Diamond Light Source Update

1. Top-up
2. Orbit Stability
3. Operating Performance
4. Low-alpha
5. Insertion Devices

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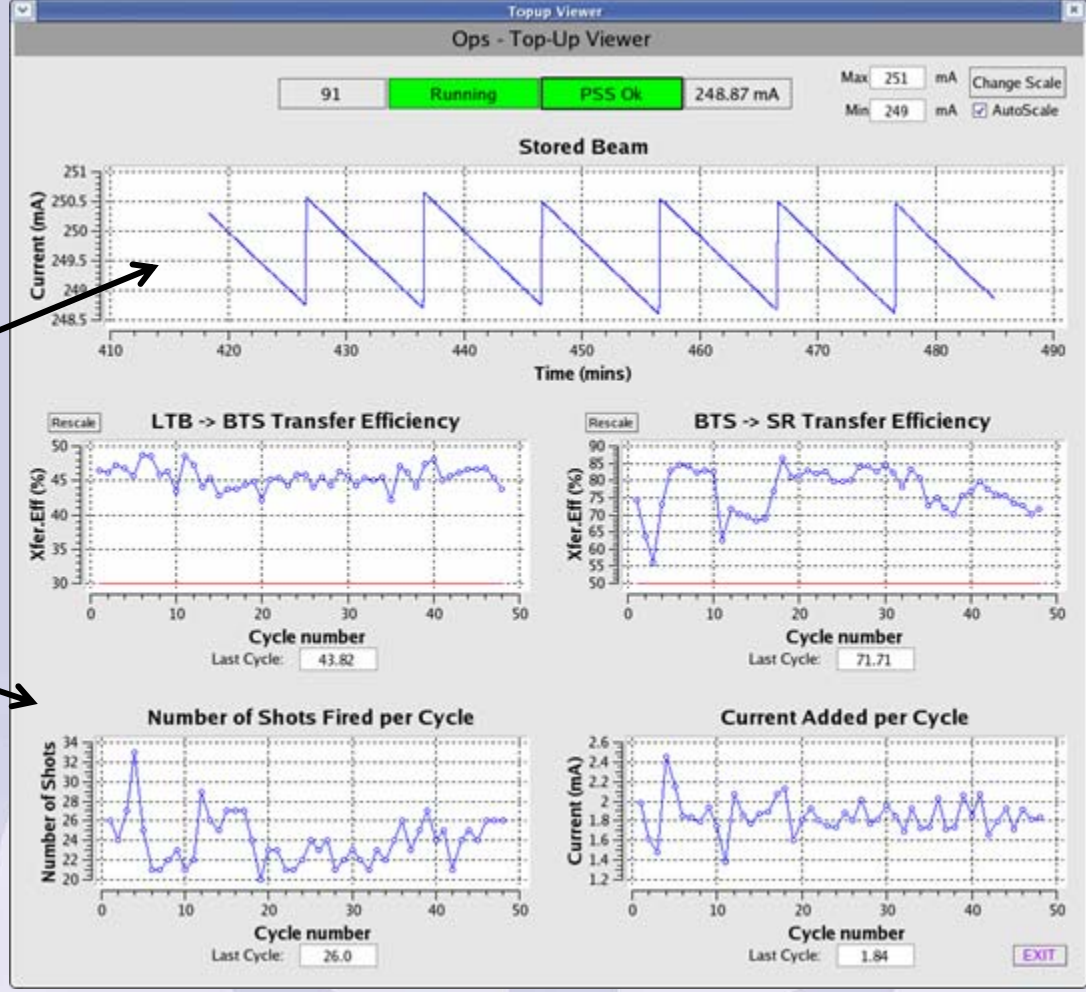
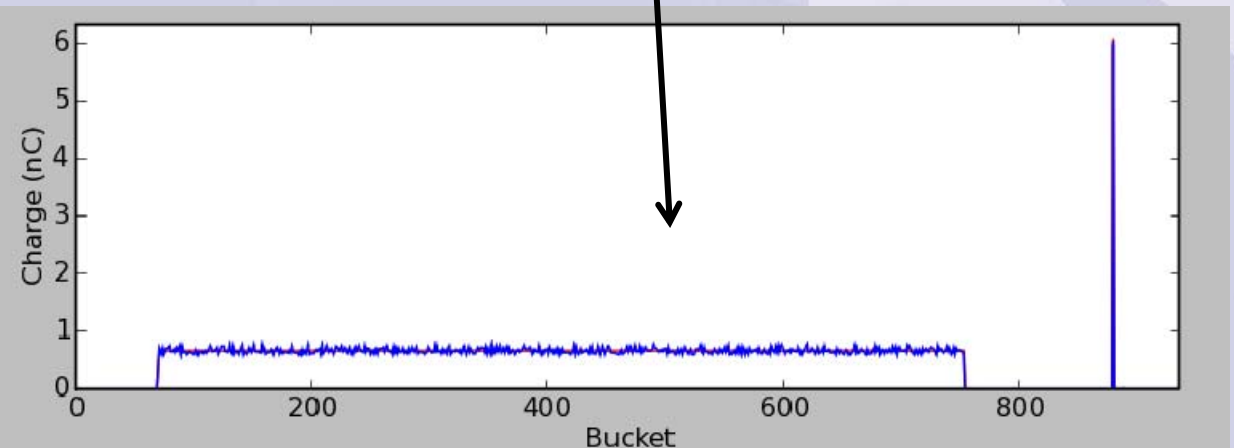
ESLS XVII, DESY, Nov. 26th-27th 2009

Top-up

- Routine since end Oct. 2008
- Injection regularly every 10 minutes
- 20-30 single bunch shots, at 5 Hz
- Arbitrary fill pattern can be set-up and maintained, e.g. “hybrid mode”

