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FLUKA studies on alternative designs

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University of Oxford

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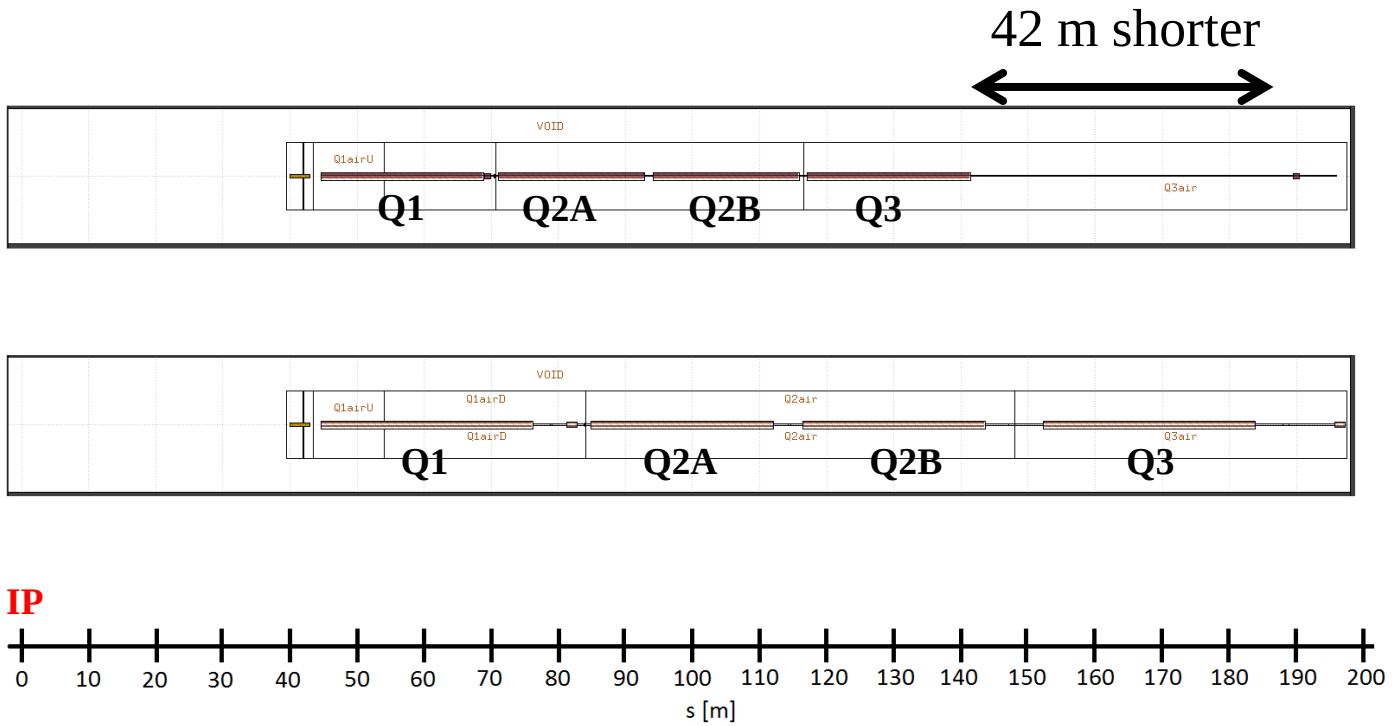
Thanks to Ilaria Besana and Francesco Cerutti (CERN)

EuroCirCol

A key to New Physics

The new triplet

A new triplet is proposed*



The question is if this new, short triplet will withstand the high radiation, already considerable for the nominal triplet

*See talk by Leon Van Riesen-Haupt: *Global chromatic aspects, L*, triplet lenght, etc.*

The new triplet

Comparison of the FF quadrupoles

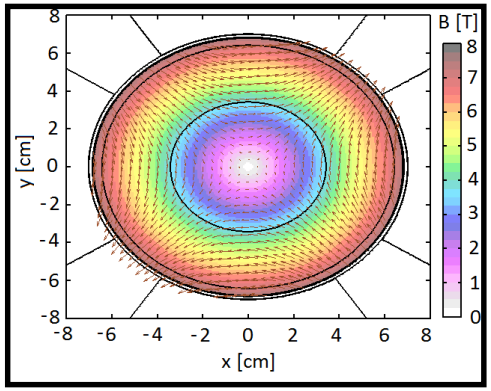
Shorter and stronger magnets

Nominal triplet

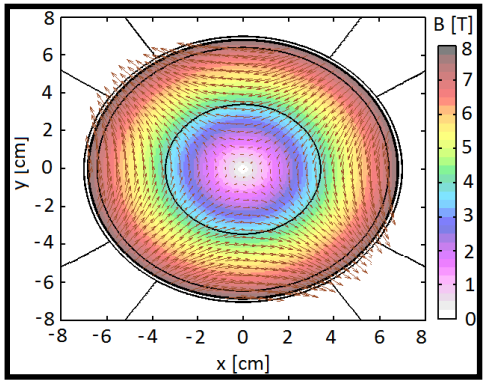
	g [T/m]	L [m]
Q1	107	30.8
Q2A	88.8	26.4
Q2B	88.8	26.4
Q3	85.8	30.8

