

Design iteration #2

- Larger aperture
- Higher gradient
- Operational margin 20 % on the LL
- Conductor according new FCC Nb₃Sn targets
- Cable designs with reduced compaction
- No grading

FCC-hh magnet parameters (L. Bottura Feb -15)

	B / G (T) / (T/m)	B _{peak} (T)	Bore (mm)	Length (units x m)
MB	16	16.4	50	4500 x 14.3
MQ	450	13	50	800 x 6
MQX	225	13	100	
D1	12	13	60	4x2 x 12
D2	10	10.5	60	4x3 x 10

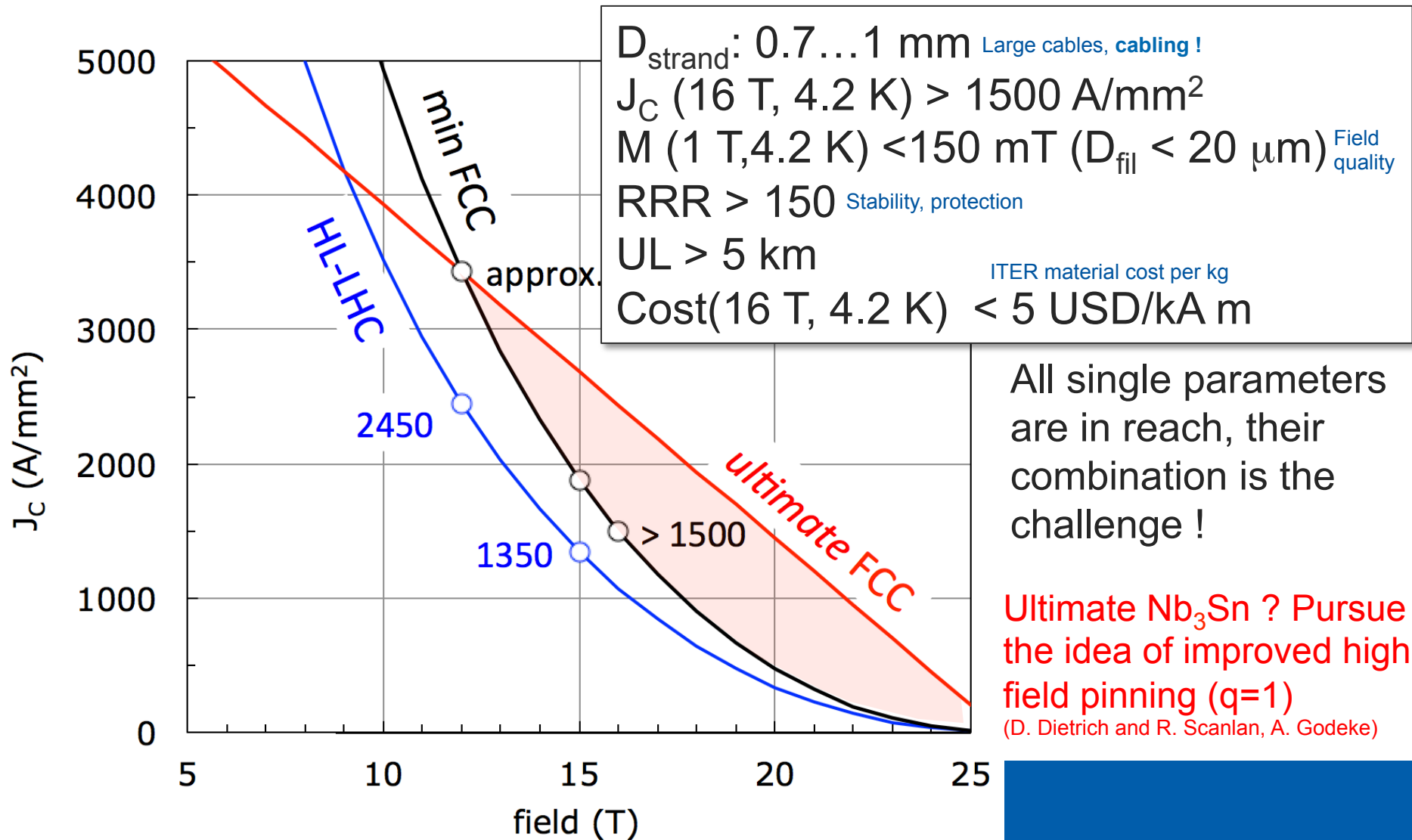
Inter-aperture distance \approx 250 mm

Yoke diameter \leq 700 mm

Stray field \leq 100 mT

FCC Nb₃Sn performance targets

(L. Bottura)



