Rationale for thresholds on MQW/MBW magnets

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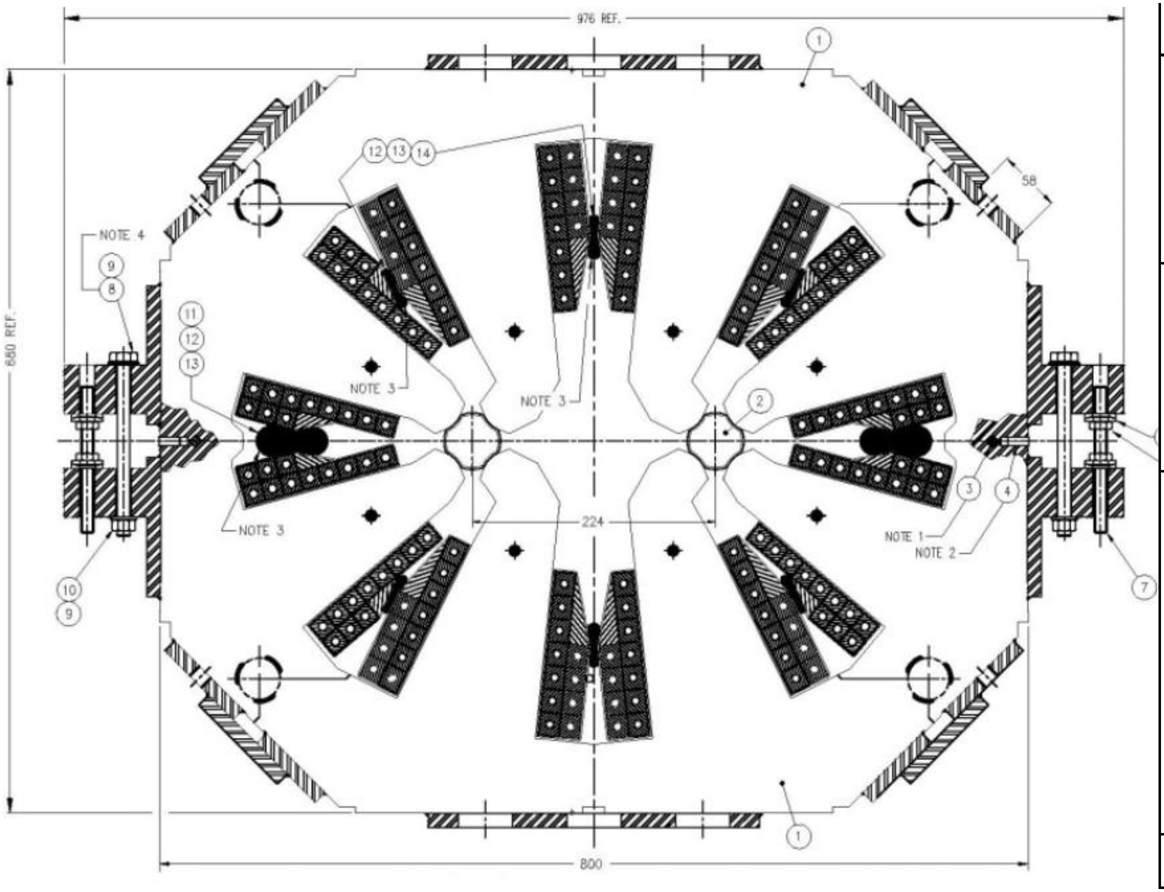
MQW normal conducting quadrupole magnet



Cross-section of the MQW twin aperture normal conducting matching quadrupole

Magnet type	MQWA	MQWB
Magnetic length	3.1 m	
Beam separation	224 mm	
Aperture diameter	46 mm	
Operating temperature	< 65° C	
Nominal gradient	35 T/m	30 T/m
Nominal current	710 A	600 A
Inductance	28 mH	
Resistance	37 mΩ	
Conductor X-section	20.5 x 18.0 mm² inner poles 17.0 x 17.0 mm² outer poles	
Cooling hole diameter	7 mm inner poles, 8 mm outer poles	
Number of turns per magnet	8 x 11	
Minimum water flow	28 l/min	
Dissipated power at I_{nom}	19 kW	14 kW
Mass	11700 kg	

