1st WORKSHOP COLLIDER-EXPERIMENT INTERFACE

Nov 30, 2012 CERN

ENERGY DEPOSITION AND TAS DIAMETER

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WP10
Energy Deposition & Absorber

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OUTLINE

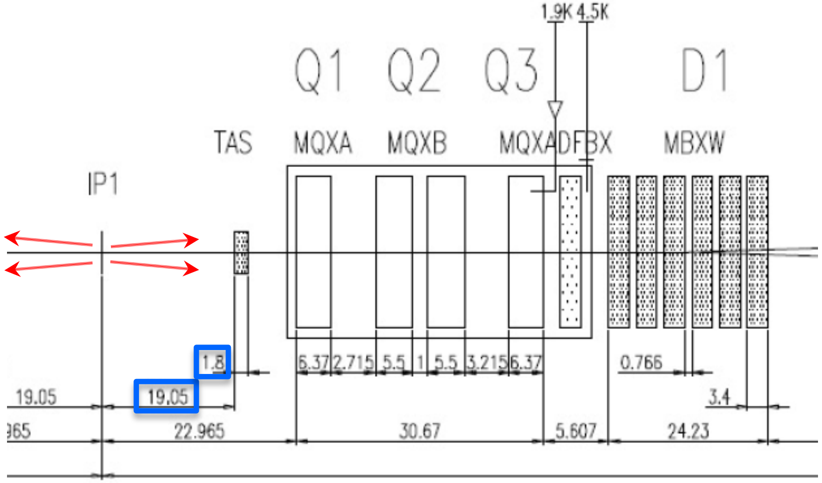
- the TAS role (as intended, imagined, and actual)
- looking around the present and future triplet
- up to the TAN
- and for the matching section see the Stefano's TCL discussion
- forward (Dispersion Suppressors and collimator insertions)

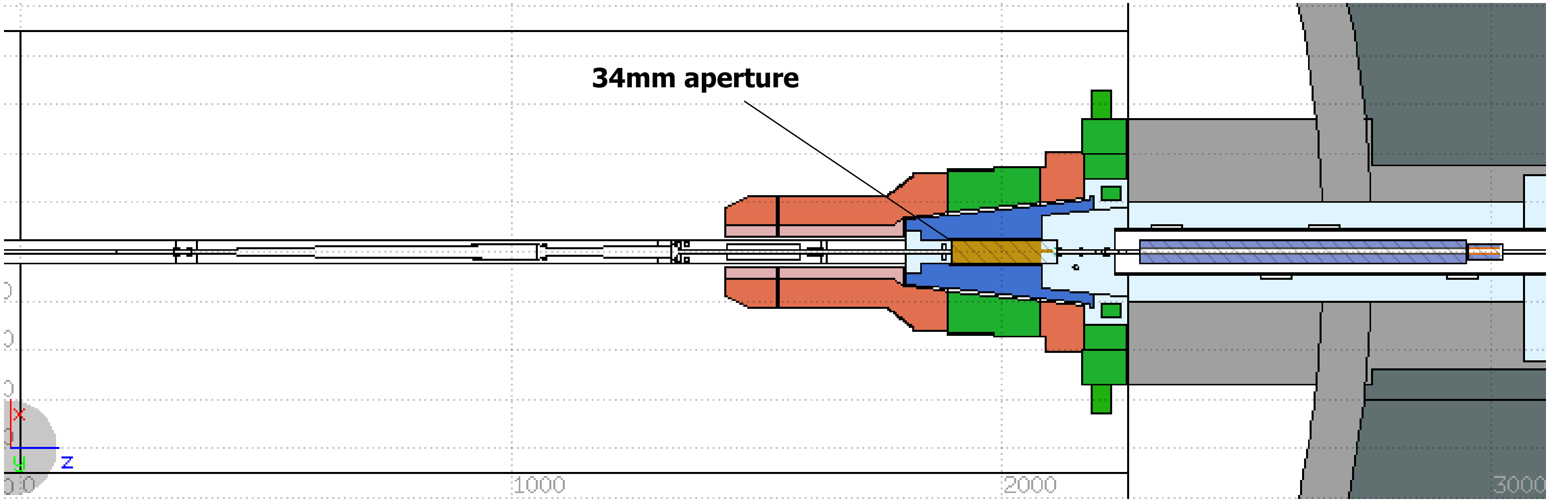
TAS: the experimenT-mAchine interface Symbol [I]

[courtesy of F. Butin, EN-MEF]

High Luminosity LHC

TAS: the experimenT-mAchine interface Symbol [II]





who does she/he like the TAS? and why?

TAS: Target Absorber of Secondaries

1. protects (only) the Q1 from the collision debris

2. protects the experiment (vacuum chamber) from incoming beam missteering (realistic scenario?)

3. role in backscattering?

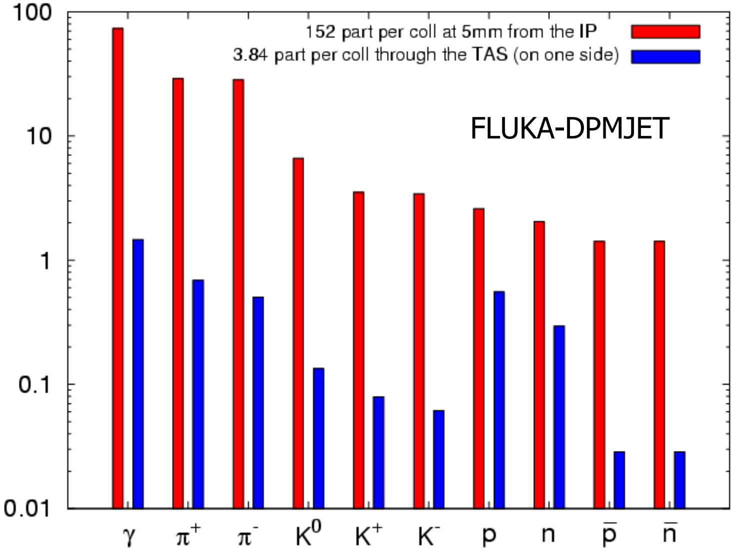
4. ...

