COLLISION DEBRIS
ON THE TRIPLET QUADRUPOLES

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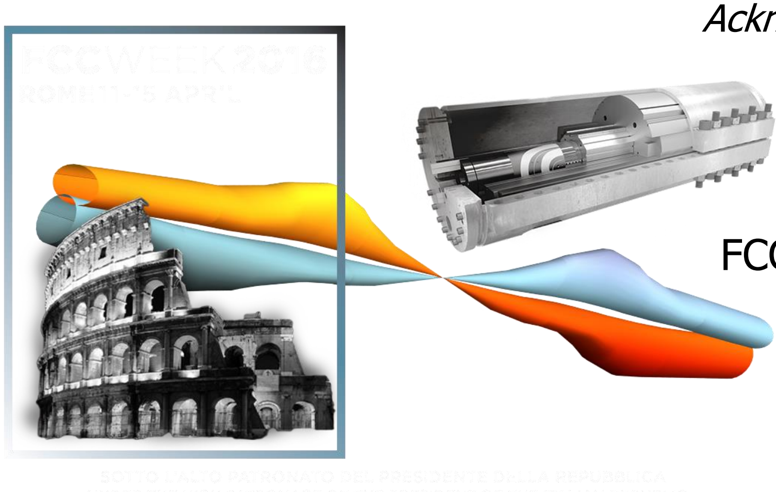
optics input by R. Martin and R. Tomas

Acknowledgments: S. Fartoukh, A. Ferrari, A. Fedynitch, A. Langner, A. Milanese, D. Schulte, E. Todesco, V. Vlachoudis



FCC week 2016, Rome

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BUILDING UPON WASHINGTON

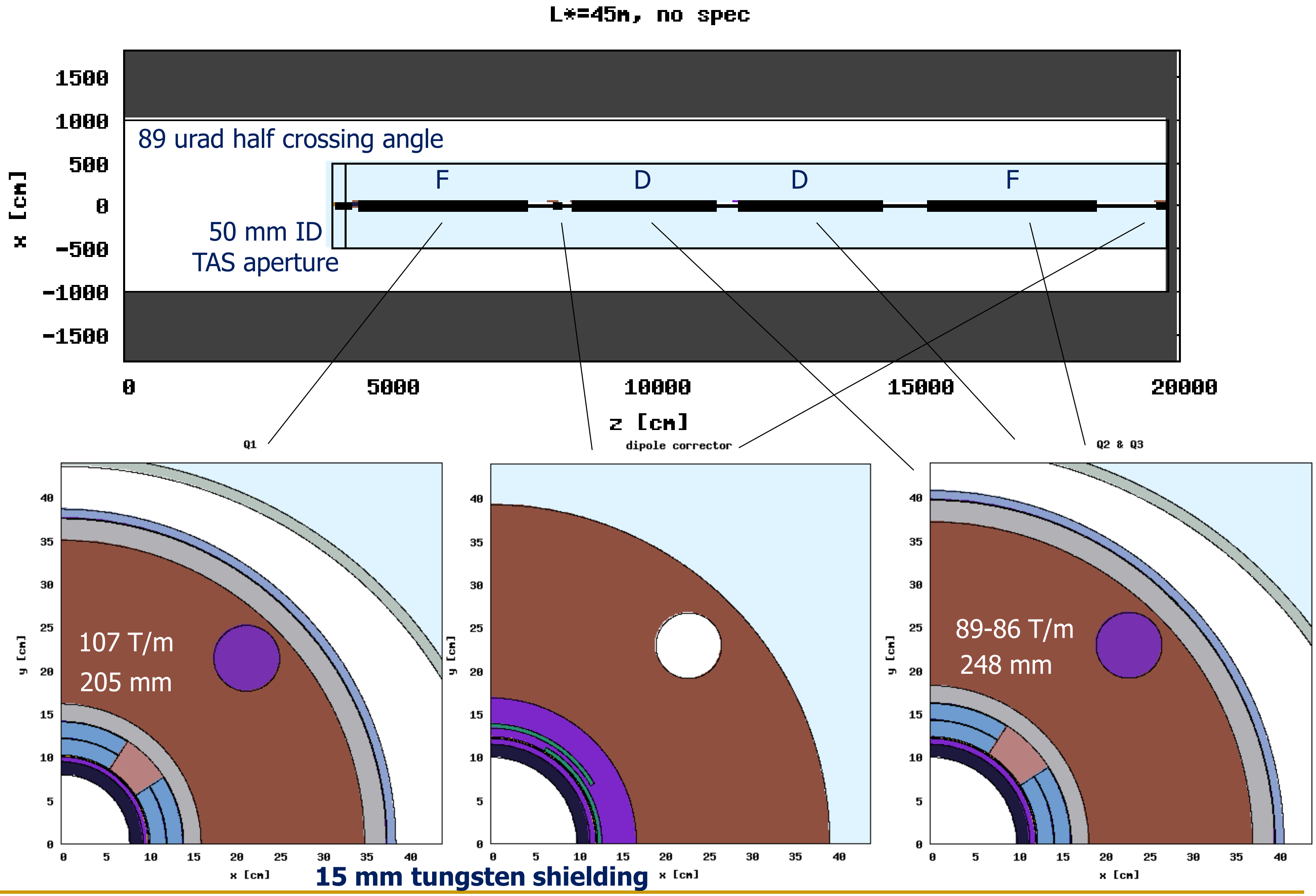
- the final focus triplet magnets are mainly impacted by pions captured by the quadrupole field

- several factors (in particular the crossing angle/plane and the coil aperture) determine the peak energy deposition profile in the superconducting coils

