

# Progress on SLHC Sextupole (MCSX)

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- Sextupole (MCSX) parameters
- 100 A short design
- 600 A long design
- 100 A long design
- Design comparison
- Radiation protection
- Conclusions



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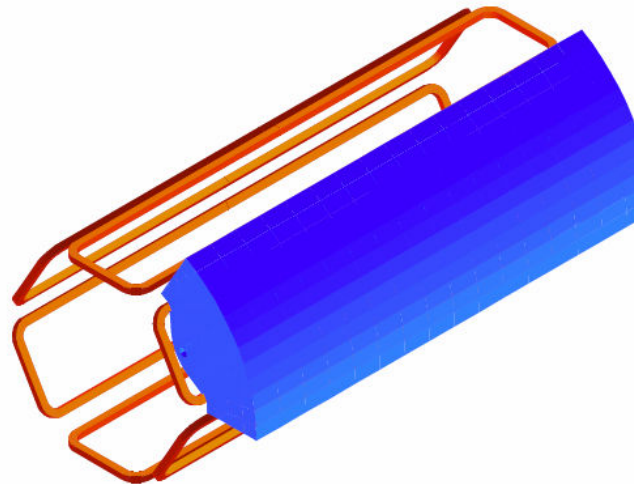
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- **Sextupole (MCSX) parameters**
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# Sextupole (MCXS) parameters

- Original specifications

Magnitude	Value	Units
Pole tip radius	70	mm
Reference radius	40	mm
Integrated strength	0.138	Tm
Max. overall length	0.5	m
Current	100 or 600	A





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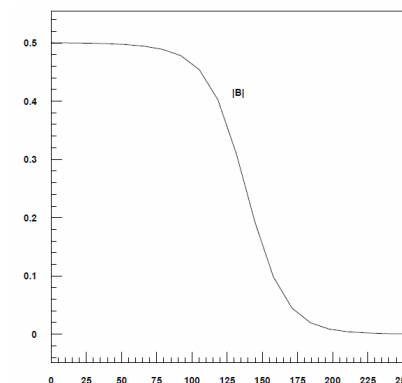
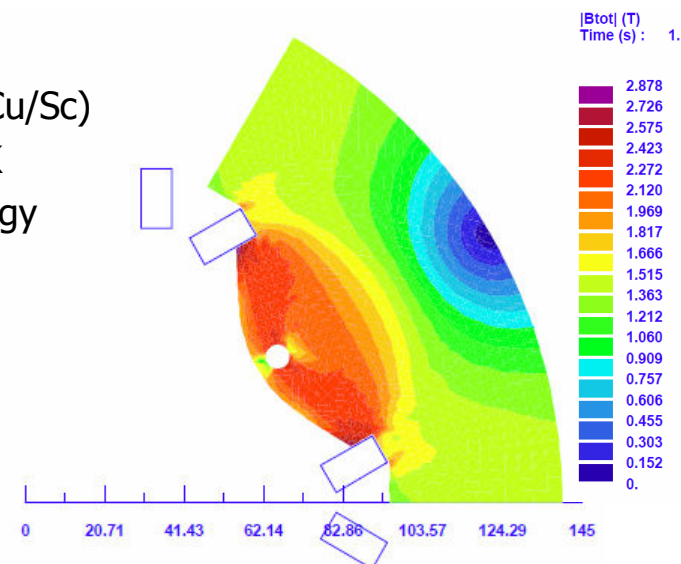
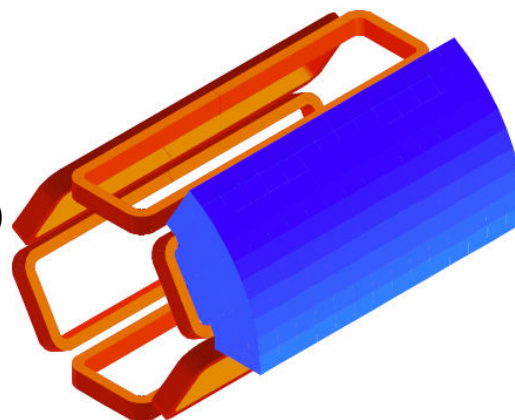
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# 100 A short design

