CompactLight linac quadrupoles

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CompactLight meeting

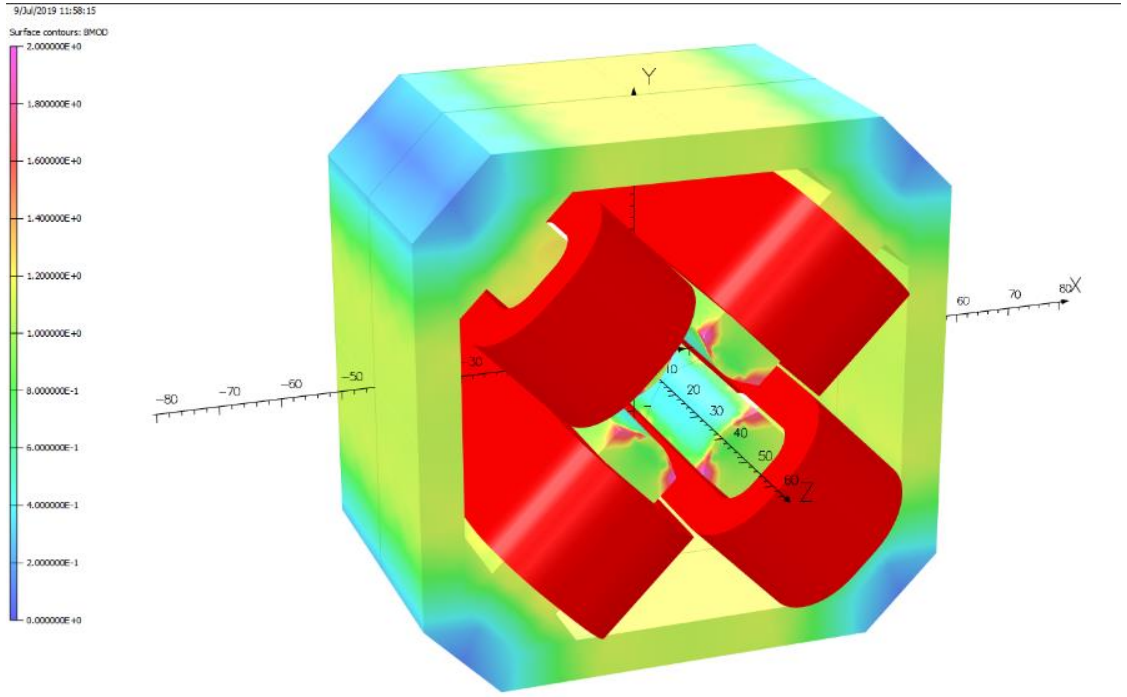
10 July 2020

Specifications

- Pole radius: 7.5 mm
- Integrated strength (gradient x length): 2.72 T
- Horizontal and vertical correctors included
- Short length