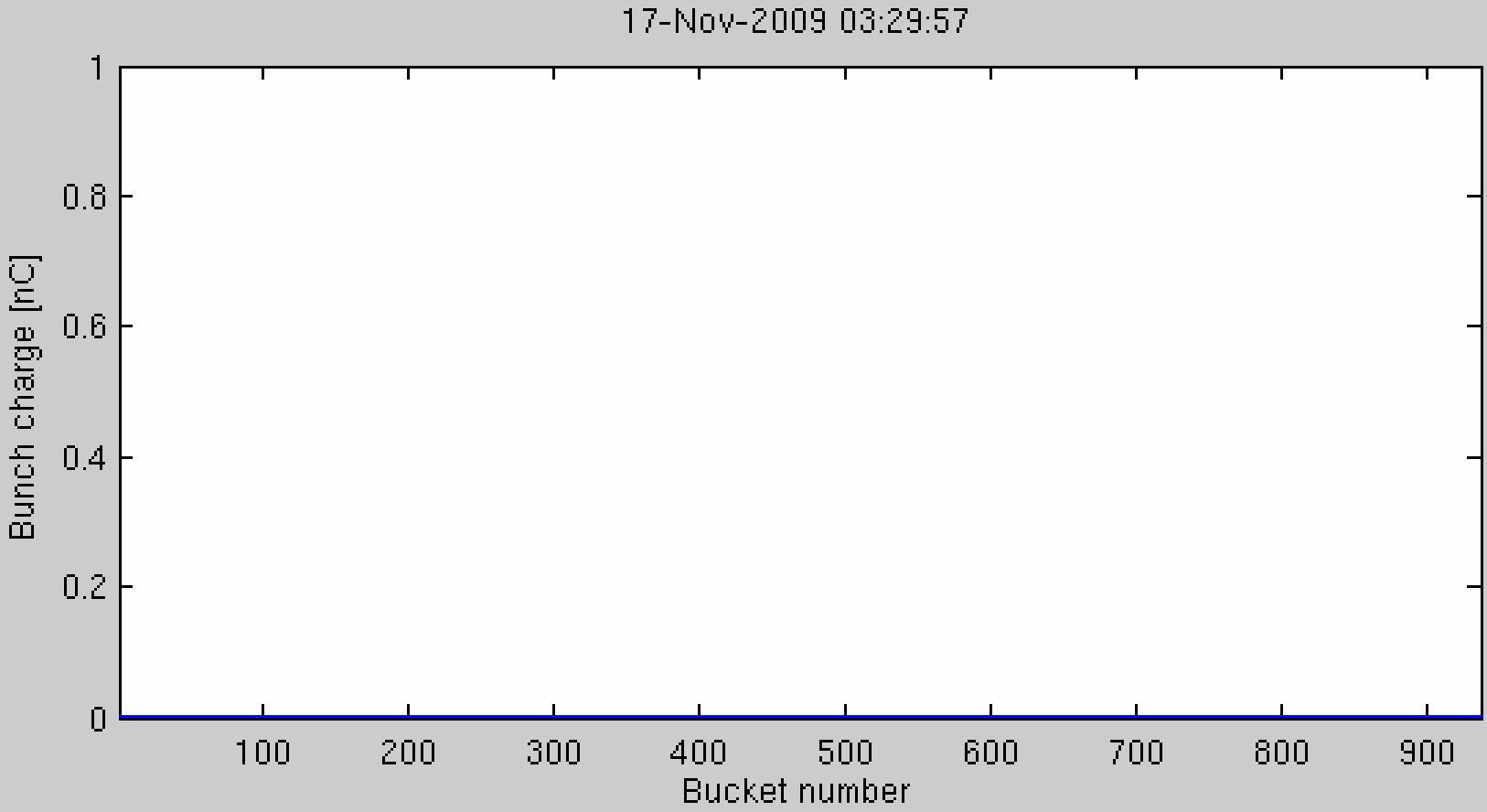




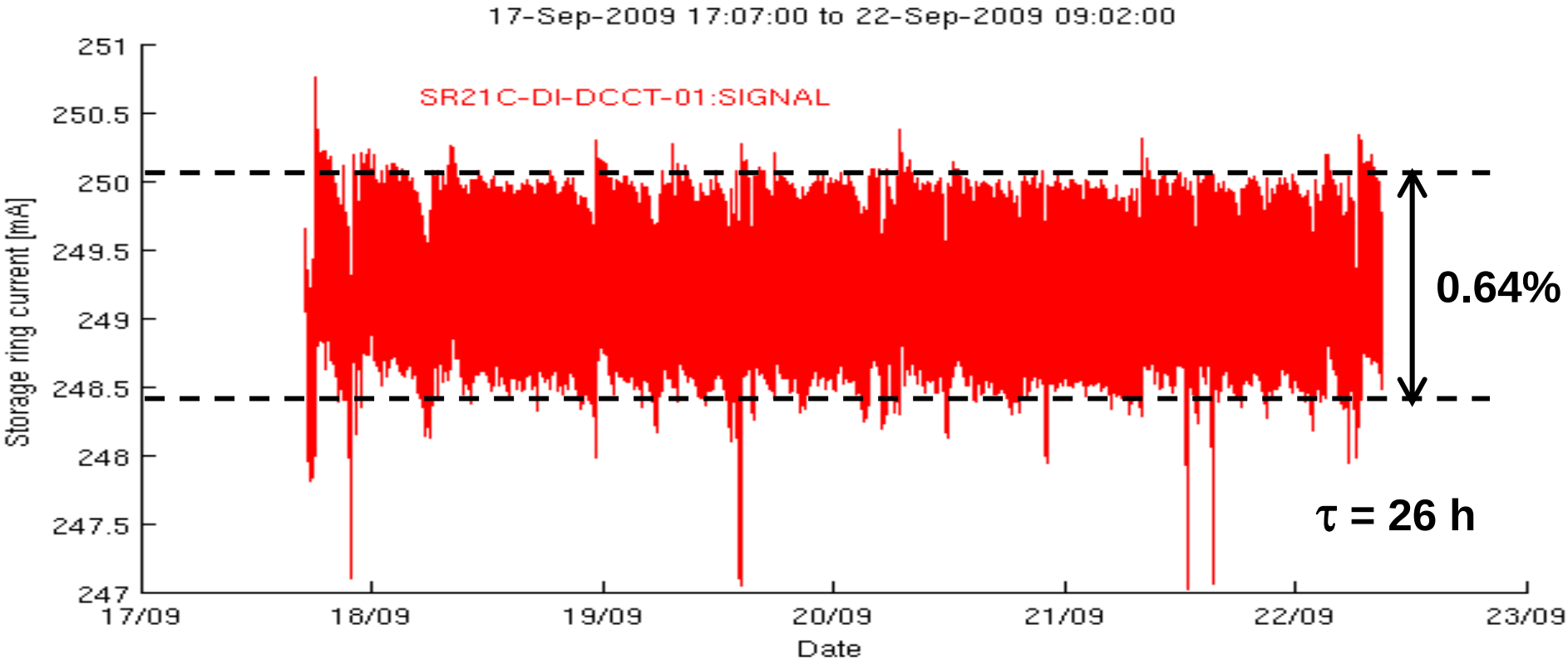
diamond

Recent:

