Diamond Light Source Update

Richard P. Walker, on behalf of the Machine Team

1. Operating Performance etc.
2. Low-alpha
3. Orbit Measurement & Stability
4. Insertion Devices

ESLS XVIII, ELETTRA, Nov. 25-26th 2010

diamond

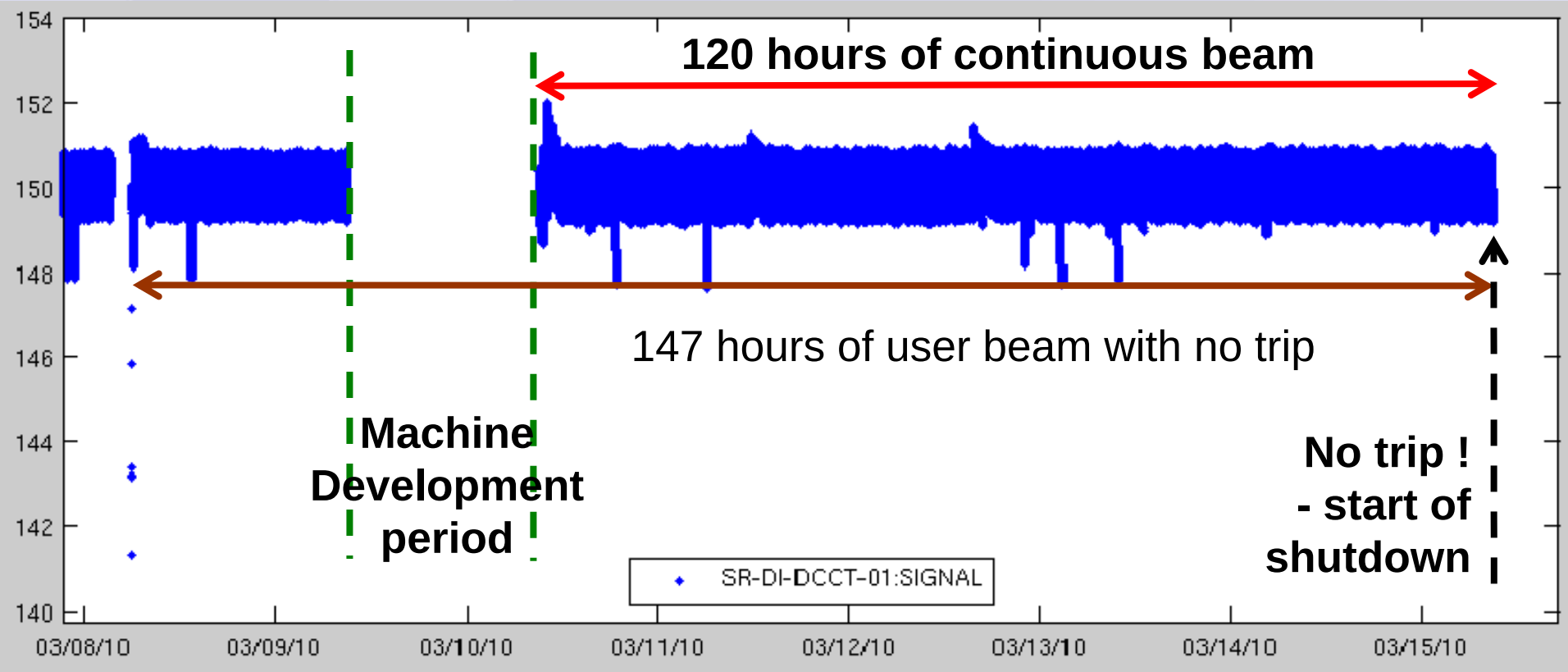
Operating Performance (User Mode)

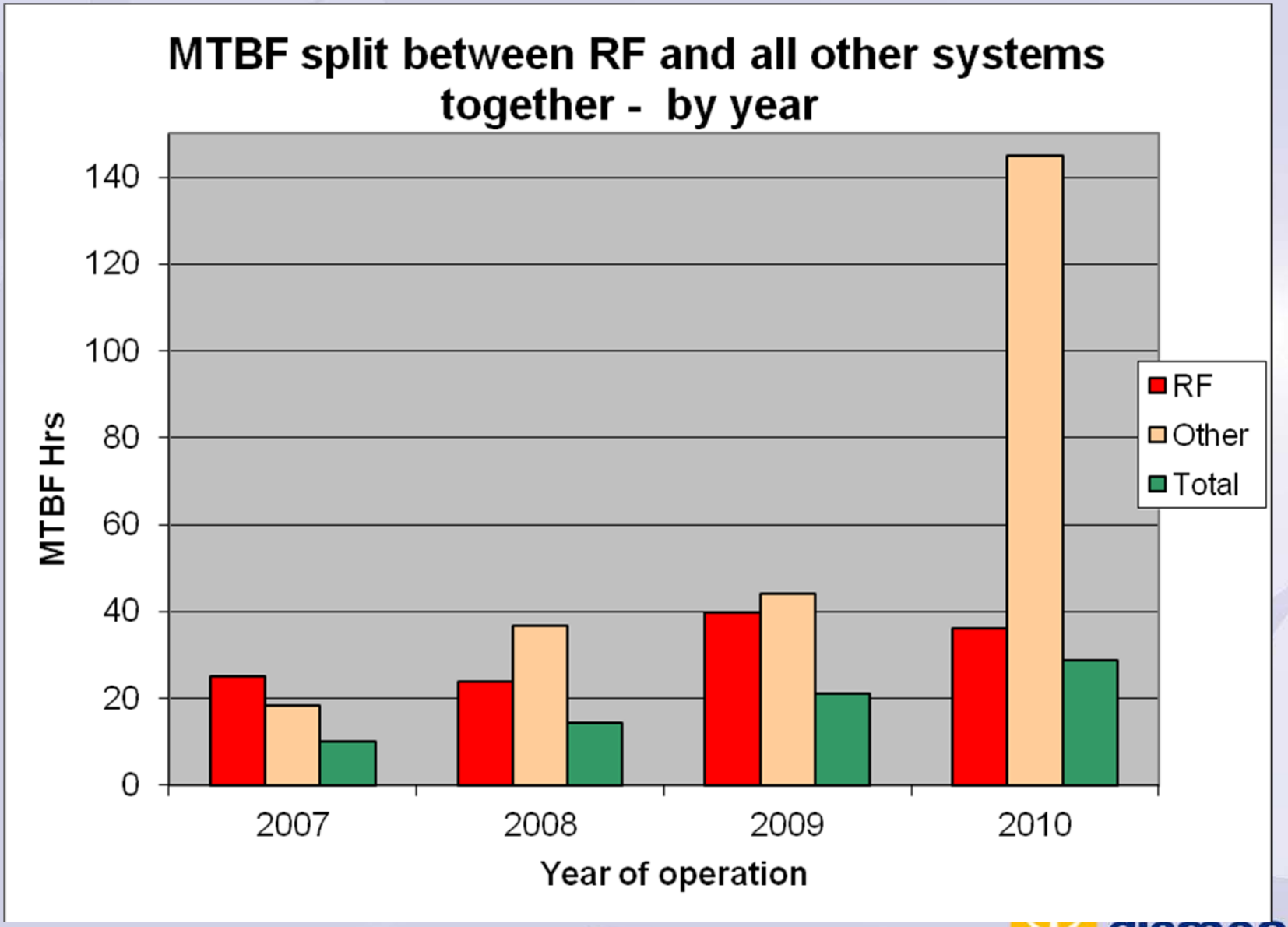
2007:	3160 h scheduled,	92.3% uptime,	MTBF = 10.6 h
2008:	4092 h scheduled,	94.9% uptime,	MTBF = 14.5 h
2009:	4656 h scheduled,	96.4% uptime,	MTBF = 21.1 h
2010:	**4848 h scheduled**		
so far	**4273 h scheduled,**	**97.9% uptime,**	**MTBF = 28.8 h**

