Status Update of Permanent Magnet Radiation Resiliency Studies at CEBAF

Progress and Campaign 1 Results

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& Team

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MOOP009

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The Team

The Magnet Study LDRD is:

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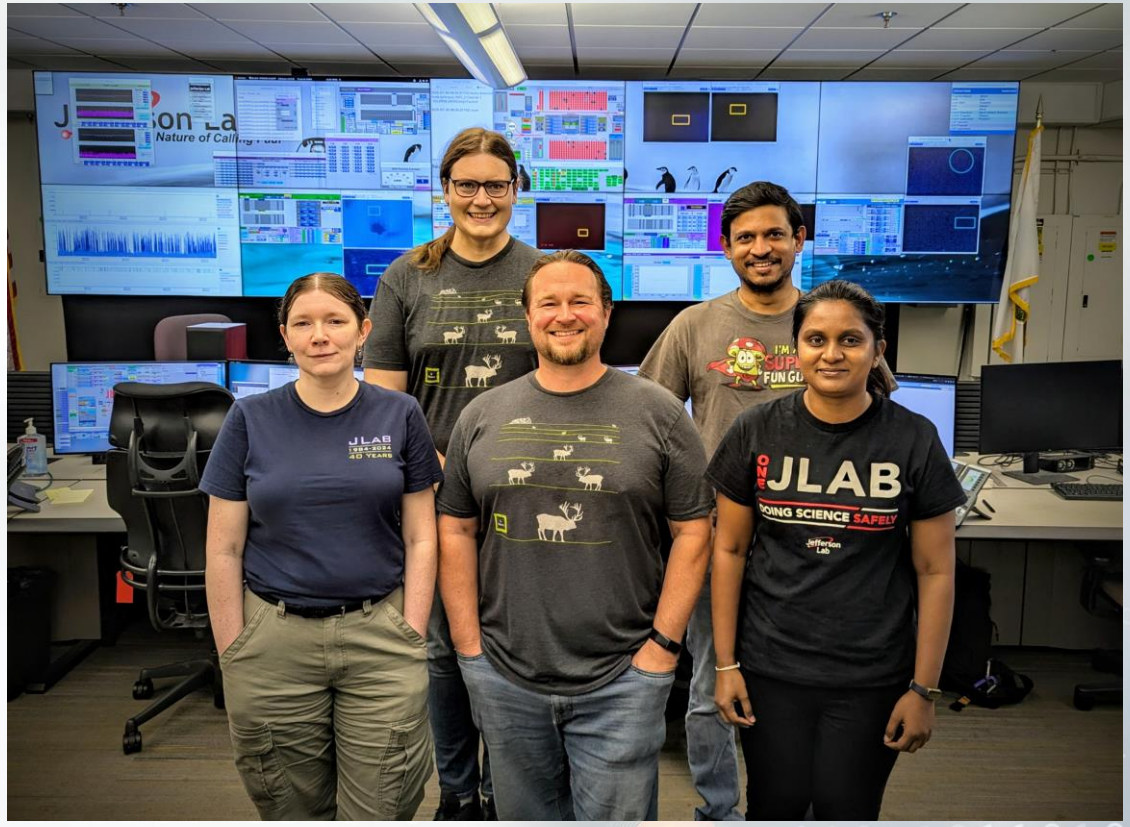
Advisors: Stephen Brooks (BNL), Stewart Boogert (Cockcroft), Will Shields (RHUL), Ben Shepherd (STFC)



The Mission

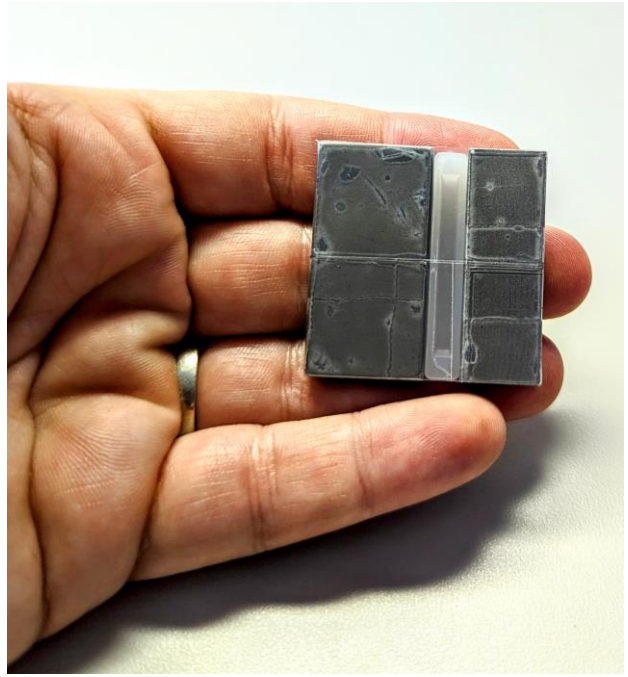
Goal: Study the degradation of permanent magnet materials in a radiation environment which resembles their intended operational environment

