Permanent Magnet Irradiation Experiment in RHIC Tunnel

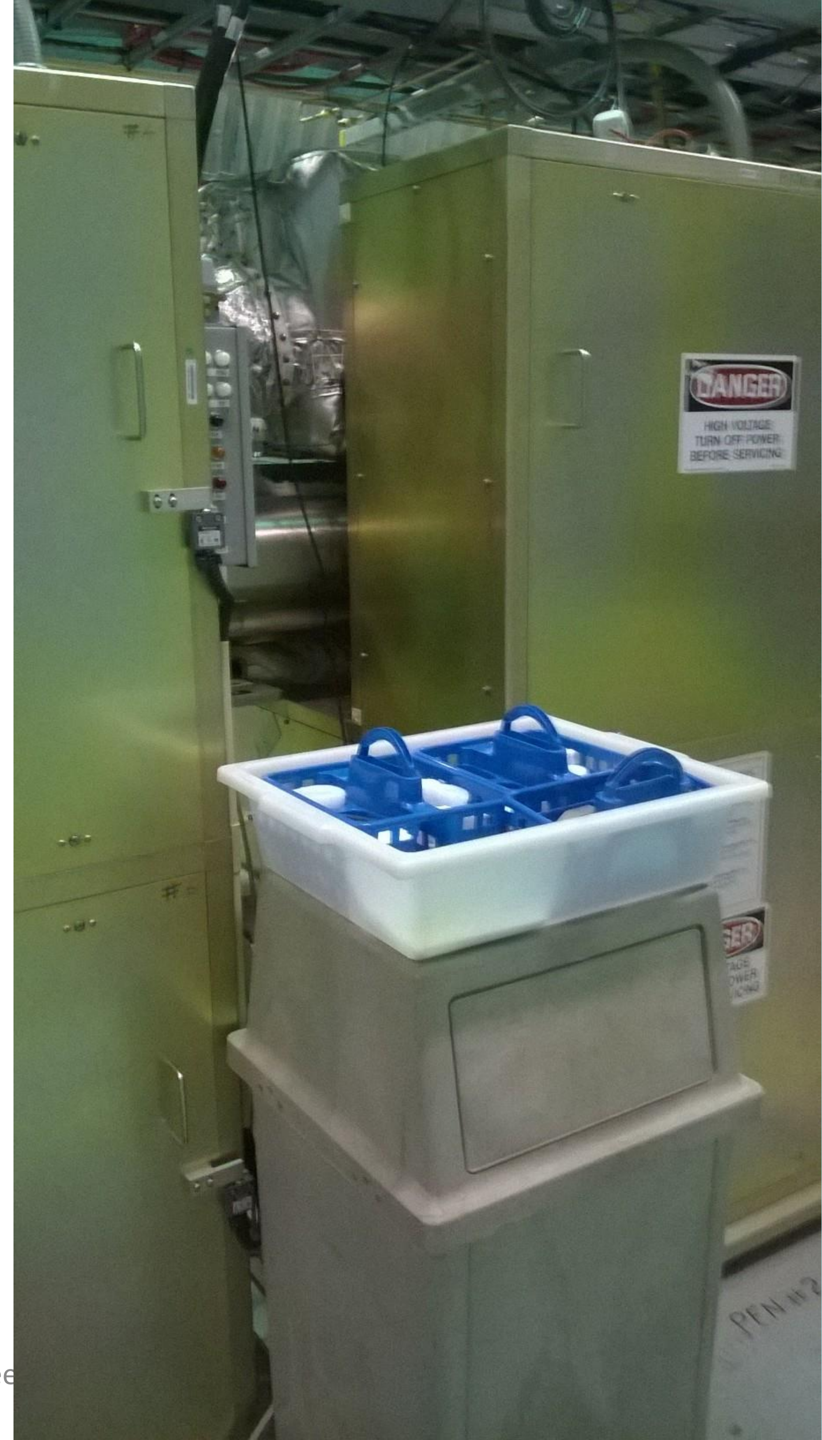
Material: NdFeB

Five Parameter Data Set

- Location of material
  - Control, kickers, dump
- Time period of irradiation (and dosimetry)
  - T0 = Start (Feb 18th), T1, T2, T3, T4, T5
- Material (five NdFeB grades of varying quality)
- Configuration (C-core, bare block, angled)
- Probe point for field measurement
  - Magnet holders have 2, 4 or 12 probe points

