HEAT DEPOSITION AND RADIATION DOSE

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WP10

Energy deposition & R2E

Special TCC for Chamonix 2018 preparation Jan 18th, 2018

OUTLINE

Triplet – D1

HL-LHC: the v1.3 picture

optics mitigation option(s)

hardware improvement

levelling with varying crossing angle

Matching Section

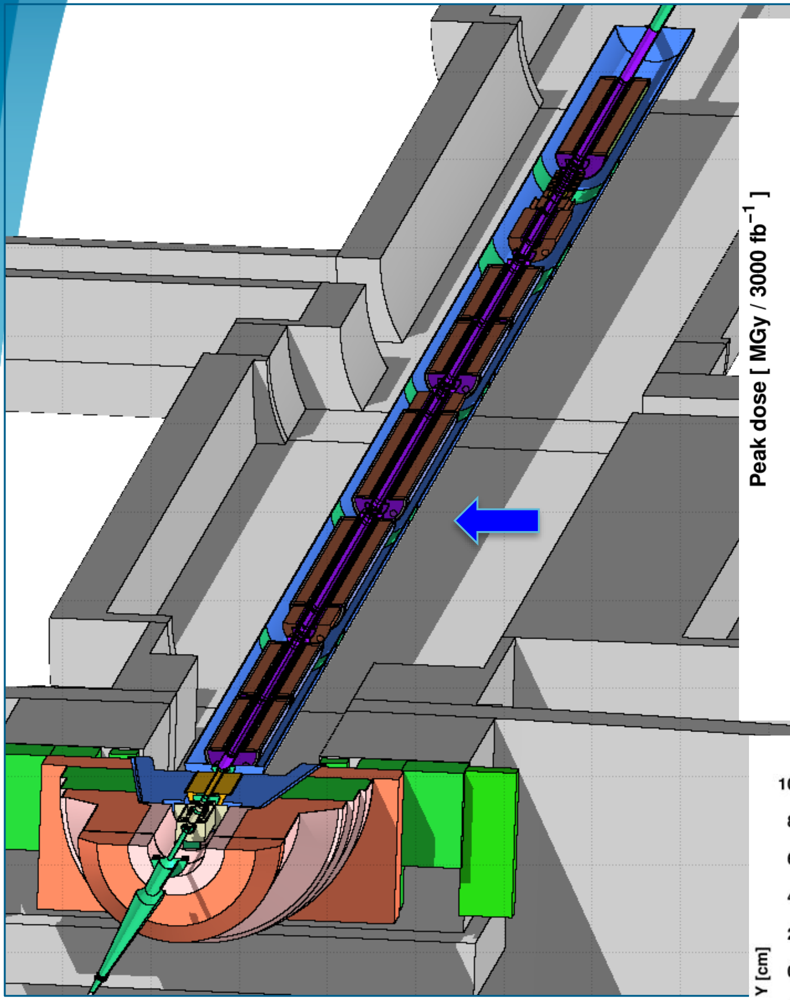
Q5 aperture reduction to 56 mm [not completed today, planned to be ready for Chamonix]

