Diamond Light Source Update

R.P. Walker, on behalf of the Machine Team

1. Operational Issues
2. New Developments (for Beamlines)
3. Superbend ?

ESLS XIX, Aarhus, Nov. 23-24th 2011

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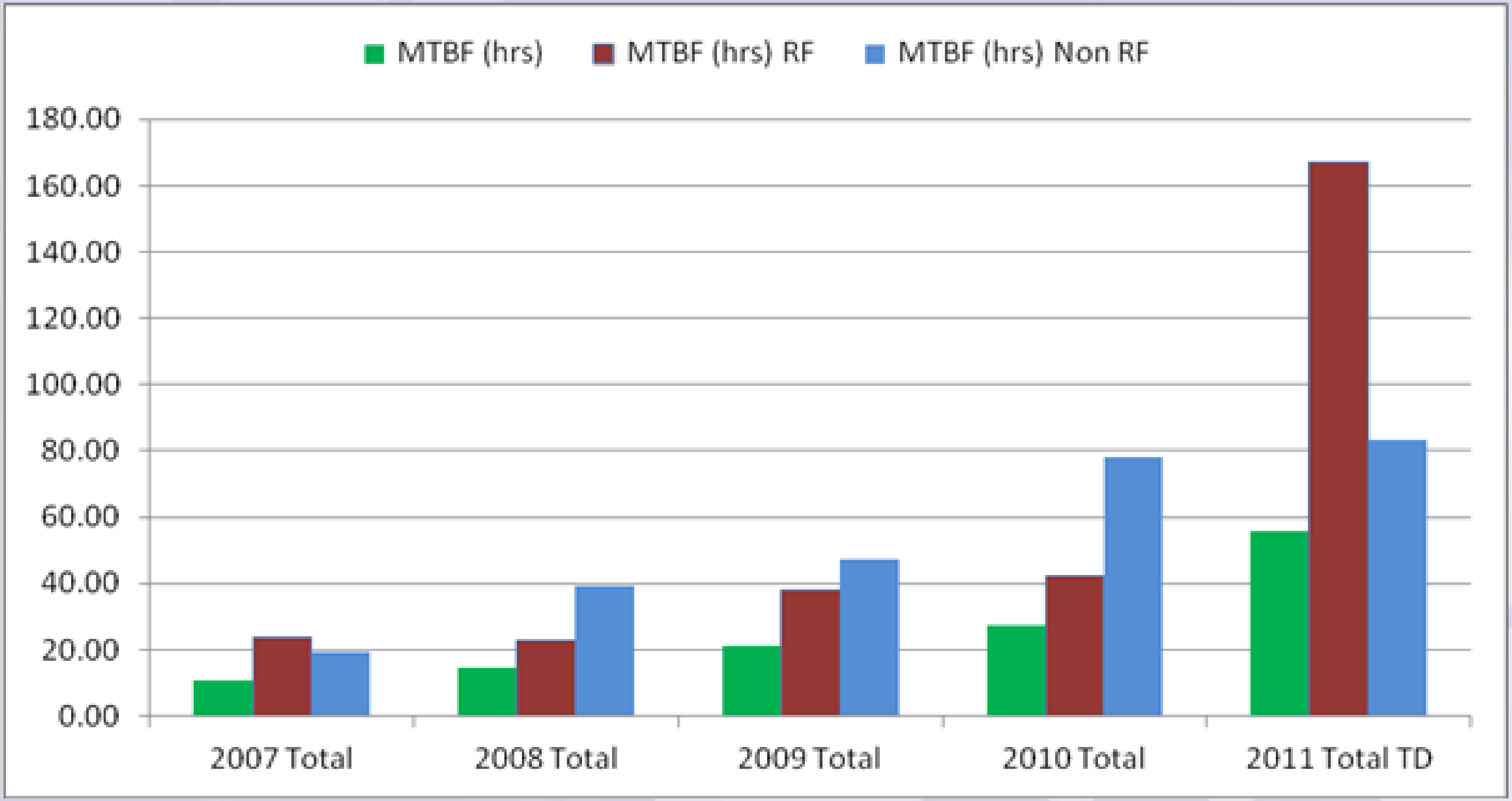
Operational Issues

