Realistic Fields for the Ring Cooler: Status Report

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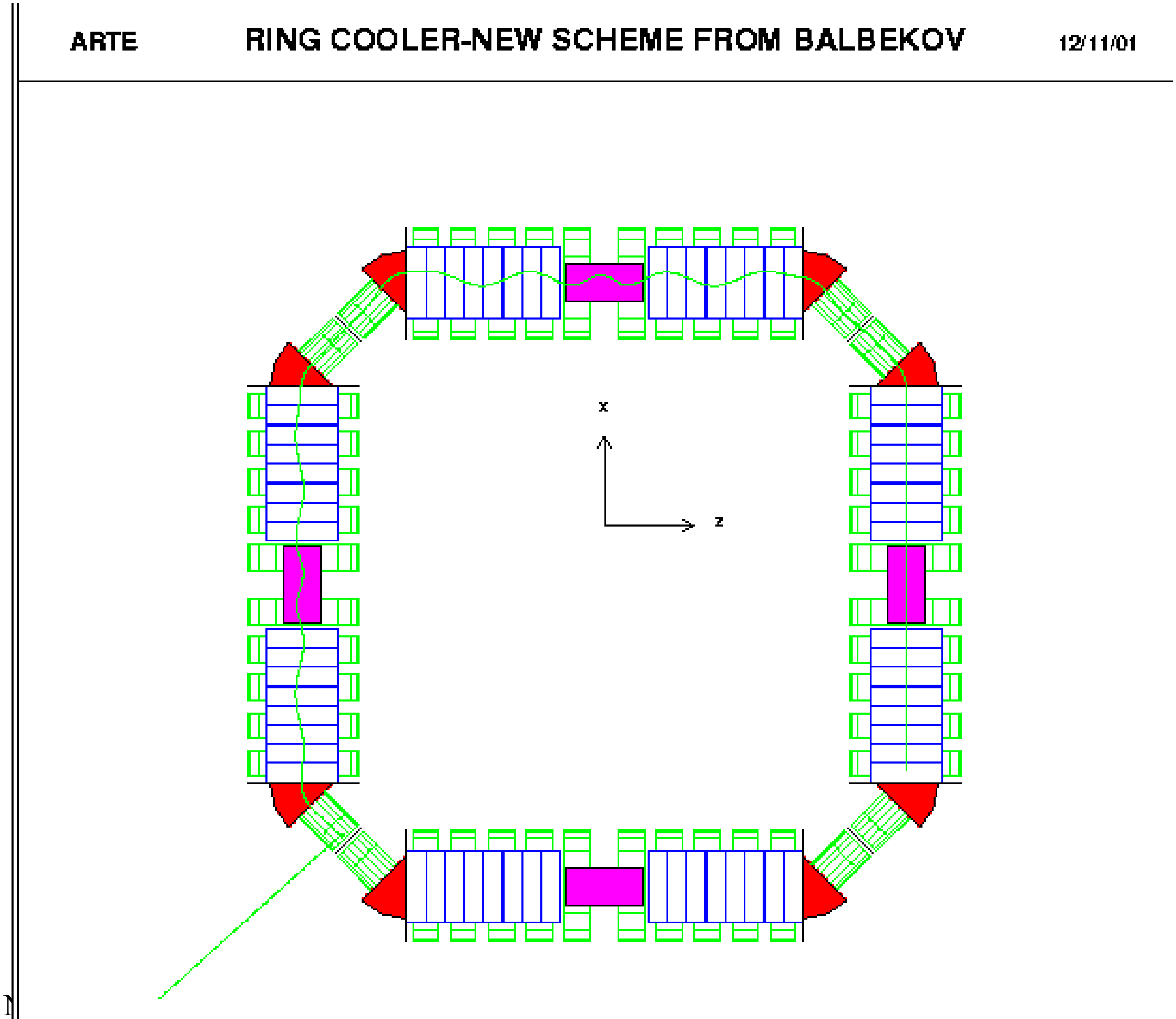

ARTE
RING COOLER-NEW SCHEME FROM BALBEKOV
12/11/01
x
z

Tracking Muons Around the Ring

- Tracking to test the field.
  - Set all absorber material to vacuum.
  - Remove all RF.
  - Cooling ring now is just a storage ring.
- Current State:
  - A *so-called* on momentum muon can get ¾ the way around the ring.
  - Going through the first bend gives it some transverse momentum.
    - This should not happen if the particle momentum is truly match to the field.
    - I am now examining the quality of the field for components that can give it a transverse momentum kick.

