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Investigation Into the Use of Rare Earth Magnets for a Spectrometer at Fermi Test Beam Facility

Michael Backfish
Switchyard Meeting
11/3/1016

Benefits Spectrometer at FTBF

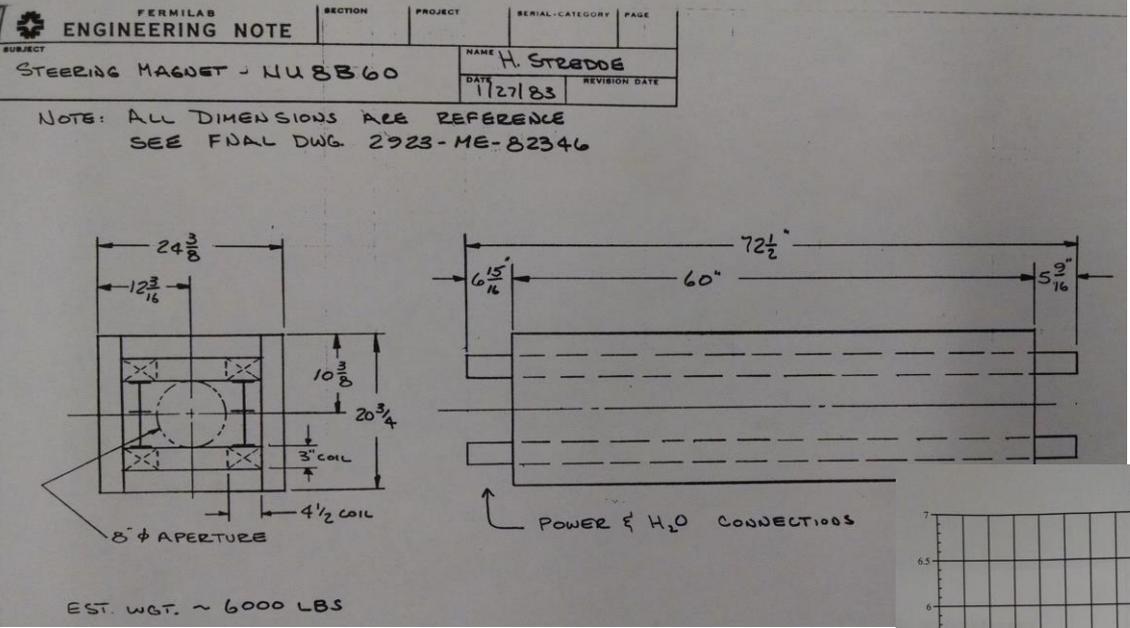
- Measure impact of accelerator components on Momentum and Dp/P
- Characterize at FTBF rather than upstream

What is Needed

- We deliver -30 GeV to +60 and +120 GeV beam to the experiment so it is likely that one spectrometer will not fit the needs of all of the beam we deliver
- As a starting point Dave Christian suspected we needed 2 magnets that could deliver 100 MeV kick or 1 that could deliver up to 200 MeV
- $3/10 B^*L = By$ (in GeV and Tesla Meters)
(for better justification see <http://extbeams.fnal.gov/users/backfish/hp/SpectrometerKick.pdf>)

Before Team Center There Was Koizumi Center

(this Data Storage medium is quite full but the search algorithm is still slightly faster than Team Centers)

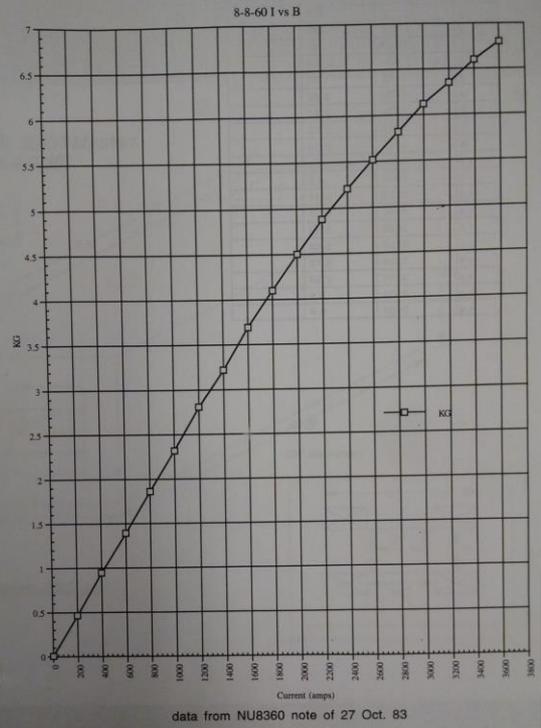


To: L. Stutte
 From: L. Barry
 Subj: NU8360 Magnet Serial # 422801

The magnet was run @ 1500 Amps continuously for 30 minutes on Wednesday 2-9-83. After the a magnetic field check was done using a Bell 610 gaussmeter ser # 73173 with probe # STL 1-0404 ser # 103745 and the gaussmeter was calibrated on the 3K6 range.

The test was run by Walt Jaskierny.

In the following results:



SCALE	Gauss	Current (Amps)	
1K	200	100	
"	435	200	2.18
"	662	300	
"	892	400	
3K	860	400	
"	1,08K	500	
"	1,30K	600	
"	1,52K	700	
"	1,75K	800	
"	1,97K	900	
"	2,19K	1000	
"	2,42K	1100	
"	2,65K	1200	
"	2,89K	1300	
10K	2,820	1300	2.17
"	3,05K	1400	
"	3,25K	1500	2.17
"	3,45K	1600	2.16
"	3,65K	1700	2.15
"	3,87K	1800	2.15
"	4,07K	1900	2.14
"	4,25K	2000	2.13

W. Jaskierny
 A. Maloušek
 J. Lindberg

J. Butler
 B. Treadler

We have two 8-8-60s

At 2000 Amps the field is .425 Tesla
 Or 194 MeV Kick

Hopelessly Trapped in N01!
 (though I will try changing this)