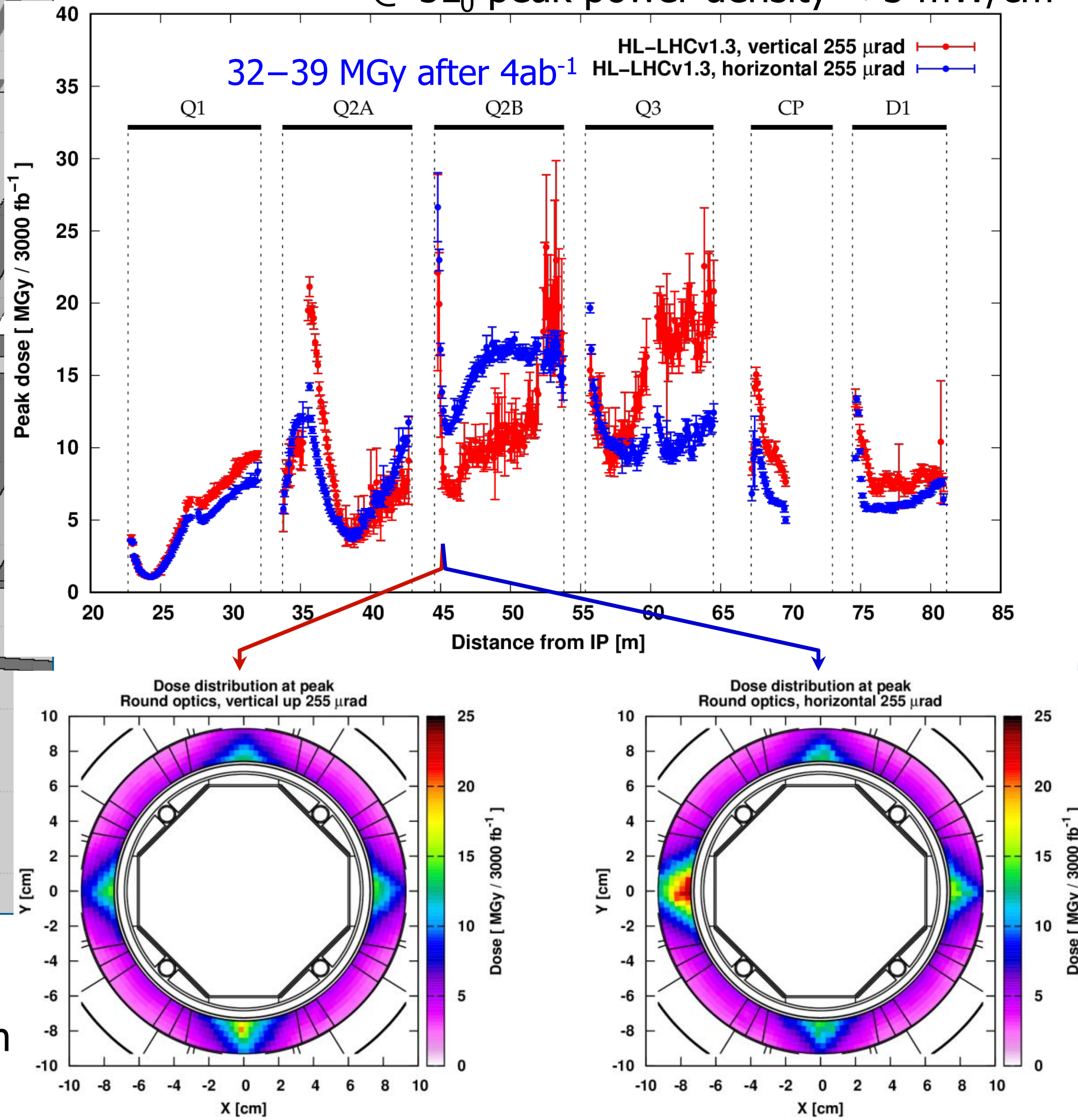
Dispersion Suppressor

Ideal picture and sensitivity to aperture imperfections

HL-LHC v1.3

@ $5L_0$ peak power density < 3 mW/cm^3





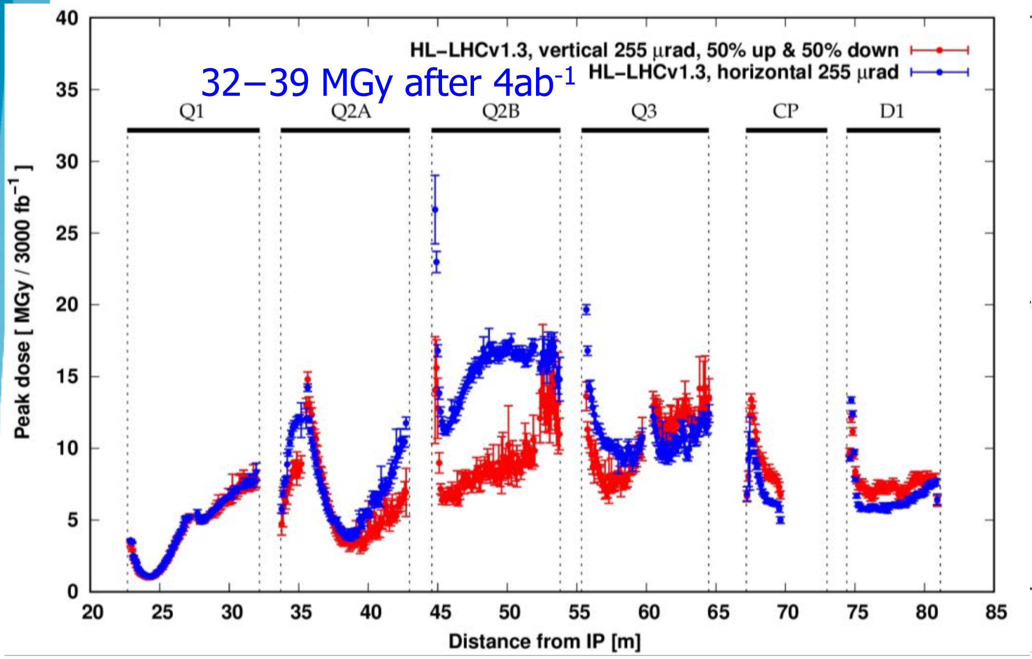
@ $5L_0$

630 (V) 595 (H) W in the cold mass

595 (V) 555 (H) W in the beam screen

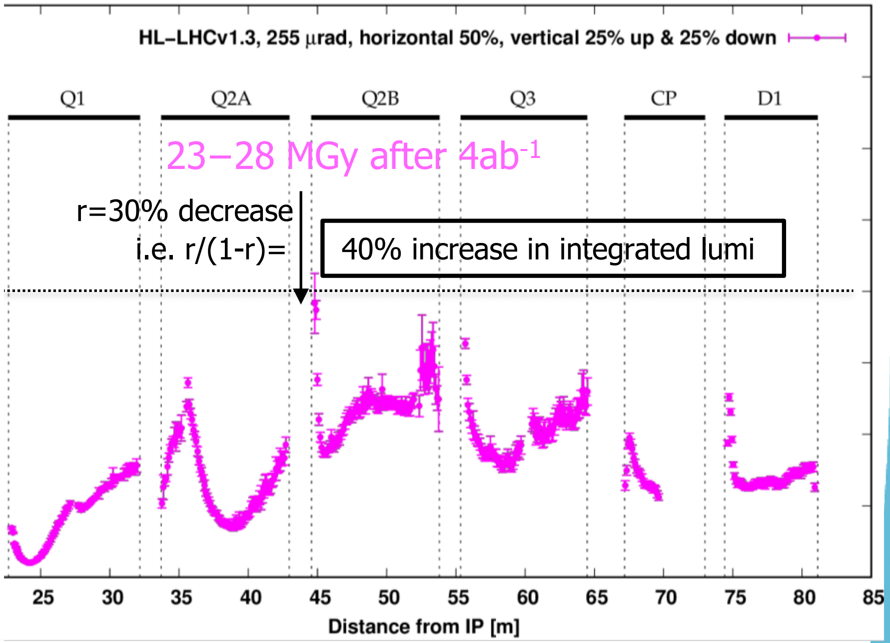
OPTICS MITIGATION

50% +V & 50% -V crossing in one insertion
100% H crossing in the other



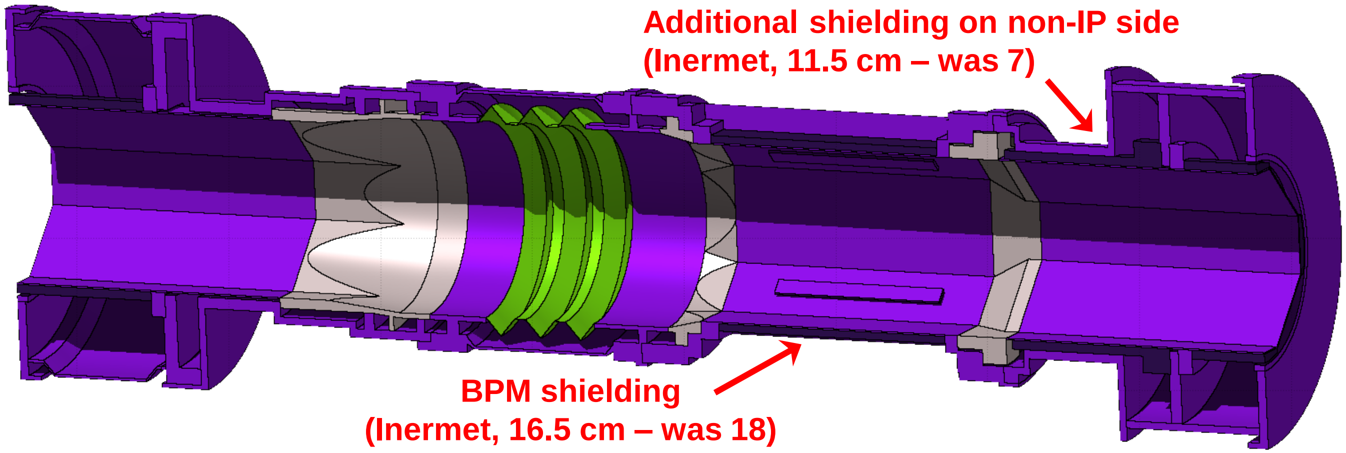
the limiting peak is obviously unmodified