Tracking Muons, continued

- It is necessary to have a muon track without transverse momentum to set the reference times for the RF cavities.
- I will need to add more diagnostic information to muc_geant to achieve this.
- It should be mentioned that most of the lost muons will occur in the field flip region. This is expected, but the short solenoid and the dipole are where I have been examining the field most carefully.

Ideal Short Solenoid Field Flip Magnet

- Top figure shows Valerie's design for the short field flip solenoid.
- The lower figure shows the field and dispersion for that magnet.
- This form of the field assumes that there is a Neumann condition at the end of the magnet.
  - The field will continue ~2 T forever.

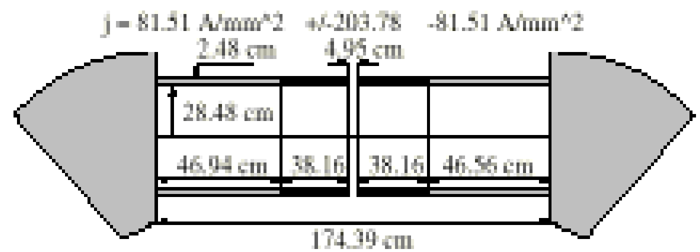


Figure 2: Layout of the short straight section.

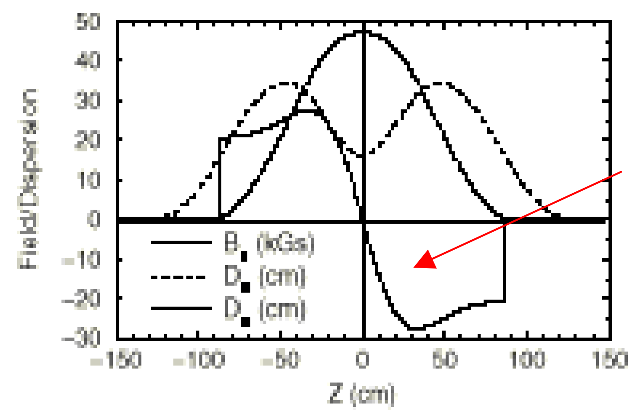
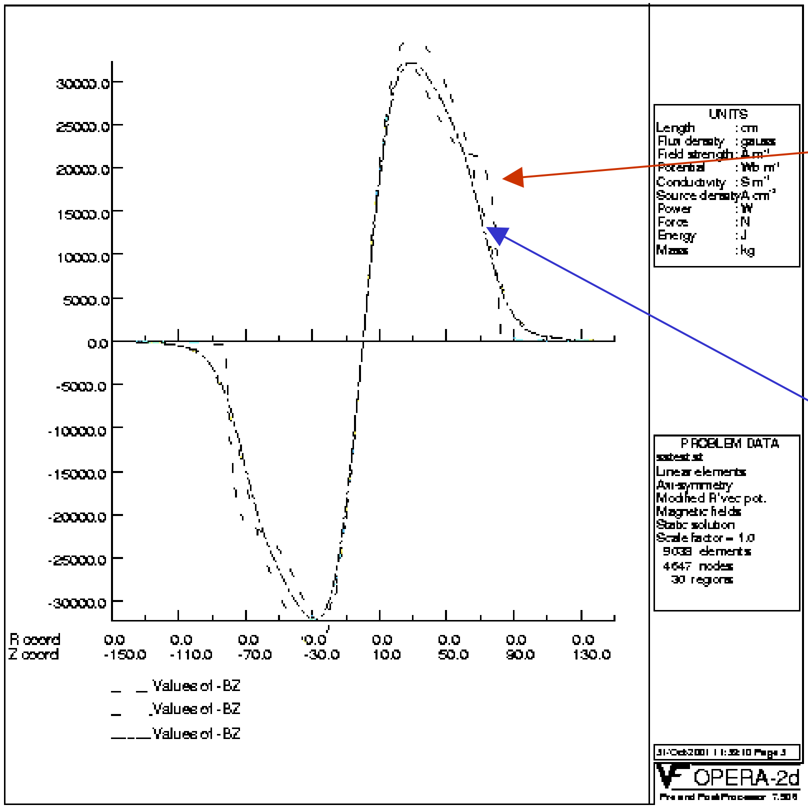


Figure 3: Axial field and dispersion functions in short SS.