- Started as feasibility study for FFA-based energy upgrade to CEBAF
- Grew to become the largest ever study of its type (in-situ, accelerator environment)
- Applicable to worldwide growing interest in permanent magnet use in accelerators
- Study ongoing!

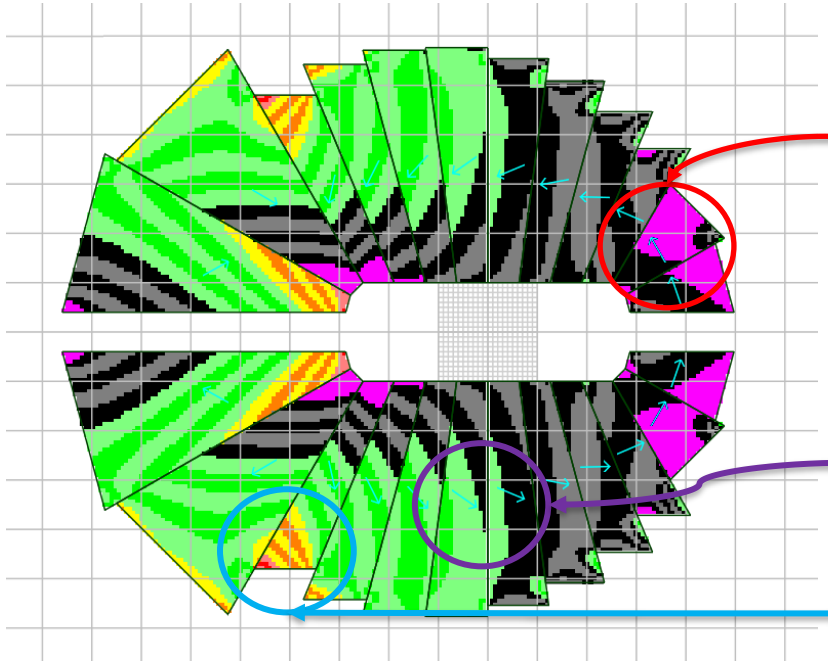
The Magnets

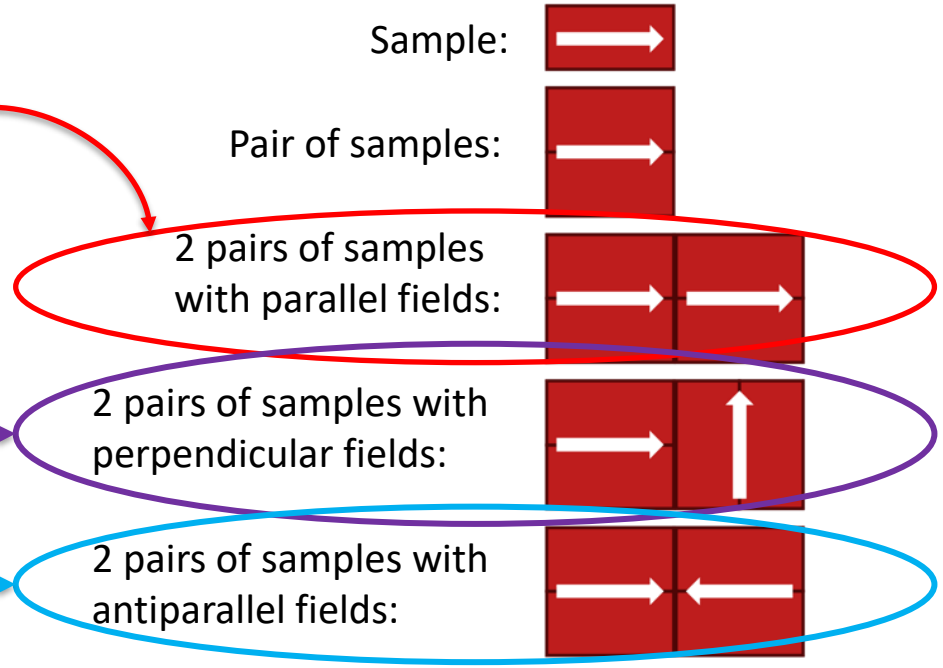
- 2 grades of NdFeB + 2 grades of SmCo
  - N42EH, N52SH, SmCo33H, SmCo35
- 2 sizes:
  - Single samples – 1.5 x 0.75 (m) x 0.25” (3.81 x 1.91 x 0.635 cm)
  - Pair assembly samples – 1.5 x 0.5 (m) x 0.25” (3.81 x 1.27 x 0.635 cm)
    - (m) indicates plane of magnetization

