



Strategy for Superconducting Magnet Development for a Future Hadron-Hadron Circular Collider at **CERN**

D. Schoerling

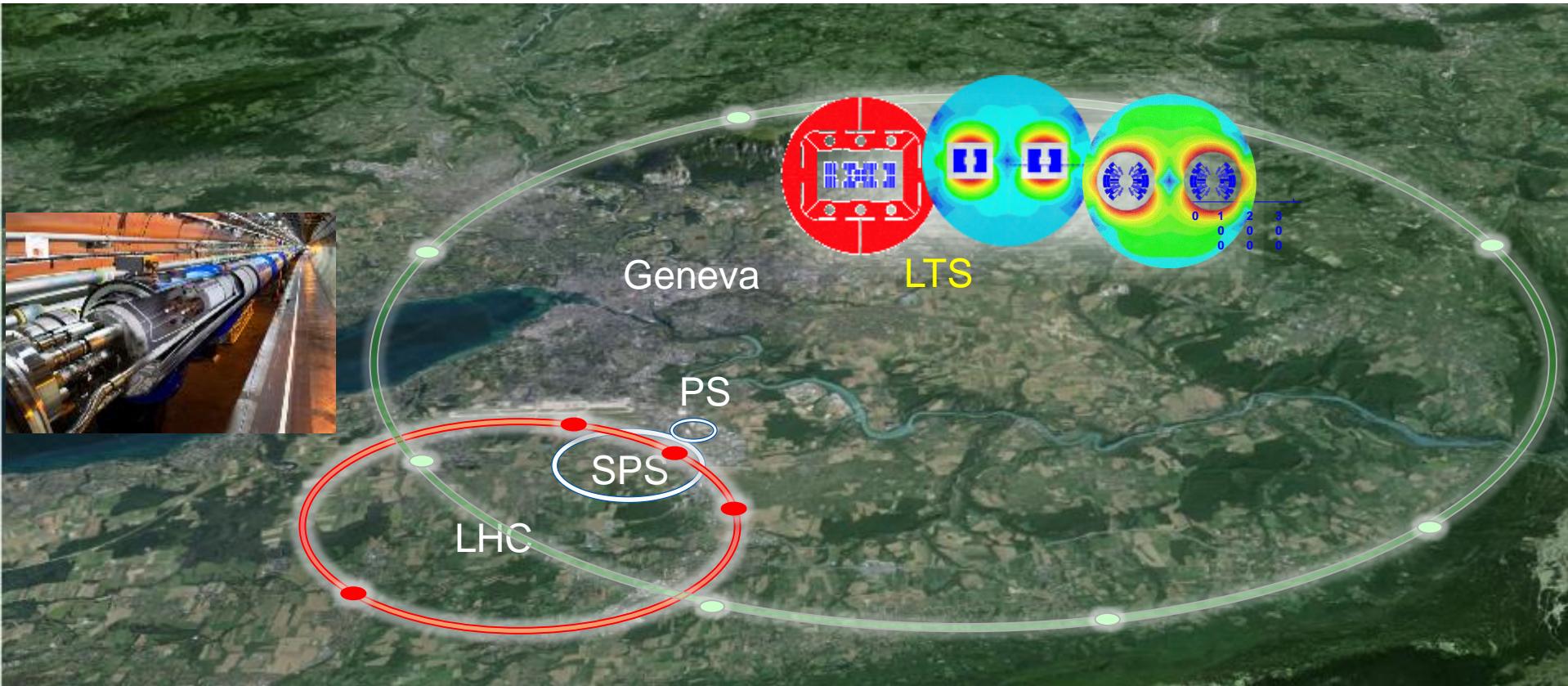
H. Bajas, M. Bajko, A. Ballarino, M. Benedikt, S.-I. Bermudez, B. Bordini, L. Bottura,
M. Buzio, G. de Rijk, M. Karppinen, F. Lackner, A. Milanese, J. van Nugteren, V.
Parma, J.-C. Perez, S. Russenschuck, F. Savary, E. Todesco, D. Tommasini