Current Status

- All magnet samples have been assembled, holders 3D printed by George Mahler
- All initial field measurements were taken
- Samples placed in the tunnel near 10 o'clock



Materials

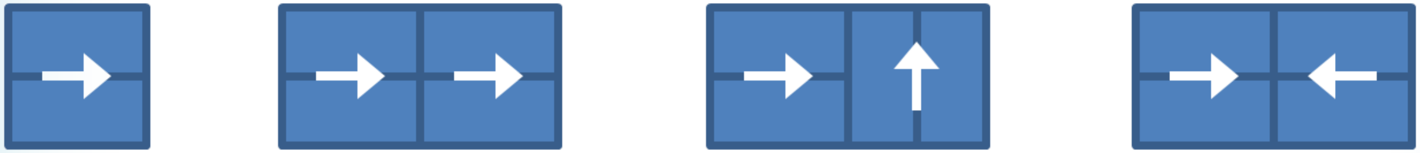
Name	Dimensions	Manufacturer	Notes
N35	3"X.75X.5(M)	Allstar Magnetics LLC	epoxy coated, 80C max temp.
N35EH			epoxy coated, 200C max temp.
VAC 863AP		VacuumSchmelze GmbH	N32~35 equiv., 180C max temp.
VAC 688AP			N25~28 equiv., 230C max temp.
N42	.25"X.75X.5(M)	magnet4less.com	Nickel coated, clearance stock

Configurations

"**C**". Magnets replacing ½" tall by ¾" wide part of the C-core stem. Test article should be 3" long, requiring one block of N35 or N35EH but 12 ¼" thick blocks of N42 to get the same size.

"**B**". Bare block of either material. For N42 use two ¼" pieces together to make ¾"x½"x½" block.

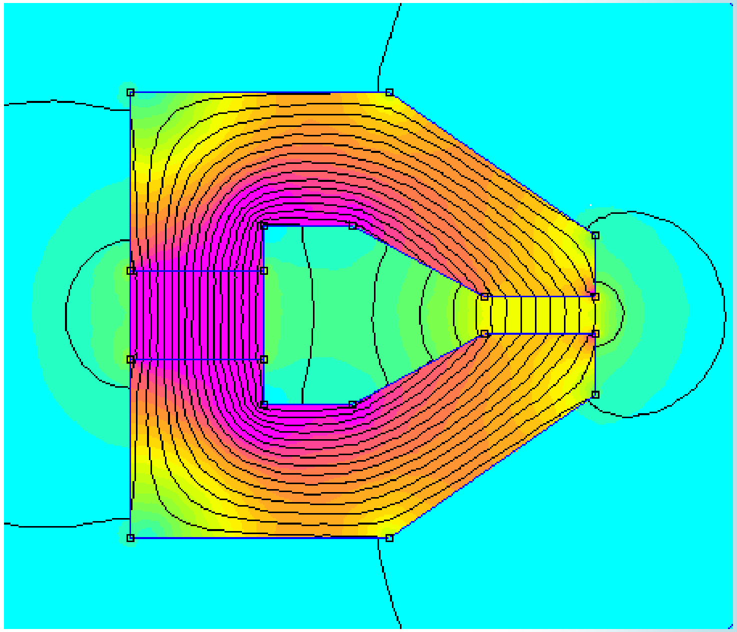
A0, **A90**, **A180**. Two blocks of two N42 pieces adjacent to each other, with one rotated by an angle relative to the other, so A0 is parallel magnetisation, A180 is opposing.

