TRIUMF

Status of DarkLight Beam Optics

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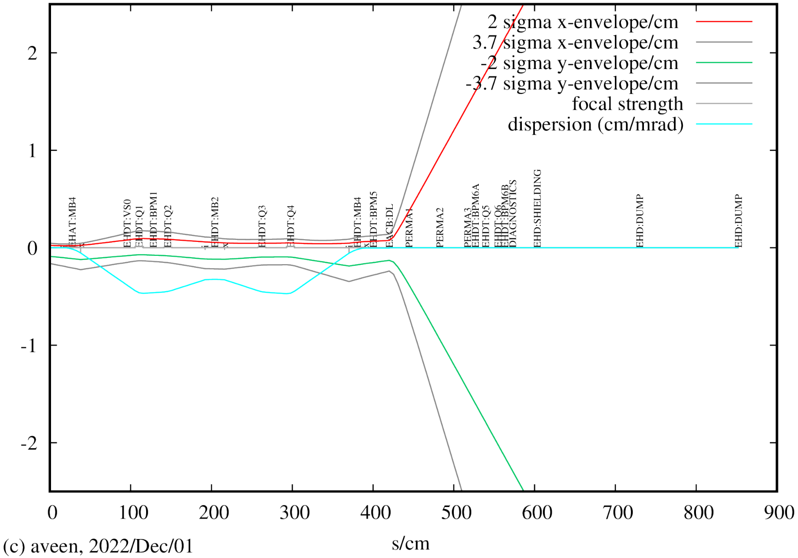
Target Scattering

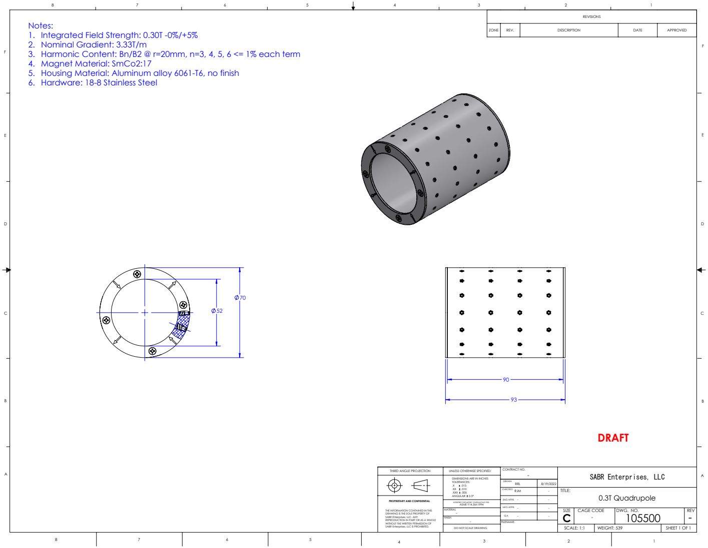


e-Linac quadrupoles

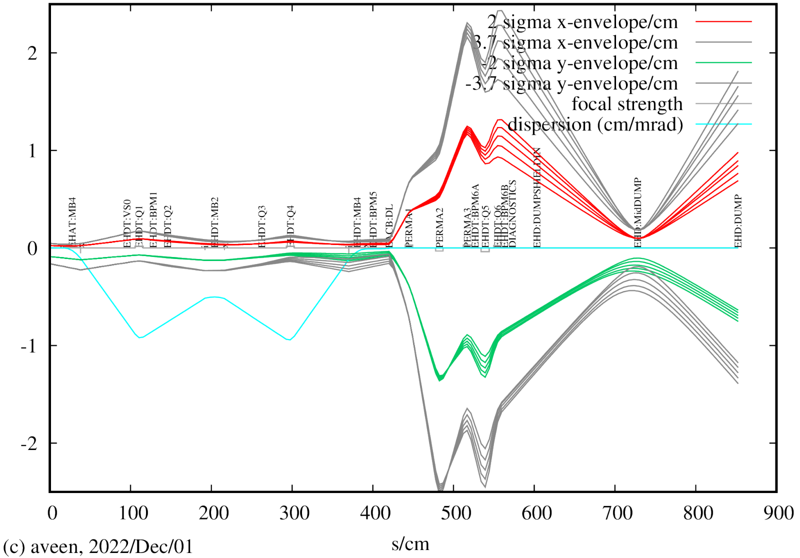
- Too large to fit between spectrometer magnets
- Require more space efficient magnets to curb scattering immediately $\rightarrow$ permanent magnets.