- conflicting aperture requirements from 2. and optics performance
  (60mm envisaged for the HL-LHC 150mm triplet coil aperture)

- irrelevant sensitivity of 1. to TAS aperture

ABSORBED AND ESCAPING POWER

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 $L=L_0$

[142.5 urad crossing]

on each side!

with a *50mm aperture TAS* (absorbing ~500W at $L=5L_0$)

about *3.5%* of the interaction products

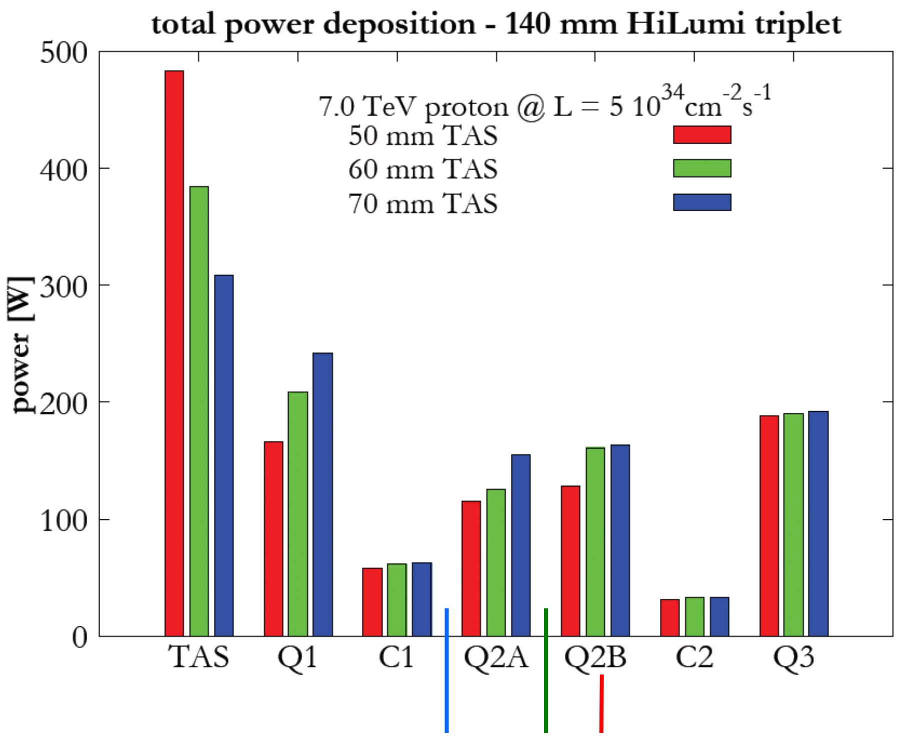
and almost *40%* of 14TeV, i.e. 3.5kW at $L=5L_0$

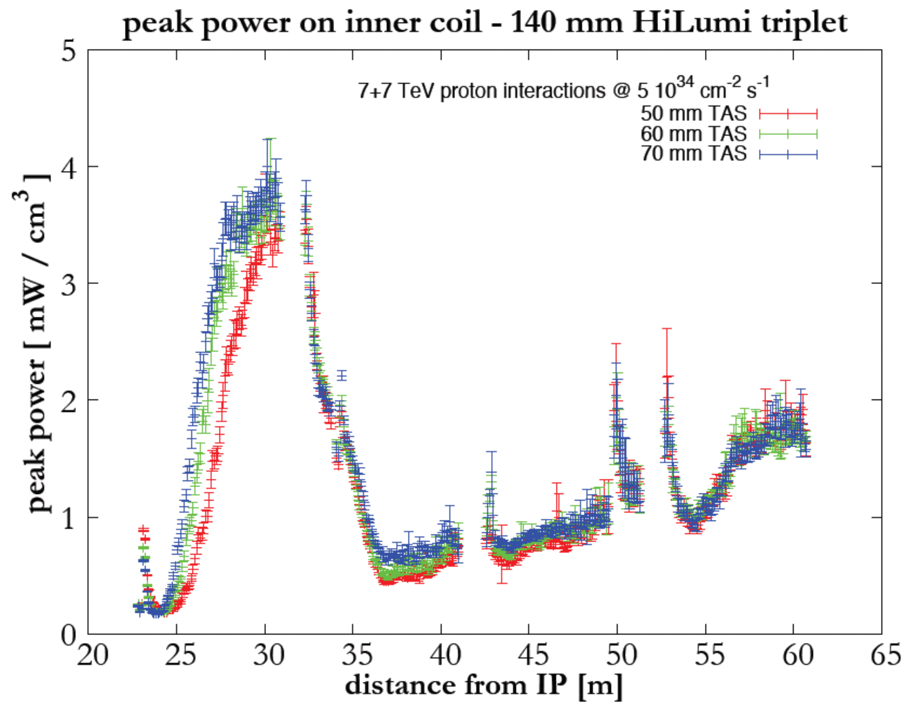
[225 urad crossing]

a *60(70)mm aperture TAS* would collect ~400(300) W at $L=5L_0$

[295 urad crossing]

IMPACT ON THE (FUTURE) TRIPLET



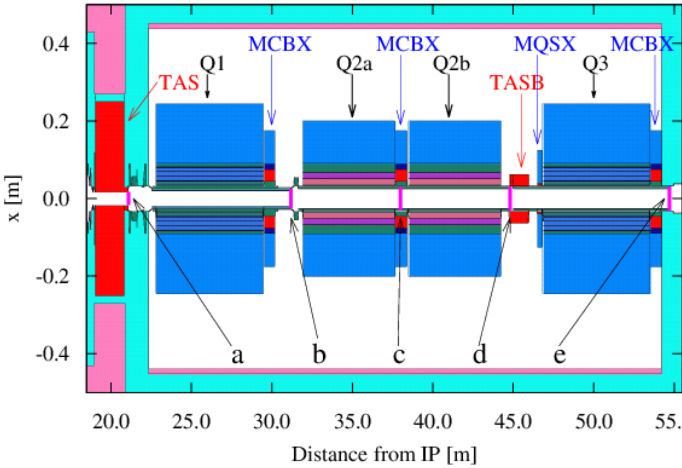


TAS aperture [mm]	TAS shadow [m]	
50	47	mid-Q2B
60	39	end-Q2A
70	33.5	end-C1

for increasing TAS aperture, the power no longer intercepted is collected in the triplet (mainly in Q1)