JAI-Nov 2016 triplet

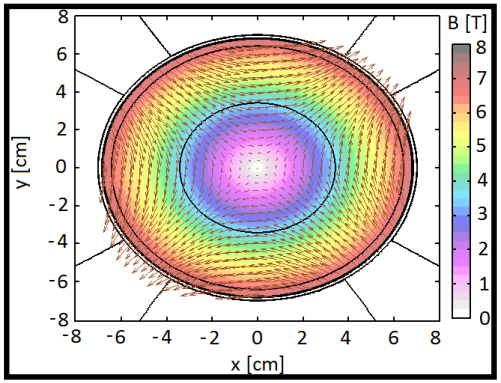
	g [T/m]	L [m]
Q1	110	23.5
Q2A	143	21.0
Q2B	143	21.0
Q3	157	23.5



Q1



Q2



Q3

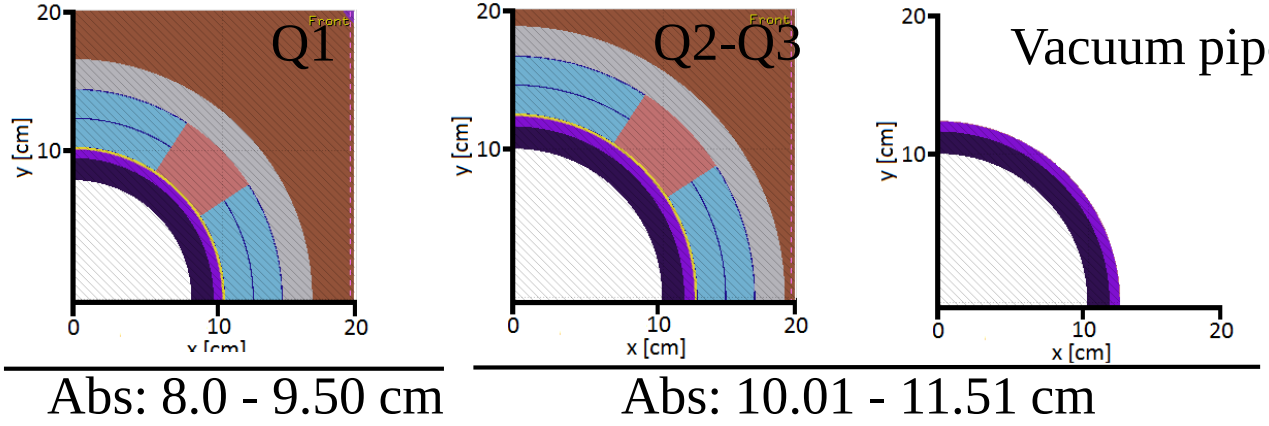
*See talk by Leon Van Riesen-Haupt: *Global chromatic aspects,L*, triplet lenght, etc.*

The new triplet

Apertures reduced

Shielding increased

Nominal triplet

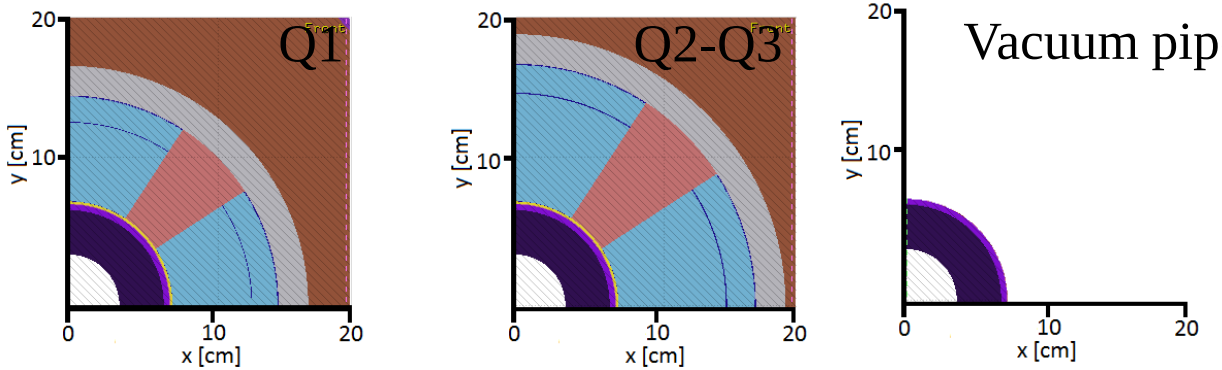


Abs: 8.0 - 9.50 cm

Abs: 10.01 - 11.51 cm

For the magnet coil: changed inner diameter of inner layer only. Valid as peak dose occurs in the inner part of the coil.

