DS Heat Load Scenarios in Collision Points and Cleaning Insertions.

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With essential input from; R.Bruce, J. Jowett, M. Karppinen, V. Parma, S. Radaelli, D. Ramos, T. Sahner, M. Schaumann.

Contents

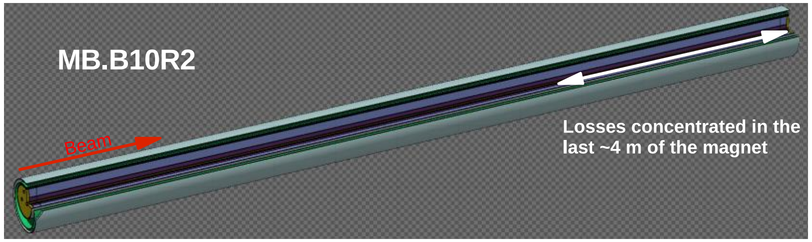
- Investigation of ion collision debris (BFPP) in IR2:
  - current MB
  - new 11T 2-in-1 dipole magnet coupled to warm TCLD collimator
- Summary of previous study on the effect of cryo-collimators for proton and lead beams in the IR7 dispersion suppressor.

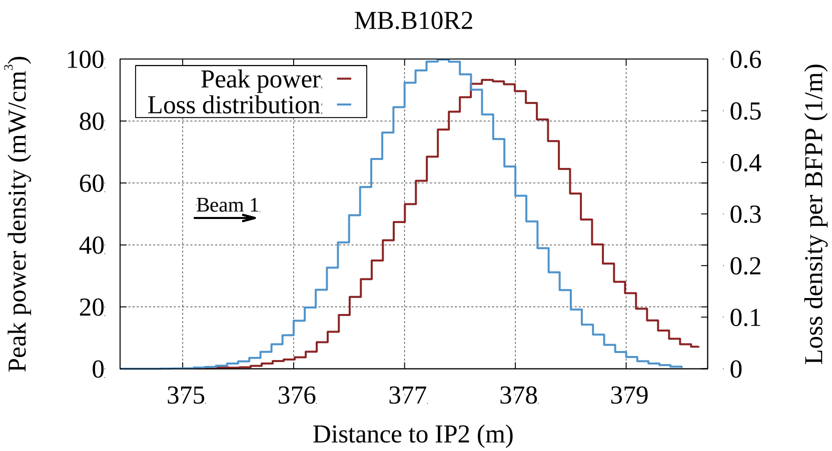
Heat load in the DS due to ion collision debris (BFPP1) in IR2

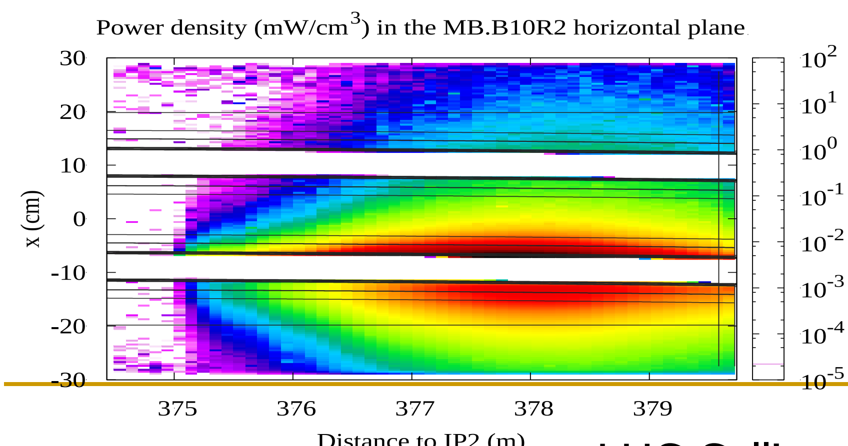
New Simulation Parameters

- Only consider BFPP, secondary beam due to bound-free pair production (208-Pb-81+)
- Cases considered
  - Existing layout, external crossing angle of 80μrad (total 150), impacts on the beam screen of MB.B10R2.B1
  - Replacing MB.A10R2.B1 by 2 shorter dipoles and a collimator, crossing angle of 4.6μrad (74),
    - half gap of 9.5mm, 0.5m Copper jaw
    - half gap of 9.5mm, 1m Tungsten jaw
    - half gap of 2mm, 1m Tungsten jaw
- Instantaneous luminosity of 6e27 $cm^{-2} s^{-1}$ integrated luminosity $10nb^{-1}$