multibunch fill + top-up in single bunch

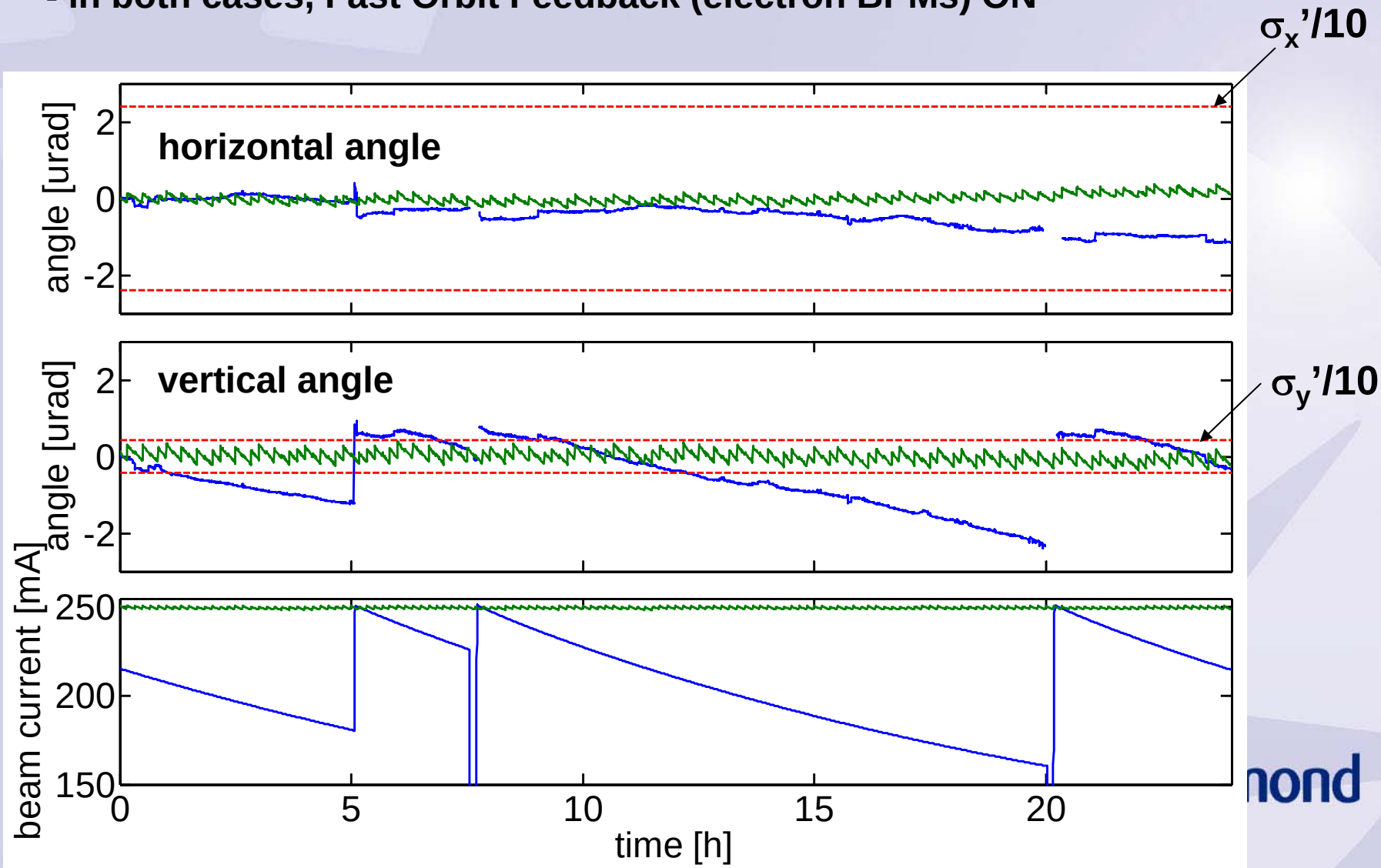


❖ 17th-19th September 2009: 112 h of uninterrupted beam:



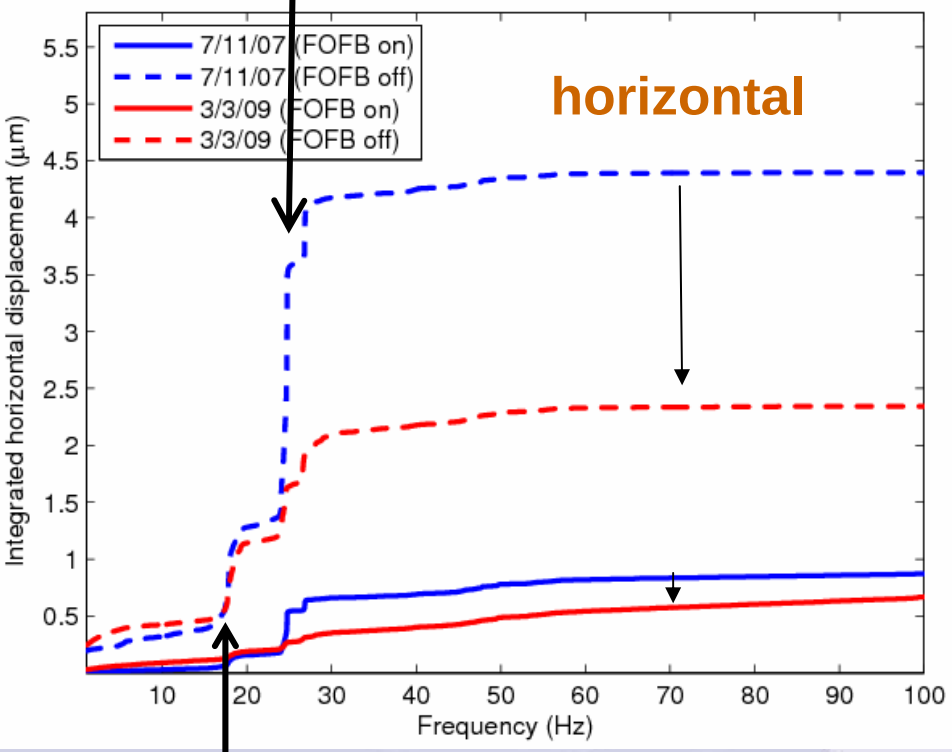
Orbit Stability Improvements: i/ Top-Up

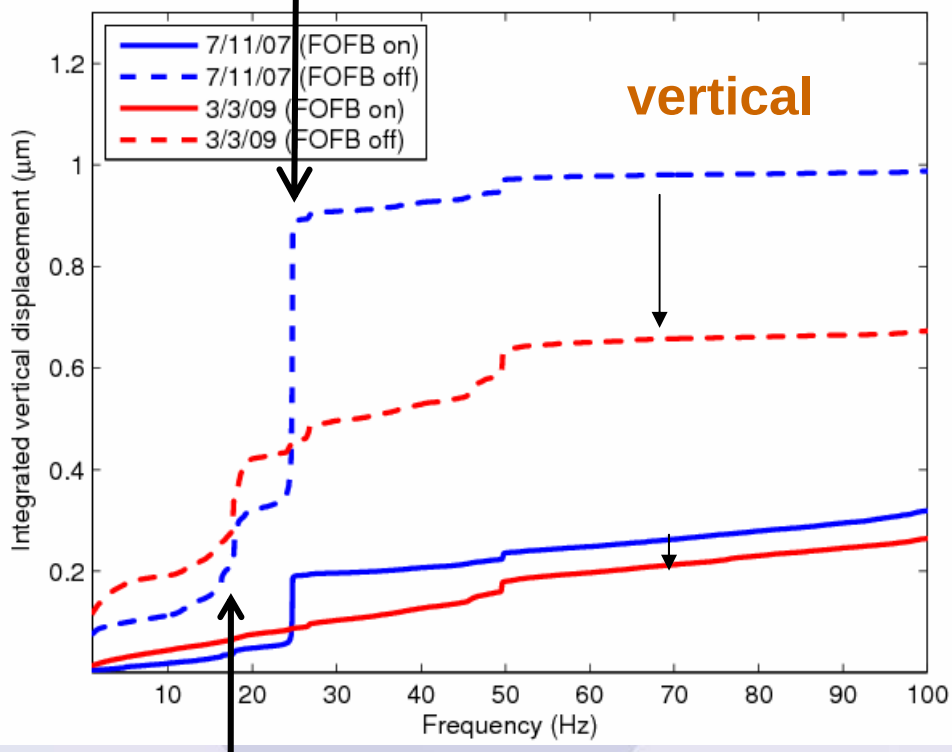
- measured using one of the photon BPMs (fixed ID gap)
- in both cases, Fast Orbit Feedback (electron BPMs) ON



ii/ Girder vibrations

Elimination of vibrations at 24.9 Hz after fixing water cooling pump mountings :





next target: air handling units, 18 Hz

Operating Performance (User Mode)