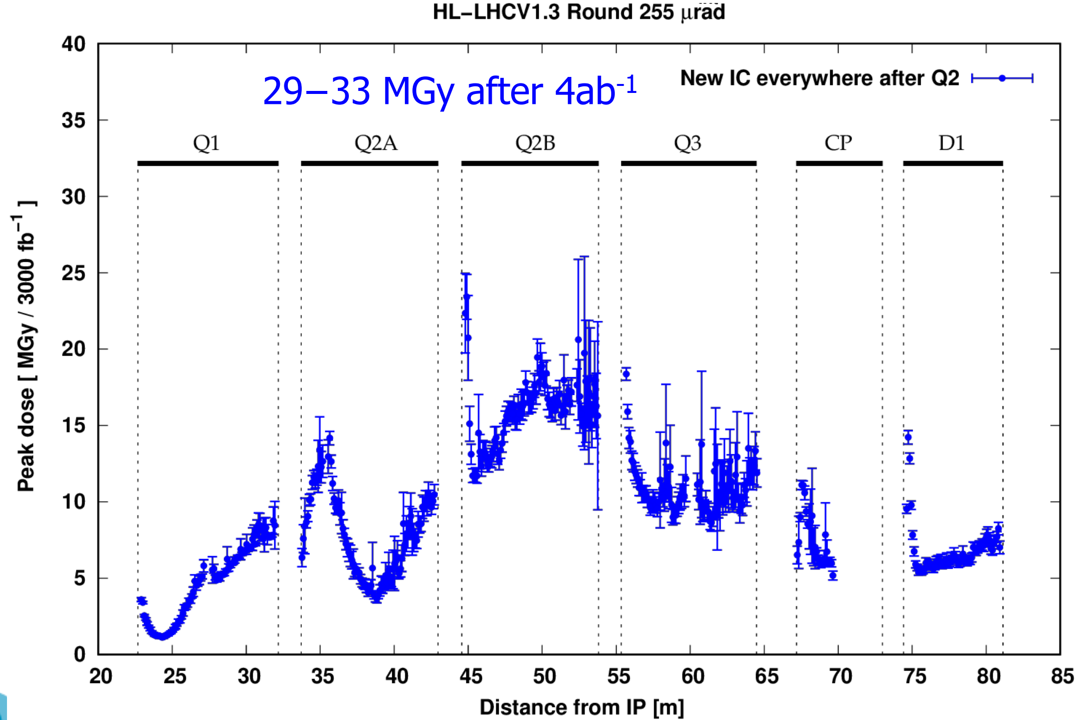
25% +V & 25% -V & 50% H crossing in each insertion



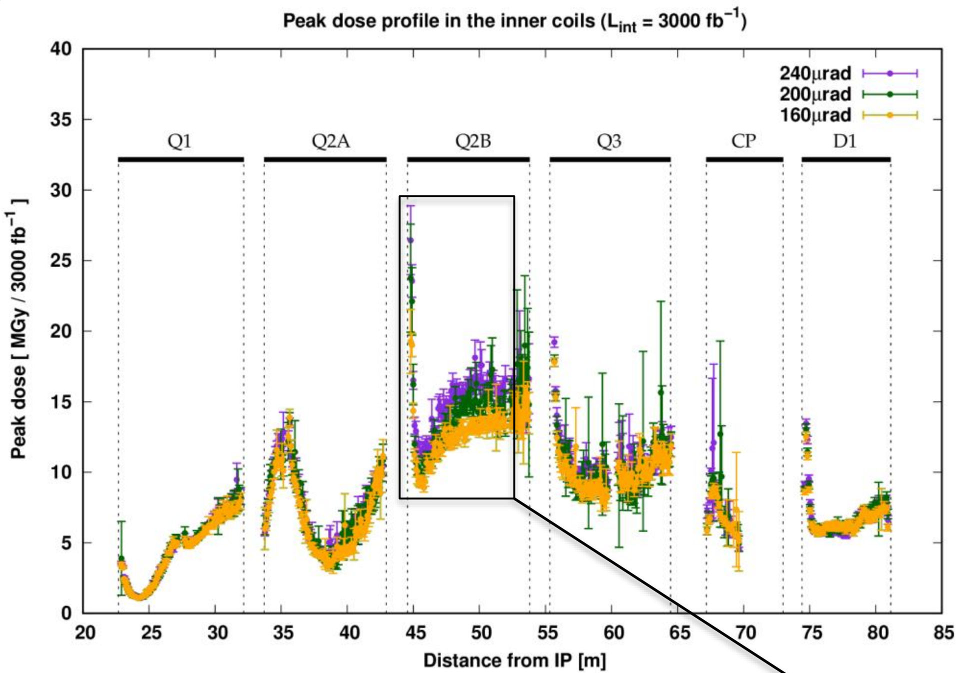
the gain is there,
but it requires a quite challenging hardware flexibility
with optics drawbacks