Existing layout - peak power





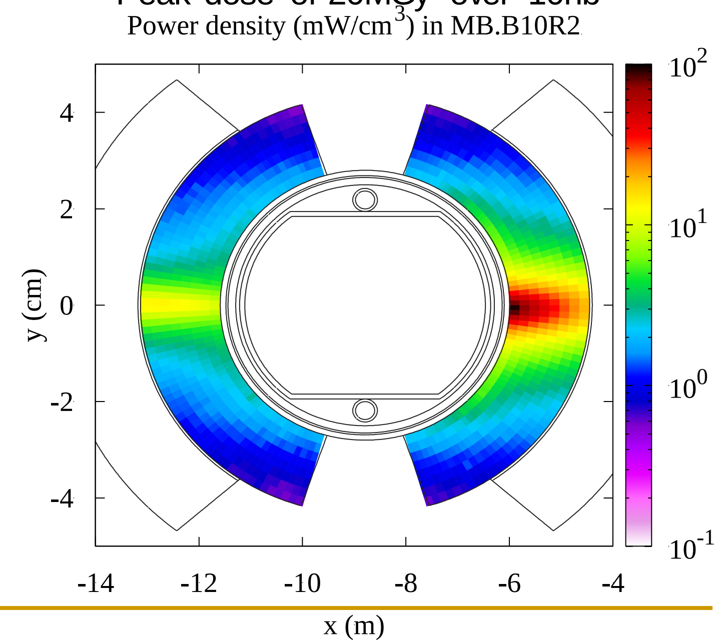


Results use an improved geometry with respect to a previous study: DOI: 10.1103/PhysRevSTAB.12.071002 200 (R.Bruce *et. al*, 2009), but are nonetheless consistent.

Peak power: 95mWcm^{-3}

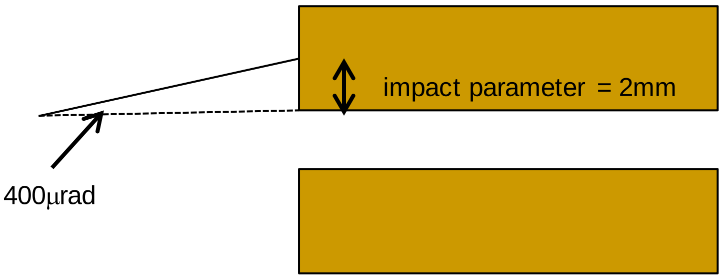
If radially averaged over cable thickness one gets a reduction of around a half