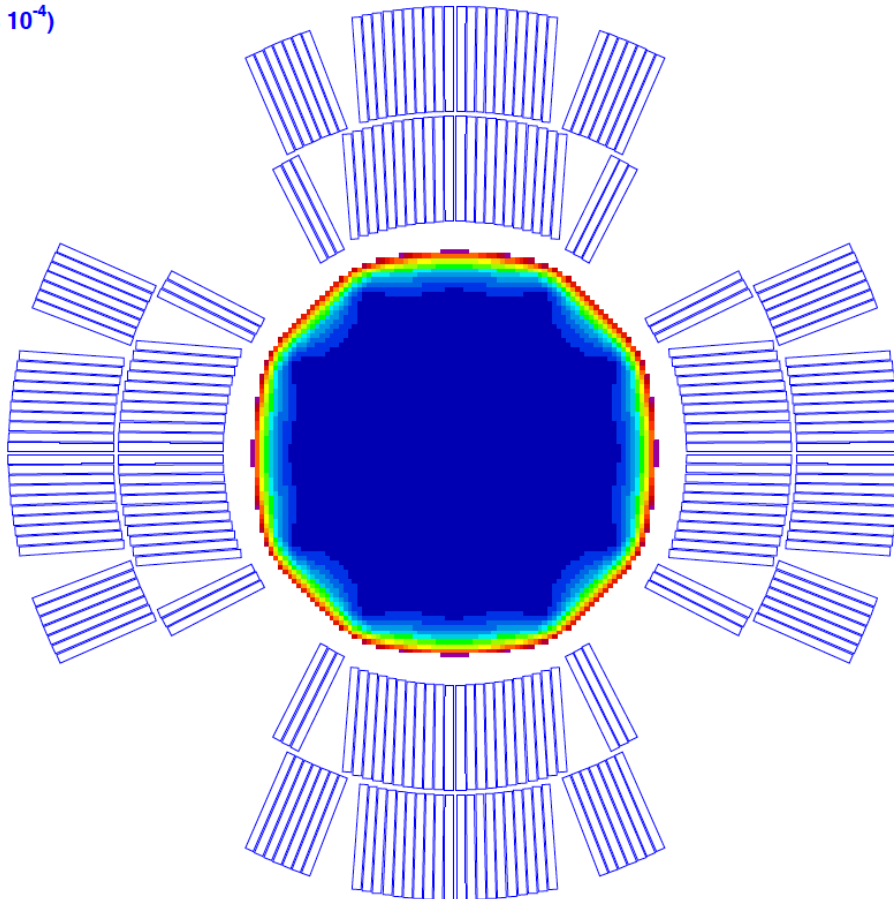
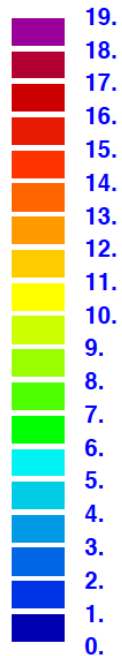
QX Cable V2

		FCC IR Quad2	FCC IR Quad2 <i>reacted</i>
Strand			
Strand diameter	(mm)	1	<i>1.015</i>
Filament diameter	(μm)	43	<i>43</i>
Cu/non-Cu		1.250	<i>1.250</i>
Jc(4.2K, 12 T)	(A/mm ²)		3450
Degradation	(%)		<i>5%</i>
RRR		>150	<i>>80</i>
Cable			
Number of strands		42	<i>42</i>
Trasp. Angle	(deg)	14.5	<i>14.5</i>
Mid-thickness	(mm)	1.804	<i>1.859</i>
Thin edge	(mm)	1.726	<i>1.778</i>
Thick edge	(mm)	1.883	<i>1.939</i>
Width	(mm)	22.471	<i>22.696</i>
Inner edge compaction		<i>0.863</i>	<i>0.863</i>
Outer edge compaction		<i>0.941</i>	<i>0.955</i>
Width compaction		1.039	<i>1.034</i>
Key-stone angle	(deg)	0.40	<i>0.41</i>
Core thickness	(μm)	25	<i>25</i>
Core material		St.Steel	<i>St. Steel</i>
Insulation			
Insulation thickness	(mm)	0.16	<i>0.14</i>
Insulation material		S2-Mica	<i>S2-Mica</i>