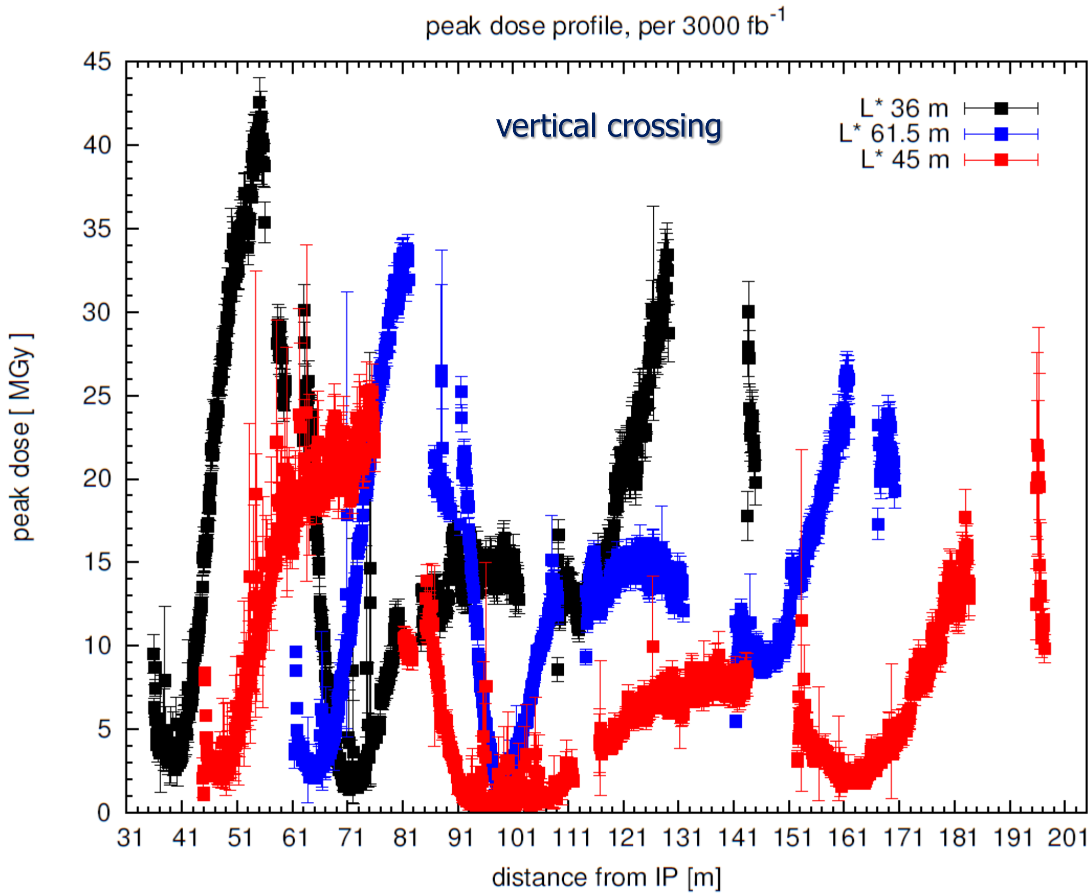
- a continuous shielding liner inside the aperture, absorbing a power of a few kW at $5L_0$, represents an essential protection solution, weakened by the interconnection gaps

- the challenge concerns especially the *magnet lifetime* (cumulated dose) rather than their operation conditions (steady power density)

L*=45m LAYOUT


L*=45m, no spec
89 urad half crossing angle
50 mm ID
TAS aperture
F
D
D
F
x [cm]
z [cm]
Q1
dipole corrector
Q2 & Q3
107 T/m
205 mm
89-86 T/m
248 mm
y [cm]
x [cm]
15 mm tungsten shielding

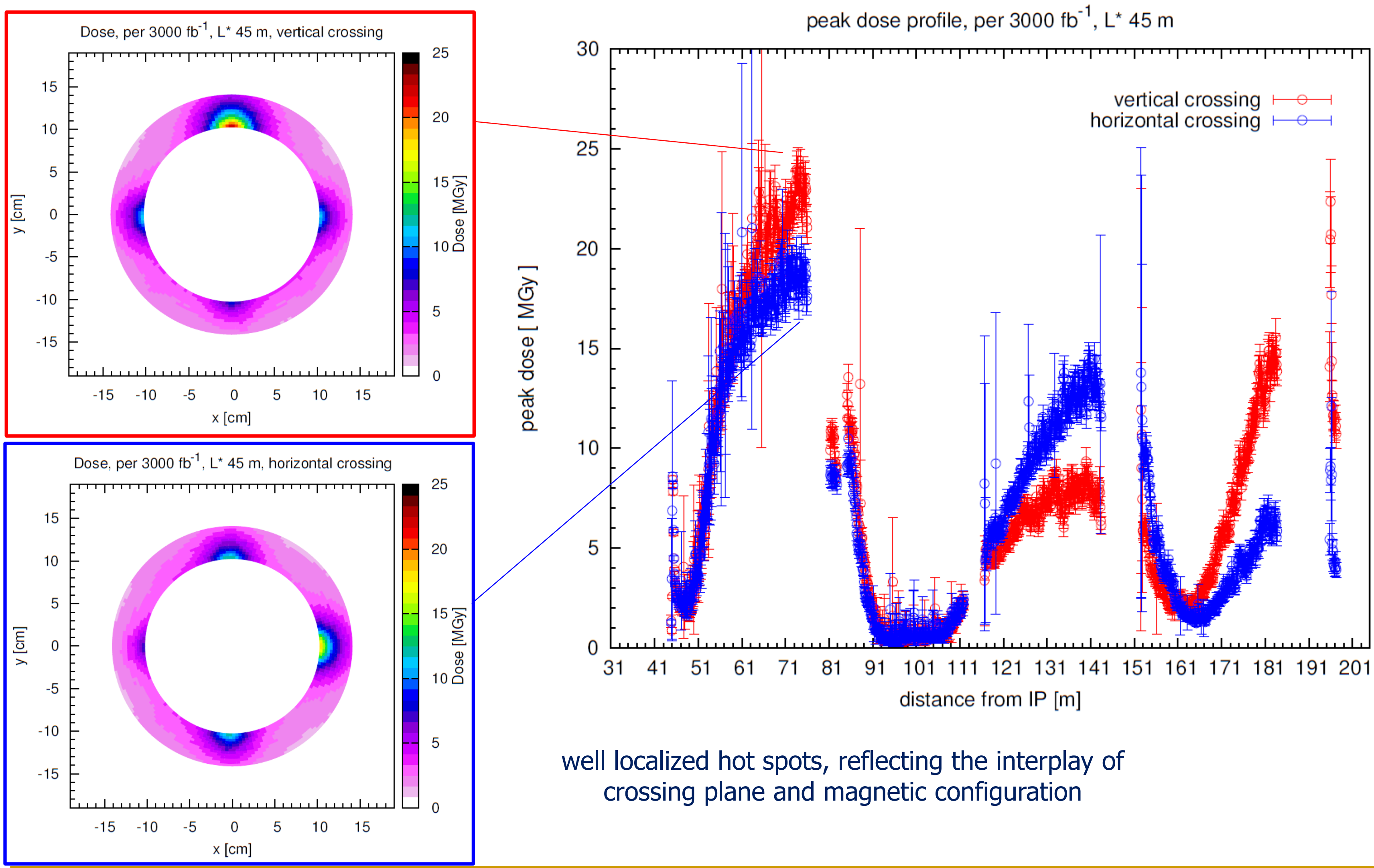
COMPARISON WITH PREVIOUS LAYOUTS (L*)