EPS-HEP 2015, Vienna

July 25th, 2015



The FCC-hh



LHC

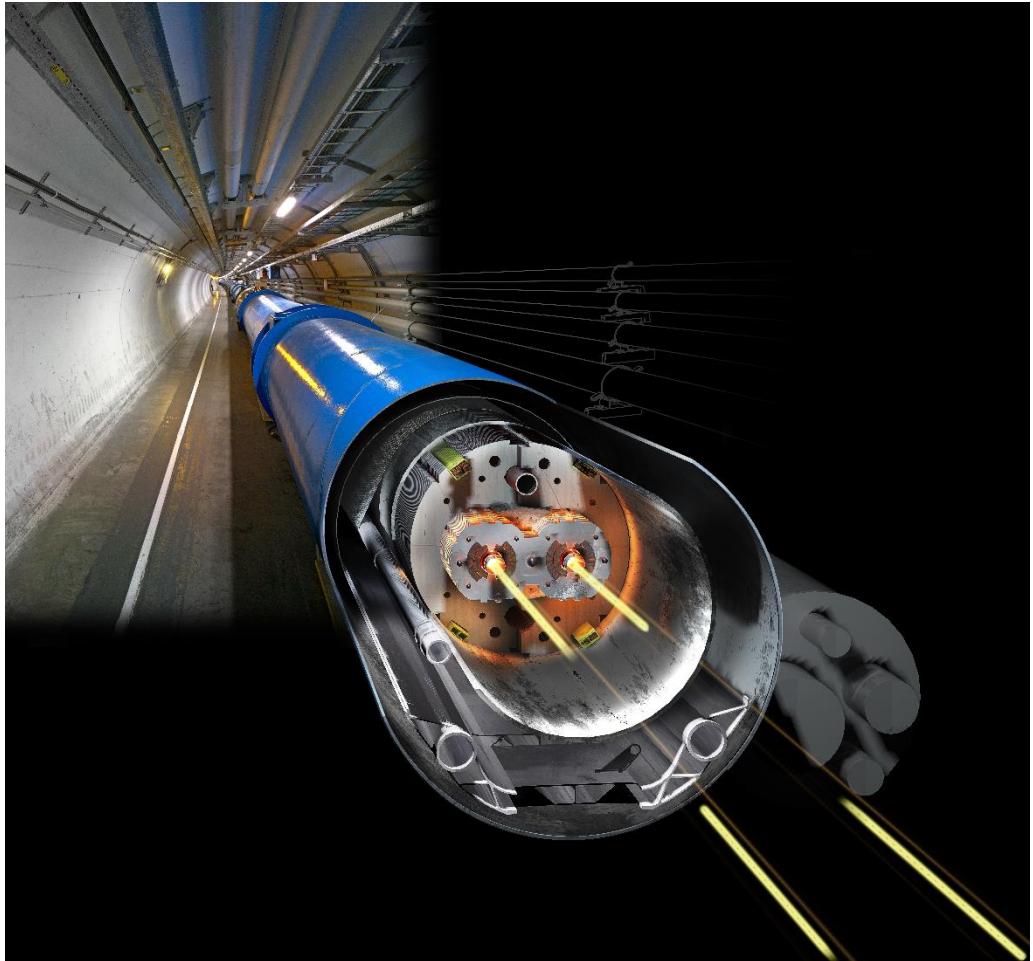
27 km, 8.33 T
14 TeV (c.o.m.)
1232 LTS dipoles

FCC-hh

100 km, 16 T
100 TeV (c.o.m.)
5000 LTS dipoles

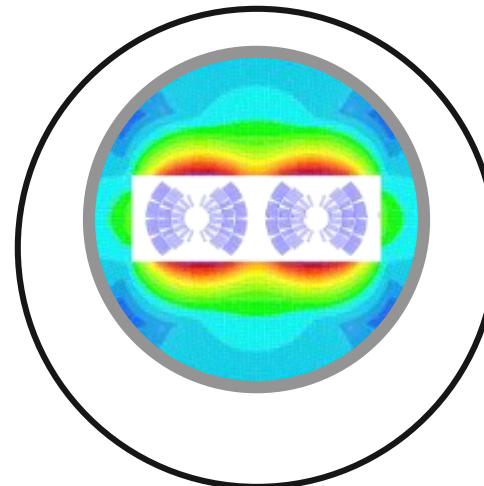
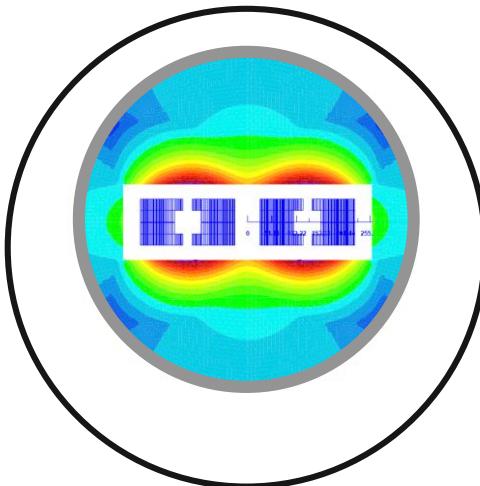
State-of-the-art: LHC

