Magnet Optimization using Poisson

Igor Senderovich

University of Connecticut

GlueX Tagged Beam
Working Group

September 10, 2009

Motivation

Some remaining Tagger Magnet design questions:

1. Can the amount of iron be decreased to save cost?
    - What price is paid in extra current/power requirement?
    - What is the effect on fields outside the magnet?
2. What machining imperfections in the poles can we tolerate?

The Tagger Review suggested that we show the *optimality of the geometry* and highlighted the need for *better-justified tolerances*.

This study serves as input for cost considerations and MC calculations of tagger resolution.

Introduction to Poisson

Poisson, part of Poisson Superfish software suite from Los Alamos, is a 2D solver for electro- and magneto-static fields.

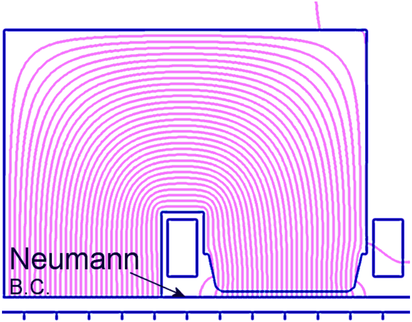
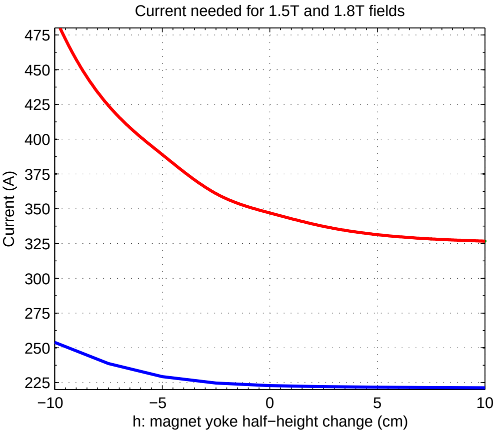


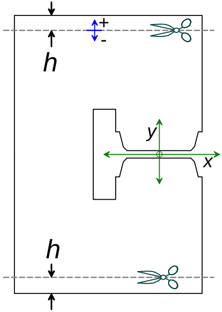
Figure: Graphical output of Poisson solver. Symmetry about $y = 0$ plane is assumed

- no replacement for real 3D calculation
- allows for a quick calculation of a field map cross-section
- may suggest how the entire field scales with certain parameters

Current Requirement

The saturated iron would require change in current to reach the required fields ($1.5\,\mathrm{T}$ operating; up to $1.8\,\mathrm{T}$ at startup, during adjustment to deal with hysteresis)





Power Requirement

The power scales as current squared! (Additionally, AC capacity for corresponding heat removal must be considered - *not included*)

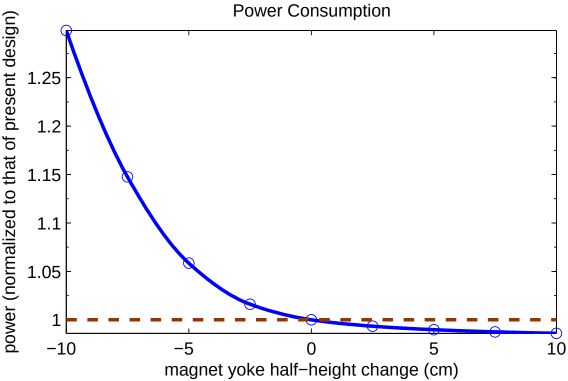


Figure: Power scaling from current design for the $1.5\,\mathrm{T}$ operating point.

Stray Fields

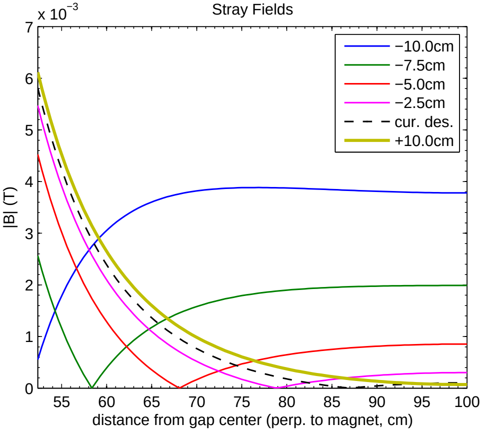
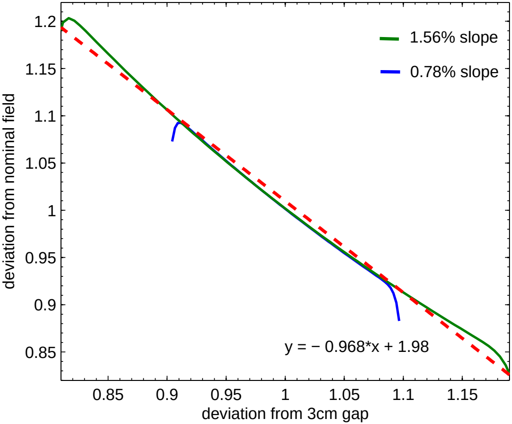
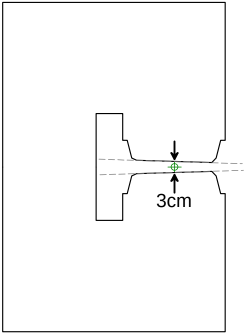


Figure: Stray fields along $y = 0$ plane for various yoke alteration scenarios. For reference: outer edge of coils is at $36\,\mathrm{cm}$

Effect of Pole Slant

A slanted pole turns out to have a very simple effect on the field. To first order, the local field depends only on local pole separation.





Horizontal Field Component

The B_x component is fairly uniform, measured along lines of constant y, to within a few percent. The $B_x(y)$ between the poles follows a straight-forward parameterization:

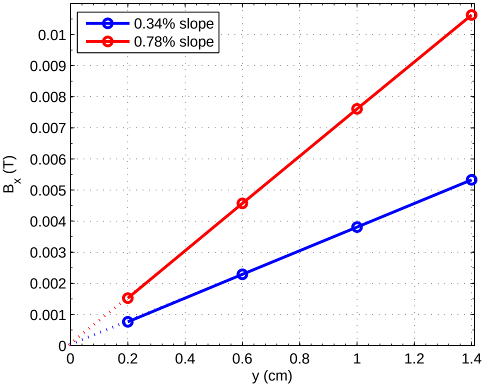


Figure: Averaged horizontal field component

Conclusion and Work Outlook

- **Yoke height**: these early studies suggest that we are near optimum - near the knee of the current/power curves
- **Pole slant**: the calculations yield straight-forward parameterizations of the field between non-parallel poles. Monte Carlo calculations with appropriately-corrected field maps will suggest a tolerance on slope.

Calculations can be performed for new iron configurations as well as other pole-machining aberrations.