WP10
Energy Deposition & Absorber

team &

Fermilab MARS team

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LARP

High Luminosity LHC

POWER AND DOSE DEPOSITION BY THE COLLISION DEBRIS

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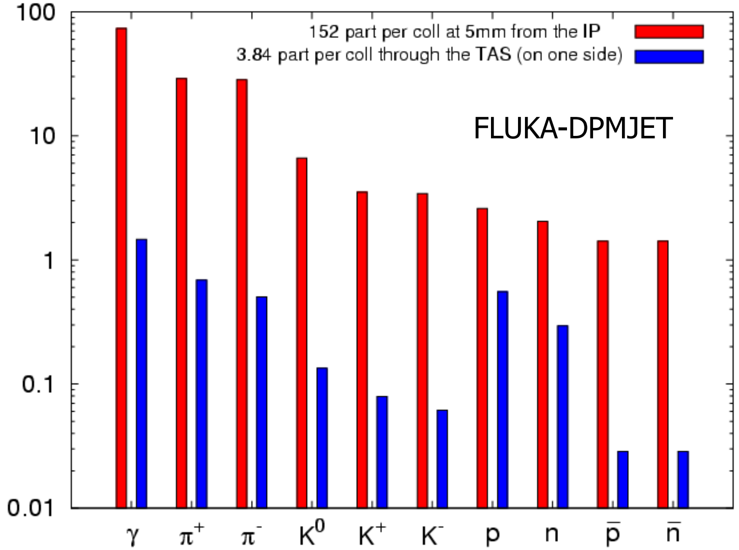
OUTLINE

- the collision debris
- (present) final focus triplet, today and tomorrow
- looking farther (at separation dipoles)
- and farther (at matching section quadrupoles)
- looking forward to high luminosities and apertures
- next steps

THE COLLISION DEBRIS [I]

7 TeV p + 7 TeV p



beyond the *present TAS* (absorbing ~150W at $L=L_0=10^{34}cm^{-2}s^{-1}$)

about *2.5%* of the interaction products

and *35%* of 14TeV, i.e. 650W at $L=L_0$

<u>on each side!</u>

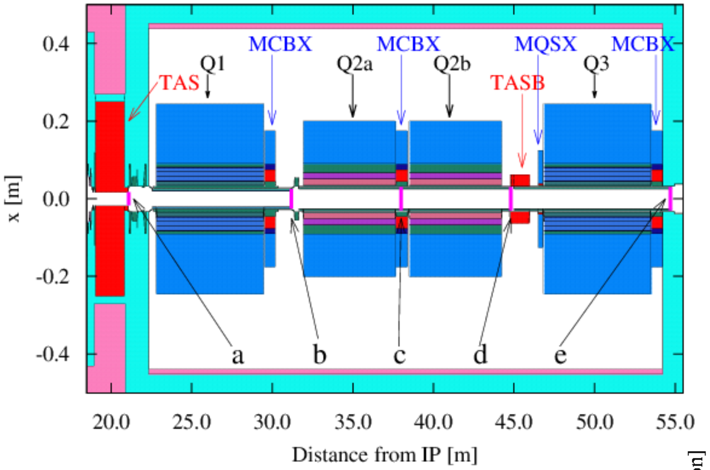
with a *50mm aperture TAS*

about *3.5%* of the interaction products

and almost *40%* of 14TeV, i.e. 3.5kW at $L=5L_0$

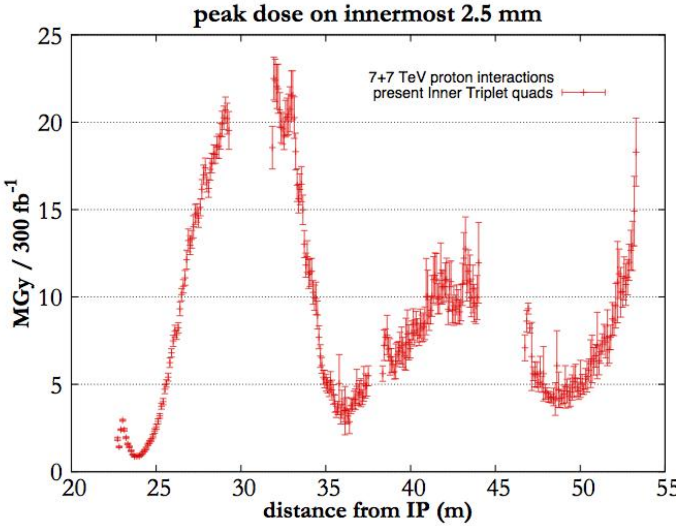
a *60mm aperture TAS* would collect 400 W at $L=5L_0$