2007: 3120 h scheduled, 92.2% uptime, MTBF = 10.5 h

2008: 4089 h scheduled, 94.9% uptime, MTBF = 14.5 h

2009: 4656 h scheduled in total

so far **3912 h scheduled, 96.2% uptime, MTBF = 20.4 h**

2010: 4896 h scheduled

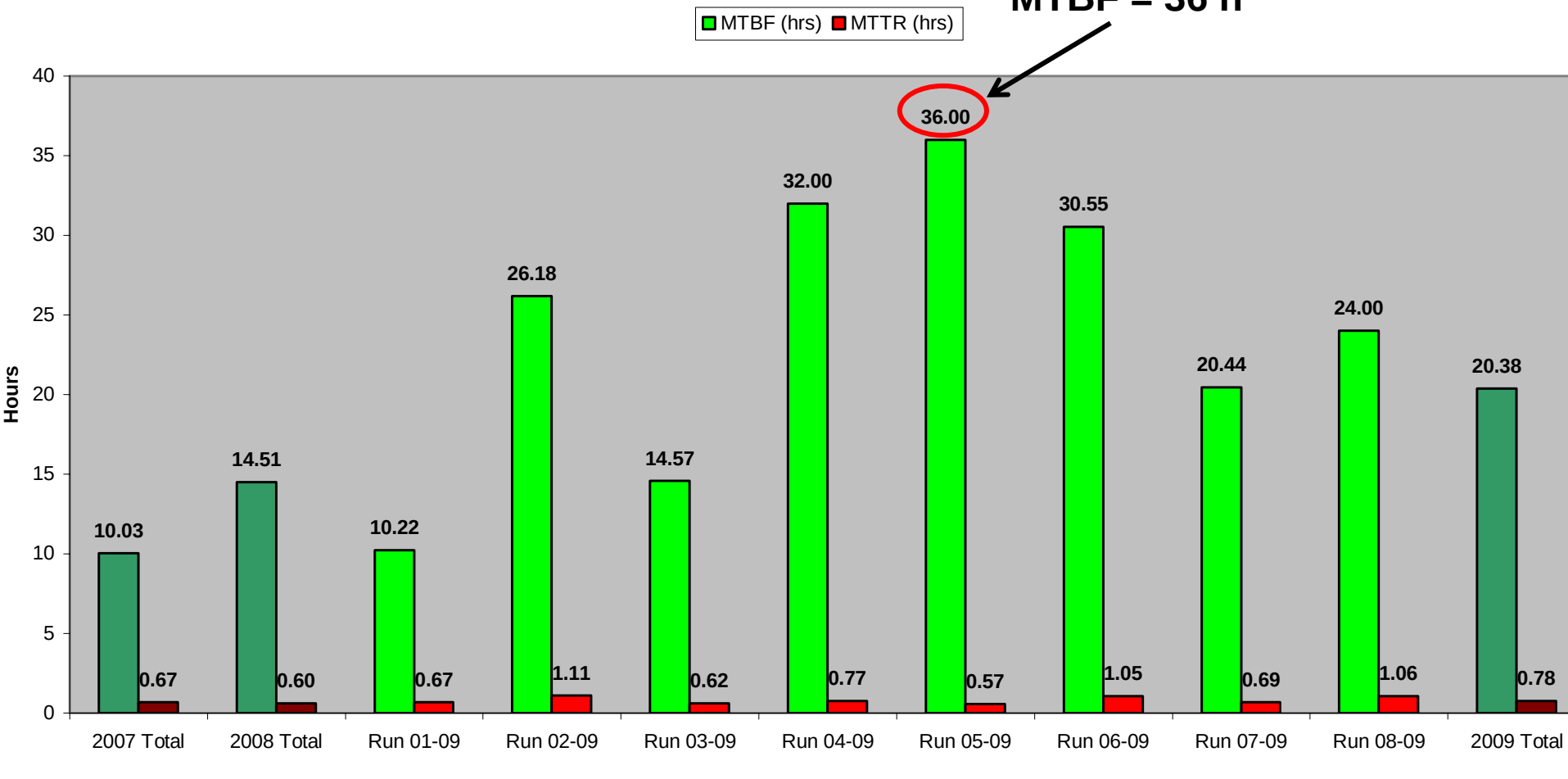
The machine has operated throughout 2009 at 250 mA, top-up mode (apart from a low-alpha run over Easter).

Two filling patterns:
- "standard": 900 bunch train (in 936)
- "hybrid": 686 bunch train + single bunch

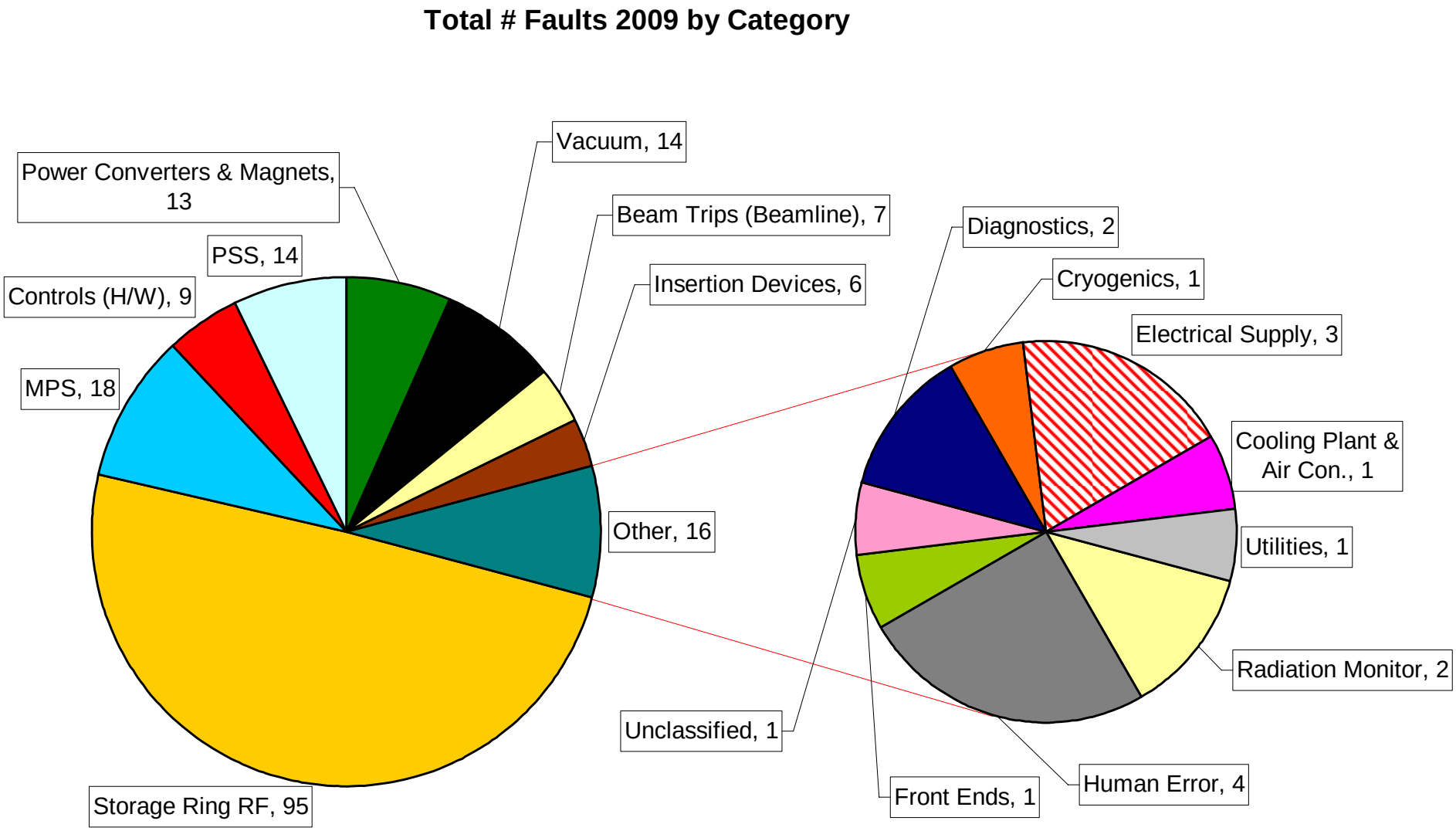
Mean Time Between Failures (MTBF)