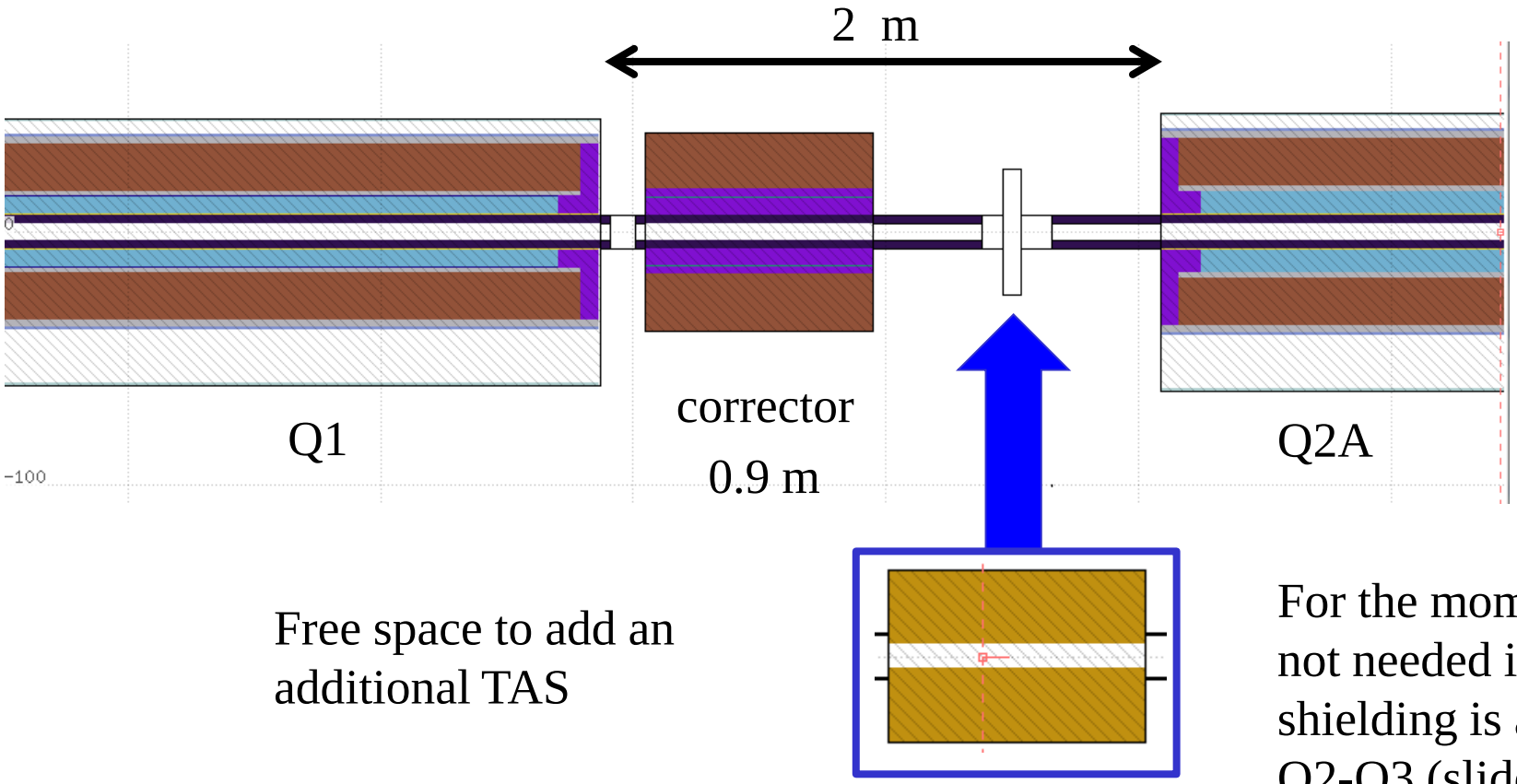
JAI Nov 2016 triplet



Abs: 3.45-6.42 cm

The new triplet

JAI-Nov 2016 triplet

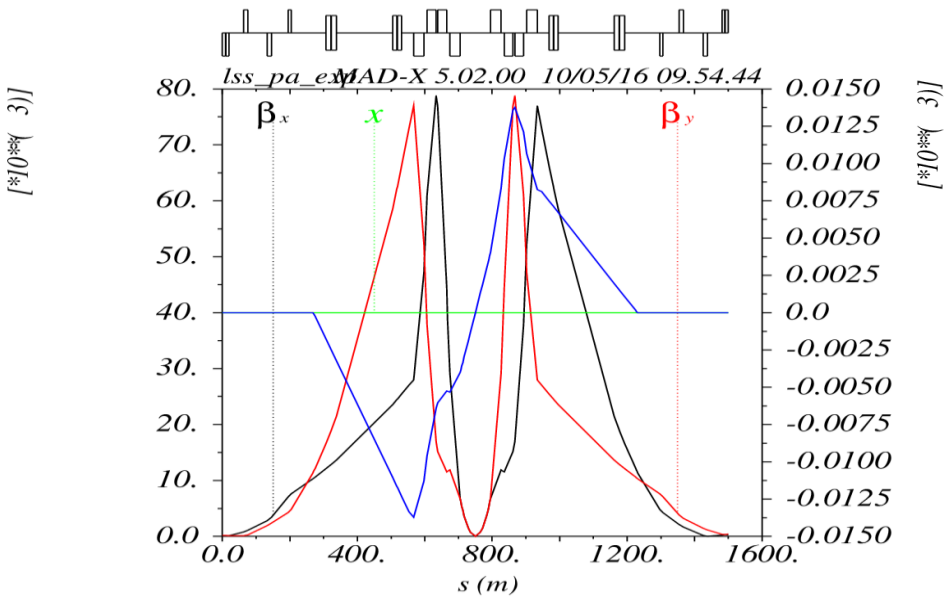