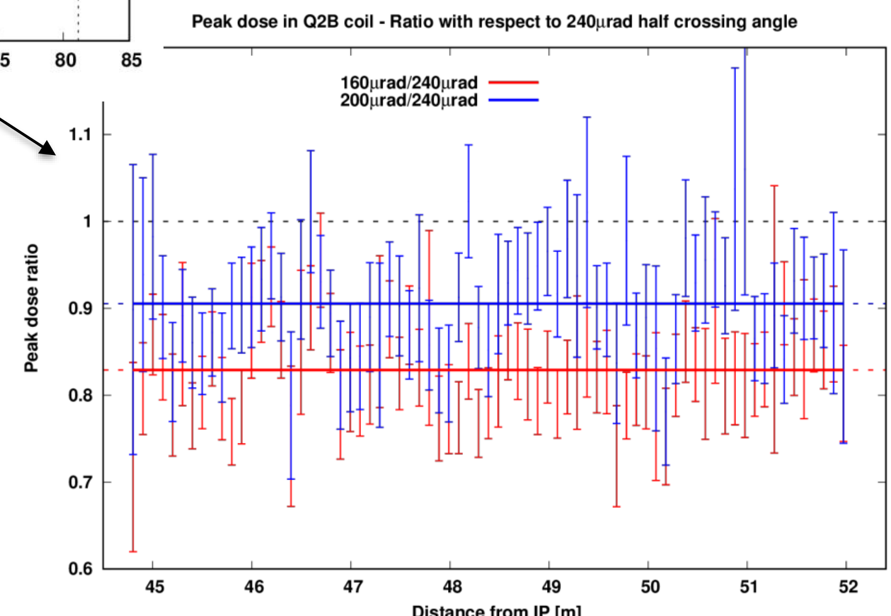
BETTER SHIELDING





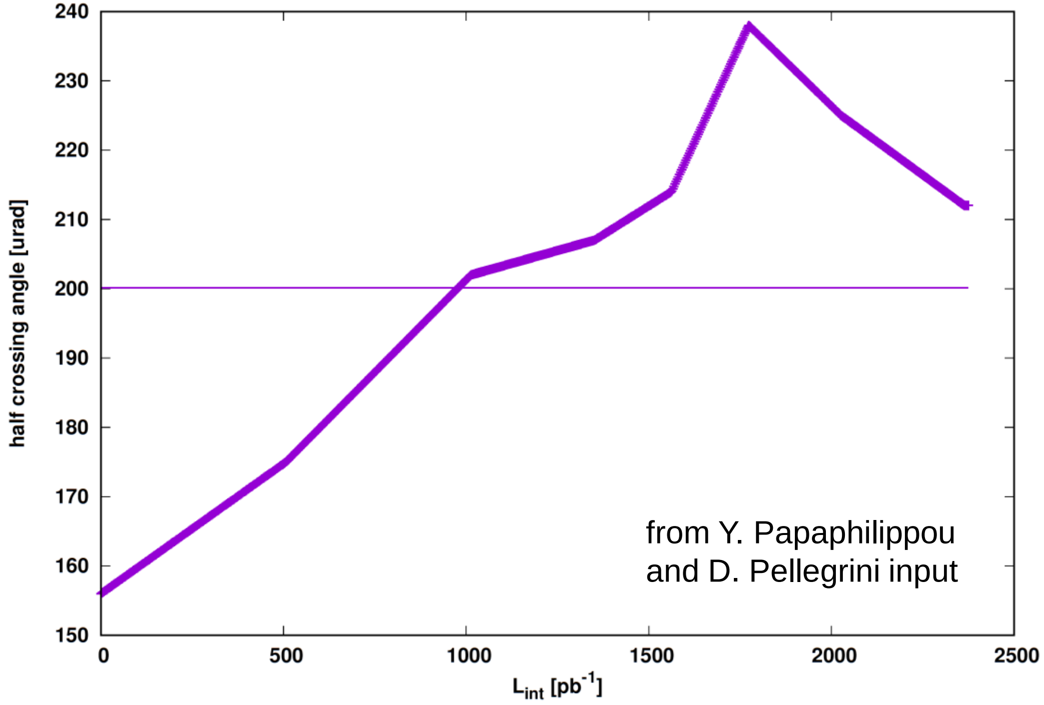
DEPENDENCE ON CROSSING ANGLE





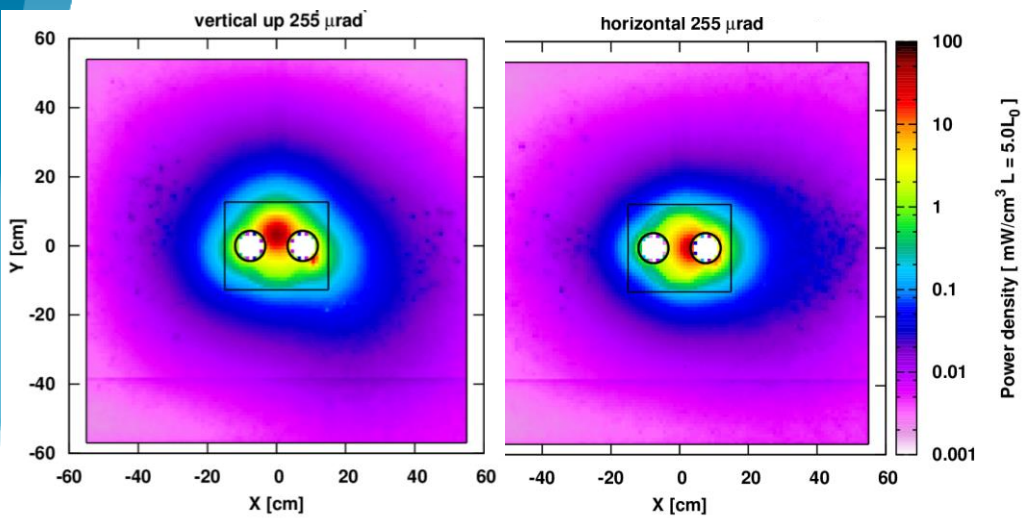
10% peak dose reduction
for 40 µrad decrease

VARYING CROSSING ANGLE FILL



scheme yielding a 10% lifetime increase

MATCHING SECTION



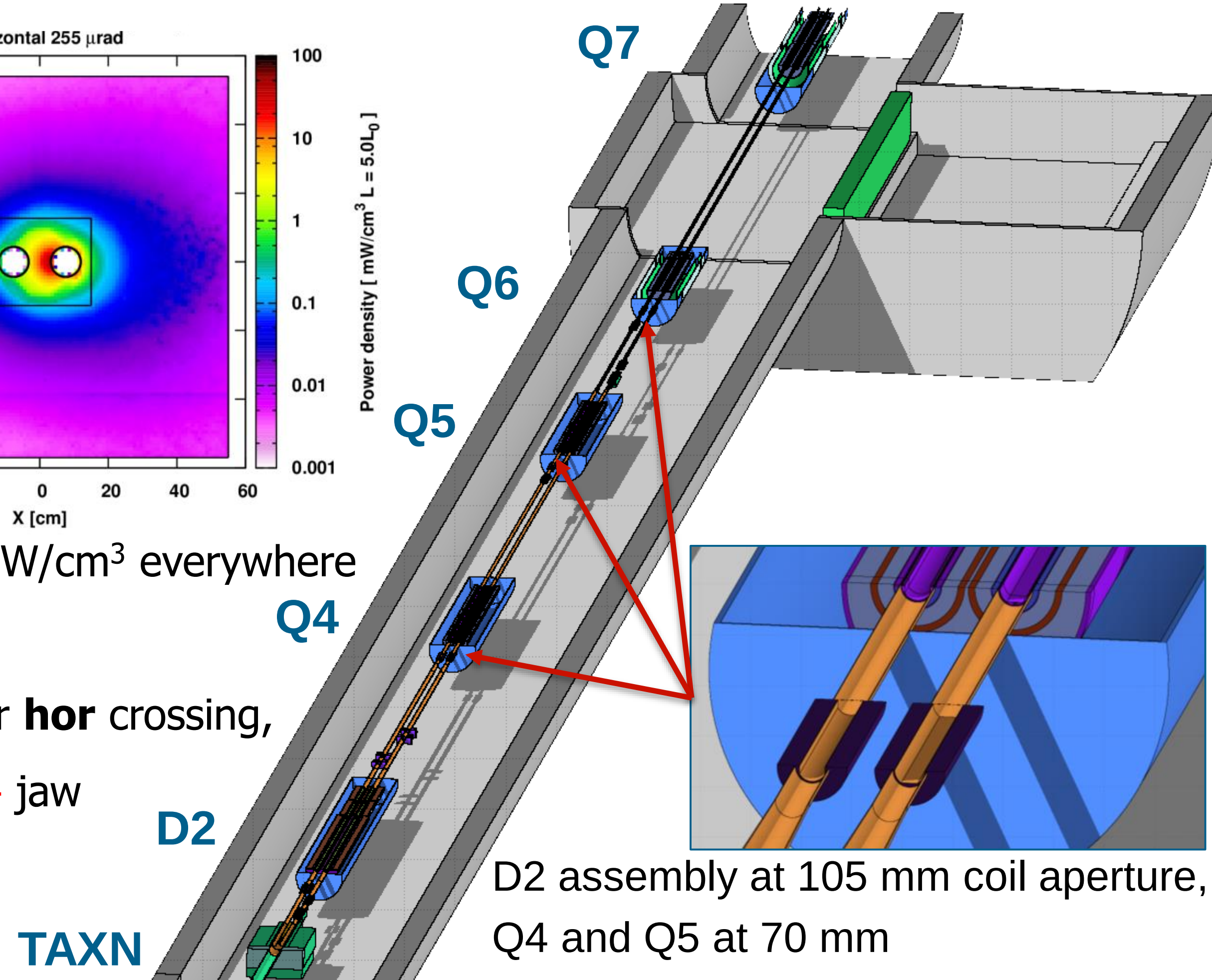
@ $5L_0$ peak power density < 1 mW/cm^3 everywhere

and 33 W in the D2 cold mass for **hor** crossing,

155 W in the most exposed TCL4 jaw

and 20 W in the TCLM4;

up to 12 MGy after 3 ab^{-1} on the D2 IP end coils



D2 assembly at 105 mm coil aperture,
Q4 and Q5 at 70 mm
Masks in front of Q4, Q5 and Q6
3 TCLs @ 13.5σ and 4 TCTs @ 12σ