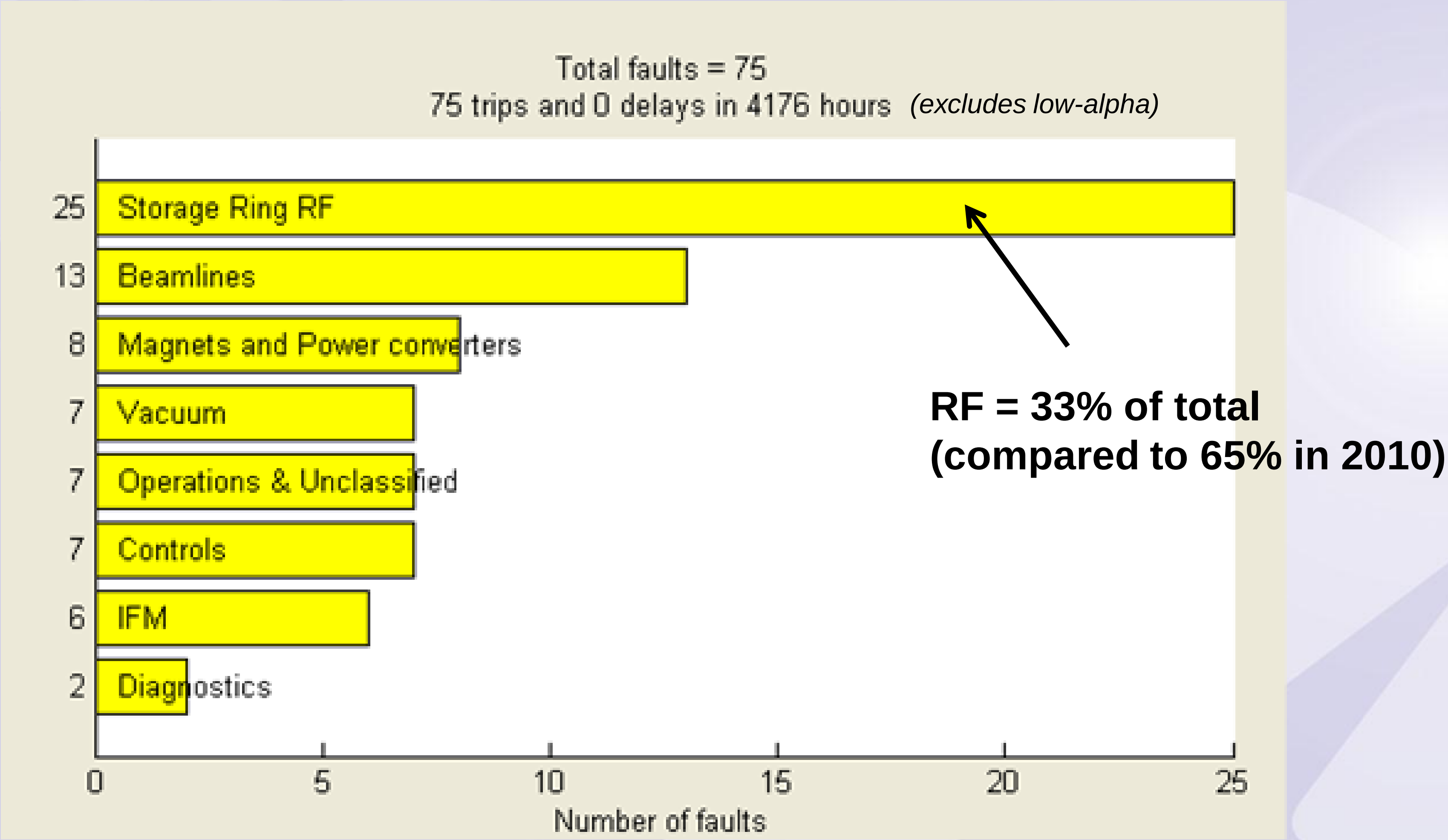
2007:	3160 h scheduled,	92.3% uptime,	MTBF = 10.6 h
2008:	4092 h scheduled,	94.9% uptime,	MTBF = 14.5 h
2009:	4656 h scheduled,	96.4% uptime,	MTBF = 21.1 h
2010:	4848 h scheduled,	97.4% uptime,	MTBF = 27.3 h
2011:	**4848 h scheduled**		
so far	***4368 h scheduled,***	***98.6% uptime,***	***MTBF = 55.7 h***

- **Top-up since Oct. 2008 (10 min interval)**
- **Filling patterns:**
  "standard": 250 mA, 900 bunch train (in 936)
  "hybrid": 250 mA, 686 bunch train + single bunch
- **Low-alpha: 2 x 4 days per year**



MTBF (hrs)
MTBF (hrs) RF
MTBF (hrs) Non RF
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2007 Total
2008 Total
2009 Total
2010 Total
2011 Total TD