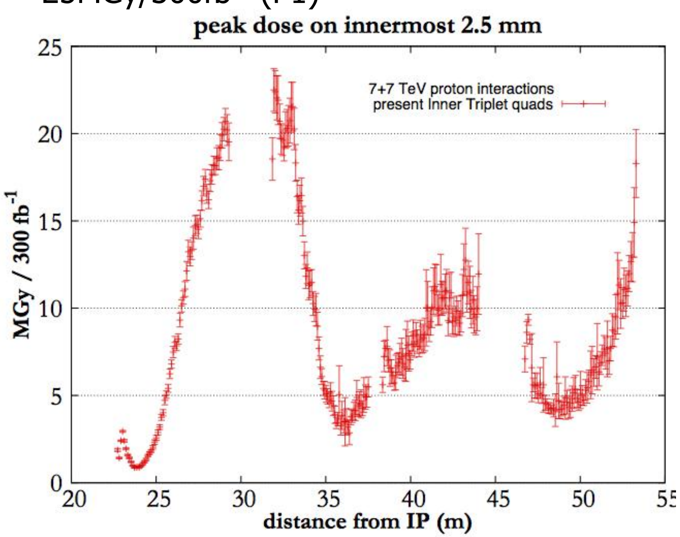
but with no impact on the quench risk

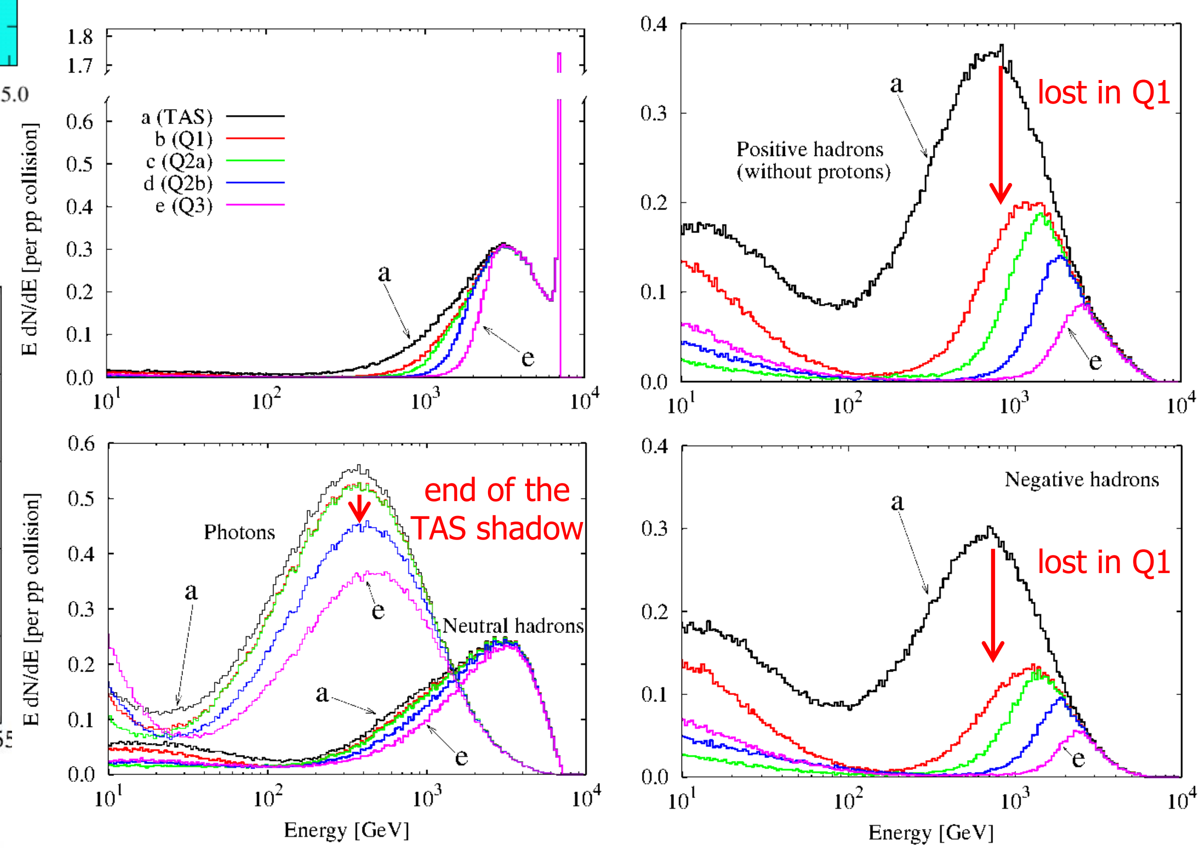
IMPACT ON THE (PRESENT) TRIPLET



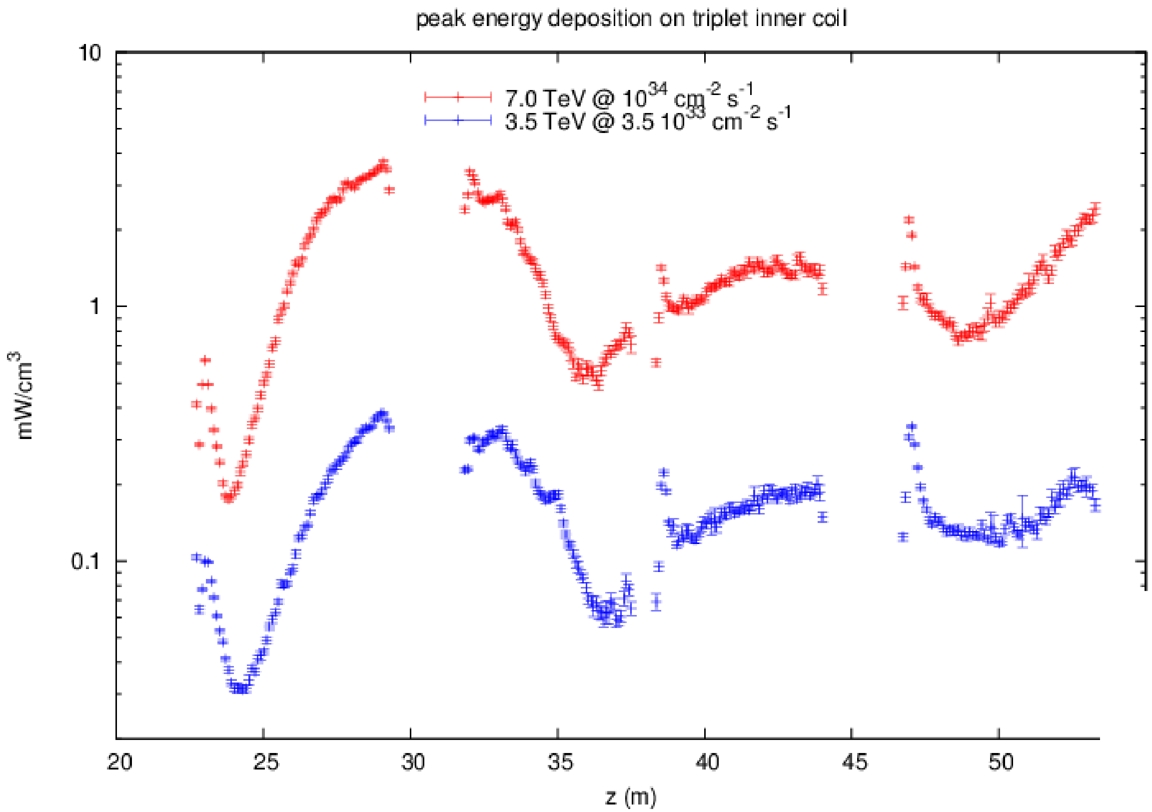
present triplet

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

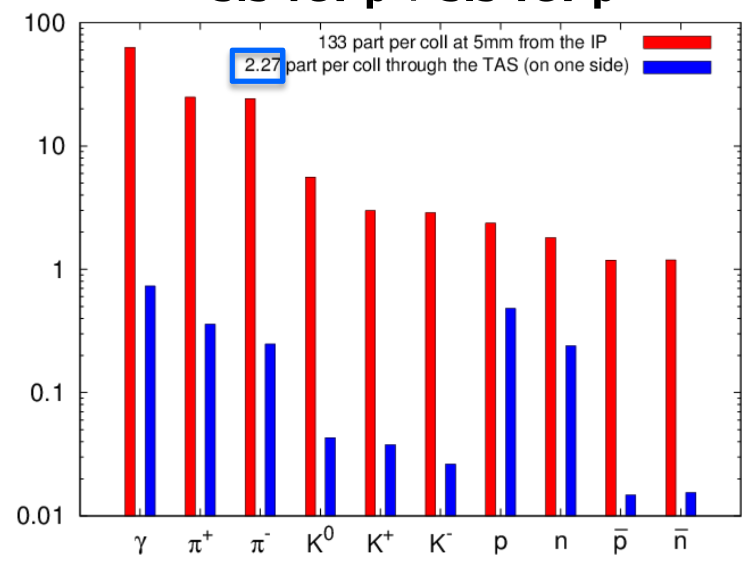