Q5 at 56 mm being studied
(with 3 TCLs @ 12σ and 4 TCTs @ 8.8σ for 15 cm β)*

PEAK VALUES IN THE MATCHING SECTION

	Horizontal crossing	
Magnet assemblies	power density [mW/cm^3 @ 5L$_0$]	dose [MGy after 3 ab^{-1}]
D2	**0.8**	**12**
Q4	**0.5**	**7**
Q5 (70 mm)	**0.2**	**3**
Q6	**0.2**	**3**
Q7	**0.5**	**7**

*with TCL at 12 σ for 50 cm β**

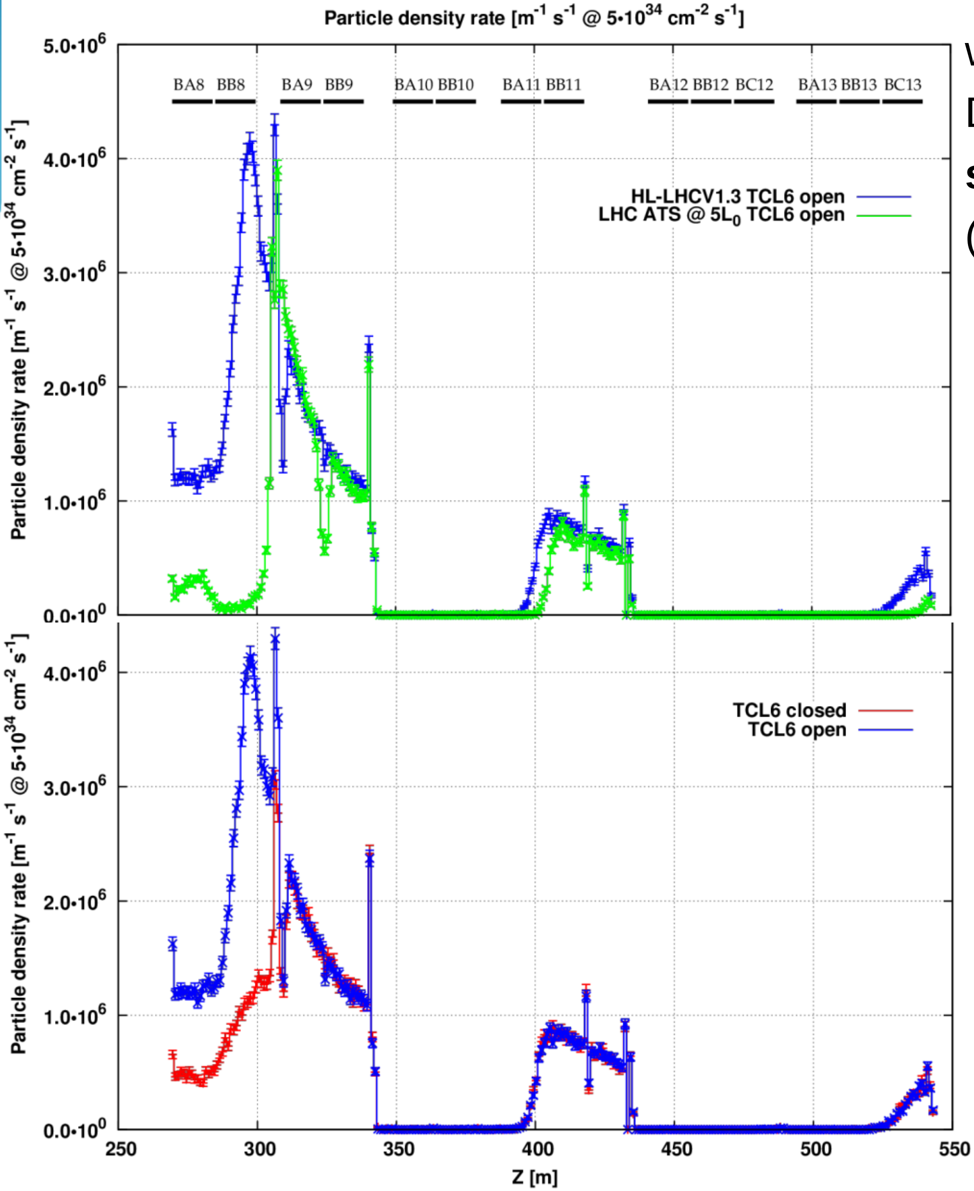
i.e. gap decreased by a factor 1.8

↓

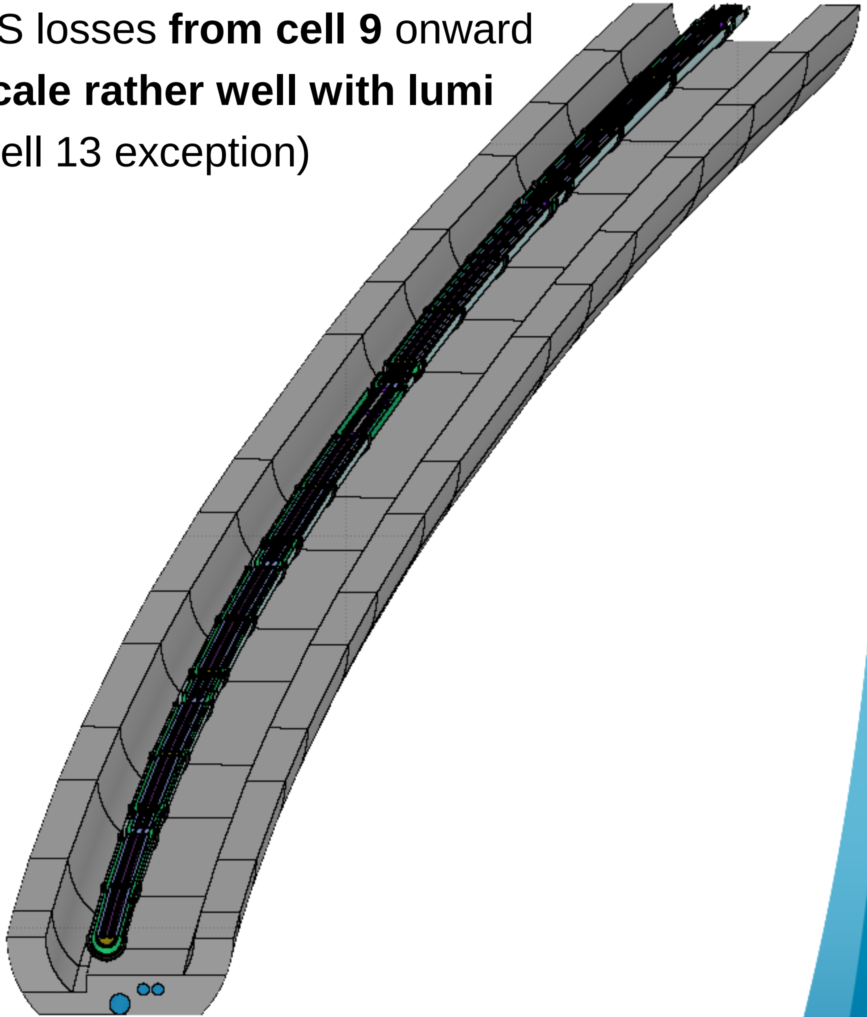
↑

(56 mm) ≈