MBW normal conducting dipole magnet

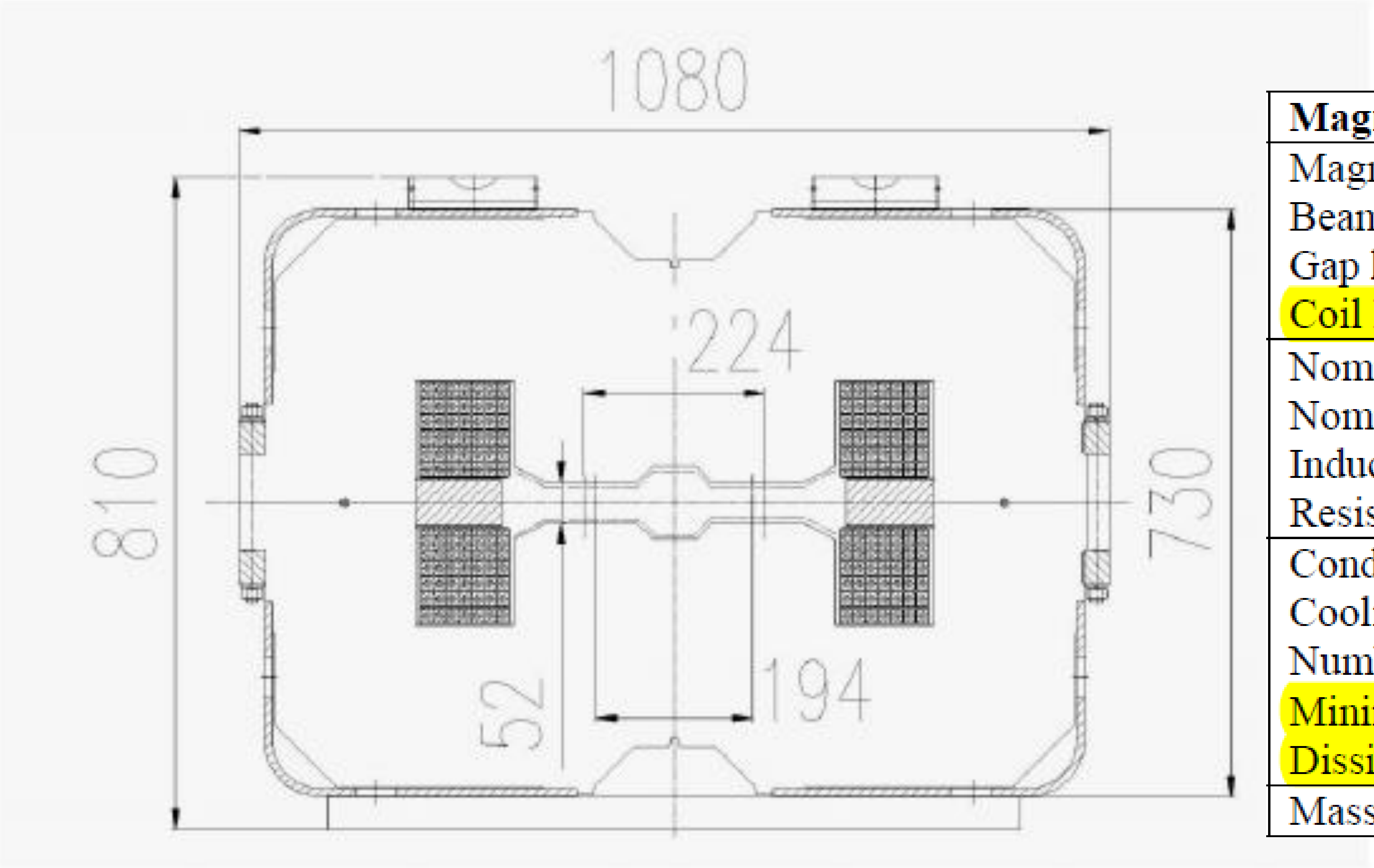


Figure 8.14: Cross-section of the normal conducting separation dipole MBW.

Magnet type	MBW	MBXW
Magnetic length	3.4 m	
Beam separation	194-224 mm	0-27 mm
Gap height	52 mm	63 mm
Coil Protection temperature	< 65° C	
Nominal field	1.42 T	1.28 T
Nominal current	720 A	690 A
Inductance	180mH	145 mH
Resistance	55 mΩ	60 mΩ
Conductor X-section	18 x 15 mm²	
Cooling hole diameter	8 mm	
Number of turns per magnet	2 x 42	2 x 48
Minimum water flow	19 l/min	
Dissipated power at I_{nom}	29kW	29 kW
Mass	18000 kg	11500 g

Slow losses, cooling limitation

Cooling power $\frac{dQ}{dt} = C_p v_s a_c \rho \Delta T$,
$C_p = 4179\ Jkg^{-1}K^{-1}$;
$\rho = 10^3 kg\ m^{-3}$

Thermo-switch on the coil set to 65 °C

Water and Coils have approximately same temperature (+/- 2°C) *(from P. Thonet)*

	MQWA (19 kW in Nominal Op.)	MQWB (14 kW in Nominal Op.)	MBW (29 kW)
Water Flow*	22l/min	22l/min	20 l/min
Water Temperature*	20 to 30 °C	20 to 30 °C	20 to 30 °C
ΔT Water /Copper(°C)	12.4	9.1	21
Max Power evacuated (kW) for ΔT = 35 C	54	54	49
Max Power evacuated (kW)induced by beam losses	35	40	20