the difference is made by the considerably larger coil aperture (**>200mm**)

wrt L*=36m (**100mm**) and L*=61m (**140mm**)

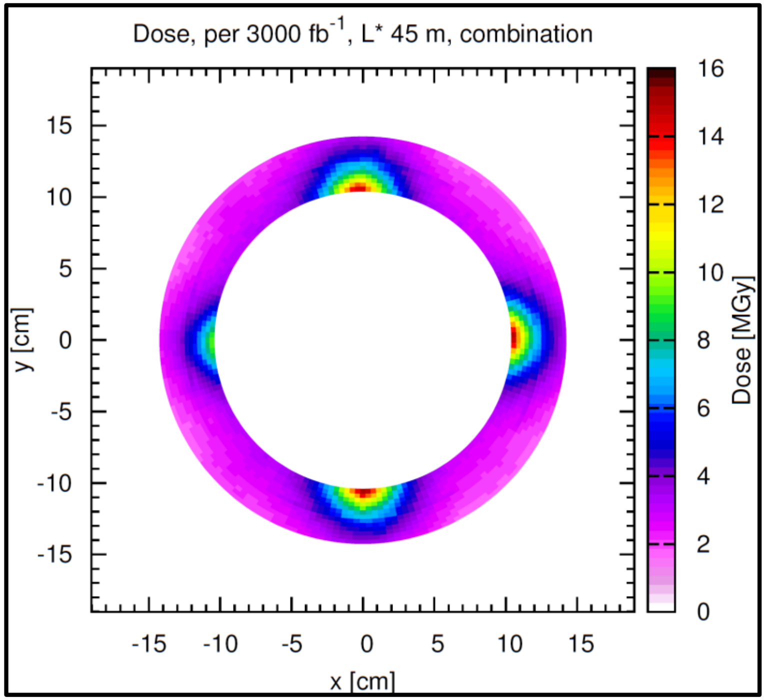
HORIZONTAL vs VERTICAL CROSSING

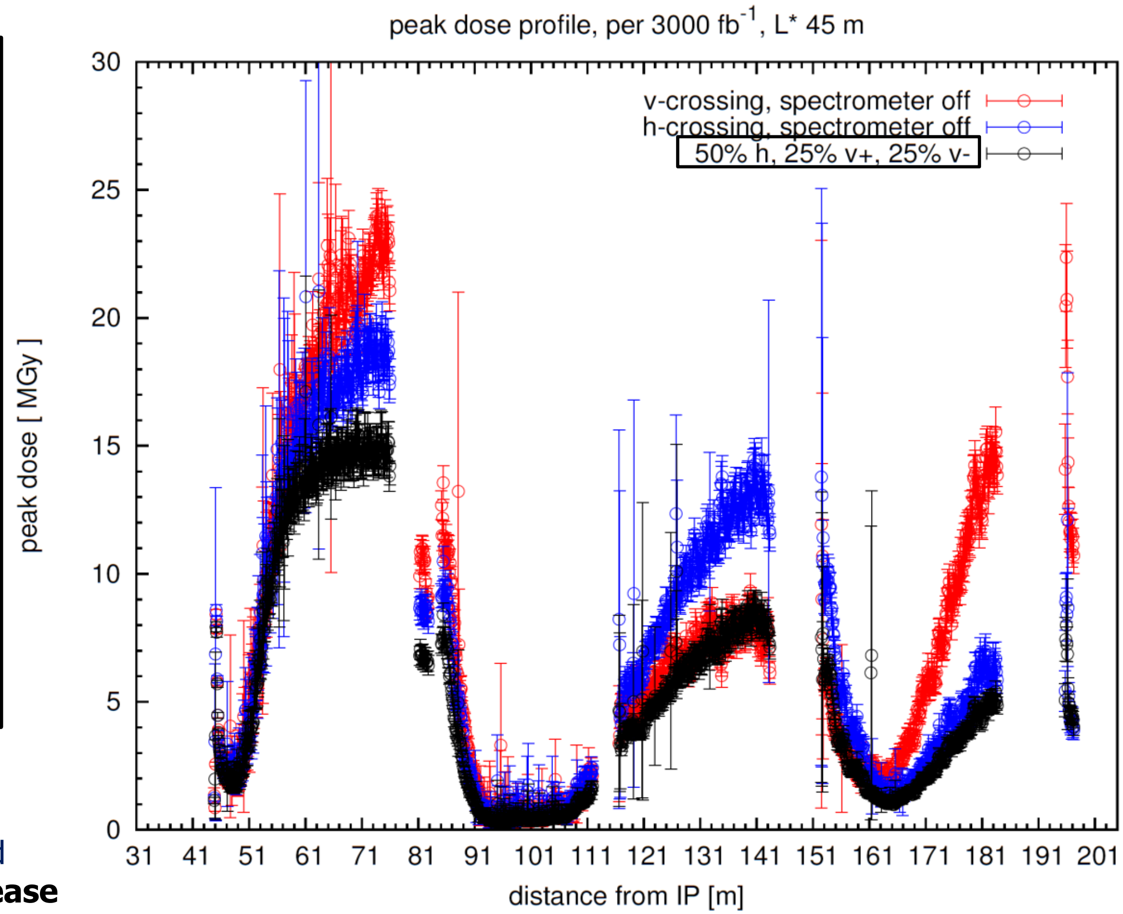


well localized hot spots, reflecting the interplay of crossing plane and magnetic configuration

