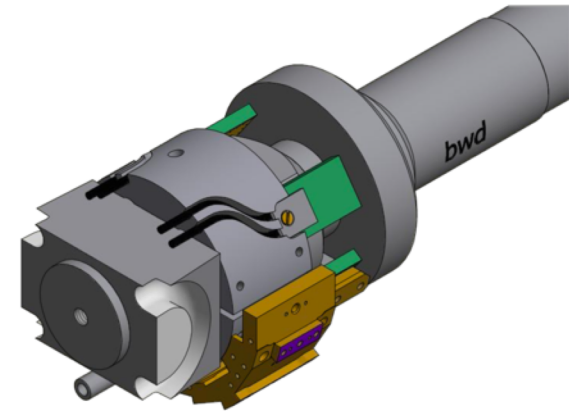
21.03.2018 (00:00 → 19:00):

BW $\phi$ 55 = 383 mRad

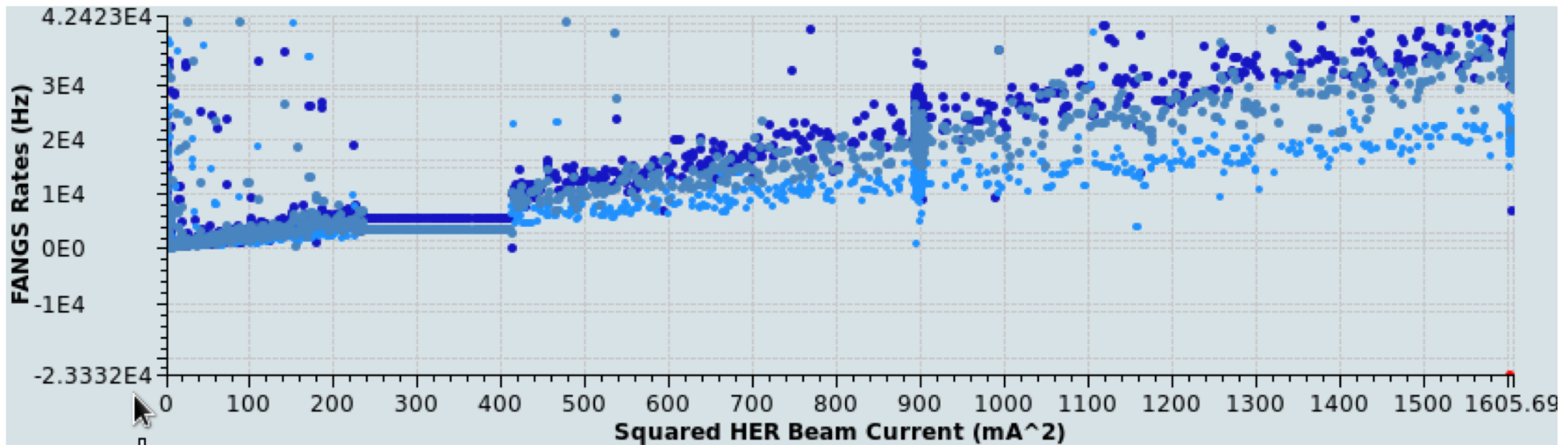
BW $\phi$ 135 = 559 mRad

BW $\phi$ 235 = 737 mRad

BW $\phi$ 305 = 861 mRad



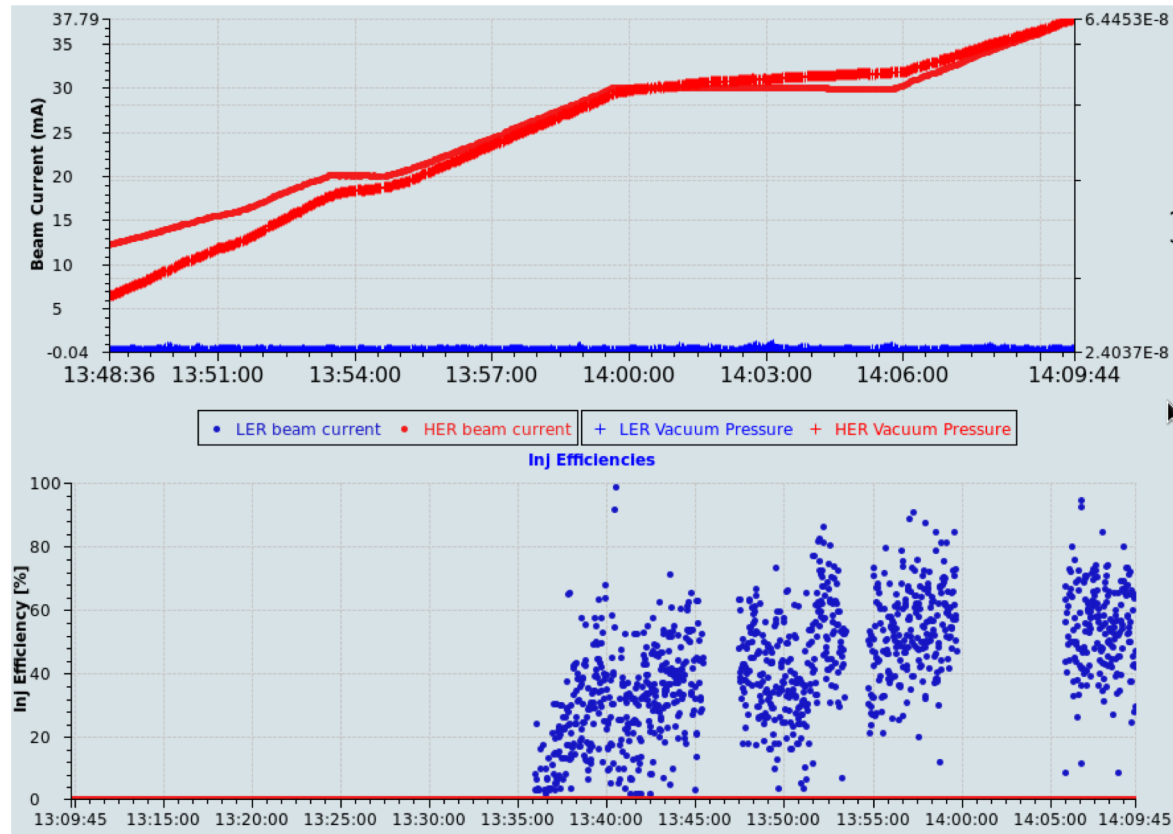
Doses accumulated mainly during HER injection



