Center for the Advancement of Natural
Discoveries using Light Emission

The status of AREAL linac magnets and magnetic measurement bench

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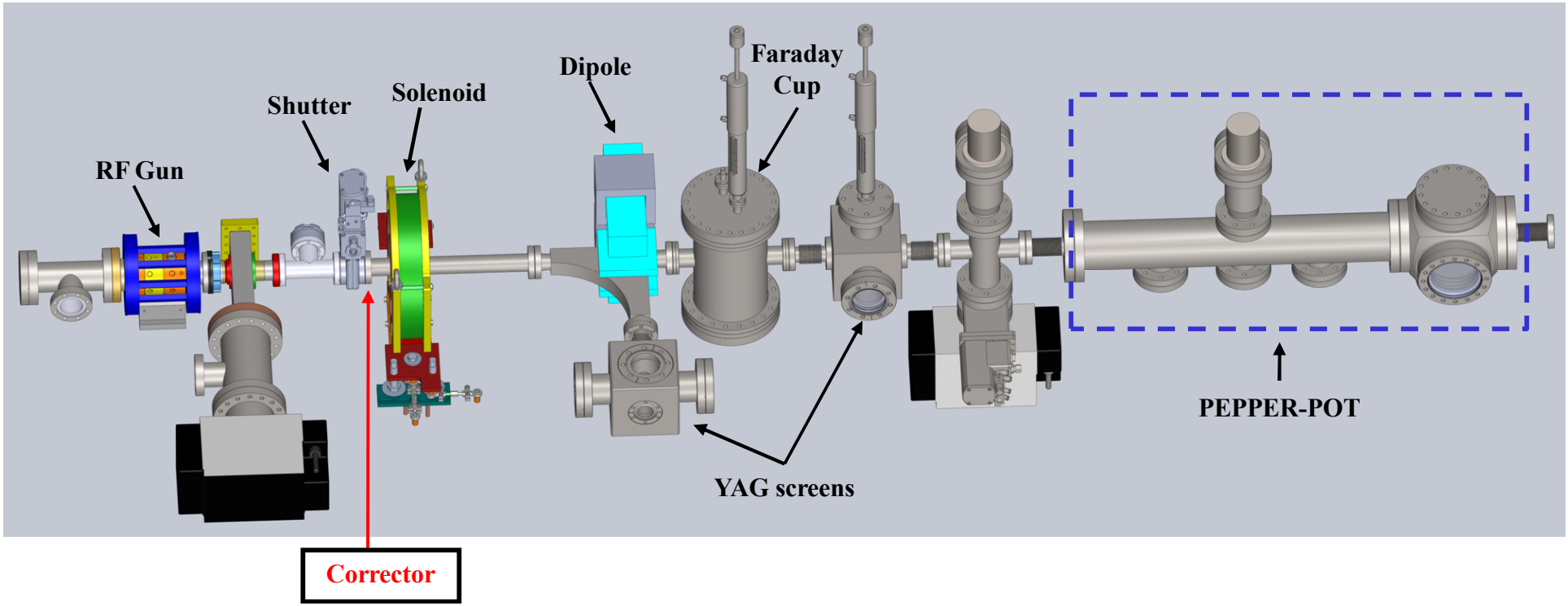
CANDLE, Yerevan, Armenia

AREAL TAC meeting, CANDLE
16-18 July 2013

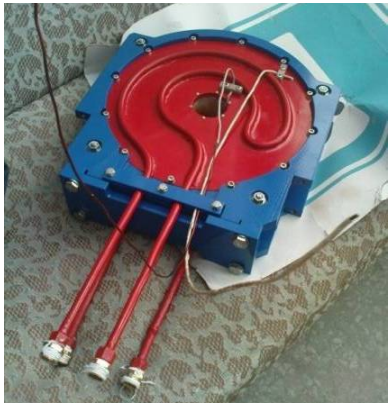
Topics

- AREAL linac Overview
- Magnets design and performance
  - Solenoid magnet
  - Dipole magnet
  - Corrector magnet
- Magnetic measurement bench

AREAL linac layout (Phase 1)



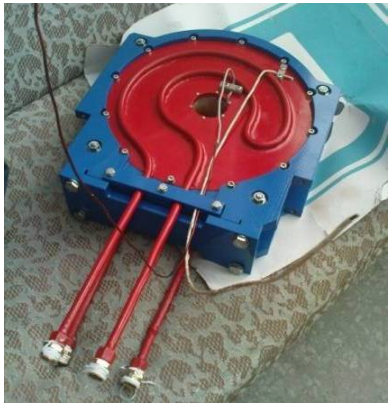
Solenoid magnet



Solenoid parameters	
Material	Copper
Number of windings	1005
Number of layers	50
Number of windings in layer	20
Coil length	41.8 mm
Wire diameter	1.9 mm
Wire diameter with insulator	1.92 mm
Wire cross section	2.835 mm^2
Density	8.96 g/cm^3
Specific resistance	1.75 μΩ-cm
Inner/outer radii of the coil	30/130 mm
Coil wire length	505 m
wire total weight	12.8 kg
Total Ohmic resistance	3.1 Ω
Solenoid length	43 mm

V. Khachatryan,
S. Nagdalyan

Solenoid magnet



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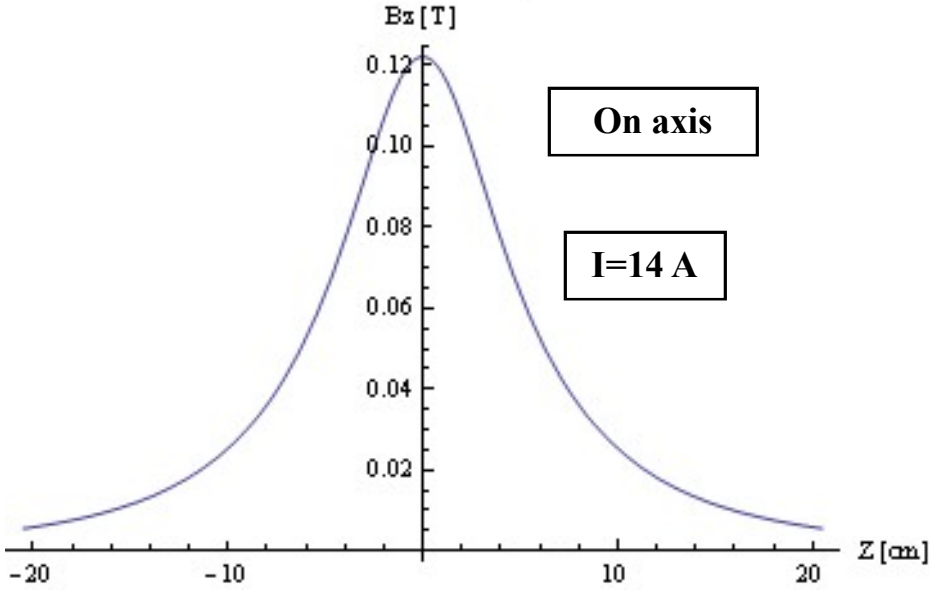
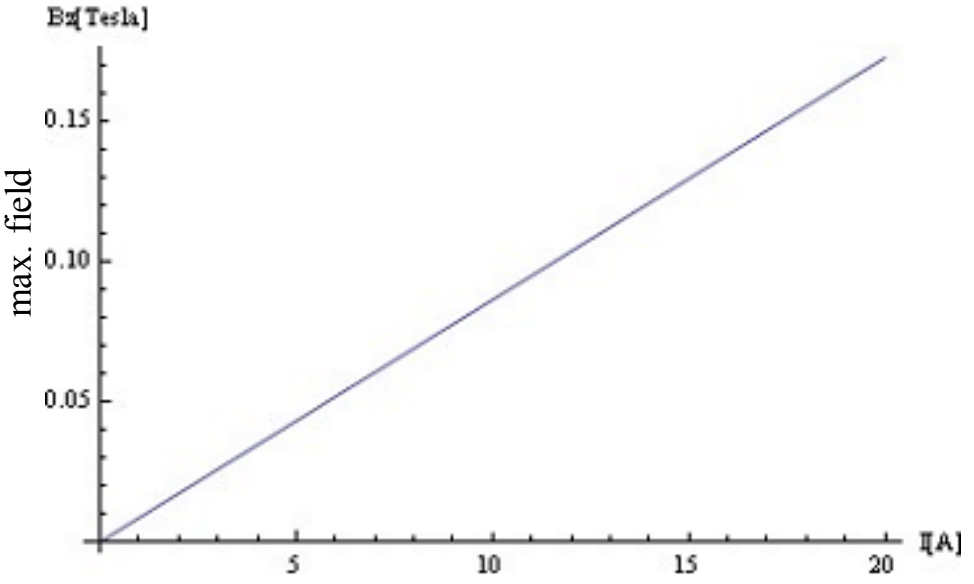