Number of Beam Trips by technical group for 2011 to-date



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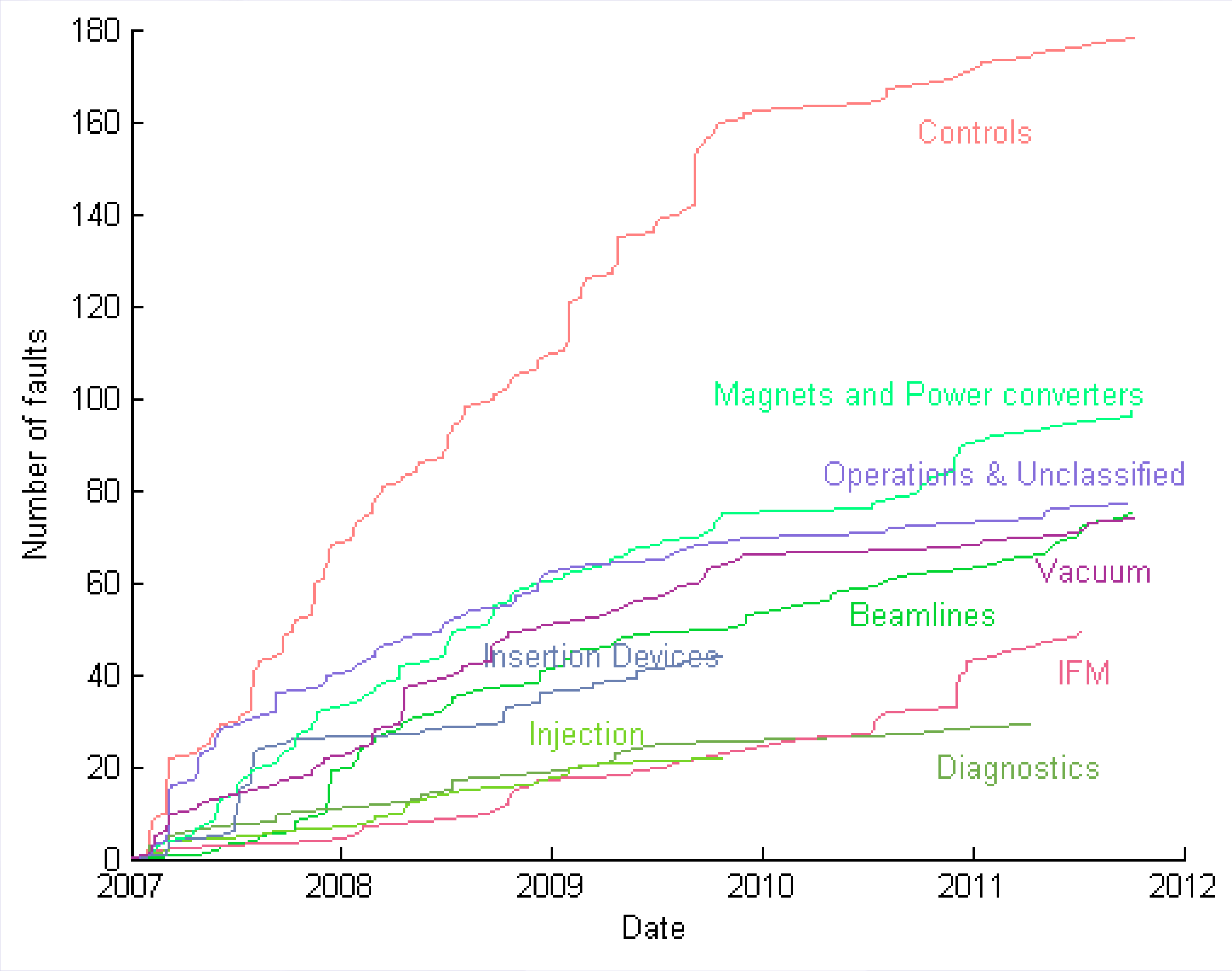
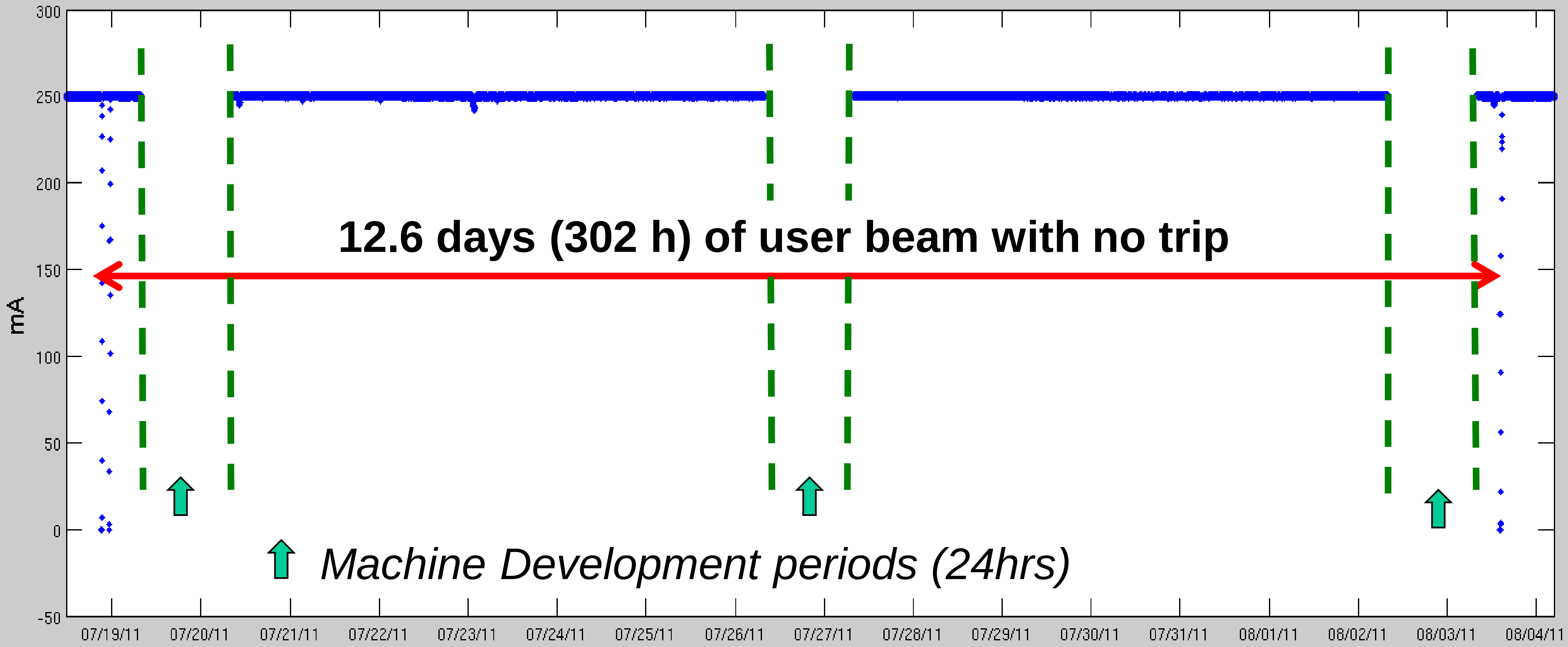
Example of new trip analysis and display software:



"An Automated Statistical Analysis Package for the Study of Synchrotron Light Source Operation", C. Christou et al, IPAC '11

Longest un-interrupted user run: July 2011



Machine Development periods (24hrs)

Low-alpha Operation (Mar./Sep. 2011)

Parameter	Value
α_1	-1×10^{-5}
Bunch Length	3.5 ps (rms)
Bunch Current	37 μA
Total Current	8 mA
Lifetime	20 h
Emittance	4.4 nm.rad
Coupling	0.25%

Superconducting RF Cavity Saga

- December 2009: “heater incident” - failure of the insulation vacuum of Cavity #2, and damage to Cavity #1.
- Cavity #2 removed and returned to RI Research Instruments for repair.
- Cavity #2 returned to DLS in July 2011, but vacuum failed on cool-down. Now under repair again at RI, delivery early 2012.
- After repair, the plan is to test, condition and install in Diamond in June 2012.
- Cavity #1 will then be removed and, at some stage, will have to be re-furbished.
- As a long-term plan to ensure continuity of operation, as well as being needed for a possible increase to 500 mA, a call for tenders for a **4th cavity** has been issued.

Update on the Superconducting Wigglers

Cryogenic Performance before/after repair by BINP in March 2011

Helium consumption	Before (200 mA)	After (200 mA)	After (250 mA)
I15 (3.5T)	1 l/h	< 0.01 l/h	< 0.01 l/h
I12 (4.2T)	0.33 l/h	< 0.01 l/h	< 0.01 l/h
Liner Temperature			
I15 (3.5T)	22 K	10.4 K	10.9 K
I12(4.2T)	12.7 K	9.7 K	9.9 K

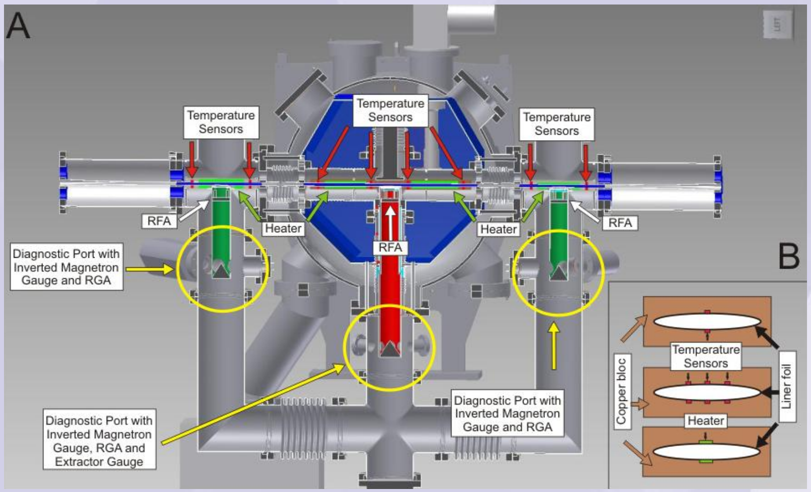
Outcome: refill of wigglers on a year to year basis compared to once every 2 weeks refill prior to the repair !

"Electron Beam Heating and Operation of the Cryogenic Undulator and Superconducting Wigglers at Diamond", J. Schouten and E. Rial, Proc. IPAC'11