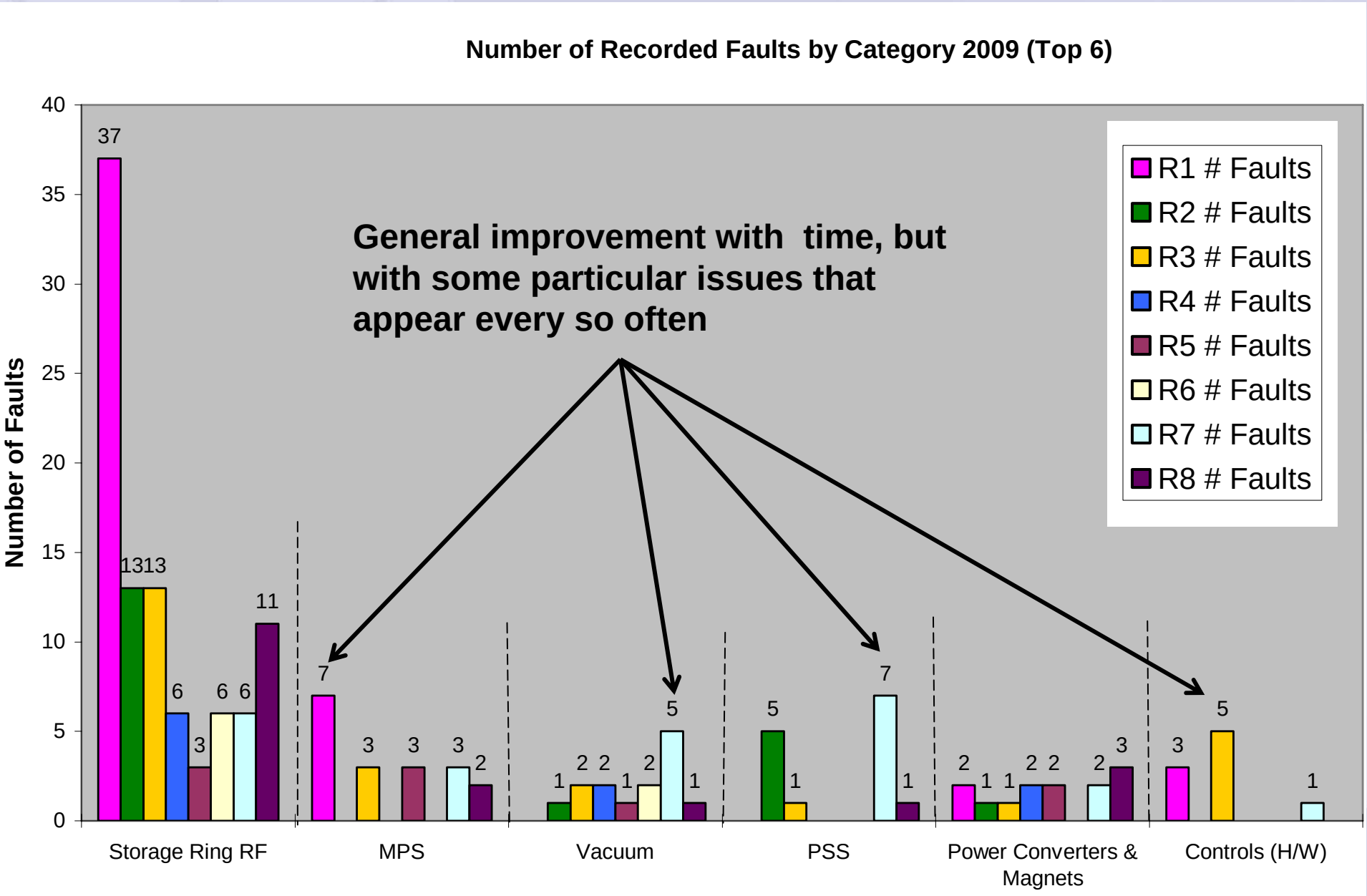
$$= \frac{\text{scheduled hours (User Mode)}}{\text{no. of unplanned beam losses}}$$