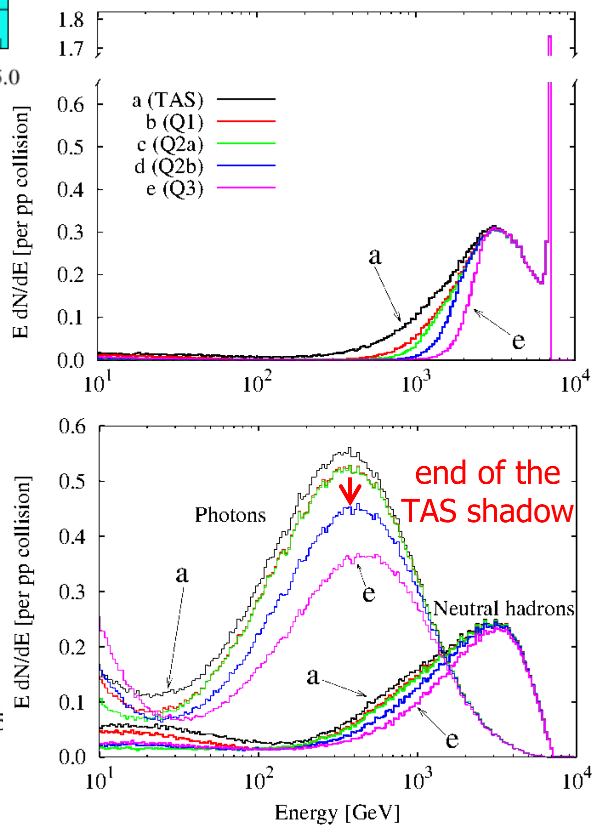
THE COLLISION DEBRIS [II]

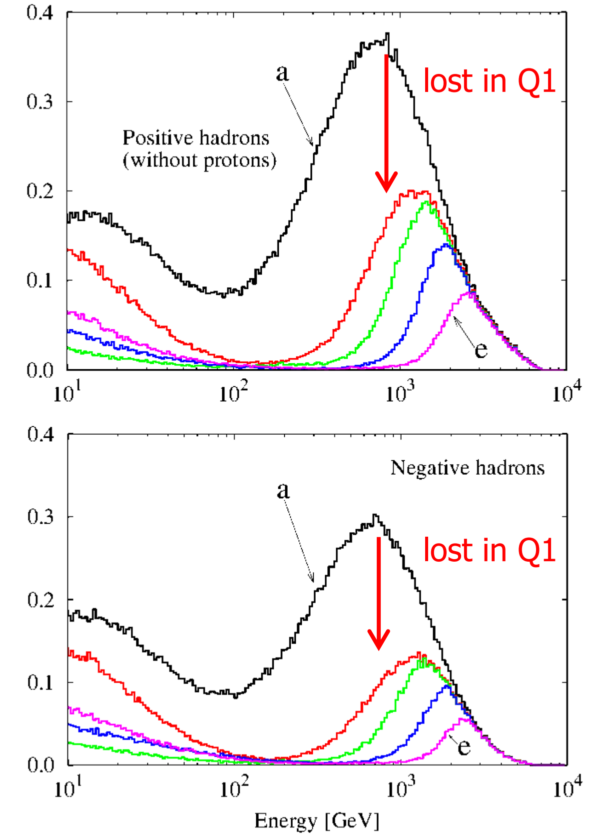


present triplet

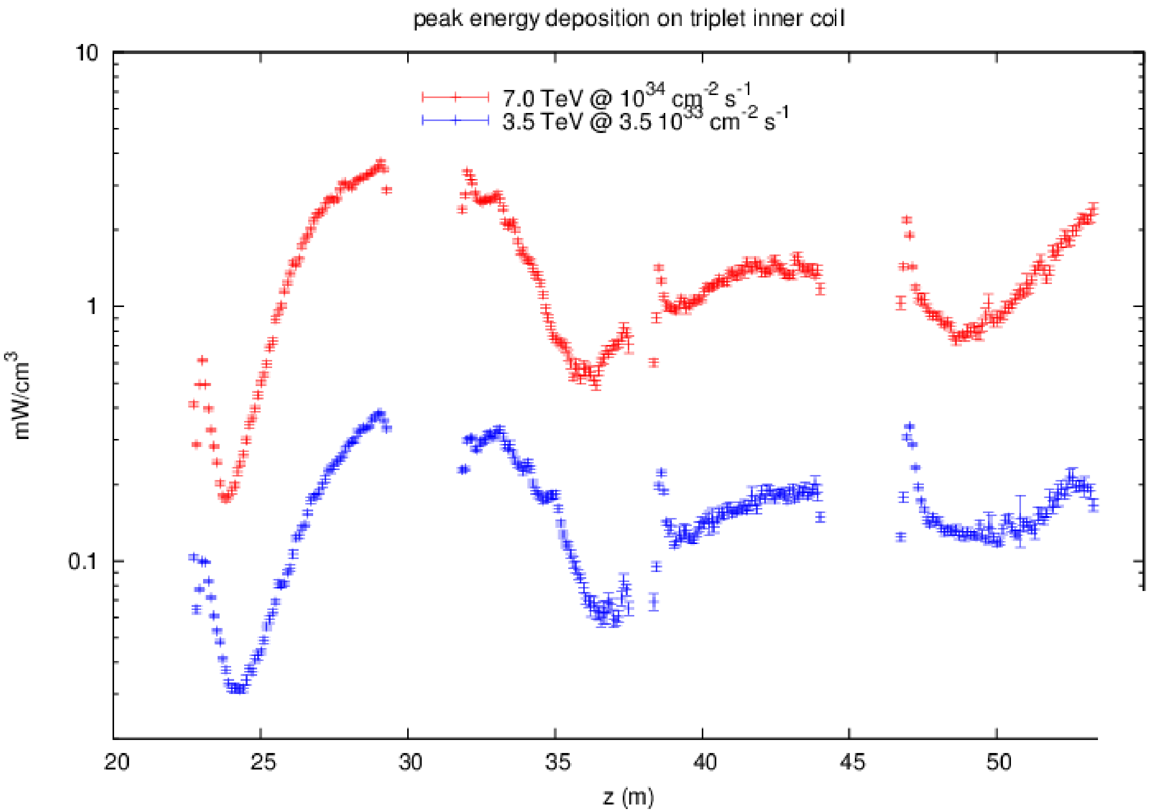
25MGy/300fb^{-1} (P1)