COLDDIAG

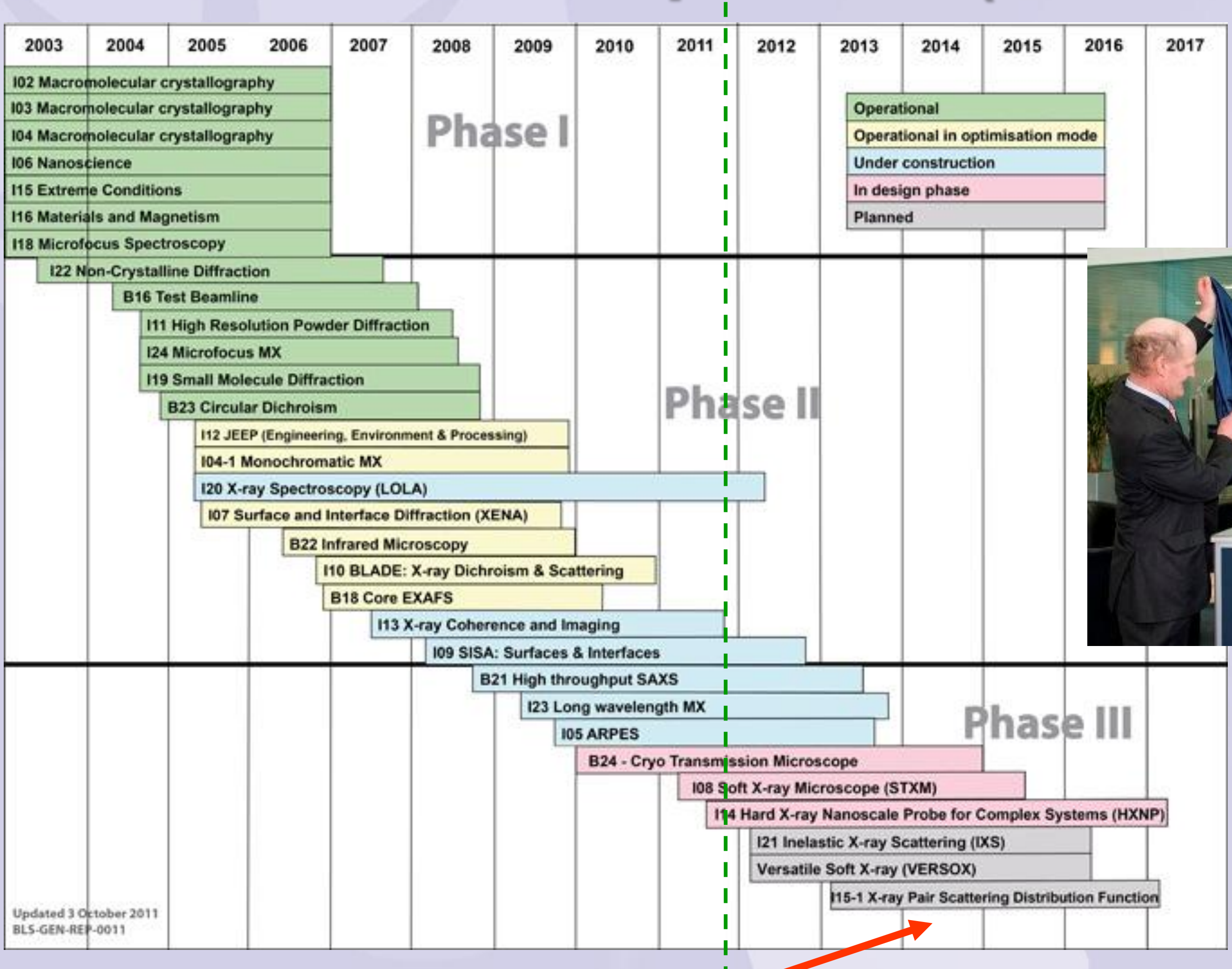
Collaboration with ANKA/KIT

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



Installed November 2011 !

New Developments (for Beamlines)



Science Minister formally inaugurates Diamond Phase III 14th March 2011

