STUDIES ON PASSIVE ABSORBERS IN IR7

motivation –

examination of different designs –

energy deposition maps –

conclusions

Francesco Cerutti, AB-ATB-EET
84th LCWG meeting Mar 19, 2007

RATIONALE

protection of the most exposed warm magnets
against excessive radiation damage and heating

LIMITS

⟶ in the long run, the accumulated **dose on the insulators in the coils** is expected to be the major factor for magnet failure

$<$ 3 MGy/y to guarantee a theoretical life-time of at least 10 y

[S. Ramberger, minutes of the 46th LCWG meeting, Nov 2004]

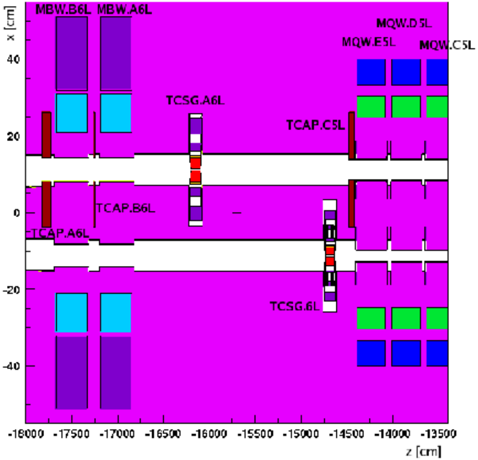
⟶ in a steady state scenario ($\geq$ 1 h), MBW and MQW can stand a **maximum power** of about 15 kW and 10 kW, respectively, if well distributed over the magnet

[ibidem]

EFFECTS

- a 1 m long tungsten TCAP shielding the first MBW of the second dogleg pair reduces the annual dose peak in the front crossing of its coils by a factor $>$ 40
- a second 20 cm W TCAP between the two elements of the pair provides an additional factor 2 for the second MBW
- a third 60 cm W TCAP in front of the MQW reduces the peak by a factor 5 and the total power by a factor 2.5 in the first quadrupole

IR7 Left Maching Section layout



horizontal losses nominal conditions top energy

Impact of different designs of the three passive absorbers

min and max values for total power (first line) and peak (second line)

element	*all W 450 x 400*	*1mm steel pipes 300 x 300*	*+ 0.25mm air gap 300 x 300*	*1.5mm Cu pipes 300 x 300*	*max section 1020 x 720 800 x 700 (3rd)*	
TCAP.A6L7.B1	30.1 112.6	27.1 106.5	26.9 105.1	27.1 104.2	35.6 103.0	kW W/cm^3
MBW.B6L7.B1	14.4 1.856	16.6 *2.320*	16.7 *2.354*	16.6 *2.359*	11.6 2.477	kW MGy/y
TCAP.B6L7.B1	4.0 31.4	3.3 24.2	3.3 23.5	3.3 23.2	3.9 22.8	kW W/cm^3
MBW.A6L7.B1	13.4 2.049	13.8 2.111	13.9 2.394	13.8 2.359	13.5 2.351	kW MGy/y
TCAP.C5L7.B1	37.6 192.4	34.4 185.1	34.2 183.5	34.4 180.7	41.5 180.2	kW W/cm^3
MQW.E5L7.B1	10.0 0.501	12.2 0.552	12.4 0.640	12.3 0.592	8.2 0.561	kW MGy/y
MQW.D5L7.B1	5.5 0.396	5.6 0.452	5.6 0.411	5.6 0.404	5.6 0.428	kW MGy/y

kW and W/cm^3 assuming 4 10^{11} p/s MGy/y assuming **1.15** 10^{16} p/y

Location of the peak in the TCAP

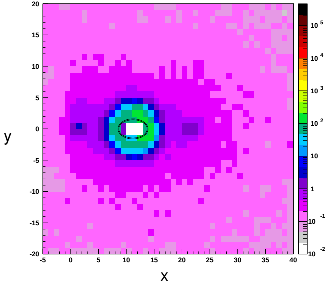
TCAP.C5L7.B1

(Cu pipes, max section: 180.2 W/cm^3)

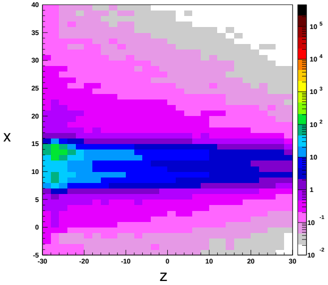
1 x 1 x 2 cm^3 scoring grid

beam 1 vacuum chamber at x = 11.2cm y = 0 with Δx = 5.1cm Δy = 2.9cm
(TCAP.A5L7.B1 and TCAP.B5L7.B1 with Δx = 5.9cm Δy = 4.4cm)