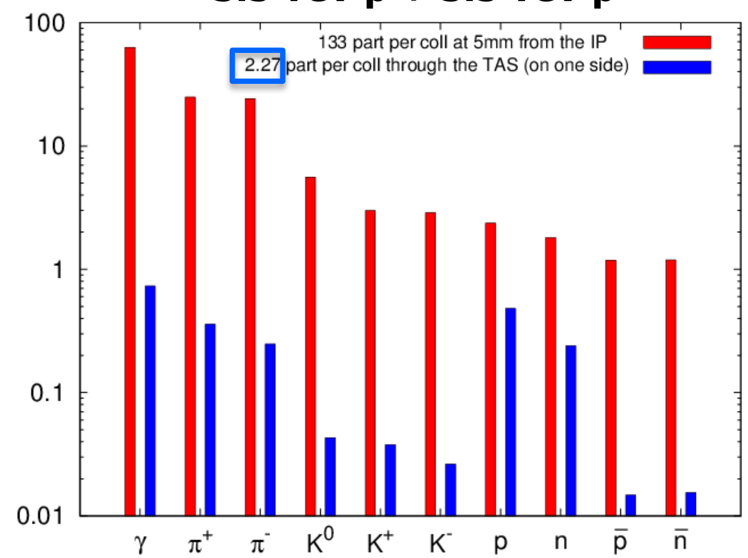




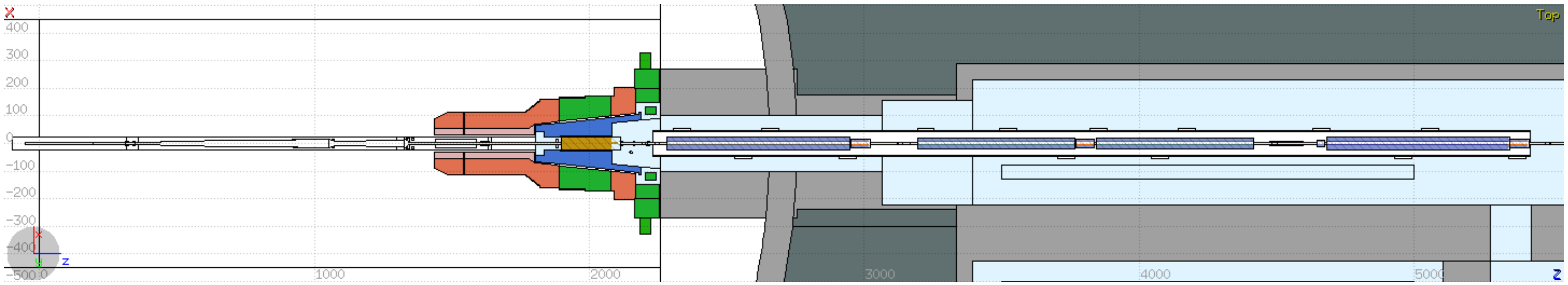
FROM 2011 TO ... POST-LS1

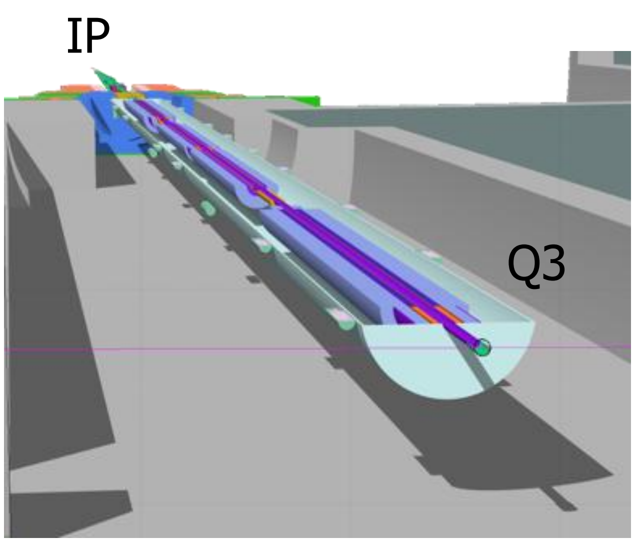


3.5 TeV p + 3.5 TeV p

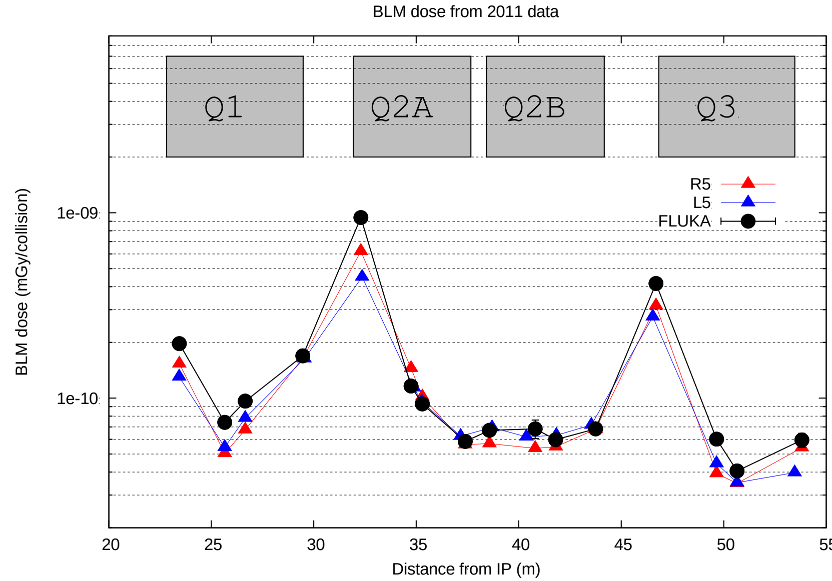