Free space to add an additional TAS

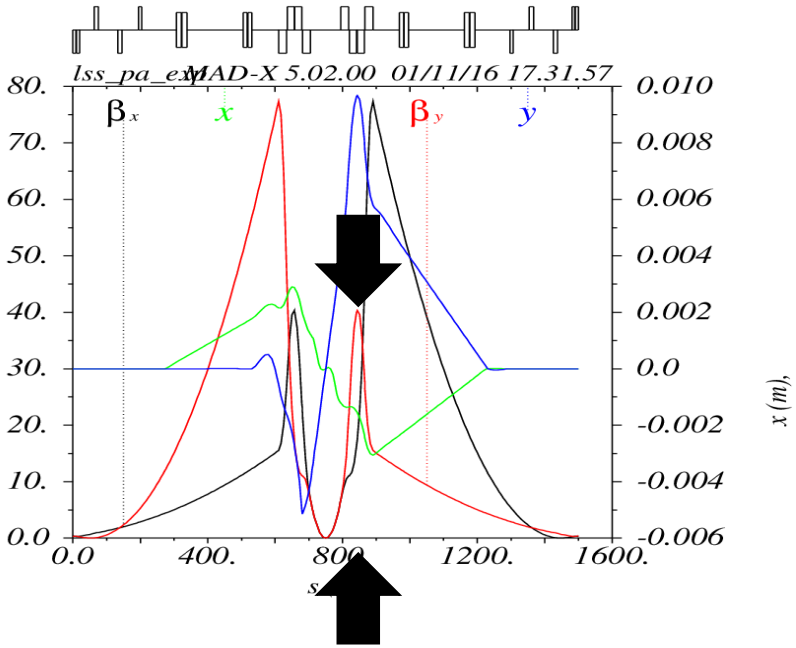
For the moment not needed if Q1 shielding is as in Q2-Q3 (slide 4)