On axis

I=14 A



V. Khachatryan, S. Nagdalyan

Solenoid magnet

DC Power Supply Requirements	
Type	Bipolar, Controllable
Load resistance	3.1 Ω
Maximal voltage	50 V
Maximal current	20 A
Minimum Power	1 kW
Current stability	$< 10^{-2}$ (< 1%)

Solenoid magnet

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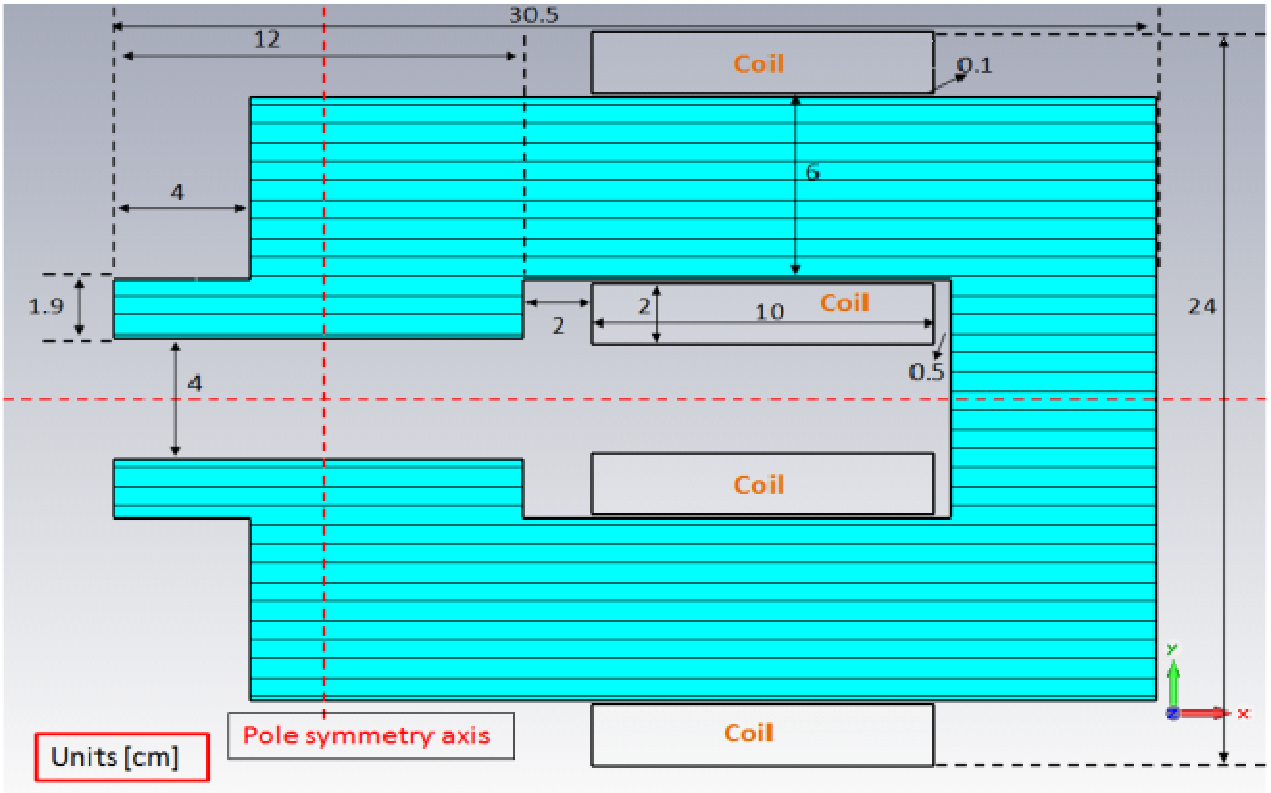
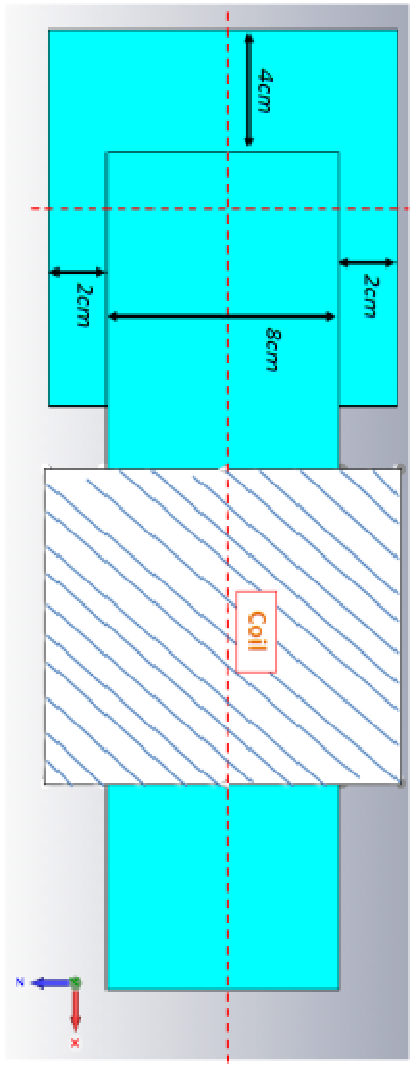
Current stability	$< 10^{-2}$ (< 1%)

Ongoing activity list to operate Solenoid

- Magnet fabrication – completed
- Magnet support design – completed
- Magnet support fabrication – in process
- Alignment table fabrication – completed
- Cooling system design – completed
- Cooling system fabrication – in process
- Power supply fabrication – in process
- Field measurement – scheduled

