5th PARAMETER & LAY-OUT COMMITTEE MEETING

Jul 2, 2013

High Luminosity LHC

D1 APERTURE REDUCTION TO 150mm

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CERN EN STI FLUKA

WP10 Energy Deposition & Absorber

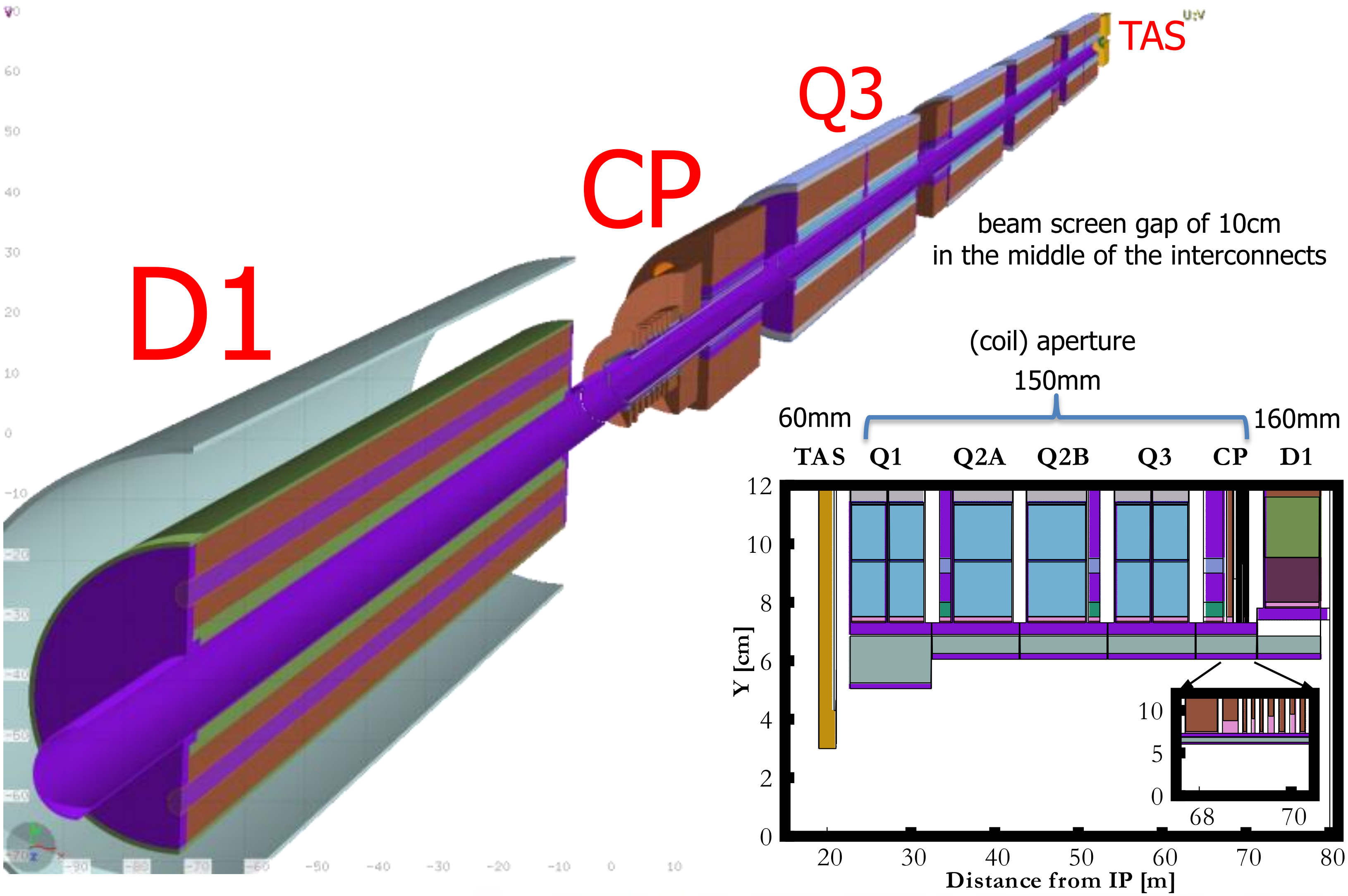
Continuous input from G. Arduini, R. De Maria, and S. Fartoukh