BENCHMARKING



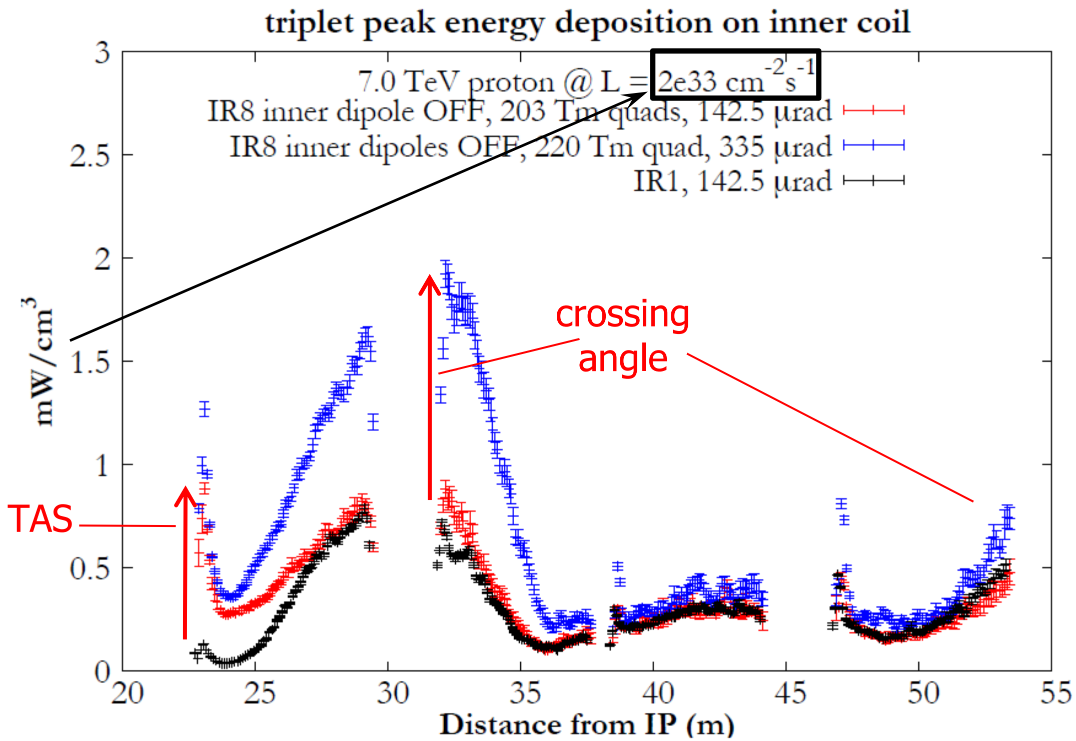


BLM response along IR5 triplet



BLM dose per collision assuming CMS luminosity measurement and 73.5 mb proton-proton cross-section (from TOTEM)