## ■ Calculation results

- **114 Amps**, 264 turns, 30100 A-turn.
- 15.4x7.97 mm coil, 0.7 mm diam. NbTi wire (1.3 Cu/Sc)
- 315 T/m<sup>2</sup>, 0.504 T @ 40 mm. WP=30.1 % @ 1.9K
- **Inductance: 1.61 H/m, 10.47 KJ/m** stored energy
- Non-linearity in the load line: **4.95 %**
- 2D **field quality** (10<sup>-4</sup> units):
  - b9: 0.0058
  - b15: -0.082
  - b21: -0.002
- Integrated **strength: 0.137 Tm**
- Effective length: **0.272 m**
- **Peak field (3D): 2.19 T**
- Iron length: **260 mm**
- Iron **weight: 82 kg**
- 3D field quality (10<sup>-4</sup> units)
  - b9: 0.04
  - b15: -0.155
  - b21: -0.009





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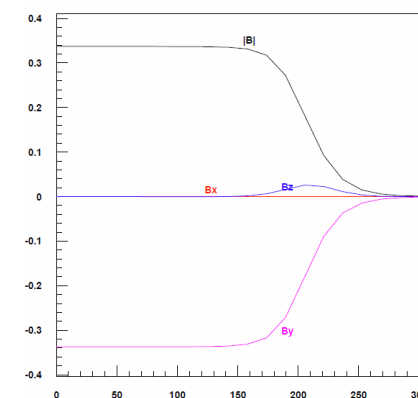
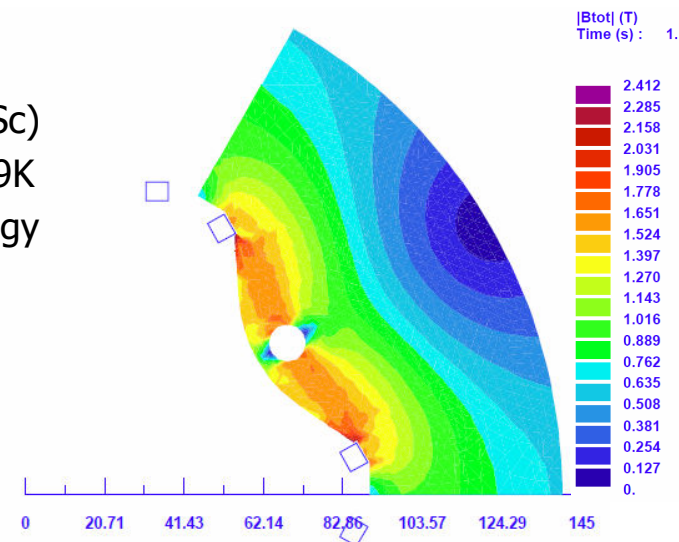
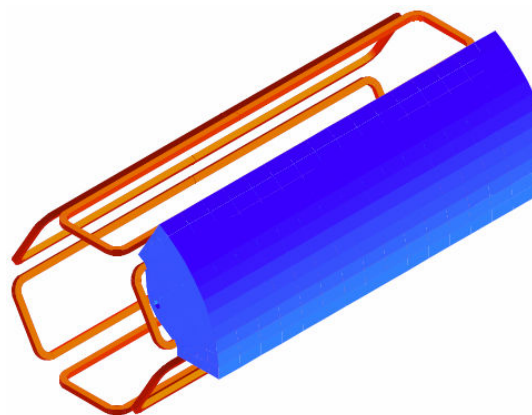
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- Sextupole (MCSX) parameters
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- **600 A long design**
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# 600 A long design

