Status of: CLIC Two-Beam Module Magnets R&D and Procurement

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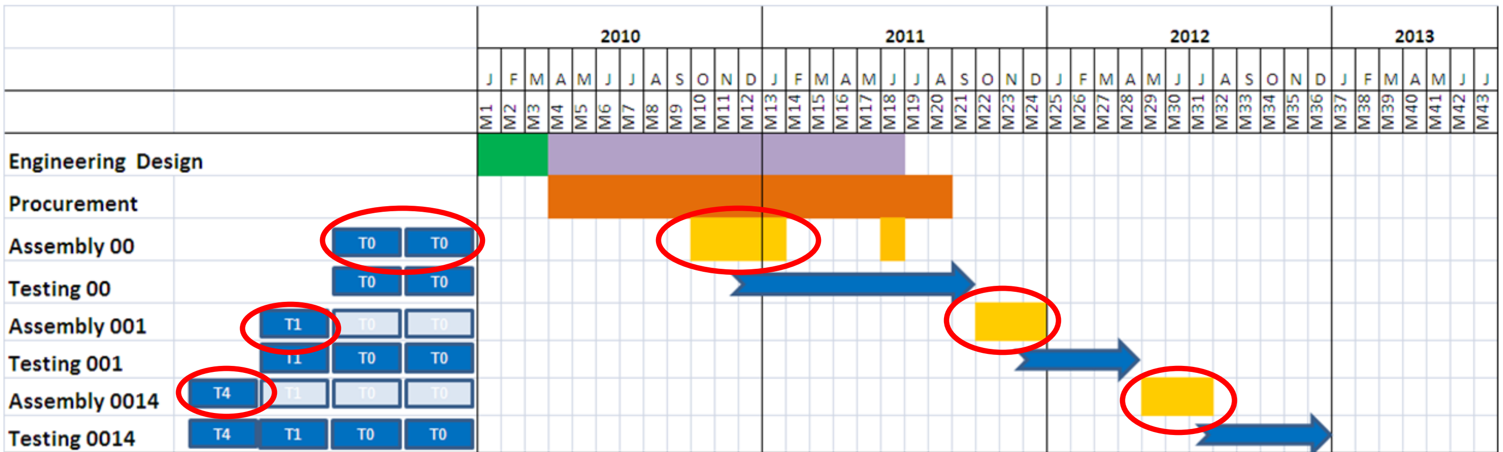
CLIC Two-Beam Module Test Program (refer to G.Riddone presentation)