Asymmetry in the accumulated dose... also seen by FANGS

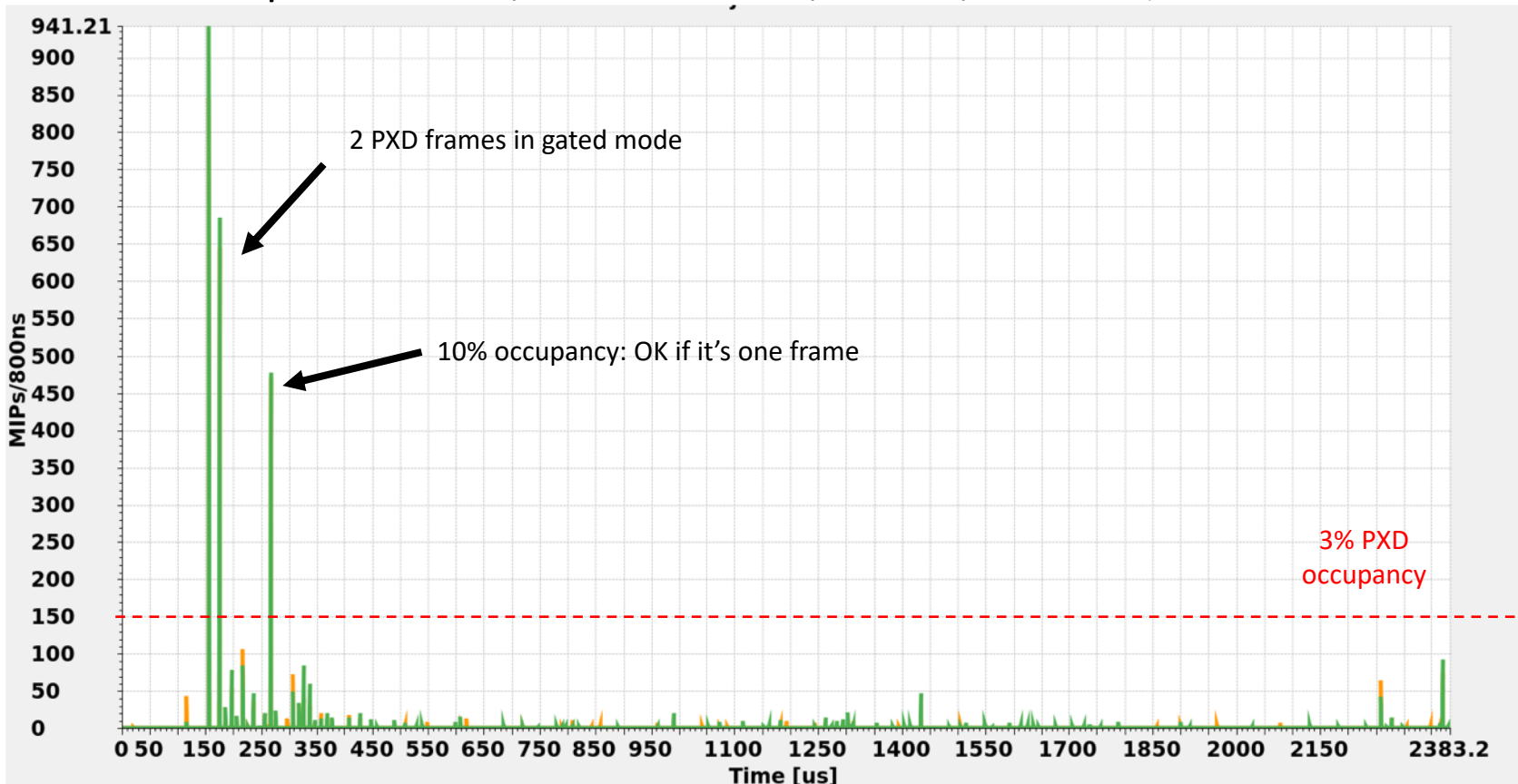
# Injection Problems

- But... it was found that several injection kickers were out of order and also a problematic RF gun
  - Once fixed, situation dramatically improved
- 5 Hz repetition rate; 1394 bunches; 40 mA; 0.25 mA/s



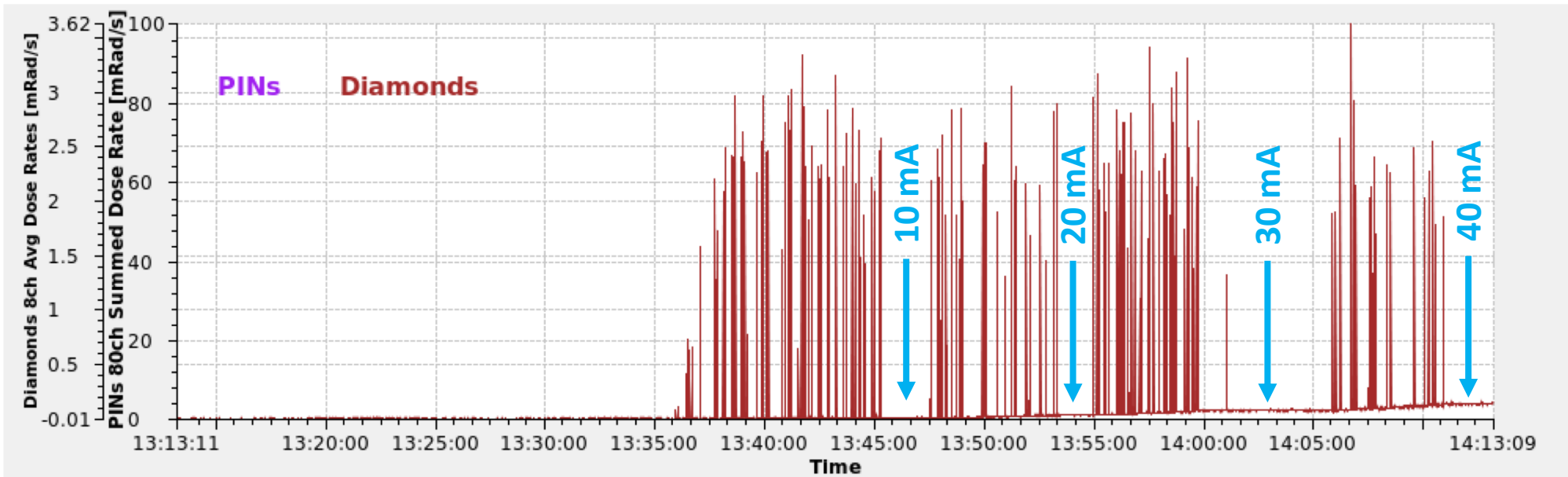
# Injection Noise

- But... it was found that several injection kickers were out of order and also a problematic RF gun
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# Integrated Doses

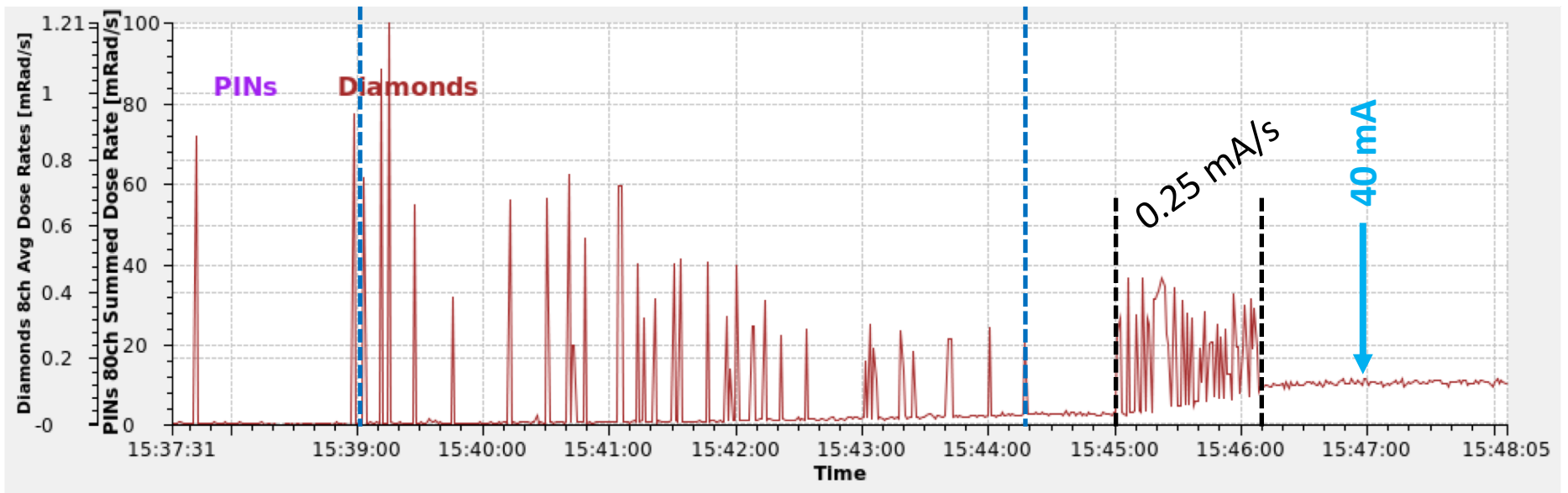
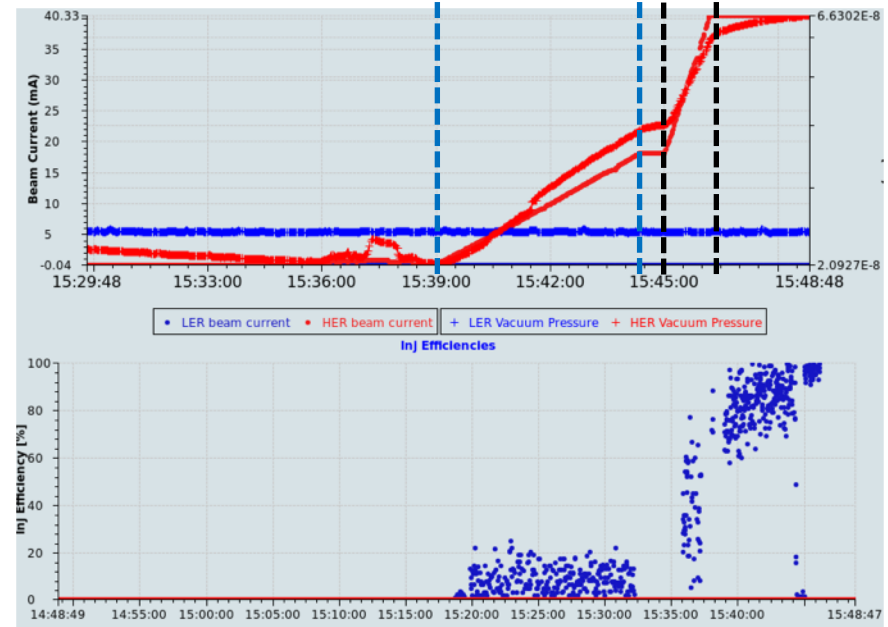
- Dose rate is much reduced with new injection scheme (and still got better)
- But with 40 mA current, baseline is no longer back to 0



