EuroCirCol WP5 Review
Geneva, May 11th - 13th , 2016

Introduction

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The Review

The status of WP5 will be submitted at least once a year to a Technical Review Committee, with the aim of focussing the baseline assumptions, design methods and solutions, technical strategies including cost analysis, towards a credible design for a 16T demonstrator magnet for the FCC machine.

The review is part of the FCC Review Program.

The review panel is composed of:

Steve Gourlay (Chair), LBNL
Giorgio Ambrosio, FNAL
Diego Arbelaez, LBNL
Luisa Chiesa, TUFTS
Joe Minervini, MIT
Ezio Todesco, CERN

The review will end with a close-out by the review Chair.
The review committee is also asked to prepare a short report with their findings, comments and recommendations.

Timetable

The timetable is organized such to leave to the reviewers regular slots for «closed discussion». These slots can also be used, on the initiative of the Review Panel, for specific discussions with experts part or not part of the EuroCirCol.

http://indico.cern.ch/event/516049

The close-out is on Friday 13th at 11h00

Charge

The charge includes comments and recommendations on:

1.Baseline conductor properties;

2.Margin on the load line

3.Hypothesis for quench protection;

4.Assumptions for the design;

5.Selection of one (possibly up to two) design option(s) to be considered for the continuation of the study until November (EuroCirCol annual meeting), keeping in mind that from November ONE design only can be finalized until the end of the study (end 2018).

Scope of the EuroCirCol WP5

Final scope of the EuroCirCol WP5 is the constructional design of a single aperture short 16T dipole model with features directly extrapolable to a 14.3 m long double aperture dipole magnet for the FCC machine. The free physical aperture is 50 mm.

The program started in June 2015 with the exploration of three design options:

- Block coil
- Common coil
- Cosine theta

The next steps are:

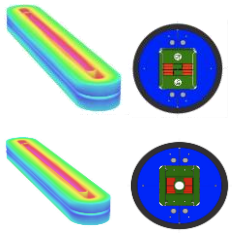
1) refine the parameter space (considering recommendations from this review)
2) select one (or two) design(s) to be explored in the new parameter space (considering recommendations from this review)
3) present a EuroCirCol baseline 2D conceptual design at the annual meeting (7-8 Nov 2016)
4) select (Nov-Dec 2016) ONE design to complete until the end of the study (Dec 2018)
5) Perform a 2nd Technical Review in June 2017

FCC 16T Technology Program

A FCC 16T Magnet Technology Program, based on «block type» configurations (ERMC+RMM+Demonstrator), is presently in place at CERN.

TASKS

Task 0: Coordination
Task 1: Strand development & procurement
Task 2: Wound conductor test facilities
Task 3: 16T Enhanced Racetrack Model Coil
Task 4: 16T Racetrack Model Magnet
Task 5: 16T Demonstrator



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ERMC
Enhanced Racetrack Model Coil
16 T midplane field
- Demonstrate field on the conductor
- Coil technology development

RMM
Racetrack Model Magnet
16 T in a 50 mm cavity
- Demonstrate field in the aperture
- Mechanics (including inner coil support)

DEMONSTRATOR
Not necessarily extendable to a long magnet
Not necessarily block type

SCHEDULE

2017: test ERMC
2018: test RMM
2019: test Demonstrator
2019: start winding the EuroCirCol Model
2021: test EuroCirCol Model

Common assumptions for the WP5 designs

General		
Number of magnets	4578	
Magnetic length	14.3	m
Dipole field at maximum beam energy	16	T
Dipole field at injection	1.1	T
Free magnet aperture diameter	50	mm
Reference radius for field harmonics	17	mm
Beam-to-beam distance	250 – 350 (common coil)	mm
Maximum outer yoke diameter	800	mm
Reference temperature T_{ref}	**1.9**	K
Margin on load line @ T_{ref}	≥18	%
Nominal current	≥8000	A
Cable insulation thickness	0.15	mm per conductor face
Minimum inter-layer insulation thickness	0.5	mm
Minimum ground insulation thickness	2	mm
Allowed multipoles (geometric), still to be trimmed		
b_{3geo}	Such to provide <3 at collision	units (part per 10^4) at reference radius
b_{5geo}	< 5	units (part per 10^4) at reference radius
b_{7geo}	< 3	units (part per 10^4) at reference radius
b_{3sat} contribution of iron saturation	< 10	units (part per 10^4) at reference radius
Quadrupole harmonic (normal-skew)	< 20	units at reference radius
Quench protection		
Maximum peak temperature	350	K (quench at 105% of nominal current)
Total protection delay	40	ms
Conductor		
Minimum allowed Cu : non-Cu	1 : 1	
Jc at 4.2K, 16T	1500	A/mm^2
Maximum number of strands in cable	40	
Minimum/maximum strand diameter *d*	*d* > 0.7/1.1	mm
Limit on cable thin edge compaction	c > 0.14	*c=1-h/2d* ; *h*= cable thin edge thickness
Material data		
Stress limit on coil ambient/cold	150/200	MPa
Coil elastic modulus : assumed independent from temperature	EX=22, EY=44, GXY=21	GPa
Coil thermal constraction 293K → 4.2K	$X=3.1x10^{-3}$; $Y=3.4x10^{-3}$	

Considerations on baseline properties

The activity carried out so far within the EuroCirCol WP5 has shown that:

the low current density in the high field conductor, coming as a consequence of the parameter space defined for the project, limits the current to around 10 kA in an optimized cross-section.

This produces too large voltages in case of a quench, imposes a too dense fractioning of the powering circuits, generates too large temperature gradients in case of quench.

We ask the reviewers to express an opinion and recommendation about a possible refining of the parameter space to overcome the above problems.
Lowering the 16T nominal field shall not be considered as an option.

Thank you for your attention