CROSSING POLARITY & PLANE ALTERNATION

idea by S. Farthouk (CERN BE-ABP)





equalizing the dose in three spots,
a reduction of more than 35% can be achieved
on the maximum dose, i.e. a **60% lifetime increase**

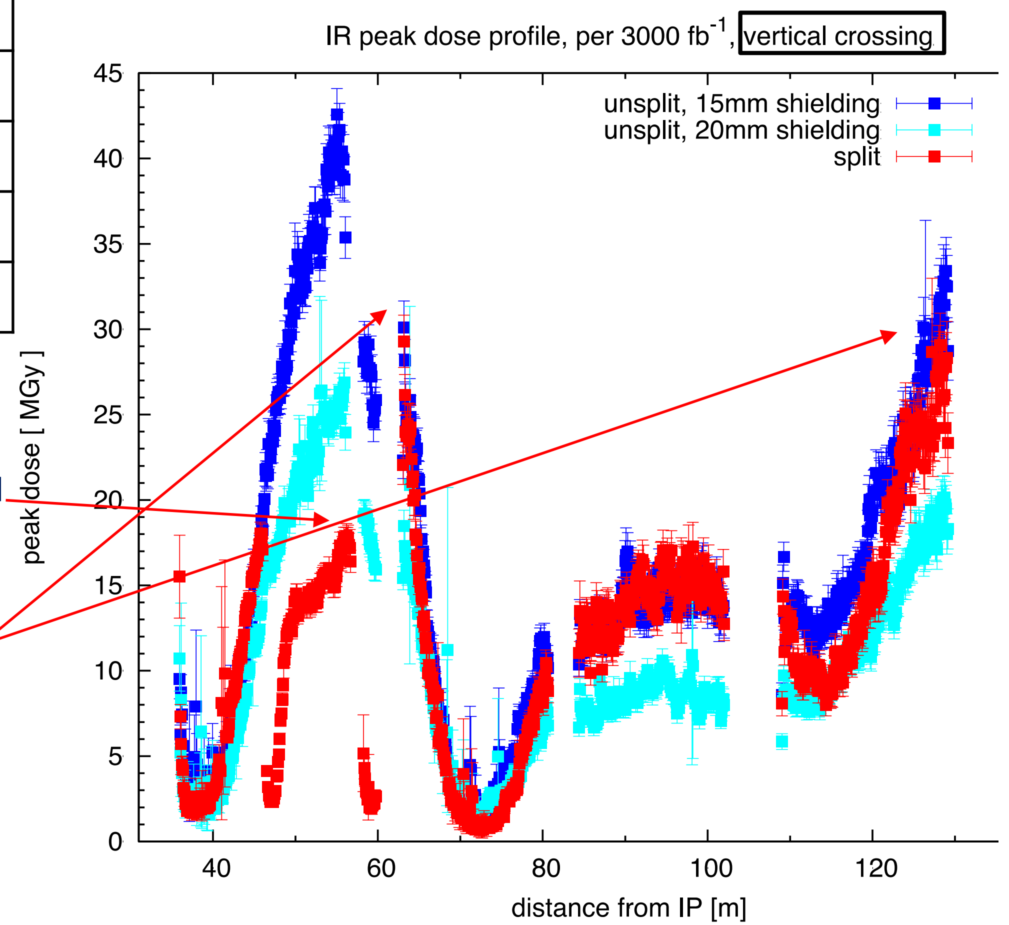
OPTIMIZED Q1 SPLITTING

idea by R. Martin (CERN BE-ABP)

