



SABR Enterprises, LLC.

Permanent Magnet Assemblies for Accelerator and NMR Applications

- Wholly Owned and Operated by
 - Robert Mercurio, Owner / Technical Director
- SABR formed in 2011
 - Latest incarnation of Field Effects, Inc > Aster Enterprises – originally founded in 1980 by Ron Holsinger, Bob Lown
- Located 25 miles from Boston in a 7,300 square foot facility





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- What we do:
 - Design and build PM devices from customer specifications
 - PM material selection: type and grade (understand material properties and tolerances)
 - SmCo2:17
 - Nd-Fe-B
 - Ceramic Ferrite
 - Proprietary computer codes for design, analysis, and tuning ('shimming') based on analytical formula (Halbach, Gluckstern)
 - Possion/Pandira
 - Integrated Engineering AMPERES (3-D boundary element method)
 - Mechanical Design
 - SolidWorks 3D solid modeling
 - Detailed drawings for component fabrication
 - Assembly fixture design



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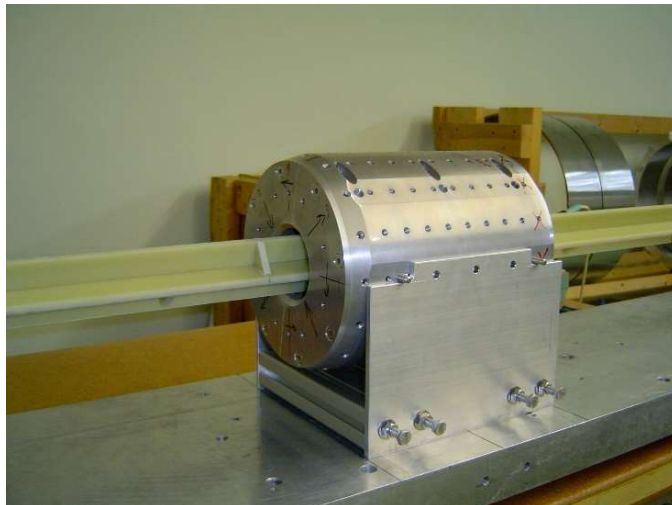
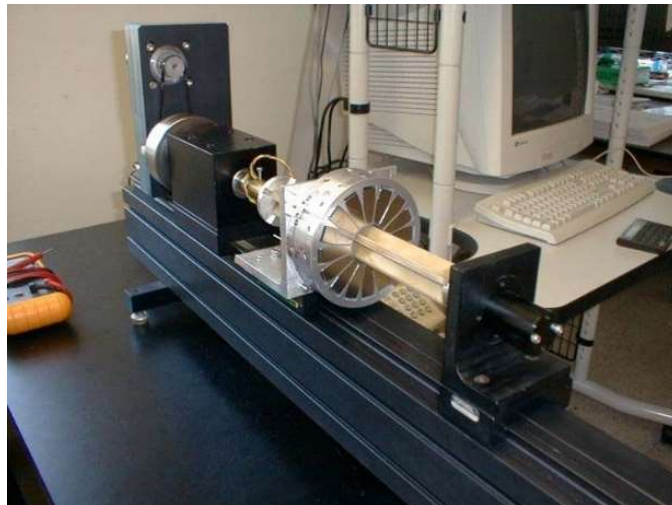
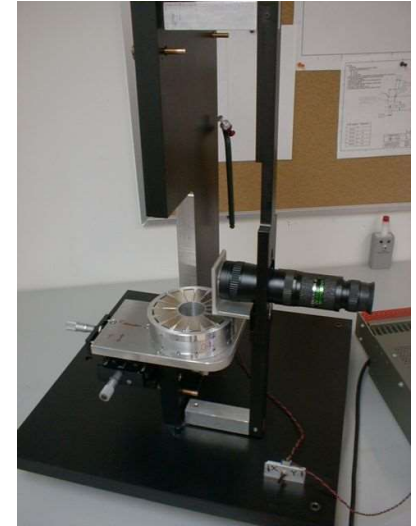
- Fabrication/Assembly
 - Fully equipped machine shop
 - 3 axis CNC – TRAK Model VMC7
 - Grinding
 - WEDM
 - Milling
 - Turning
 - Welding
 - Magnet material processing and inspection
 - Magnetizer – Walker Model LE6000 (6000 joule, 800 V)
 - Ovens (thermal stabilization)
 - Helmholtz Coil Block Measurement System
 - Computer controlled
 - Lakeshore Model 480 Flux Meter
 - Custom assembly tooling