Dipole magnet

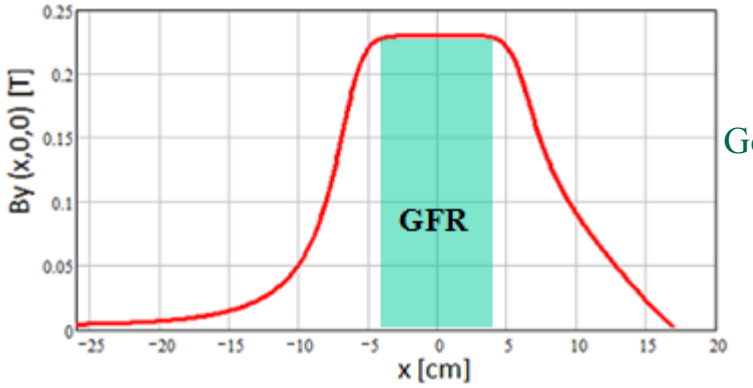


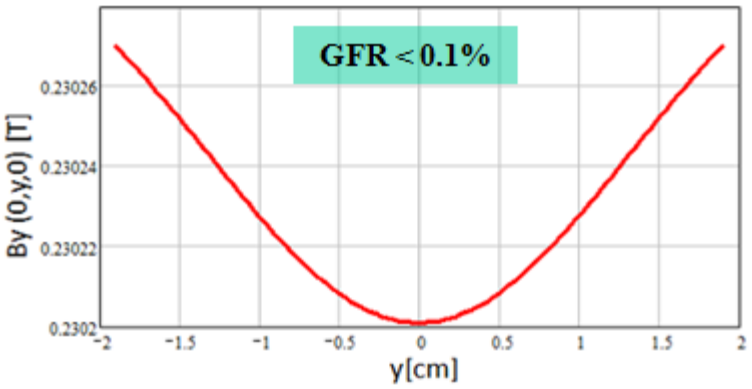


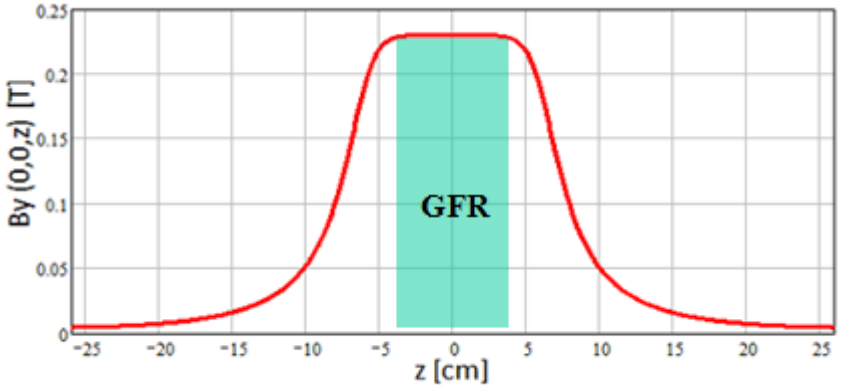
Dipole magnet

Field profiles

Good Field Region (GFR) $\longrightarrow \Delta B/B_0 < 1\%$







Dipole magnet

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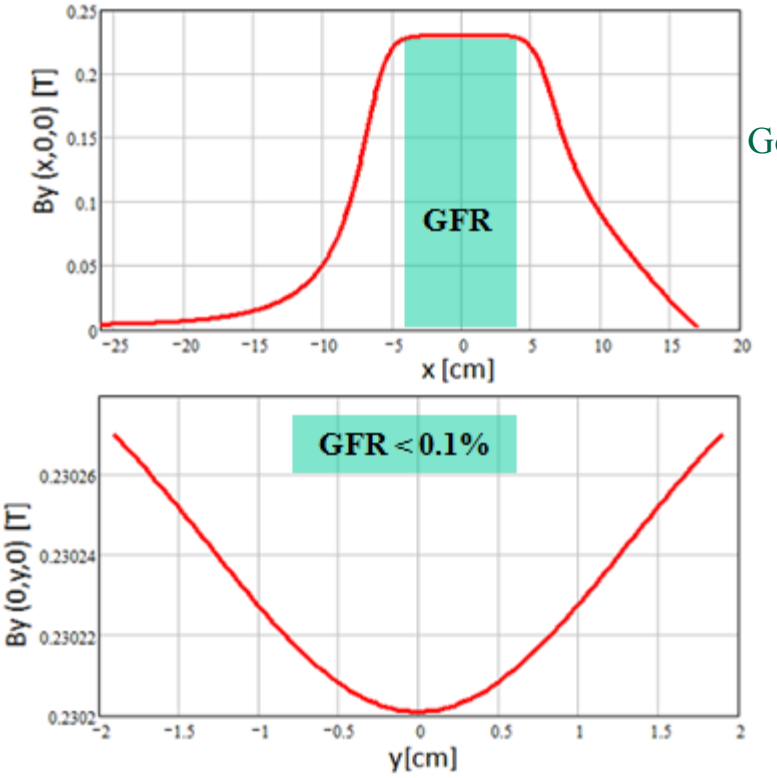
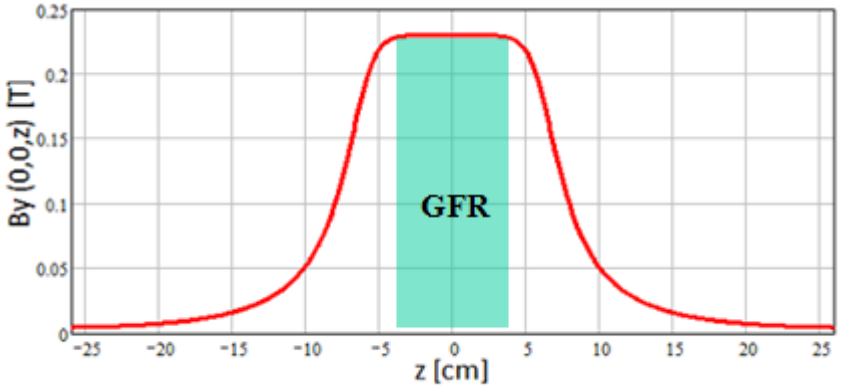
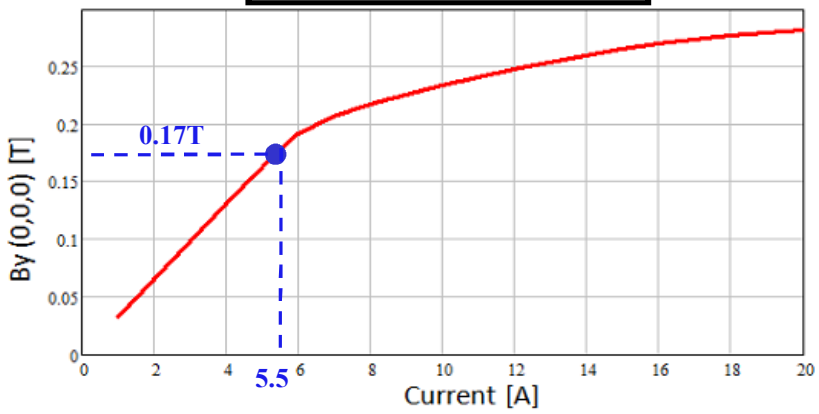
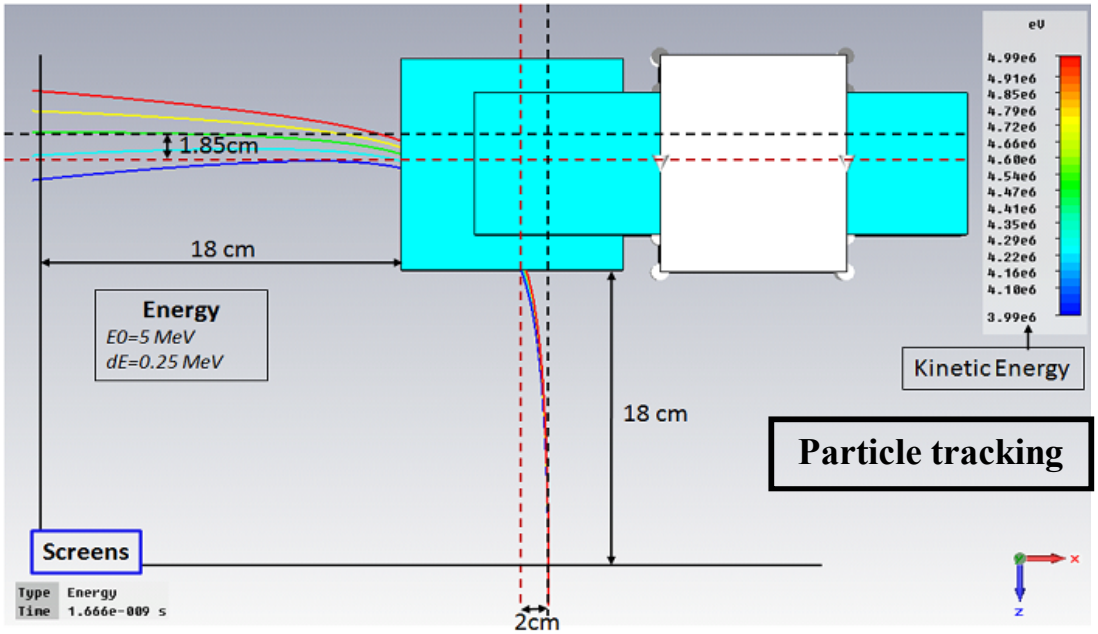