Hot competition for the final Phase III beamline!

Richard P. Walker

ESLS XIX, Aarhus, Nov. 23-24th 2011

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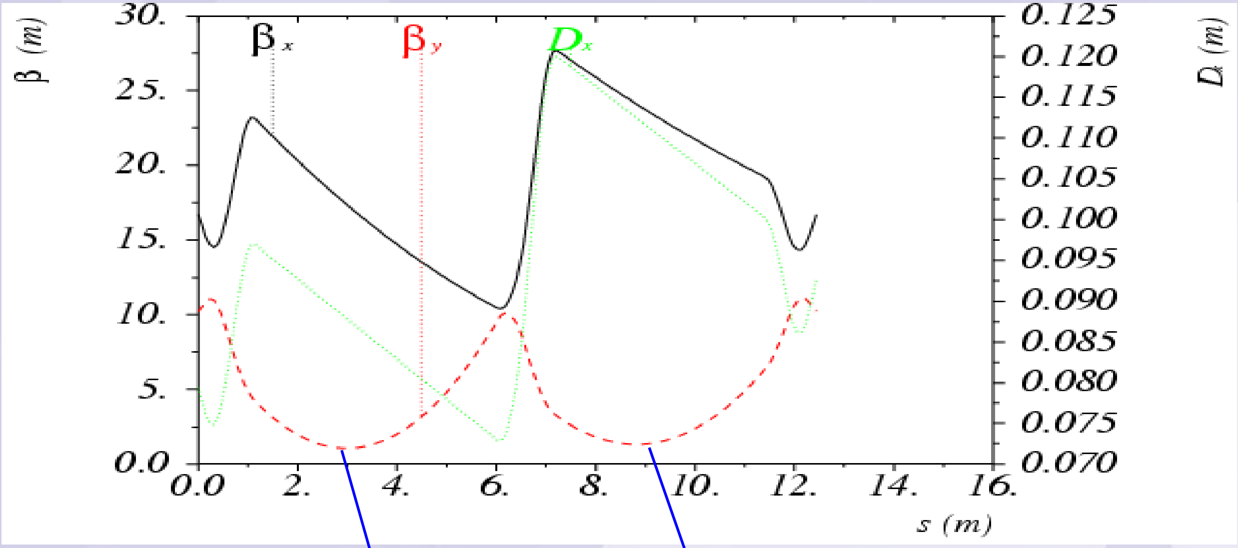
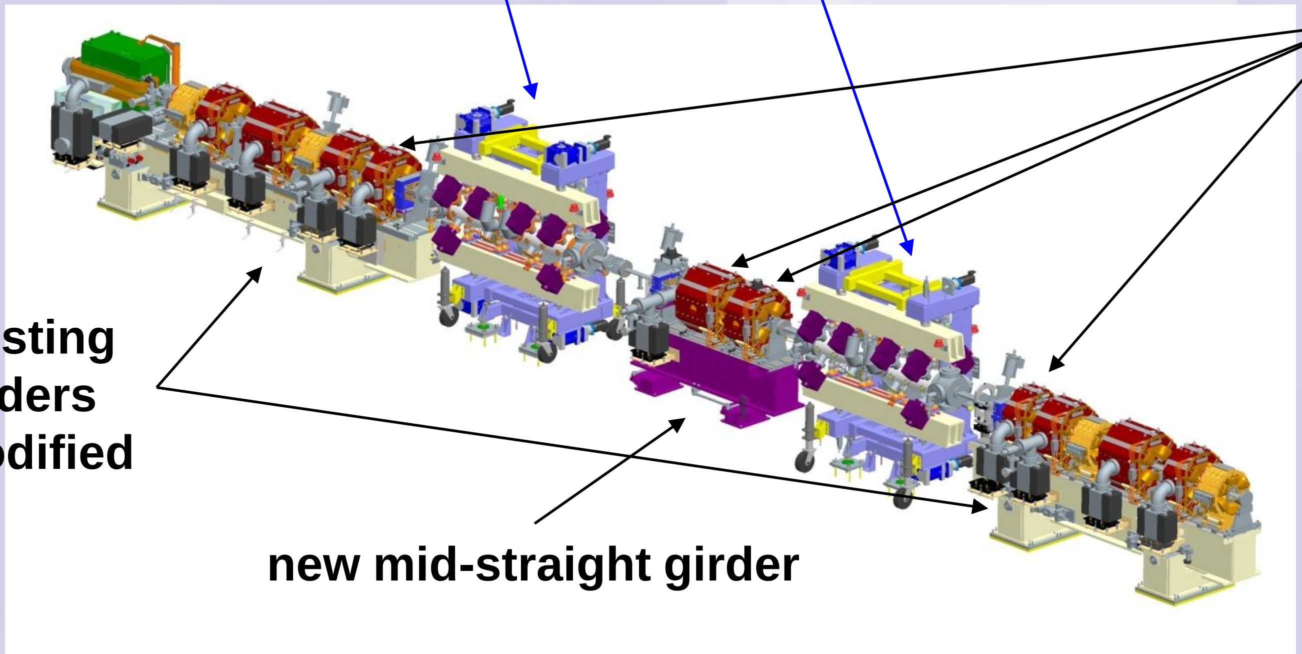
"Double mini-beta" and Horizontally Focusing Optics