## ■ Calculation results

- **600 Amps**, 32 turns, 19200 A-turn.
- 5.84x5 mm coil, 0.73x1.25mm NbTi wire (1.6 Cu/Sc)
- 210.7 T/m<sup>2</sup>, 0.337 T @ 40 mm. WP=54.3 % @ 1.9K
- **Inductance: 0.028 H/m, 5.15 KJ/m** stored energy
- Non-linearity in the load line: **0.2 %**
- 2D **field quality** (10<sup>-4</sup> units):
  - b9: -0.0075
  - b15: -0.066
  - b21: -0.003
- Integrated **strength: 0.1387 Tm**
- Effective length: **0.41 m**
- **Peak field (3D): 2.19 T**
- Iron length: **392 mm**
- Iron **weight: 126 kg**
- 3D field quality (10<sup>-4</sup> units):
  - b9: 0.172
  - b15: -0.059
  - b21: -0.001







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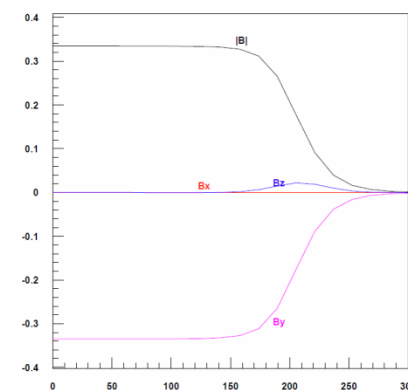
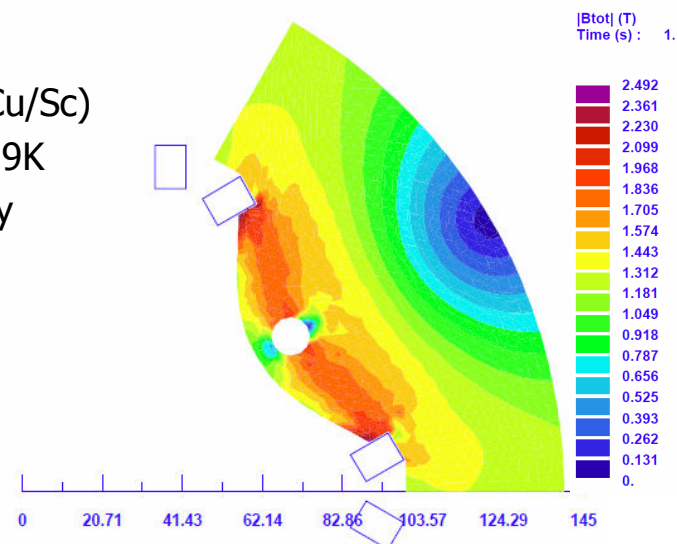
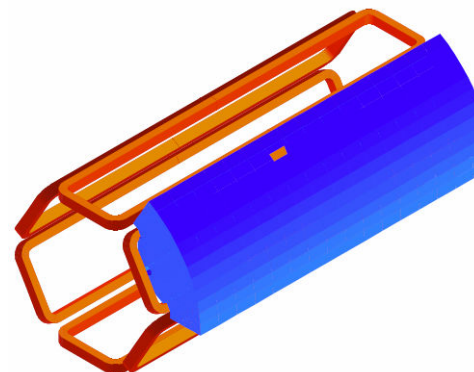
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# 100 A long design

## ■ Calculation results

- **100 Amps**, 192 turns, 19200 A-turn.
- 7.97x11.2 mm coil, 0.7 mm diam. NbTi wire (1.3 Cu/Sc)
- 209.7 T/m<sup>2</sup>, 0.336 T @ 40 mm . WP=26.2 % @ 1.9K
- **Inductance: 1.16 H/m, 5.84 KJ/m** stored energy
- Non-linearity in the load line: **0.4 %**
- 2D **field quality** (10<sup>-4</sup> units):
  - b9: -0.049
  - b15: 0.025
  - b21: 0.00007
- Integrated **strength: 0.1375 Tm**
- Effective length: **0.41 m**
- **Peak field (3D): 1.89 T**
- Iron length: **392 mm**
- Iron **weight: 122 kg**
- 3D field quality (not optimized):
  - b9: -1.22
  - b15: 0.0033
  - b21: 0.017