Test modules – LAB [2]: schedule



Actuators/sensors under fabrication

MB T1 and T4 at CERN in August

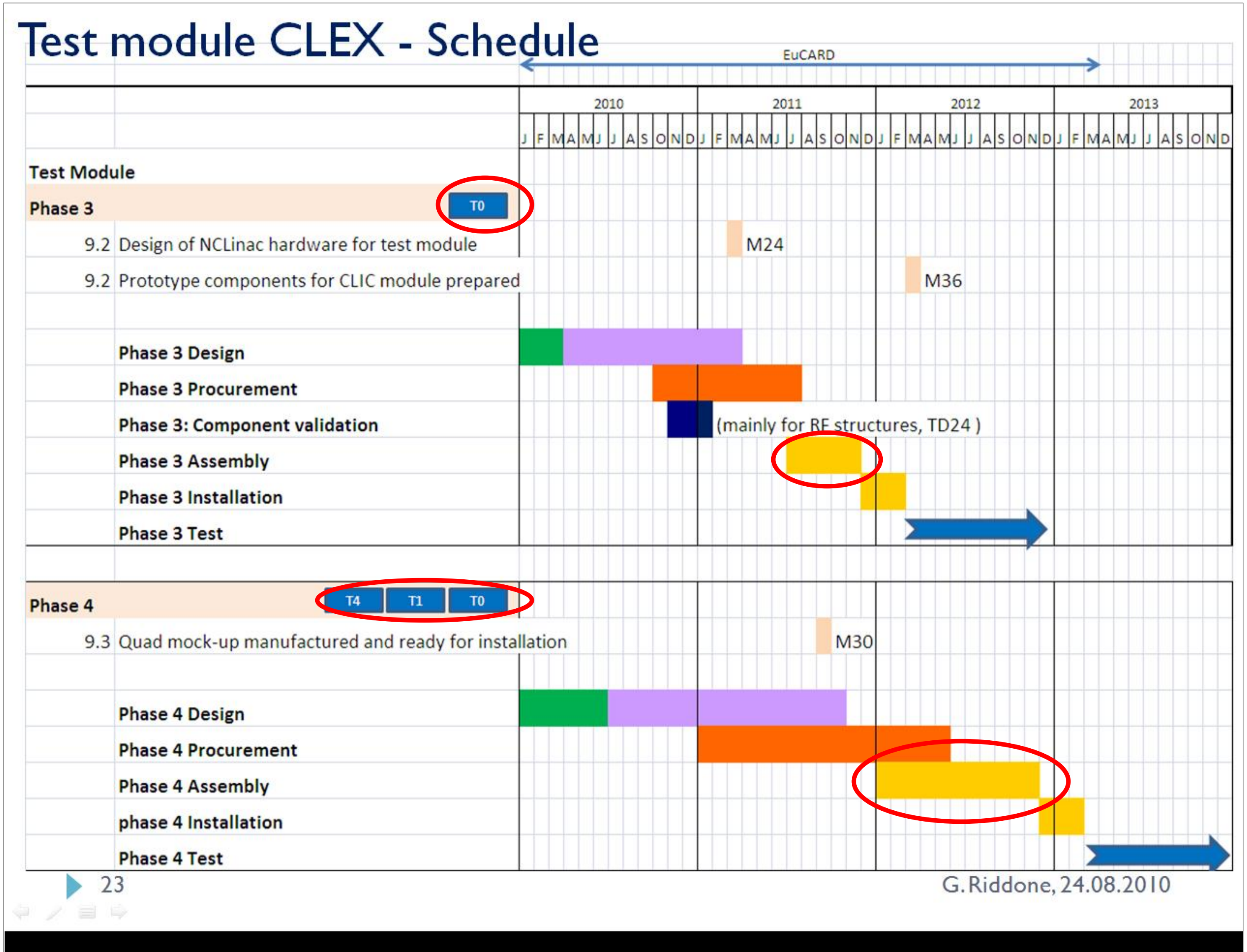
Girders under fabrication (three companies and three different strategy)

Under tendering: vacuum system and RF system

For details, see
EDMS number: 1076281

13 G.Riddone, 24.08.2010

CLIC Two-Beam Module Test Program (refer to G.Riddone presentation)



So, for "Test Module-LAB" Program (T4+T1+T0+T0), to be provided:

- **2 MB Quads** (one **Type1** and one **Type4**)
- **8 DB Quad**

1) Main Beam Quads Status:

REAL magnets (nominal dimension an operating conditions) are under procurement for critical studies (nm stabilization)

Status of main components:

- **Coils for 4 prototypes:**

  (2 Type1 and 2 Type 4): **OK, delivered and fully receptioned**

- **Iron Quadrants for 2 prototypes:**

  at Metrology Lab under fine inspection (because not fulfilling the contractual tolerances)

Magnets for CLIC Two-Beam Module Test Program

First 10 Coils (for 2 magnets + spares) at CERN acceptance

Quadrants (for 2 magnets + spares) delivered at CERN Metrology Lab

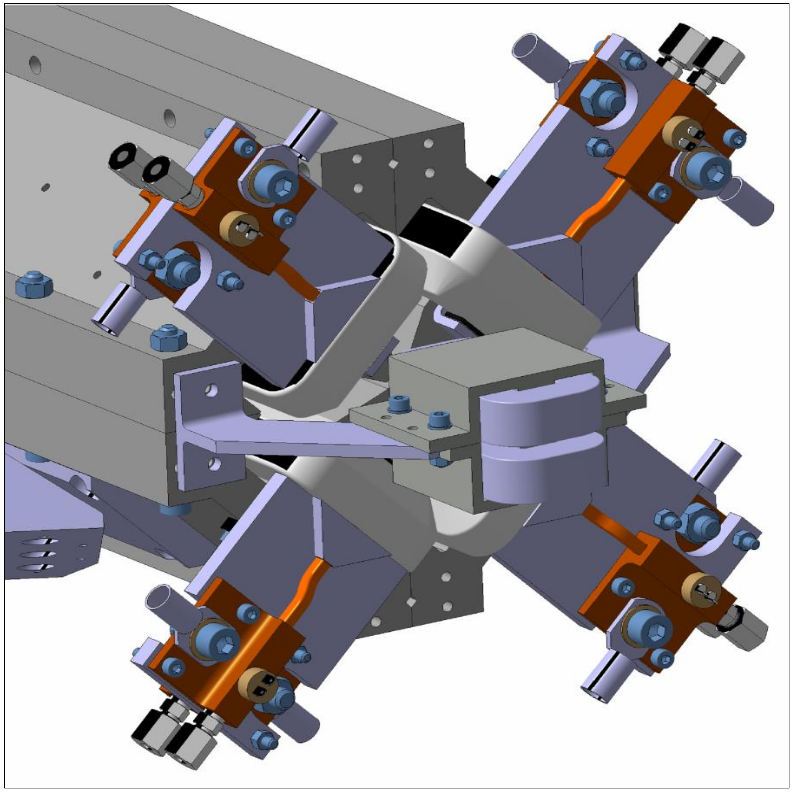
Main Design and Operational Parameters for the actual (and for an alternative, bigger) version of the MBQ Type4