Run 05-09
Second best Run so far
MTBF = 36 h

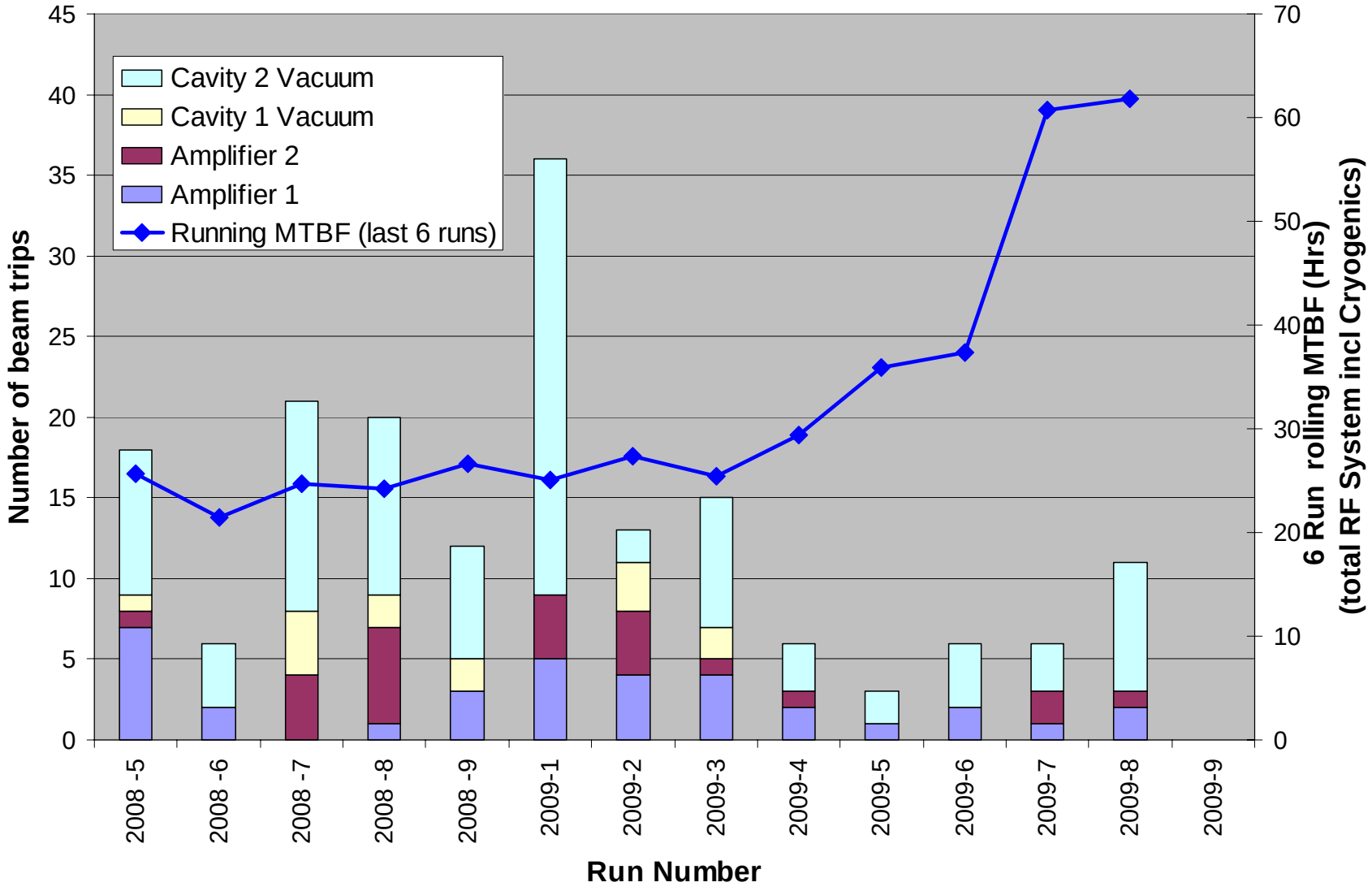


Fault Statistics

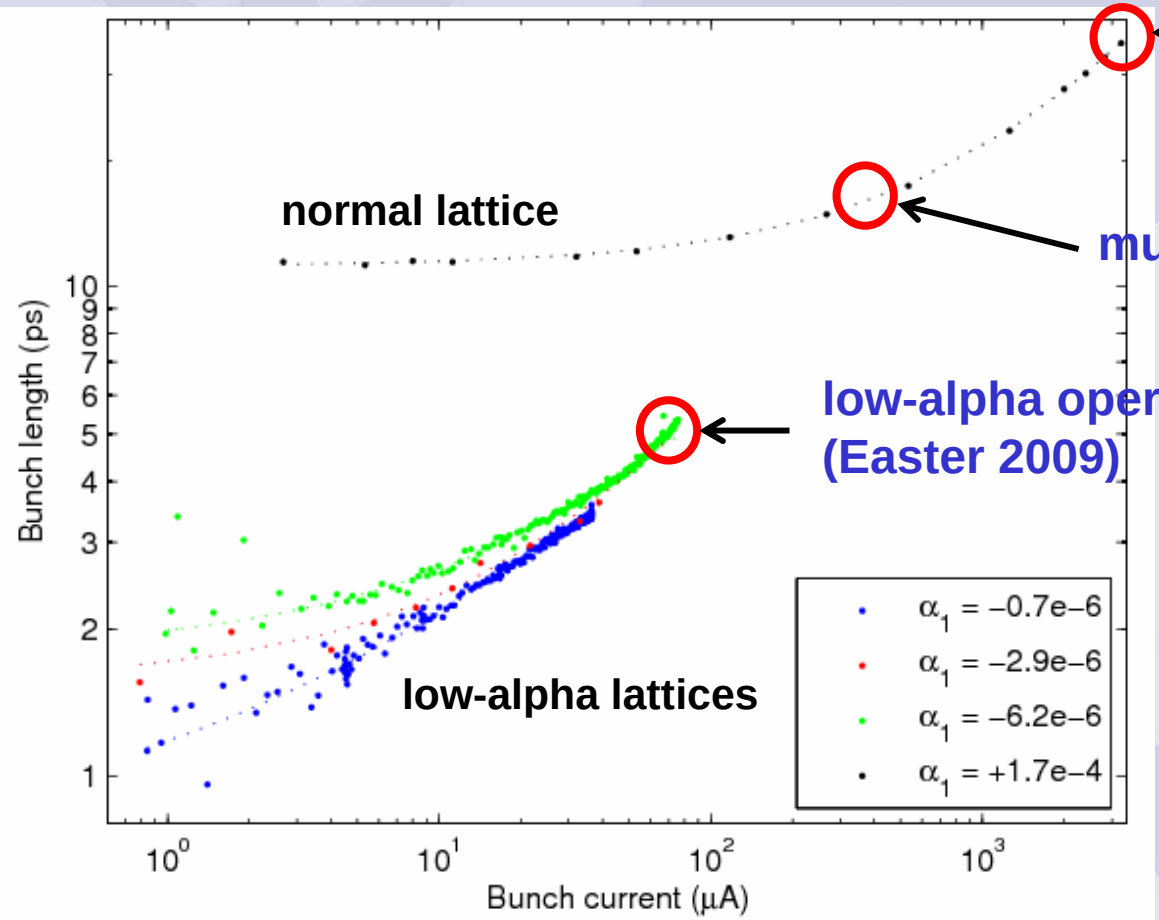



Number of Recorded Faults by Category 2009 (Top 6)
General improvement with time, but with some particular issues that appear every so often
Number of Faults
R1 # Faults
R2 # Faults
R3 # Faults
R4 # Faults
R5 # Faults
R6 # Faults
R7 # Faults
R8 # Faults
Storage Ring RF
MPS
Vacuum
PSS
Power Converters & Magnets
Controls (H/W)

Dual Cavity Statistics



Low-alpha Operation



"hybrid" bunch (3.2 mA)

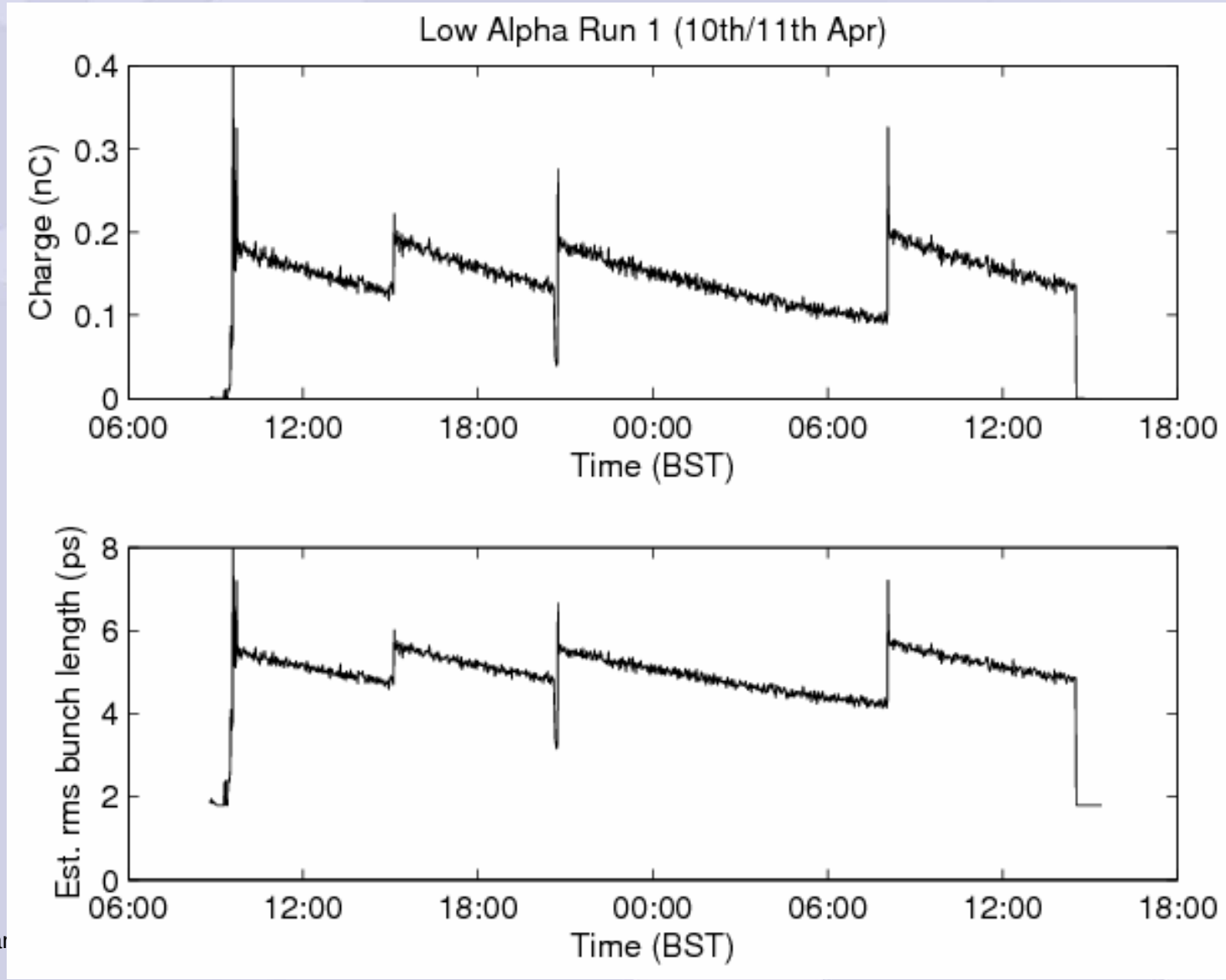
multibunch operation (0.36 mA)

low-alpha operating point (Easter 2009)

α_1	-2-3×10^{-6}
Bunch Length	~ 5 ps (rms)
Bunch Current	~ 80 μA
Lifetime	~ 12 h
Emittance	~ 30 nm.rad
Coupling	< 0.1%

- a new working point is being developed with not-so-low-alpha and closer to nominal emittance

Low-alpha Operation (Apr. ’09)



Insertion Devices

Beamline	ID	Type	Min. gap
I02	U23	In-vacuum	5 mm
I03	U21	In-vacuum	5 mm
I04	U23	In-vacuum	5 mm
I04.1	U28	Short ex-vacuum	16.25 mm
I06	HU64	APPLE-II	16 mm
I07	U23	In-vacuum (spare)	7 mm
I11	U22	In-vacuum	5.4 mm
I12	SCW2	4.2 T S/C Multipole Wiggler	
I15	SCW1	3.5 T S/C Multipole Wiggler	
I16	U27	In-vacuum	7 mm
I18	U27	In-vacuum	5 mm
I19	U22	In-vacuum	7 mm
I20.1	W83	Hybrid Multipole Wiggler	11 mm
I22	U25	In-vacuum	5 mm
I24	U21	In-vacuum	5 mm