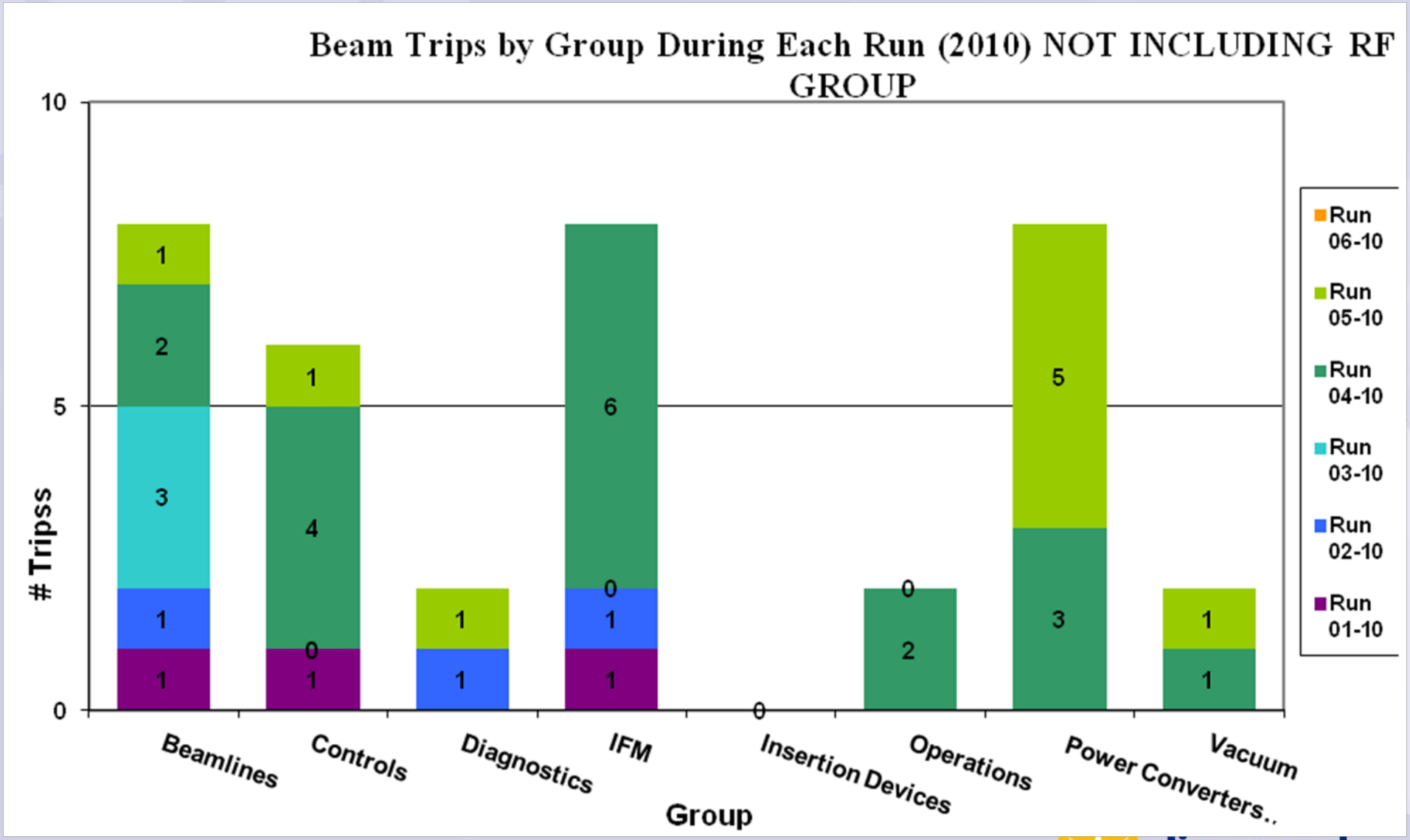
Top-up since Oct. 2008 (10 min interval)

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

Longest period with no trip - March 2010




MTBF split between RF and all other systems together - by year
MTBF Hrs
0
20
40
60
80
100
120
140
2007
2008
2009
2010
Year of operation
RF
Other
Total


Beam Trips by Group During Each Run (2010) NOT INCLUDING RF GROUP
10
5
0
Tripss
Beamlines
Controls
Diagnostics
IFM
Insertion Devices
Operations
Power Converters..
Vacuum
Group
Run 06-10
Run 05-10
Run 04-10
Run 03-10
Run 02-10
Run 01-10
1
2
3
1
1
1
4
0
1
1
1
6
0
1
1
0
0
2
5
3
1
1

Organization of Operations

(as requested by Emanuel)

i) From 2006

3 shifts x 8 hours /day Monday-Friday

2 shifts x 12 hours/day Saturday-Sunday

Each shift operated by one dedicated Operator (from 7-man team) + one "volunteer" (from 20-30 man pool).

No shifts during machine shutdowns

ii) From Sep. 2009

Volunteers replaced by Experimental Hall Coordinators (7-man team)

iii) From Nov. 2010

Operator and EHC teams increased to 8-men

2 shifts x 8 hours/day during shutdowns also, including week-ends, but not over Christmas/NewYear

Superconducting RF Cavity Problems

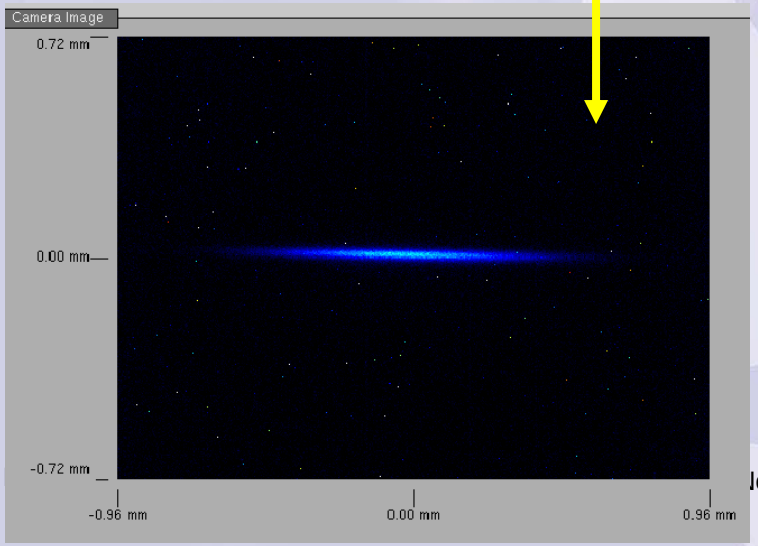
- **Due to a failure of the insulation vacuum of Cavity #2 over the Xmas holidays, the cavity had to be removed from the ring.**
- **Initial operation in 2010 with single cavity at 150 mA.**
- **Cavity #3 was installed in the June shutdown.**
- **Reliability improved from early July with a change in operating conditions.**
- **Beam current was increased to 200 mA from August 4th.**
- **Cavity #2 is under repair, and due for return Mar. 2011.**
- **The current plan is to install Cavity #2 in June 2011 to confirm its operation and assess the changes that have been made to improve reliability (pick-up design, Cu plating etc.).**

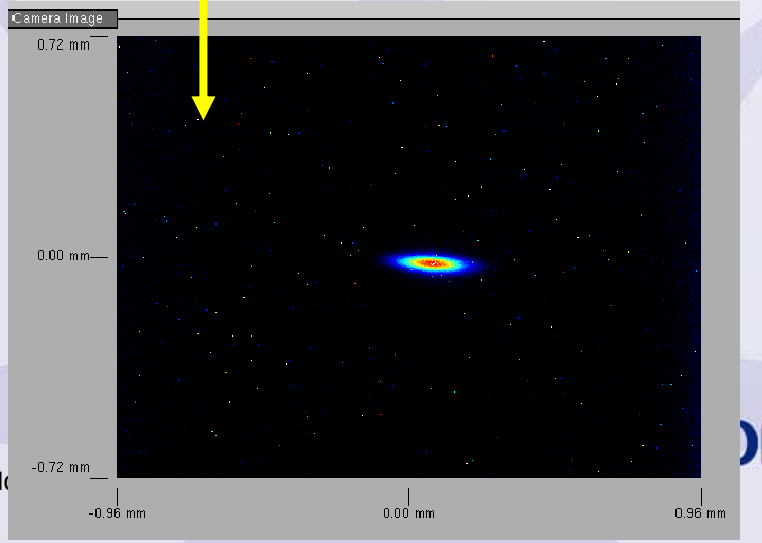
“Low-alpha” Mode (April 16-20th 2010)

New operating point with lower emittance:

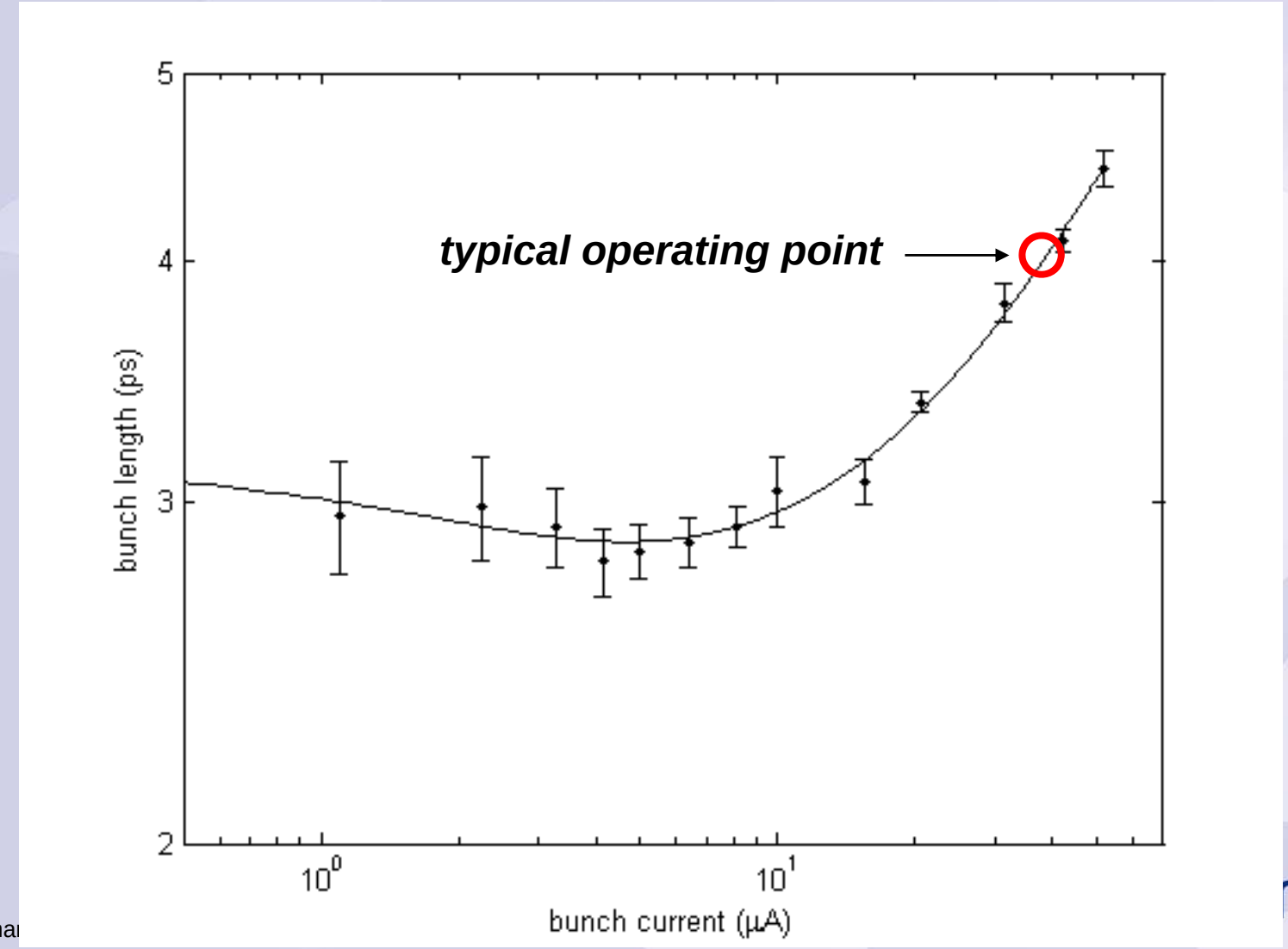
Parameter	April 2009	April 2010
α_1	$-2\text{-}3\times10^{-6}$	-1×10^{-5}
Bunch Length	~ 5 ps (rms)	~ 4 ps (rms)
Bunch Current	~ 80 μA	~ 40 μA
Lifetime	~ 12 h	~ 15 h
Emittance	~ 30 nm.rad	~ 4.4 nm.rad
Coupling	~ 0.05%	~ 0.15%

images of the electron beam using the X-ray pinhole camera

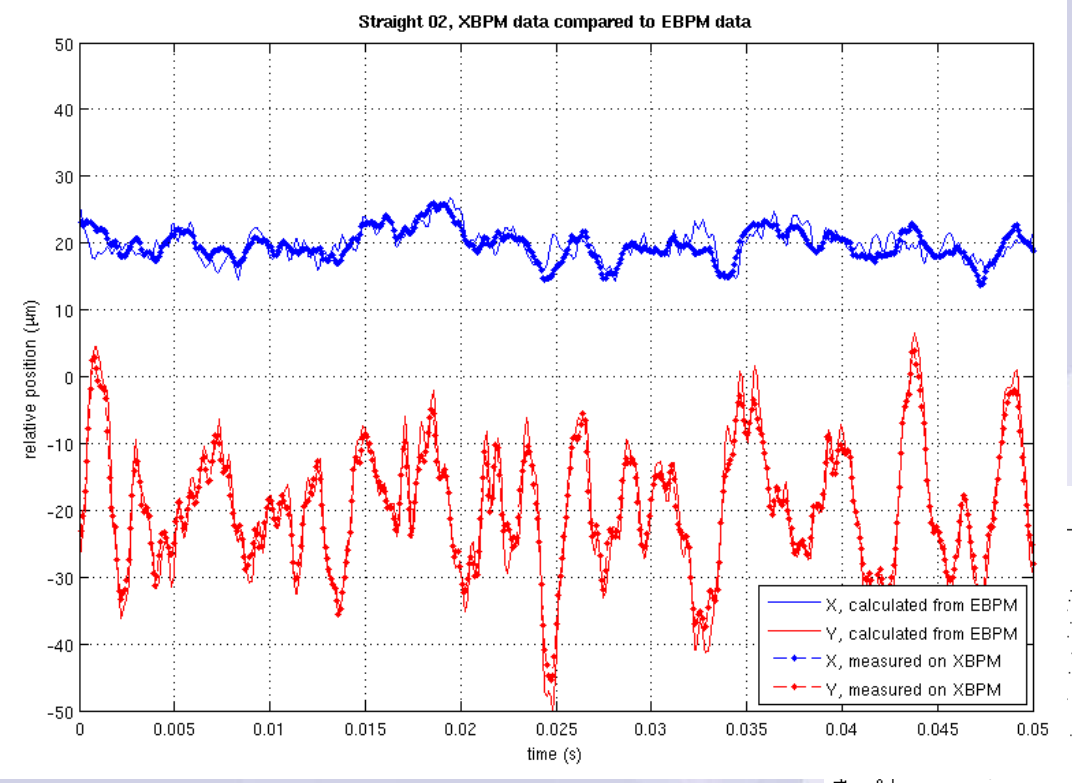




Measured bunch length vs. current under April '10 User Mode conditions:



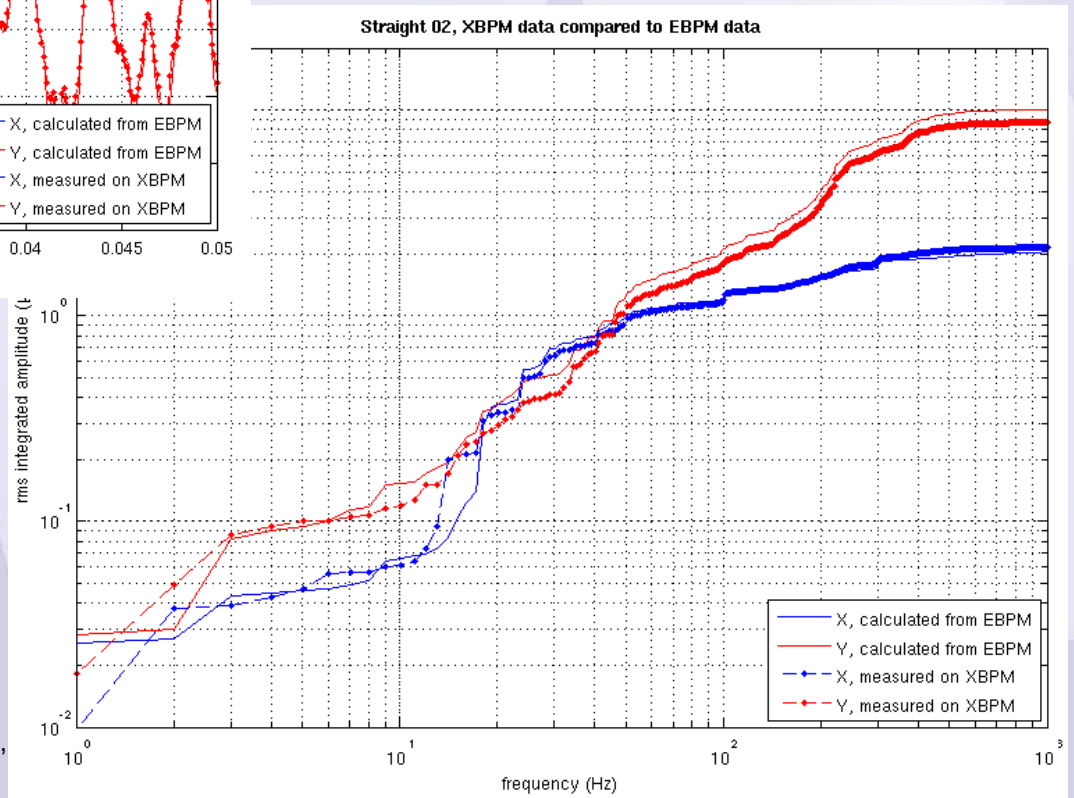
Orbit Measurements & Stability



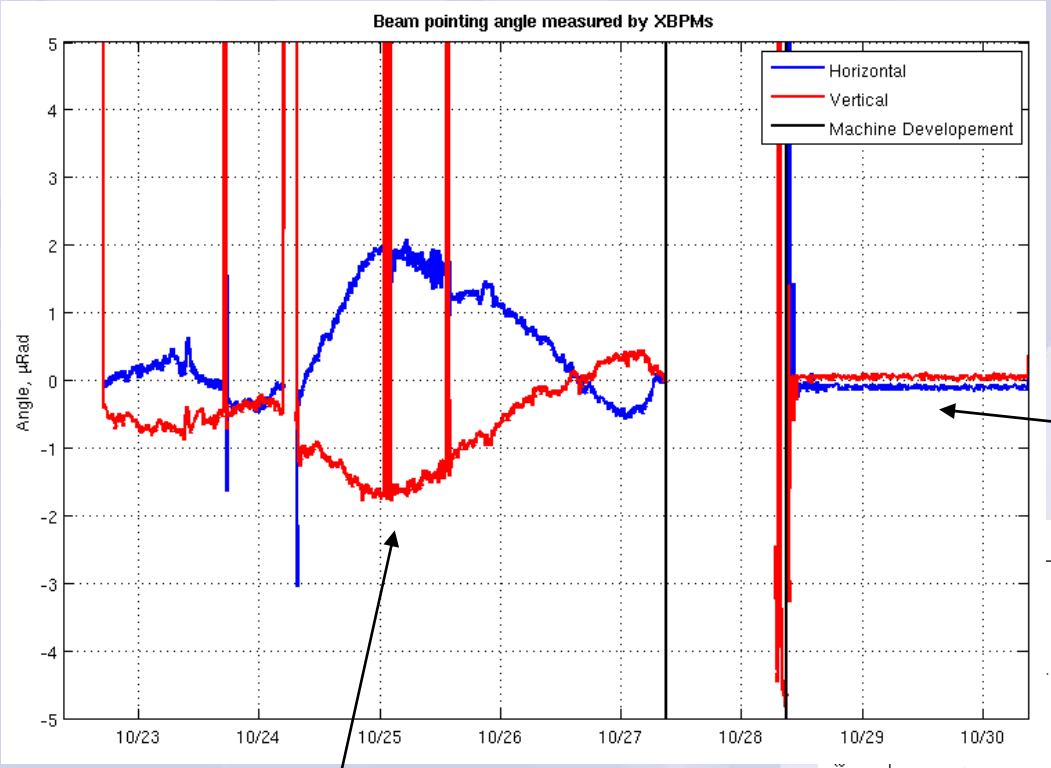
Synchronous acquisition of eBPM and XBPM data at 10 kHz (LIBERA Photon)

Projected X and Y at the XBPM1, 12.3 m from ID centre

excellent agreement !

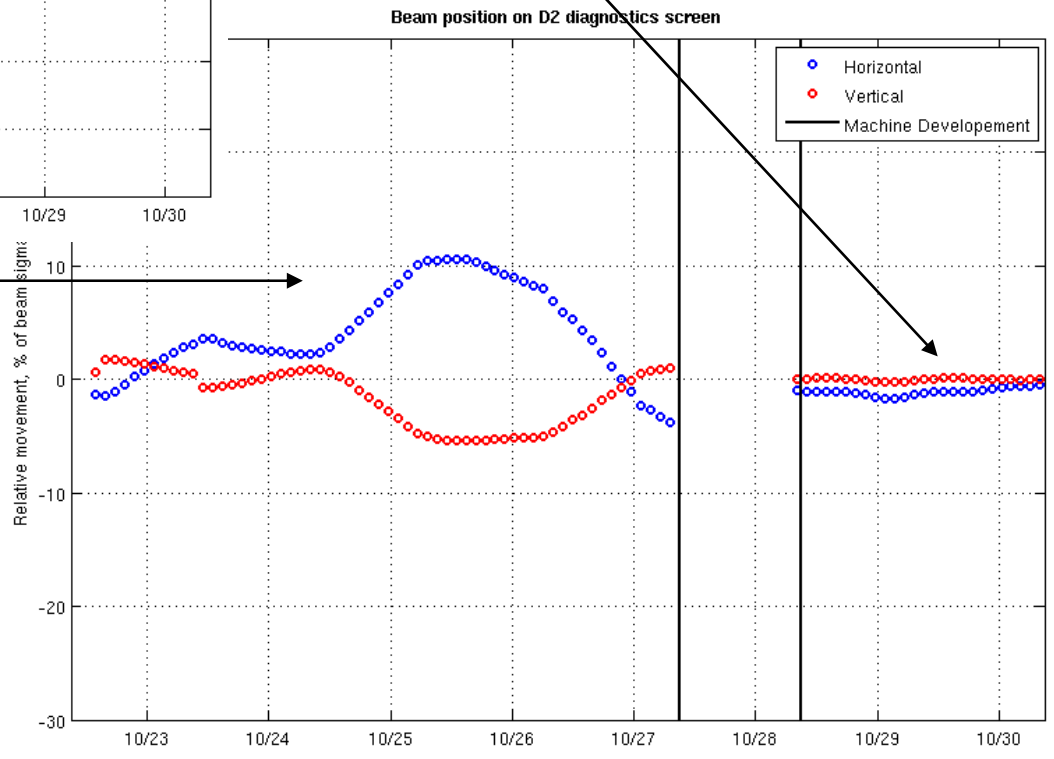


XBPM feedback



Slow drifts seen by the I19 beamline have been eliminated by up-dating eBPM set-points in FOFB at 0.5 Hz using XBPM data (at fixed ID gap).