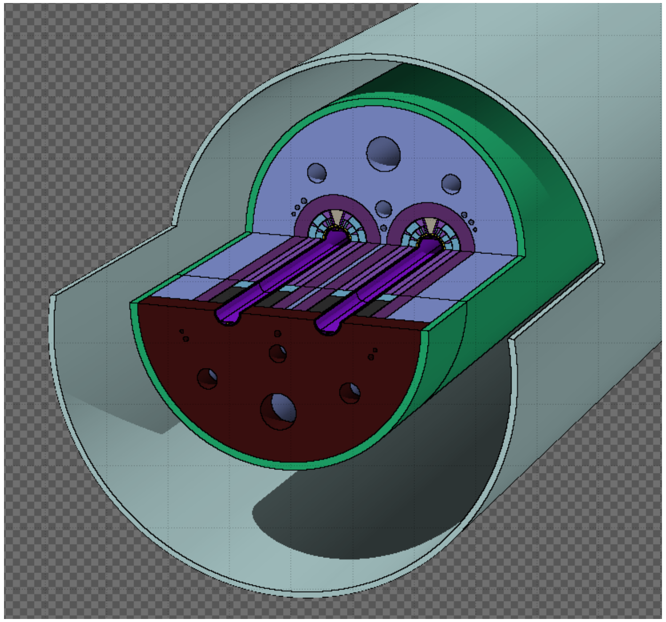
Peak dose of 20MGy over 10nb^{-1}

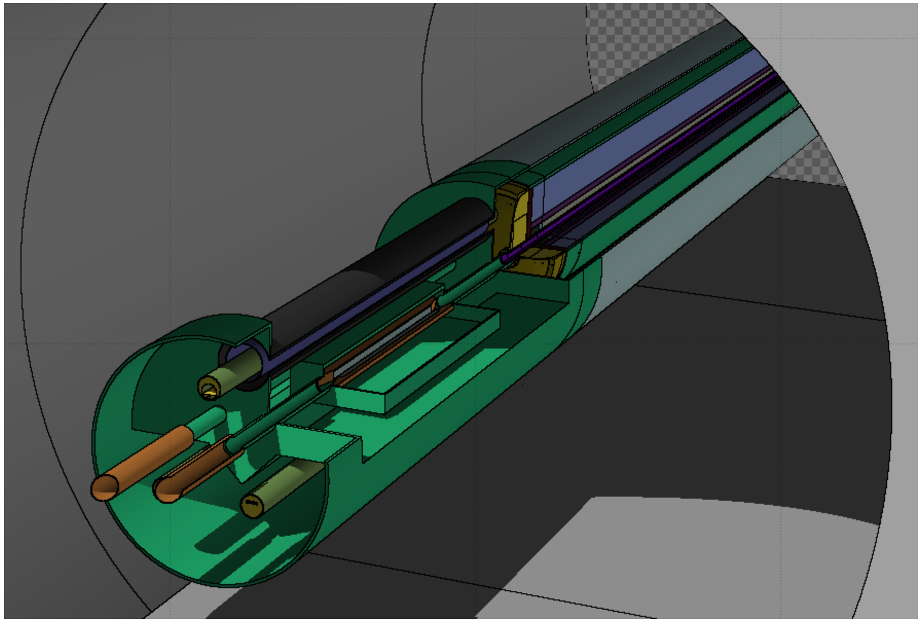


TCLD and 11T dipole (MBHDP)

- Modelled in FLUKA to include all geometry essential for energy deposition studies.
- For dipole, magnetic field map included to allow particle tracking.