P. Ferracin, T. Nakamoto, E. Todesco, F. Toral, and Q. Xu R. Kersevan

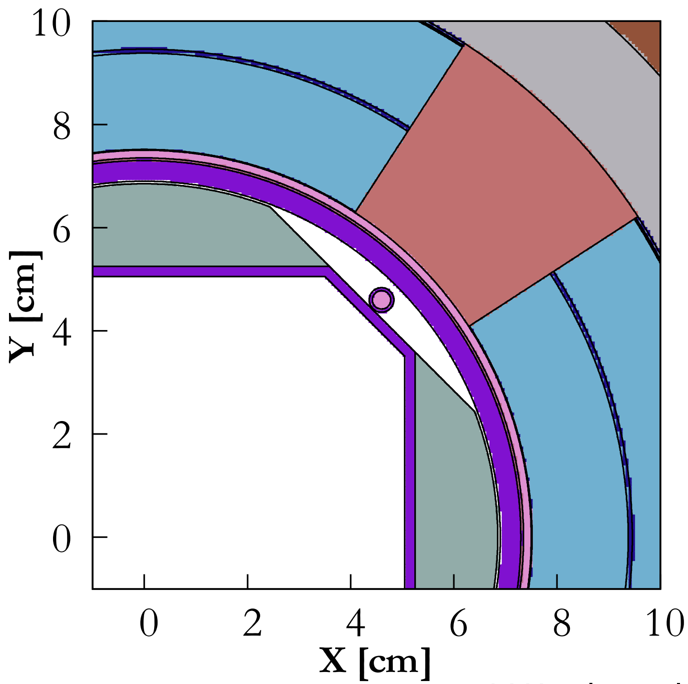
OUTLINE

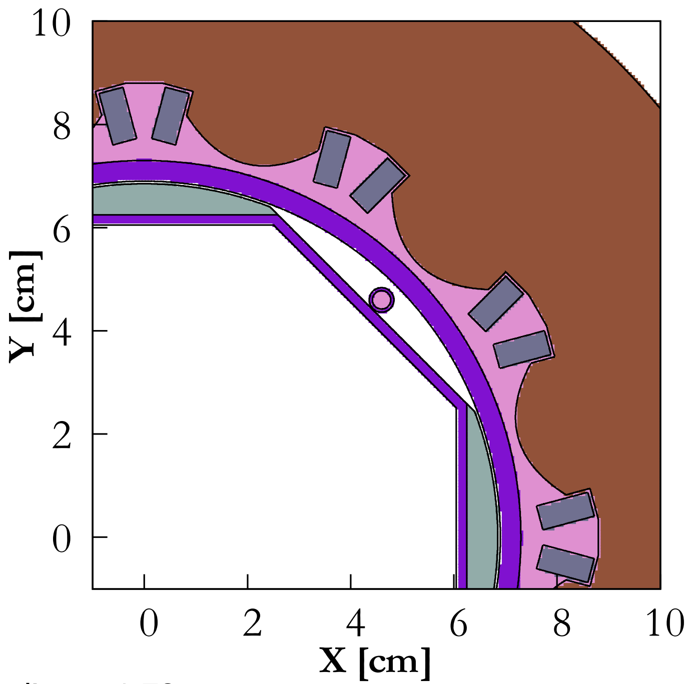
- the 150mm Nb_3Sn triplet (and Nb-Ti correctors) with a baseline shielding
- dependence on crossing plane
- dependence on the interconnect layout (BPMs)
- integral power → cryogenic load
- **D1**
- what's next

FLUKA GEOMETRY



SHIELDING AND APERTURE



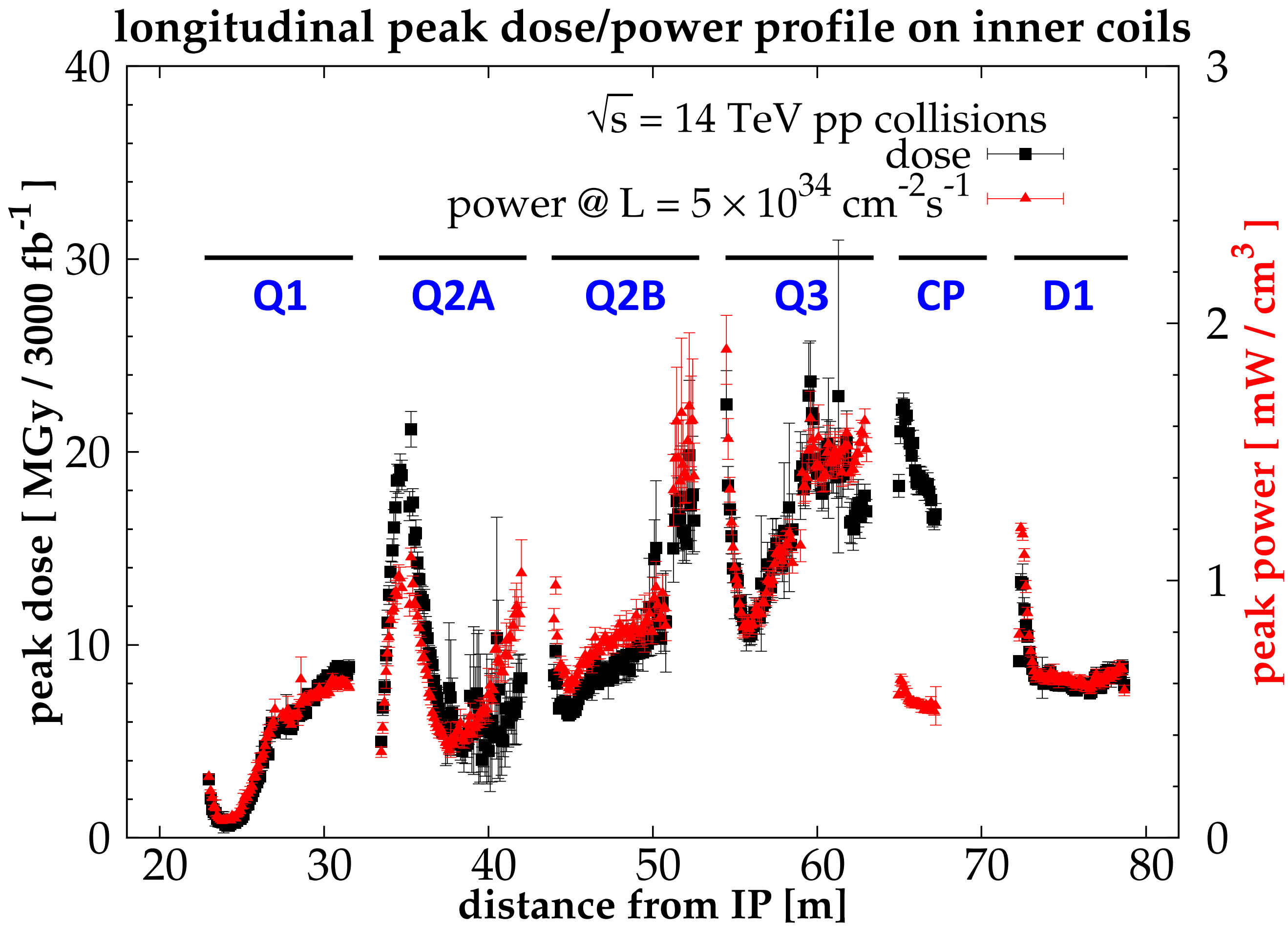


4 LHe channels with inner radius = 1.78 mm
Tungsten density = 19.3 g/cm³ (no packing factor)

4mm cold bore

0.5 mm clearance between absorbers and cold bore
in reality should be 1.5mm (including sliding rings) [R. Kersevan] → effective aperture in Q2?