with XBPM feedback



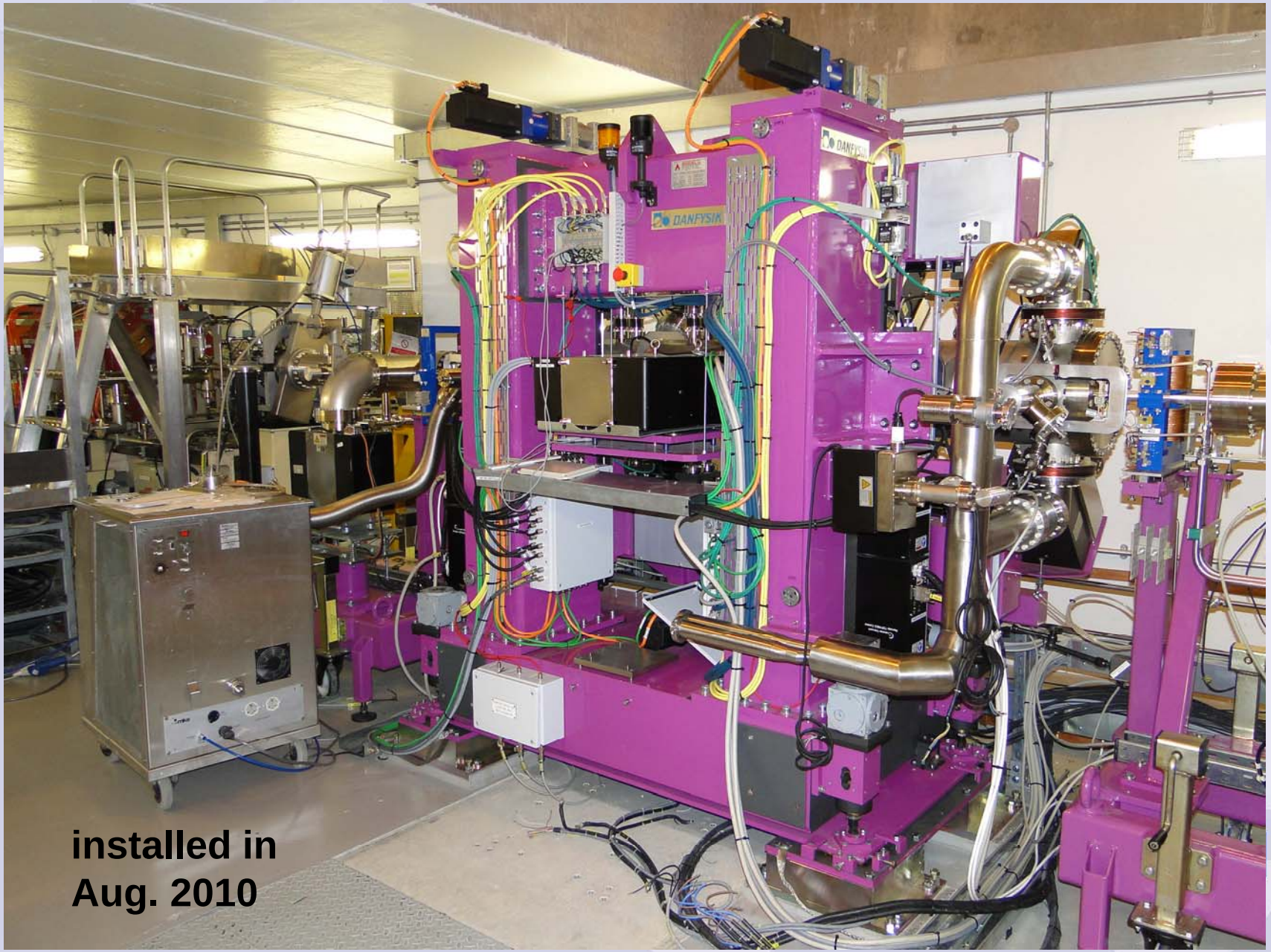
no XBPM feedback

"Observation and Improvement of the Long Term Beam Stability using X-ray Beam Position Monitors at DLS", C. Bloomer et al, IPAC '10

Insertion Devices

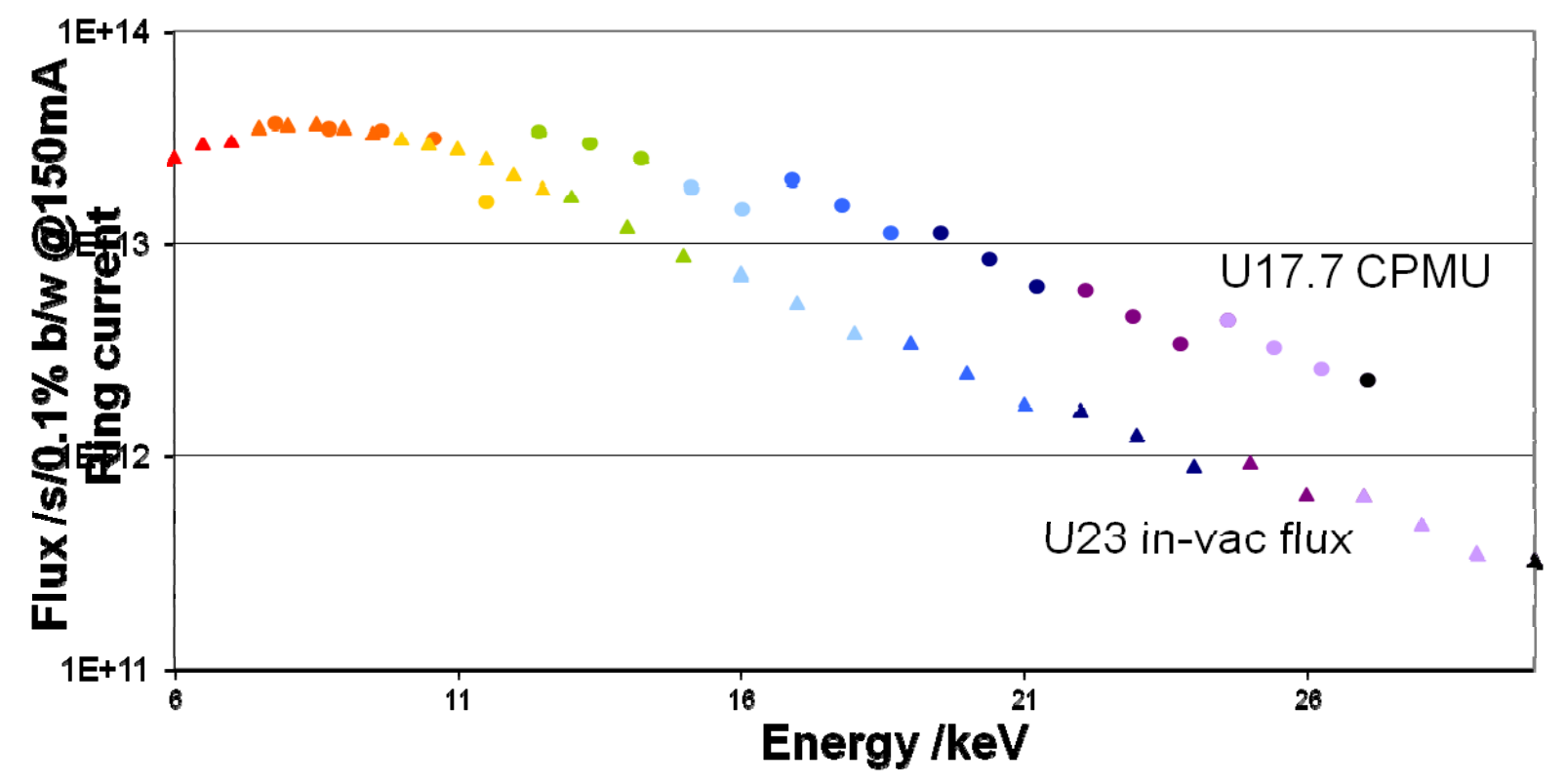
Beamline	ID	Type	Min. gap
I02	U23	In-vacuum	5 mm
I03	U21	In-vacuum	5 mm
I04	U23	In-vacuum	5 mm
I04.1	U28	Short ex-vacuum	16.25 mm
I06	HU64	APPLE-II	16 mm
I07	U23	In-vacuum CPMU	5.8 mm
I11	U22	In-vacuum	5 mm
I12	SCW2	4.2 T S/C Multipole Wiggler	-
I13	U23	In-vacuum (spare)	*commissioning*
I15	SCW1	3.5 T S/C Multipole Wiggler	-
I16	U27	In-vacuum	5 mm
I18	U27	In-vacuum	5 mm
I19	U22	In-vacuum	5 mm
I20	W83	Hybrid Multipole Wiggler	11 mm
I22	U25	In-vacuum	5 mm
I24	U21	In-vacuum	5 mm