- Nominal field: 8.33 T
- Operating temperature: 1.9 K
- 1232 dipoles



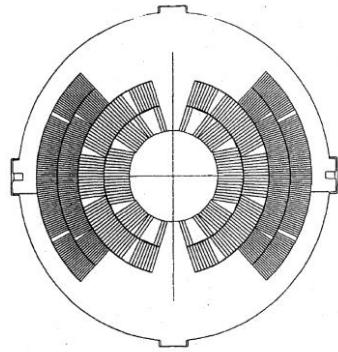
FCC vs LHC dipole

- Twice the magnetic field →
 - 2 x more Ampere turns
 - 4 x higher forces/m
 - ~6 x more stored energy/m
- 4 x more magnets



Laboratory scale achievements

Cos- θ (D20, achieved bore field 13.5 T at 1.9 K)



D. Dell'Orco et al., IEEE Trans. Appl. Supercond., Vol. 3, No.1, 1993

Block (HD2c, achieved bore field 13.8 T at 4.3 K)

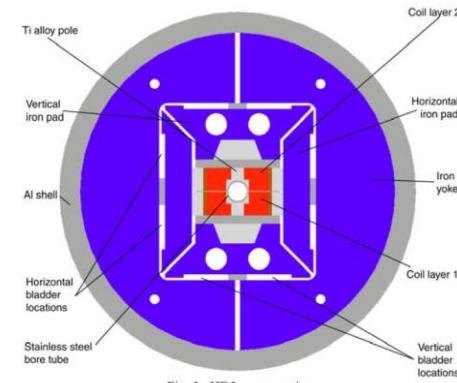


Fig. 2. HD2 cross-section.

P. Ferracin et al., IEEE Trans. Appl. Supercond., Vol. 19, No.3, 2009

We need to achieve a much higher operational field than the laboratory world record.