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- Magnetic Measurement and Tuning
 - Quadrupole Wire Center Measurement System
 - Rotating Coil Harmonic Measurement System
 - 3 axis computer controlled field mapping systems (2)
 - Group3 DTM-151 Digital Teslameter(2)
 - Metrolab PT2025 NMR Probe
 - Senis F3A Three Axis Magnetic Field Transducer





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- **Products**

- PM Drift Tube Quadrupoles (Halbach Array)
- PM Halbach Array Quadrupoles (clear bore from \varnothing 1.25m to \varnothing 5mm)
- Beam Line Dipoles
 - Halbach Array
 - Hybrid (Iron and PM)
 - Temperature Compensation (low curie temperature nickel alloys)
- Spectrometers
- Bench Top NMR
 - Halbach Array Dipoles
 - Hybrid Iron Pole designs
- Custom



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Drift Tube Quadrupoles



GTA - CWDD



CERN 100T/m prototype



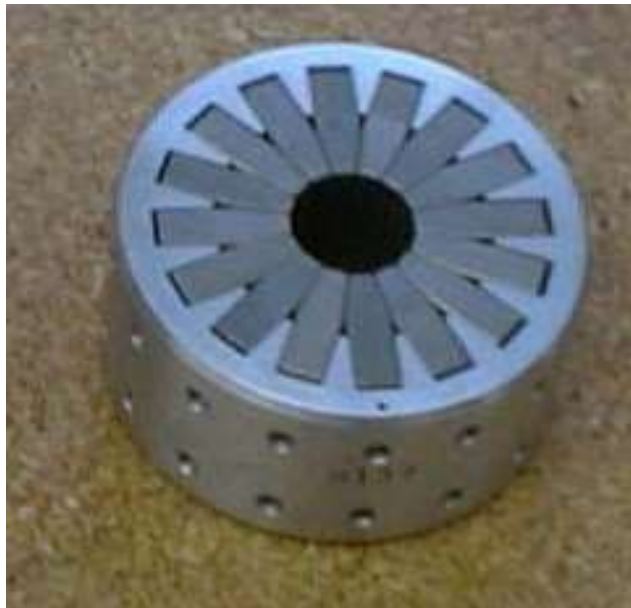
SSC

Tunable field strength and harmonic content – selectively remove material from bore with WEDM
'Pole tip field' $\approx 1.1 - 1.2$ Tesla