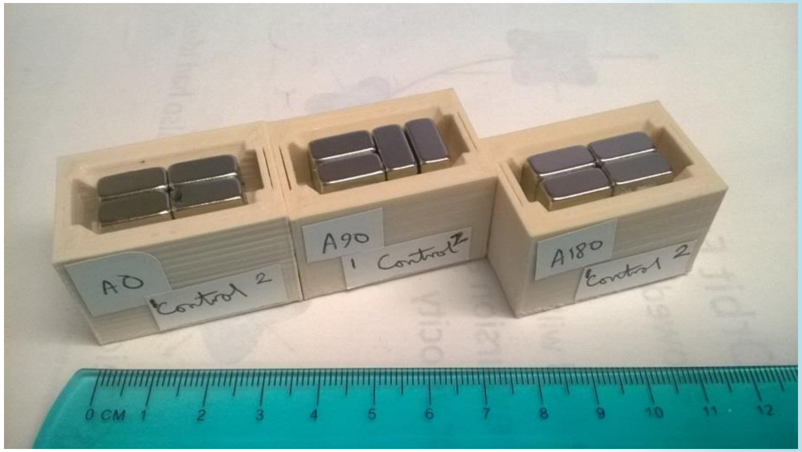


Above from left to right: pieces N42-B, N42-A0, N42-A90, N42-A180 shown with the ¾" block axis into the screen. The field is measured at the centre of the ½"x¾" face the arrows are pointing to, with the A variants taken apart and both halves measured.

Configurations (ctd.)

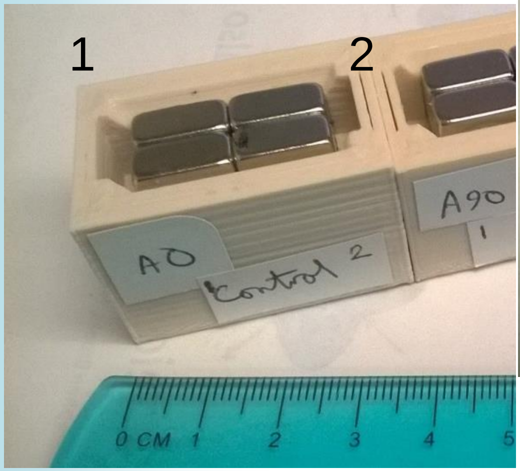
- C-core produces ~0.4T (eRHIC field) in 5mm gap
- Type “A” angled configurations are meant to test opposing field situations
  – Contained in 3D printed holders with probe points

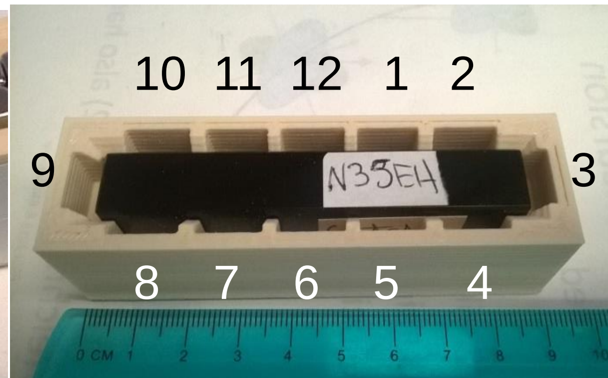




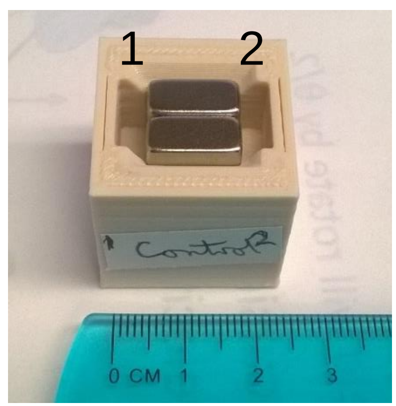
Field Probe Points

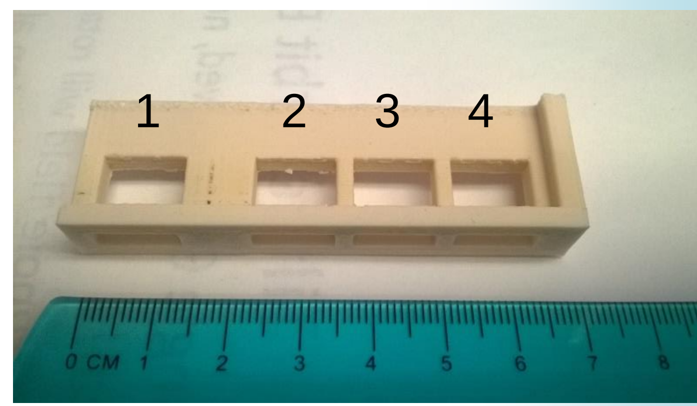
Type A	Type B	Type C





For N42:





Probe sockets designed to fit magnet division's field probe that is accurate down to 1 Gauss.