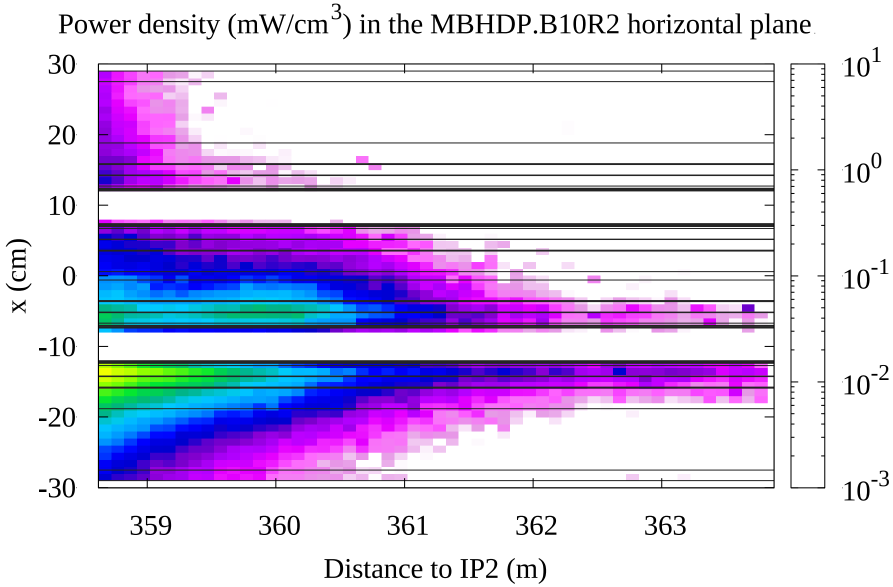


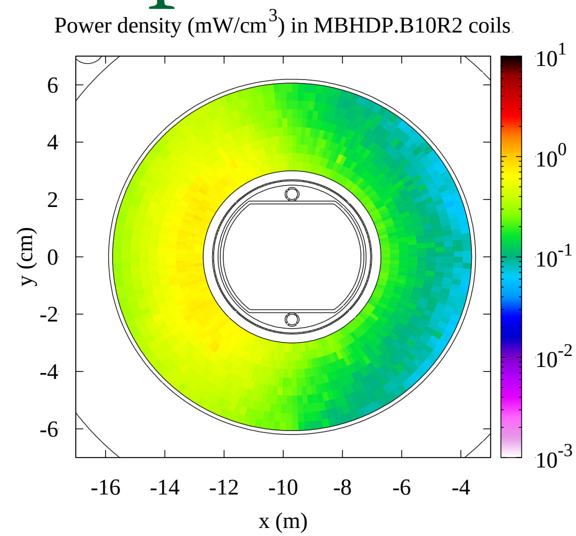




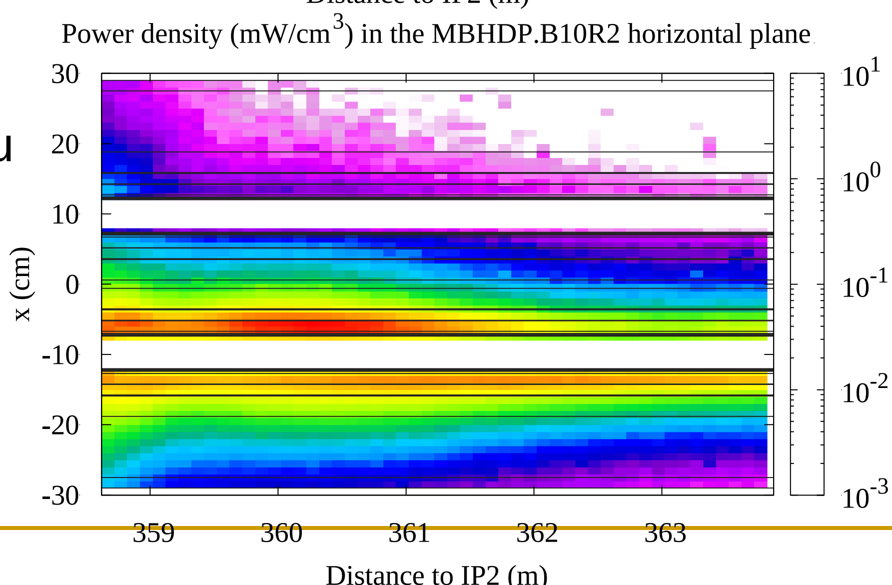
DS Coll. + MBHDP - peak power

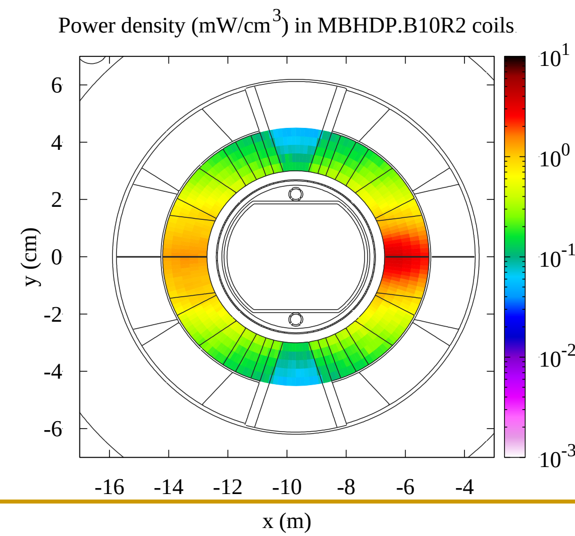
1m W



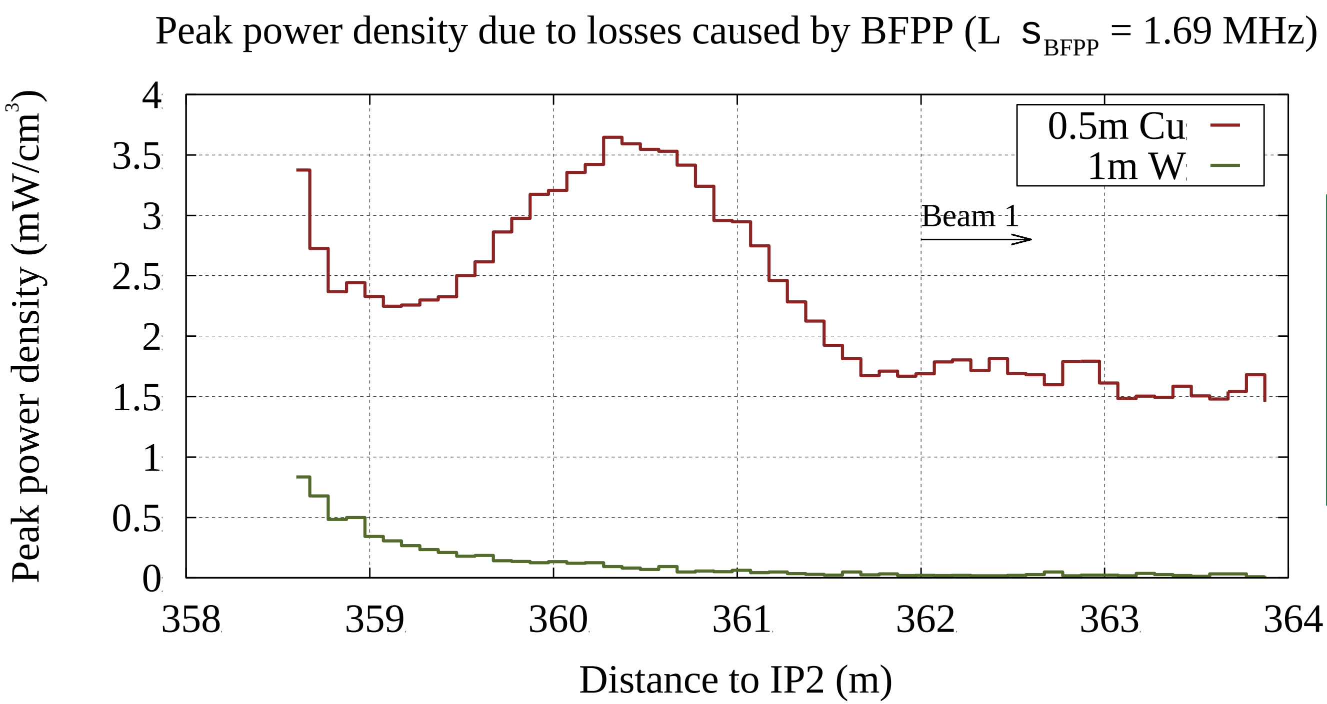


0.5m Cu





Peak power deposition: MBHDP - cont.



Reduction factor greater than 4 between the two cases.

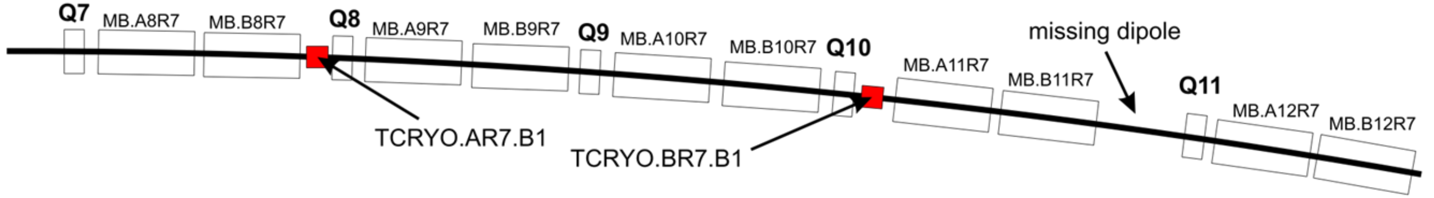
0.5m copper jaws give a peak power density of 3.7 $mWcm^{-3}$ in the coil of the magnet.