FROM 2011 TO … POST-LS1

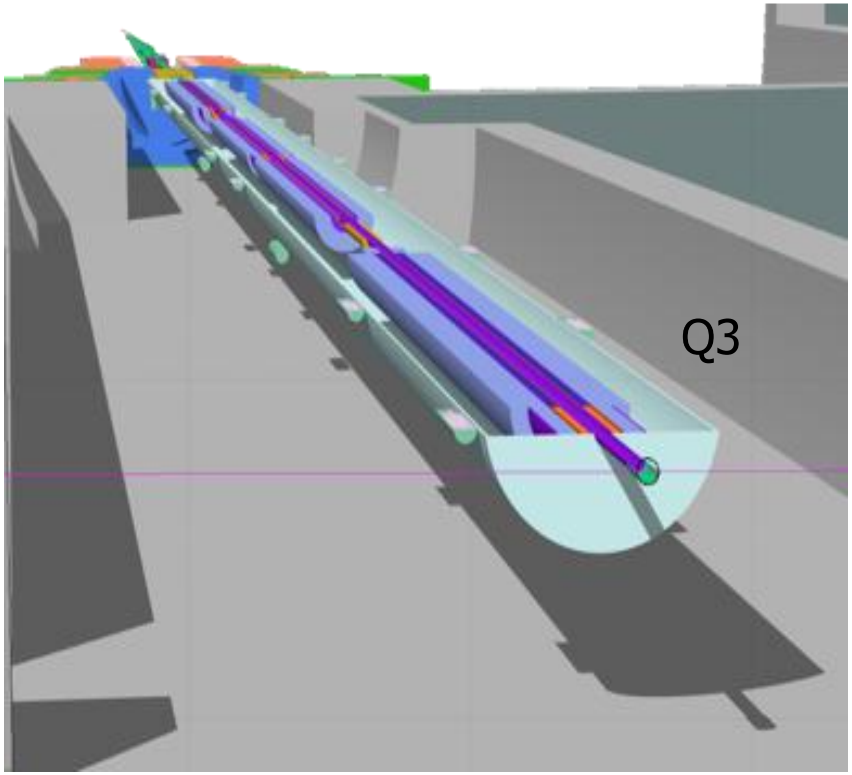


3.5 TeV p + 3.5 TeV p

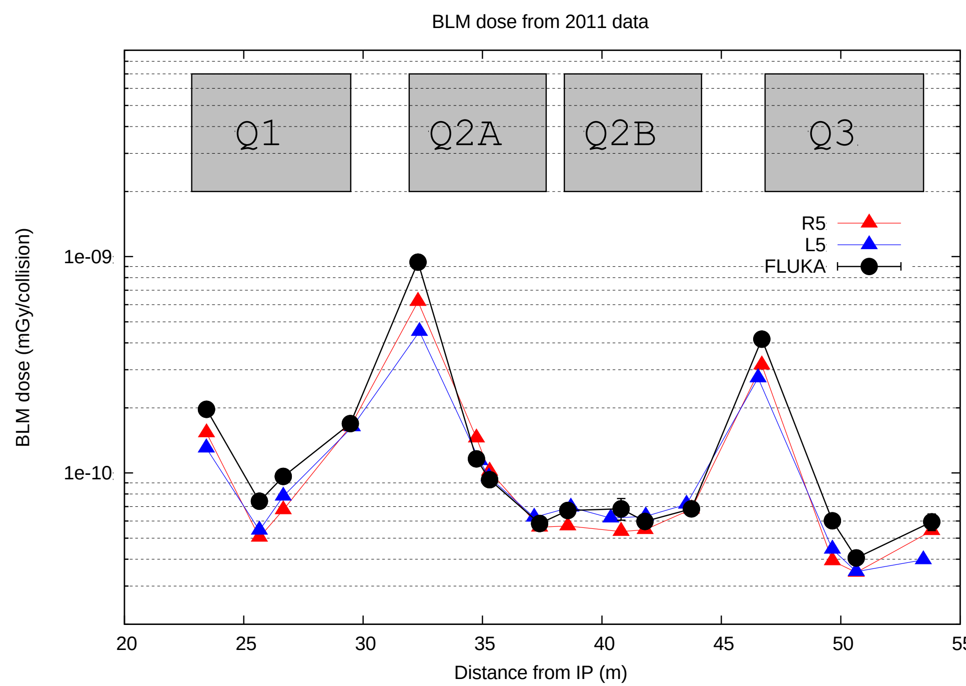


BENCHMARKING

IP



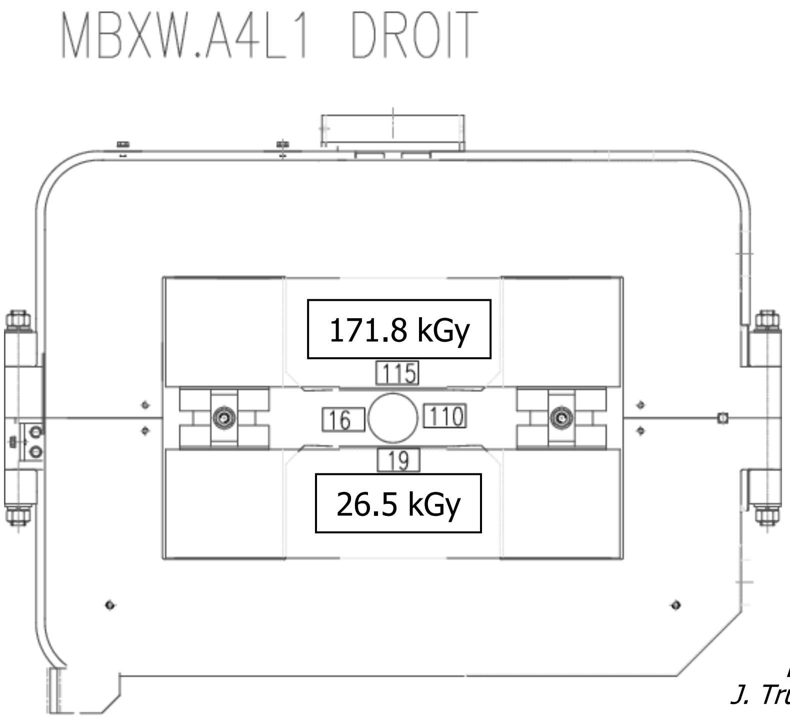
BLM response along IR5 triplet

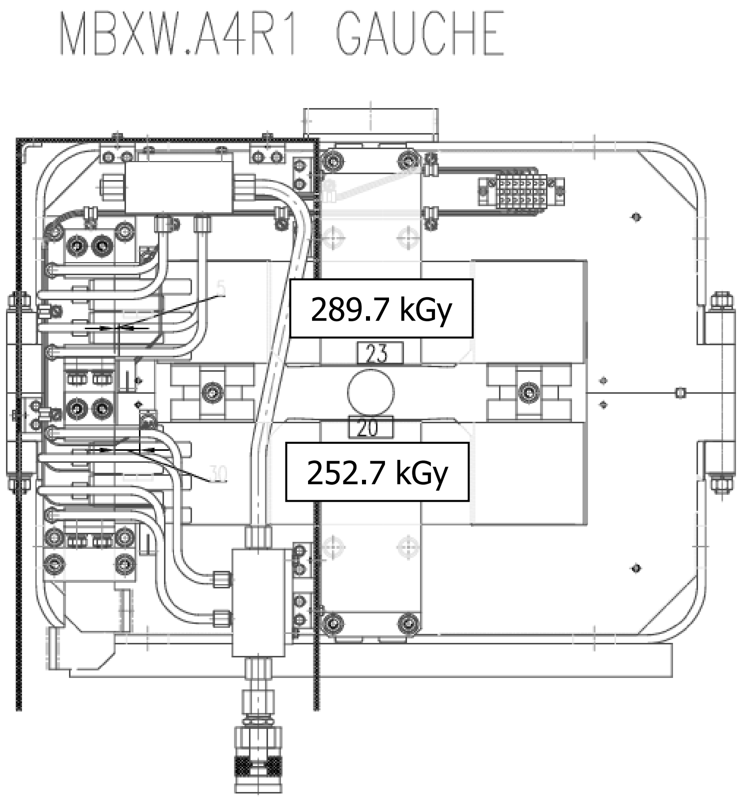


BLM dose per collision assuming CMS luminosity measurement