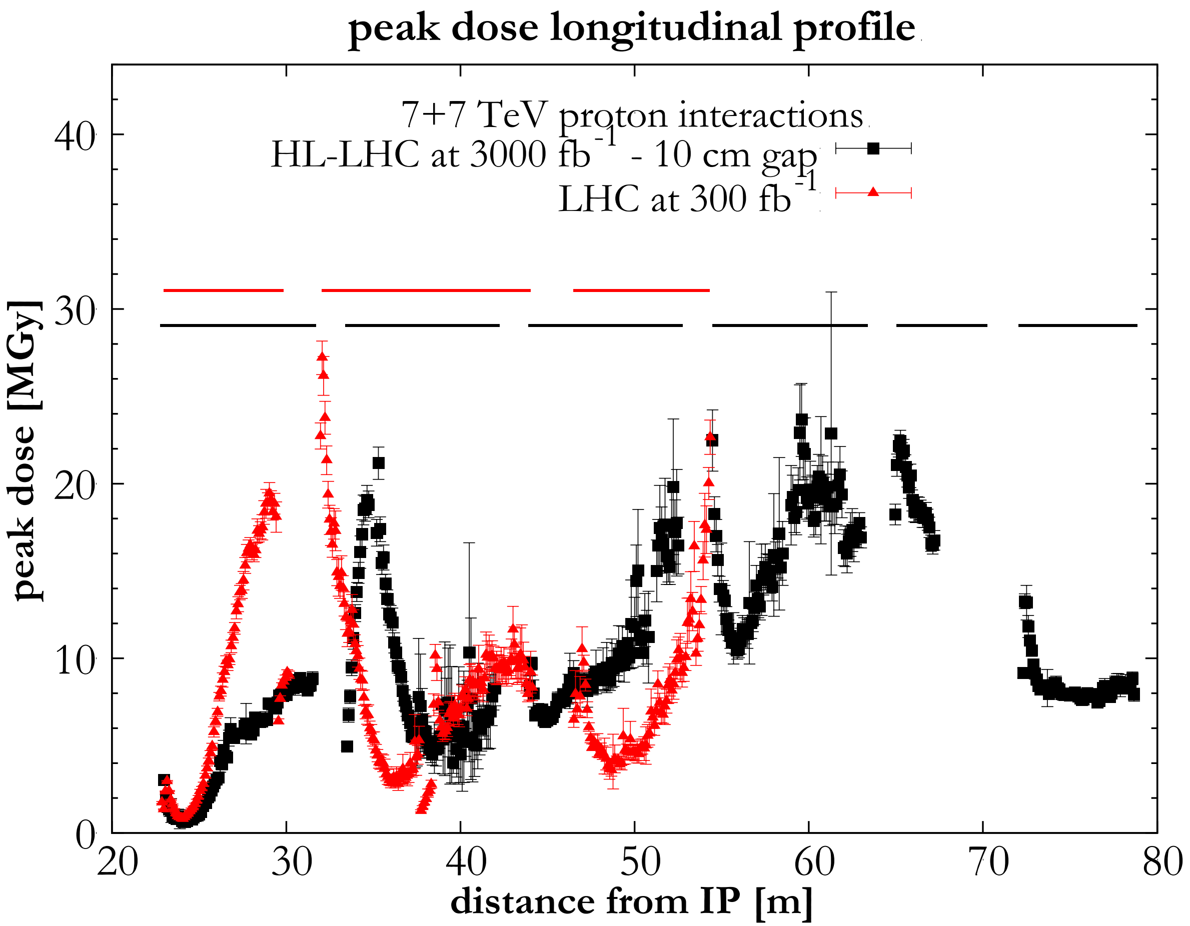
DEGRADATION AND QUENCH RISK EVALUATION: THE IMPACT OF THE COLLISION DEBRIS



power density averaged over the entire radial thickness of the cable, dose averaged over the innermost 3 mm

10 cm beam screen interruption in the interconnects

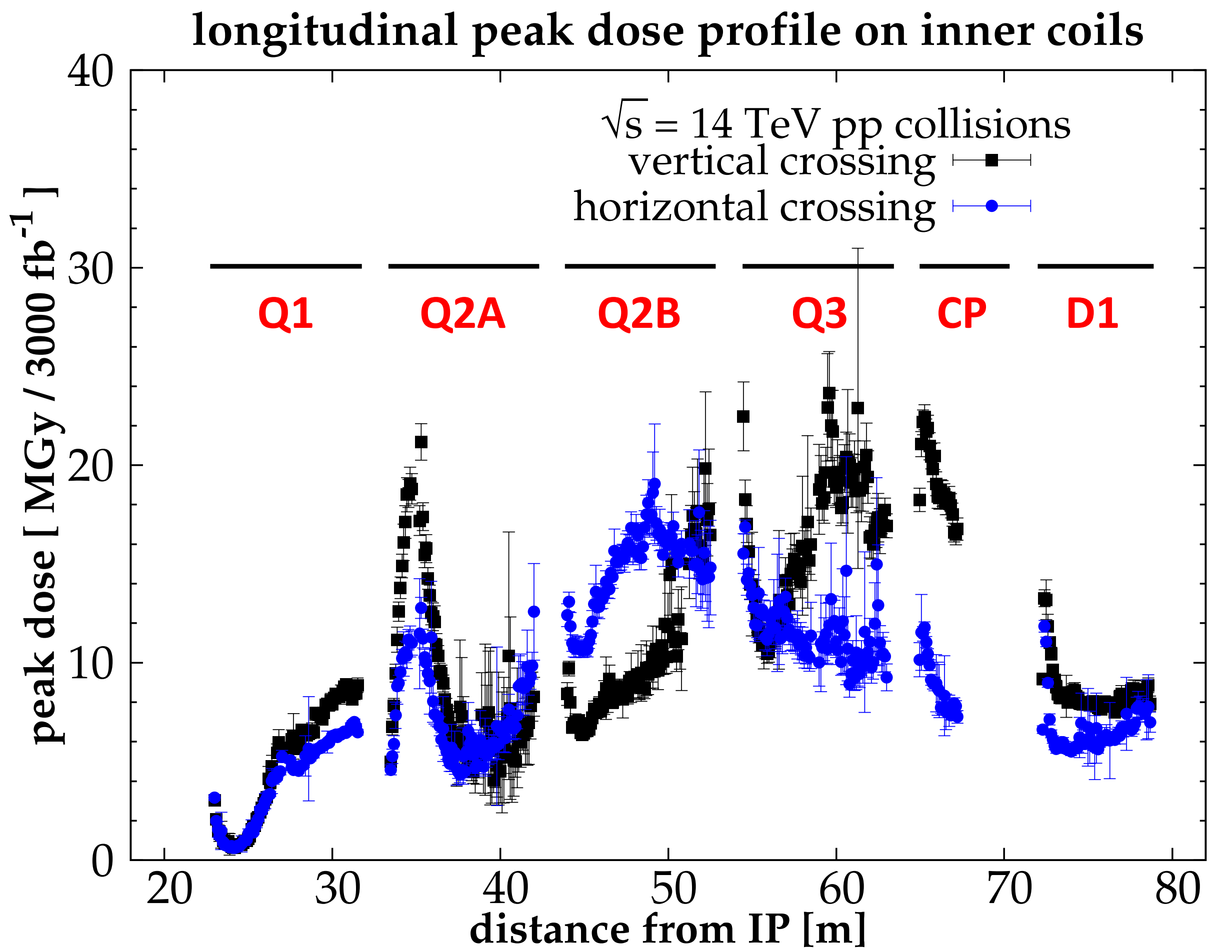
HL-LHC vs LHC
(BEFORE vs AFTER LS3)