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# Design comparison (I)

- 2D comparison

	100 A short design	600 A long design	100 A long design	Units
Nominal current	114	600	100	A
Coil and insulated wire dimensions	Coil 15.4x7.97, Wire Ø 0.7	Coil 5.84x5, Wire 0.73x1.25	Coil 15.4x7.97, Wire Ø 0.7	mm
Nº of turns	264	32	192	
Gradient	315.05	210.74	209.79	T/m <sup>2</sup>
Nominal field @ 40 mm	0.5041	0.3372	0.3357	T
Non-linearity	4.95	0.2	0.4	%
Working point @ 1.9 K	30.1	54.39	26.21	%
Self inductance	1.61	0.028	1.16	H/m
Parallel and perpendicular forces (per coil block)	15.9, 28.8	7.8, 17	6.4, 15.8	kN/m

# Design comparison (II)

- 3D comparison

	<b>100 A short design</b>	<b>600 A long design</b>	<b>100 A long design</b>	<b>Units</b>
Effective length	0.272	0.41	0.41	m
Integrated strength	0.137	0.1387	0.1375	Tm
3D peak field (on cross section)	2.19	2.19	1.89	T
Iron length	260	392	392	mm
Iron weight	82	126	122	kg



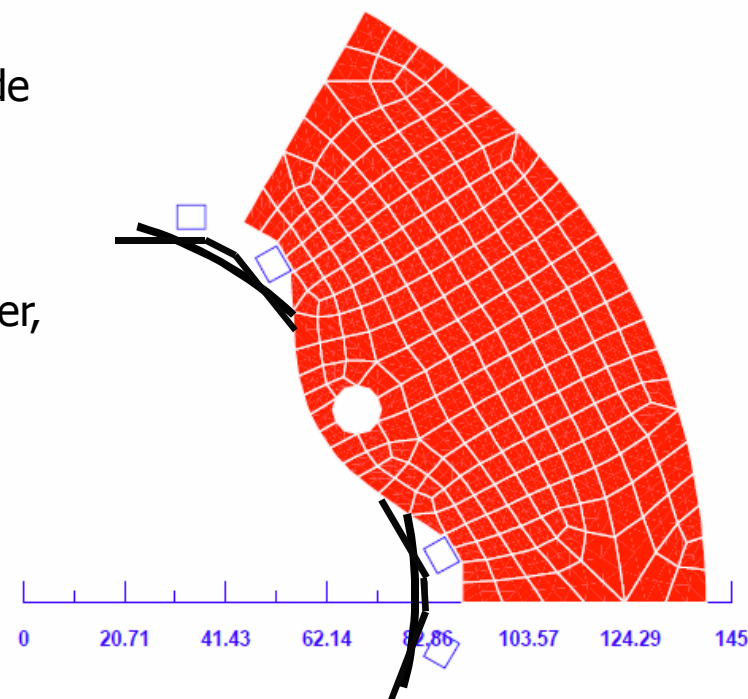
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# Radiation protection

- **Avoid degradation** of organic compounds (insulation, adhesive, etc).
- Three possible **solutions**:
  - Tungsten or copper **shielding tube** inside the aperture (holes to fit the pole tips can be done if necessary)
  - 6 **shielding plates** along the coils (copper, stainless-steel...)
  - Use of **radiation resistant materials** for the coil (cyanate ester, polyimide)





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# Conclusions

- Both 100 and 600 A designs **are possible** in a superferric type.
- **Non-saturated (long)** designs are preferred because of the **linearity** in the load line.
- **600 A long design** seems a good option because the coil is simpler and **easier to manufacture**.
- **Radiation protection** has to be discussed.
- The beam optics has been **redefined** and other correctors are now required. This affects to the presented sextupole **parameters**.