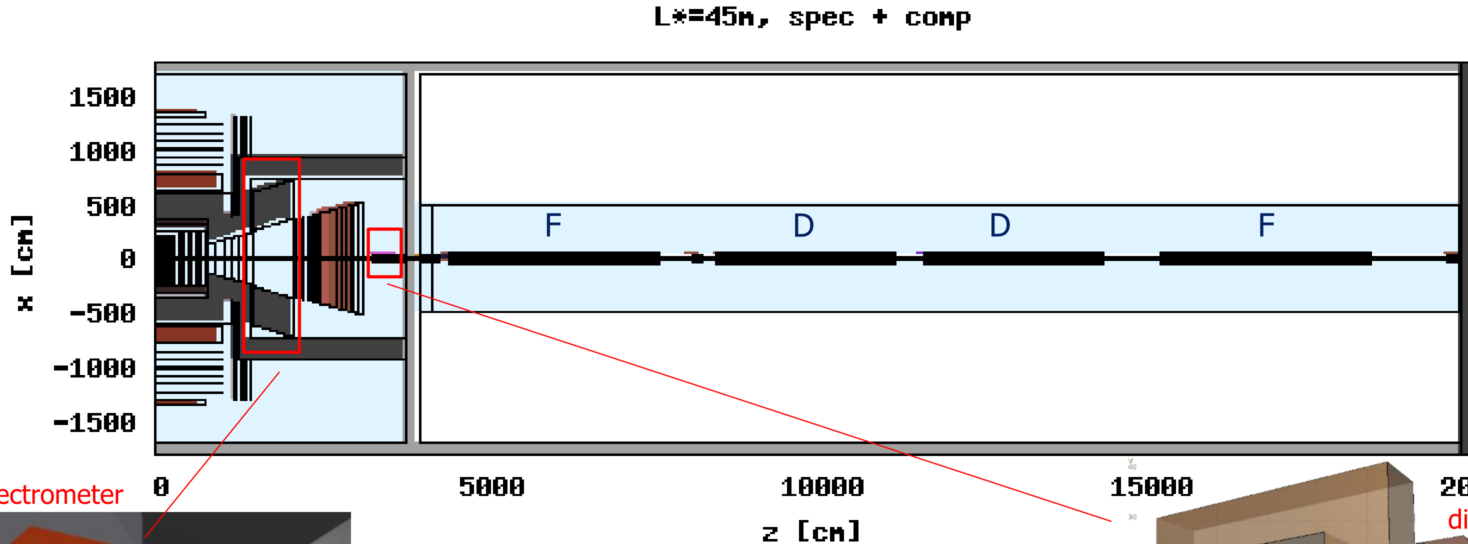
L*=36m	length [m]	gradient [T/m]	coil ID [mm]	W thick. [mm]
Q1A	10	**239**	**92**	**21**
Q1B	10	**200**	**110**	**24**
Q2A&B	17.5	189	115	15
Q3	20	191	115	15

the maximum dose at the Q1 (non-IP) end is counteracted by increasing in Q1b the coil aperture and the absorber thickness, thanks to relaxed beam aperture requirements in Q1. Q1a provides strength compensation.

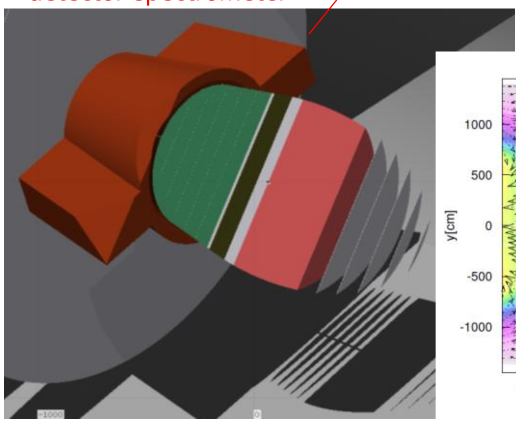
The lifetime gets limited by downstream lower maxima.

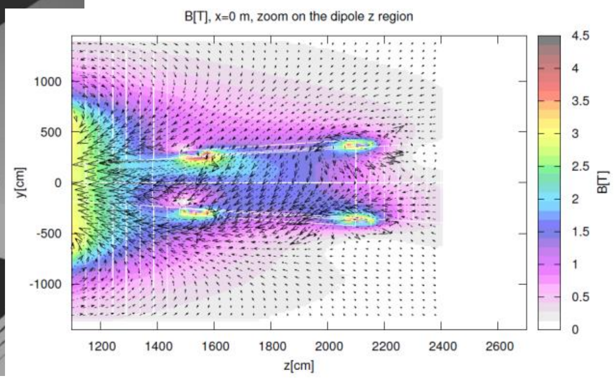


L*=45m LAYOUT WITH SPECTROMETER



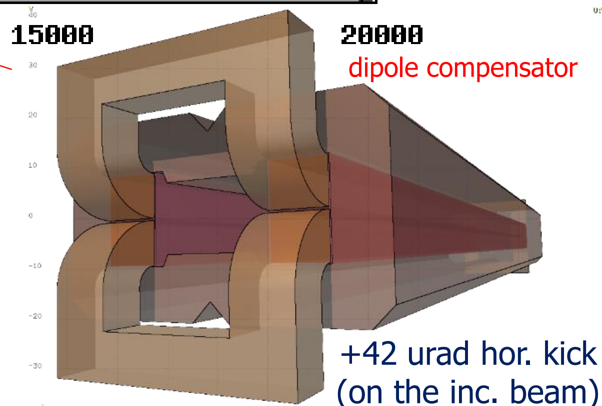
detector spectrometer



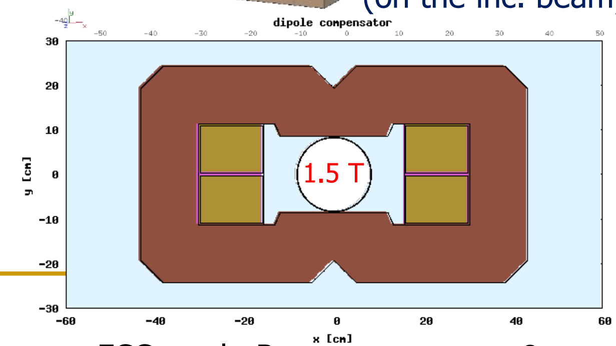


-60 urad horizontal kick
(on the incoming beam)