* Operational values confirmed by *D. Tommasini and P. Thonet*

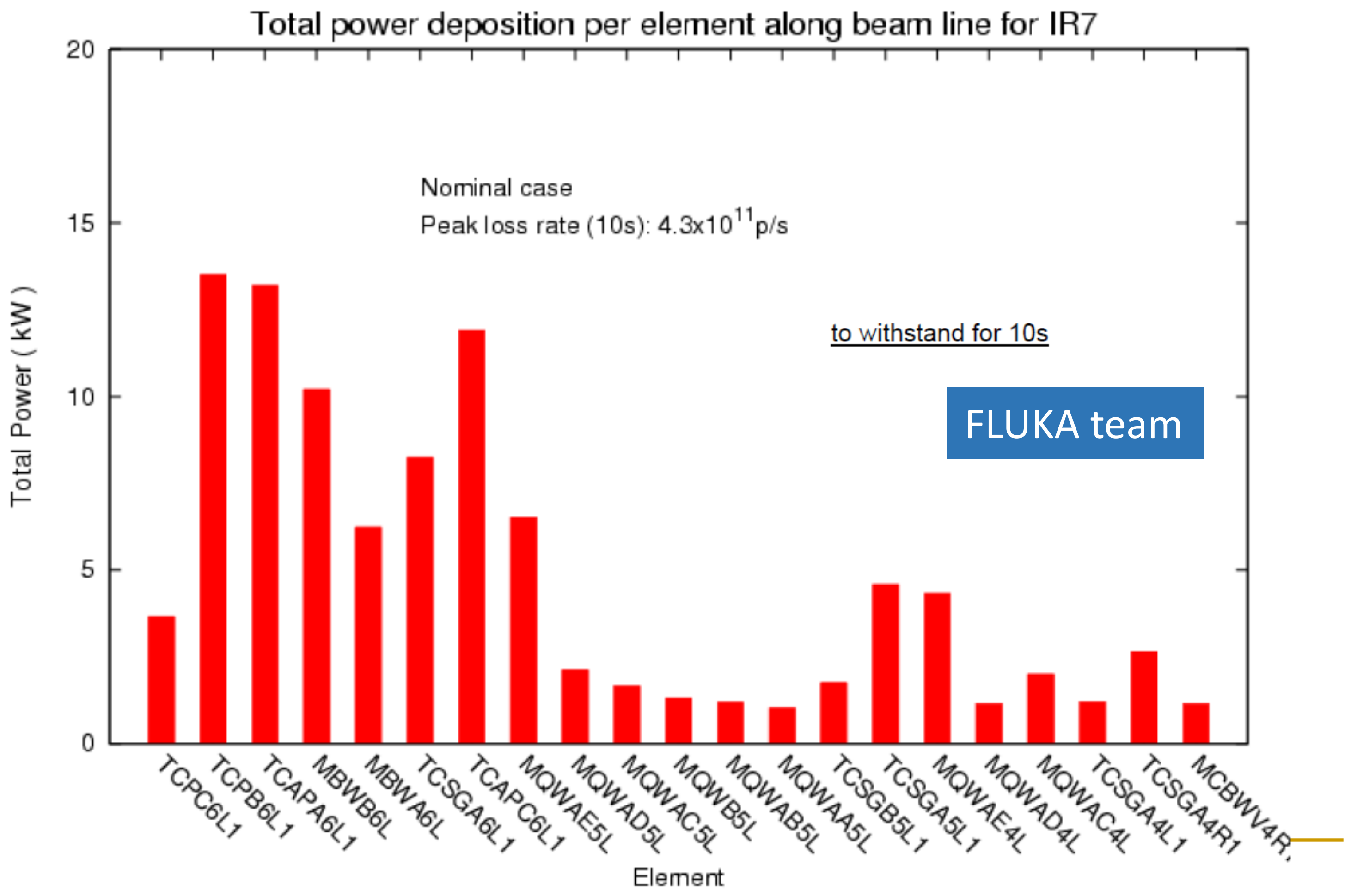
- **Orbit Bump Scenario:** To calculate a maximum loss rate, we need an estimation of the **Average losses on the whole MBW and MQW per lost proton**

Normal Cleaning Scenario at 7 TeV

- **Study done at 3.5 TeV:** Update for 7 TeV required.

- **By extrapolation at 7 TeV:** 500 kW hitting primary collimators. Highest heat load on first MBW (~20 kW) and MQW (~15 kW).

241 KW hitting the beam 1 collimators for 0.2h beam lifetime @ **nominal** intensity (i.e. 2808 bunches with 1.15 10^{11}p each)



Fast losses on vacuum pipe and coils

Copper properties: Cp = 0.385 J/(g K) ; ρ = 8.96g/cm3

- Melting point (ΔT~1040°C, T~1100 °C) => ΔE = 3.6 kJ/cm3
- From TT40 Experiment (1.32 10^{12} protons @450 GeV,~500 °C) used as input for the Setup Beam Flag => ΔE = 1.9 kJ/cm3
- Copper at T=100 °C (ΔT=60 °C) => ΔE = 0.21 kJ/cm3

Thresholds Proposition: Coils at ΔE = 0.21 kJ/cm3 & Beam pipe at ΔE = 1.9 kJ/cm3

To be seen with the BLM response