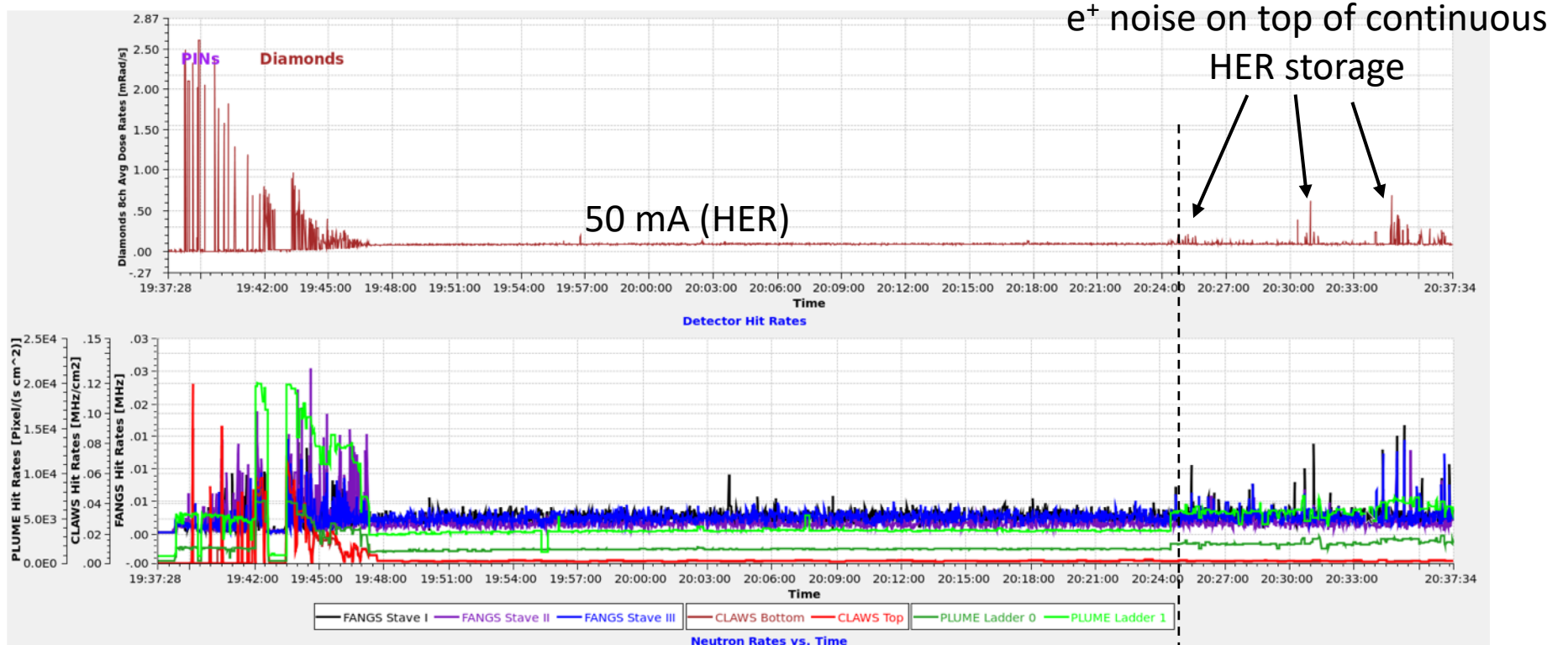
# Integrated Doses

- Even one step further...  
Optimizing injection gave us another factor 10 reduction

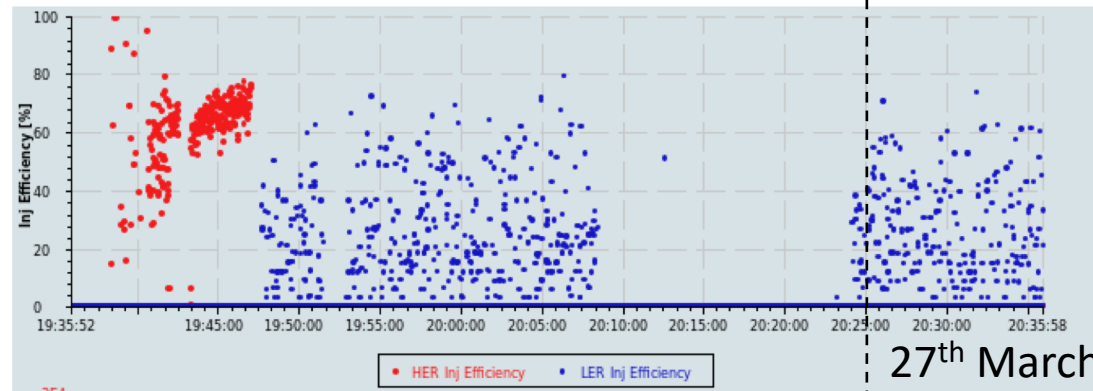
5 Hz repetition rate; 1394 bunches; 40 mA