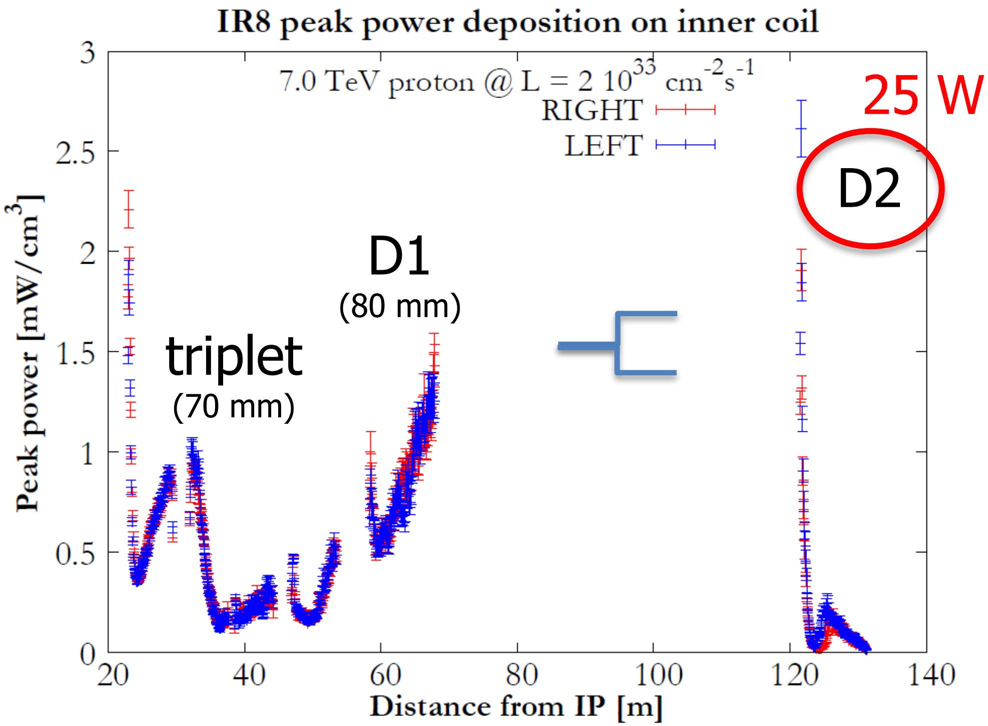
TAS AND CROSSING ANGLE EFFECT



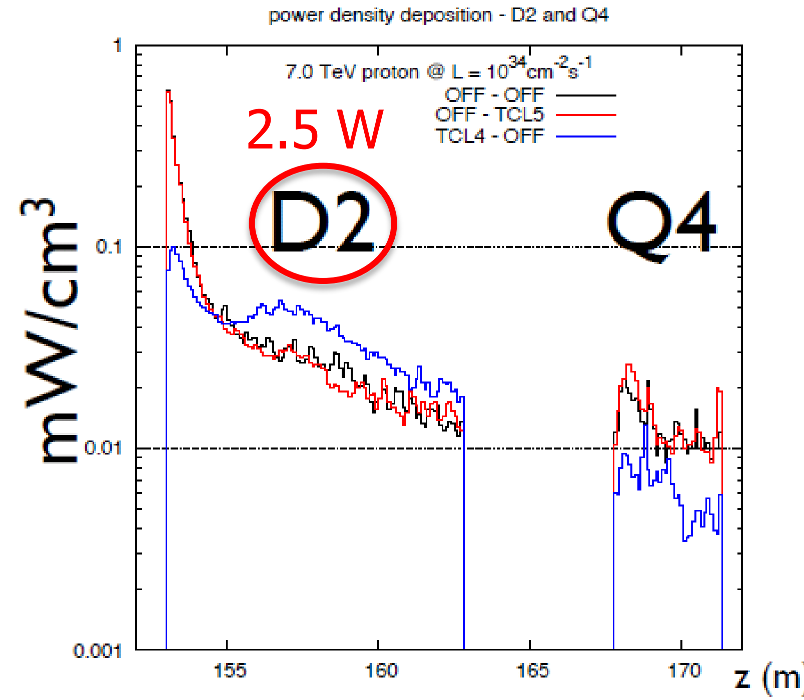
- the TAS has meaning only for (the first half of) of Q1!
- the crossing angle plays a significant role