The new triplet

Nominal triplet



JAI-Nov 2016 triplet



Beta functions reduced at Q1 and Q2

* Leon Van Riesen-Haupt*: Global chromatic aspects,L*, triplet lenght, etc.*

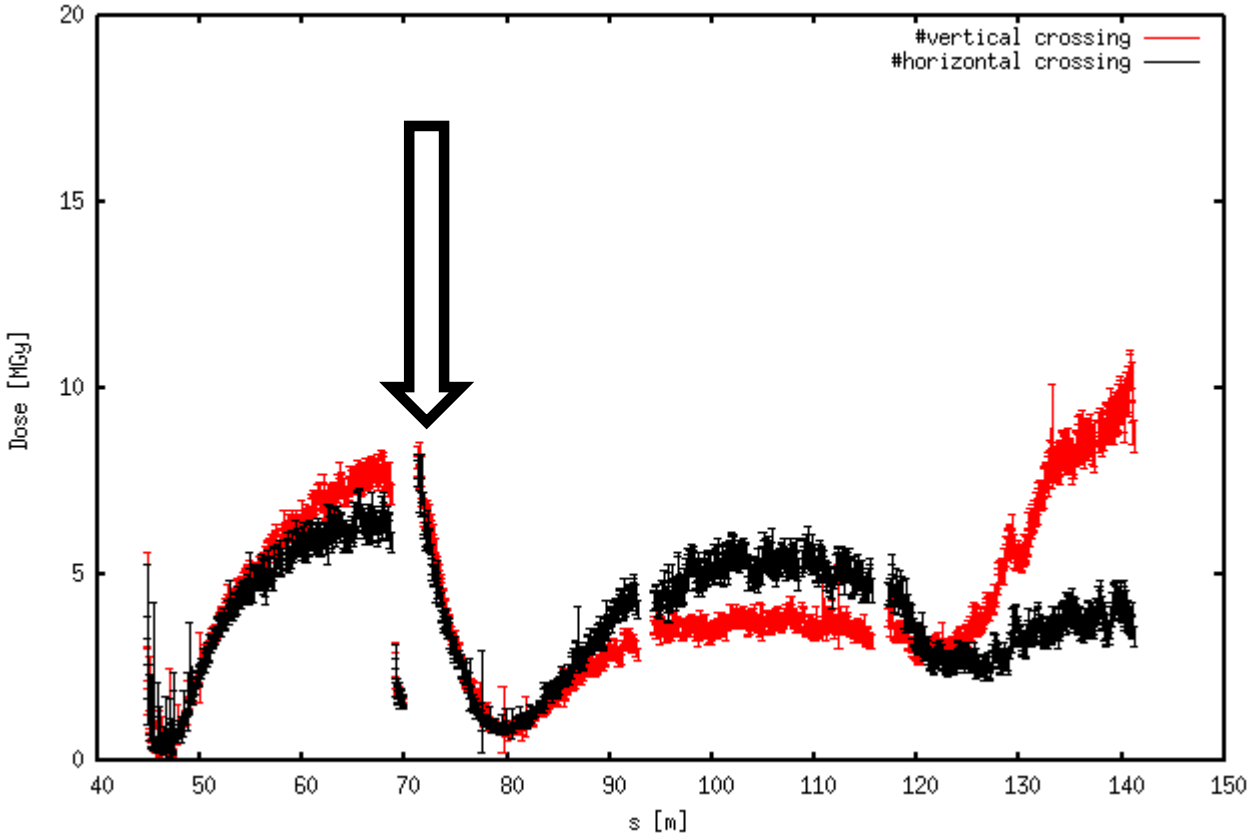
FLUKA simulations

- Model parametrized for fast iteration with optics
- Parameters: magnet length, position, **B**, absorber, quadrupole coils

- Spectrometer off
- (Half) Crossing angle 89.15 μrad both horizontal and vertical crossing
- L integrated: 3 ab^{-1}
- Cross section : 108 mbarn