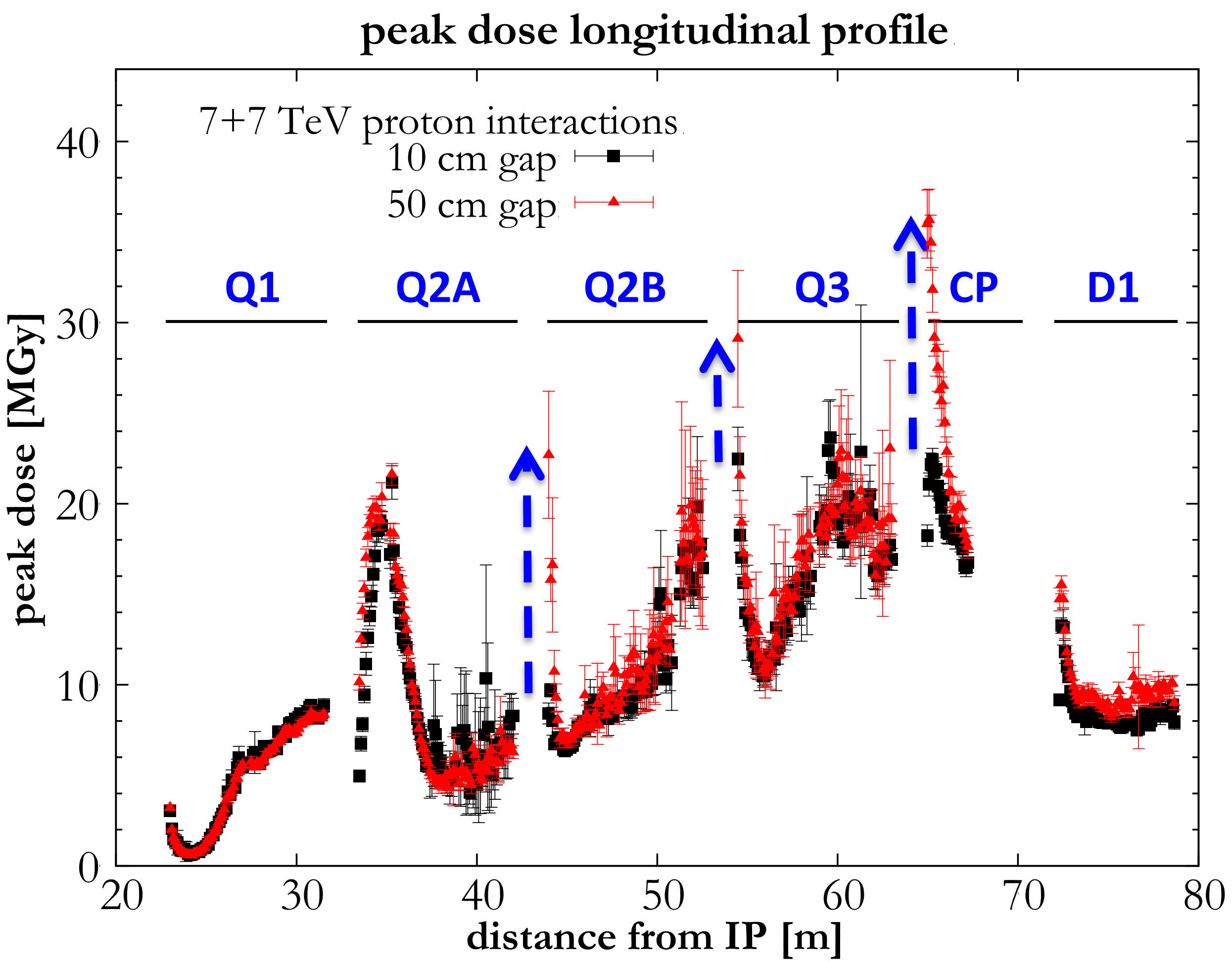
beam screen interruptions in the present machine: Q1-Q2 ~ 45 cm, Q2-Q3: ~ 15 cm