MAIN BEAM Quadrupole Parameters

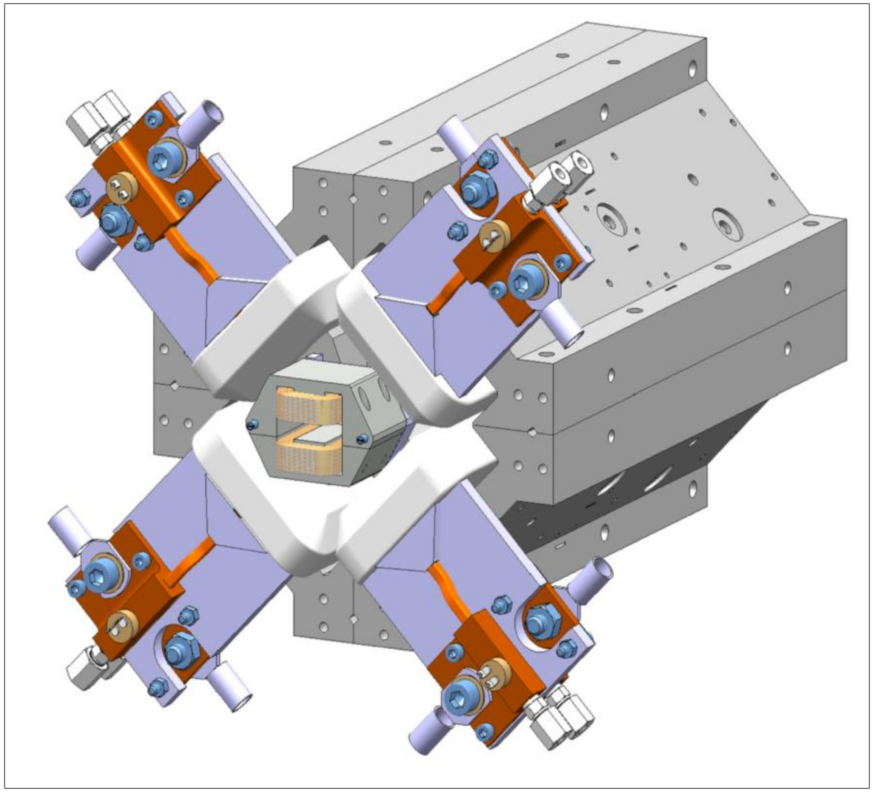
	17 turns magnet (Present structure)	41 turns magnet
Yoke length [mm]	1844	1844
Magnet length [mm]	1901.8	1901.8
Yoke weight [kg]	80x4=320	140x4=560
Conductor weight [kg]	12.5x4=50	30x4=120
Total magnet weight [kg]	370	680
cooling circuit per mag	4	4
ID number	6881	6881
height/width [mm]	5.6	5.6
hole diameter [mm]	3.6	3.6
x=y [mm]	1	1
r [mm]	1	1
Nturns per pole	17	41
Conductor Length per pole [m]	68	164
I [A]	126	56
Current density [A/mm^2]	6.01	2.67
Resistance [mOhm]	241.3	581.95
Inductance [mH]	42.8	248
Power [W]	3831	1825
Voltage [V]	30.4	32.59
coolant velocity [m/s]	1.12	0.54
cooling flow [l/min]	0.69	0.33
Pressure drop [bar]	4.26	2.89
Reynolds number	6147	2929
Temperature rise [K]	20	20

…similar procurement scheme expected for the “Test Module-CLEX Program” : MB quads procurement, we could utilize the same magnets but, better ,the other 2 still under procurement...