FLUKA simulations

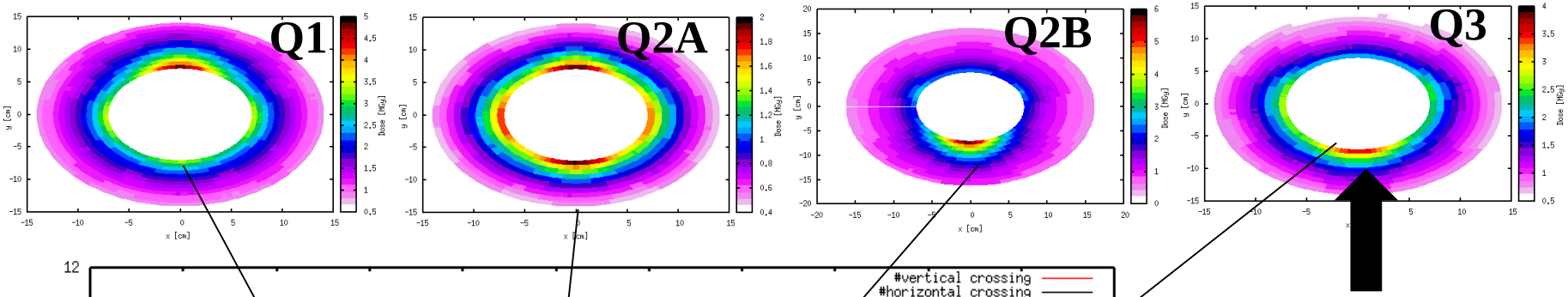
Simulated dose for 3 ab^{-1}

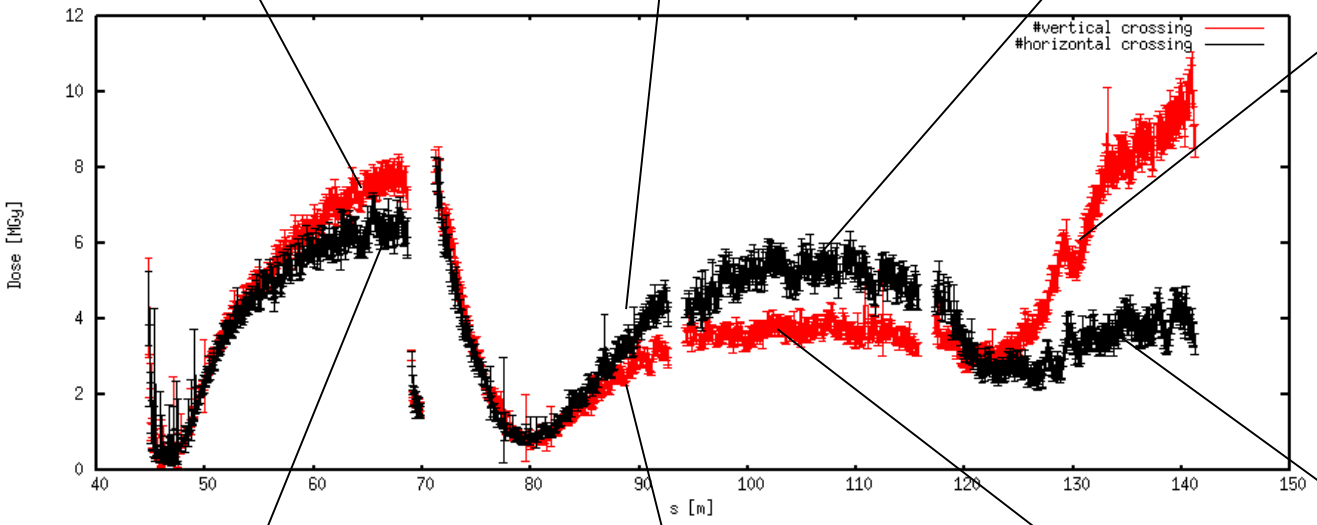


The increased shielding at Q1 aimed a reduction of the dose in Q2A (otherwise the peak goes very high)

The new triplet: dose

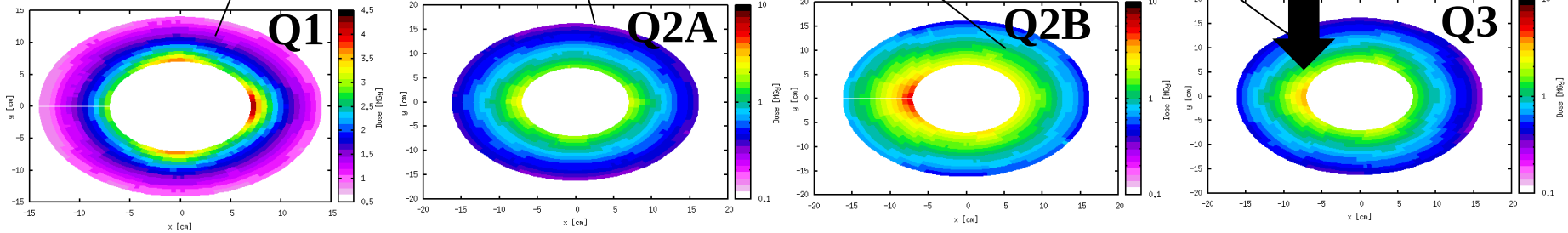
vertical





Localized maxima at a single side of the magnet

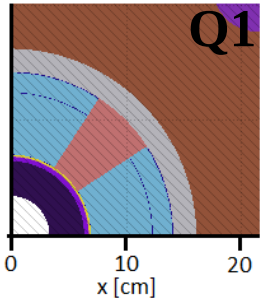
horizontal

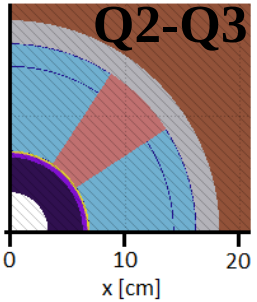


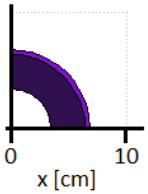
Variation of the absorber

This case is limited in acceptance

r = 3.45 cm, A = 12σ

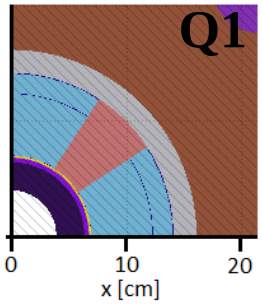


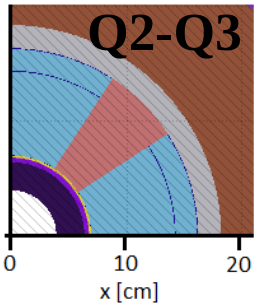


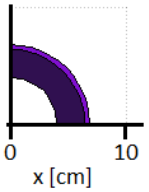


Other two cases have been simulated. Same magnets, varying the thickness of the absorber.