High Luminosity LHC

HORIZONTAL vs VERTICAL CROSSING



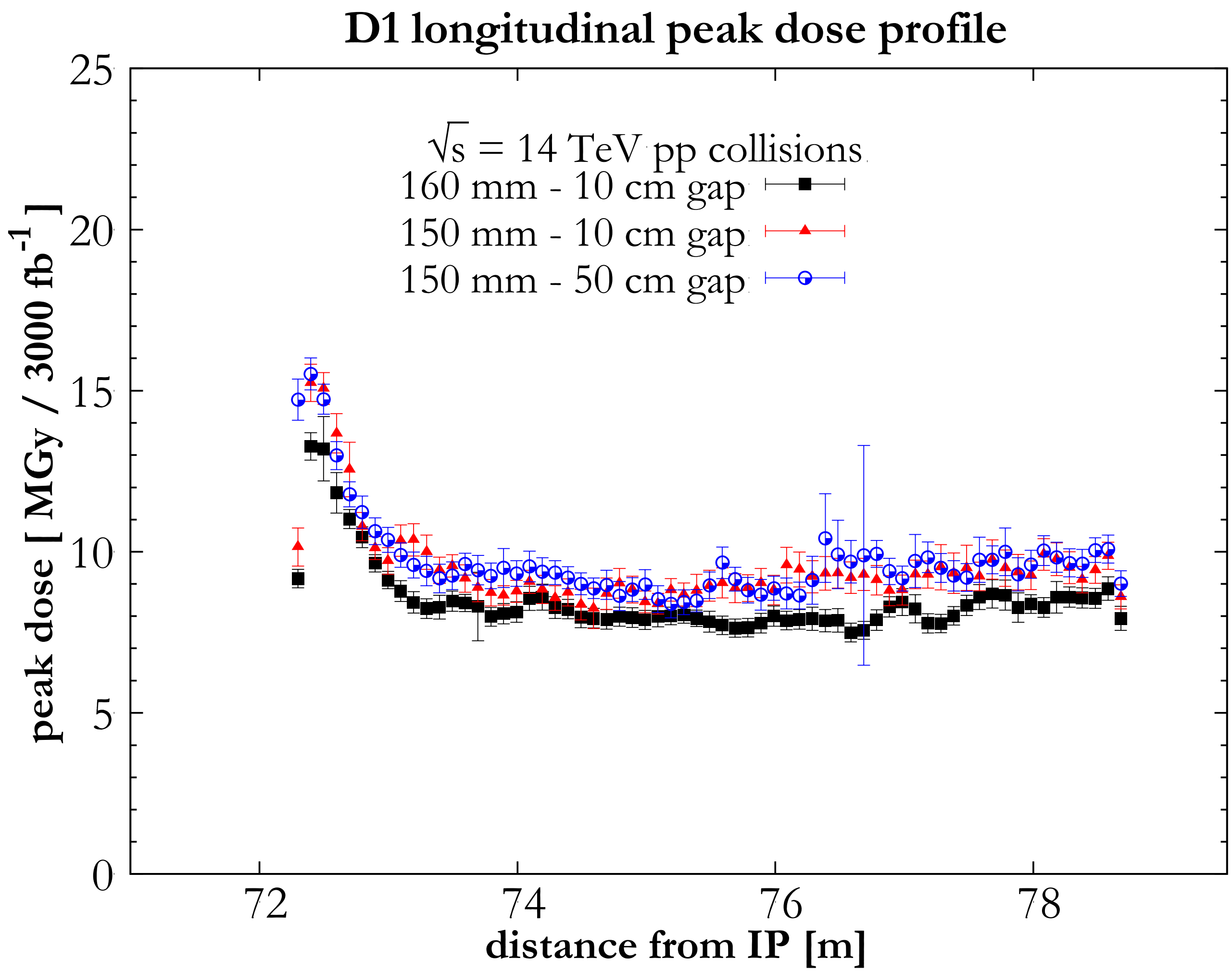
SHIELDED BEAM SCREEN INTERRUPTION



INTEGRAL POWER

	10 cm gap in ICs		50 cm gap in ICs	
	Magnet cold mass	Beam screen	Magnet cold mass	Beam screen
	Power [W]			
Q1A + Q1B	100	175	100	170
Q2A + orbit corr.	95	60	100	65
Q2B + orbit corr.	115	80	120	80
Q3A + Q3B	140	80	140	80
CP	55	55	60	55
D1	90	60	90	60
Interconnects	20	140	20	105
Total	**615**	**650**	**630**	**615**

D1: 160mm vs 150mm



CONCLUSIONS

- the first study on the foreseen 150mm triplet indicates that a continuous tungsten shielding of 16mm in Q1 and 6mm up to D1 allows not to exceed the *peak dose* value expected for 10 times less integrated luminosity in the present triplet and to keep *peak power density* quite below the envisaged quench limits

- the beam screen shielding interruption in the interconnects, along the BPMs, features an evident worsening on the front face of Q2B, Q3 and in the CP orbit corrector

- over the Q1-D1 string, cold mass and beam screen are each subject to a load of more than 600W at $5L_0$

- any optimization of the Q2 effective aperture?

- no significant effect is found for the **D1 aperture shrinking to 150mm**

- results by the MARS team are in production

- the HL-LHC crossing angle and (TAN) aperture are expected to expose the downstream elements (D2 in primis) much more than now, especially *for horizontal crossing*

RESERVE SLIDES

BASIC PARAMETERS

HLLHCV1.0 round optics from R. De Maria
- 295 μrad half crossing angle
- $\beta^* = 15$ cm

normalization
- 85 mb p-p inelastic (and diffractive) cross-section at $\sqrt{s}$=14TeV
- dose after 3000 fb^{-1}
- power at $\mathcal{L} = 5 \times 10^{34}\ cm^{-2}\ s^{-1}$

DPMJET III as event generator

scoring resolution (binning)
- $\Delta z \simeq 10$ cm, $\Delta\varphi = 2^o$
- $\Delta r \simeq 3$ mm for dose evaluation
  - entire cable size for power density evaluation