I07 Cryogenic Permanent Magnet Undulator



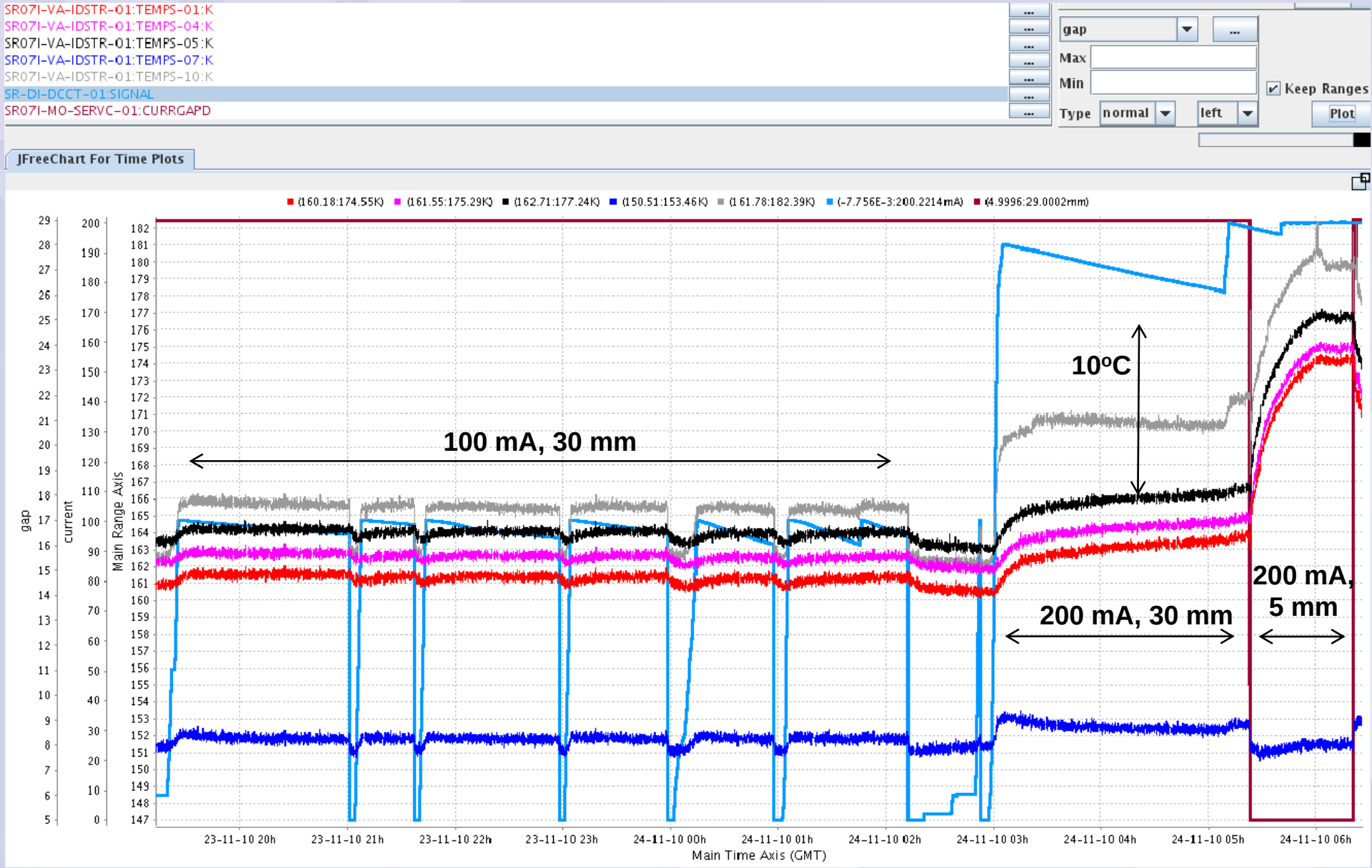
Preliminary results – ID not fully optimised (5.8 mm gap)