Permanent magnet quadrupoles

Notes:
1. Integrated Field Strength: 0.30T -0%/+5%
2. Nominal Gradient: 3.33T/m
3. Harmonic Content: Bn/B2 @ r=20mm, n=3, 4, 5, 6 <= 1% each term
4. Magnet Material: SmCo2:17
5. Housing Material: Aluminum alloy 6061-T6, no finish
6. Hardware: 18-8 Stainless Steel

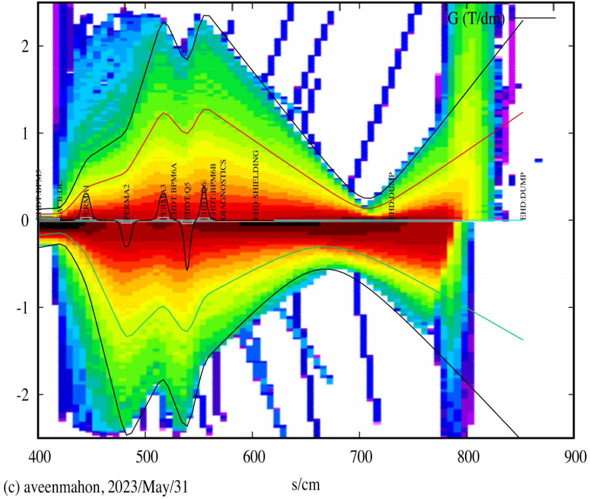


Beam Optics Model - Previous



Beam Optics Model - Previous

- Good agreement with FLUKA
- BUT too much dose



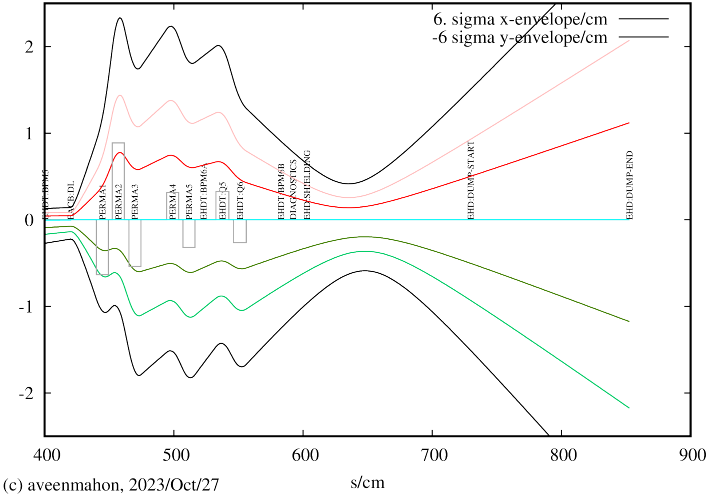
Beam Optics Model

Requirements:

- 3.7 sigma envelope fully contained withing 1” radius of beampipe
- Minimize beam size through the dump
- Valid for energy range of 27-31 MeV
- Compatible with regular operation (no target)
- Include sufficient diagnostics elements for operation
- Minimize dose rates in FLUKA