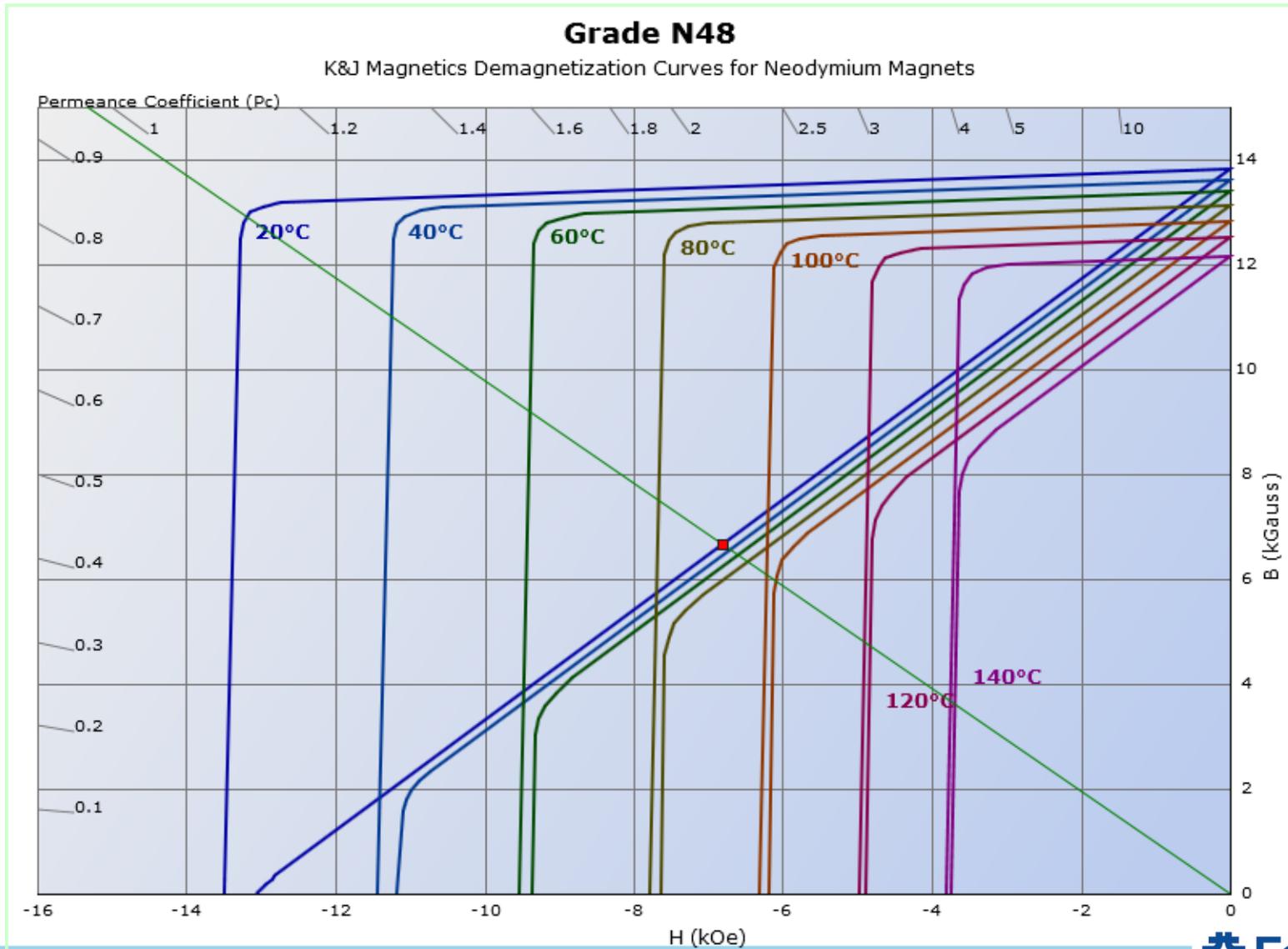
What About Permanent Magnets

- Adams Bump power supply estimate was \$15,000 for a 50 amp supply
- Something that Can do 2000 Amps would likely be a significant cost

Neodymium Magnets NdFeB

- Developed by General Motors in 1982
- Recently it has been used to make lightweight loudspeakers
- High Coercivity (resistance to being demagnetized)
- High Saturation (1.3 Tesla)
- Stores large amounts of magnetic energy ($B_{hmax}=64$ MGOe)

Demagnification Curve



Apex Magnets

https://www.apexmagnets.com/6-x-4-x-2-block?fee=5&fep=164&gclid=CNe0hIW4_s8CFZGGaQodRv0C2w



6" x 4" x 2" Block - Neodymium Rare Earth Magnet

Model: M6x4x2BL

\$699.99

Quantity

[add to cart](#)