Max. field vs current



Dipole magnet



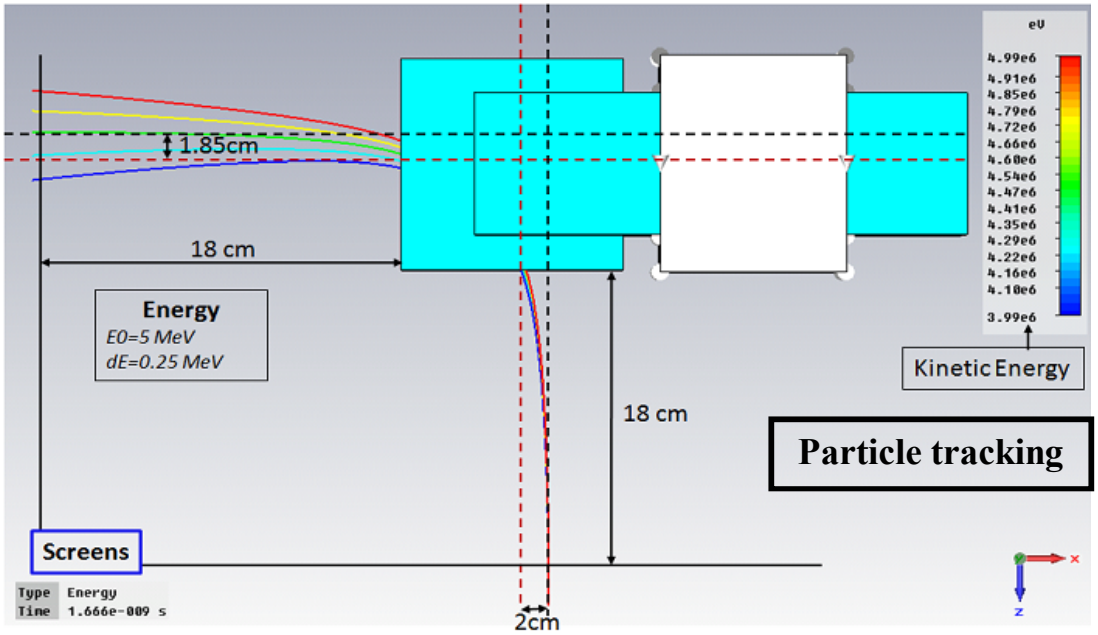
Dispersion

$$D = -0.24016$$
$$D' = -0.96173$$

Energy spread measurement

$$\sigma_x = \sqrt{\varepsilon_x \beta_x + (D\delta)^2}$$

Dipole magnet



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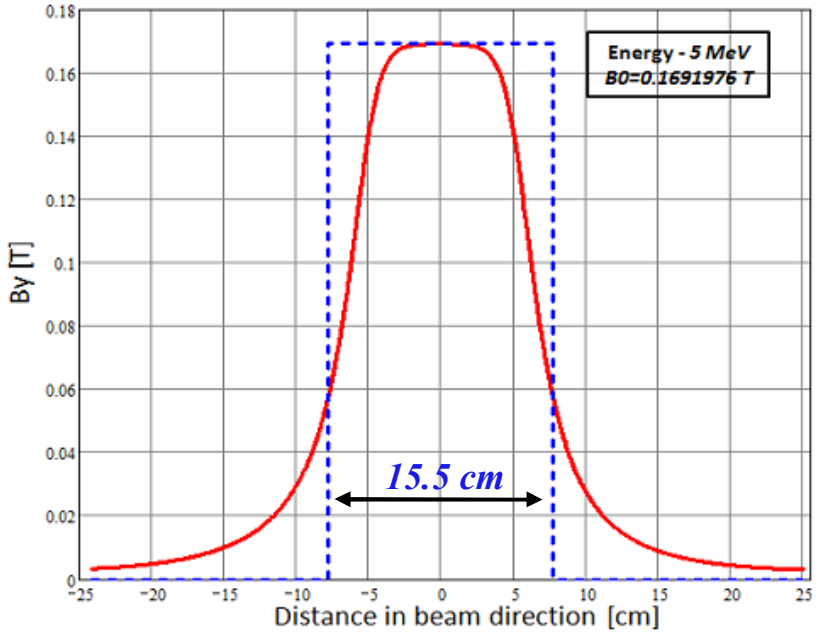
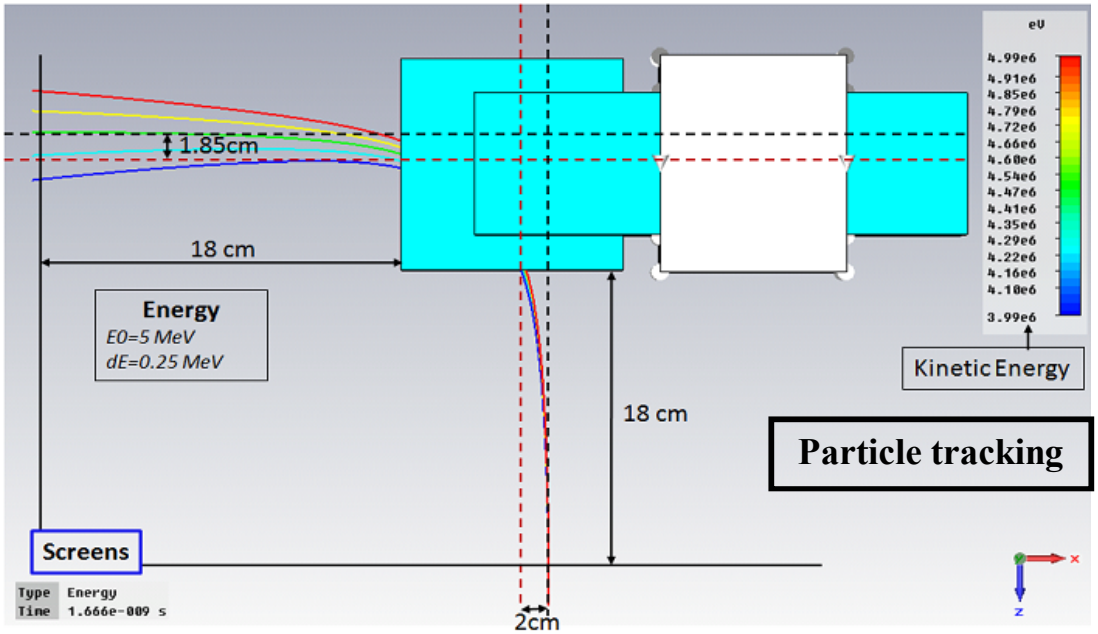
Hard-edge approx.