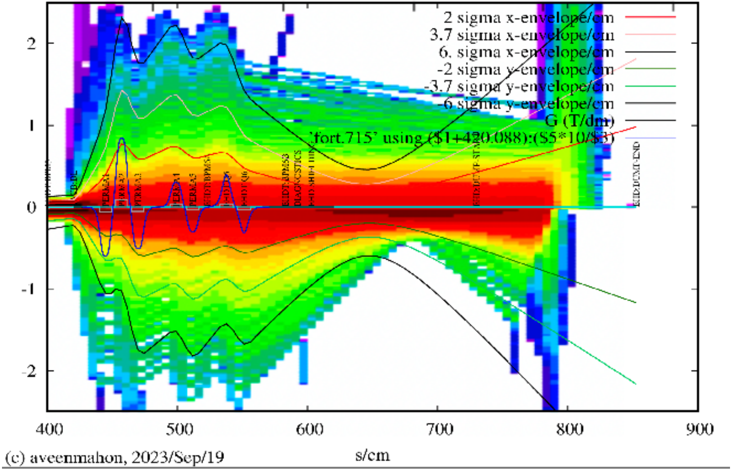
Beam Optics Model - progress

- 6 sigma envelope now contained
- 5 PMQs: 0.6 T, 0.84 T, 0.51 T, 0.3 T, 0.3 T



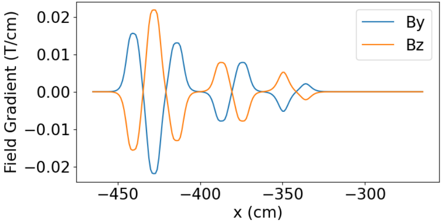
Beam Optics Model - progress

- BUT when overlayed with FLUKA envelopes didn't match

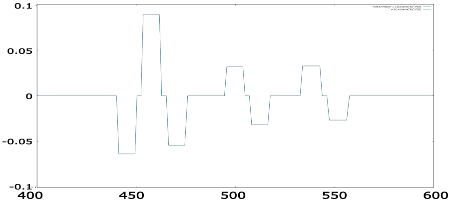


Hard vs Soft Edge Quads

Soft quad input into FLUKA:



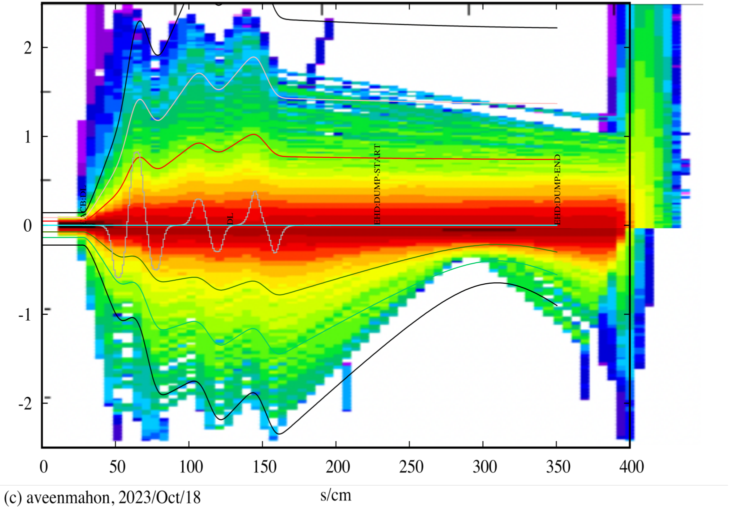
Hard edge quad in TRANSOPTR:



- Believed to be causing discrepancy
- Implement soft quad in TRANSOPTR

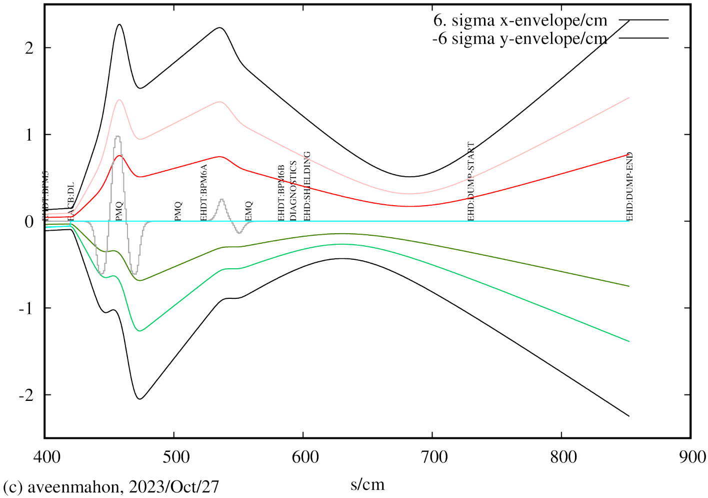
Hard vs Soft Edge Quads

- Checked soft quad with this model - better match with FLUKA!



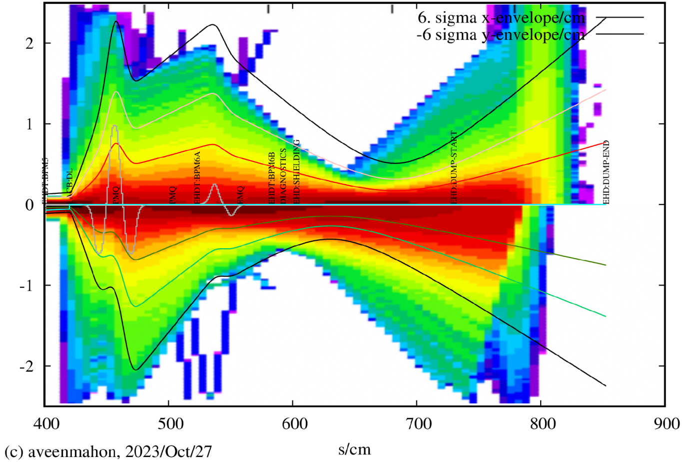
Beam Optics Model - latest

- Re-optimized model using soft quads
- Down to only 3 PMQs: 0.62 T, 1.0 T, 0.62 T