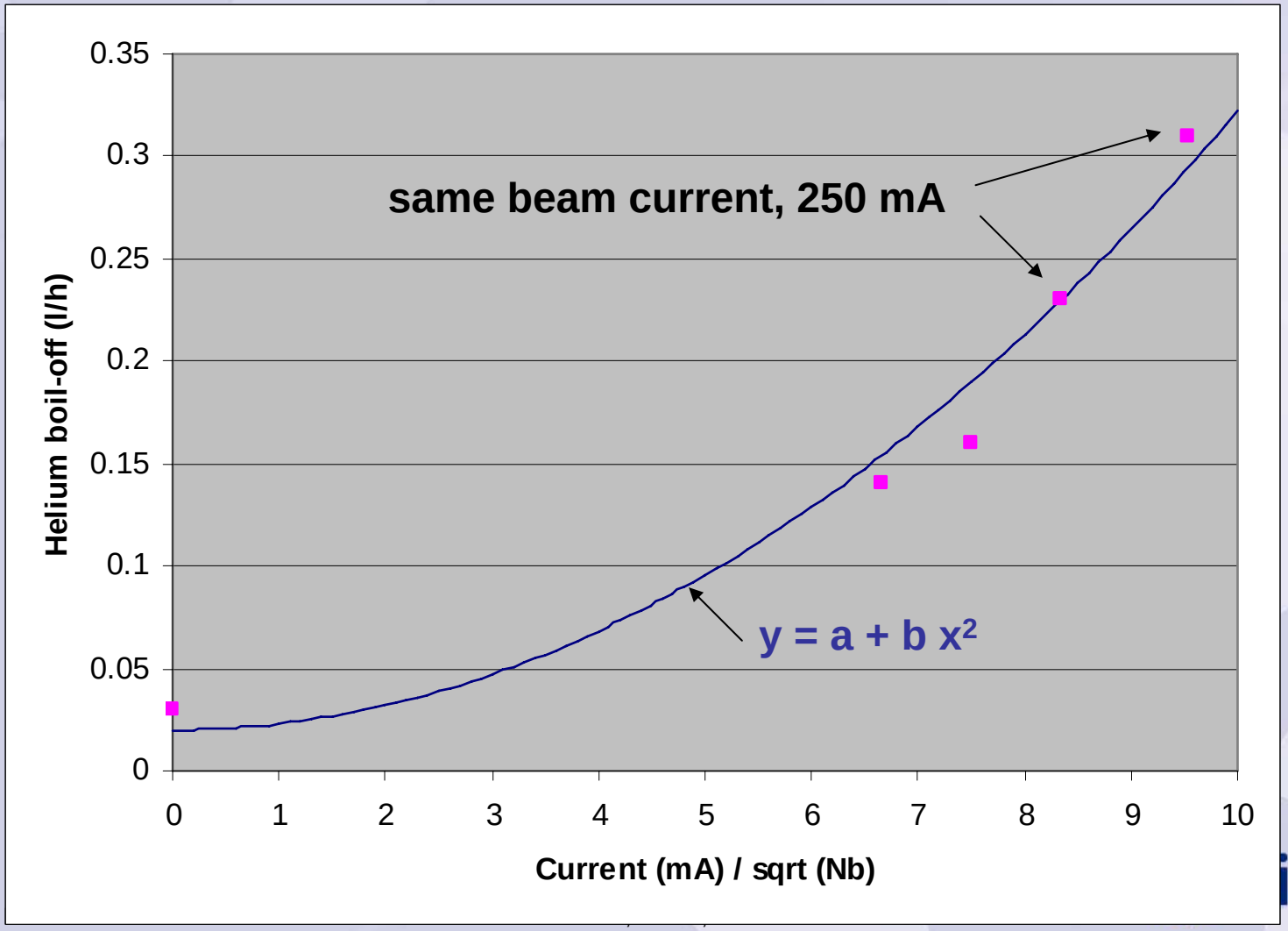
Superconducting Wigglers

- **Operating reliably at 3.5 T (I15) and 4 T (I12)**
- **I12 SCW Helium consumption not as good as hoped, and outside specification (< 0.1 l/h)**
- **I15 SCW a factor 7 worse, despite several interventions; not clear why**
- **Helium consumption is strongly beam current, and also fill pattern dependent, and has been the main factor in restricting operation to 250 mA**

	Beam current	No. Bunches	Helium boil off
I12	250 mA	900	0.23 l/h
I12	250 mA	686	0.31 l/h
I15	250 mA	900	1.6 l/h
I15	250 mA	686	2.3 l/h

- **300 mA operation should be possible with 900 bunch fill (i.e not hybrid mode)**
- **We are currently investigating various He recovery and refill options.**

- **Preliminary data suggests Helium boil-off is due to RF heating …**
  … more data needed to confirm !



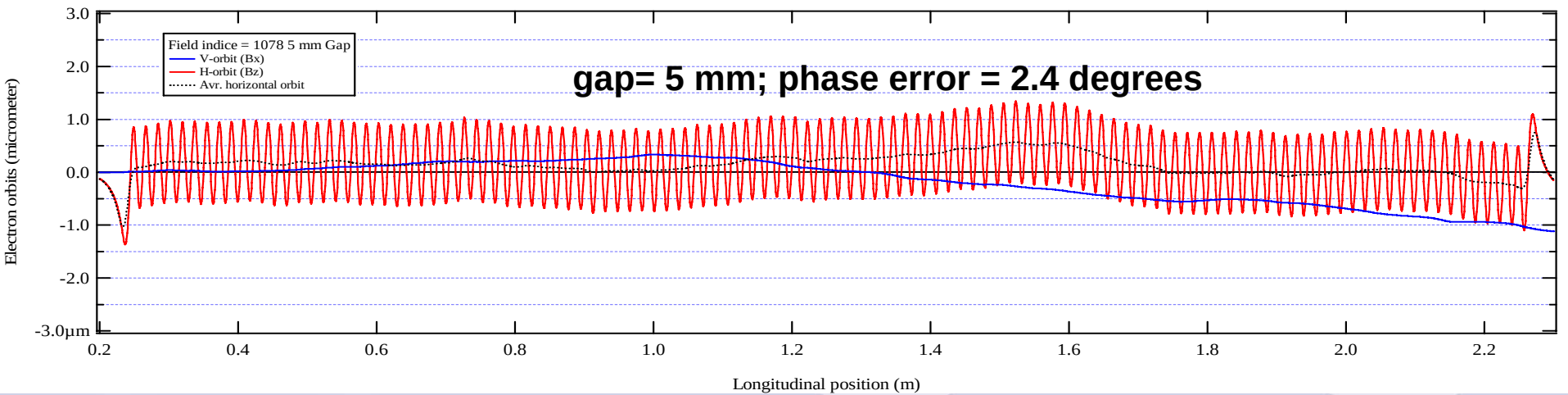
Cryogenic Permanent Magnet Undulator (U17.7)

- Under construction at Danfysik.
- Magnetic shimming (at room temperature) completed.
- Delivery expected in January 2010