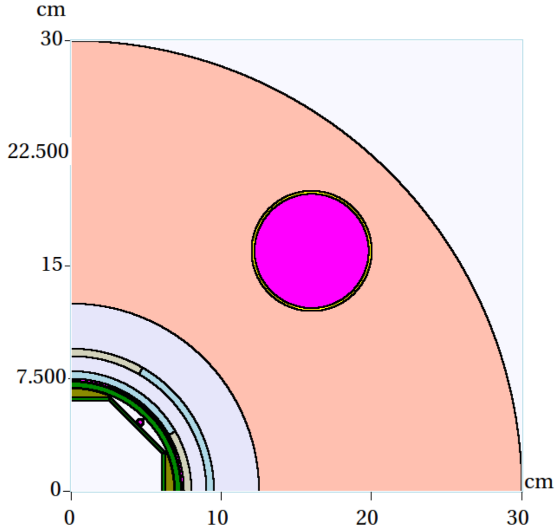
	Magnetic length [cm]	Magnet end [cm]
Q1-Q3 module	400.2	22.5
Q2 module	679.2	22.5
Orbit correctors	120/220	7.5
Super-ferric magnets^	7.9÷71.6	1.2÷1.6
D1 dipole	636.0	22.5

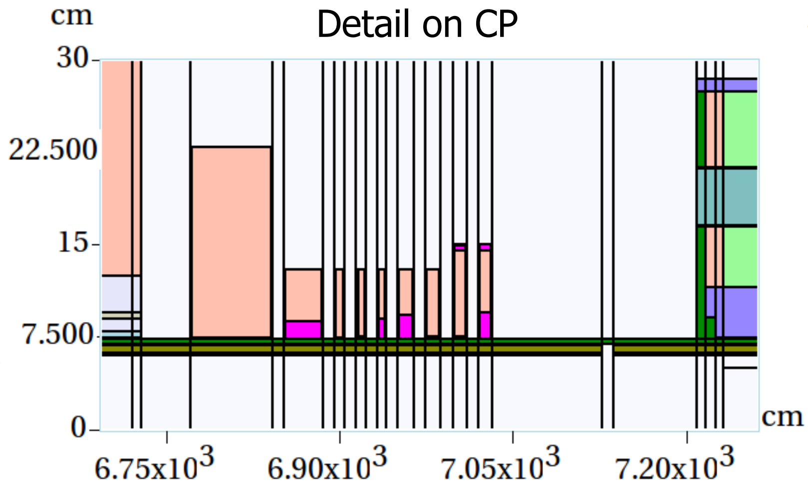
^ Magnetic length does not include return coils, except for super-ferric magnets where total length is equal to magnetic length

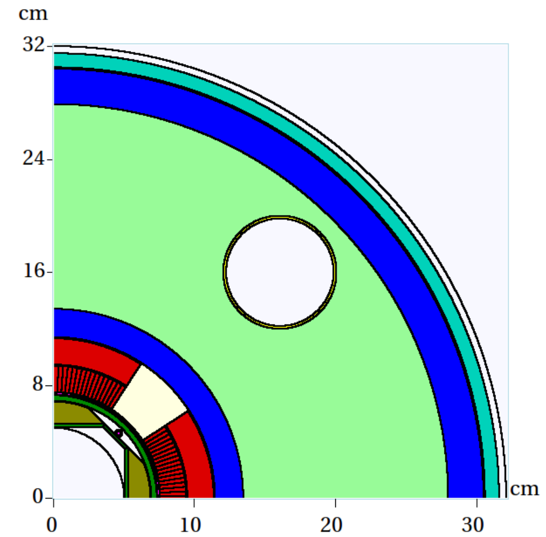
Distance between magnetic lengths in different cryostats is 2m

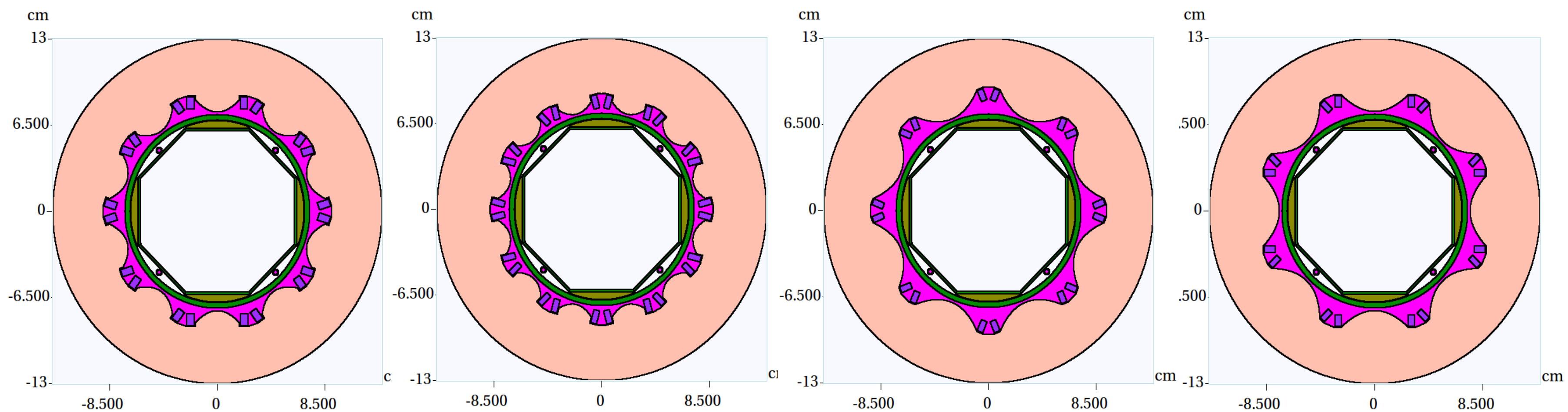
MARS GEOMETRY

[N. Mokhov, I. L. Rakhno, I. Tropin]