dipole compensator

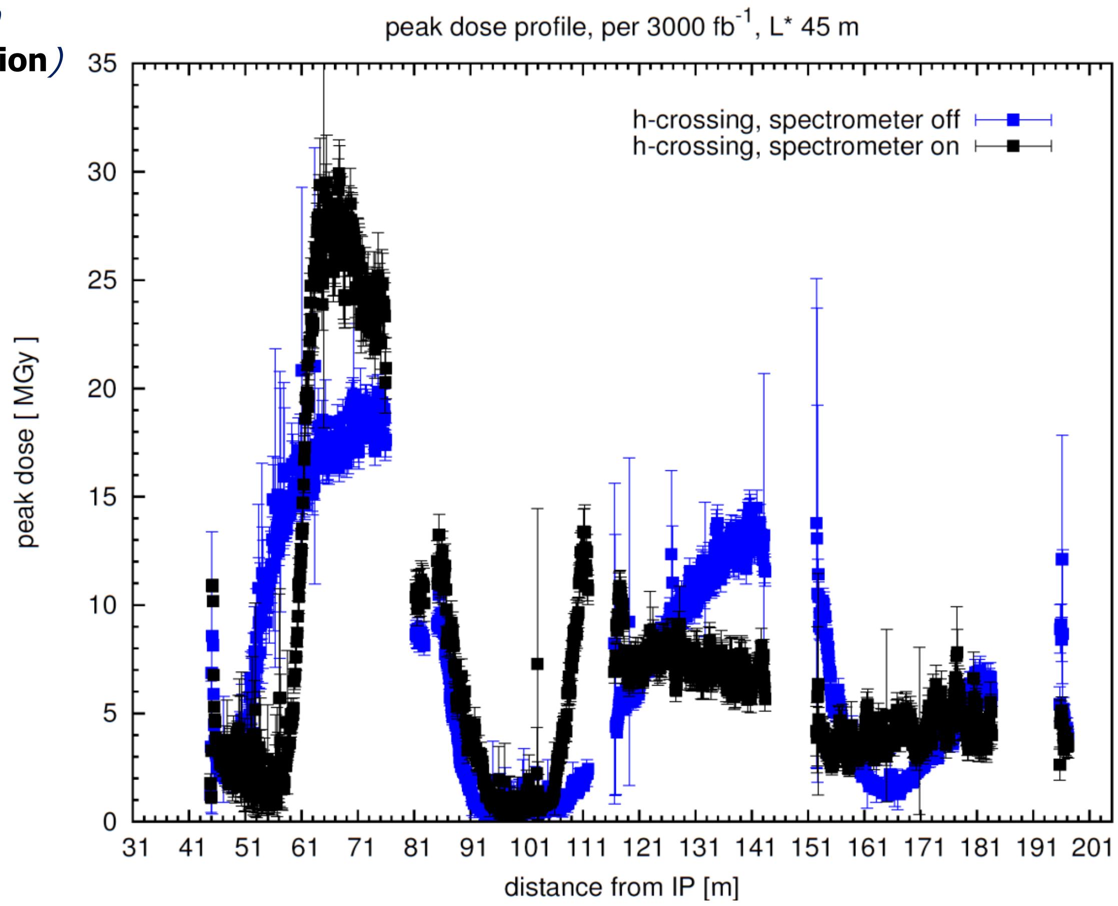


+42 urad hor. kick
(on the inc. beam)



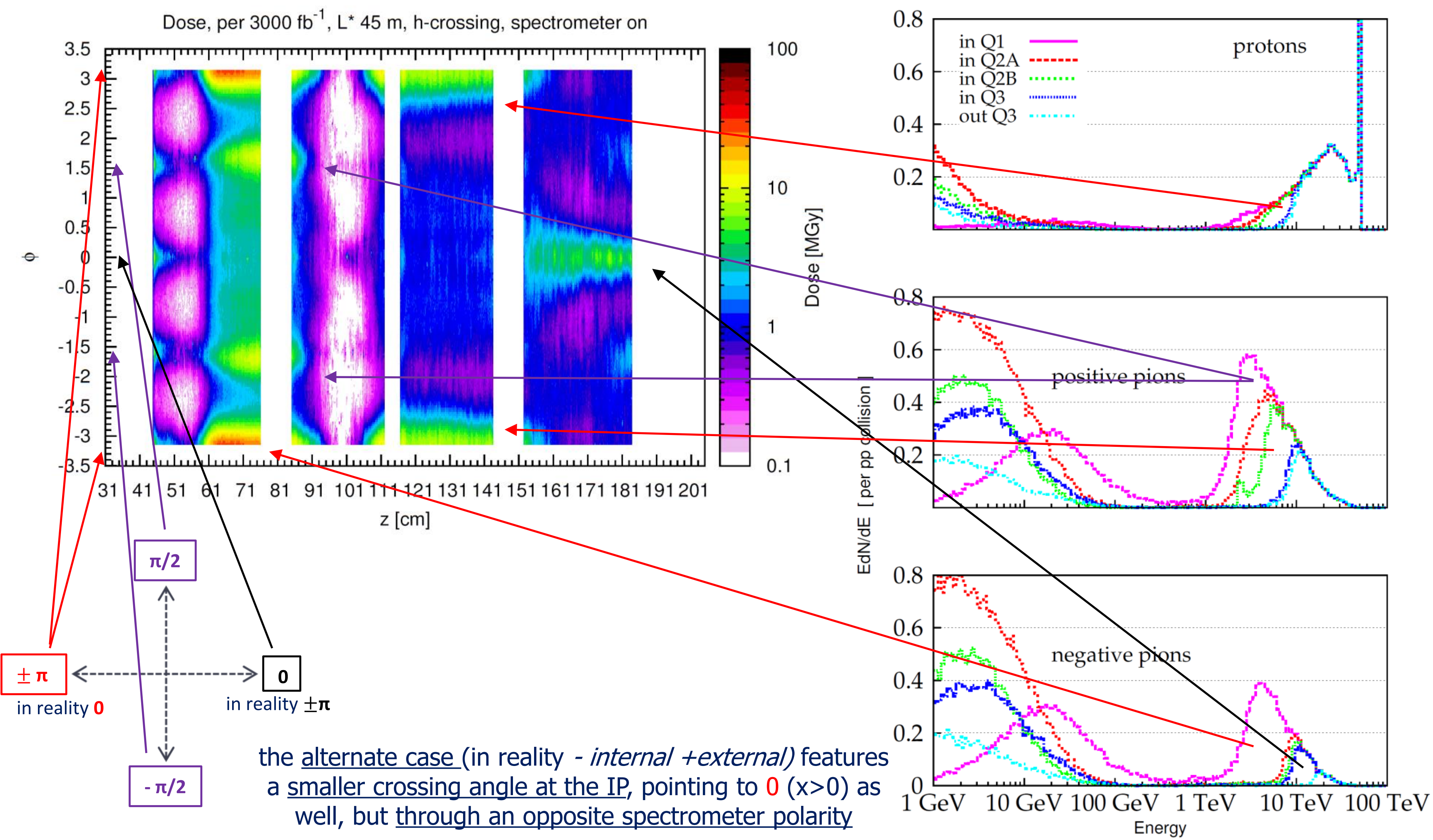
HORIZONTAL CROSSING [I]