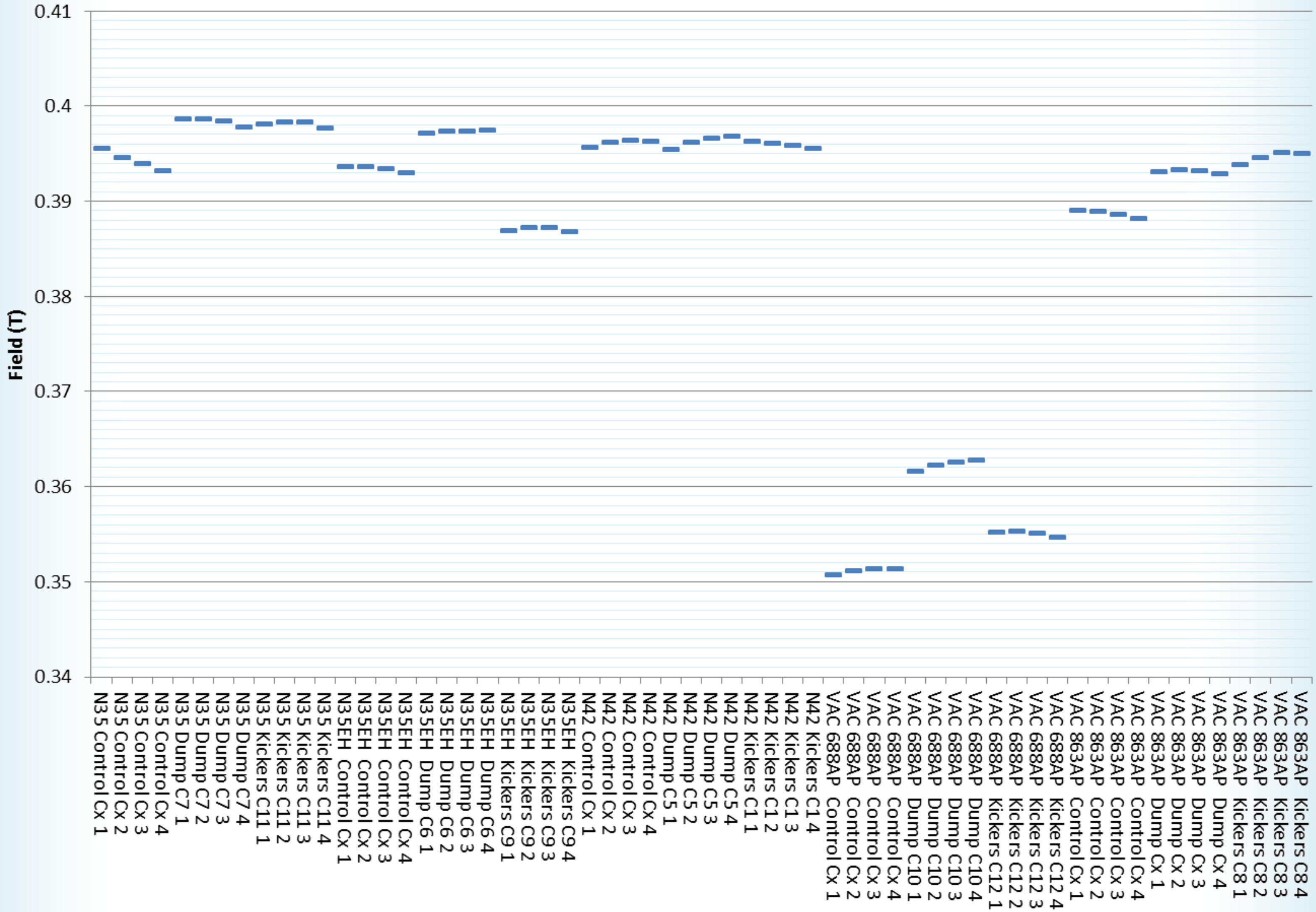
228 measurements per time period!