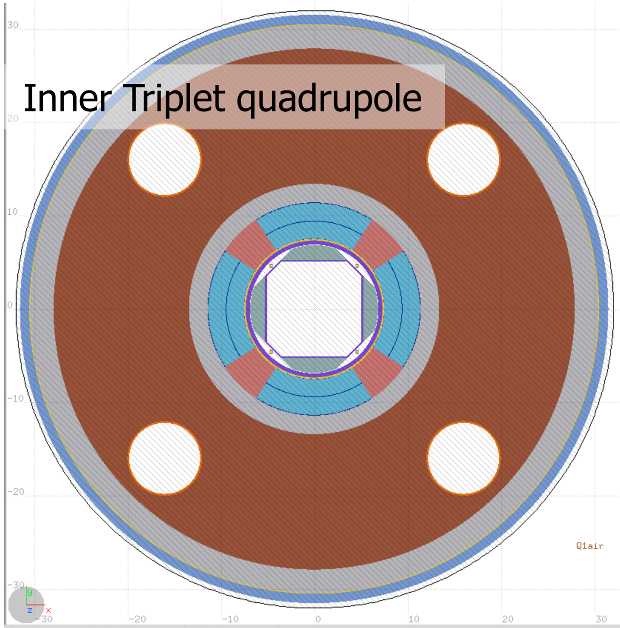


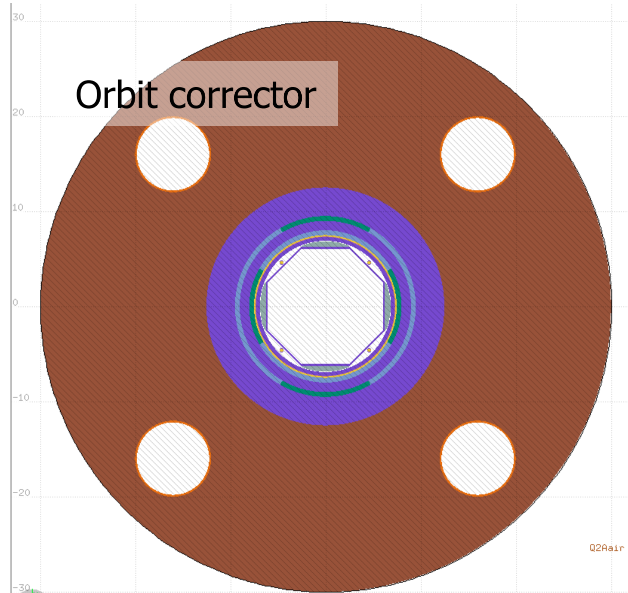


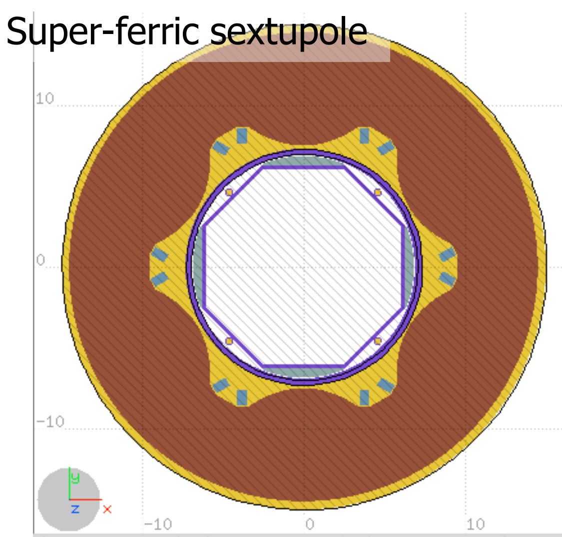


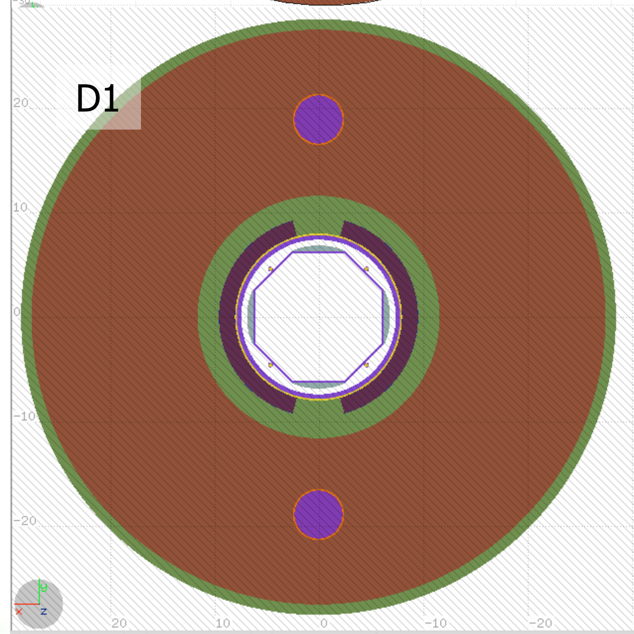


FLUKA GEOMETRY [II]