-110 urad half horizontal crossing angle
(-18 internal -92 external)
intended *to mimic the real case of +110 (+18+92,* **same sign i.e. worse combination***)*



the detector spectrometer alters the peak dose profile in the triplet, inducing a significant increase of the maximum dose

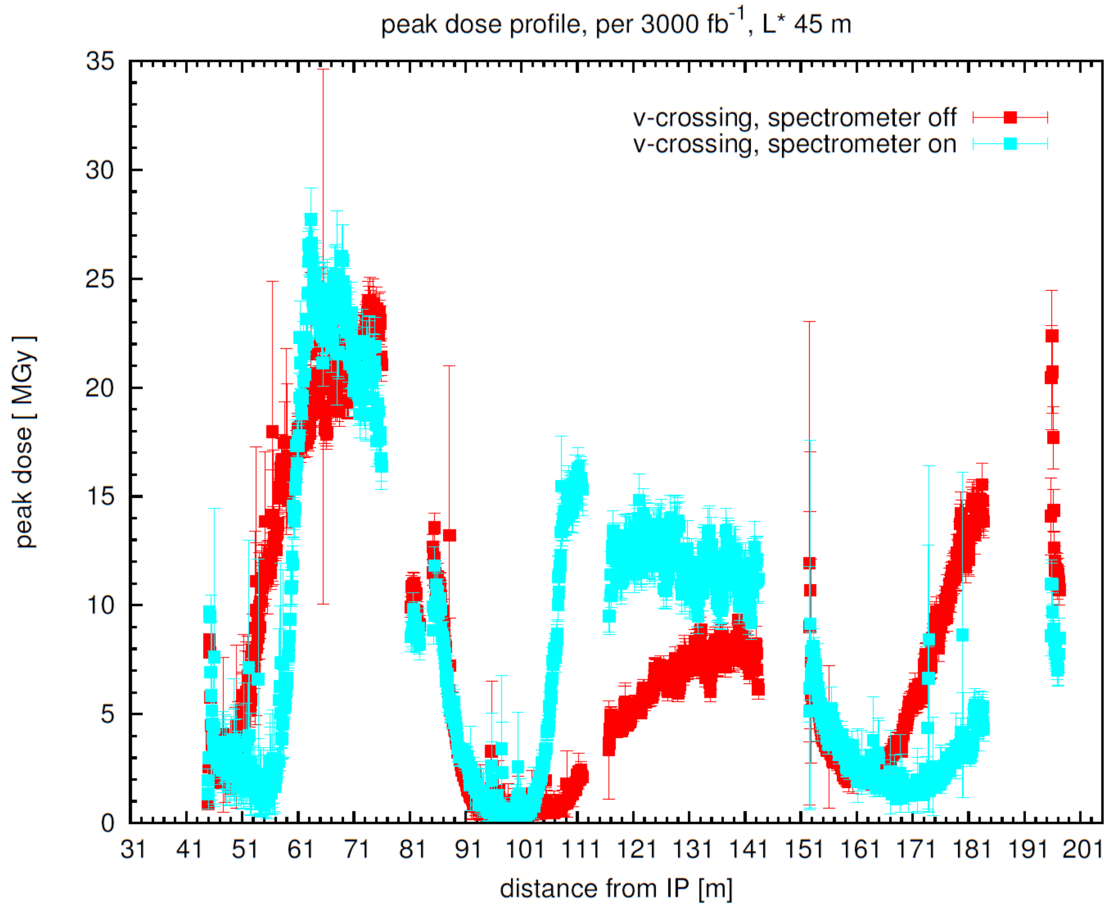
HORIZONTAL CROSSING [II]



the alternate case (in reality *- internal +external)* features a smaller crossing angle at the IP, pointing to 0 (x>0) as well, but through an opposite spectrometer polarity