$$l_{eff} = \frac{\int B_y \, ds}{\max(B_y)}$$



Dipole magnet



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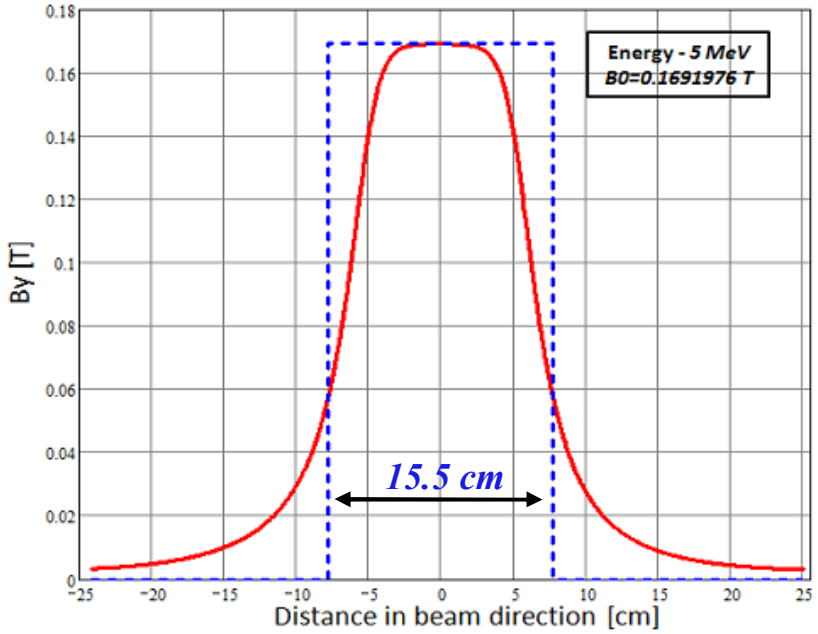
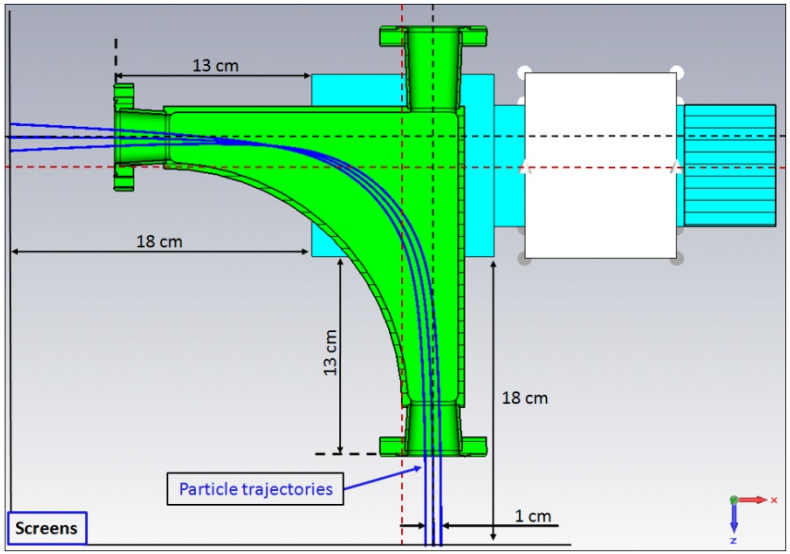


DC Power Supply Requirements	
Type	Bipolar, Controllable
Load resistance	2 Ω
Maximal voltage	50 V
Maximal current	20 A
Minimum Power	1 kW
Current stability	$< 10^{-2}$ (< 1%)

Dipole magnet

Vacuum chamber - 90° bend



Dipole magnet

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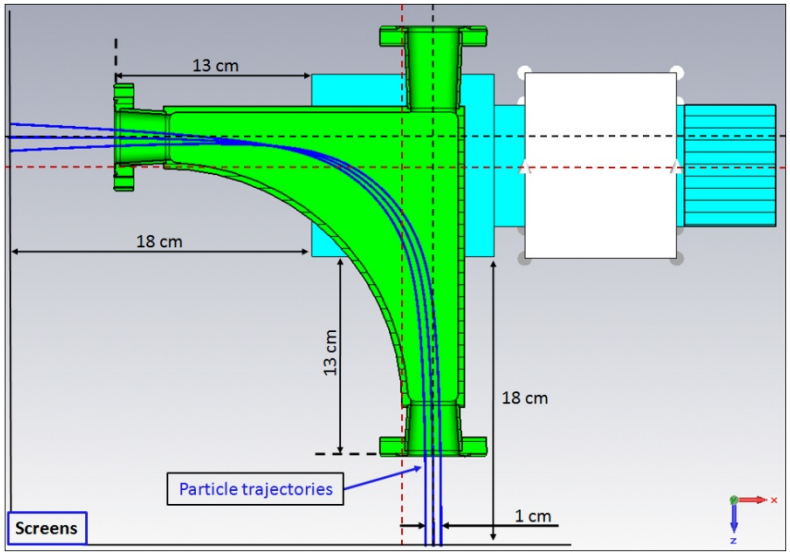
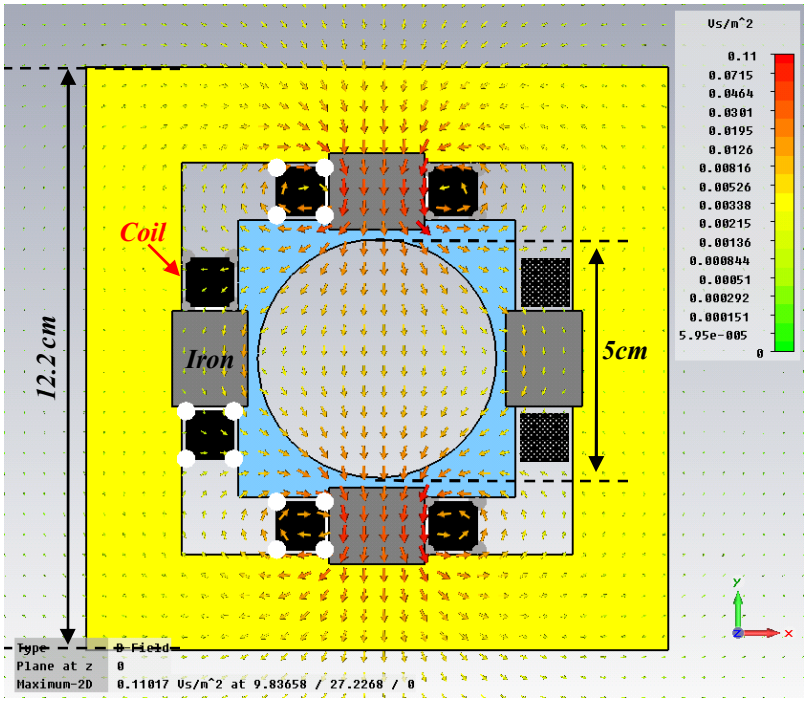
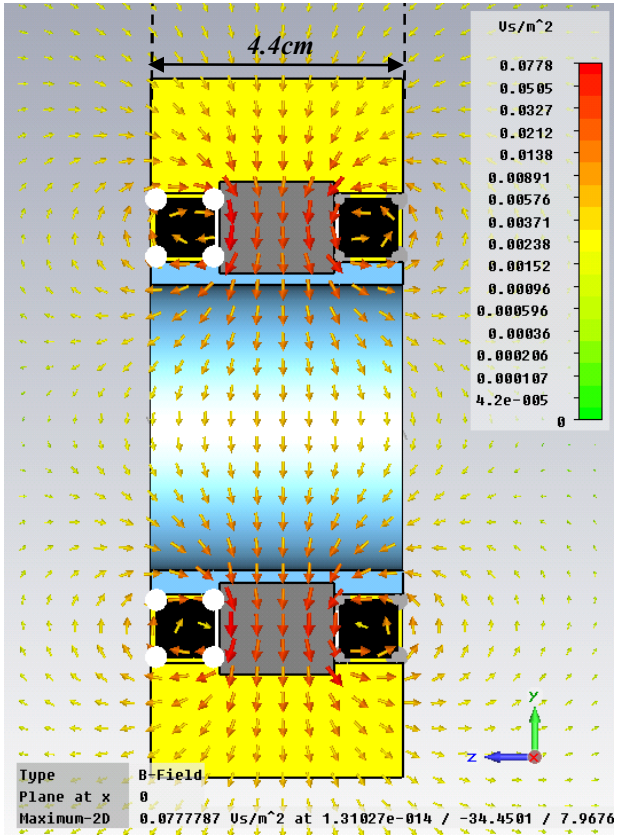