The Dipole Steering Correctors ("fast steering", added later in the project): conceptual design exist; to be finalized and procured; it will be eventually mounted in a 2nd phase:



"type4" look-like assembly



"type1" look-like assembly

2.) DriveBeam Quadrupoles Status:

Due to changes in the baseline (strength, space available, etc.) design activities still on-going, so for the starting activities of the "Test Module-LAB" Program (i.e. next year), mock-ups will be procured:

Mock-ups intend to simulate: overall dimensions, weight, interfaces with other components (vacuum chamber, BPM, etc,) and thermal load toward neighbor components (by means of small electrical heaters).

For 2nd phase of the LAB activities and for the "Test Module-CLEX" Program, real magnets will be provided.

R&D is proceeding on two lines:

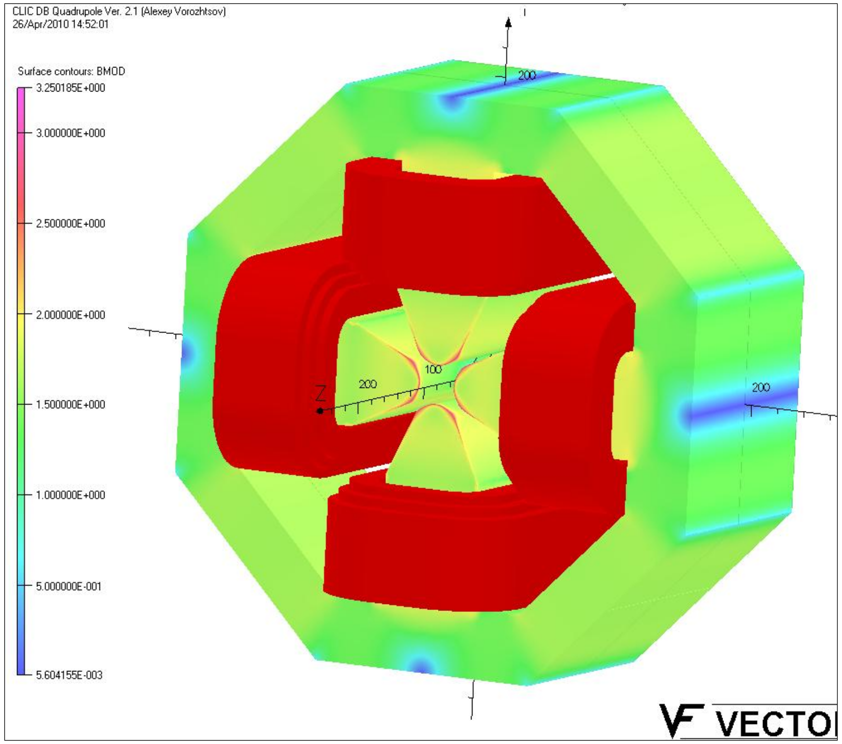
a) Baseline with an electro-magnetic quad design