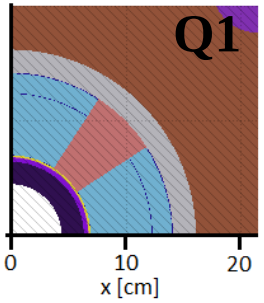
r = 4.0 cm, A = 16σ

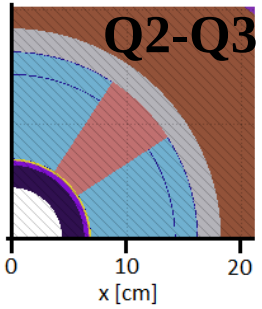


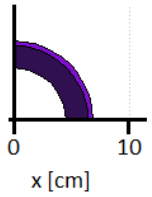




r = 4.5 cm, A = 19σ

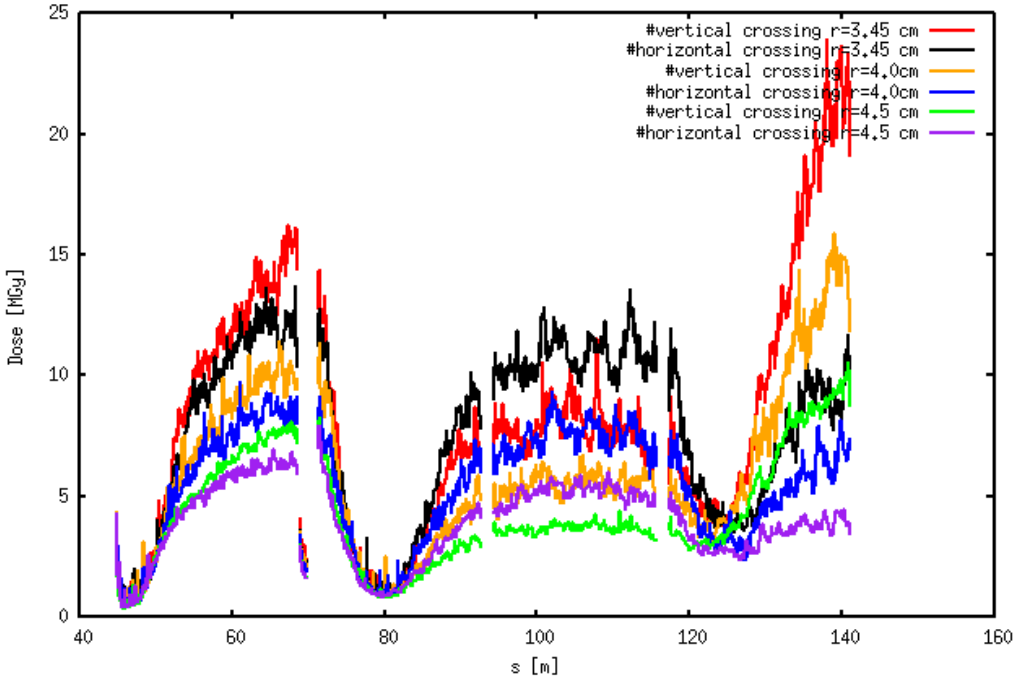






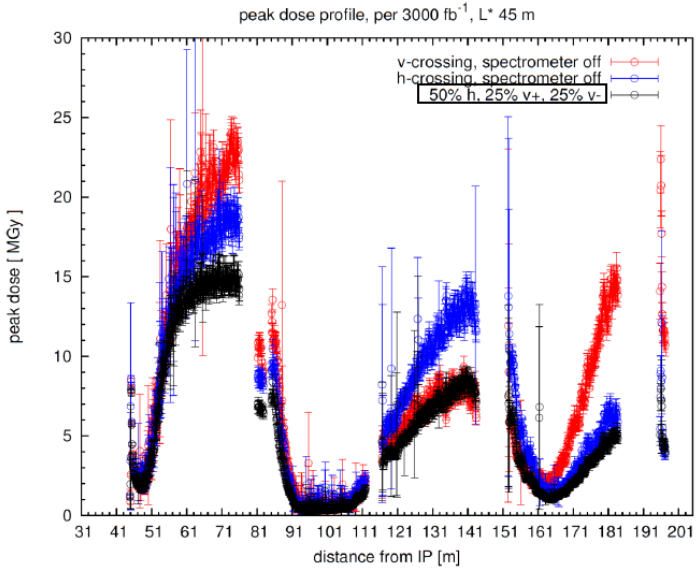
Variation of the absorber: dose

Simulated dose for 3 ab^{-1}



Excessive at Q3 (large beta function), specially for the vertical crossing.

Maximum dose 10-25 MGY for the vertical crossing and 8-15 for the horizontal.