QX V2 Coil X-section

Rel. field errors (units 10^{-4})



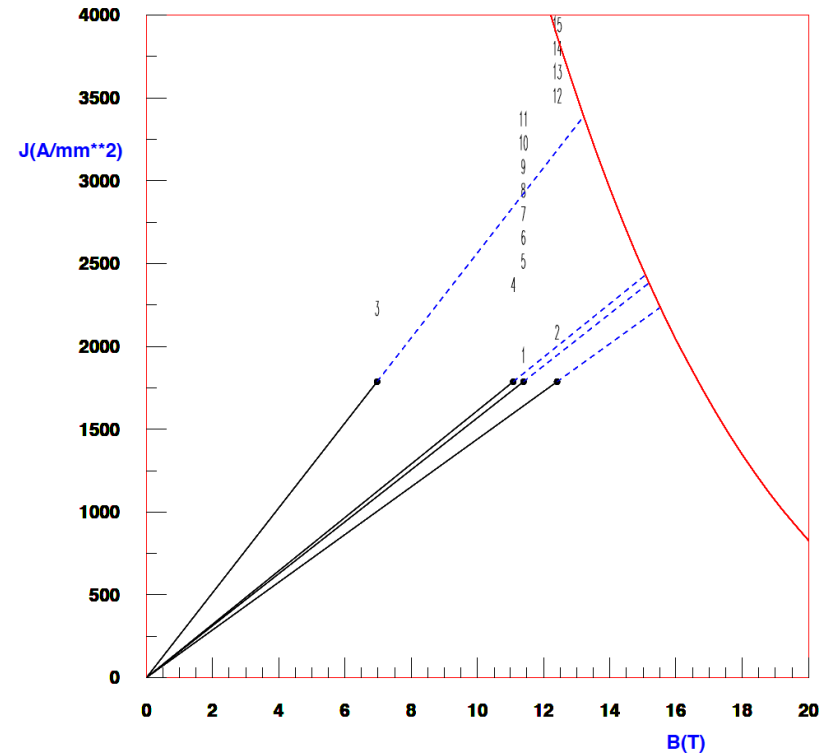
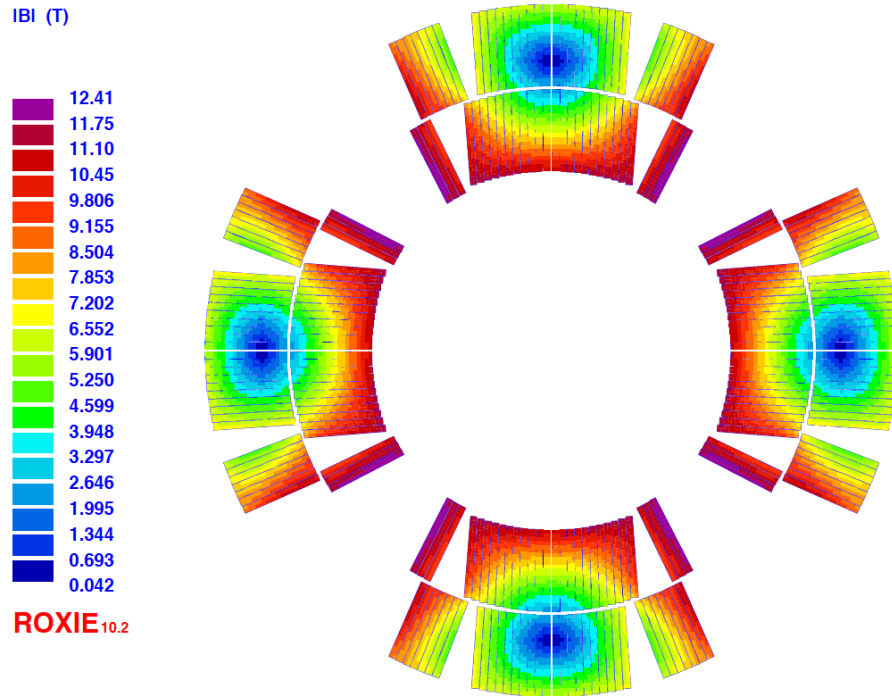
Field errors with iron saturation at 225 T/m

- Aperture $\varnothing 100$ mm
- 31 turns (IL 14, OL 17)
- No grading
- I-L insulation 1.0 mm
- Mid-plane insul. 0.2 mm