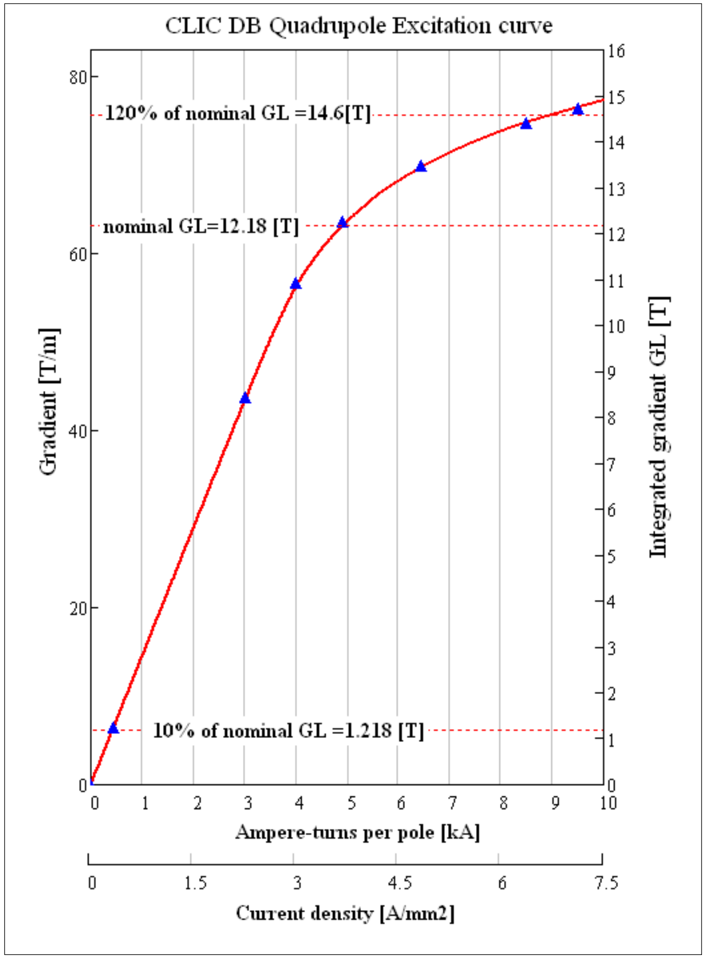
b) Alternative option with tunable permanent magnet design.

Magnets for CLIC Two-Beam Module Test Program

a) Baseline electro-magnetic design

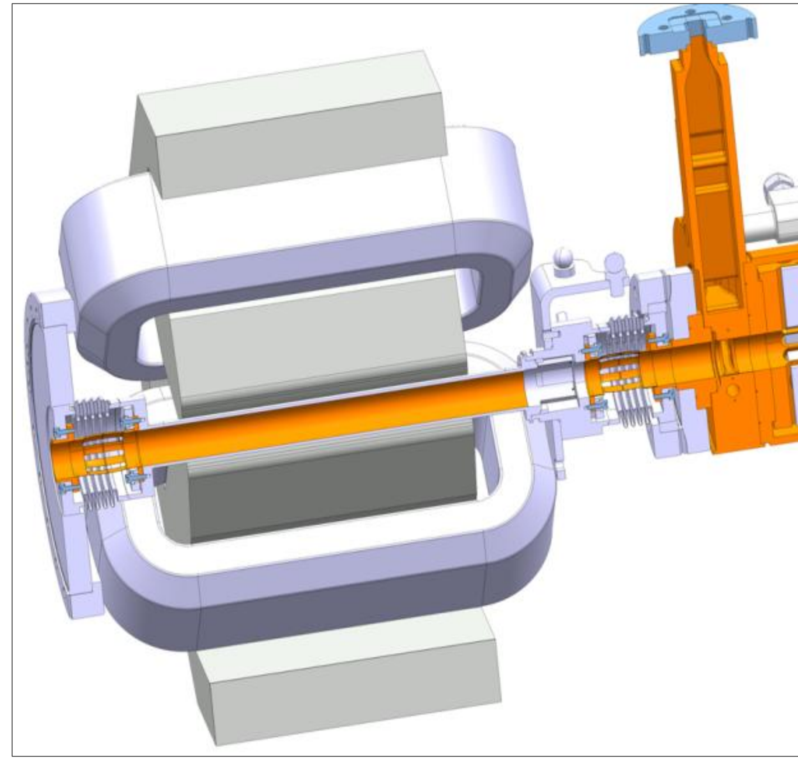
*(refer to presentation of **A. Vorozhtsov** in WG 6 Session of Wednesday 20 Oct. morning)*