and 73.5 mb proton-proton cross-section (from TOTEM)

CHALLENGING OBSERVATIONS

dose measured over the period Jan-Jun 2012 on the D1 return coils – IP1 face, both sides - (TE-MSC, DGS-RP, EN-STI)

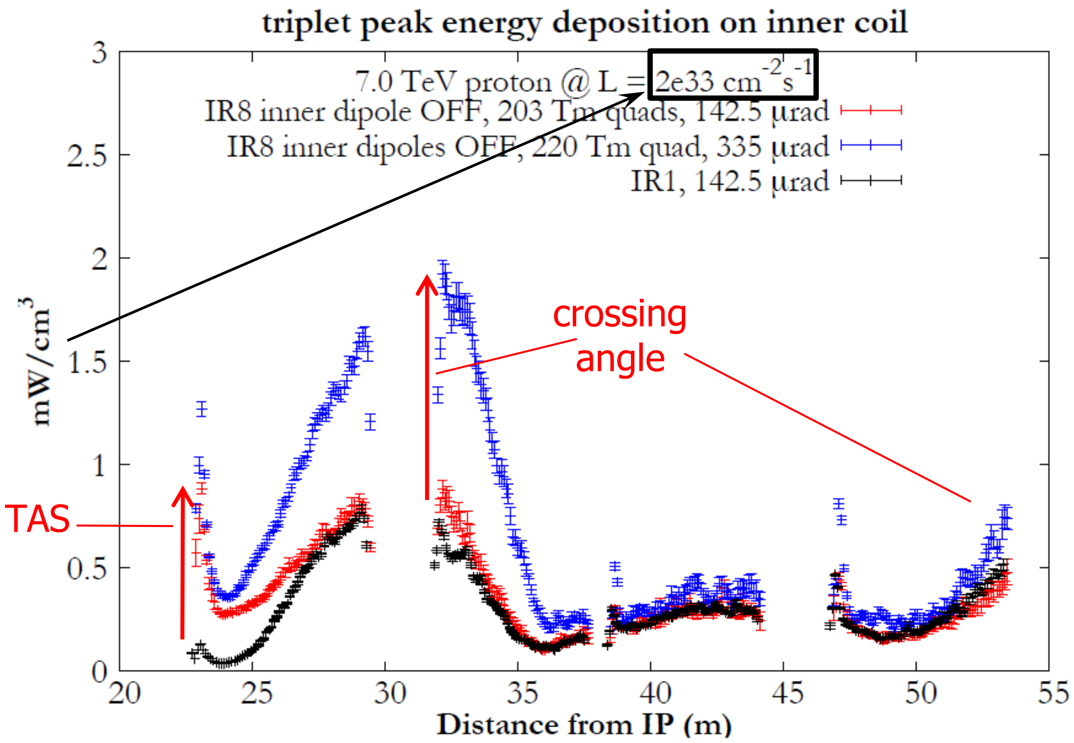




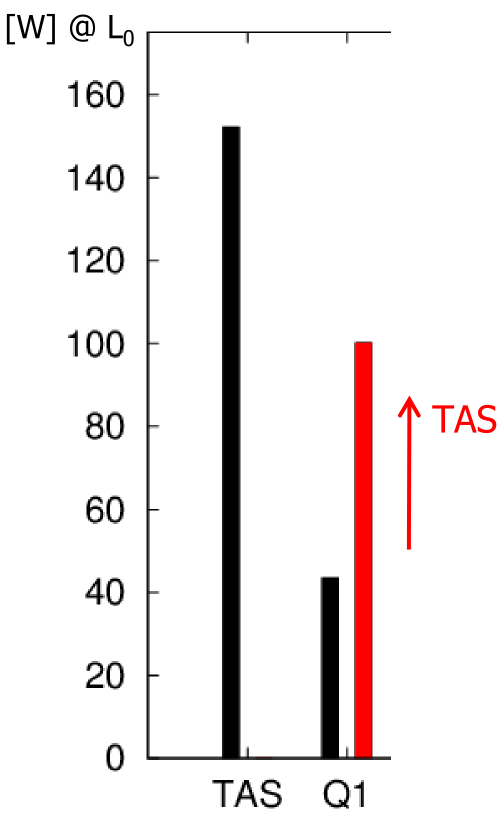
[courtesy of J. Trummer, DGS-RP]