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Drift Tube Quadrupoles

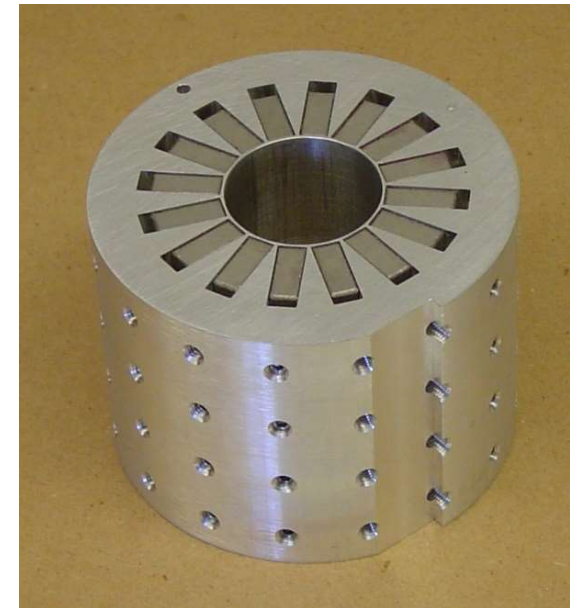


Commercial customer
Touching Pieces
As built tolerances
acceptable



SNS
 $B_{pt} = 0.33T$

Tunable strength and harmonic content
Radial motions of magnet segments

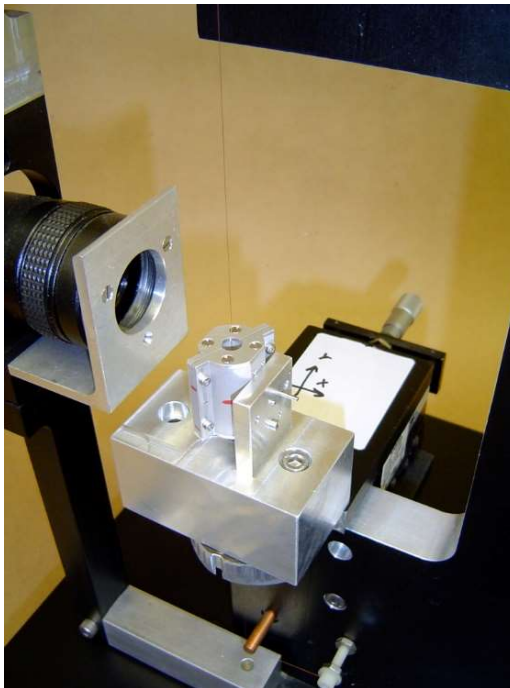


CERN Linac4 Tank1
 $B_{pt} = 0.61 - 0.24T$

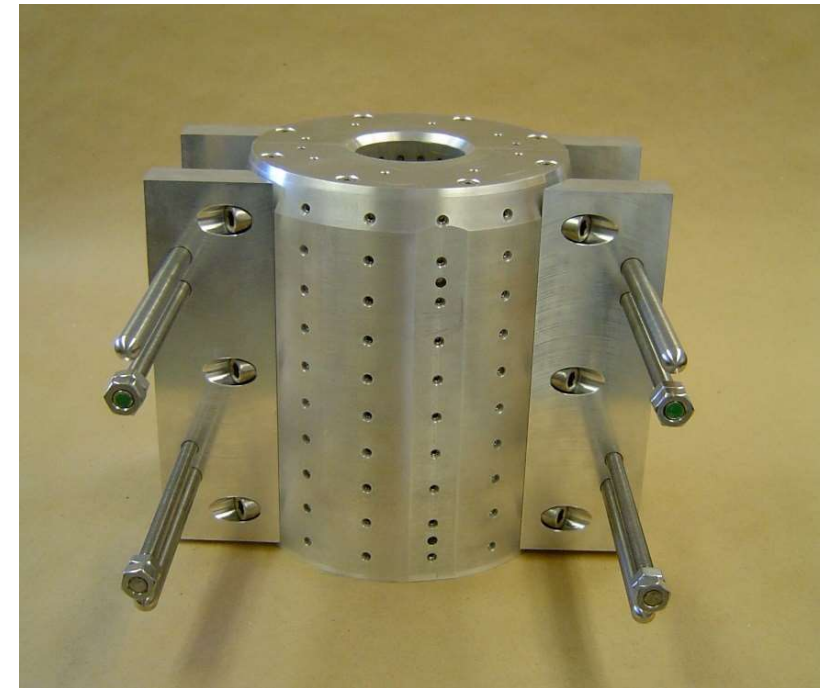
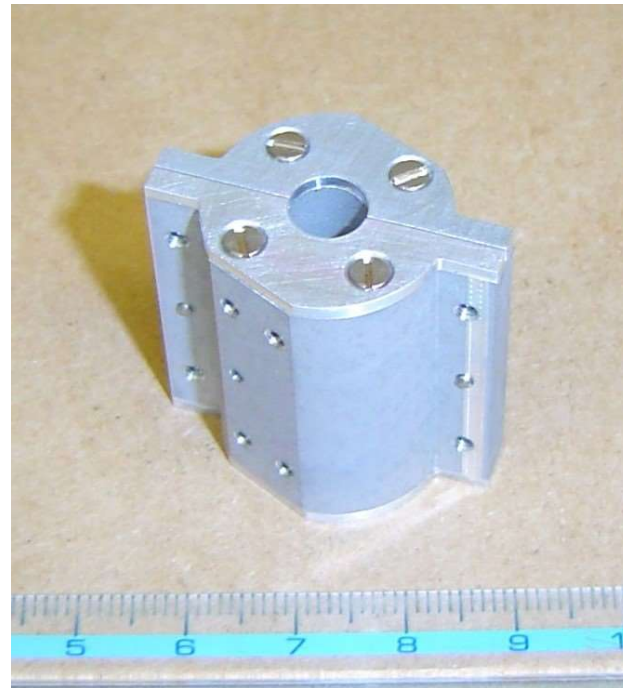