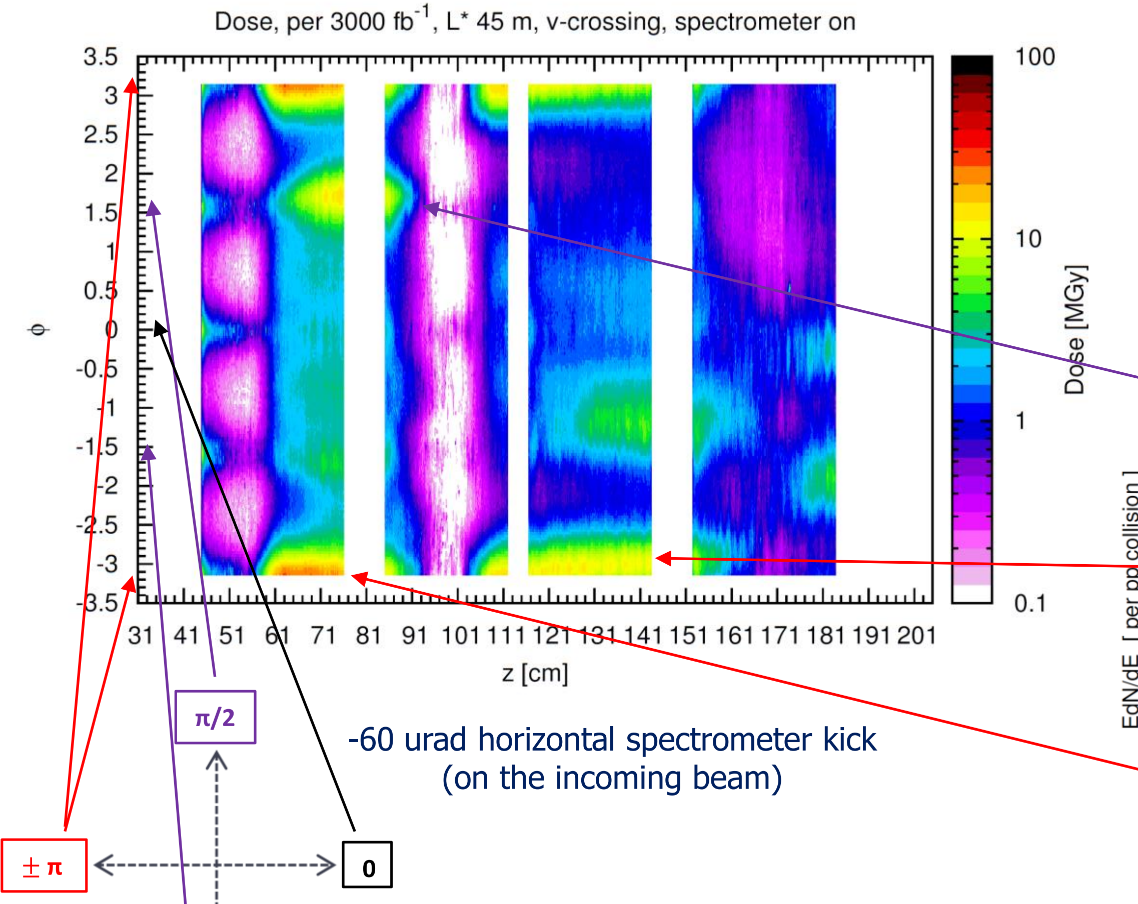
VERTICAL CROSSING [I]

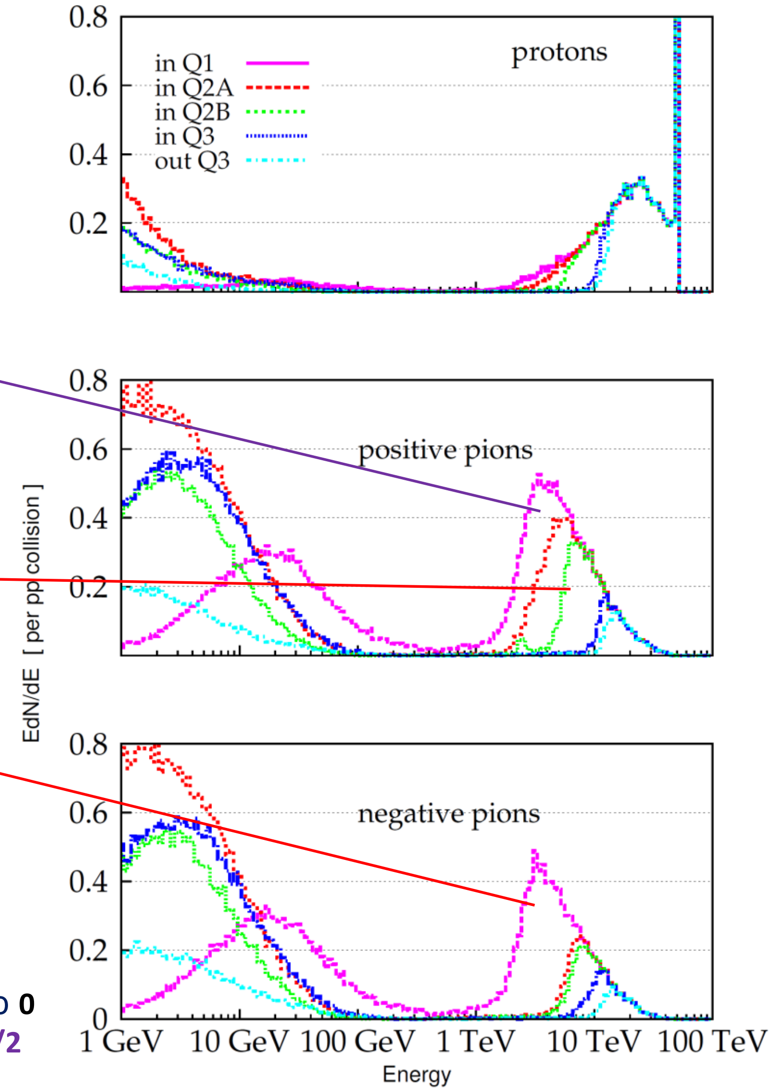
+85 urad half vertical crossing angle
(internal horizontal angle fully compensated by external correction)



the detector spectrometer alters the peak dose profile in the triplet, without a significant increase of the maximum dose

VERTICAL CROSSING [II]





three degrees of freedom:

- opposite spectrometer polarity moves the **π** peak to **0**
- external angle inversion moves the **π/2** peak to **- π/2**
- triplet polarity inversion (FDDF into DFFD)

CONCLUSIONS

The L*=45m layout benefits from a very large coil aperture, keeping the maximum dose at **40 MGy per 5ab^{-1}** with 15mm tungsten shielding (at 33 MGy for horizontal crossing), provided a suitable extension of the *absorber in the interconnections* is guaranteed

Regular crossing plane and vertical angle polarity alternation would allow to go down to 25 MGy per 5ab^{-1} in both high luminosity insertions, yielding a **60% lifetime increase** for the triplet (Q1)

The detector spectrometer changes (worsens) the picture, but not drastically, opening to the possible exploitation of several degrees of freedom (internal and external angle polarities and triplet polarity)