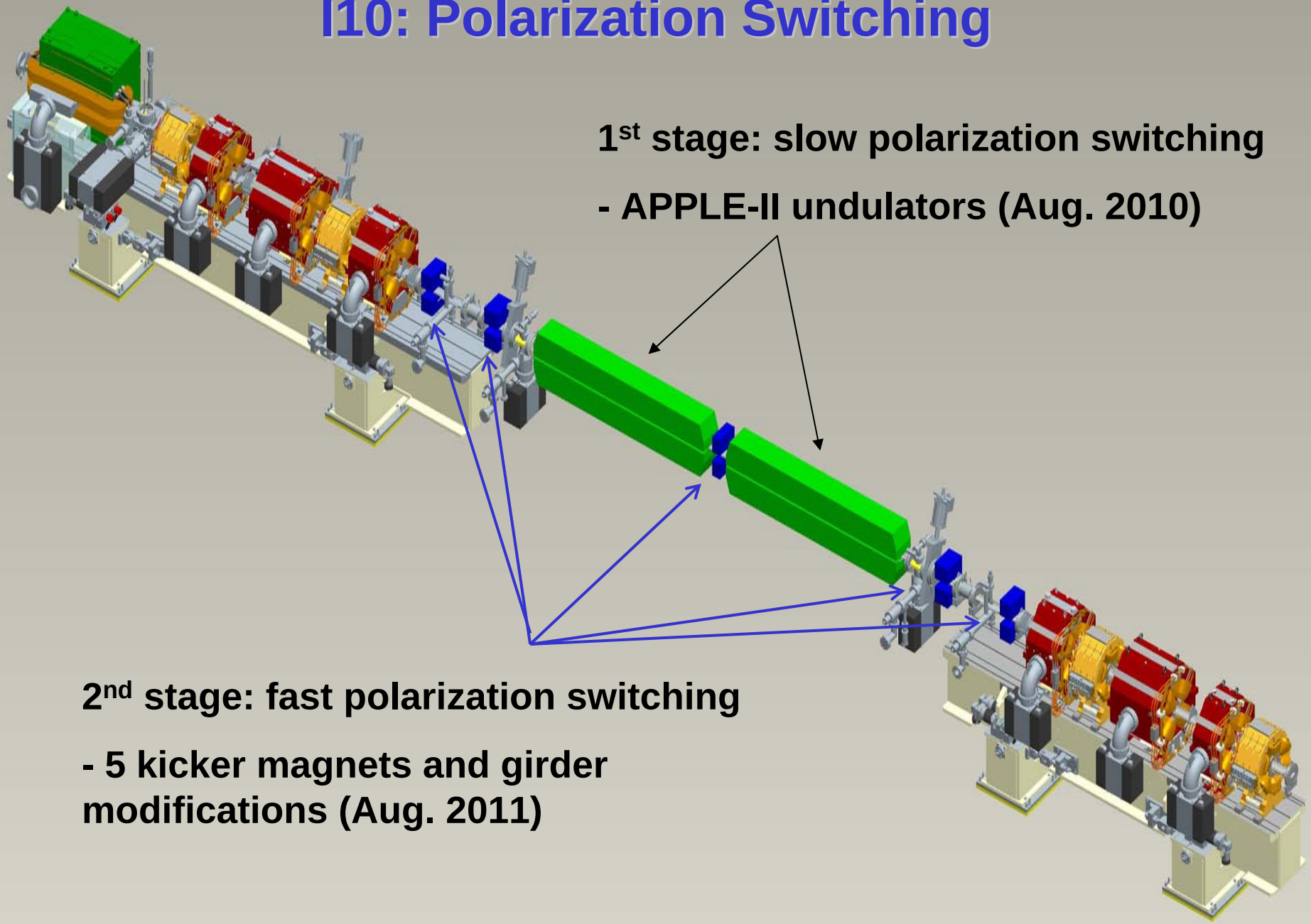
113 periods

K = 1.7 (5 mm gap)

Working temperature 120-150 K



I10: Polarization Switching



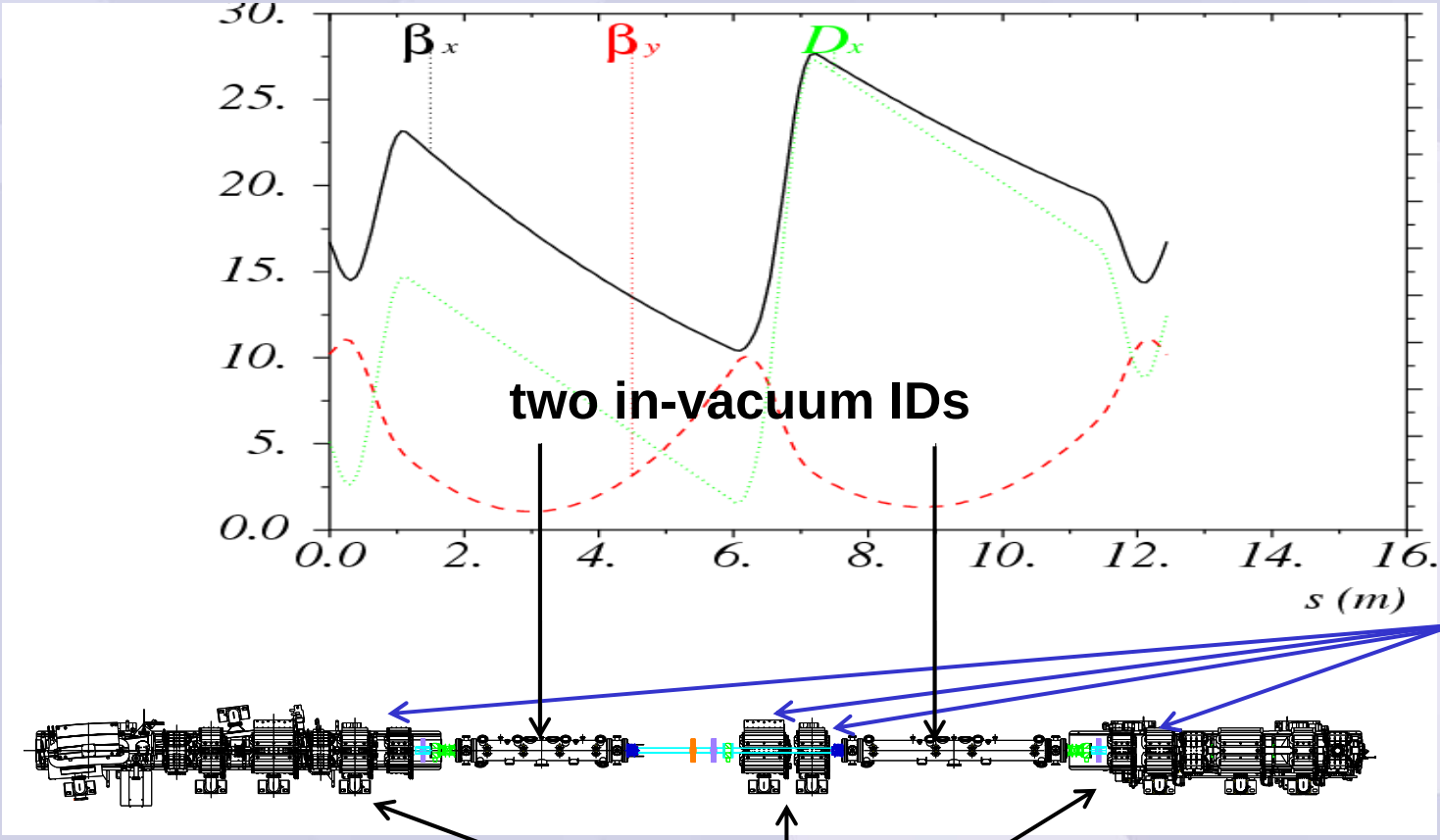
1st stage: slow polarization switching

- APPLE-II undulators (Aug. 2010)

2nd stage: fast polarization switching

- 5 kicker magnets and girder modifications (Aug. 2011)

I13: "Double mini-beta" and Horizontally Focusing Optics



4 new quadrupoles

Two girders to be modified, and new mid-straight girder, August 2010

Same again in March 2011 for I09

Thanks for your attention

diamond