Dosimetry and Schedule

- Kicker location ~0.25Gy/day (Paul Bergh study)
  - Dump presumably more but no-one has measured
- Time periods: 2 weeks, 1, 2, 4, 8 months
- Use TLDs for T1, T2 (limit 2-7Gy)
- Use DOSE-MAP films from Ashland, calibrated between 2-200Gy for all 5 time periods
  - Six locations, three per tray, shown on next slide
- Can change location to AGS if insufficient dose

Dosimeter Layout in Tray

T0 Fields for C-cores



C-core Fields Statistics

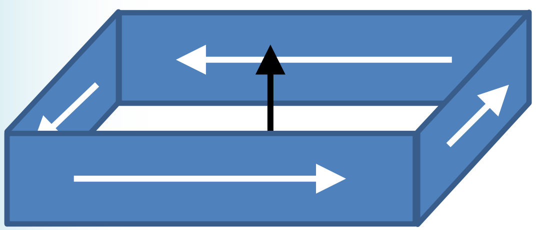
Material	"N" Grade (MGOe)	B_r spec (T)	Average Gap Field (T)	Range of Variation of (3) Samples (relative)
N35	35	1.17-1.22	0.3969	1.03%
N35EH	35	1.17-1.22	0.3926	2.64%
VAC 863AP	32~35	1.17~1.21	0.3921	1.52%
VAC 688AP	25~28	1.03~1.08	0.3562	3.13%
N42	"42"	"1.32"	0.3961	0.07% (shuffling??)

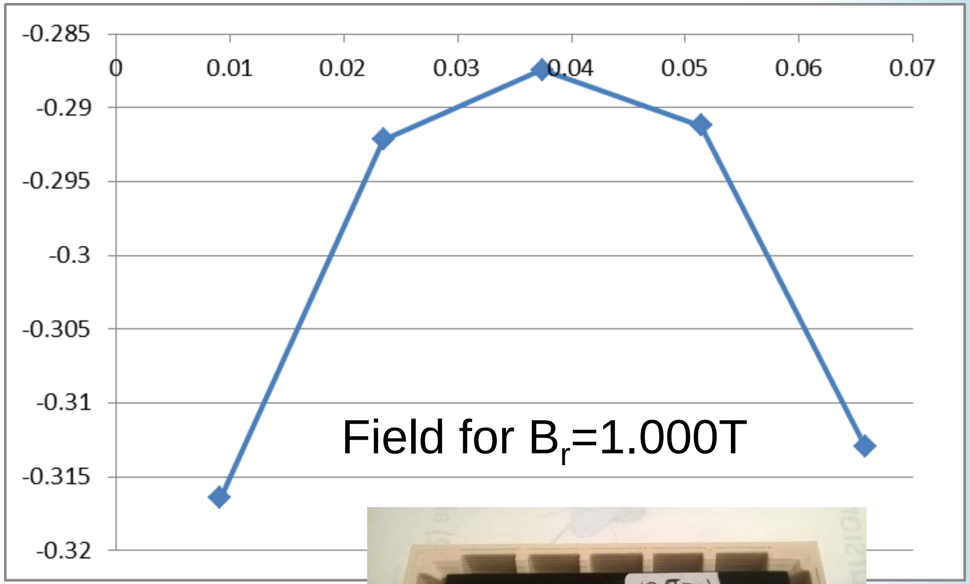
Range of variation within the gap (between probe points 1,2,3,4) was 0.22% on average.