TAS AND CROSSING ANGLE EFFECT

for quench risk



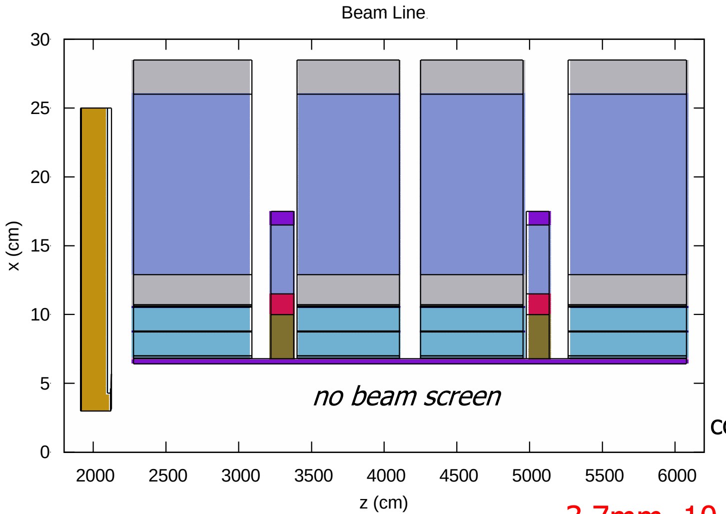
for cryogenic load

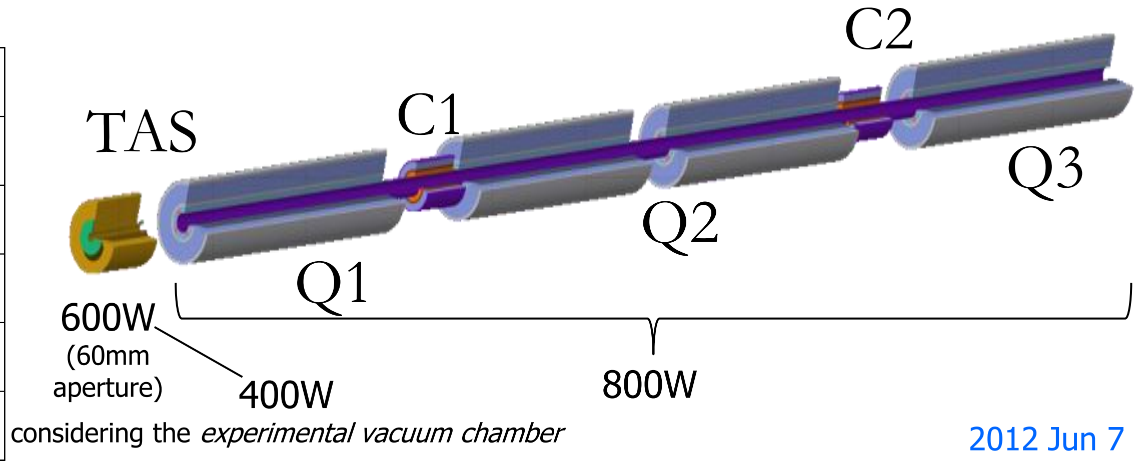


- the TAS has meaning only for (the first half of) of Q1!
- the crossing angle plays a significant role