1m tungsten jaws give a peak of 0.8 $mWcm^{-3}$

Comparison of scenarios

	Peak power density (mW cm^{-3})	Reduction factor	Peak Dose (MGy) for 10nb-1	Total power on magnet (W)	Total power on jaw1 (W)	Total power on jaw2 (W)
MB - no collimator	95	1	20	105	-	-
1m W	0.8	114	0.2	8.4	77	13
0.5m Cu	3.7	26	0.8	46	42	6.5
1m W 2mm half gap	<0.1	>900	<0.1	3.0	96	6.5

Heat load in DS due to beam halo collimation in IR7

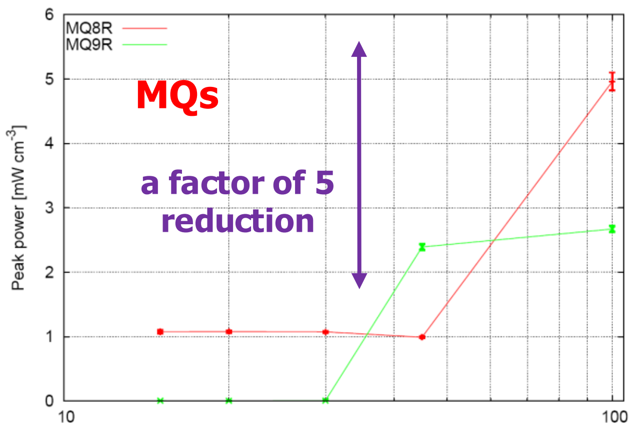


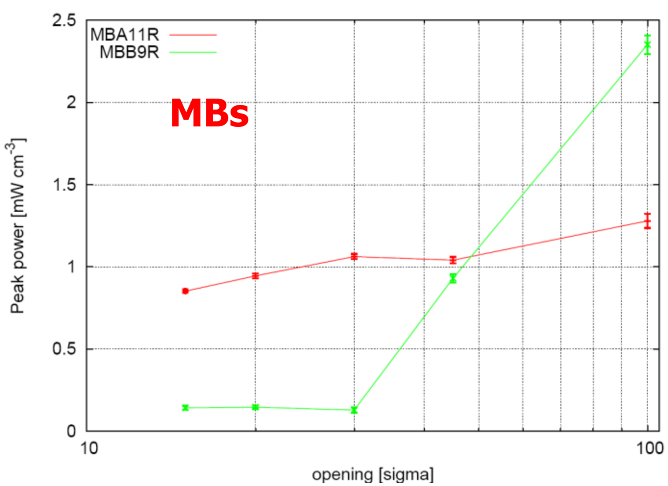
DS collimator effectiveness - protons

1m copper with 15, 20, 30, 45 sigma half-gap

(100 sigma half-gap means no TCRYO)

peak power in the coils

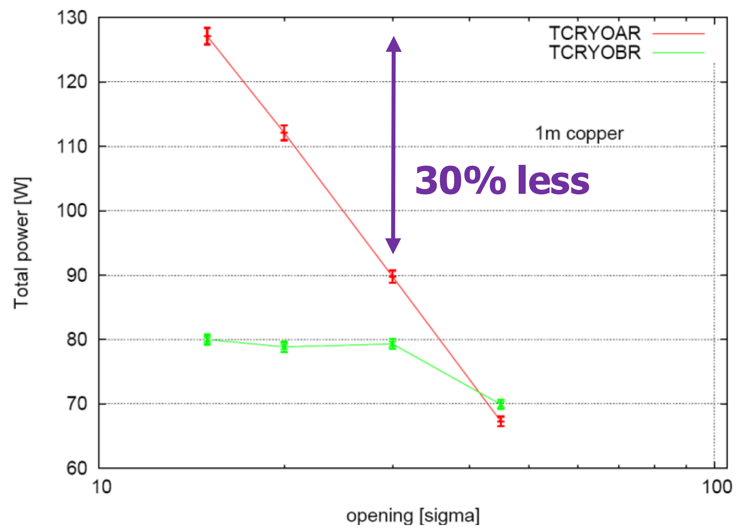




Study (shown by F.Cerutti at CDR LHC Phase II Collimation 02/04/09) looking at the effect of cryo-collimators on the LHC beam halo power deposition in the IR7 dispersion suppressor.

