# Proposal for quadrupole families

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# Assumptions



- Magnet families grouped to reduce production cost, simplify production and installation.
- Savings in investment cost to be compared with disadvantages in operating costs.
- Where possible, existing magnets (or magnet designs) should be used. In many cases the present magnet specifications can be adopted.
- Selection of magnetic material (or combination with non-magnetic material) should ensure that quadrupoles are operated outside the remanence and are excitable to saturation.
- The ratio of bore radius to quadrupole length should not be smaller than ¼.
- The maximum pole tip field should be around 1 T (or conservative 0.75 T).

# Assumptions



The maximum/nominal/minimum energy in the different sections is:

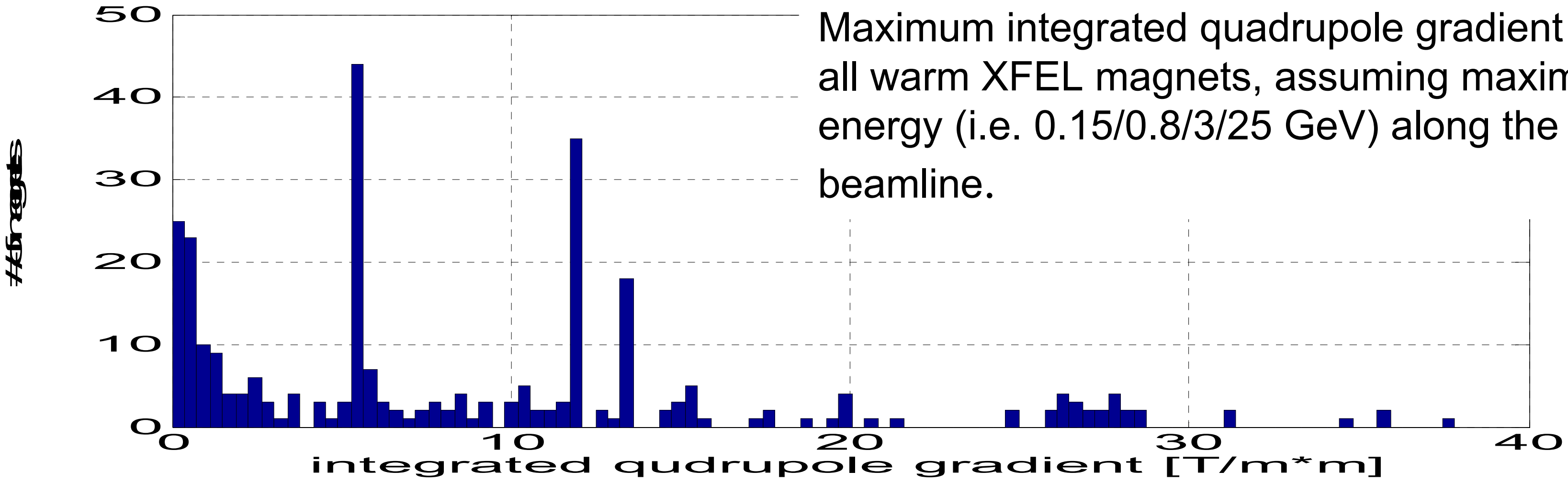
| | | | | |
|---|---|---|---|---|
| I1: | 150 | 130 | 100 | MeV |
| B1: | 800 | 500 | 400 | MeV |
| B2: | 3.0 | 2.0 | 1.0 | GeV |
| CL…: | 25.0 | 17.5 | 6.0 | GeV |