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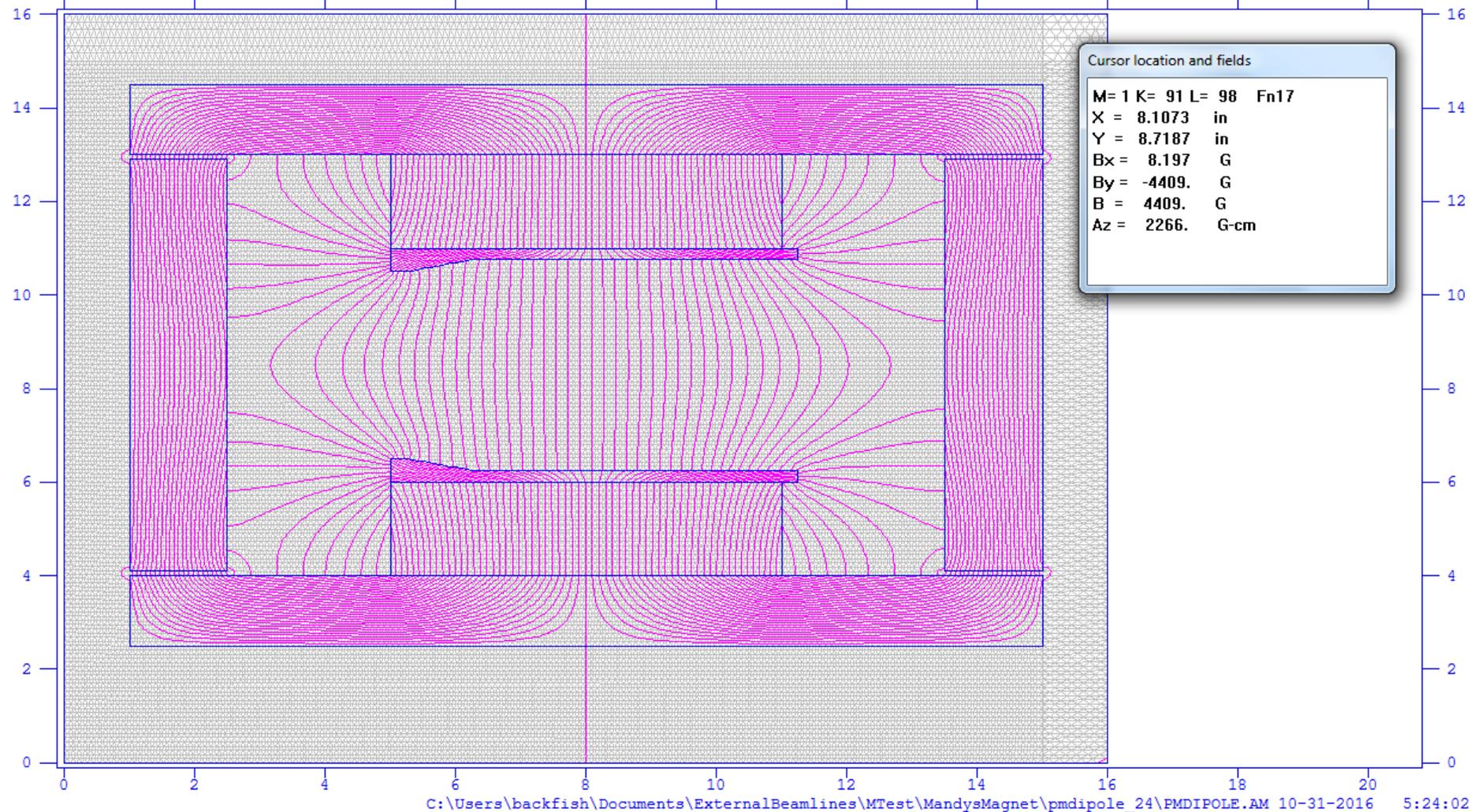
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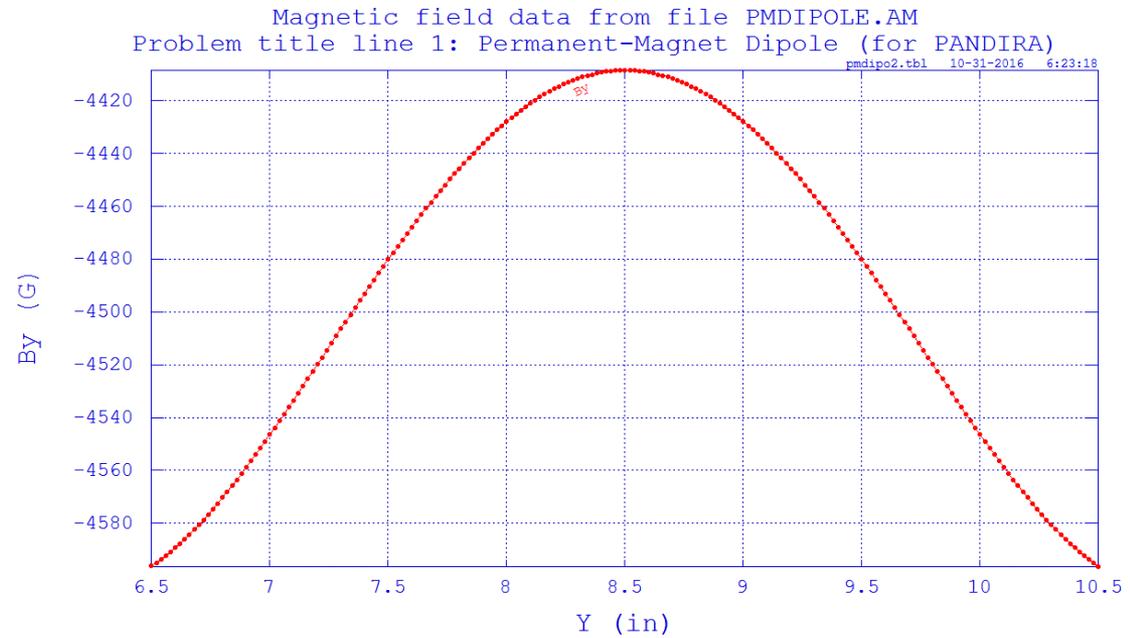
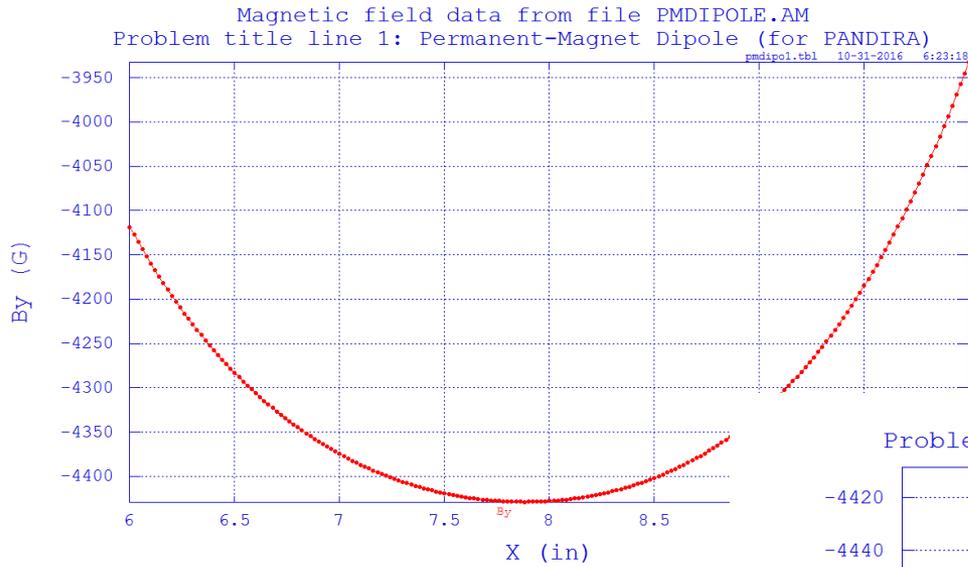
- 1 magnet
- 6" long x 4" wide x 2" thick (152.4mm x 101.60mm x 50.8mm)
- Material: Neodymium (NdFeB)
- Grade: N48
- Coating: Nickel
- Magnetization: Through Thickness
- Pull Force: 1,082.2 pounds
- SKU# M6x4x2BL
- *****WARNING*** This is an EXTREMELY Powerful and VERY DANGEROUS Magnet!**
- The end user **MUST USE SAFETY PRECAUTIONS** when unpacking and using this magnet.
- Wear safety glasses.
- Use heavy gloves.
- ***** DO NOT ALLOW CHILDREN TO PLAY WITH THIS MAGNET***.**
- By the act of bidding or buying, the purchaser, agrees they have read the above warning and will not hold the seller responsible for any damage or injury which could result from the misuse of this product.
- **NEODYMIUM MAGNETS ARE NOT SAFE FOR CHILDREN**