# First LER Injections

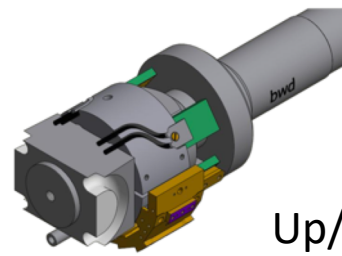


First positron 'noise' reaching Tsukuba Hall

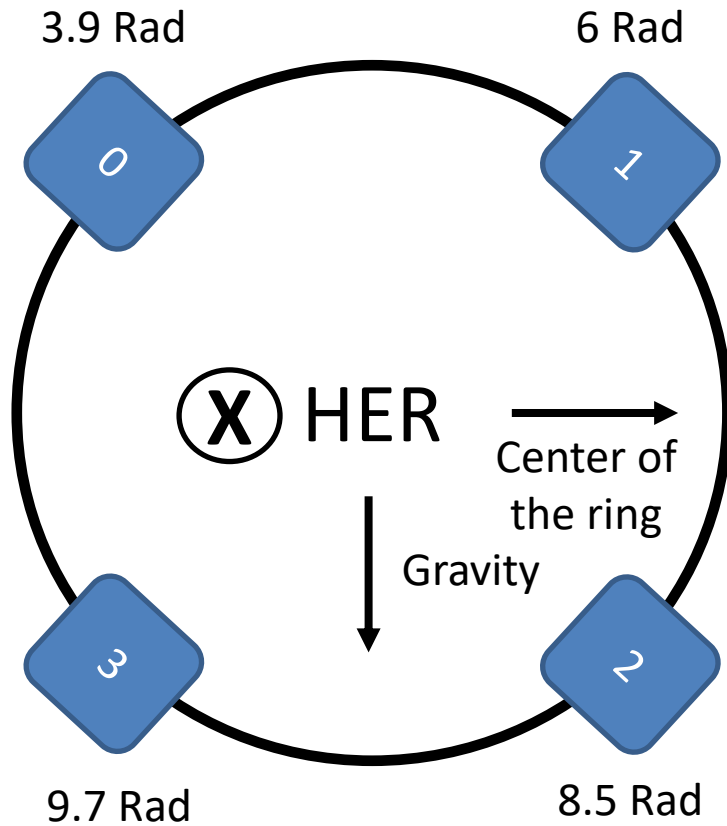




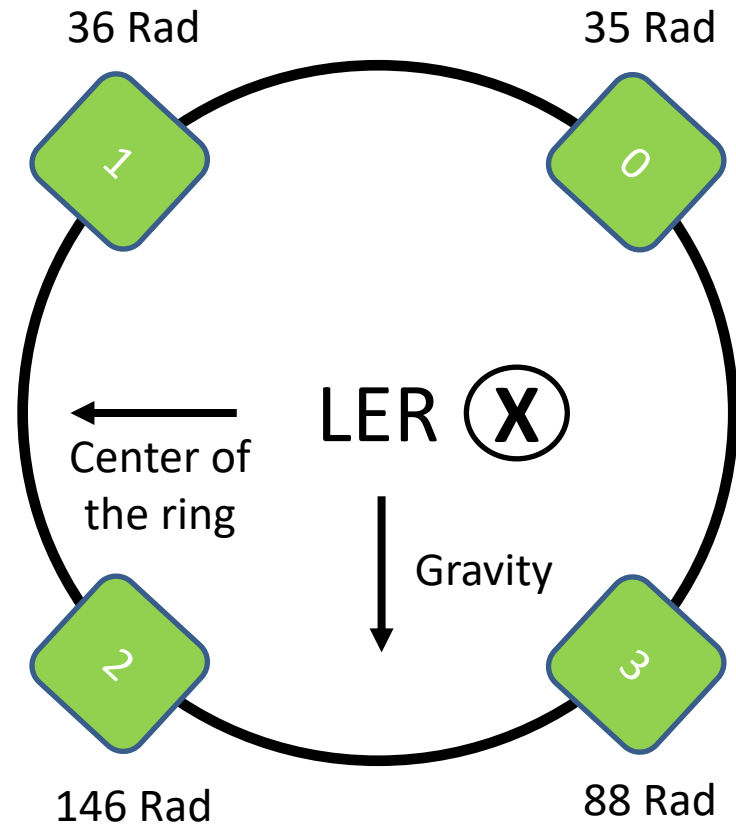
# Dose Distribution



Up/down and left/right asymmetry



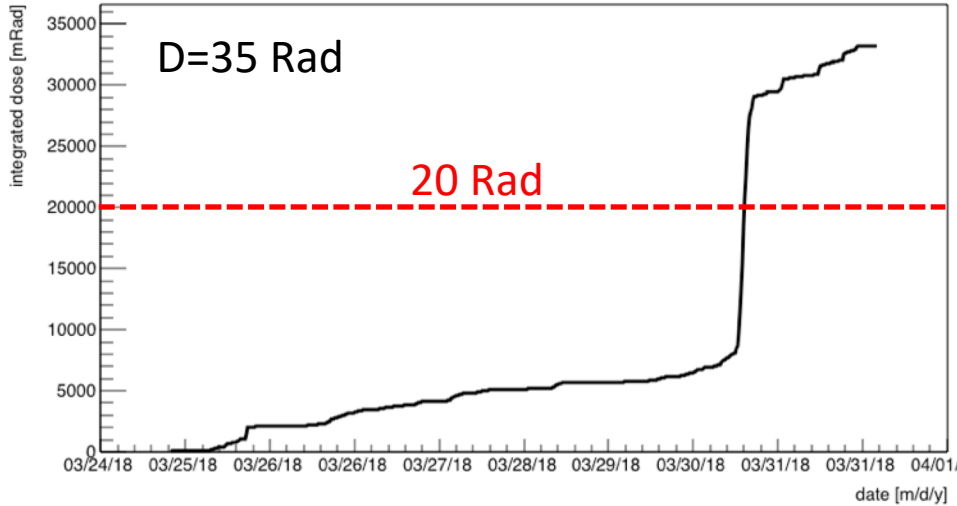
19 – 24 March



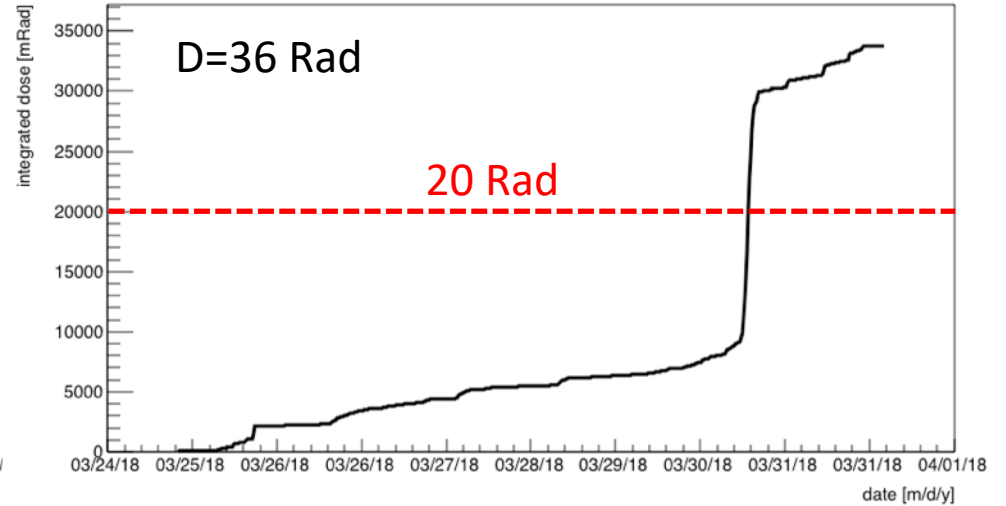
24 March – 1 April

# Integrated Doses: LER Injection

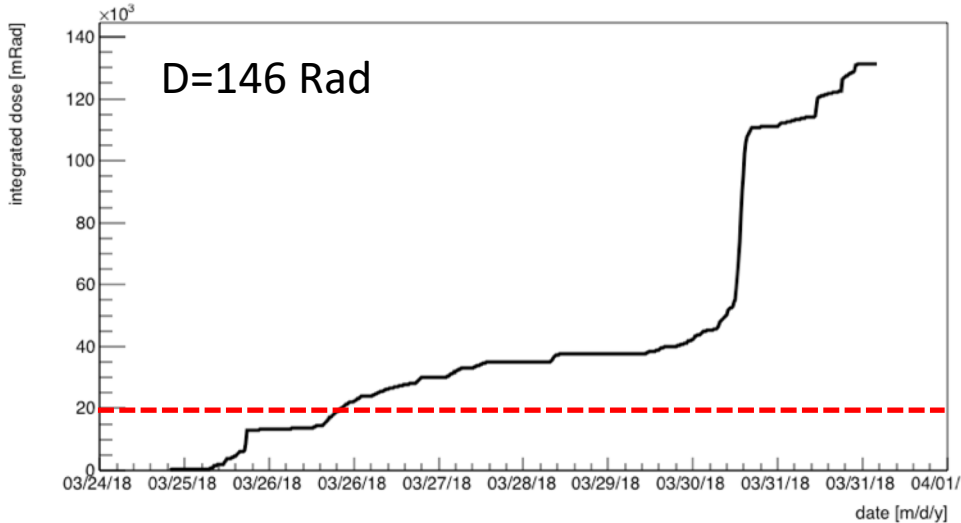
integrated Dose FWD0 from 25 March to 30 March 2018



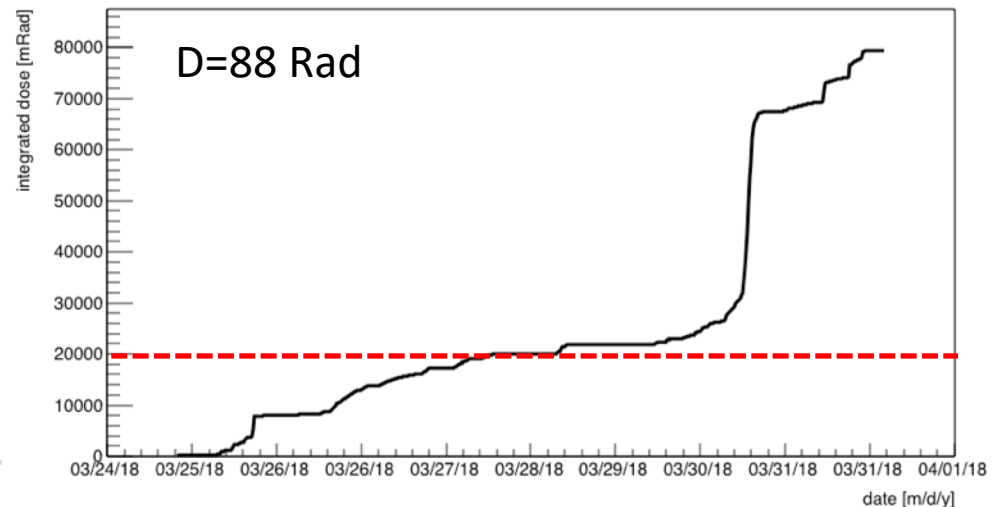
integrated Dose FWD1 from 25 March to 30 March 2018