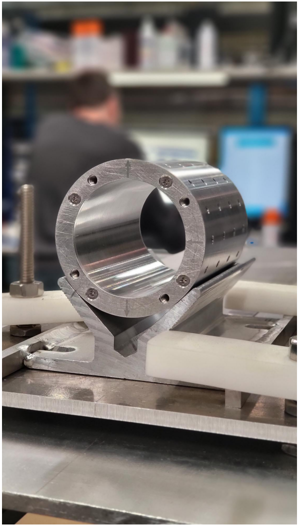
Beam Optics Model - latest

- Overlay with FLUKA not quite a perfect match yet - investigating initial beam parameters and energy spread



PMQs at TRIUMF!

- Magnetic field mapping
- Check parameterization



Parameterization of Magnetic fields

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Quadrupole shapes

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(Received 17 January 2012; published 30 July 2012)

The usual practice of constructing quadrupoles from truncated cylindrical hyperbolae is put into question. A new shape is proposed. This shape has an analytic potential function. The exact shape of the analytic quadrupole may be impractical, but in the short case where aspect ratio length/aperture ≈ 1, pole shapes can be spherical. The optimal spherical radius is found to be 1.65 times the aperture radius. An example is also given demonstrating that for aspect ratio >1, the aberrations of order 5 and higher are lower for the optimized shape.

- Strength function

$$k(z) = \frac{K}{2}\,\mathrm{sech}^2 z. \tag{6}$$

- Magnetic field components:

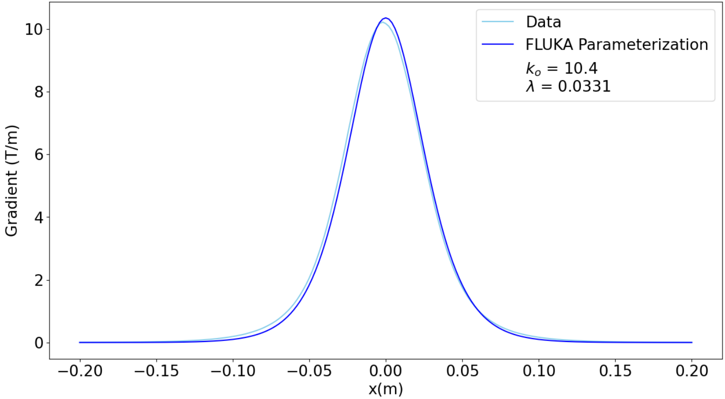
$$F_x = \frac{K}{2}\frac{\sin 2x}{\cos 2x + \cosh 2z} = \frac{K}{2}\frac{\sin x \cos x}{\cos^2 x + \sinh^2 z} \tag{10}$$

$$F_y = -\frac{K}{2}\frac{\sin 2y}{\cos 2y + \cosh 2z} = -\frac{K}{2}\frac{\sin y \cos y}{\cos^2 y + \sinh^2 z} \tag{11}$$

$$F_z = \frac{K}{2}\left(-\frac{\sinh 2z}{\cos 2x + \cosh 2z} + \frac{\sinh 2z}{\cos 2y + \cosh 2z}\right). \tag{12}$$

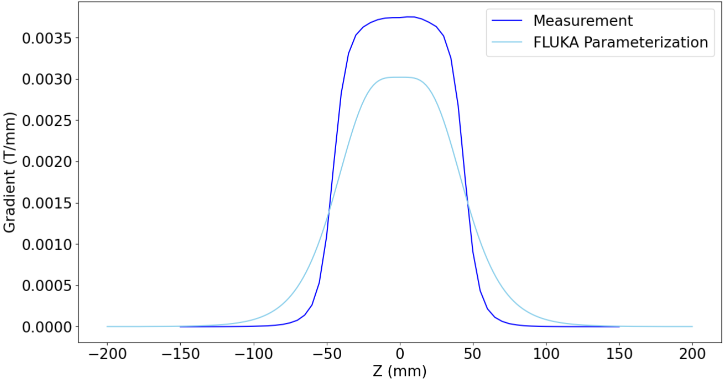
Field Map - EMQ

- Comparison of EMQ field mapping with above parameterization



Field Map - PMQ

- For PMQ we made the assumption that it would be the sum of two sech^2 functions to obtain a flat top.
- BUT now we have the actual field mapping of PMQs.



- Comparison shows discrepancy - need to adjust parameterization.

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Thank you
Merci