Poisson and Pandira

Permanent-Magnet Dipole (for PANDIRA)

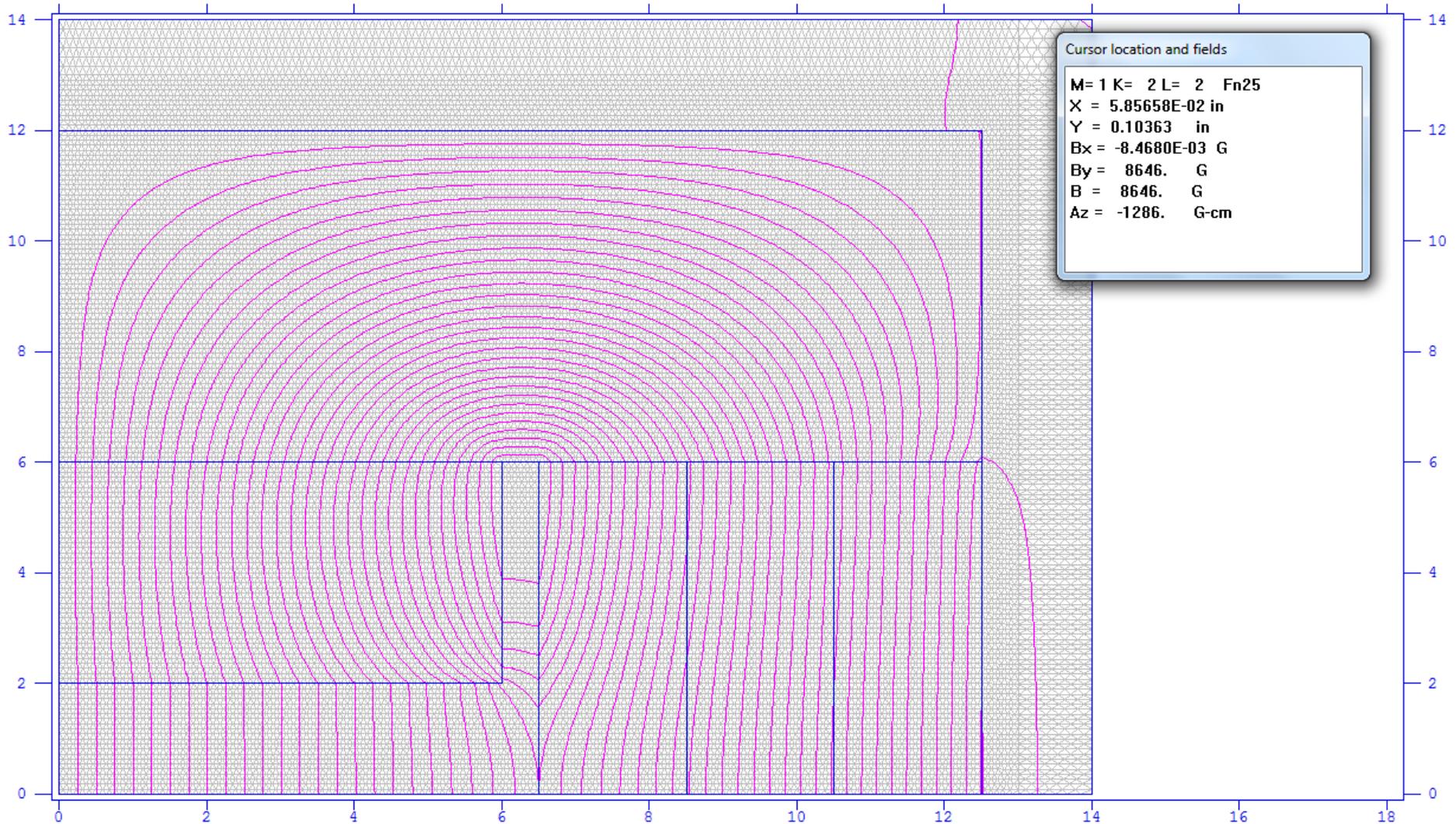


Not Good Enough



New Shape

Permanent-Magnet Dipole (for PANDIRA)