TAN EFFECT

P8 2 10^{33} cm^{-2} s^{-1} without TAN



P5 10^{34} cm^{-2} s^{-1} with TAN

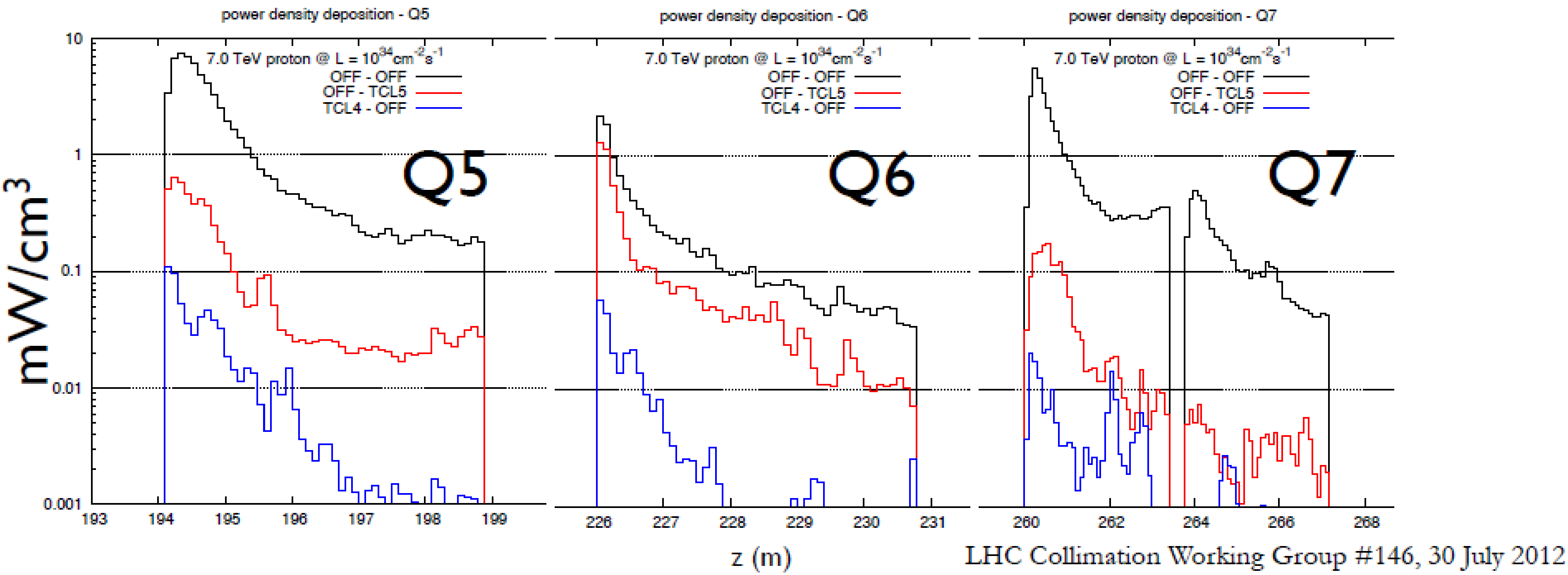


- the TAN is clearly essential for the D2 protection at high luminosities

[cf. CERN/TIS-RP/IR/94-17 (1994) and LHC Project Report 633 (2003)]

TCL EFFECT

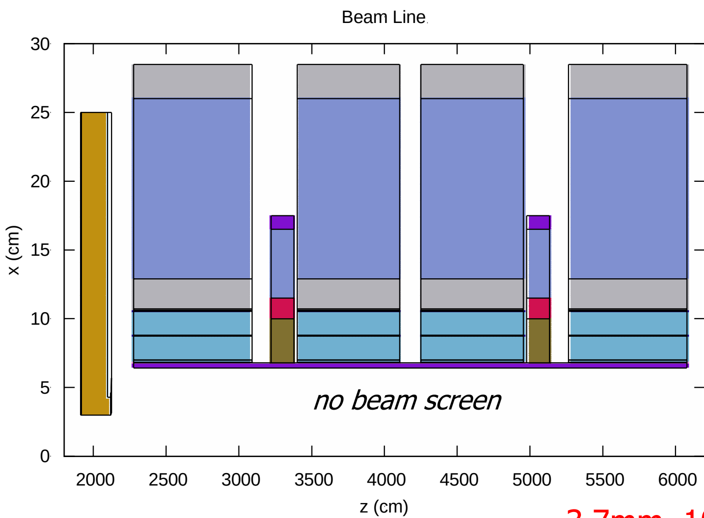
P5 10^{34} cm^{-2} s^{-1} w/ and w/o TCL

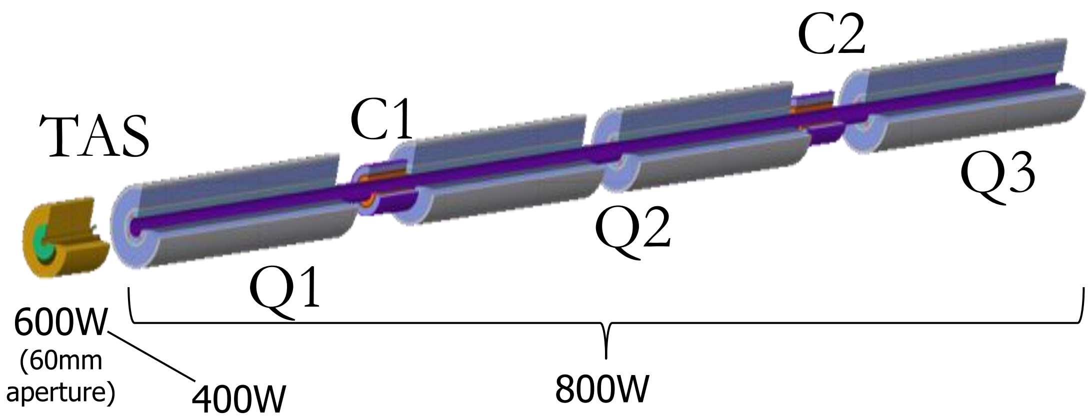


- Q5 and Q7 require TCL in place

[cf. LHC Project Report 398 (2000) and LHC Project Report 633 (2003)]

THE HL-LHC TRIPLET
(ITS Nb_3Sn 140mm OBSOLETE VERSION)