T0 Fields for Bare Blocks

Analytic Field Model

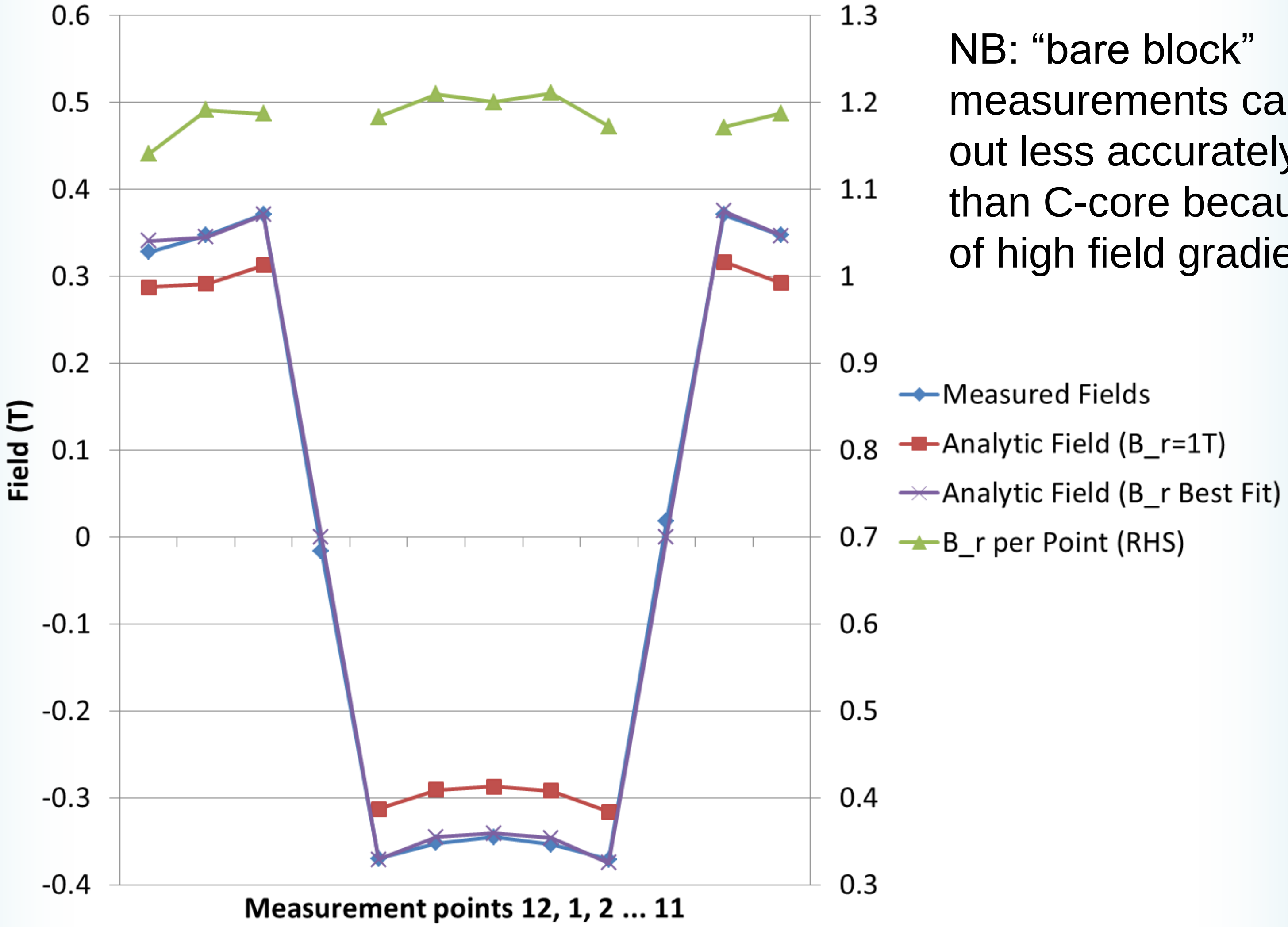
- Assume constant **M** (magnetisation) within cuboid, with $\mathbf{M} = \mathbf{B}_r/\mu_0$ (and $\mathbf{M} = \mathbf{0}$ outside)
- $\mathbf{J}_{bound} = \nabla \times \mathbf{M}$ = surface currents around block





- Calculate with Biot-Savart law double integral

N35 Control B block (example)



NB: "bare block" measurements came out less accurately than C-core because of high field gradient

Derived B_r Values