Ongoing activity list to operate Dipole

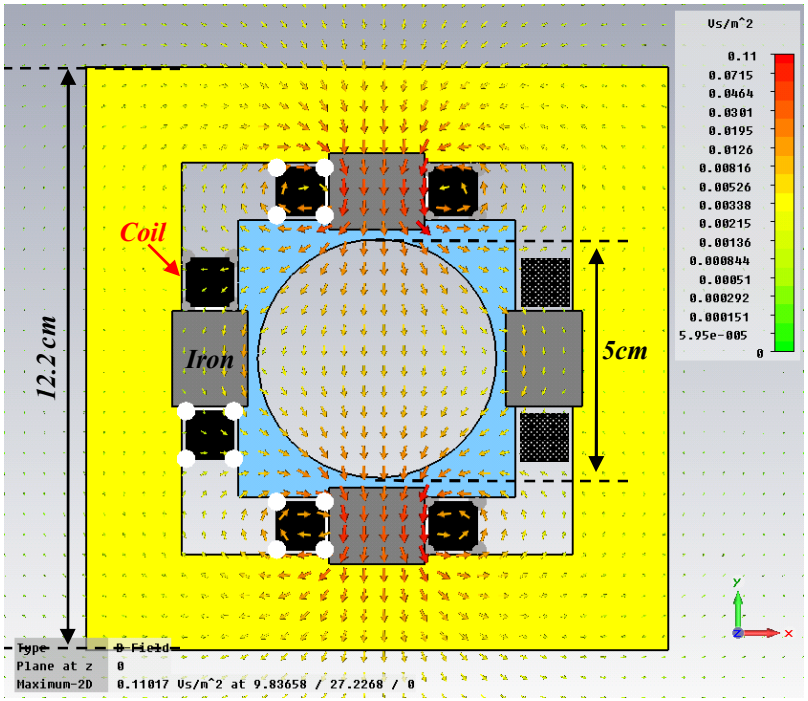
- Magnet design – completed
- Magnet fabrication – in process
- Magnet support design – in process
- Alignment table fabrication – completed
- Vacuum chamber fabrication – completed
- Power supply fabrication – in process
- Field measurement – scheduled