Flux gain ~ 3.5 at high energy

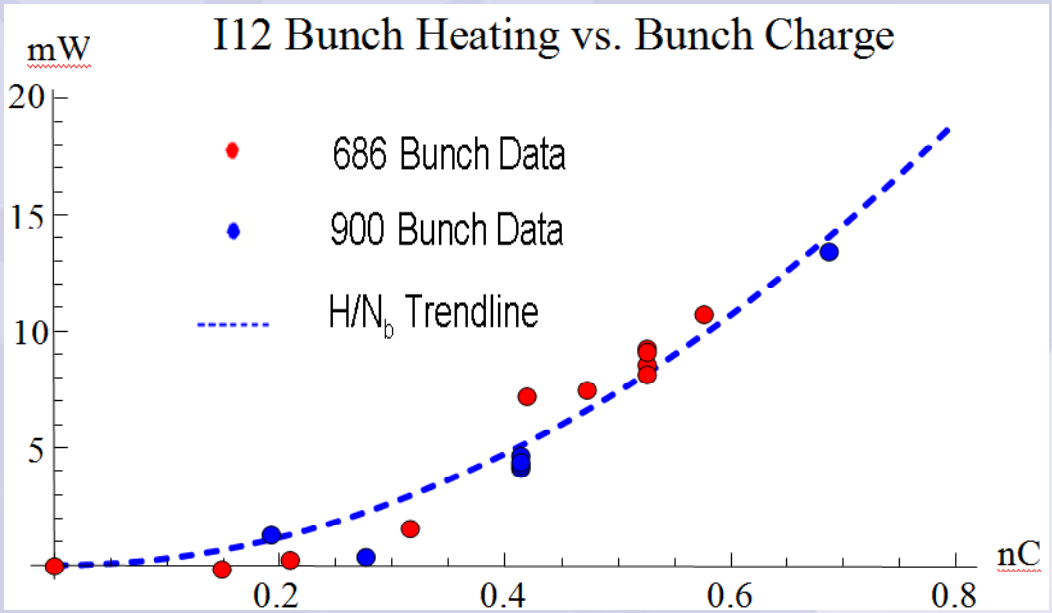


picture provided by I07 Principal Beamline Scientist, Chris Nicklin

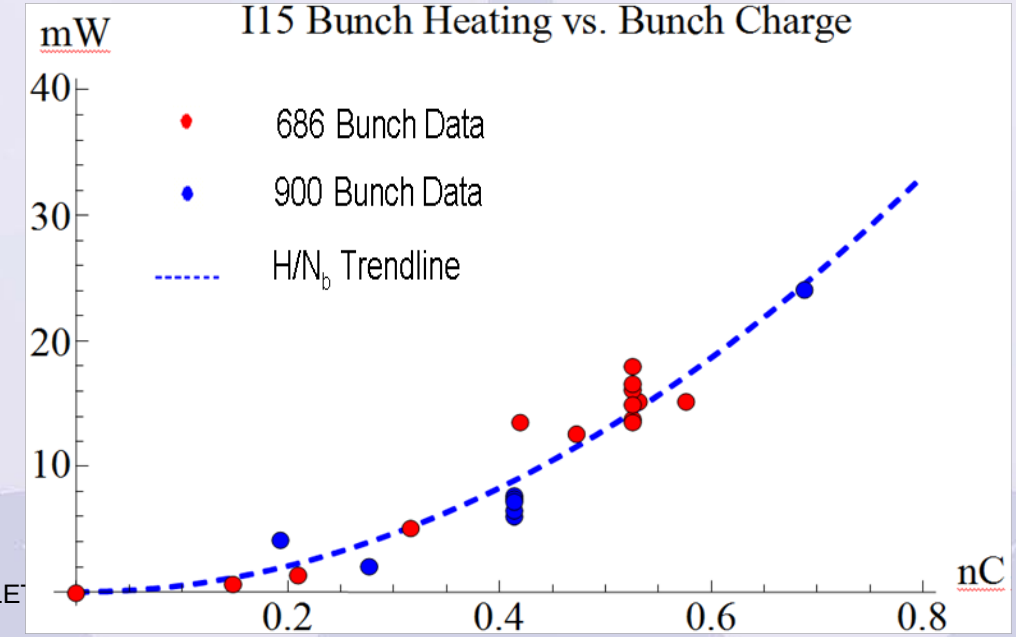
CPMU magnet array temperature stability



Superconducting Wigglers



conclusive evidence for beam current (RF) heating



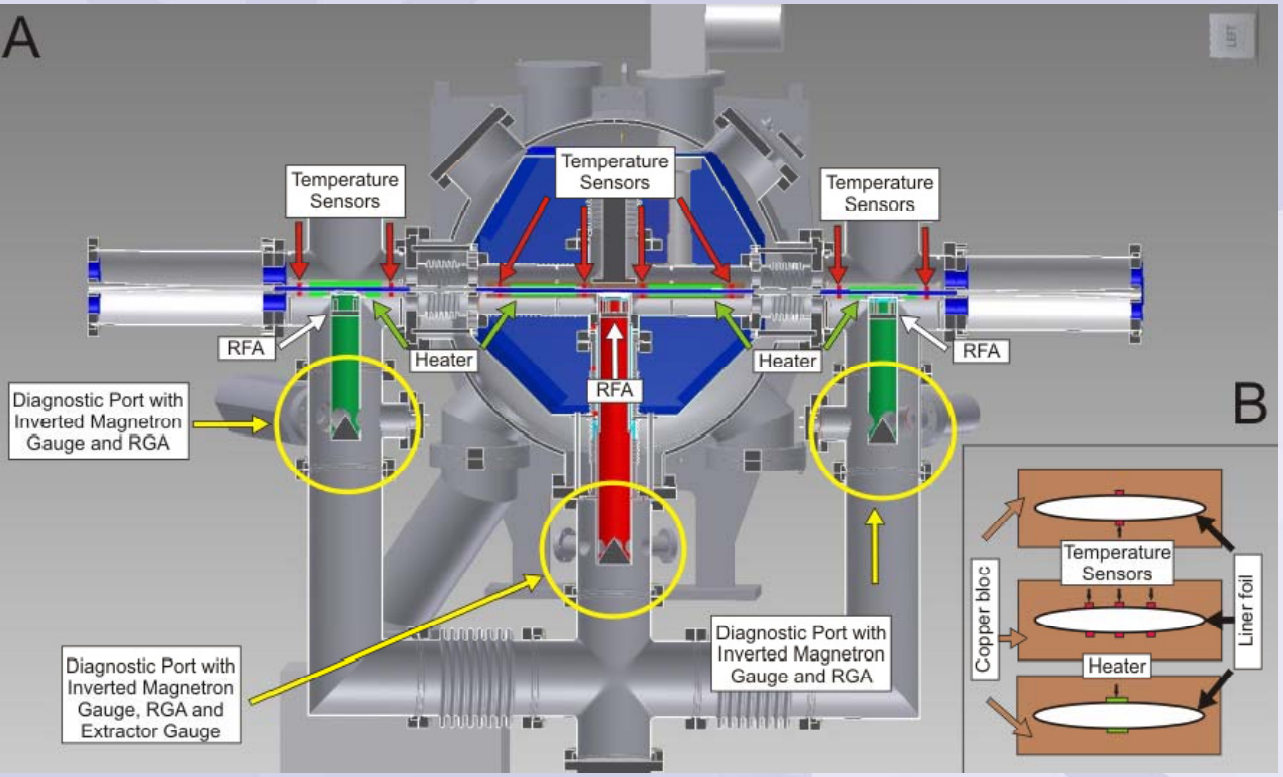
"Electron Beam Heating Effects in Supeconducting Wigglers at Diamond Light Source", E. Rial and J. Schouten, Proc. IPAC'10

Helium consumption and estimated total power incident on the liner, derived from the cryocooler load maps, at 250 mA with 73% fill

	Helium boil-off	Boil-off power	Total Power
I12	0.3 l/h	0.2 W	9.2 W
I15	1.2 l/h	0.8 W	16.6 W

- **Why I15 much worse than I12 not totally clear, but suspected that Cu liner is touching the helium can**
- **Intervention planned on I15 wiggler in March 2011:**
  - new Cu liner with reduced inner aperture (9 mm instead of 10 mm)
  - improved spacers with lower thermal conductivity
  - changes to thermal transition bellows units

COLDDIAG



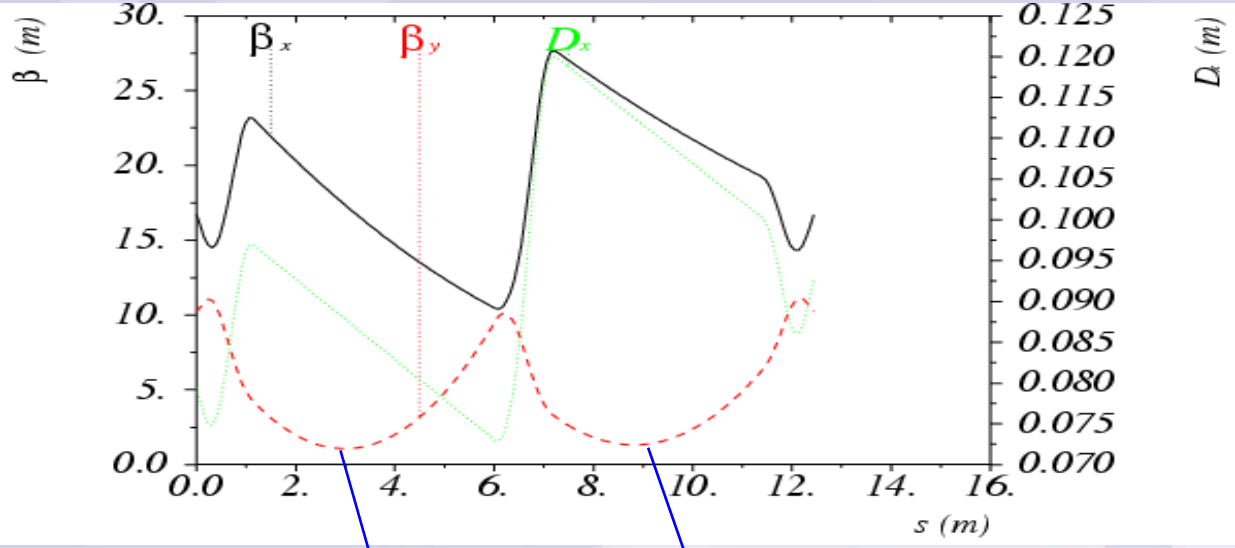
Collaboration with ANKA

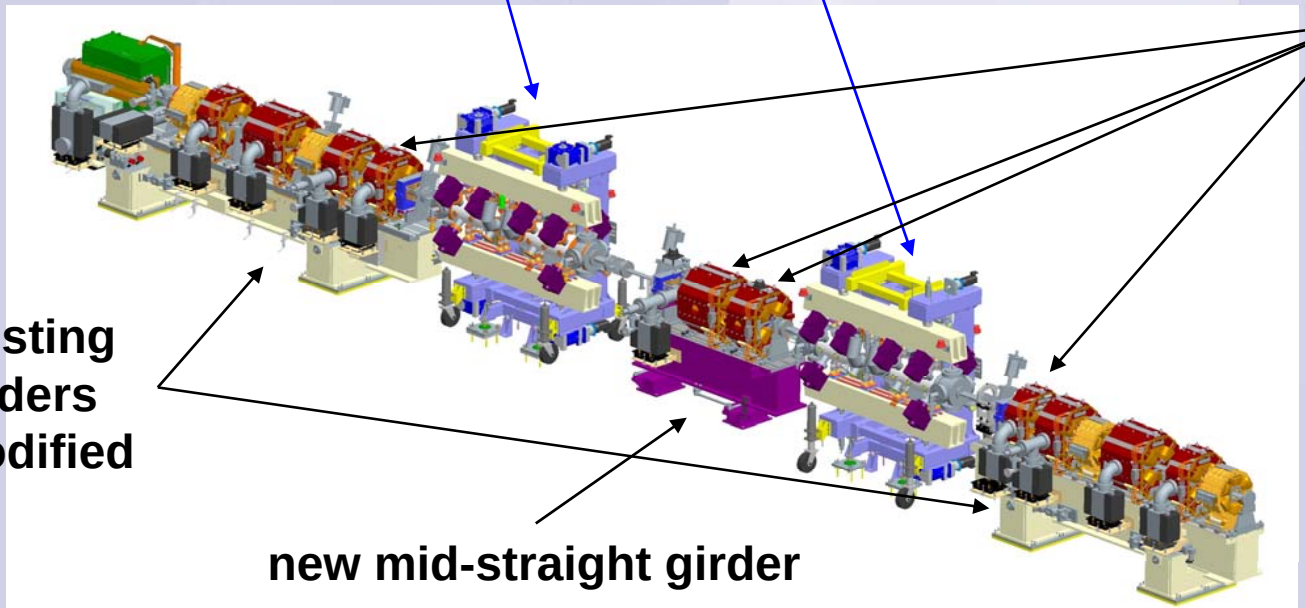
Aim is to measure heat loads on cryogenic surfaces under various beam and vacuum conditions, to support future development of superconducting undulators (and wigglers)

Planned installation in Diamond in June 2011

"Status of COLDDIAG: a Cold Vacuum Chamber for Diagnostics", S. Gerstl et al., Proc. IPAC'10