z = –27cm (3cm z-depth) W/cm^3

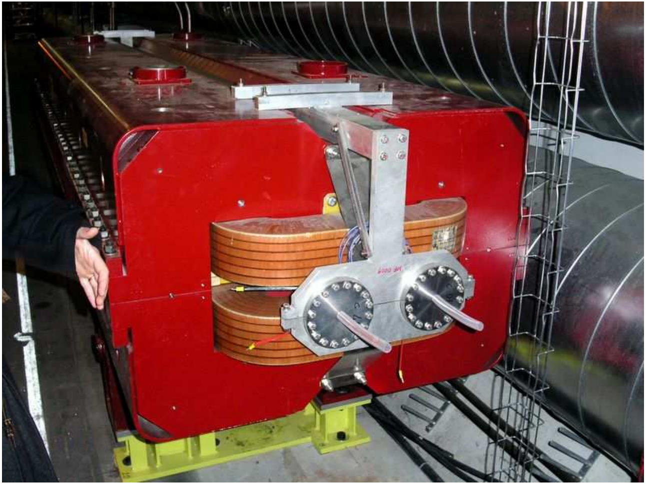


y = –1.5cm W/cm^3



x = 13.5cm

MBW



Location of the peak in the MBW

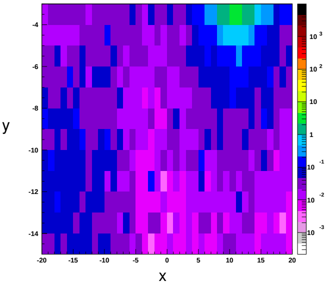
MBW.B6L7.B1

(Cu pipes: 2.359 MGy/y statistical error ∼10%)

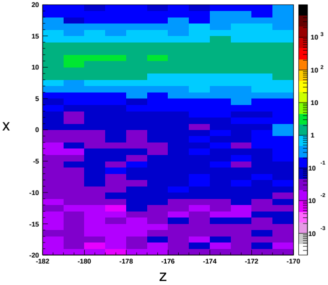
1 x 1 x 1 cm^3 scoring grid beam 1 vacuum chamber at x = 11.2cm y = 0 with Δx = 5.9cm Δy = 4.4cm

z = −180.5cm MGy/y

(1.5cm z-depth in the front return coils)

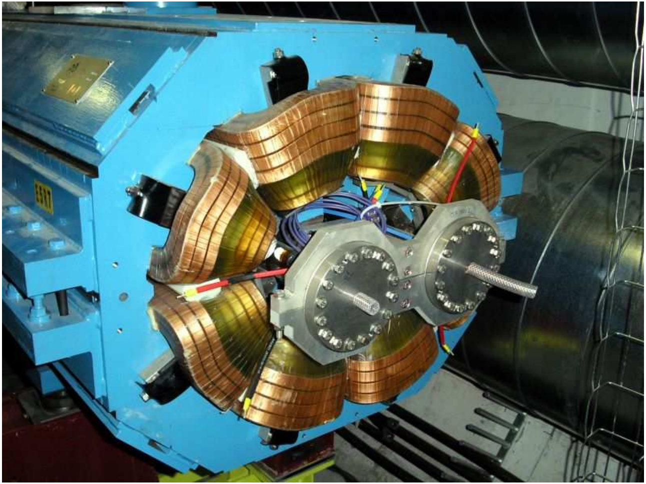


y = −3.5cm MGy/y



x = 11.5cm

MQW



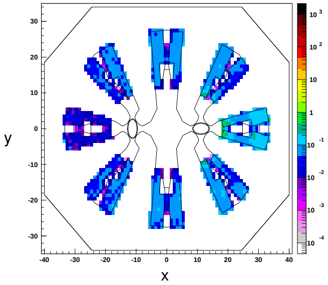
Location of the peak in the MQW

MQW.E5L7.B1

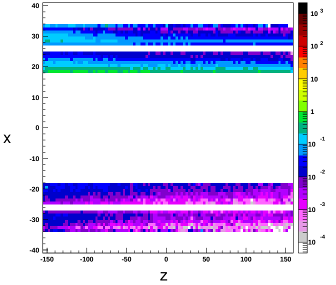
(Cu pipes: 0.592 MGy/y   statistical error $\sim$10%)

1 x 1 x 3.15 cm^3 scoring grid   beam 1 vacuum chamber at $x = 11.2$cm $y = 0$ with $\Delta x = 5.1$cm $\Delta y = 2.9$cm

z = −131.8cm (27.6cm z-depth) MGy/y



y = −1.5cm MGy/y



x = 18.5cm

Conclusions

annual dose peak in the warm magnets (for **nominal** luminosity !!! **1.15** vs 2.00 – ultimate – 10^{16} p/y):

- 2.5 MGy/y in the MBW with pipes in TCAP ($\sim$25% increase in comparison with the all W – i.e. no pipe – configuration)
- $<$ 0.7 MGy/y in the MQW

total power in the warm magnets (for peak loss rate 4 10^{11} p/s):

- constant in the second element: 14 kW in MBW.A6L7.B1 and 5.5 kW in MQW.D5L7.B1
- in MBW.B6L7.B1 from 17 kW (pipe in TCAP.A6L7.B1) to 11.5 kW (1020 x 720 mm^2 TCAP.A6L7.B1)
- in MQW.E5L7.B1 from 12.5 kW (pipes in TCAP) to 8 kW (max section TCAP [800 x 700 mm^2 TCAP.C6L7.B1])

total power in the passive absorbers:

- 40 kW in TCAP.C6L7.B1

power peak in the passive absorbers:

- $\leq$ 200 W/cm^3 in TCAP.C6L7.B1

a "sandwich" structure for TCAP (pipe + tungsten core + small gap + iron body) appears a viable solution as well, to be further simulated as soon as a more detailed design becomes available