The magnet bore radius should not be smaller than

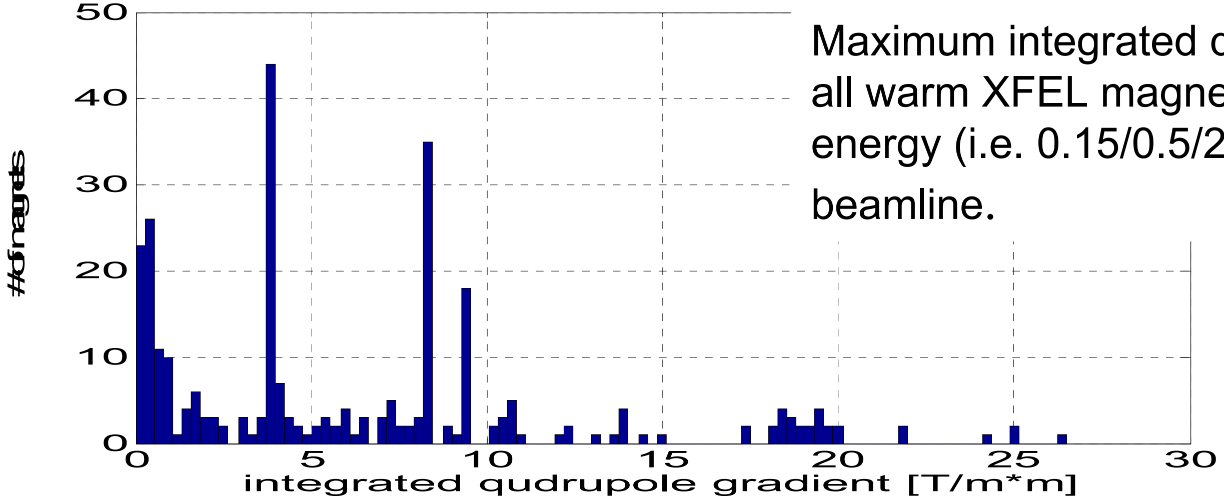
| | |
|---|---|
| I1: | 20 mm |
| B1: | 20 mm |
| B2: | 20 mm |
| CL…: | 25 mm |
| Und. : | 10 mm |

# Distribution of integrated gradients






Maximum integrated quadrupole gradient for all warm XFEL magnets, assuming maximum energy (i.e. 0.15/0.8/3/25 GeV) along the beamline.




Maximum integrated quadrupole gradient for all warm XFEL magnets, assuming nominal energy (i.e. 0.15/0.5/2/17.5 GeV) along the beamline.

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# Quad Families

| Name | Length [m] | Max. Int. Grad. [T/m*m] | Bore-radius [m] | Max. $B_{pole}$ [T] | Location | Count |
|---|---|---|---|---|---|---|
| QA | 0.1 | 10 | 0.01 | 1 | Undulators | 126 |
| QI | 0.2 | 1 | 0.025 | 0.125 | Injectors | 26 |
| QC | 0.2 | 2 | 0.025 | 0.25 | Bunch Compressors<br>Field quality $10^{-4}$ on a radius of 0.6 x r | 45 |
| QD | 0.2 | 4 | 0.025 | 0.5 | | 18 |
| QE | 0.2 | 6 | 0.025 | 0.75 | Beam Distribution | 55 |
| QF | 0.35 / 0.5 | 14 | 0.025 | 1 / 0.75 | | 100 |
| QH | 0.7 / 1.0 | 28 | 0.025 | 1 / 0.75 | | 46 |
| QG | 4 | 80 | 0.05 | 1 | Dump<br>Hera QC: L=1.0, Int. Grad=19 T/m*m | 3 |

- Optimization and final layout of quadrupoles at Efremov institute (St. Petersburg)
- Proposal expected by end of this year

# Apertures in the XFEL

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1.10.2007

# Definitions

- Beam Stay Clear (smallest aperture required for the beam and its halo)

$$A_{SC} \geq 100\sqrt{\beta\varepsilon} + 0.03D$$

- Magnet Aperture or Magnet bore (largest possible outer vacuum chamber dimension)

$$A_{bore}$$

- Magnet bore – vacuum chamber wall thickness - alignment tolerance

$$A_{VC} \leq A_{bore} - 2\mathrm{mm} - 1\mathrm{mm}$$

★

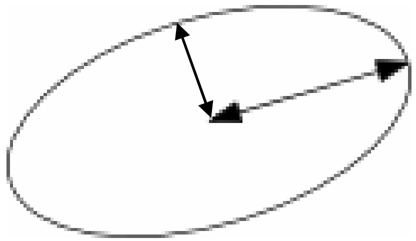
- Physical required inner vacuum chamber dimensions