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First implementation (I13) in August 2010:

Qy 12.36 → 12.86 ***(see Beni Singh's talk at last ESLS)***

Optically OK, but resistive wall instabilities prevented operation at high current → had to increase the vertical tune above the integer (Qy→ 13.09)

- **new optics established in User Mode from end Oct. 2010**
- **better matched optics from beginning of January 2011**

Second implementation (I09) in March 2011:

Much easier ! .. Model optics with integer vertical tune shift (Qy→ 13.36)

New optics commissioned and in use during User Mode from April 27th

"Implementation of Double Mini-Beta Optics at the Diamond Light Source", B. Singh et al., Proc. IPAC'11

I10: Polarization Switching

i/ APPLE-II undulators: installed

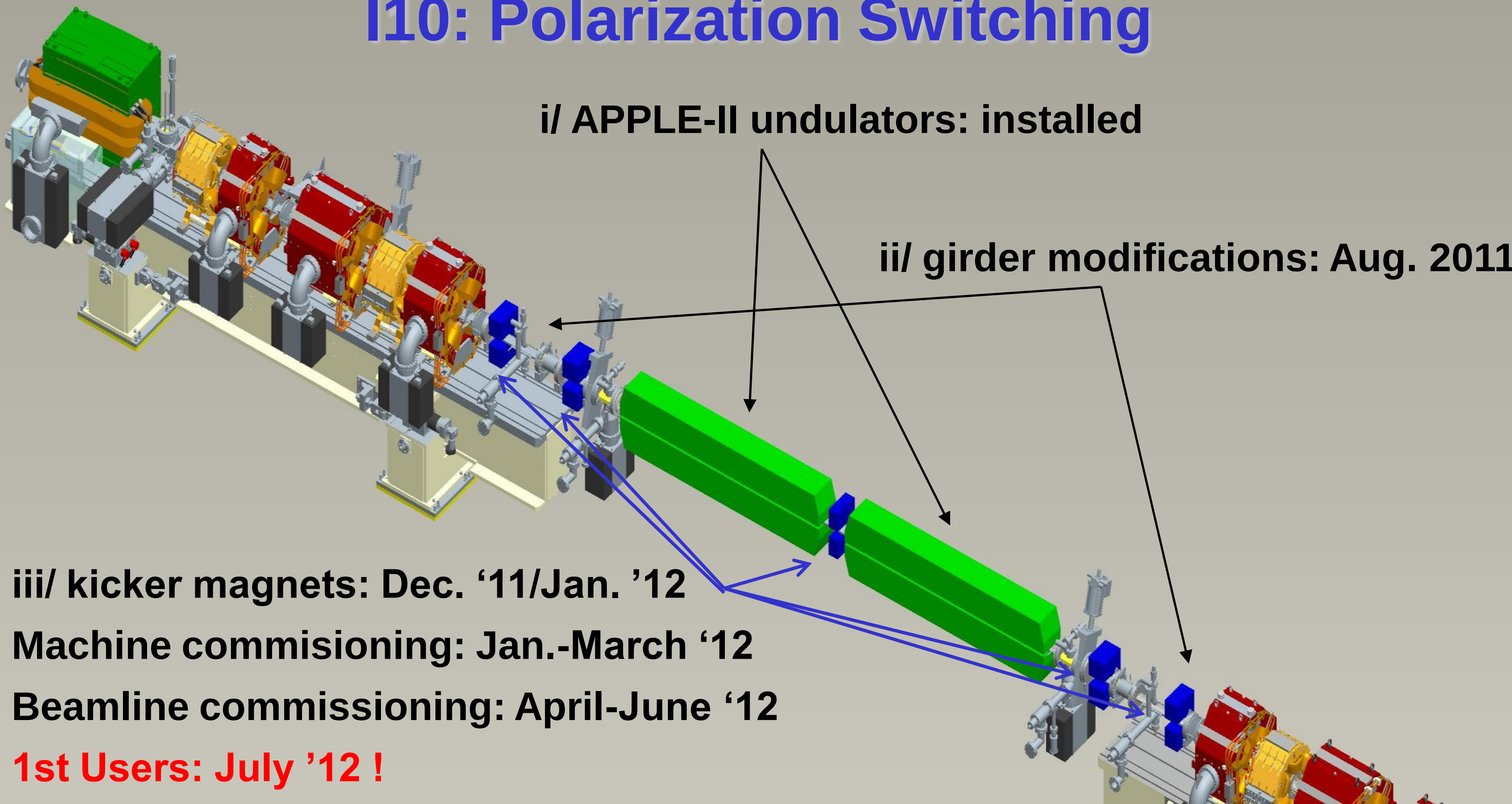
ii/ girder modifications: Aug. 2011

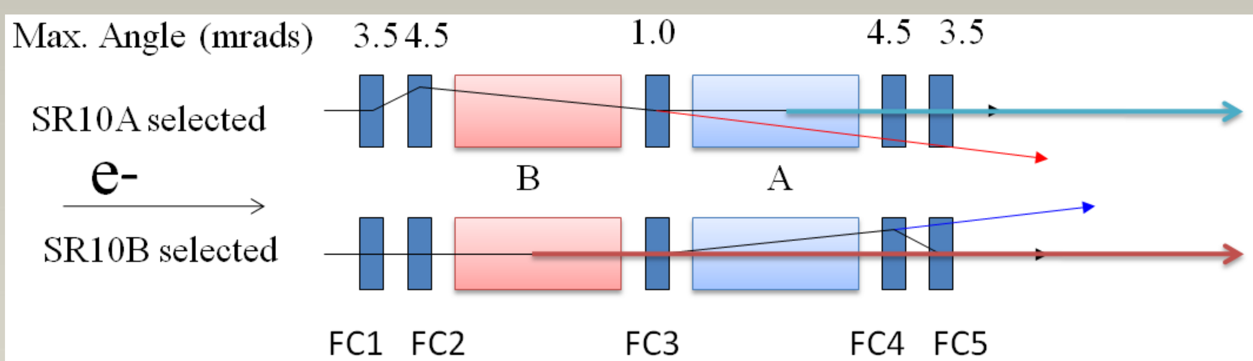
iii/ kicker magnets: Dec. ‘11/Jan. ’12

Machine commisioning: Jan.-March ‘12

Beamline commissioning: April-June ‘12

1st Users: July ’12 !





I05: 5 m APPLE-II

- **Specified to reach 18 eV in all polarization modes**
- **34 x 140 mm periods; By = 0.9T, Bc = 0.53T, Bx = 0.63 T**
- **Significant effect on the electron beam, particularly vertical polarization mode.**

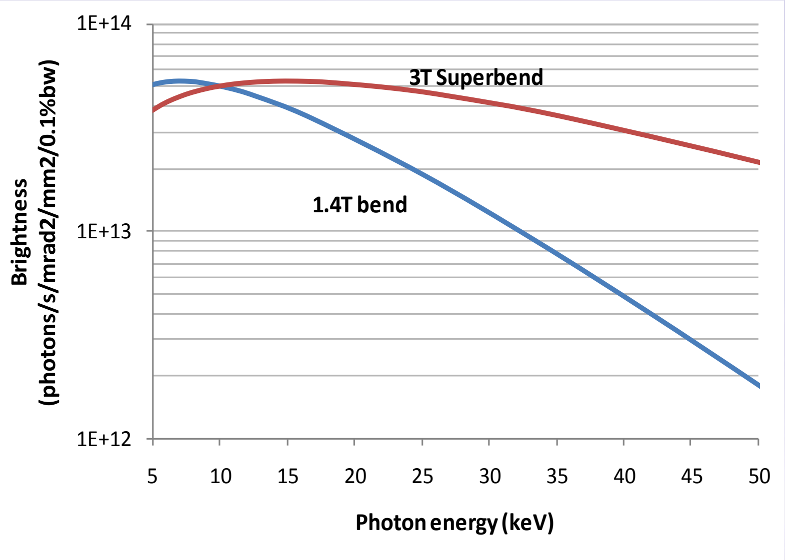
  Don't consider a feed-forward, global optics correction viable

  → planning to use correction of dynamic field integrals using "active shims", à la BESSY-II

Other issues:

- **Significant power loading on slit absorbers, and also not negligible on straight section vessels ..**
- **Mechanically not so trivial; not many successful 5 m APPLE devices around the world …**

Superbend



Why ?

One of the proposals for the final Phase III beamline, requires 4-40 keV photons; a 3T Superbend is proposed.