integrated Dose FWD2 from 25 March to 30 March 2018

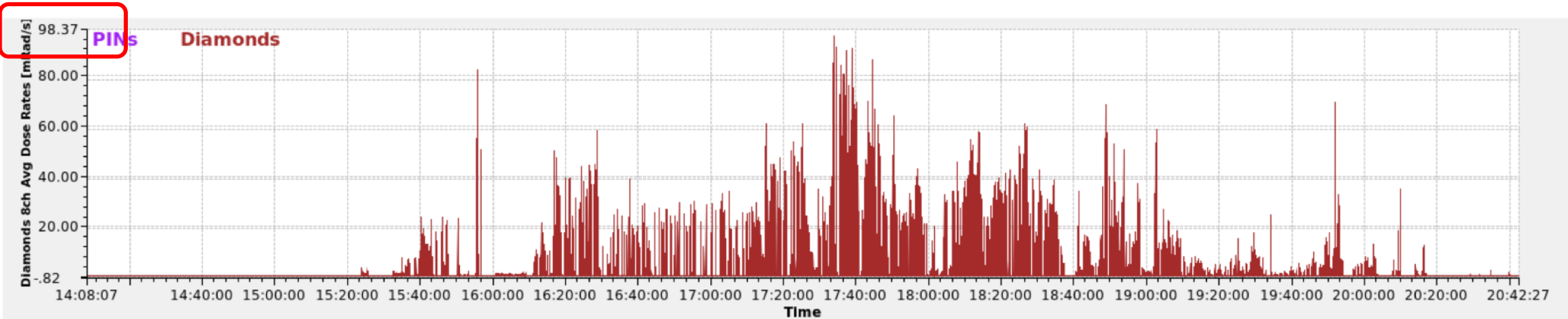


integrated Dose FWD3 from 25 March to 30 March 2018

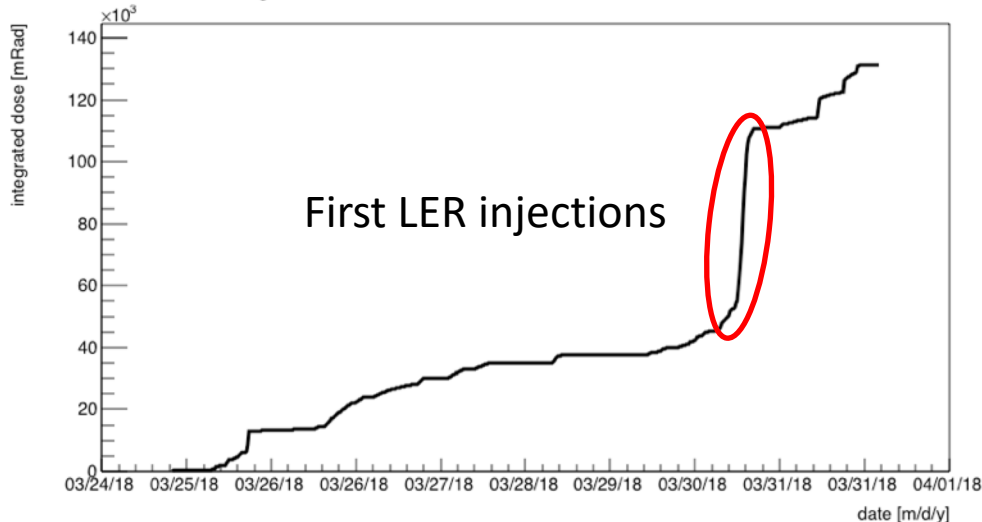


# LER Injection

Good:  $\sim 0.1$  mRad/s  
Normal:  $\sim 1$  mRad/s  
Bad:  $\sim 10$  mRad/s



integrated Dose FWD2 from 25 March to 30 March 2018



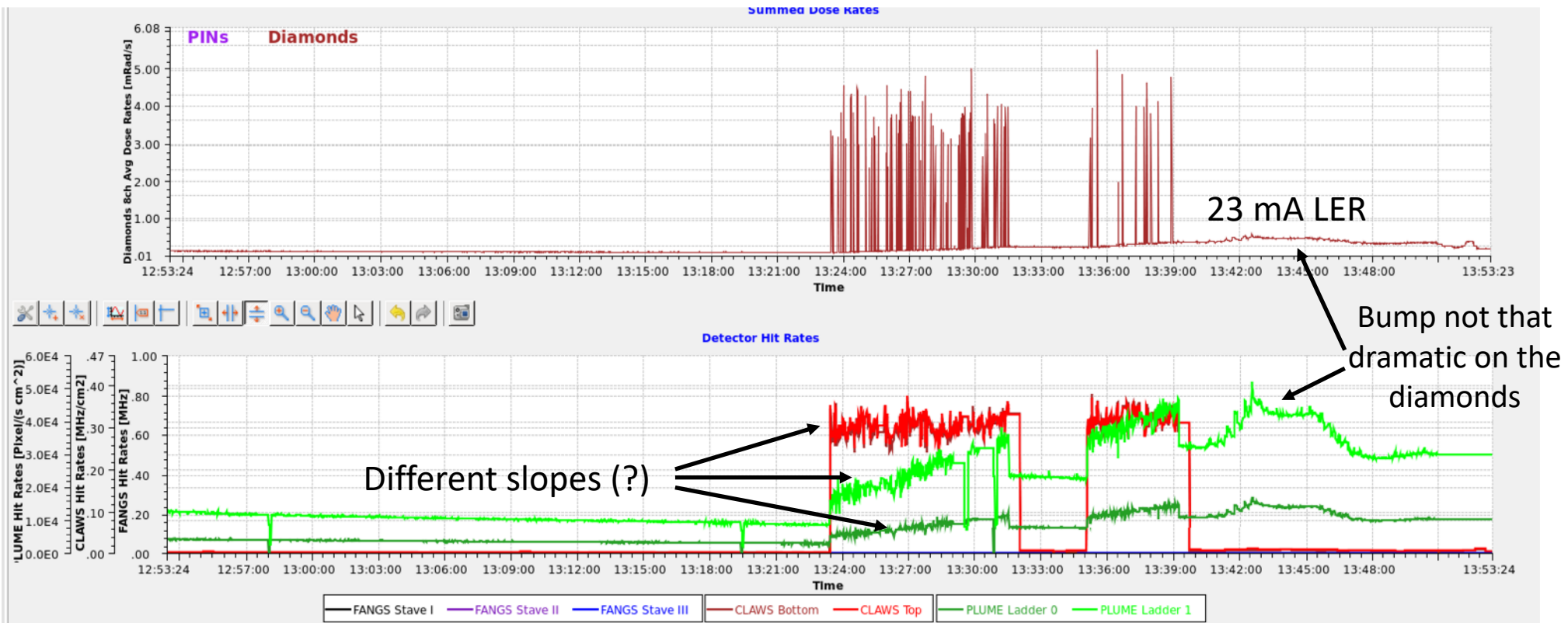
Under normal circumstances, we would have aborted beam:

Fast abort: 1 kRad/s over 1 ms

Slow abort: 100 mRad/s over 100 s

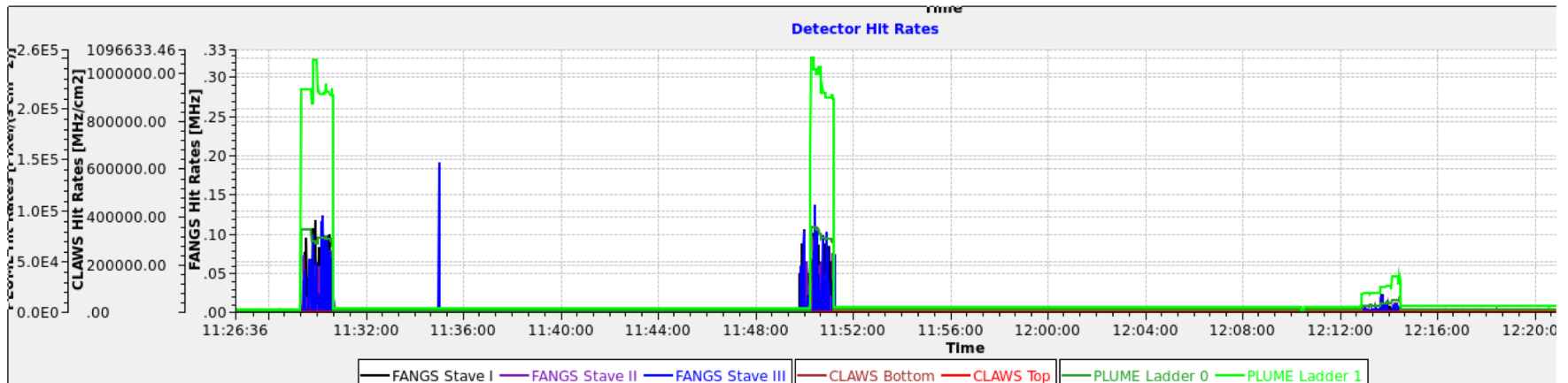
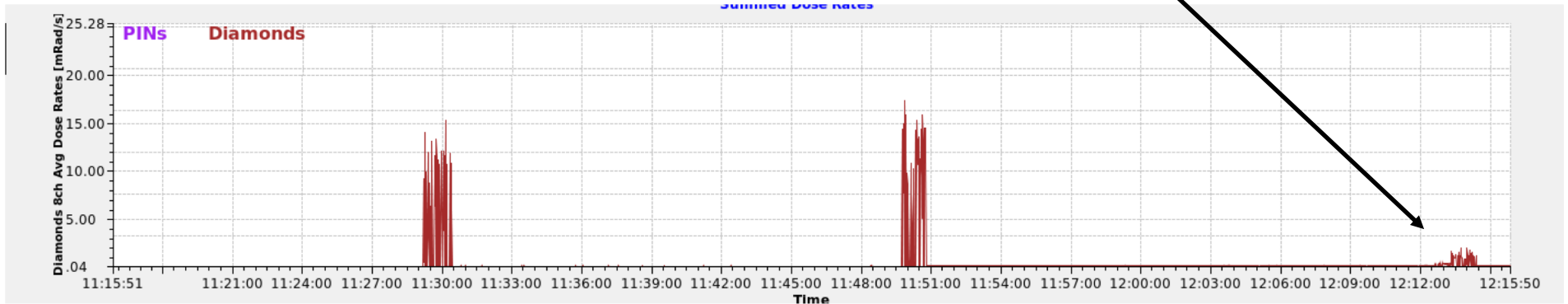
# After LER Tuning

- LER injection is greatly improved
- Further movable mask optimization will further help

