Magnetic Shielding
Prototyping Studies

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Endcap / Joint prototyping: Why?

As discussed in the past ...

Will need to remove some sub-assemblies ~10–100 times for access to interior of experiment

How to do this in “easy/quick” way with good magnetic seal?

FEA TOSCA calculations indicate big impact of end-caps on shielding factor

(also data on impact of gap)
Delivery of prototype (Jan 2009)

upstream

downstream

end-cap with screws
“Lapped Connection” Design

Basic idea

Attempt to form magnetic seal by overlapping material across two surfaces (whether themselves overlapping or not)

This prototype: Joint had minimal to no overlap of end-cap with cylinder (~ 1/8” - 1/16” gap) (retrofitting constraints)
Modifications to prototype

Clamps applied here

Overlap material

Aluminum backer rings
Modifications to prototype

- Cylinder
  - Al connector plate
  - Aluminum backer ring (split into 4 pieces)

- End-Cap
  - Aluminum backer ring
Assessment tests

Measure residual fields along cylinder axis:

1) Test “lapped seal” materials: μ-metal foils, Metglas
2) Baseline these results to the (vendor preferred) “screwed end cap”
No end cap: degaussing effect

Residual fields measured (magnitudes plotted)

Transverse Residual Fields

Axial Residual Fields

Backgrounds:
- $x \sim 0.11 \, G$
- $y \sim 0.44 \, G$
- $z \sim 0.16 \, G$
Lapped tests: μ-metal foils

μ-metal foils:

“perfection annealed”

2-mil and 6-mil CO-NETIC AA foils (Magnetic Shield Corporation)

4” width (~$16/linear-foot)
Lapped tests: $\mu$-metal foils

**Transverse Residual Fields**

- $\mu$-Metal Foil Overlaps, Transverse Component
  - Compare: Screwed End Cap
  - 2-mil $\mu$-Metal Foil Overlap
  - 6-mil $\mu$-Metal Foil Overlap
  - Compare: No End Cap

**Axial Residual Fields**

- $\mu$-Metal Foil Overlaps, Axial Component
  - Compare: Screwed End Cap
  - 2-mil $\mu$-Metal Foil Overlap
  - 6-mil $\mu$-Metal Foil Overlap
  - Compare: No End Cap

Differences between 2-mil and 6-mil overlap foil are small.

- 6-mil foil somewhat “stiffer” (didn’t lay as “flat” on surface; should be less problematic on larger diameters)

**Bottom line**: Lapped connection with $\mu$-metal foil overlap performed basically as well as “screwed end cap” in center region.
This graph shows the permeabilities of our most common shielding materials with respect to one another.
Baselining prototype performance

TOSCA calculations of residual fields:

Transverse

Axial

TOSCA (Amuneal B-H curve)

Data (before degaussing)

Data (after degaussing)

Note: Data/TOSCA for case of rear end-cap removed
1/2”-gap tests

- Foam spacer ~ 0.5”
- Performance of 0.5” gap + foil comparable to screws

Transverse
- No End Cap
- Gap, No Overlap
- Gap, 2-mil foil
- Gap, 6-mil foil
- Screws

Axial

then “covered” with lapped connection as before
End-Cap Bevel Size

- **A**: No End Cap
  - Axial
  - Transverse

- **B**

- **C**

- **D**

  Central region relatively insensitive to end-cap size
Two Nested Cylinders

Transverse

Axial

12” diameter, 2” spacing