B_z on axis

Short Solenoid Fields From Opera2D

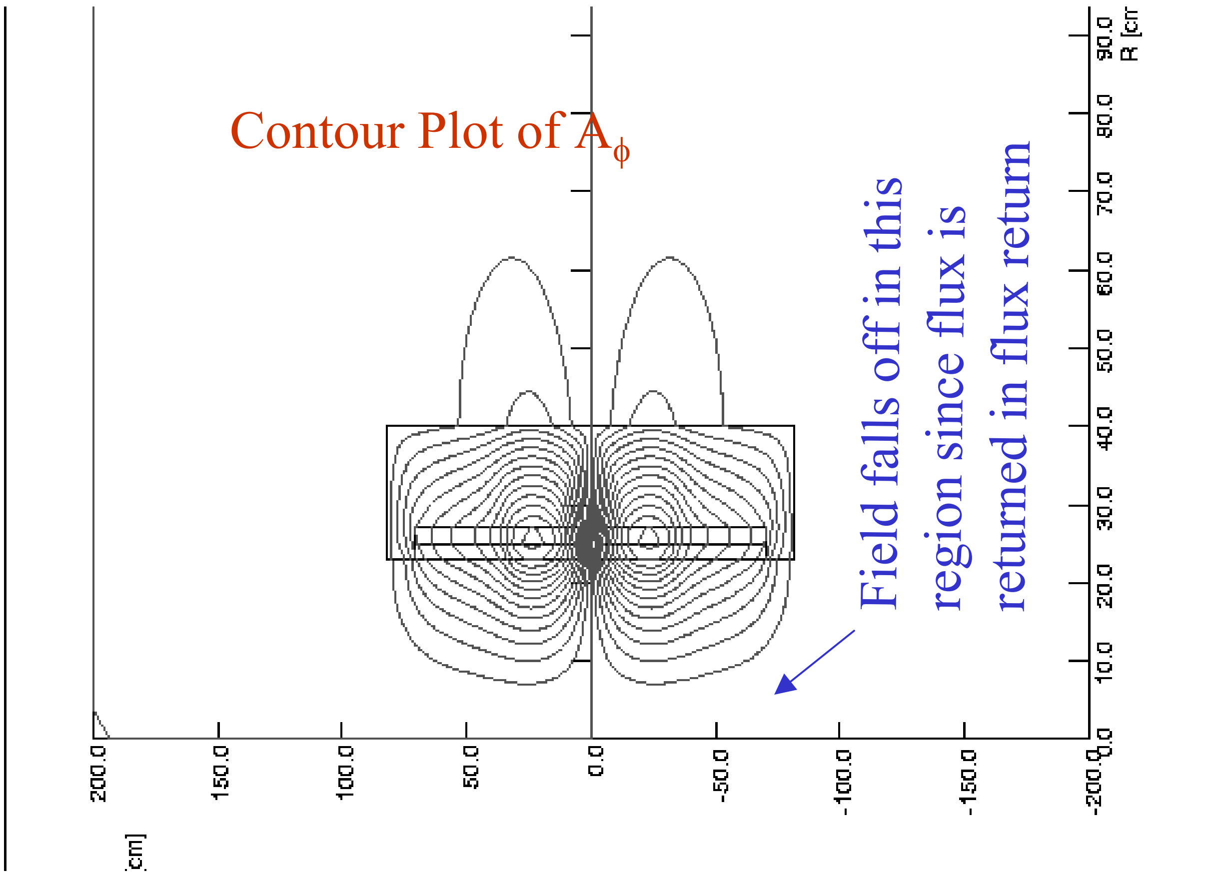


Field with iron covering ends

This forces field to be sort of parallel to axis

Field with aperture for muons

Contour Plot of Field Lines in Short Solenoid

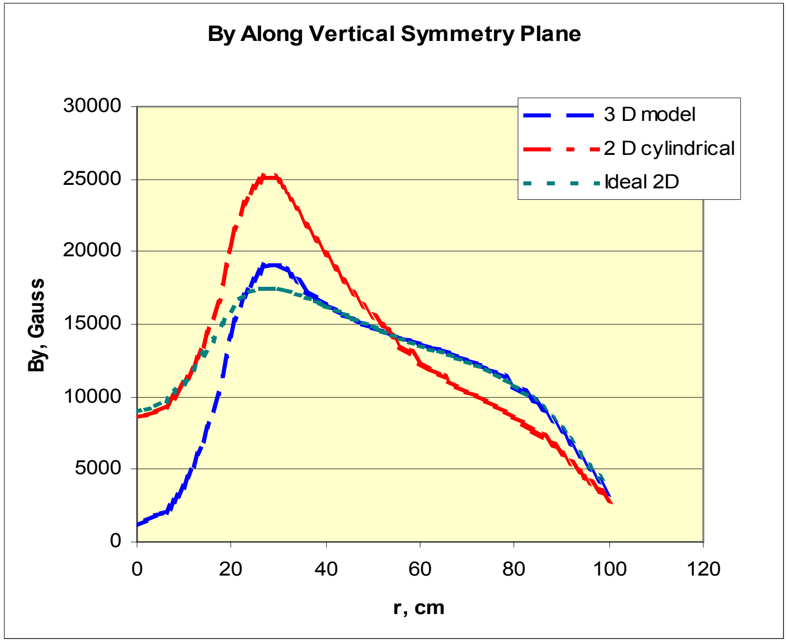


Comments of Short Solenoid

- I am not sure that Valerie's Field for the short field flip solenoid can actually be achieved.
  - The magnetic mirror effect that was assumed does not allow space for an aperture.
  - I have contemplated adding extra current near the ends to force the field closer to the axis. This would put field into the adjacent dipole magnet.
- How critical is it to have this field plateau at the ends?
  - It probably does not affect circulating muons near the reference path.
  - It may affect how the muon beam is cooled.
    - Valerie do you have any comments?

B_y along Vertical Symmetry Plane

- Figure shows three curves:
  - Ideal Field:
    - 2D field from shaped iron pole and effective yoke width.
    - Calculate index=0.473
  - 3D Field Calculation
    - Calculation using TOSCA
    - Gives index=0.47
  - 2D cylindrical Calculation
    - Uses same pole profile, but has closed cylinder out of plane.