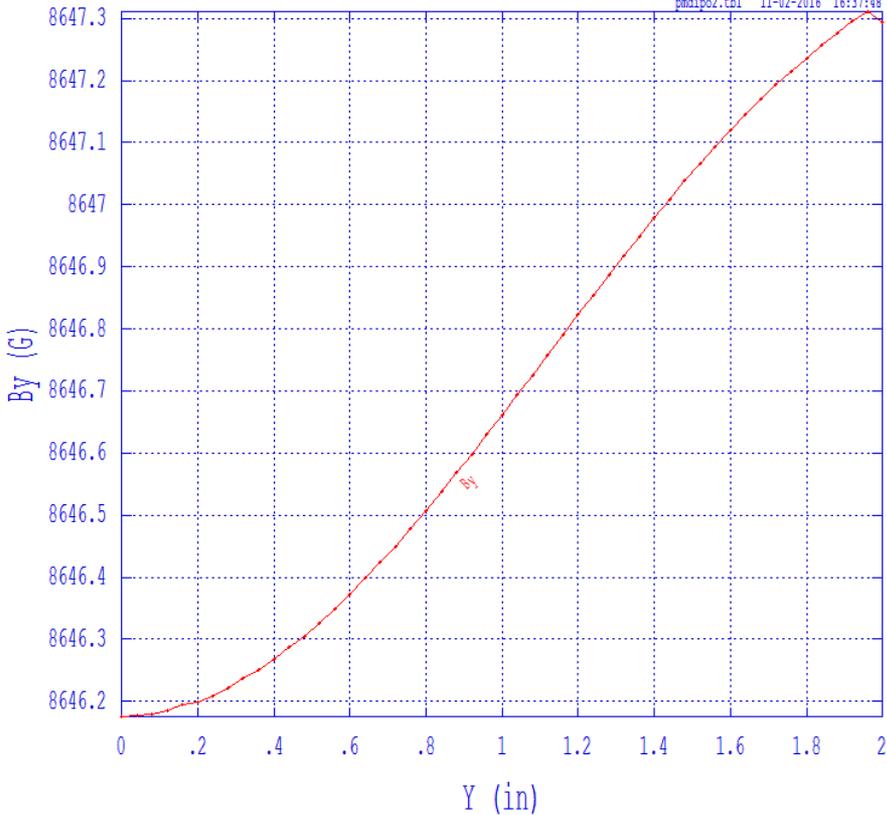


C:\Users\backfish\Documents\ExternalBeamlines\MTest\MandysMagnet\pmdipole 50\PMDIPOLE.AM 11-02-2016 6:42:02

Now are Actually Playing the Correct Game

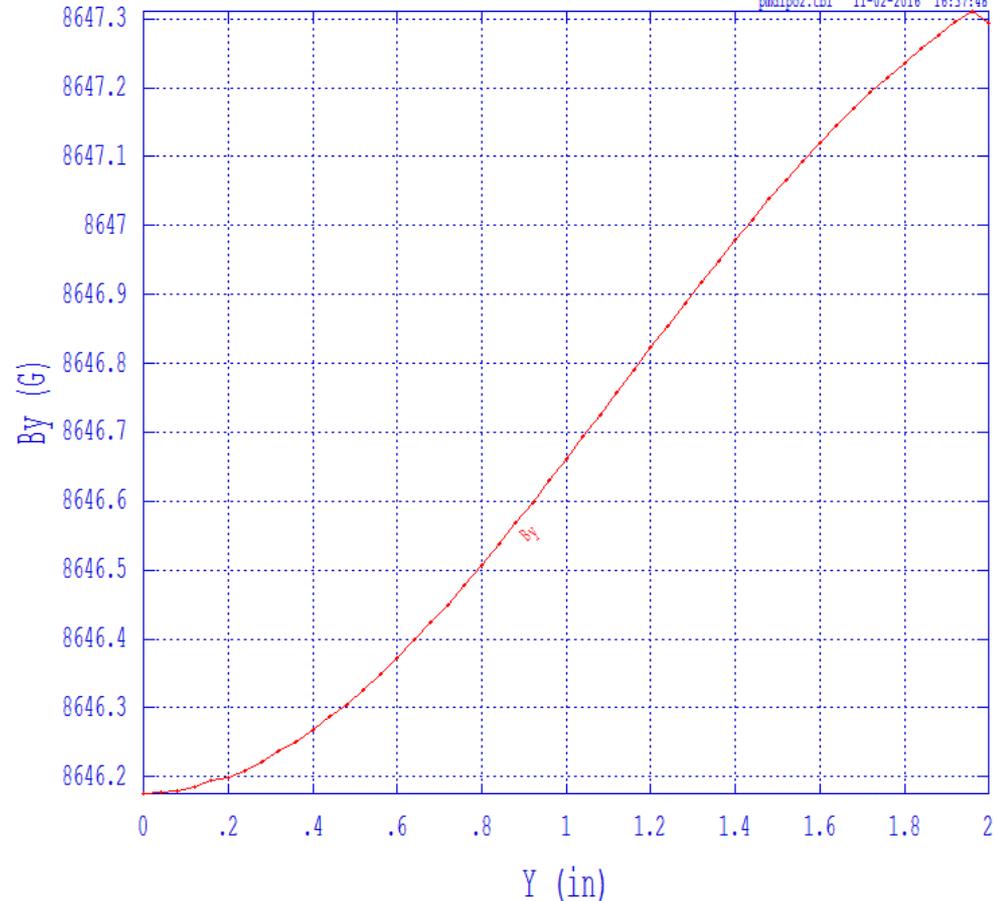
Magnetic field data from file PMDIPOLE.AM
Problem title line 1: Permanent-Magnet Dipole (for PANDIRA)