- the TAS absence redoubles (+130%) the Q1 load

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

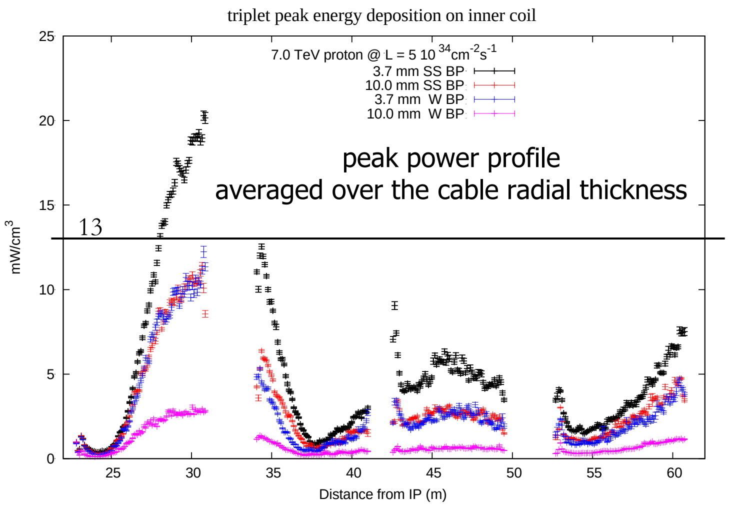


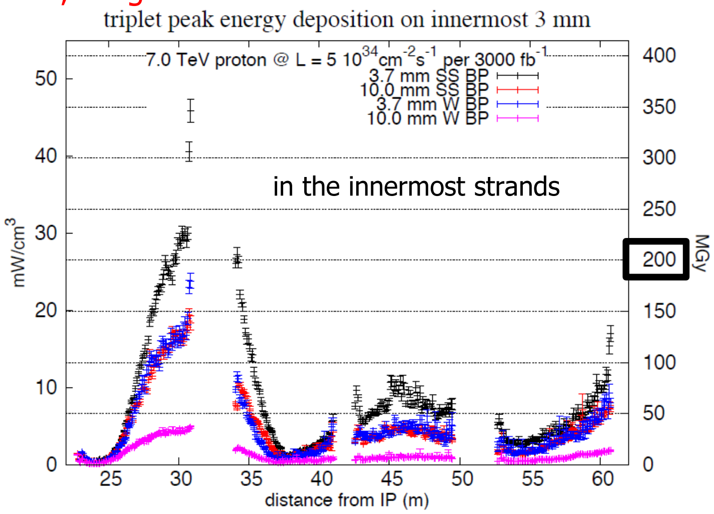


2012 Jun 7

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*

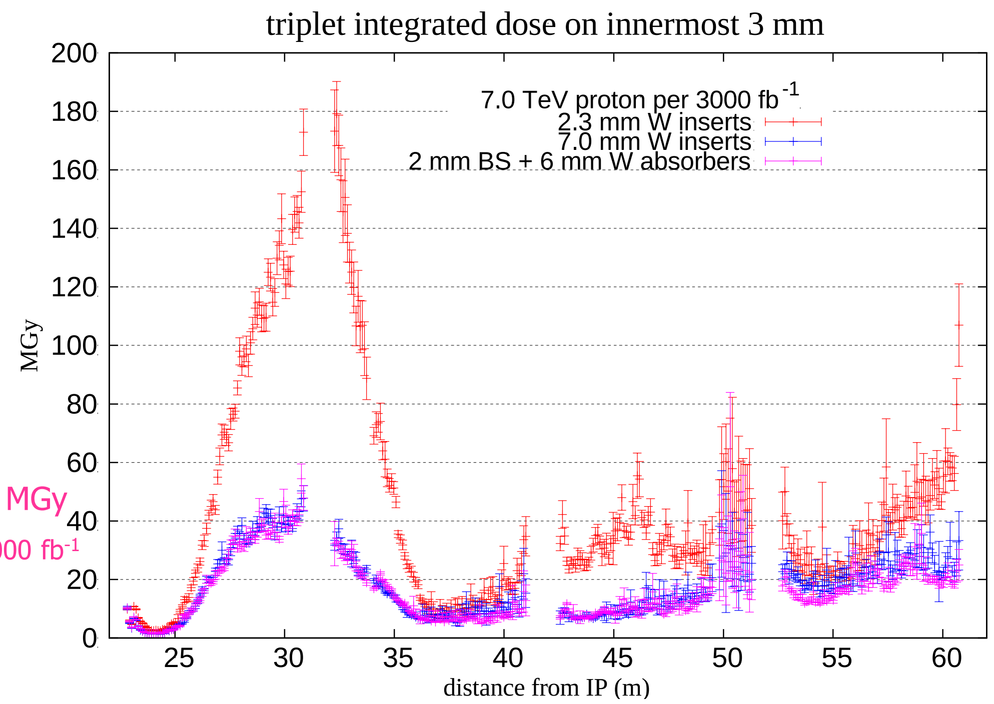
with 0.5 mm clearance between BP and W

111.6 mm residual aperture at mid-planes

for 140mm coil aperture

< 50 MGy

per 3000 fb^{-1}

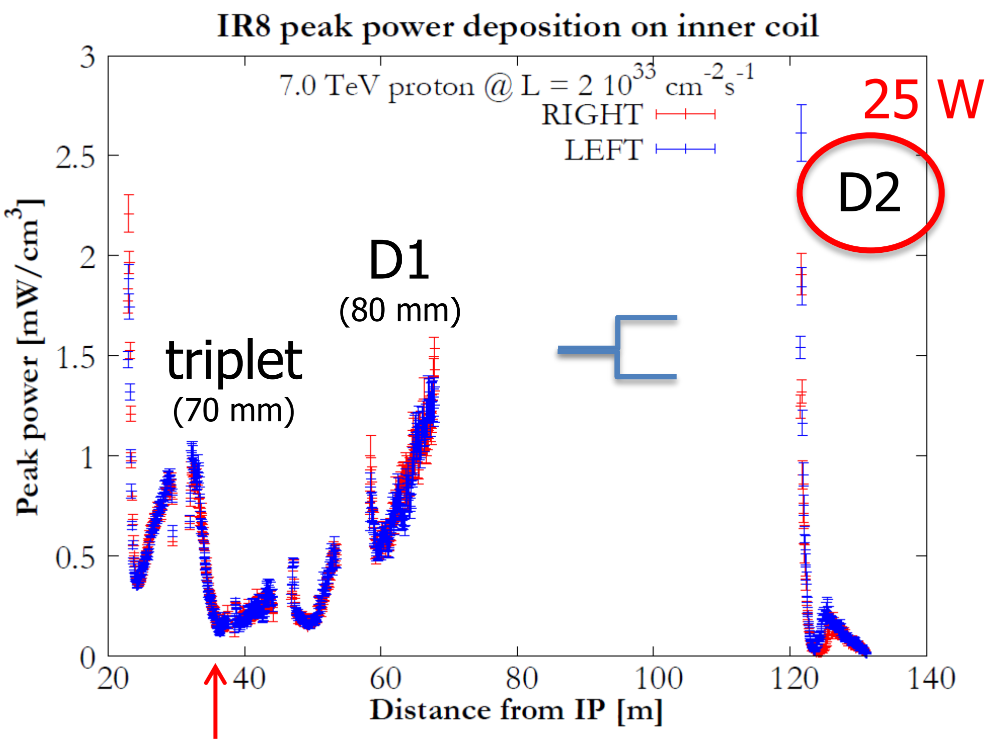


- to stay below 20MGy, one should envisage 9 mm W absorbers

  i.e. ~115 mm residual aperture at mid-planes for 150mm coil aperture

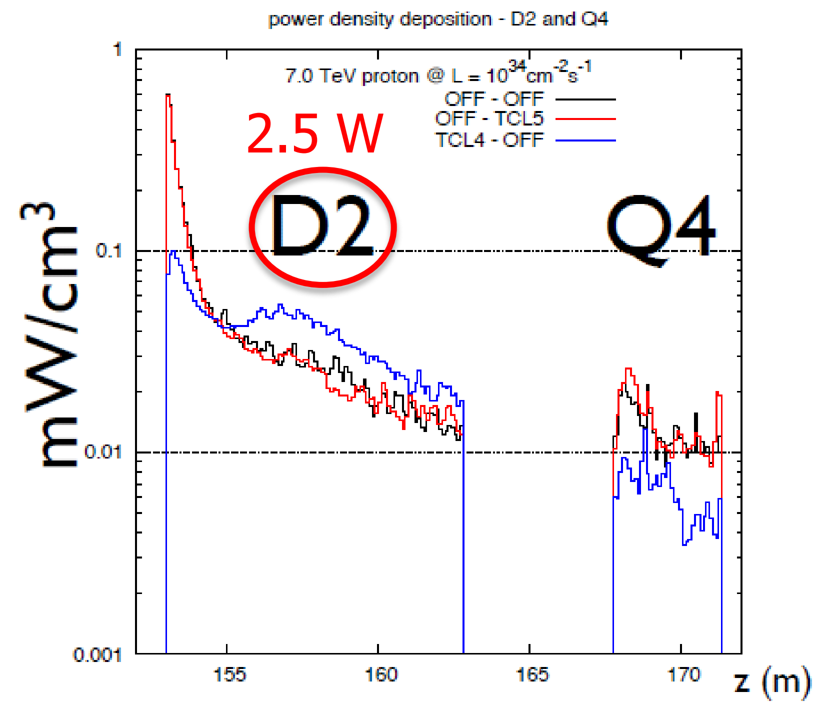
TAN EFFECT

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



peaks on the horizontal plane despite the vertical external crossing (impact from *beam screen orientation)*

P5 10^{34} cm^{-2} s^{-1} with TAN (190W)

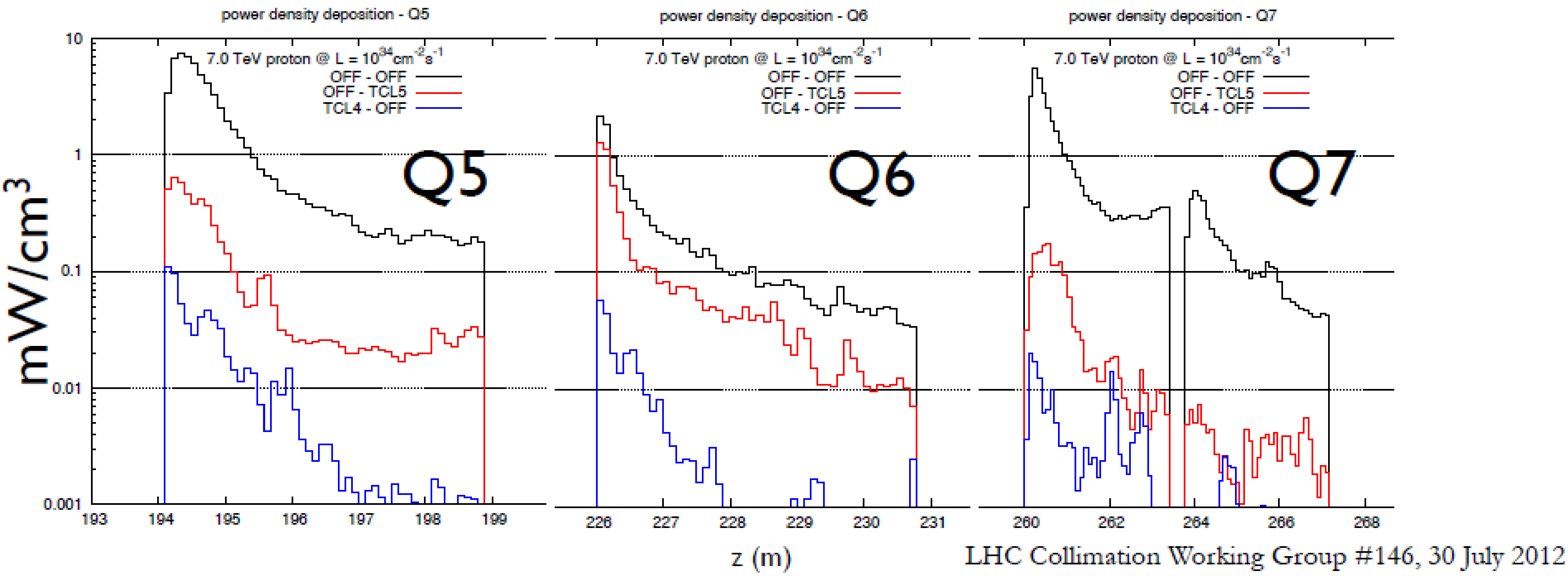


- the TAN is clearly essential for the D2 protection above a few 10^{33} cm^{-2} s^{-1}