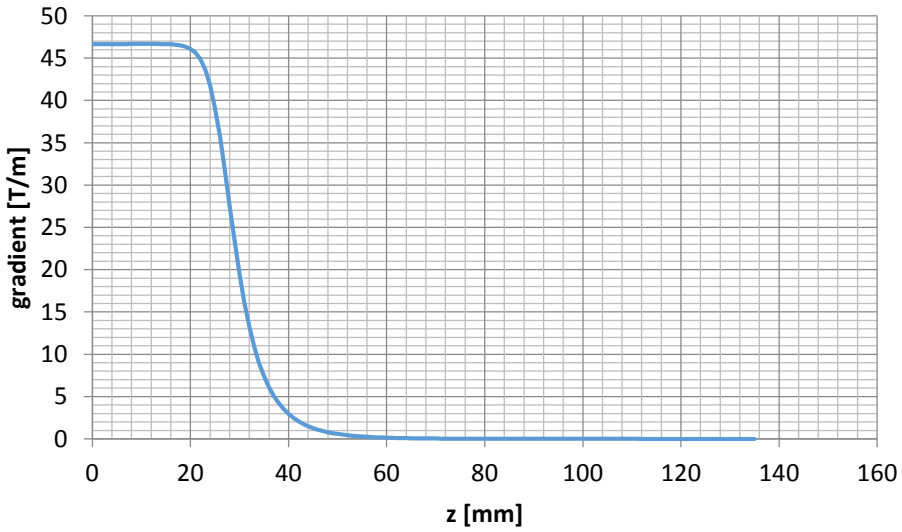
Opera-3D quadrupole design

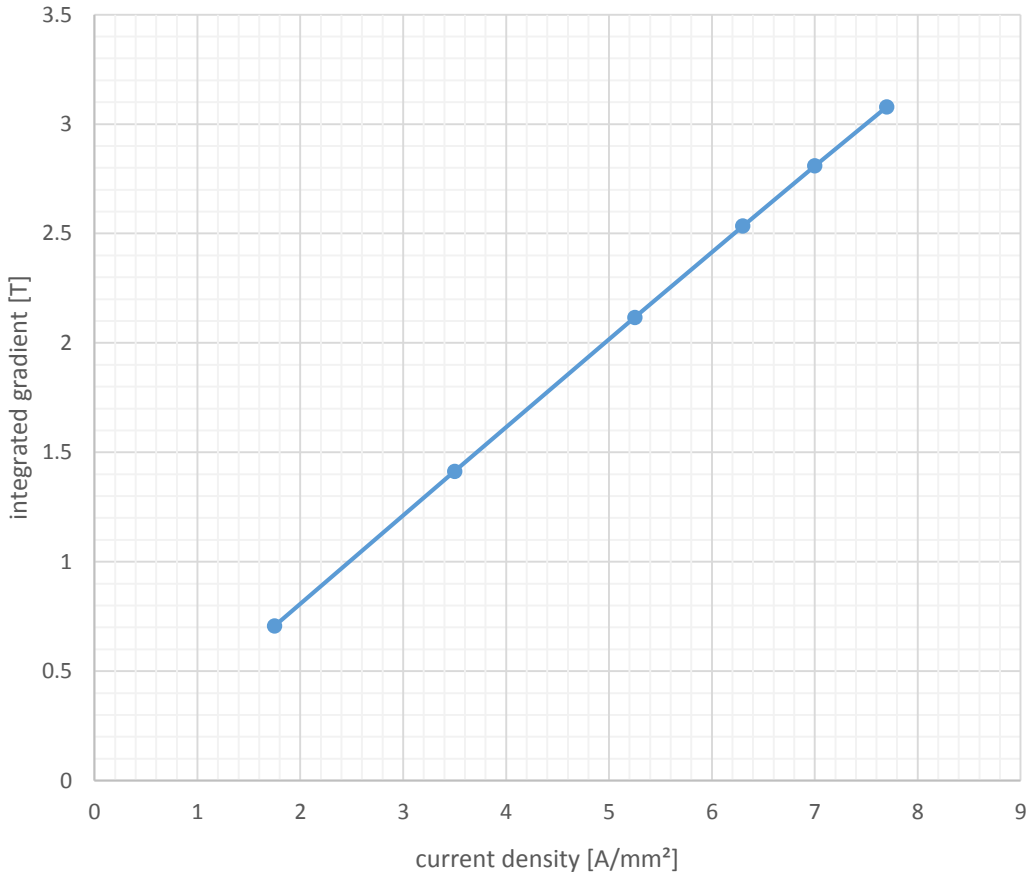
- Aperture **15 mm** diameter
- **7 A/mm²** in conductors of cross-section **7x21.5 mm**
  - OK for water-cooled
- Steel yoke length: **52 mm**
- Total length including overhang: **76 mm**
- Height and width: **90 mm** (will be extra with corrector windings)