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Beam Line Quadrupoles



Split housing
Ø7mm bore

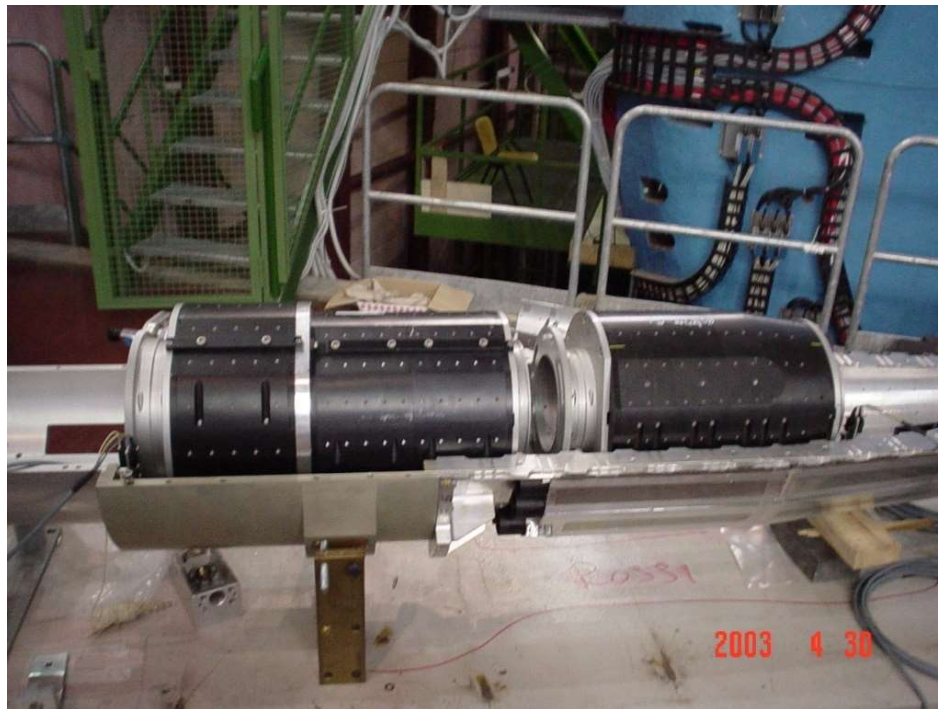


DAΦNE QD0
Split housing
Ø66mm bore



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Interaction Region Quadrupoles

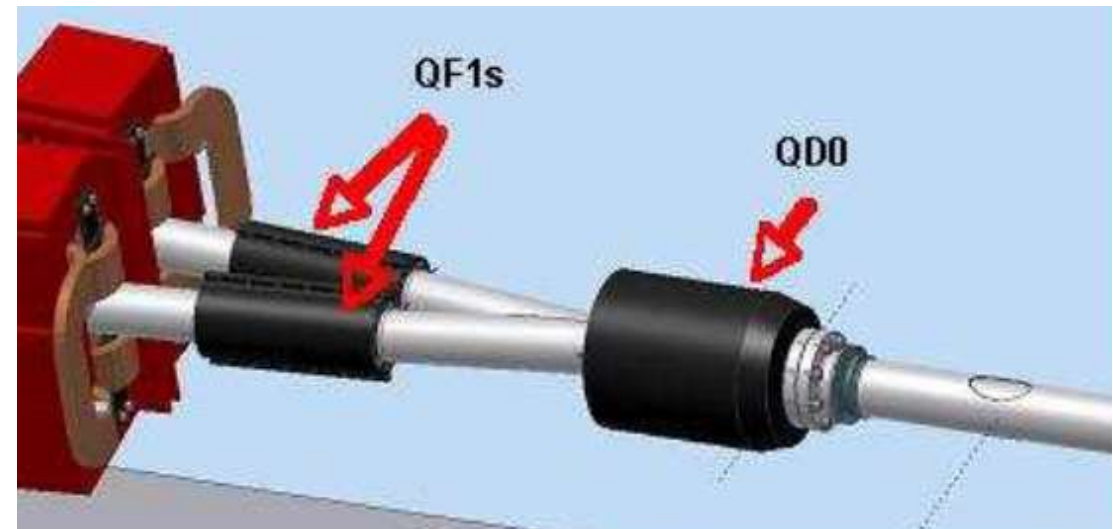


INFN Frascati – KLOE
 $\Delta B/B < 5 \times 10^{-4}$



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Interaction Region Quadrupoles