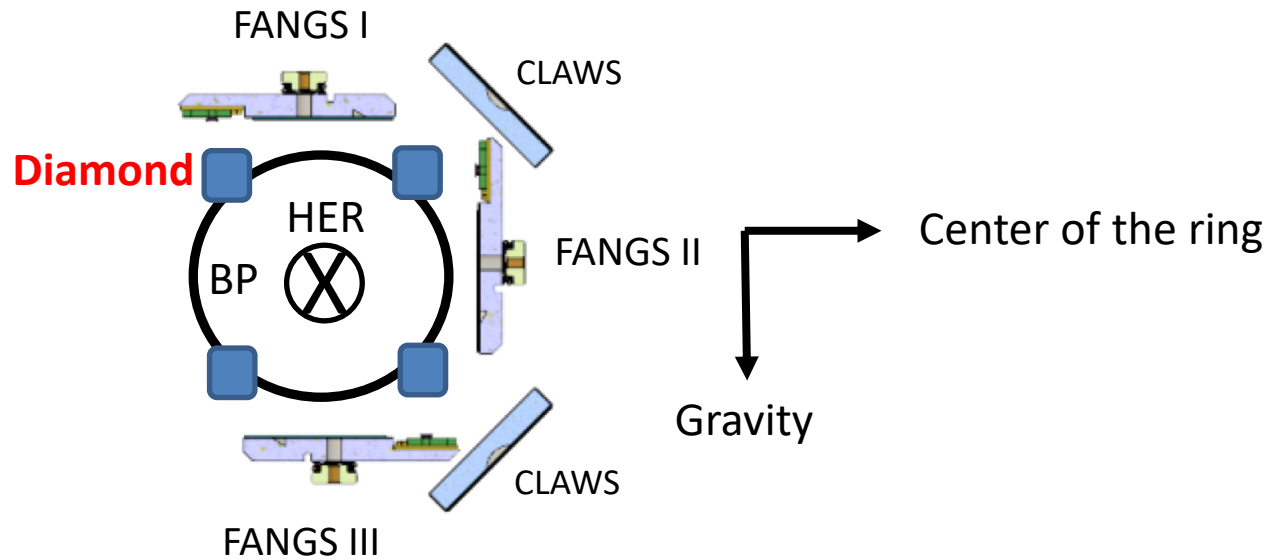


# Closing Movable Masks

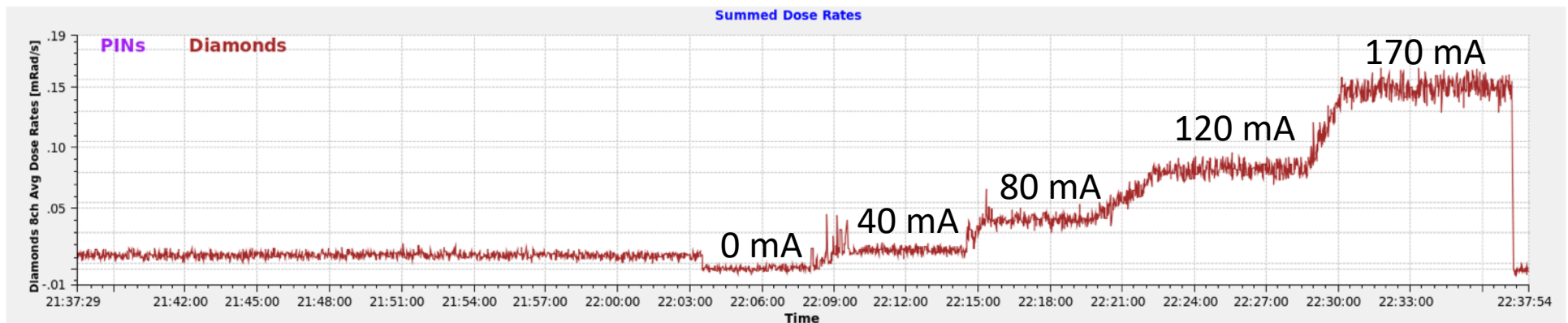
Collimators closed down to  $30\sigma$  beam size (effectively, around 5 mm closer than fully open mode)



# Injection and Storage Doses



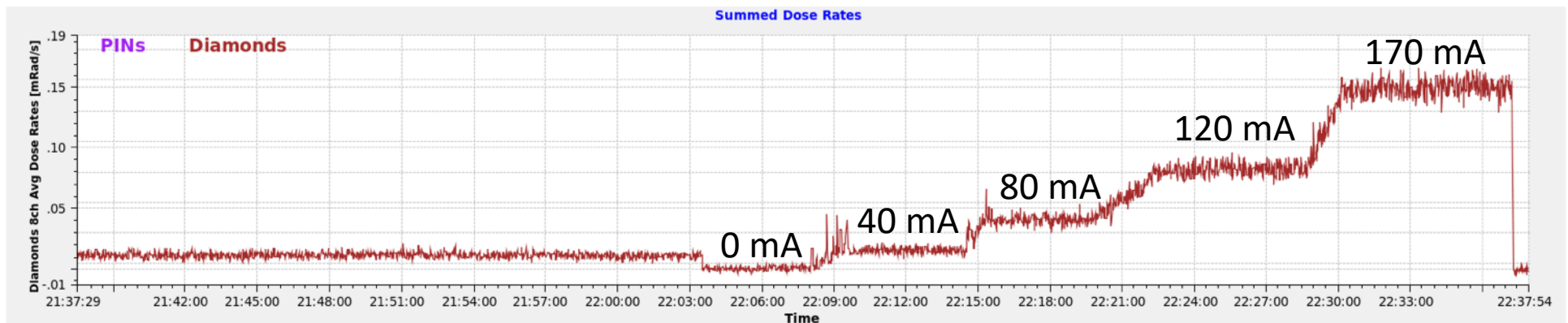
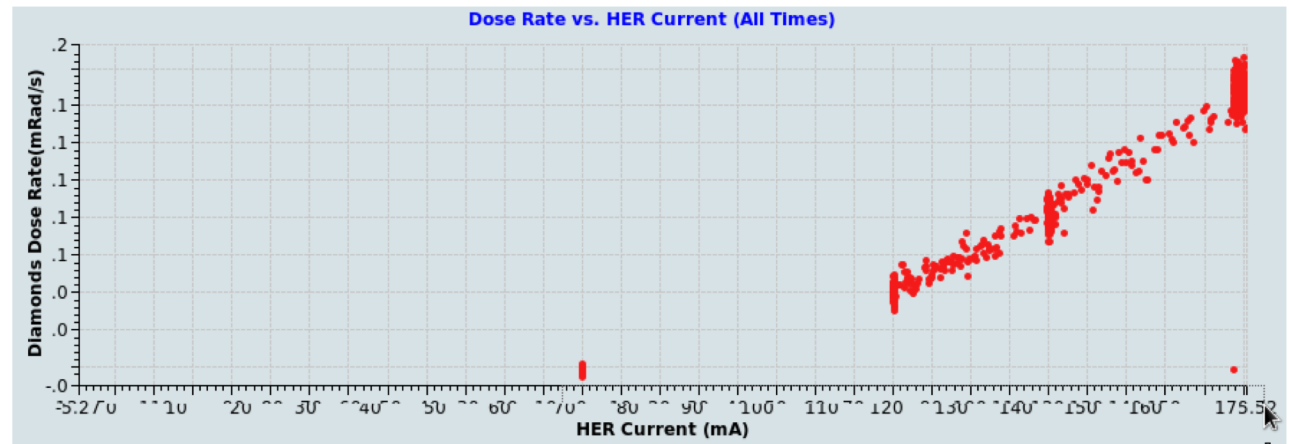
HER current: 0 mA – 170 mA  
 Refill rates: 0.45 – 0.6 mA/s  
 Injection rates: 5 Hz - 12.5 Hz



# Injection and Storage Doses

- 1) After injection tuning and closing movable masks → Injection noise is gone\*\*  
Only some small ripple at low currents
- 2) Injection is reproducible and accumulated dose rates are *linear* with current

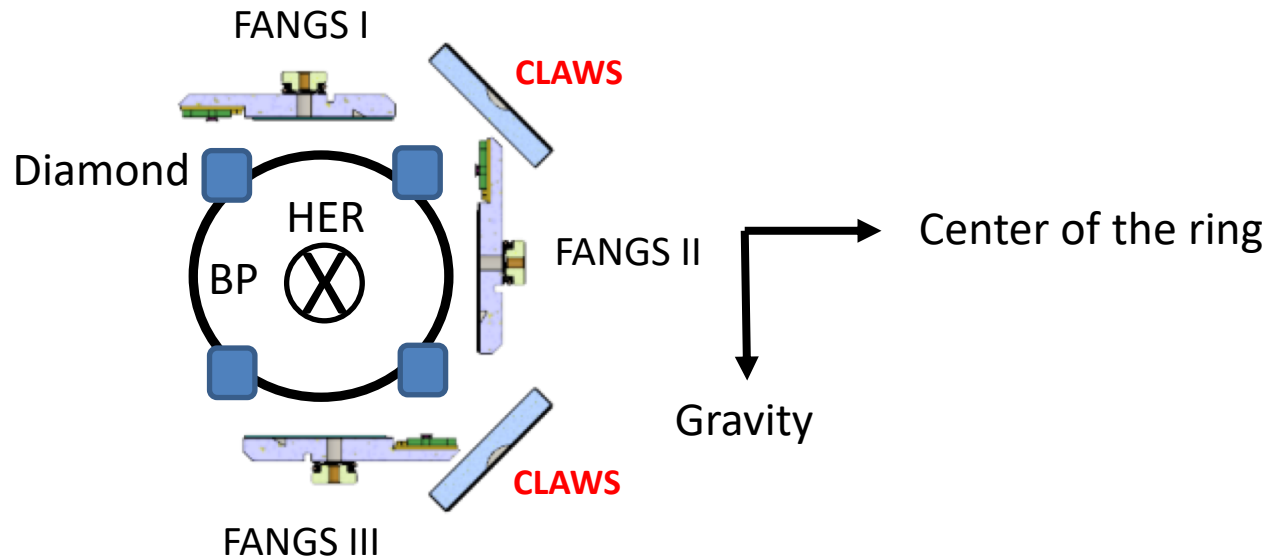
HER current: 0 mA – 170 mA  
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Injection rates: 5 Hz - 12.5 Hz