DISPERSION SUPPRESSOR

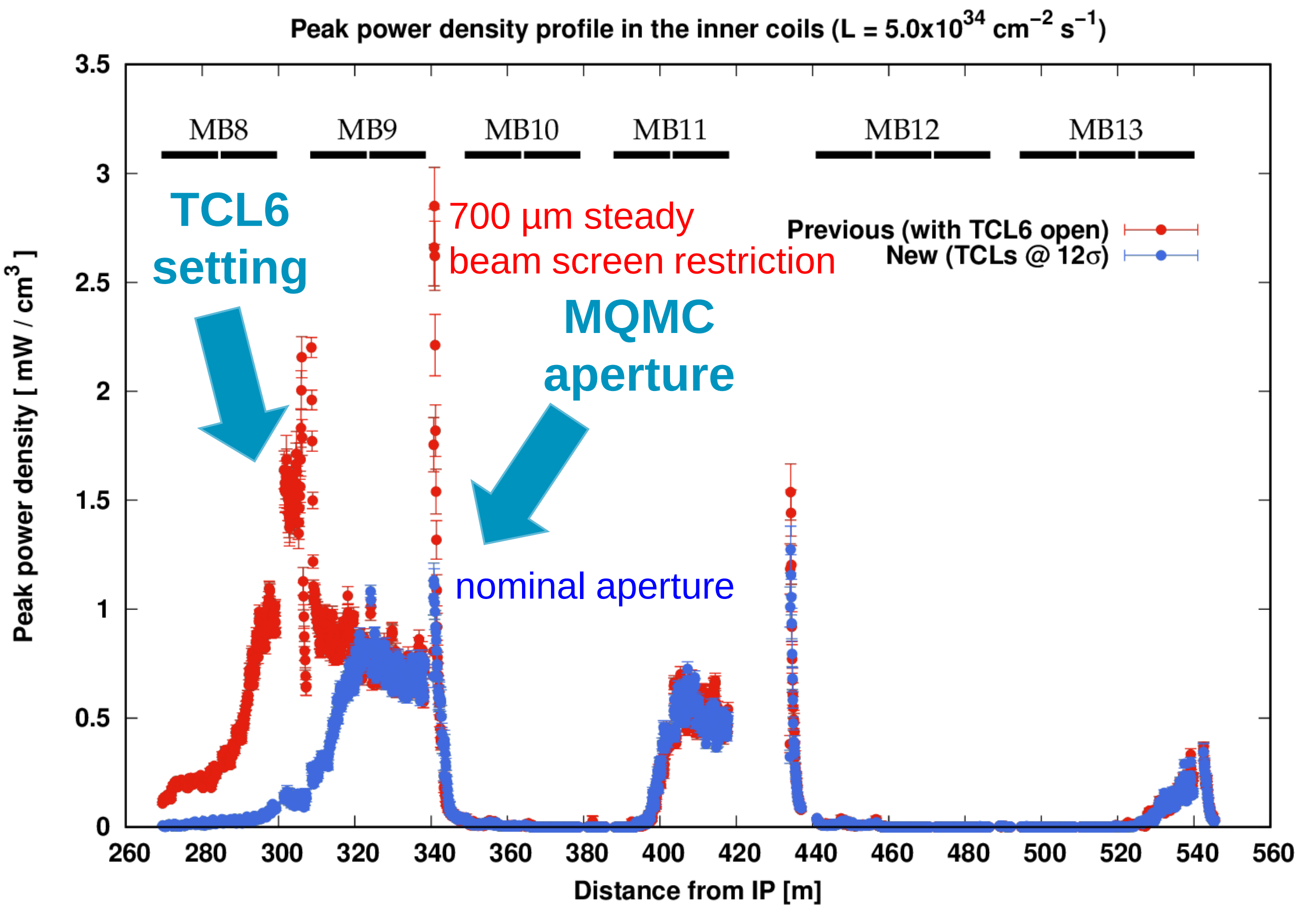


wrt present LHC ATS optics, DS losses **from cell 9** onward **scale rather well with lumi** (cell 13 exception)



TCL6 has a noticeable impact only up to cell 8

DS COILS IN THE HL-LHC ERA [I]

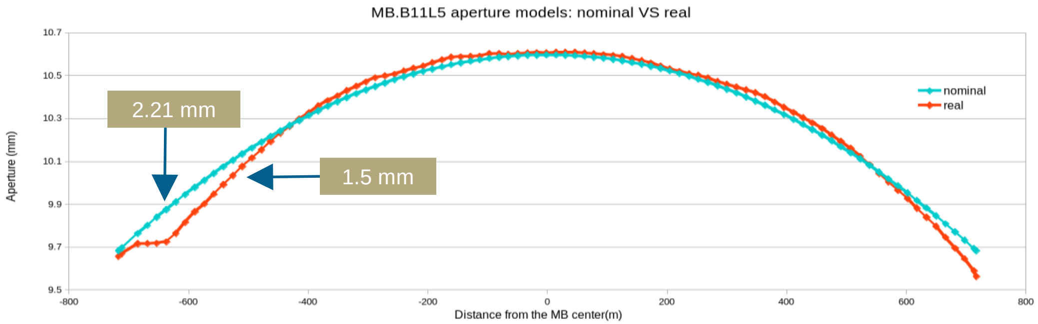


Maximum peak power density values in the coils around 1-2 mW/cm^3 @ 5L$_0$

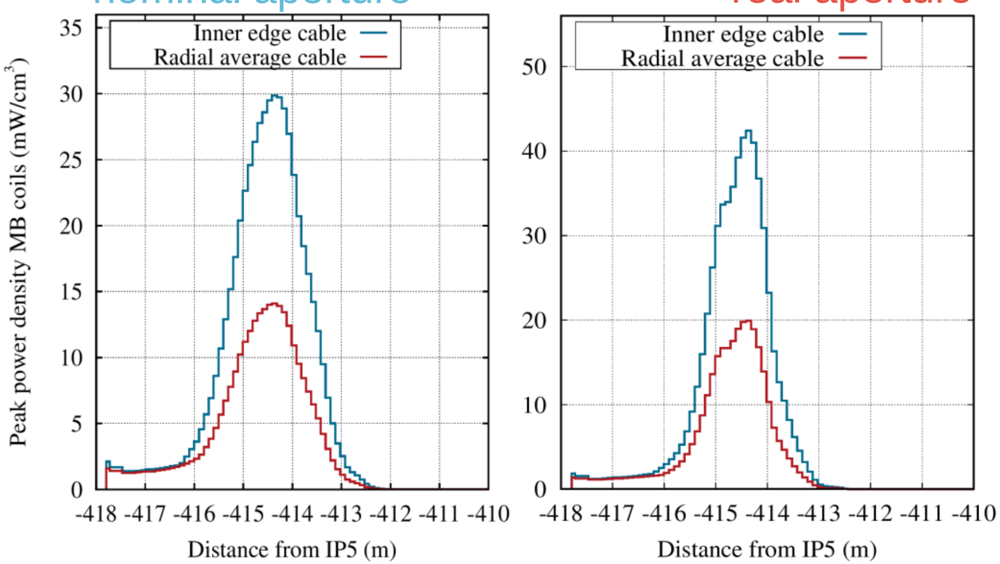
Pronounced sensitivity to aperture imperfections