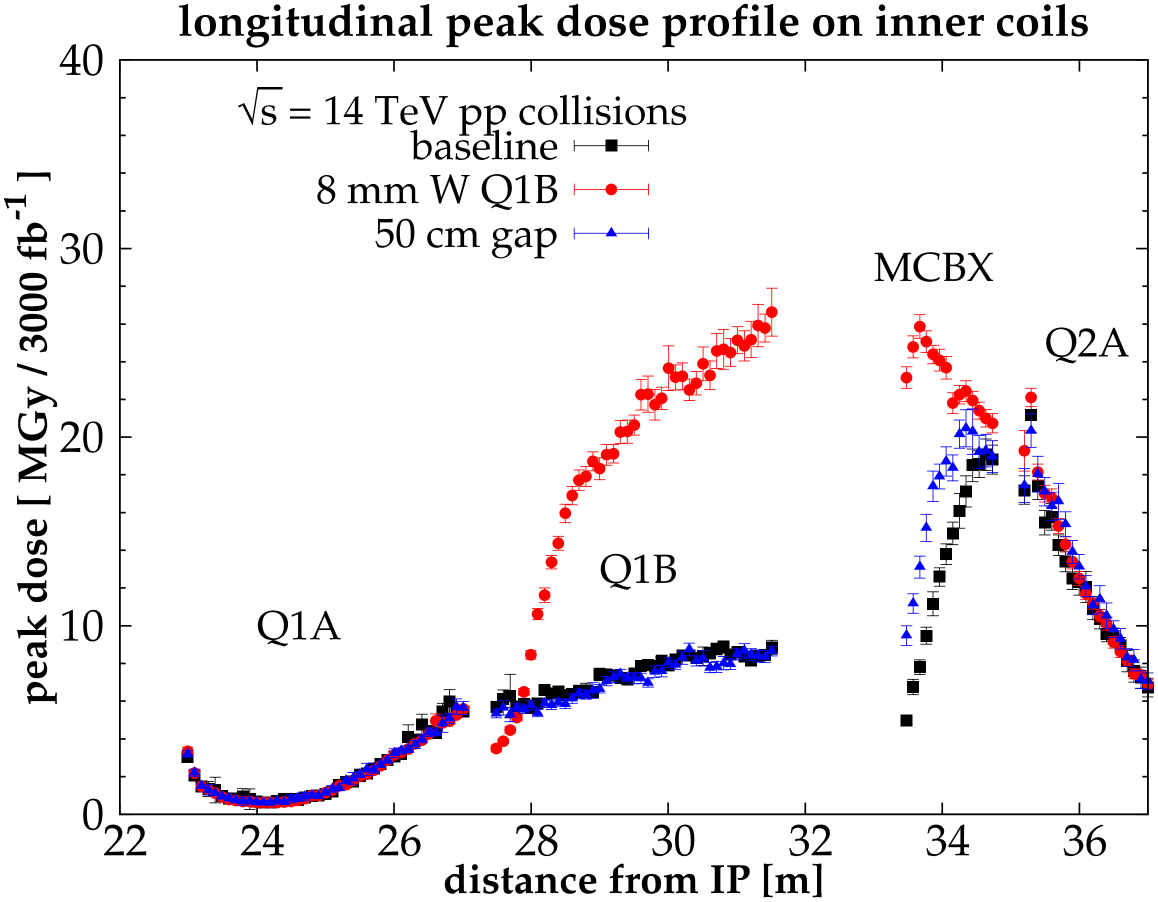






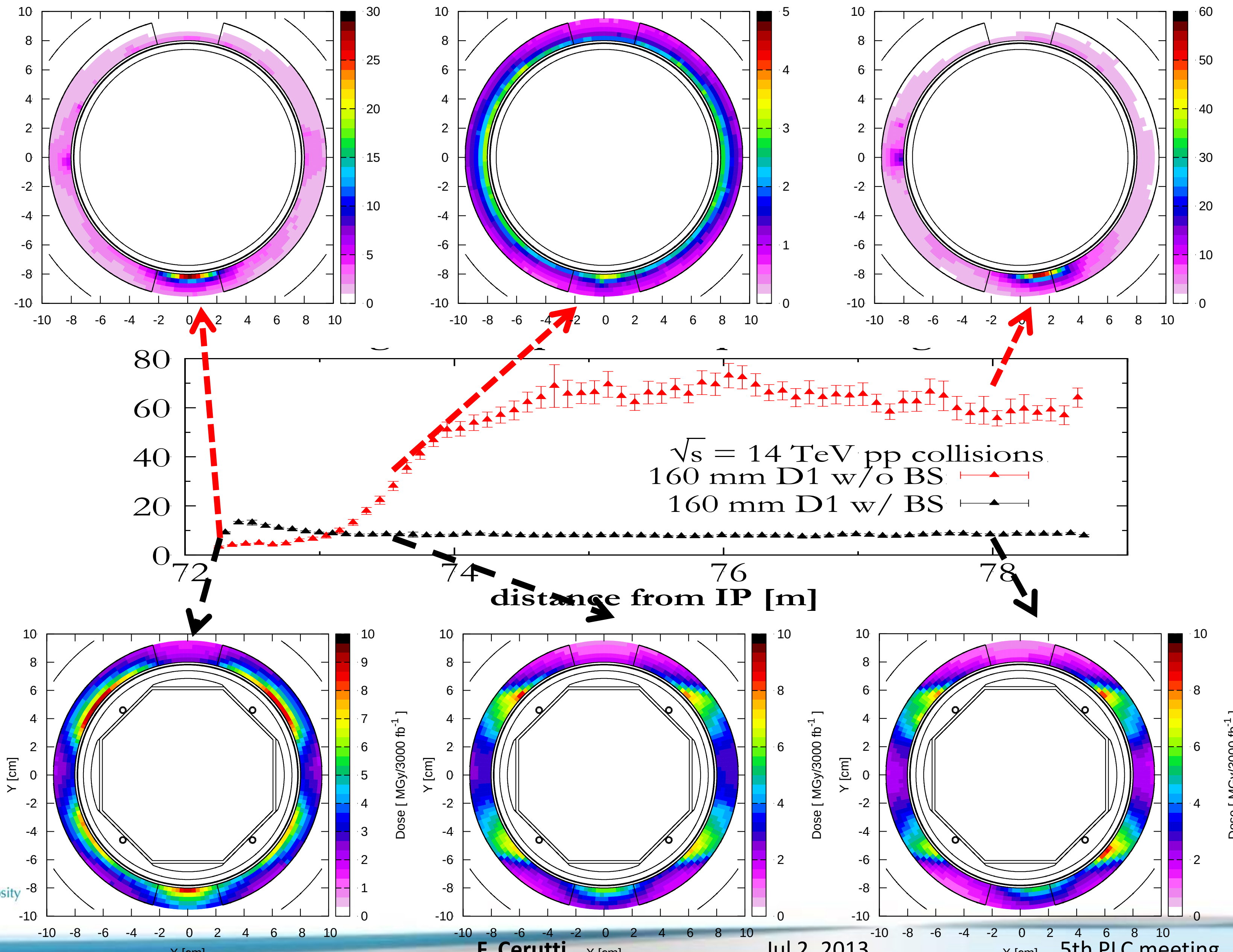
THE Q1-Q2 REGION

playing with the W thickness in Q1B and with BS gap length in the IC



	baseline		**8 mm W in Q1B**	
	Power [W]			
Magnet	Cold mass	BS	Cold mass	BS
Q1A	30	38	30	38
Q1B	**69**	**132**	**86**	**84**
MCBX	**21**	**17**	**36**	**22**
Q2A	72	43	75	43
Q2B	99	68	98	68

ENERGY DEPOSITION IN D1



WHATEVER