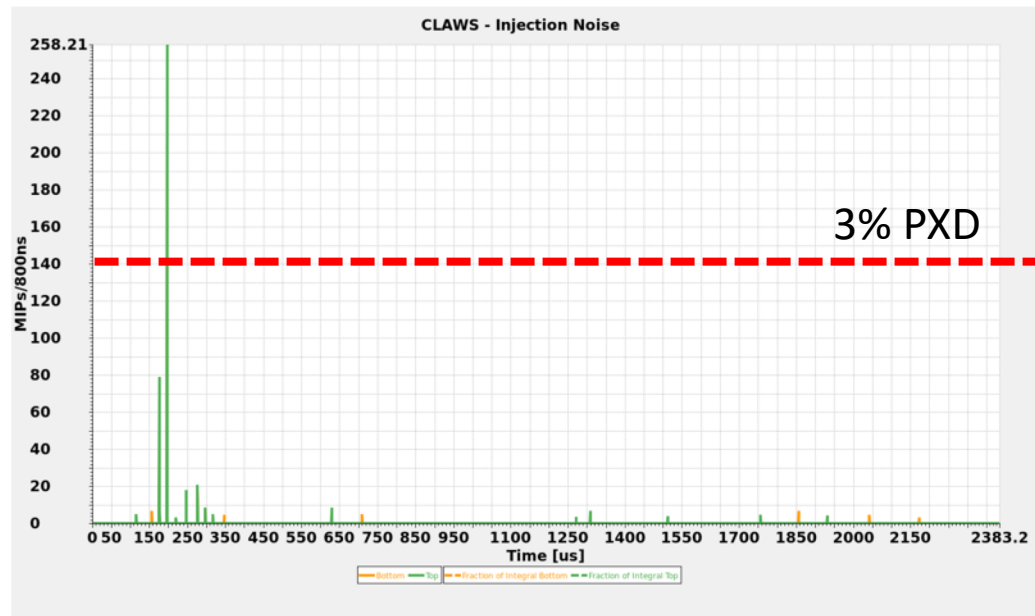


# Injection and Storage Particle Rates

HER current: 0 mA – 170 mA  
 Refill rates: 0.45 – 0.6 mA/s  
 Injection rates: 5 Hz - 12.5 Hz

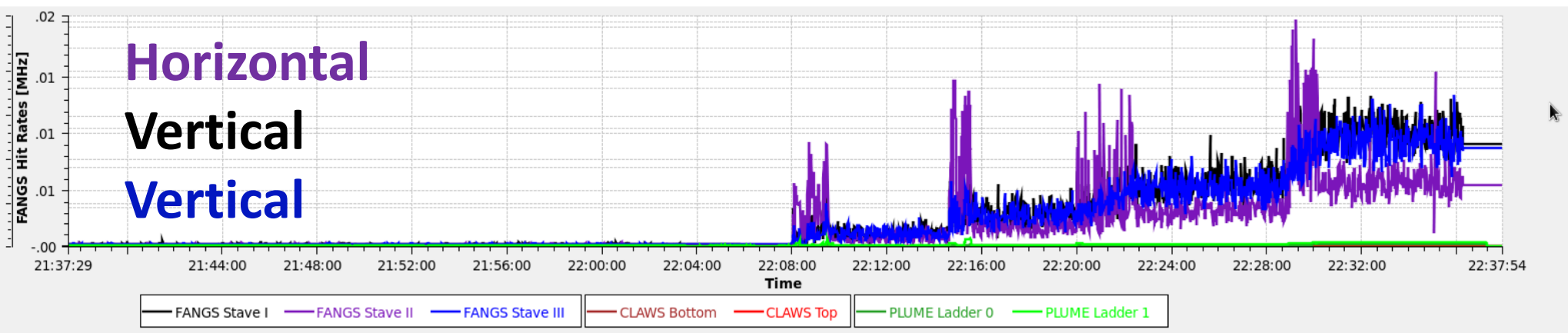
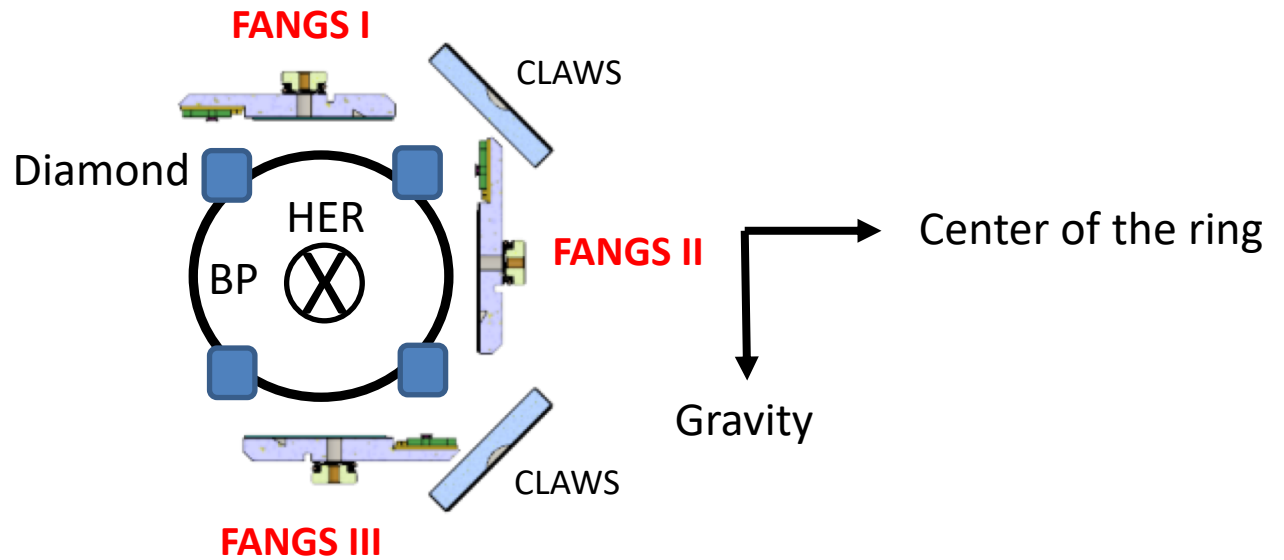


- 1) Beyond the limit for 1 revolution cycle → OK
- 2) Very quiet and stable



# Injection and Storage Particle Rates

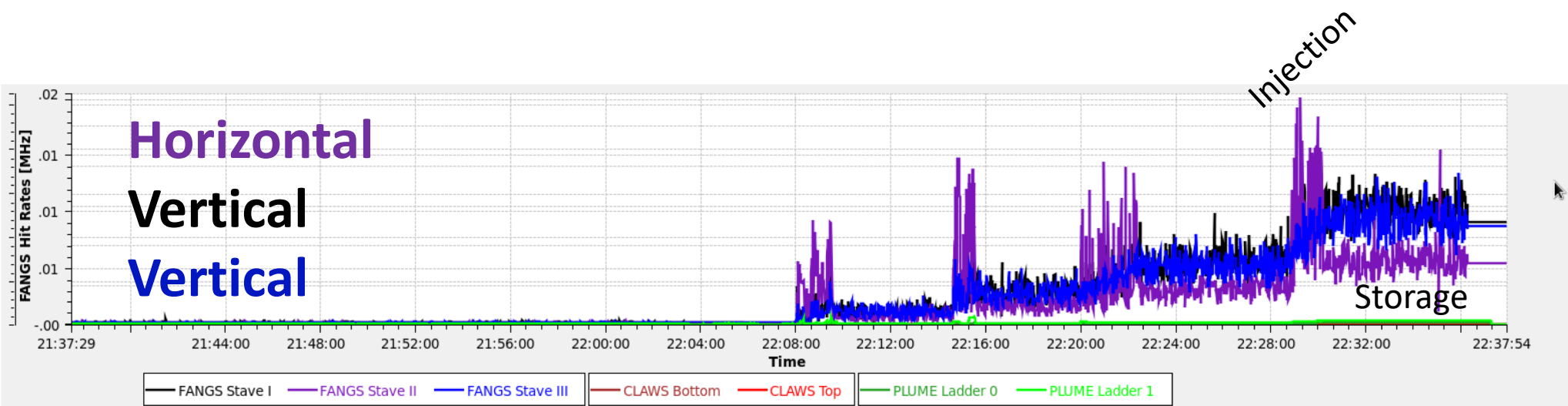
HER current: 0 mA – 170 mA  
 Refill rates: 0.45 – 0.6 mA/s  
 Injection rates: 5 Hz - 12.5 Hz