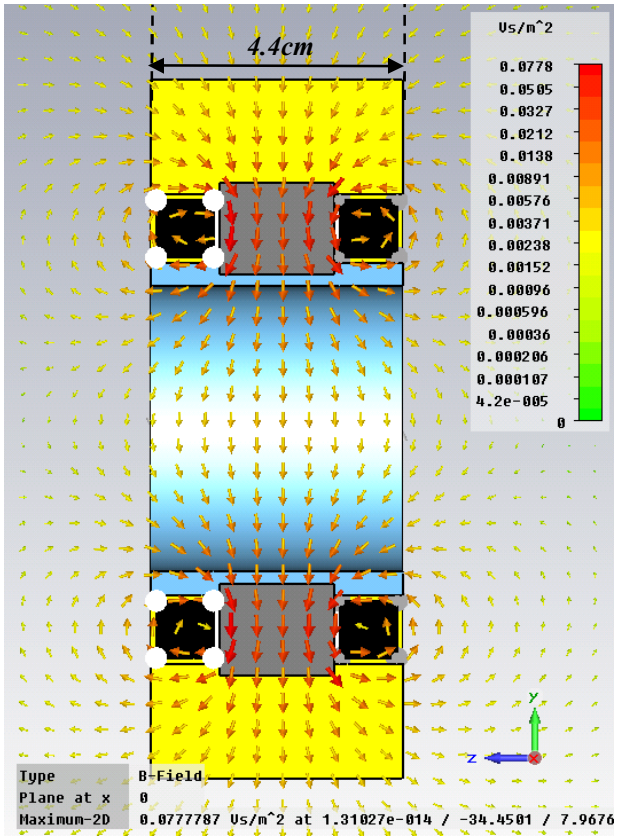
Corrector magnet

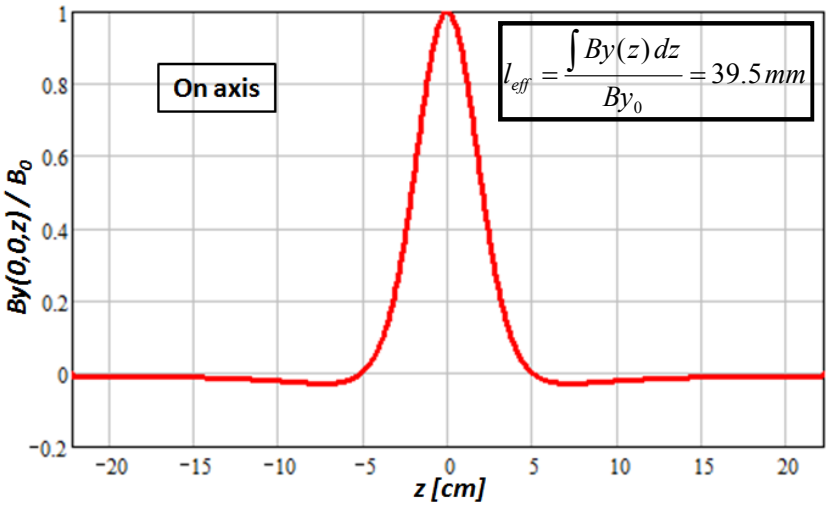




Corrector magnet







$$I = 2\,A \;\rightarrow B_0 = 6\,mT$$

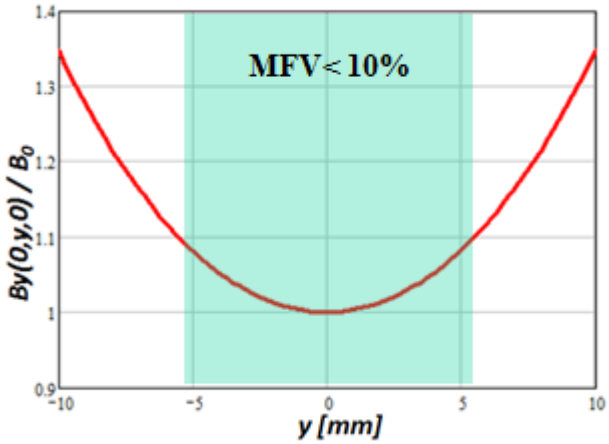
$$\Downarrow$$

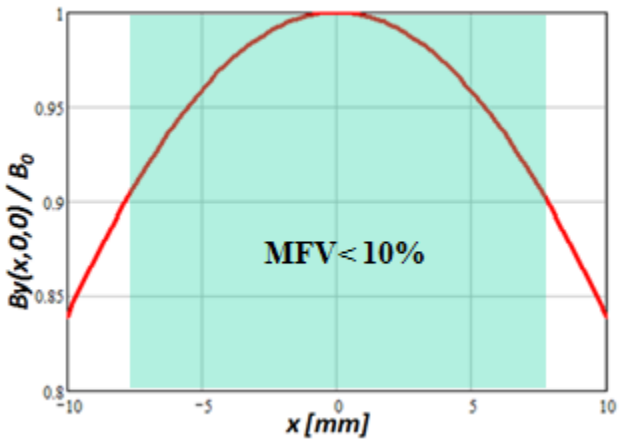
$$\Delta\alpha[mrad] \approx 0.2998 \cdot \frac{B_0[mT]\,l_{eff}[mm]}{E[MeV]} \overset{E=10MeV}{\approx} 7\,mrad$$

Corrector magnet

Field profiles - $B_0 = B_y(0,0,0) = 6mT$

Magnetic Field Variation (MFV) $\longrightarrow \Delta B/B_0$





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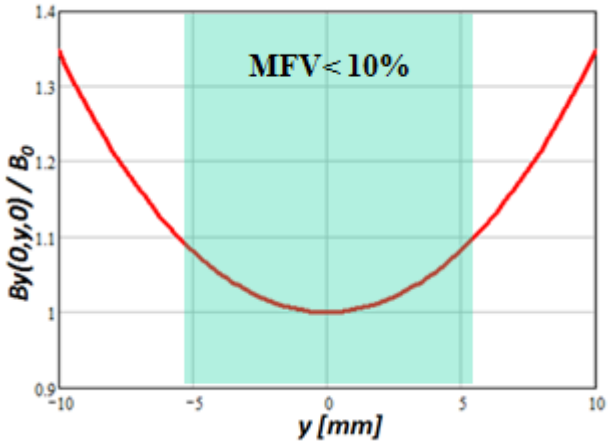
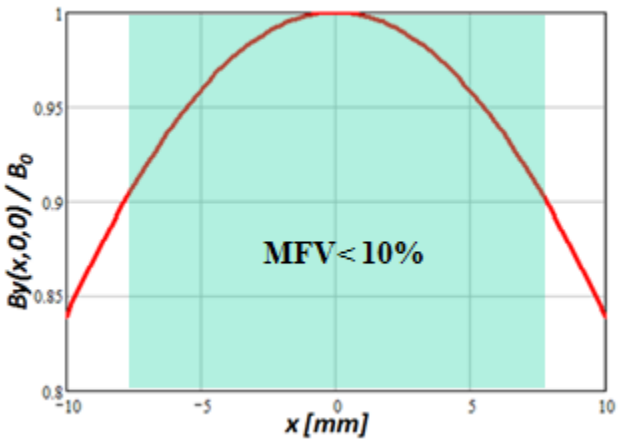
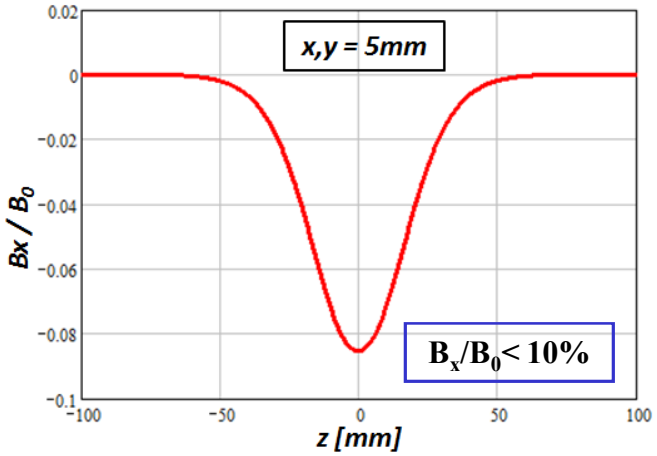
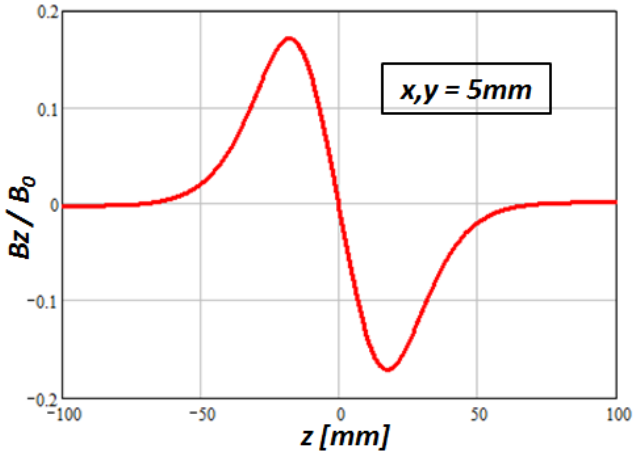






$B_{x,z} \sim x\,y$



Corrector magnet

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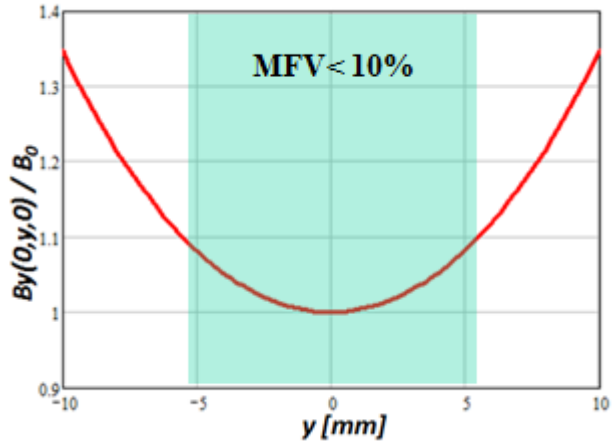