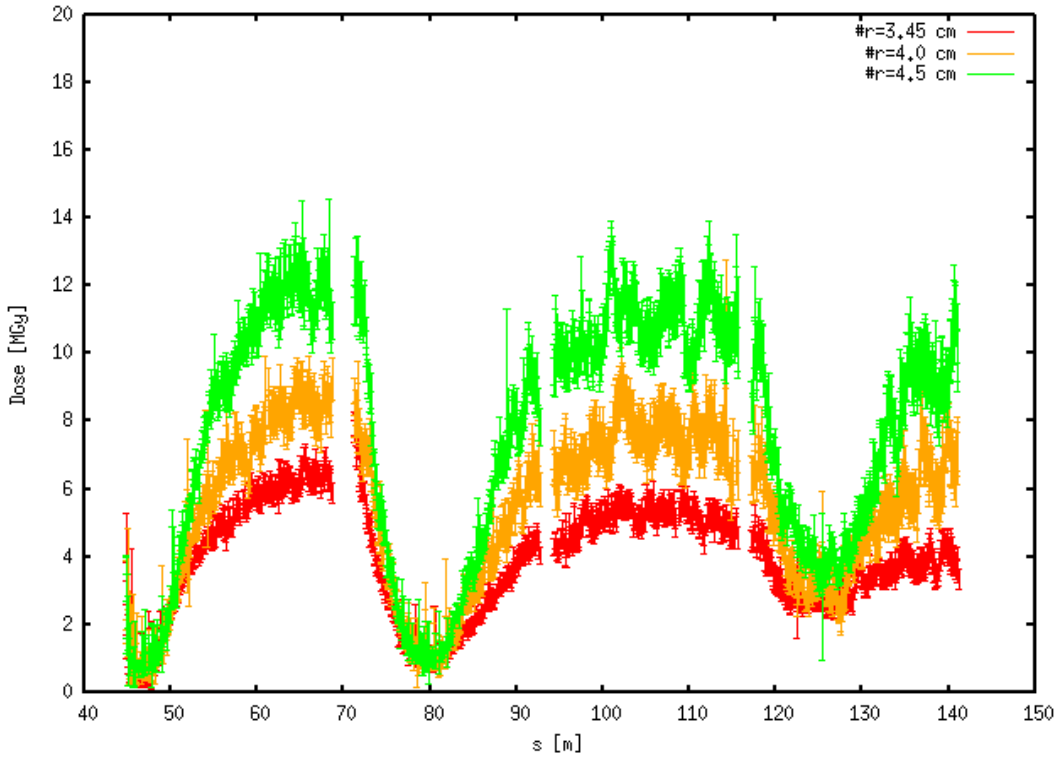


Comparison with the results of the nominal triplet (Ilaria, FCC week 2016)

Variation of the absorber: dose

As the maxima are localized within one side of the magnet, alternating crossing plane reduces the peak dose [Ilaria*].

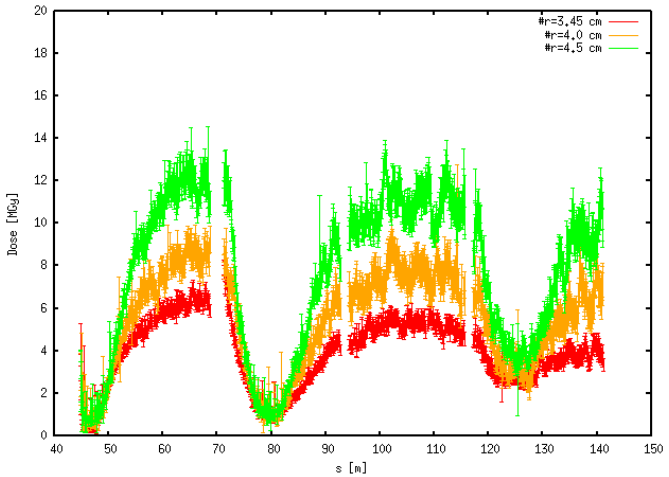
Maximum dose for 50% time horizontal crossing and 50 % vertical.

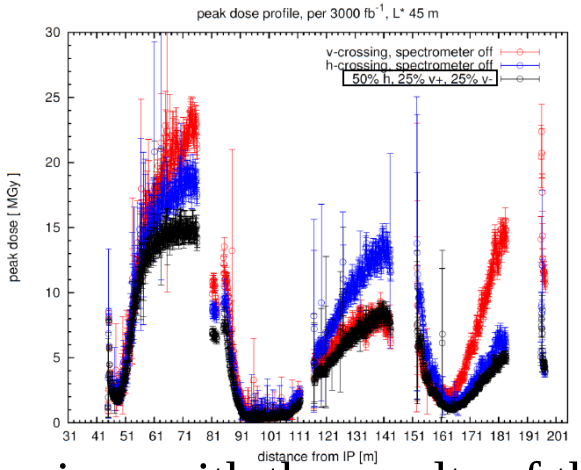


Peak dose reduced and more evenly distributed across the quadrupoles

*Ilaria Besana: FCC week 2016: *Collision debris on the triplet quadrupoles*

Variation of the absorber: dose





Comparison with the results of the nominal triplet (Ilaria, FCC week 2016)

Inner radius [cm]	Shielding thickness [cm]	Beam stay clear [σ]	Max dose H [MGy]	Max dose V [MGy]	Max. dose 50% hor 50% ver [MGy]
4.5	1.9	19	**25**	**15**	**14**
4.0	2.4	16	15	10	10
3.45	3.0	12	10	7	7

Even for the highest acceptance the peak dose is reduced to 14 MGy

Conclusions

- A new triplet 'JAI November 2016' has been designed.
- This triplet is more compact that the nominal one.
- After some iteration with optics, three different variations in the quadrupoles have been presented.
- The dose is reduced with respect to the original case thanks to the increased shielding in pipe and magnets.
- The results improves considerably if alternating crossing is used.
- Dose does not represent a stopper for shortening the triplet.