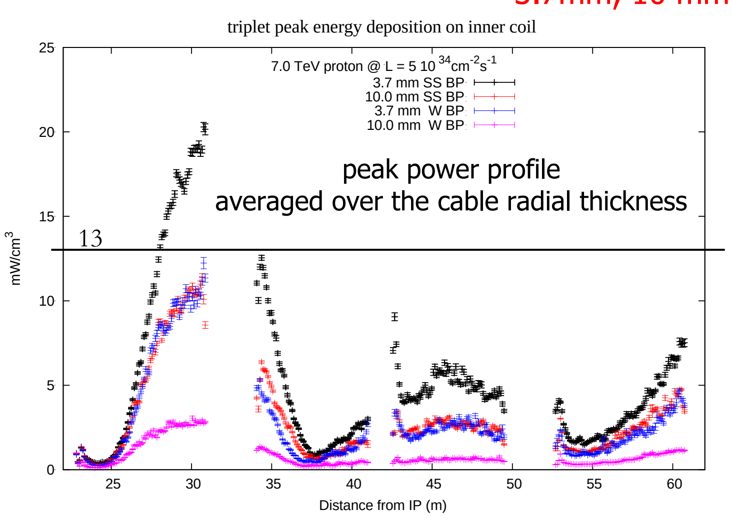


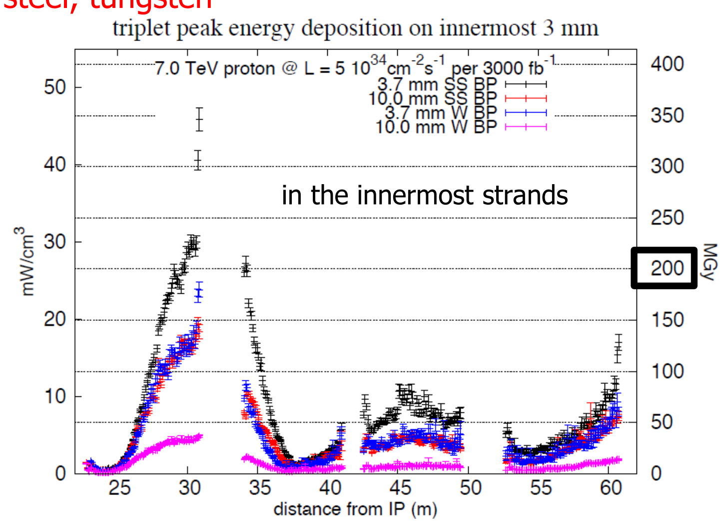
considering the *experimental vacuum chamber*