Quadrupole gradient

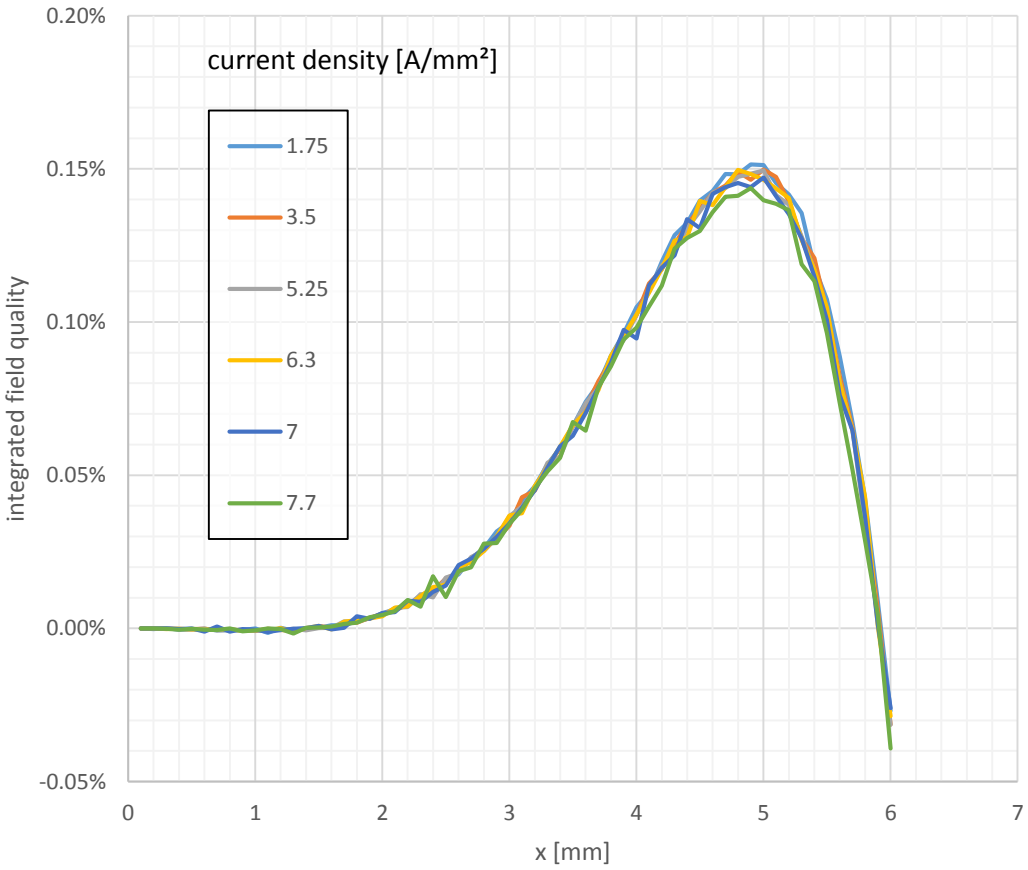
- Gradient **47 T/m** at 7 A/mm²
- **2.81 T** integrated (target 2.72 T)
- Magnetic length **60 mm**
- Good linearity, no saturation





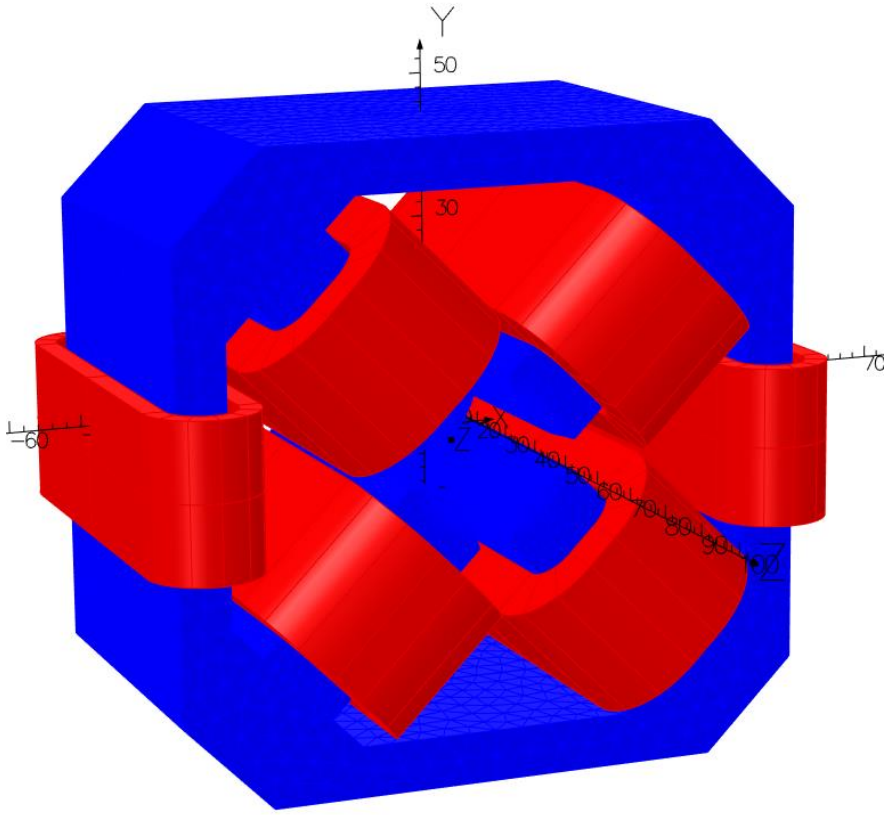
Field quality

- Integrated gradient quality: **0.15%** over **±6mm** (0.1% over ±4mm)
- Could be improved by fine-tuning pole profile
- Independent of excitation (no saturation)