$$A_{phys}$$

# Remark



- Numbers always describe the semi-major and semi-minor axis of an ellipse



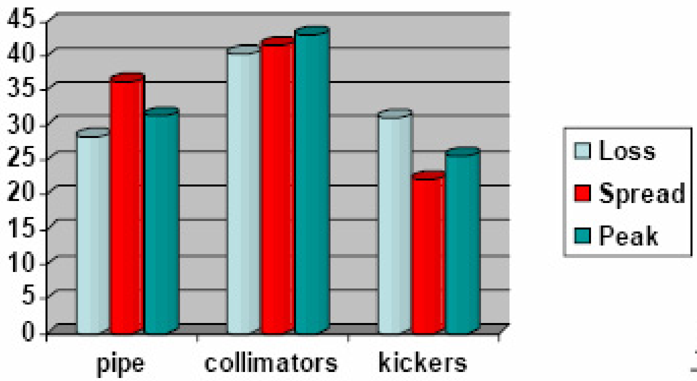
# Longitudinal Impedance Budget from LINAC to SASE2

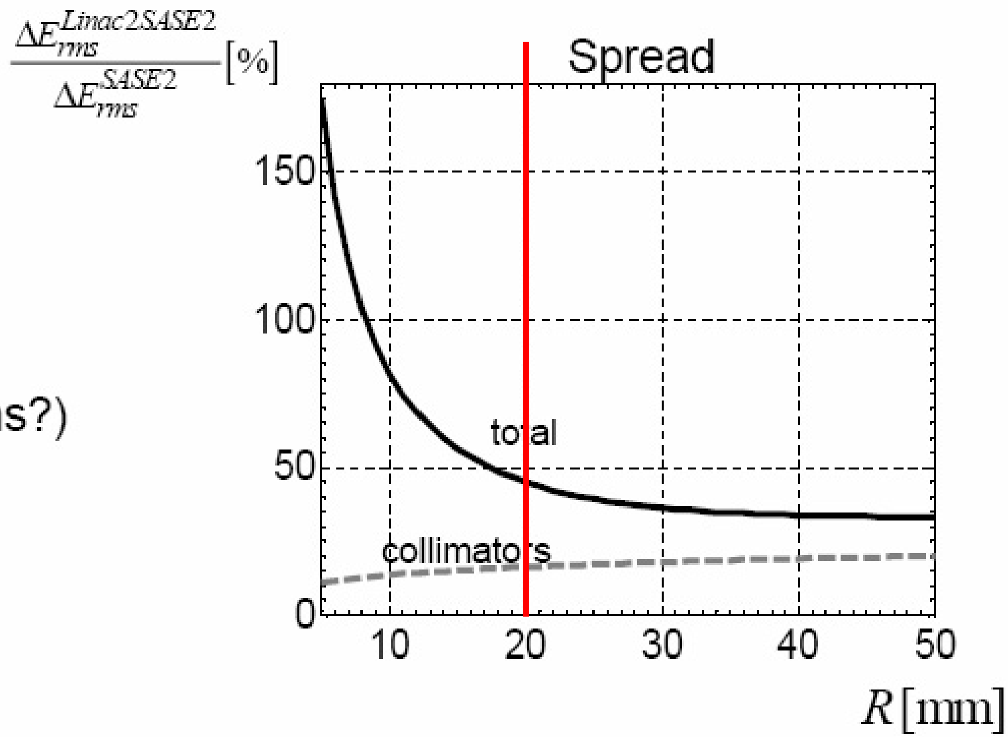
Igor Zagorodnov
Beam Dynamics Group Meeting
13.11.06

- Includes resistive and geometric wake from vacuum chamber, collimators, kicker vacuum chamber

# Conclusion

Igor Zagorodnov
Beam Dynamics Group Meeting
13.11.06




Impact on FEL performance?
(spectrum from SASE simulations?)

# Remarks



- Inner vacuum chamber radius 20 mm in collimation / beam switch yard section
- Exceptions:
  - Collimators and spoilers
  - Kicker vacuum chamber
  - Switch yard septum section