I13 “Double mini-beta” and Horizontally Focusing Optics



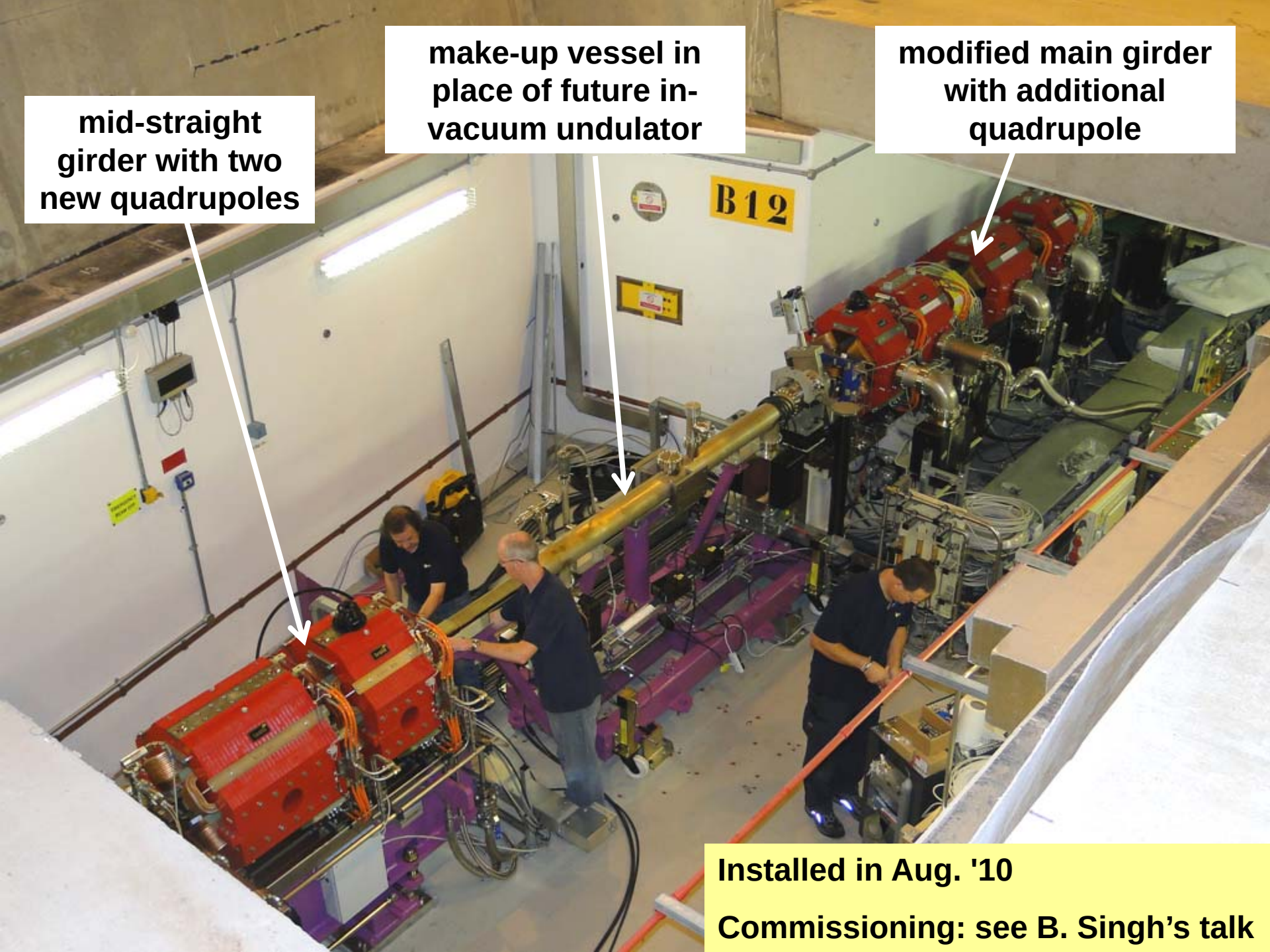


4 new quadrupoles

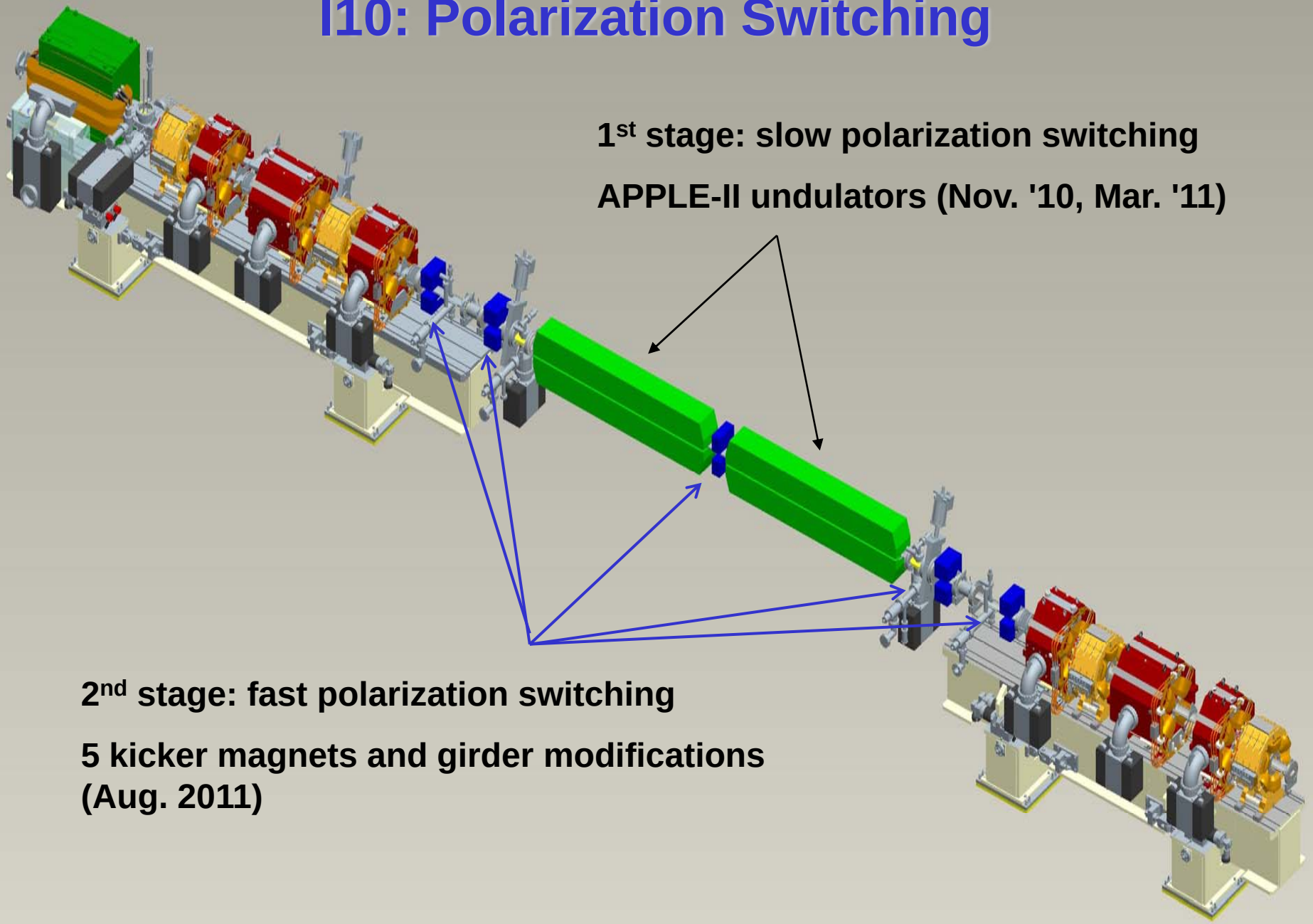
existing girders modified

new mid-straight girder

diamond


mid-straight girder with two new quadrupoles
make-up vessel in place of future in-vacuum undulator
modified main girder with additional quadrupole
B12
Installed in Aug. '10
Commissioning: see B. Singh's talk

I10: Polarization Switching



1st stage: slow polarization switching

APPLE-II undulators (Nov. '10, Mar. '11)

2nd stage: fast polarization switching

5 kicker magnets and girder modifications (Aug. 2011)

Thanks for your attention