pmdipo2.tbl 11-02-2016 16:37:48



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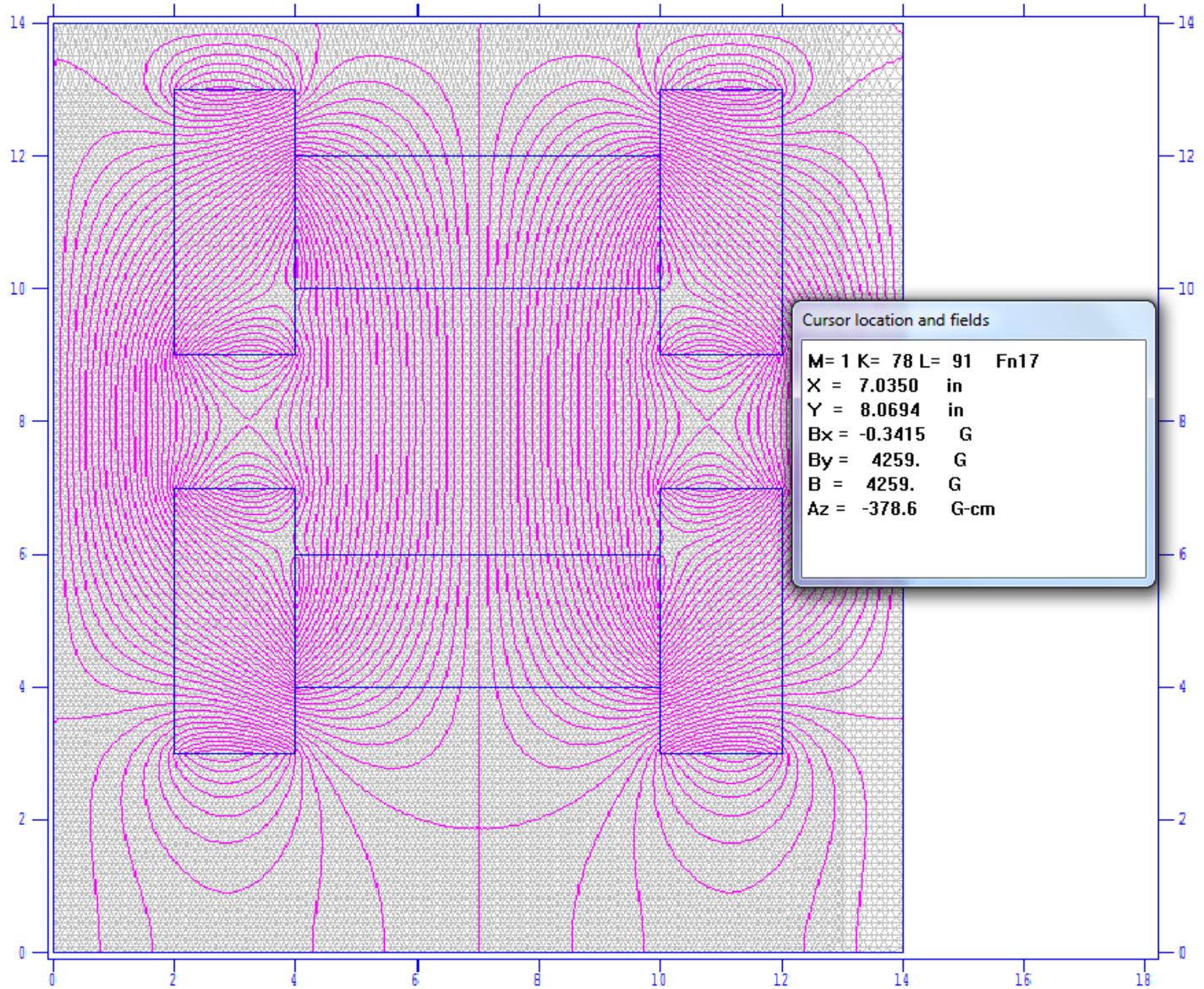
pmdipo2.tbl 11-02-2016 16:37:48



Halbach Array

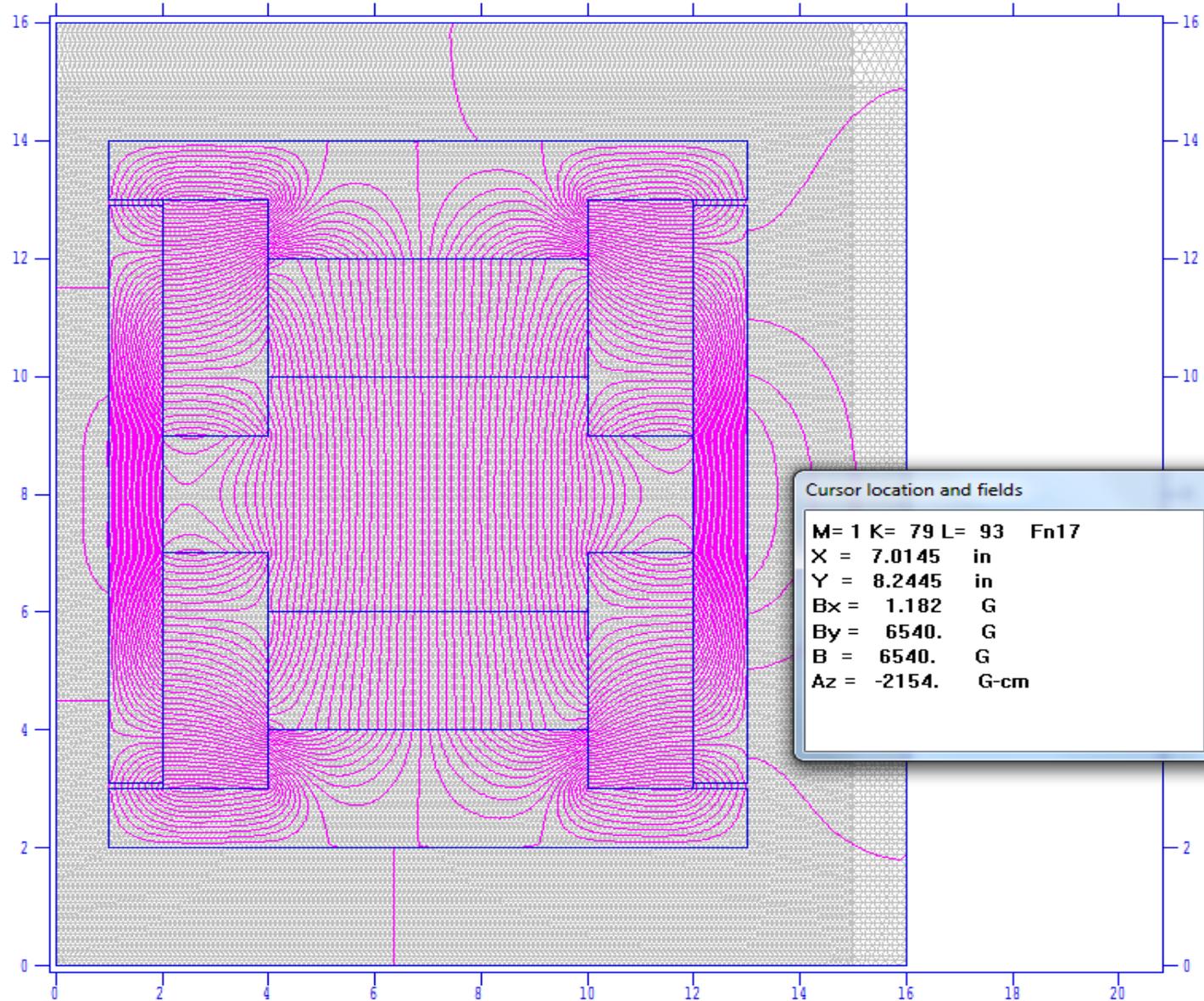
Source: Jim Volk "Permanent Magnet Work at Fermilab 1995 to present" in DocDB