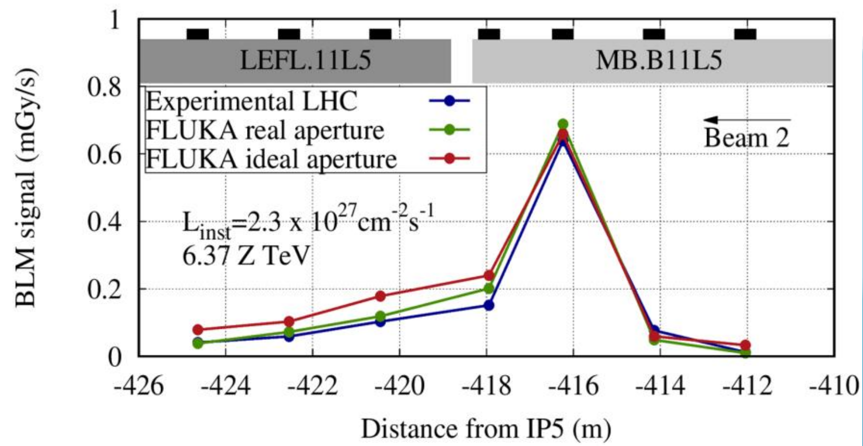
REAL APERTURE EFFECT

by C. Bahamonde and A. Lechner



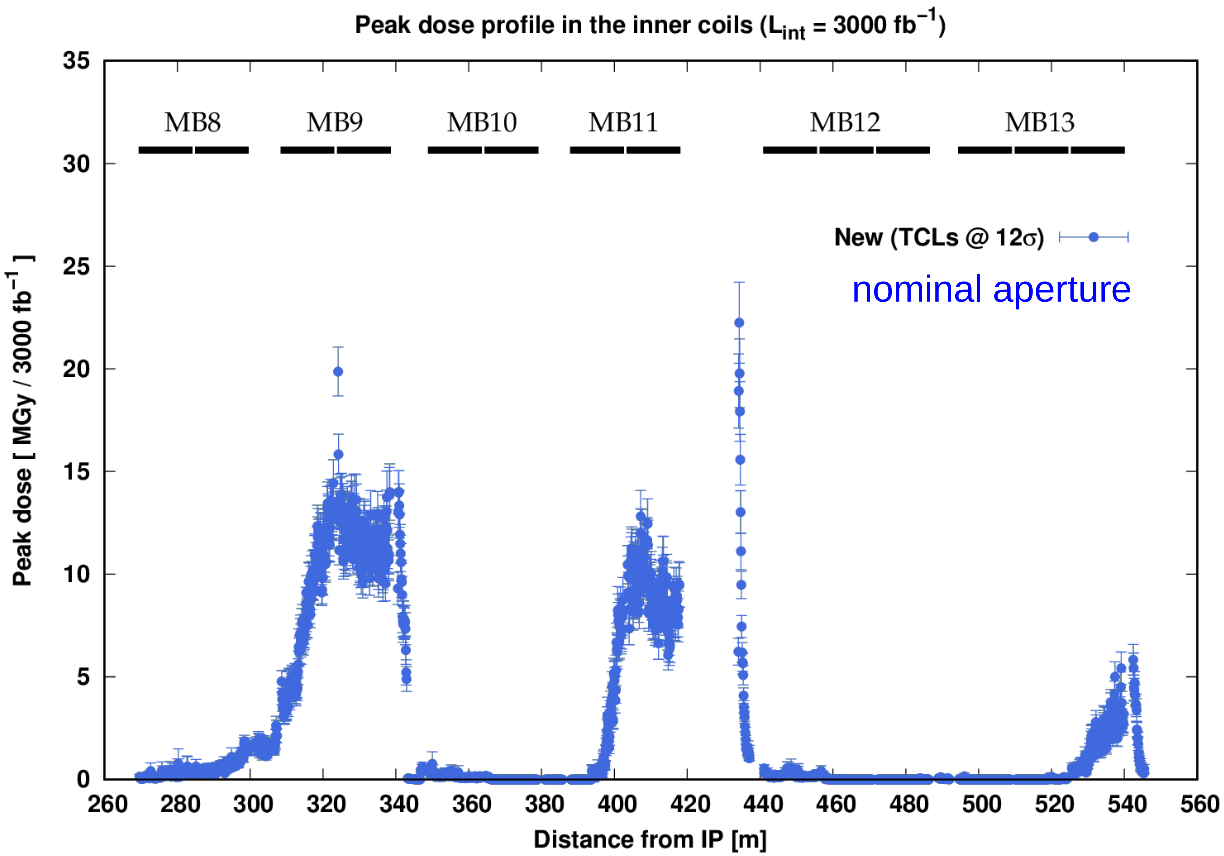
BFPP losses on





35% increase in peak dose

DS COILS IN THE HL-LHC ERA [II]



Maximum dose below 20 MGy for 3000 fb^{-1} (MQ11 peak estimation is conservative due to the absence of the specific LEGR-to-MQ interconnect)

CONCLUSIONS

The structural Q2B weak point is brought to slightly exceed 30 MGy after 4 ab^{-1}, with a clear asymmetry between the hor and ver crossing insertions.

The crossing plane flexibility is capable to provide a valuable benefit but has heavy implications.

The crossing angle variation along the fill can offer a 10% gain for the considered scheme.

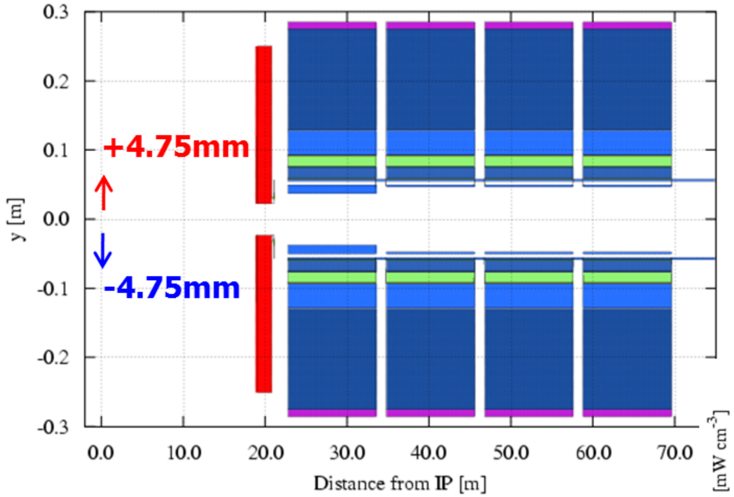
Despite the weaker TAXN effectiveness, collimators and masks can offer a reasonable protection to the matching section.