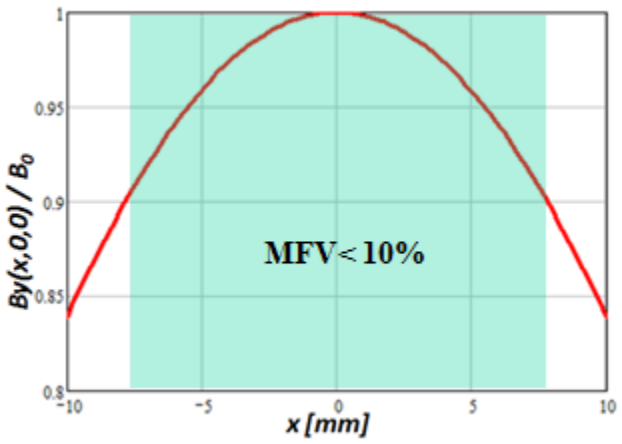

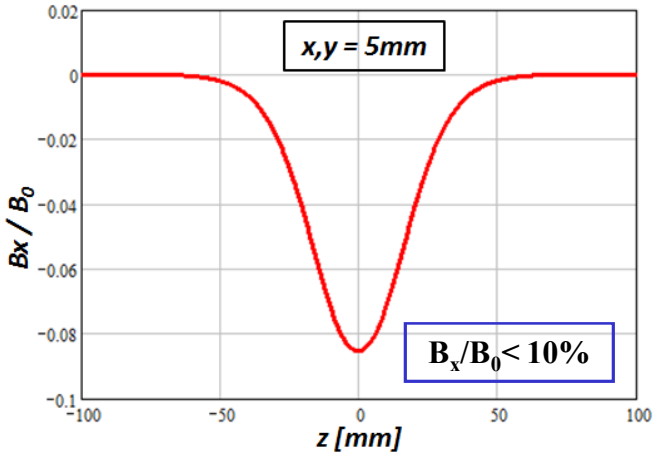

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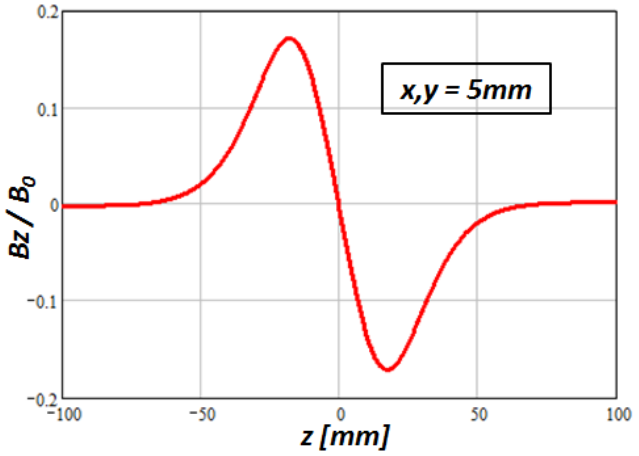


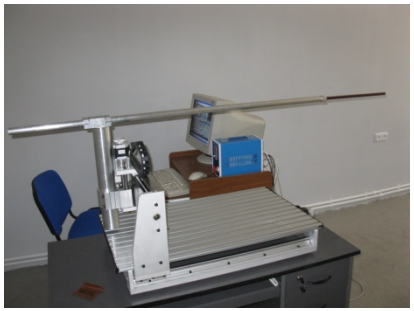
Impact on beam dynamics ? → **Status – design stage**

Magnetic measurement bench

Required Equipment

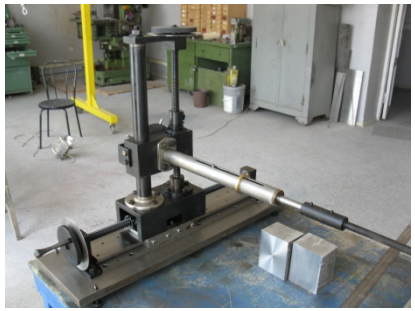
3D coordinate table

- Remote control



Status - Ready

- Mechanical control



Status - Fabrication

Magnetic measurement bench

Required Equipment

3D coordinate table

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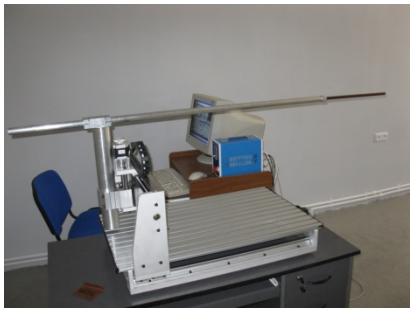

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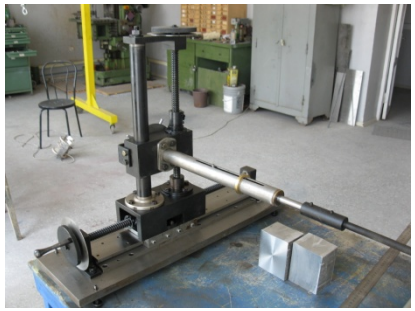
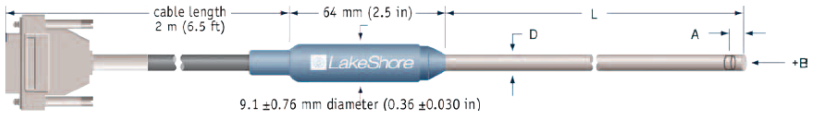
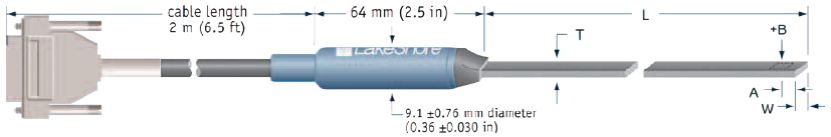


Status - Fabrication

Gaussmeter + Hall probes





Technical specifications

- measurement range – 0-35 kG (3.5 T)
- DC measurement accuracy – 0.2%

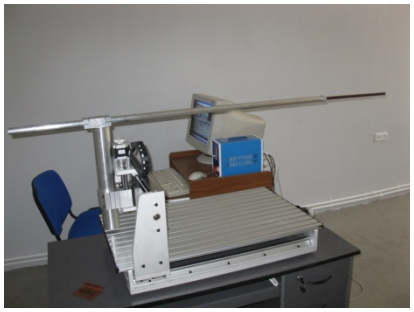
Status - shipment in process

Magnetic measurement bench

Required Equipment

3D coordinate table

- Remote control



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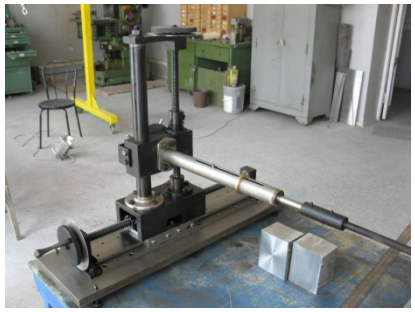

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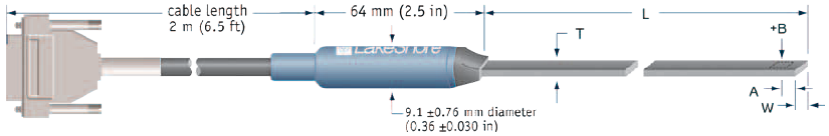

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