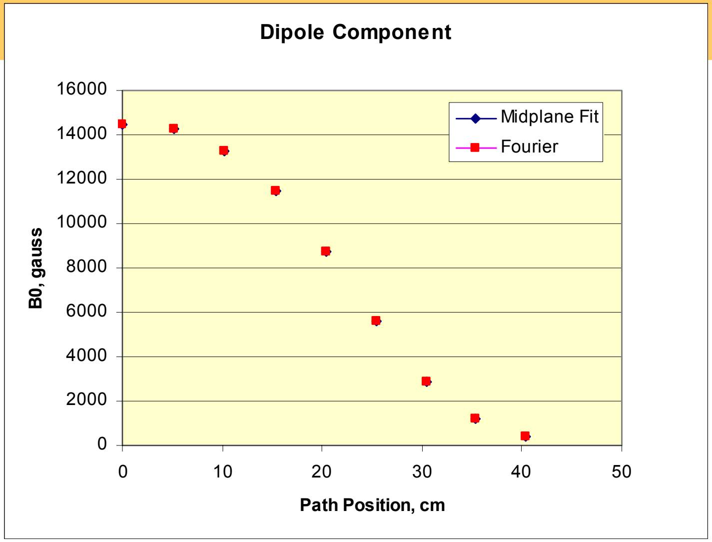


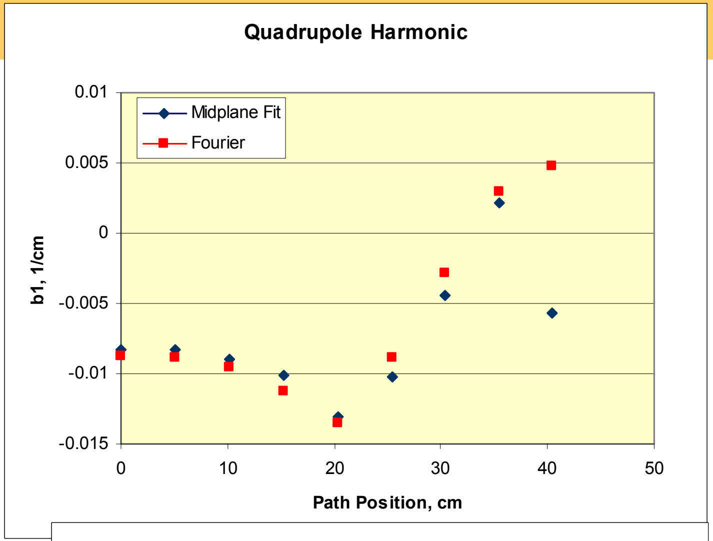
Avoiding a 3D Map

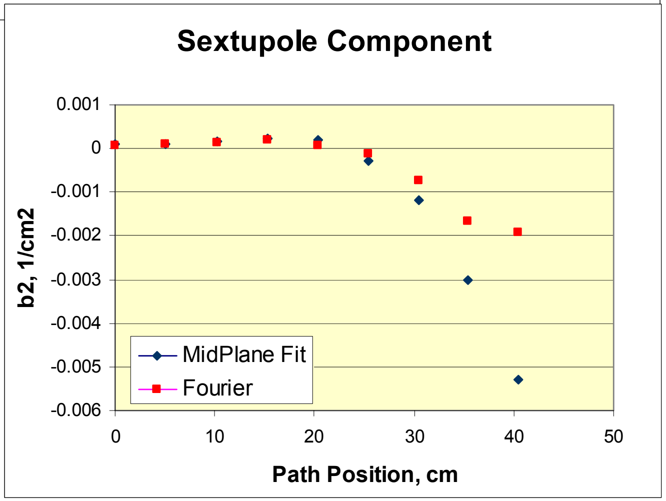
- The 2D part of a long accelerator magnet is traditionally parameterized by Fourier harmonics.
- A generalization of the traverse field that takes into account the s dependence of the field has the form:

$$B(r,\varphi,s) = \left[K_1(z) - \frac{3}{8}\frac{d^2K_1}{ds^2}r^2 + \frac{5}{192}\frac{d^4K_1}{ds^4}r^4 + \cdots \right]\sin(\varphi) + \left[K_2 r - \frac{1}{6}\frac{d^2K_2}{ds^2}r^3 + \frac{1}{128}\frac{d^4K_2}{ds^4}r^5 + \cdots \right]\sin(2\varphi) + \cdots$$

Transverse Harmonics as a Function of *s*







$$\frac{1}{B_o \pi} \oint B(\varphi)\cos(2\varphi)\, d\varphi$$

Calculated along the reference path

Dipole Field Description

- The dipole magnet field on the axis of symmetry has an index, n=-(r/B)dB_y/dr=½.
  - Is this true off the symmetry plane? If not we may not have weak focusing. This has to be established.
- The harmonic description that is currently in Muc_Geant is not correct. I am about to put in the description that I previously shown (two transparencies ago).
  - I have calculated harmonics of $B_\phi(s)$ and $B_r(s)$ at positions along a reference path through the dipole magnet at 5 different radii using the TOSCA program.
  - I have fit the previous formula (2 transparencies ago) parameterizing K(s) as:
    - $K_n(s) = a[\tanh((z-z_o)/\lambda) - \tanh((z+z_o)/\lambda)]$ for each n

Preliminary Results from Fit

		From Bphi			from Bphi + Br		
Fit results							
	a	lambda	z0		a	lambda	z0
Dipole	-6594.9	9.9746	23.677		-6743.5	11.13	22.985
	0.1204	5.58E-04	3.74E-04		0.0896	3.55E-04	2.72E-04
Quadrupol	52.528	6.0348	24.56		50.162	6.4513	18.306
	1.34E-02	4.40E-02	4.11E-03		1.19E-02	2.50E-03	3.33E-03
Sextupole	1.1439	6.0369	21.03		1.1652	6.6777	22.589
	0.001486	0.0101	0.0129		0.001	0.006788	0.008746

To Do List

- Obviously this is work in progress.
- Highest priority is to be able to track particles around the ring with these fields and with RF and absorbers.
- Next we need to examine what the effect of realistic fields have on cooling.
  - Are there magnet design changes to improve it.
- Apply these magnets schemes to octagonal rings.