2012 Jun 7

L. Esposito presentation at the WP's joint meeting

3.7mm, 10 mm x stainless steel, tungsten





SHIELDING

3.7 mm BP + 2 mm BS + *6 mm W absorbers*

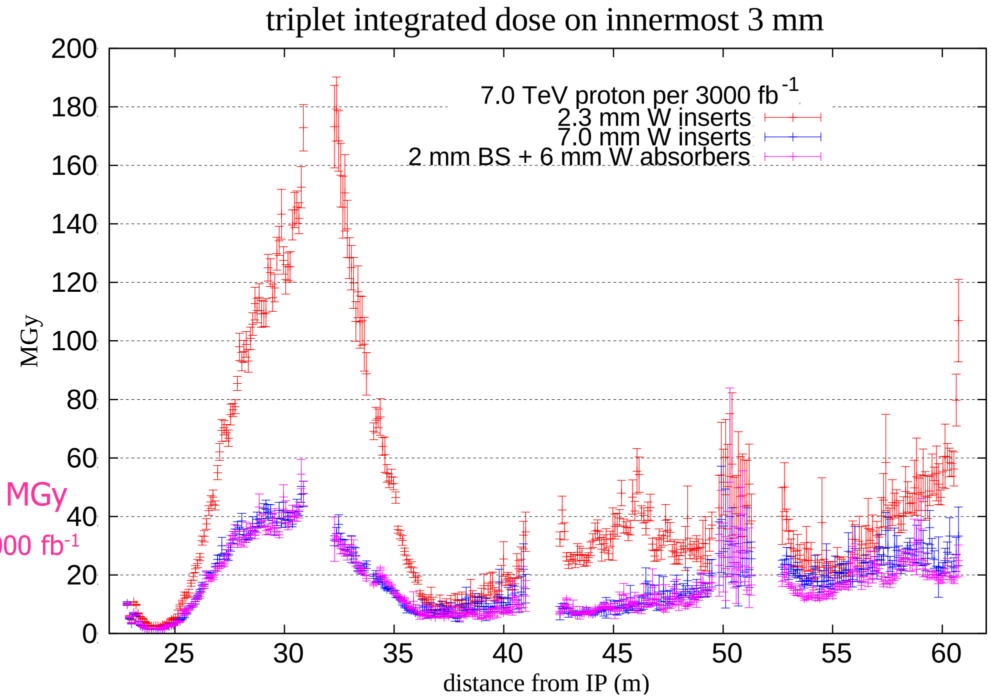
with 0.5 mm clearance between BP and W

111.6 mm residual aperture at mid-planes

for 140mm coil aperture

< 50 MGy

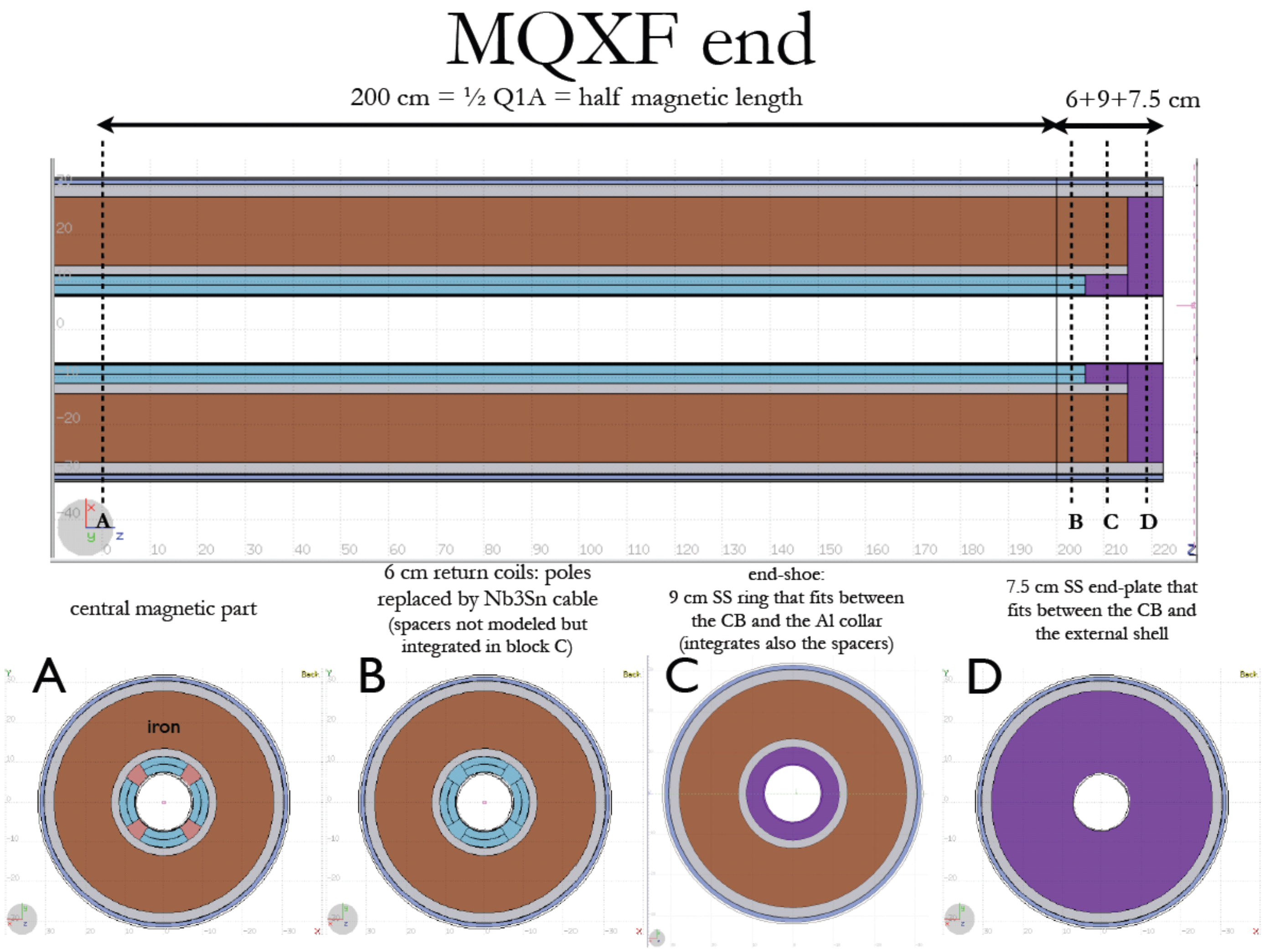
per 3000 fb^{-1}



- to stay below 20MGy, one should envisage 9 mm W absorbers
  i.e. ~115 mm residual aperture at mid-planes for 150mm coil aperture

TOWARDS A MORE REALISTIC MODELING OF MAGNET ENDS

... where highest energy deposition takes place



CONCLUSIONS AND PERSPECTIVES

• Coil insulator damage in the new triplet quadrupoles (and in the nearby correctors, D1...) over the target HL-LHC integrated luminosity, looks as the main issue from the radiation point of view. In order to stay below few ten MGy, several mm of tungsten must be embedded inside the aperture at mid-planes.

• As soon as optics, layout (distances) and correctors' specs are defined by WP2 and WP3 colleagues, a new energy deposition study will be launched for the adopted 150mm quadrupole aperture, including the downstream corrector package and 160mm D1 (already implemented).

• For the present machine, the P1 and P5 Dispersion Suppressors do not look to be at risk for proton operation (see TCL study with WP5).

• The LHCb luminosity upgrade to 2 10^{33} $cm^{-2}s^{-1}$ turns out to be compatible with the present machine layout (a warm protection may be desirable to reduce the load on the D2).

• Warm magnets in P7 and P3 will hardly survive the radiation dose from collimator losses over the HL-LHC era (tentative lifetime approached after $300fb^{-1}$ at 7 TeV beam operation).