- $FQ_{r30mm}(225 \text{ T/m})$:
 - $b6 = 0.23$ units
 - $b10 = -0.15$ unit

- $L_{diff} = 3.0$ mH/m
- $E_{mag} = 1.08$ MJ/m

QX V2 Load-Line @1.9 K

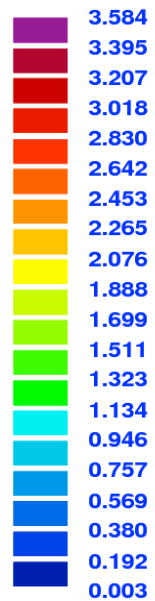


- $G(26.2 \text{ kA}) = 225 \text{ T/m}$
- $B_p(26.2 \text{ kA}) = 12.4 \text{ T}$
- $w_p(26.2 \text{ kA}) = 80 \%$
- $w_p(26.2 \text{ kA}, 4.3\text{K}) = 86 \%$

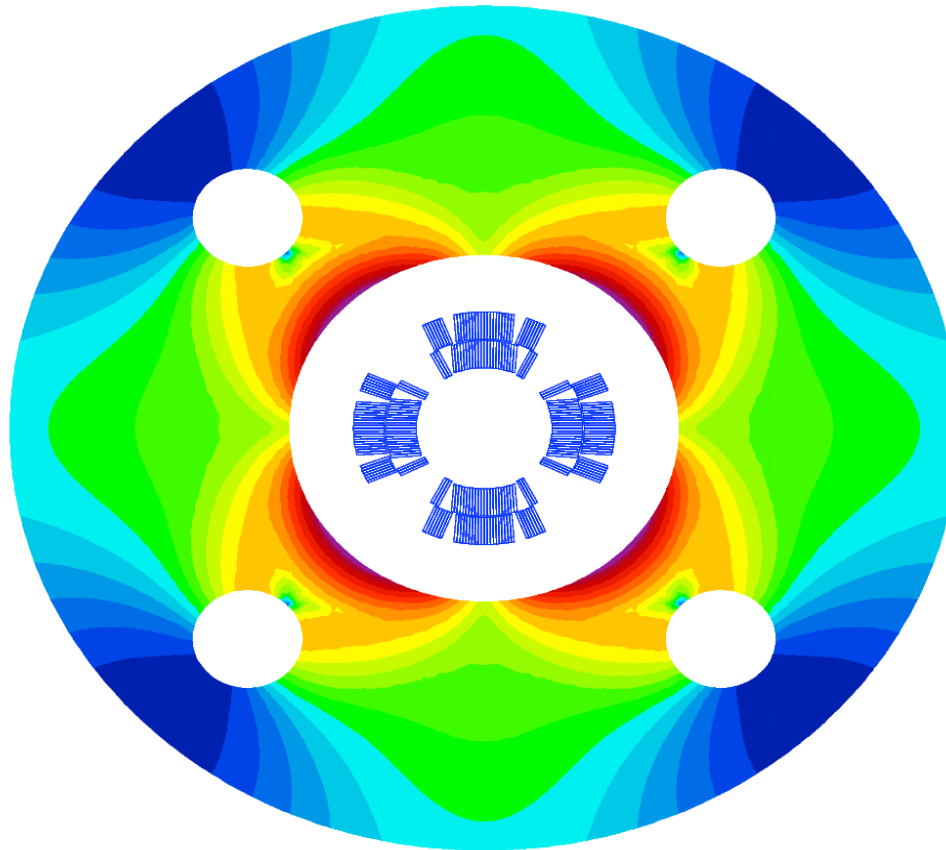
- $T_{\text{marg}} = 4.7 \text{ K}$
- $B_c = 15.5 \text{ T}$

QX V2 Magnet X-Section

|Btot| (T)



ROXIE_{10.2}



Yoke

- ID 288 mm
- OD 700 mm

FCC IR Quadrupole V2 Parameters

Coil aperture	(mm)	100
Nominal current, I_{nom}	(A)	26200
Nominal Gradient, G	(T/m)	225
Margin on load-line at 1.9 K	(%)	20
Inductance at I_{nom}	(mH/m)	3
Stored energy at I_{nom}	(MJ/m)	1.08
Number of turns/pole		31
Inner layer		14
Outer layer		17
Yoke ID	(mm)	288
Yoke OD	(mm)	700
b6 at I_{nom}	(x 1E-04)	0.23
b10 at I_{nom}	(x 1E-04)	-0.15