Implications

- **Position of the radiation source point near the entrance to the magnet (~ 25 mrad) demands that the field must rise to full value as steeply as possible (can't adopt an SLS type magnet)**
- **Aperture of existing dipole magnet, 46.6 mm, too large for an efficient magnet design:**

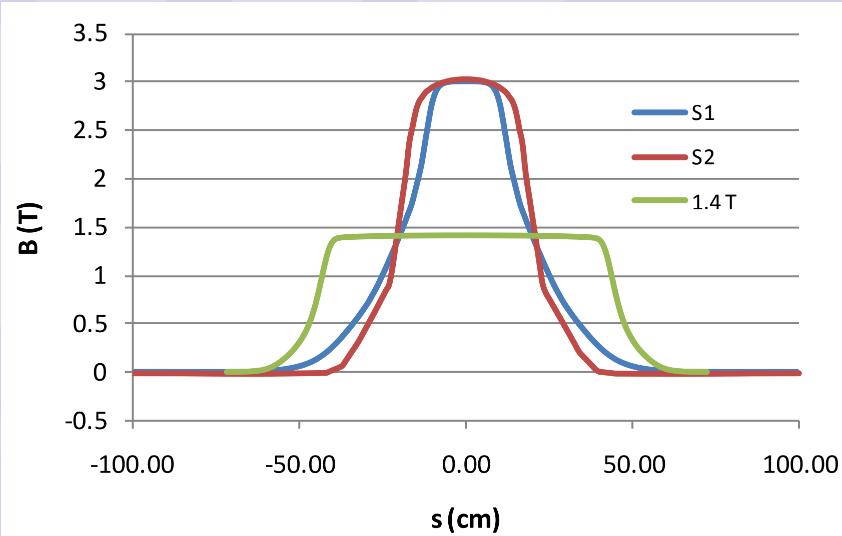
$\Rightarrow$ **New dipole vessel with reduced aperture: BSC = 25 mm, gap = 33 mm.**

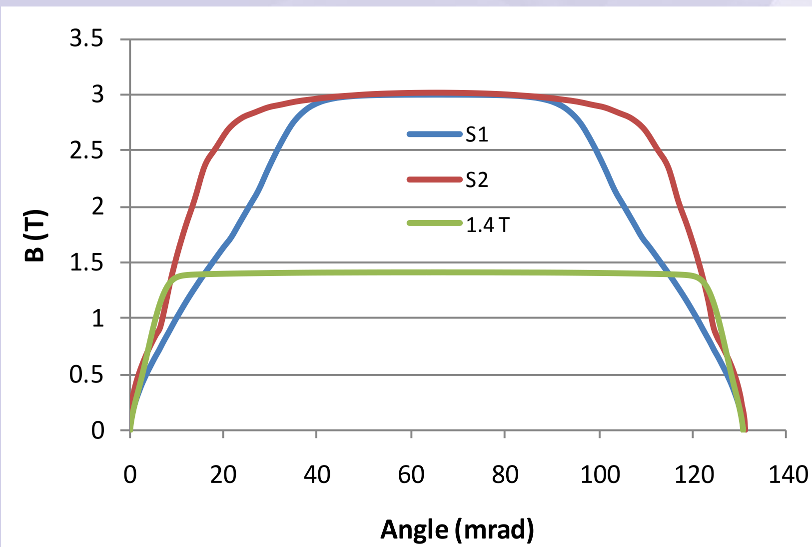
- **Higher power and power density:** *4.3 → 10.8 kW, 0.63 → 1.29 kW/mm² (peak, n.i.)*

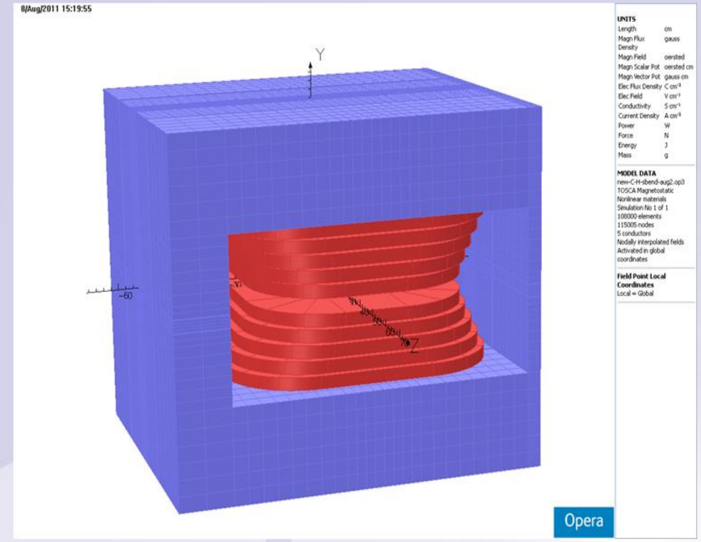
$\Rightarrow$ **New design of crotch absorber is needed**

- **Acc. Phys. and Vacuum aspects look OK.**

Current design of normal conducting Superbend (S2)







Peak field	3 T
Pole gap	33 mm
No. of coils	2
No. of turns/coil	130
Current	1353.5 A
Current density	8.5 A/mm^2
Voltage	78 V
Power	105 kW

Status

Awaiting decision about the final Phase III Beamline before continuing design work.

"Study of the Possibility of Implementing a Superbend in the Diamond Light Source", R.P. Walker et al., Proc. IPAC'11

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Thanks for your attention!