INFN Frascati – Upgraded DAΦNE
 $\Delta B/B < 5 \times 10^{-4}$



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LANL Proton Radiography Magnifier Permanent Magnet Quadrupoles



x7



x21

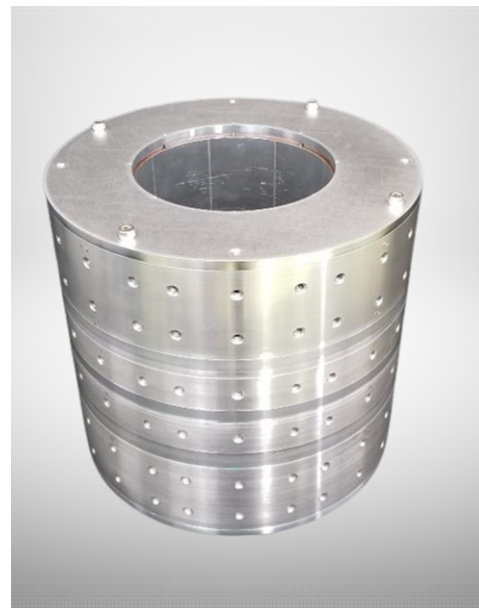


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Halbach Array Dipoles



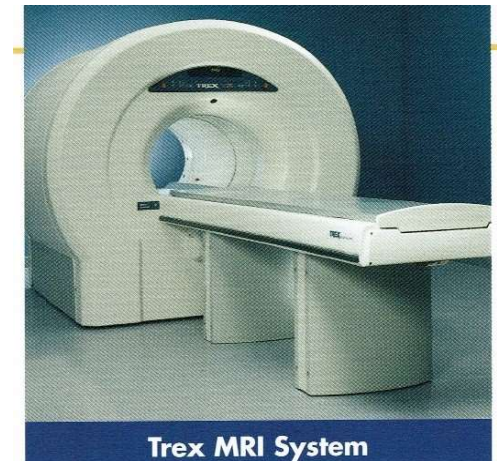
DANCE Sweeper
 $B \cdot L = 0.1T$, $L = 0.5m$
 $\text{Ø}190mm \times 500mm$
90 kg



NMR - 0.32T
 $\text{Ø}138mm \times 225mm$
<100 ppm p-p
 $\text{Ø}40mm$ DSV
36 kg



MRI – 1.4 Telsa
 $\text{Ø}110mm \times 400mm$
600 kg Nd-B-Fe



MRI - Elliptical



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Hybrid (Iron and PM) Dipoles



Fermilab Recycler
Permanent Magnet Dipole

$.4122 \pm 0.03\%$ T-m, $B = .2352$, $L_{eff} = 1.753m$,
 $< 0.03\%$ 15mmx80mm

Thermal Stability $< 0.01\%/^{\circ}C$ 21°C to 31°C,
Weight=460kg

Adjustable Field Integral at Fermilab $\pm 0.05\%$

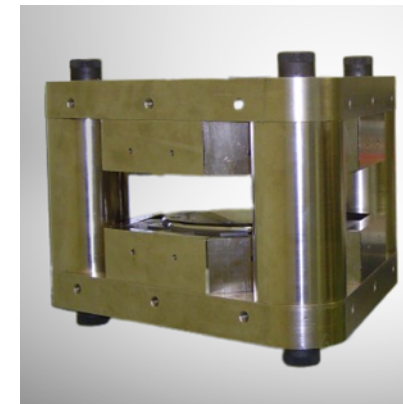


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Bench Top NMR



UCSB
B = 0.35T
35mm gap



Questions / Comments?

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