TCL settings to be optimized in mm rather than σ.

The exposure of a reduced aperture Q5 is being studied.

Dispersion suppressor losses are expected to mainly display the expected lumi scaling, inducing for an ideal aperture profile a max dose of about 20 MGy after 4 ab^{-1}, still subject to a pronounced sensitivity to aperture imperfections.

IP DISPLACEMENT



in the crossing plane

vertical axis

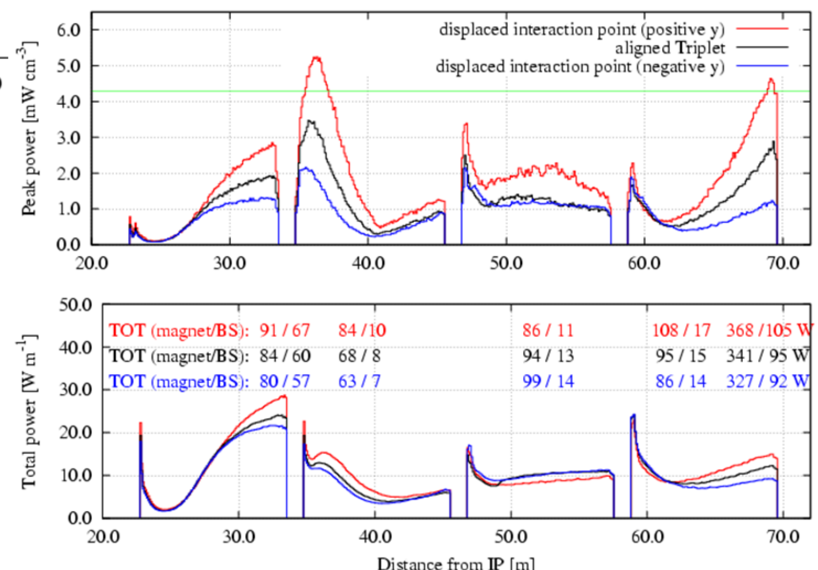
vertical crossing

(+225 urad half crossing angle)

+50% for peaks

+10% for totals

when the debris cone is moved to a higher field region at the triplet entrance

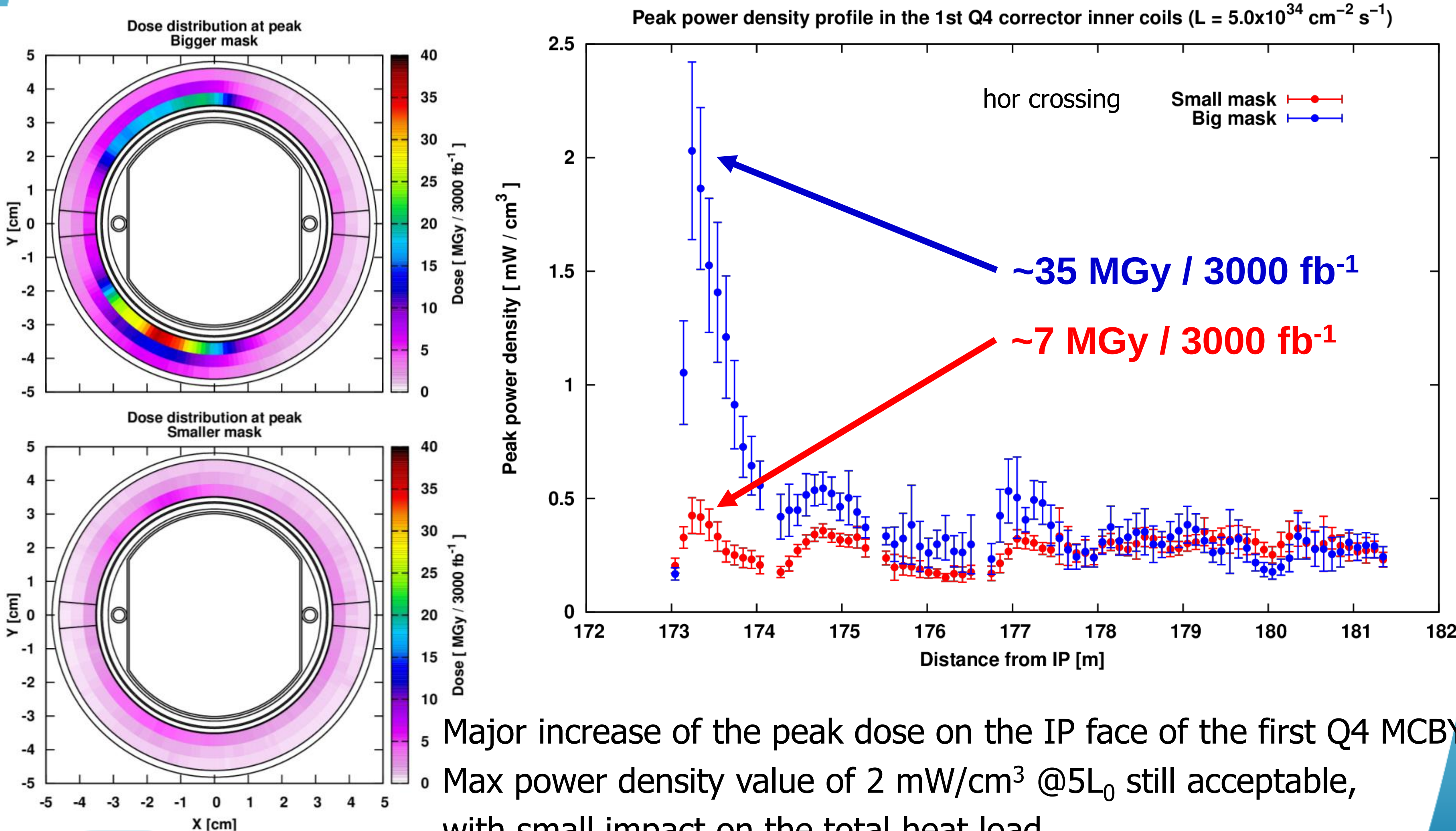


SLHC-IRP1, TDG Meeting, June 4th 2009 F.Cerutti 3

Effect to be evaluated for realistic conditions

SENSITIVITY TO MASK APERTURE/MISALIGNMENT

The warm masks are designed to match the beam screen aperture of the respective magnet
Assuming a 2 mm radial enlargement:



Major increase of the peak dose on the IP face of the first Q4 MCBYV
Max power density value of 2 mW/cm^3 @5L_0 still acceptable,
with small impact on the total heat load