Magnets for CLIC Two-Beam Module Test Program

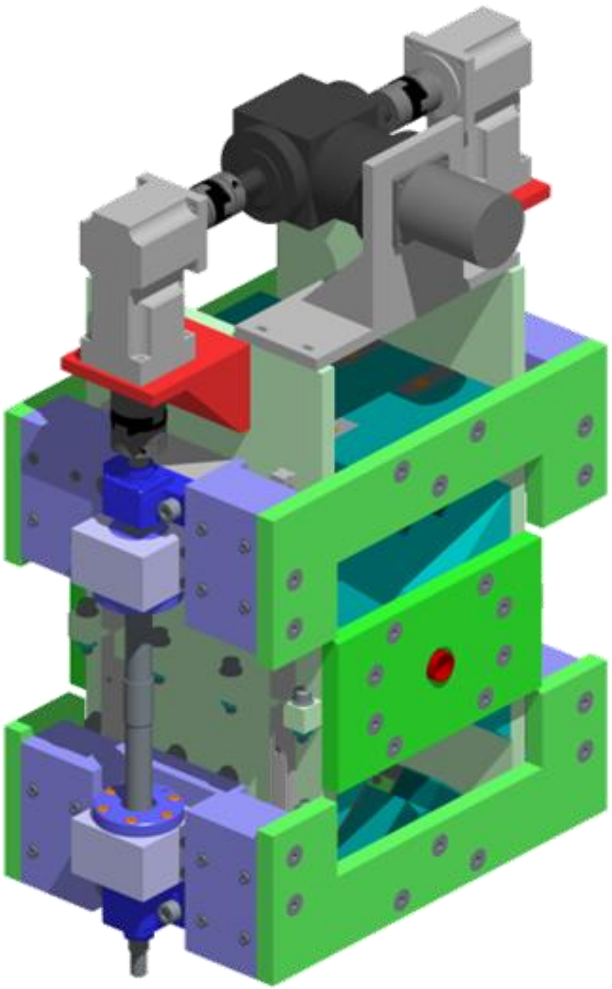
CLIC DB Quadrupole Parameters	Units			
Assembled MAGNET				
Magnet size **H×S×L**	[mm×mm×mm]	390×390×286		
Magnet mass	[kg]	149.2		
Full aperture	[mm]	26		
Good field region(GFR) diameter	[mm]	11×2=22		
YOKE				
Yoke size **H×S×L**	[mm×mm×mm]	390×390×180		
Yoke mass	[kg]	29.4×4=117.6		
COIL				
Hollow Conductor size	[mm]	6×6, Ø=3.5		
Number of turns per coil		52		
Total conductor mass	[kg]	31.6		
		Operation mode		
		Nom."min"(10%)	**Nom."max"(100%)**	**"Ultimate" (120%)**
Magnetic length	[mm]	194.7	194	192.5
Gradient at Z=0	[T/m]	6.26	62.78	75.85
Integrated gradient ∫Gdl	[T]	1.218	12.18	14.6
Integrated gradient quality in GFR	%	0.04	0.01	0.02
Electrical parameters				
Ampere turns per pole	[A]	432	4840	9100
Current	[A]	8.3	93	175
Current density	[A/mm²]	0.3	3.6	6.8
Total resistance	[mOhm]	99	99	99
Total inductance	[mH]	40	40	40
Voltage	[V]	0.82	9.2	17.3
Power	[kW]	0.007	0.86	3.03
COOLING		**Air (natural convection)**	**Water**	**Water**
Cooling circuits per magnet			4	4
coolant velocity	[m/s]		1.1	1.9
cooling flow per circuit	[l/min]		0.6	1.1
Pressure drop	[bar]		2.2	5.7
Reynolds number			4122	8210
Temperature rise	[K]		5	10



…integration with other critical components (BPM, PET, vacuum pipe, etc.) quite delicate…

b) Optional Tunable Permanent Magnet Design

*(refer to presentation of **J. Clarke** in WG 6 Session of Wednesday 20 Oct. morning)*



Advantages:

-Very limited electrical requirements (moving actuators)

- no cooling needs

Disadvantages (or specific difficulties):

-Complexity (moving parts)

-Reliability (tuning is individual)

-Stability of the PM blocks versus:
time/temperature/radiation

***Cost** :*

Limit the production cost for a so impressive series (> 40000 units), is a challenging aspect (but this for both solutions).

Steering capability (static) *required also for the DBQ,*

proposal is:

- for EM baseline design: steering by current trim in the main coils

- for the optional PM design: steering by mechanical displacement of the quadrupole (extra-movement of the structure).

Conclusions:

-***MB QUAD:* prototypes procurement is ongoing: we have components at CERN to start the assembly of two quads (Type1 and Type4).**

-***Components for other two prototypes are also under procurement.***

- ***DB QUADS:* design is proceeding on two lines: a classical EM design and a Tunable PM design.**

-***Prototypes procurement for both solutions will be soon launched.***

-***BEAM STEERING* possible solutions were also defined and are under design for both type of quadrupoles.**

Acknowledgments:

Thanks to all the (small) team working on this R&D and procurement program:

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Thank you for the attention