Integrated correctors

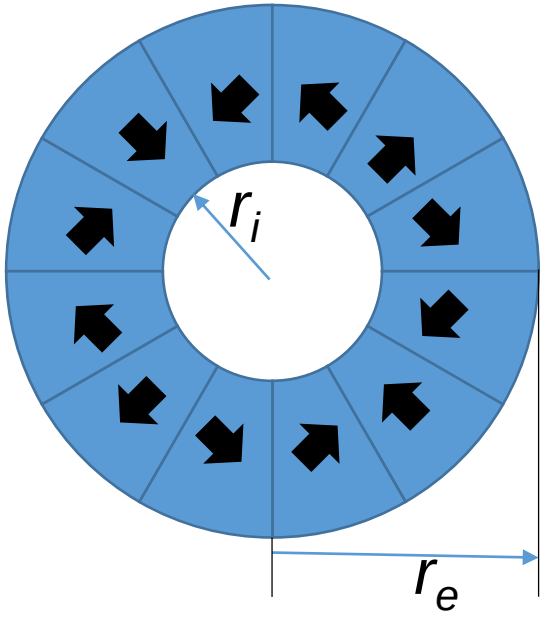
- Added one pair of coils for now:
  vertical field = horizontal correction
- **3x11 mm** cross section
- Adds **16 mm** to overall width and height (now **106 mm**)
- Current density **7 A/mm²**
  - OK for water cooling
- Integrated field **3.0 Tmm**



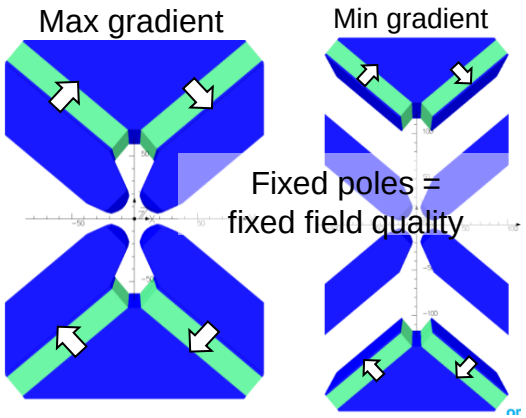
Alternatives

- Halbach PM
- Strong; narrow gap
- Fixed field

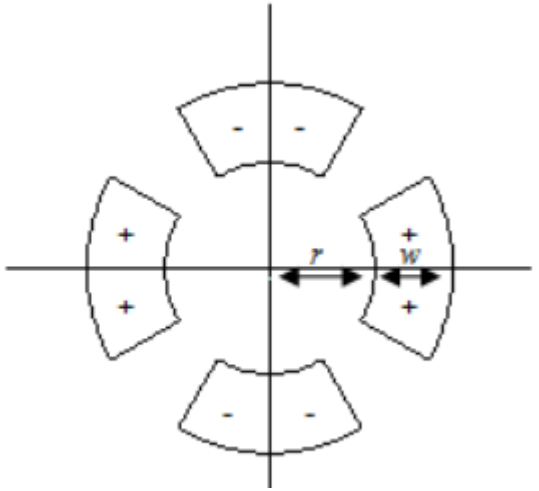
$$G = 2B_r K\left(\frac{1}{r_i} - \frac{1}{r_e}\right)$$



or… ZEPTO quad
PM with mechanical tuning

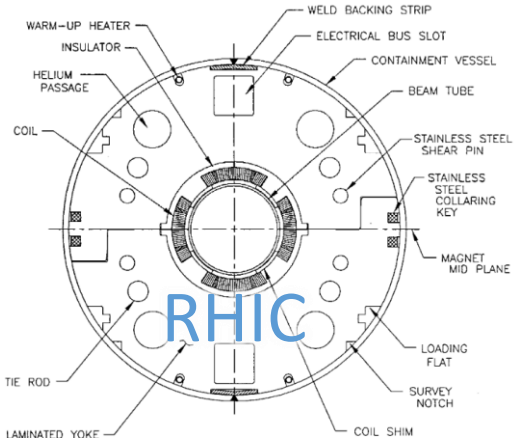


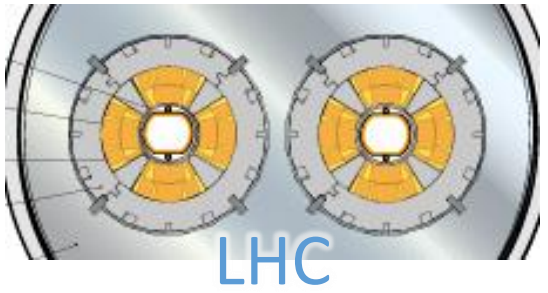
- Cos 2θ superconducting quad
- No iron required



$$G \equiv \gamma_0 j \ln\left(1 + \frac{w}{r}\right)$$

$\gamma_0 = 6.6 \times 10^7\ \mathrm{T \cdot m \cdot A^{-1}}$





Open questions

- Field quality?
- Strength of integrated correctors?
- Space required for BPM?
- Need to reduce overall size?