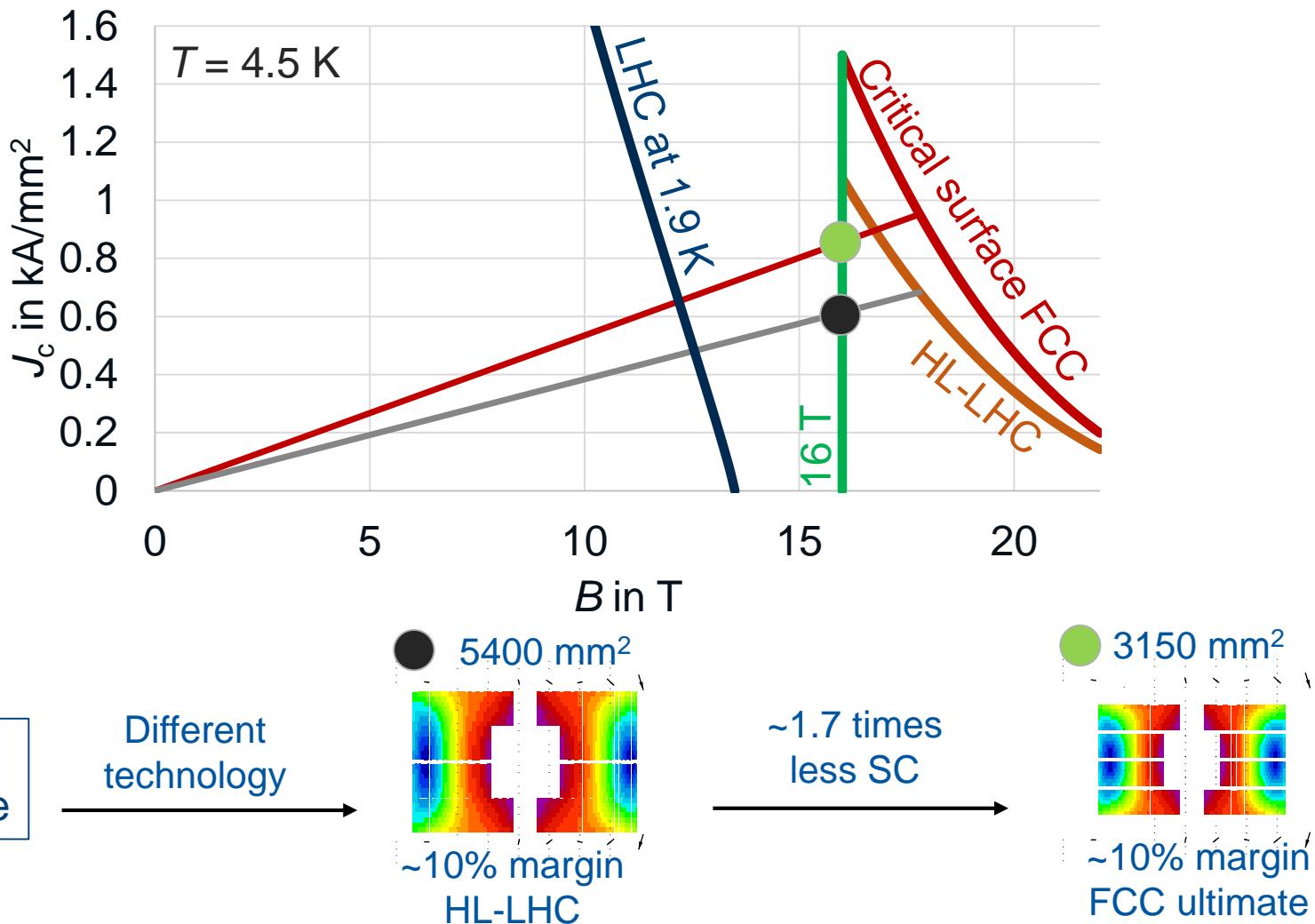


- Better conductor
- Sufficient operational margin
- A suitable design & construction

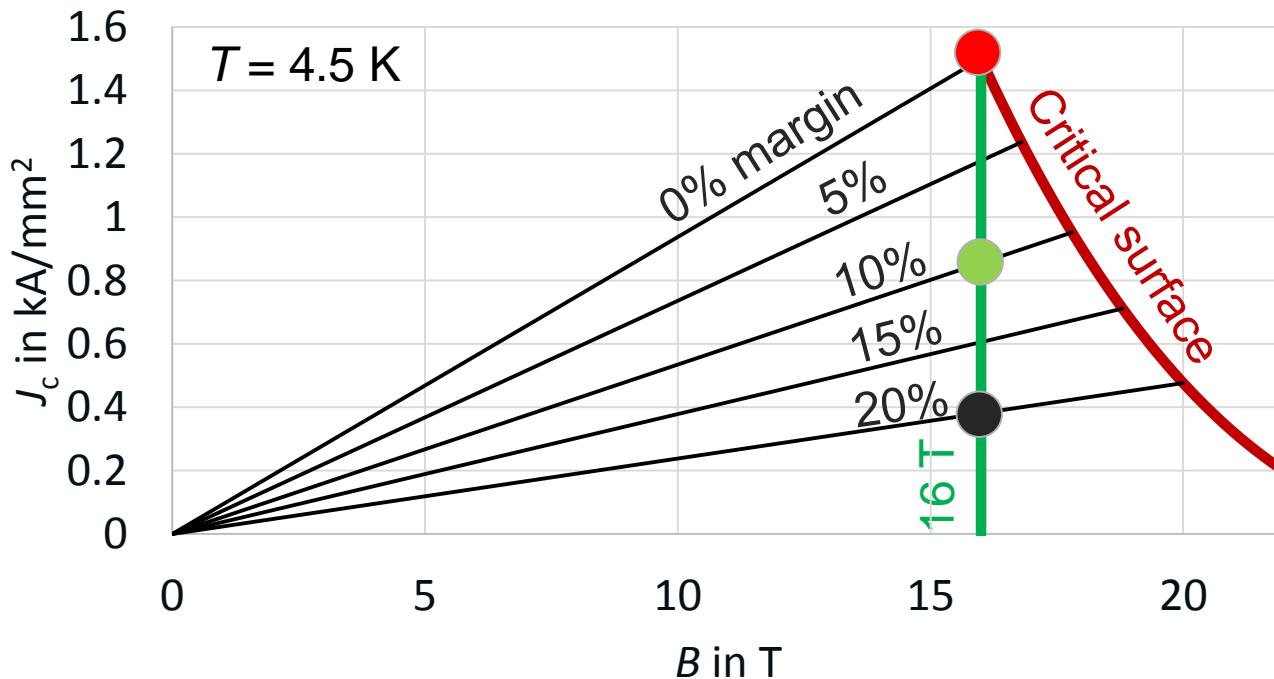


Development program

Performance of Superconductor



Operational margin



● 1880 mm^2
■ $\sim 2\%$ margin

1.7 times
more SC

● 3150 mm^2
■ $\sim 10\%$ margin

2 times
more SC

● 6250 mm^2
■ $\sim 17\%$ margin

Development programs



WP 5

Producing a design of a 16 T
accelerator model magnet at
4.5 K and with 10% margin