[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



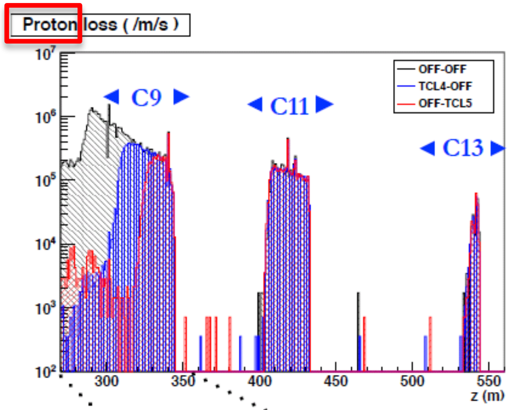
- Q5 and Q7 require TCL in place

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

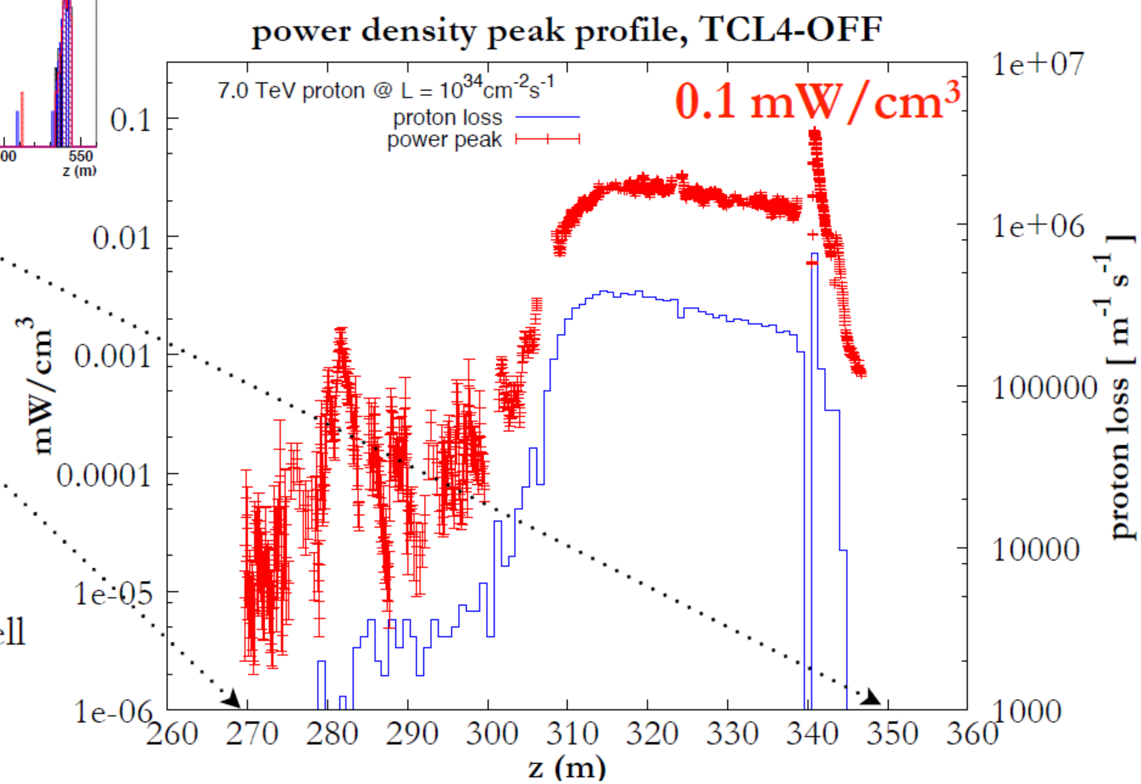
DISPERSION SUPPRESSORS

TCL4-5 not effective from cell 9 onwards

DS.R5

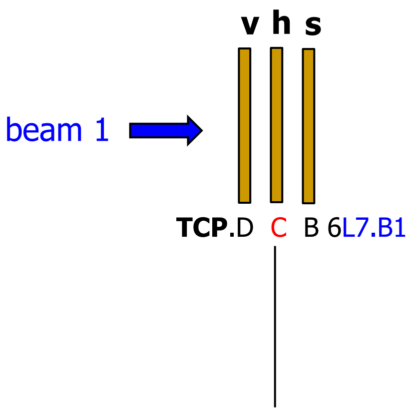


Contributions from upstream showering not evaluated for C8

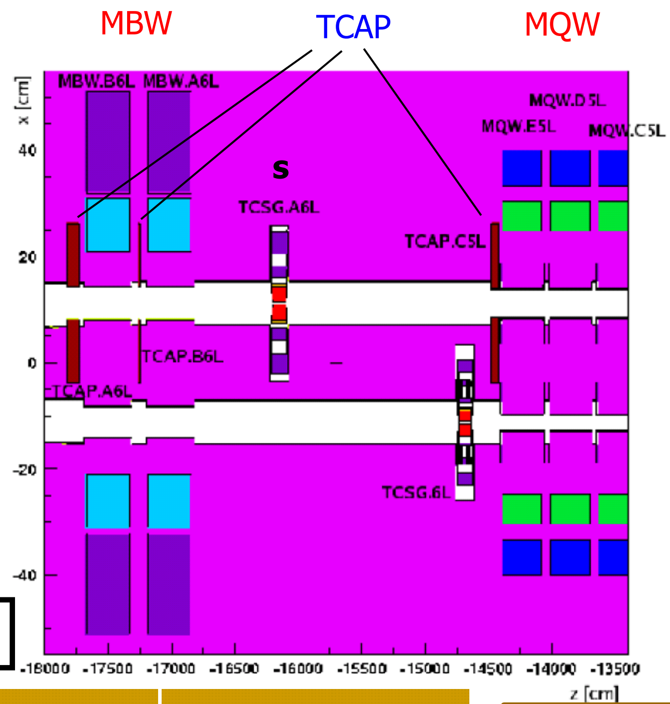


In C9 peak power well below 1 mW/cm^3

COLLIMATOR INSERTIONS



assuming a horizontal halo



DOSE TO WARM MAGNETS

IP7

collimator losses scaling with luminosity (elastic from experiments?)

	7 TeV	3.5 TeV
magnet	peak dose [MGy]	*for **intermediate** collimator settings*
MBW.B6L7	3.3	1.7
MQWA.E5L7	0.9	0.3

for **1.15 10^{16}** lost protons per beam

taking for 4 TeV with **tight** settings

2	one would get by normalizing to **1.4 10^{15}** beam 1 protons lost in P7	250kGy	100-400 kGy measured
0.5		60 kGy	60 kGy

projection of 30 MGy on the MBW and 5 MGy on the MQW for 6.5 10^{16} lost protons (300fb^{-1}), at the levels of the expected failure thresholds

CONCLUSIONS

- The TAS aperture is not critical wrt Q1 protection

- 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 due to the TAN absence).

- An effective cleaning is assured by the TCL(s) in the matching section

- 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, to be followed up with the ATS optics).

- 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).

extended and accurate FLUKA model of the LHC available

for secondary particle shower and energy deposition calculations