# Injection and Storage Particle Rates

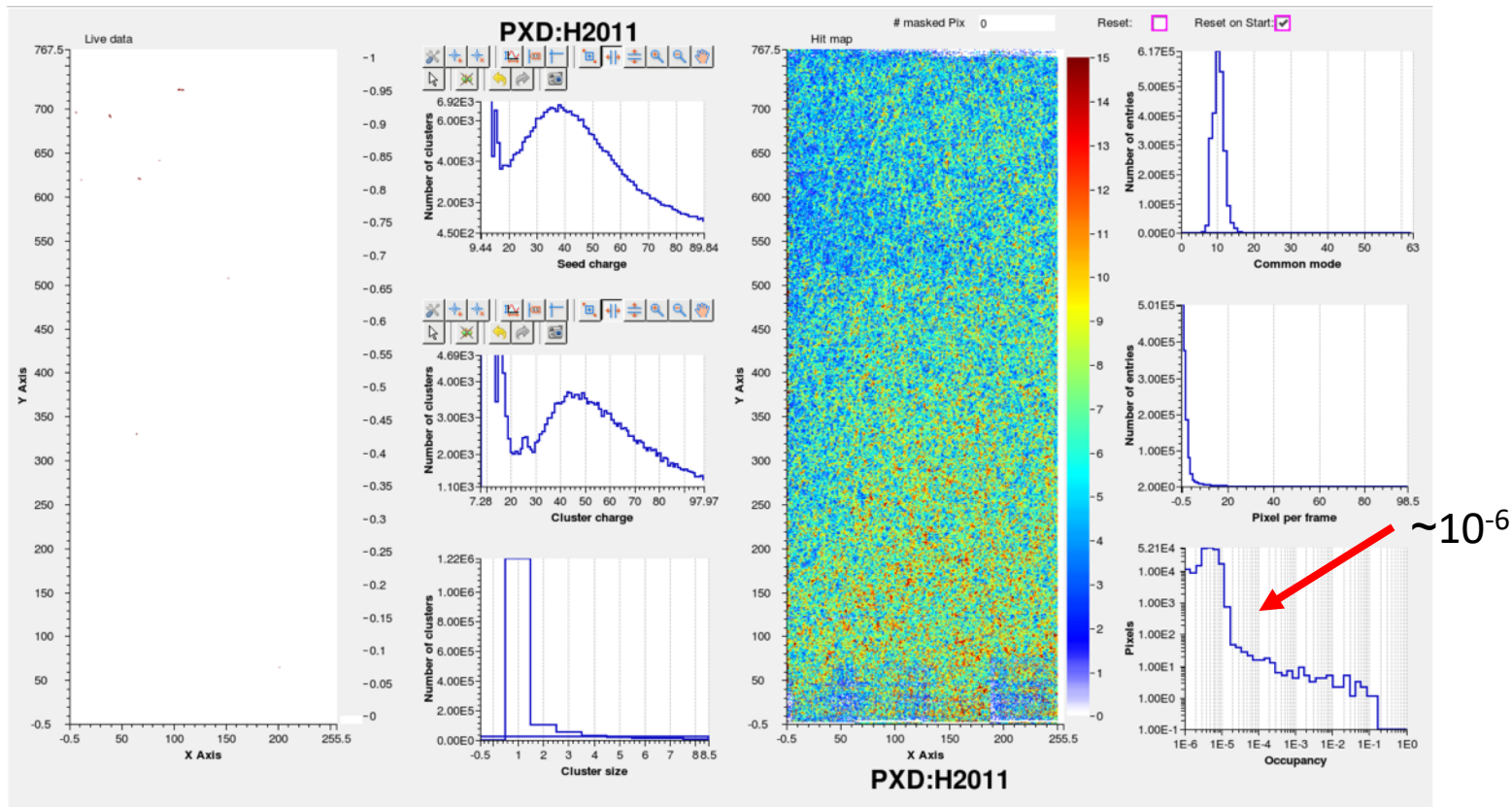
- 1) Injection noise seen in the horizontal plane (not in vertical)  
Probably the reason why the other detectors are so quiet during injection
- 2) Once beam storage reached: Higher rates in the vertical plane

HER current: 0 mA – 170 mA  
Refill rates: 0.45 – 0.6 mA/s  
Injection rates: 5 Hz - 12.5 Hz



# Switching on Belle II

- PXD, SVD, ECL and KLM switched on during HER beam storage
- Low occupancy and stable conditions observed
- LV on in TOP and ARICH
- CDC completely off



PXD occupancy with 30 mA HER 29

# Summary

- Machine commissioning runs smoothly
  - 170 mA in HER (target: 200 mA)
  - 70 mA in LER (target: 300 mA)
- Soon move to collision optics. First collisions expected soon...
  - When do we switch on PXD continuously?
- Injections gave us some headache, but now dramatically improved
- Backgrounds low and stable during HER/LER beam storage
  - Also HER injection under control
- So far, almost qualitative results only...
  - Analysis ongoing

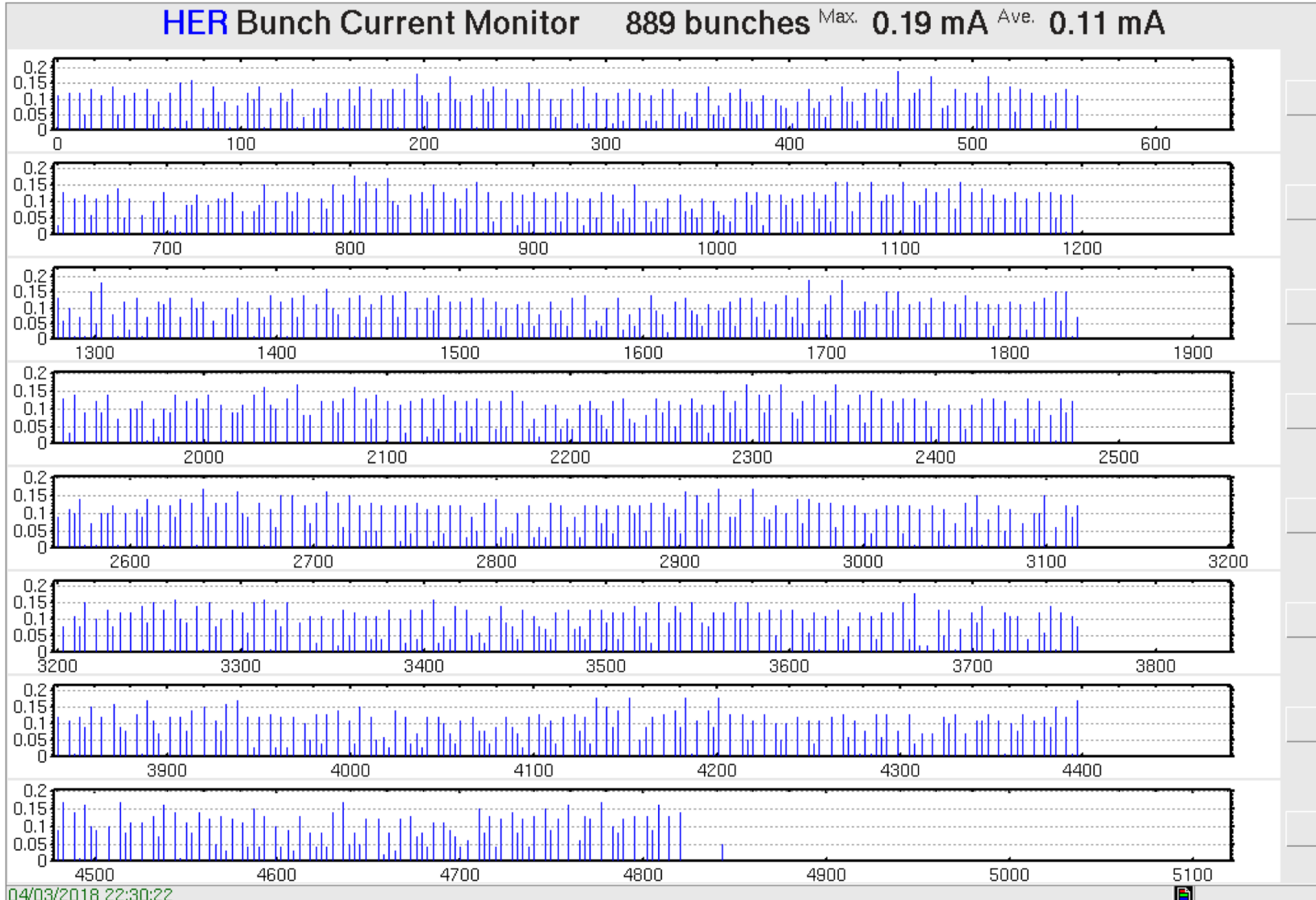


**Thank you**

# Bunch Pattern

File Edit Command Window

2018-04-03 22:30:24 Help





# Closing Movable Masks