MQTLIs ~1mW/cm^3 (MQTLI8R) for 15, 20, 30 sigma

total power in the **TCRYOs**



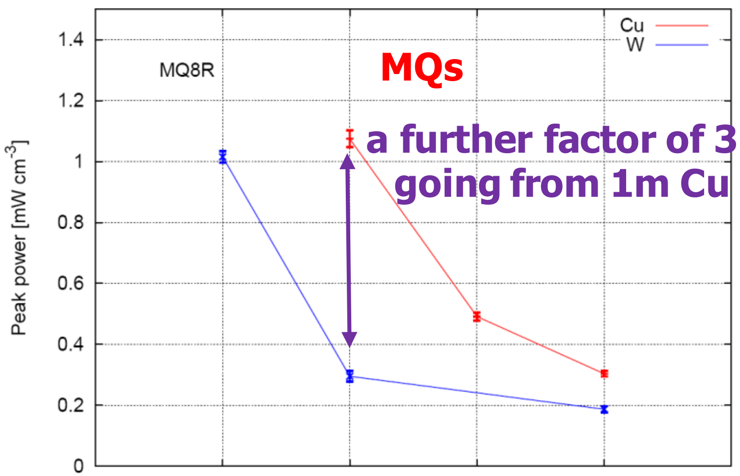
power values for 0.2h beam lifetime

EFFECT OF THE TCRYO LENGTH/MATERIAL

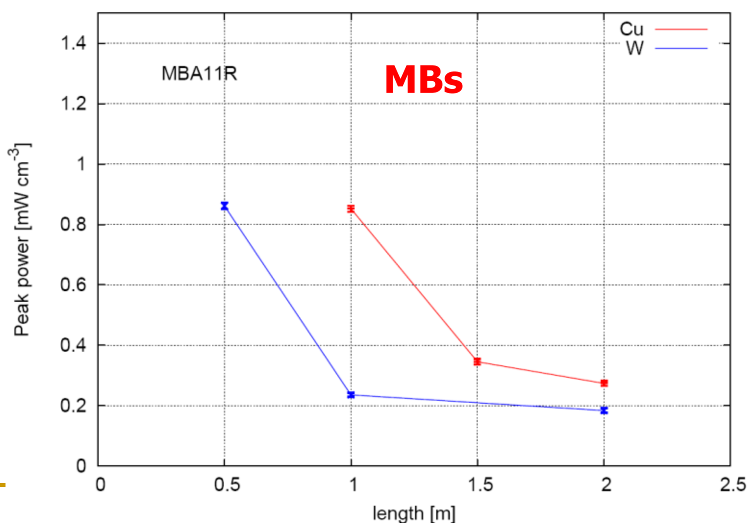
F.Cerutti

0.5, 1, 1.5, 2 m copper/tungsten with 15 sigma half-gap

power values for 0.2h beam lifetime



peak power in the coils



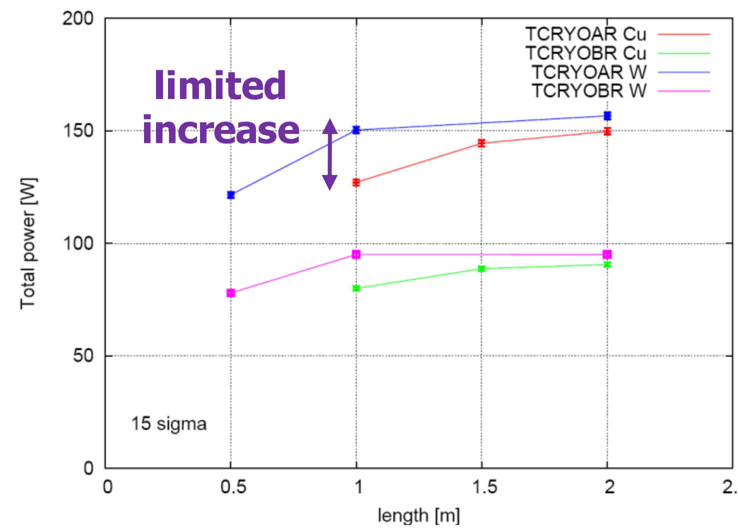
peak power in the **TCRYOs**

1.1 W/cm^3 in the Cu jaw

2.6 W/cm^3 in the W jaw

on a 4mm x 4mm x 1cm volume

total power in the **TCRYOs**

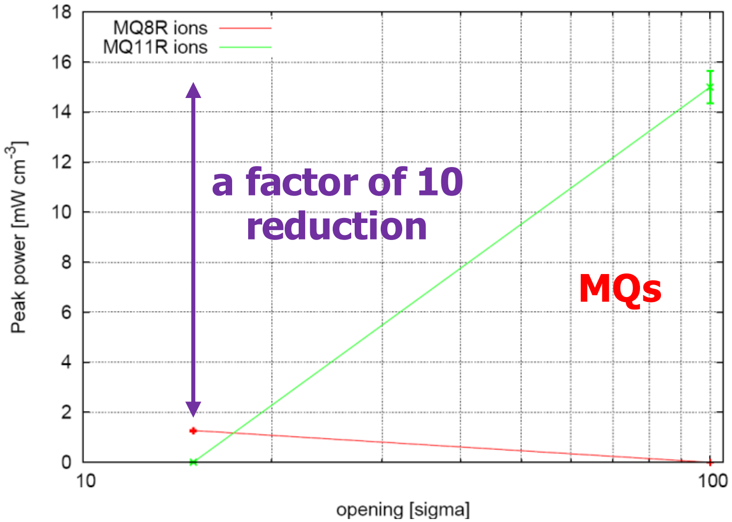


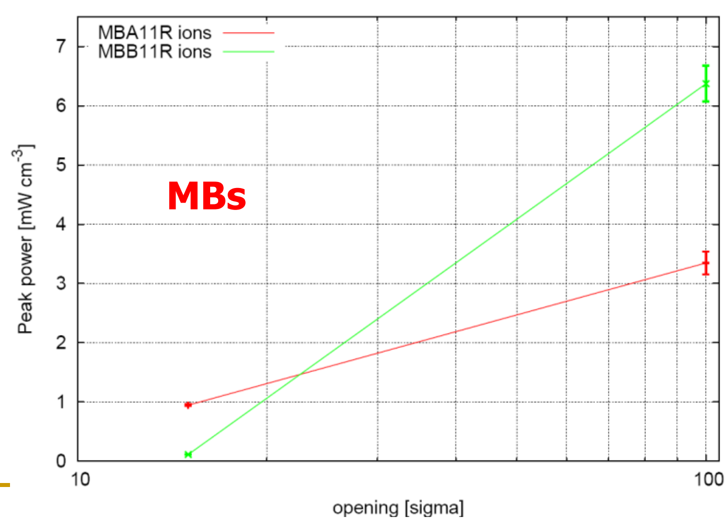
EFFECT OF THE TCRYO (LEAD BEAM)

1m copper with 15 sigma half-gap

(100 sigma half-gap means no TCRYO)

power values for 0.2h beam lifetime





peak power in the coils

F.Cerutti

MQTLIs

~1mW/cm^3 (MQTLI8R)

peak power in the **TCRYOs**

1.75 W/cm^3 in the Cu jaw

on a 4mm x 4mm x 1cm volume

total power in the **TCRYOs**

120 W in the TCRYOAR

125 W in the TCRYOBR

Conclusions

- The envisaged increase in luminosity to 6e27 cm^{-2} s^{-1} will lead to peak power deposits of almost 100 $mWcm^{-3}$ in MB.B10R2.B1 due to the BFPP secondary beam from ion collisions.
- Replacing MB.A10R2.B1 by two shorter dipoles and a collimator can reduce this by a factor of between 20 and 100 depending on the length and material of the jaws. Despite BFPP ions impacting only the external jaw, the role of the second jaw is far from being negligible.
- The peak deposits can be reduced further by reducing the collimator half gap.
- DS collimators in the halo cleaning insertions also ensure a significant reduction factor for both proton and ion beams (at least 10 with 1m metallic jaws).