Permanent-Magnet Dipole (for PANDIRA)



With Yoke

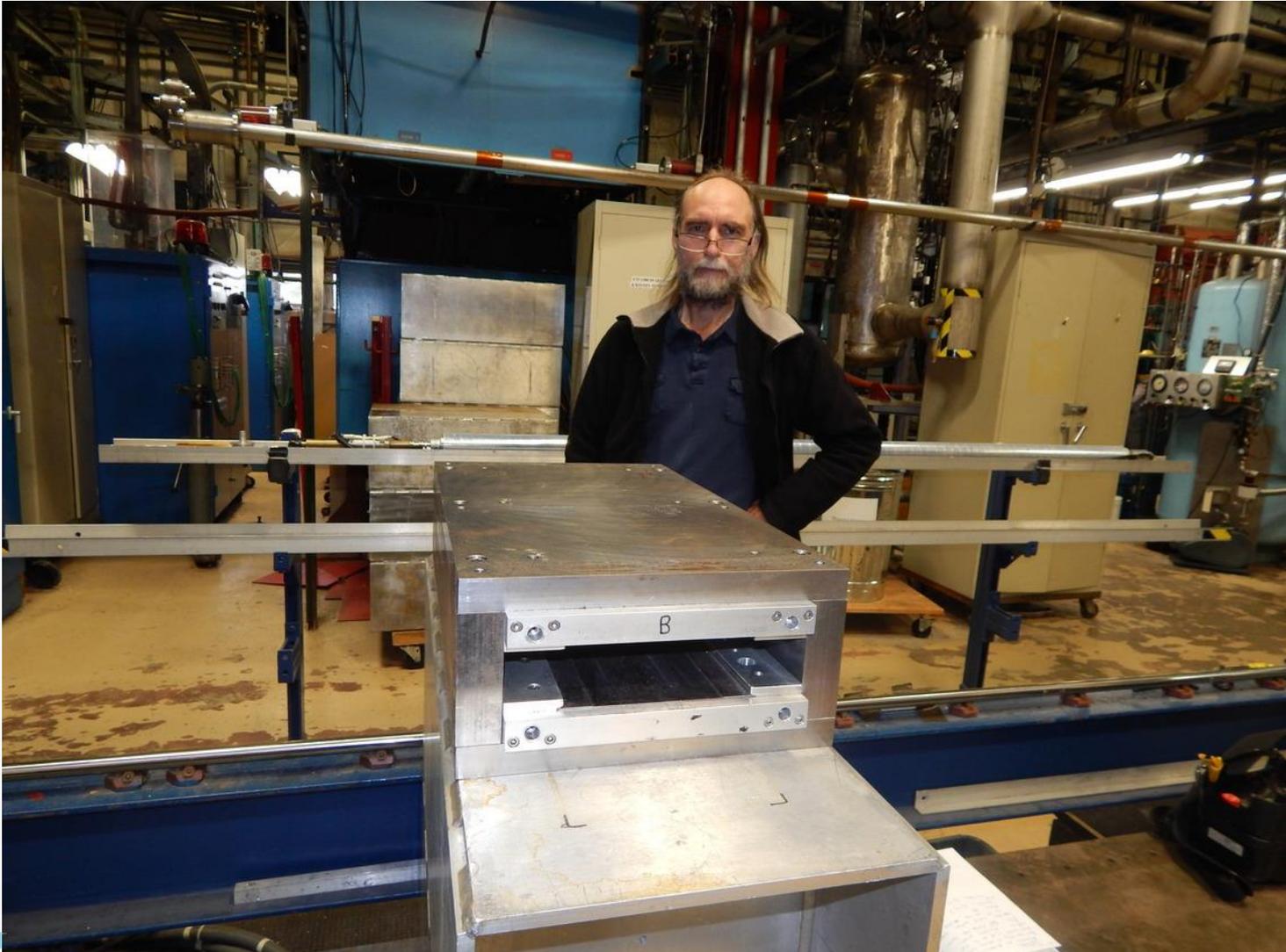
Permanent-Magnet Dipole (for PANDIRA)