FCC technology companion
program



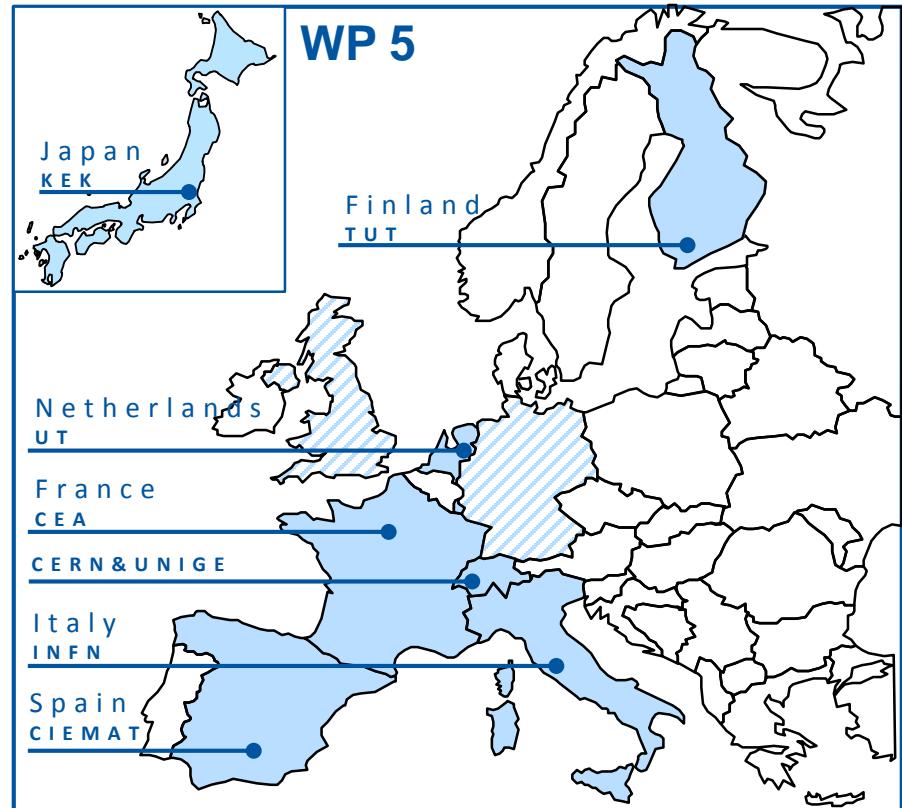
Other programs (wire, design and
manufacture of magnets)

EuroCirCol



WP 5

Producing a design of a 16 T
accelerator model magnet at
4.5 K and with 10% margin



 KEK Inter-University Research Institute Corporation
High Energy Accelerator Research Organization



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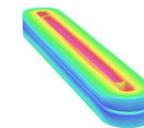
 **UNIVERSITY OF TWENTE.**

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OF TAMPERE**

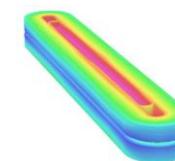
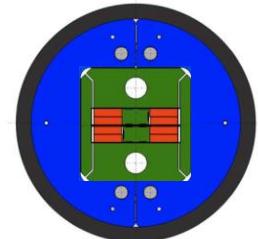
FCC Technology



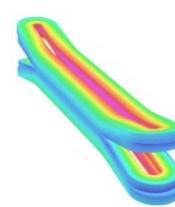
- ERMC (16 T mid-plane field)
- RMM (16 T in a cavity of 50 mm)
- Demonstrator (16 T in a 50 mm gap)
- Procurement of 75 km Nb_3Sn wire for a short model



ERMC



RMM



Demonstrator ($\cos-\theta$ also under study)

Schedule

Program	Activity	Begin	End	2015	2016	2017	2018	2019	2020	2021
FCC Technology	Design of a model magnet	01.05.2015	30.04.2019							
	Conductor R&D	01.05.2015	30.04.2021							
	ERMC	01.05.2015	30.05.2017							
	RMM	31.12.2015	31.12.2017							
	16 T Demonstrator	30.05.2016	31.12.2018							
	16 T Model	01.06.2019	30.05.2021							

Conclusion

- CERN is presently strongly engaged in the development of the superconducting magnets for the HL-LHC project.
- The efforts devoted to this activity, appropriately complemented by more tailored programs, will be extremely beneficial for conceiving a realistic conceptual design study of the FCC within the next 4 years.
- The main scopes of these programs are the increase of the superconductor performance and the demonstration of the production of a 16 T magnetic field in a 50 mm dipole aperture with 10% margin at 4.5 K.