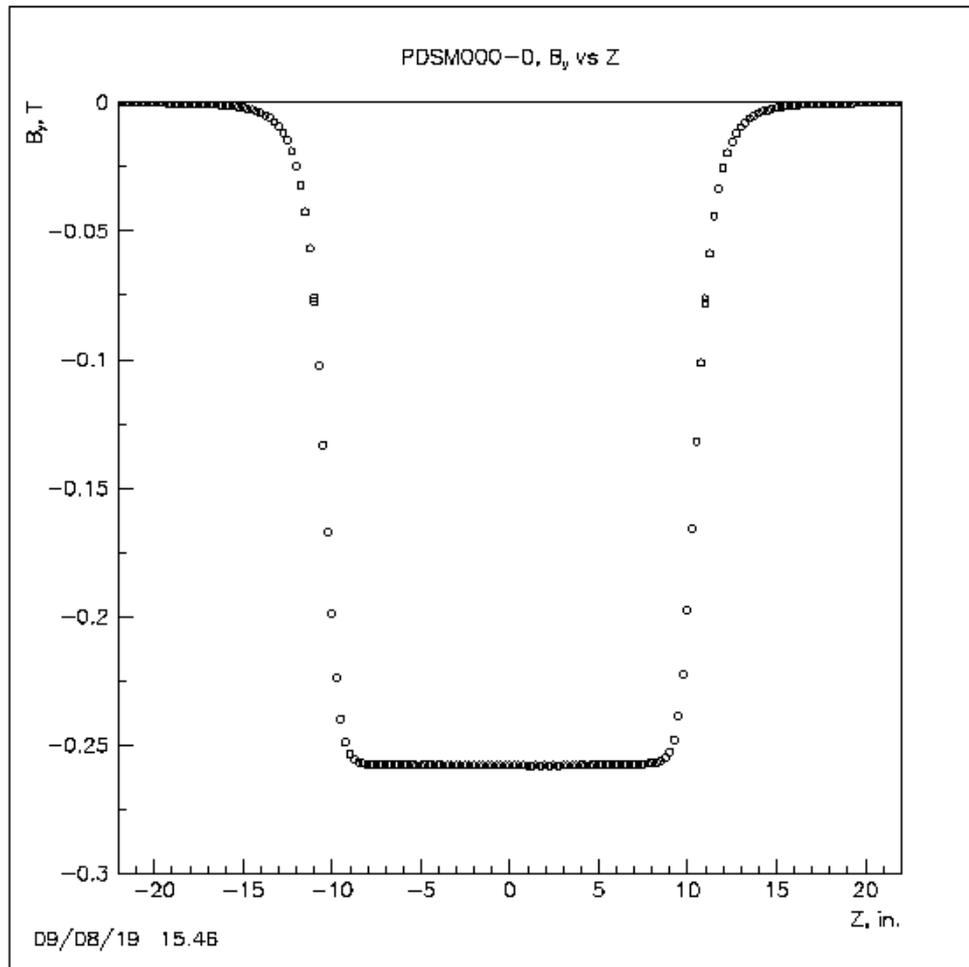
Samarium Cobalt SmCo “PDS magnet” In the Recycler Injection Line after the NOVA ANU Upgrade



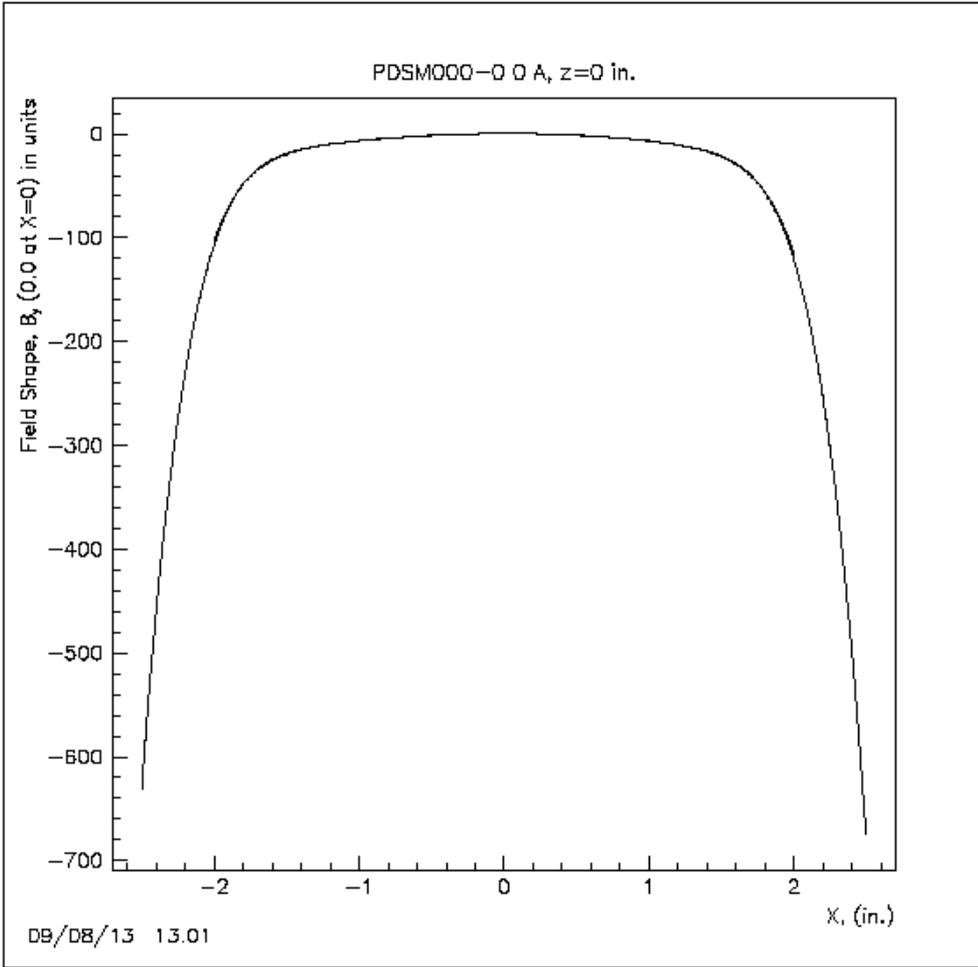
“PDSM Magnet” Baby Version



Longitudinal Field



Field Measurements



Next Steps and Sources

- Evaluate Cost
- Determine Mechanical Forces
- Send Preliminary Design to Technical Division and Jim Volk for ridicule
- I would like to make this system modular so we could build a 4 or 8 inch version with the ability to add more sections as the design is better understood.
- Source: Jim Volk “Permanent Magnet Work at Fermilab 1995 to present” in DocDB
- <http://www-tdserver1.fnal.gov/Project/ProEng/MagnetPhotos/pics.asp?qsPath=PDS>
- <http://www-tdserver1.fnal.gov/Project/JobFiles/ObsoleteDrawings/460000-460999/460527B1.TIF>
- <http://www-tdserver1.fnal.gov/Project/ProEng/MagnetPhotos/pics.asp?qsPath=PDSM>
- <http://www-tdserver1.fnal.gov/Project/JobFiles/ObsoleteDrawings/459000-459999/459039-1.TIF>
- https://wwwtsmtf.fnal.gov/magnet_data_directories/PDSM/
- https://wwwtsmtf.fnal.gov/magnet_data_directories/PDS/
- http://www-tdserver1.fnal.gov/AcceleratorSupport/NOvA_ANU/