- Single samples for direct measurements of magnet material degradation studies
- Pair assembly samples to study impact of reverse flux on degradation



Two samples with spacer. Left is NdFeB single sample, right is SmCo pair assembly sample. Field aligned horizontally in photo. Both are covered in tape for safety.

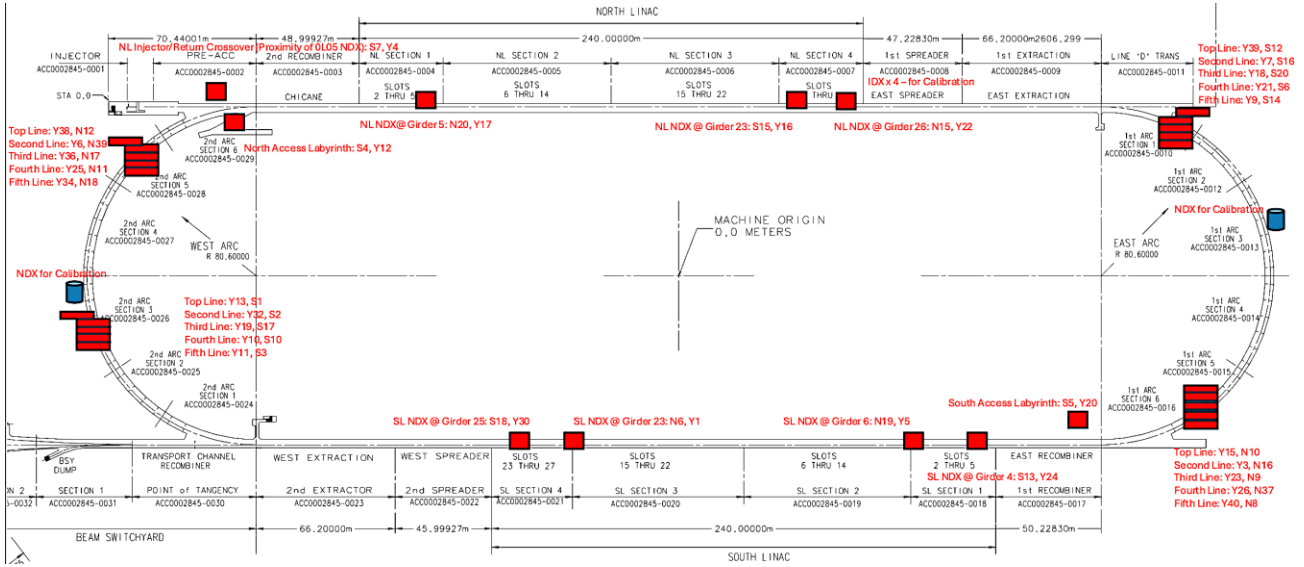




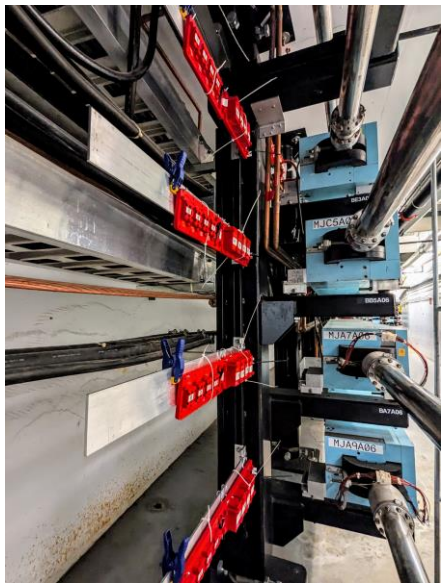
S. J. Brooks, “Permanent Magnets for the CEBAF 24GeV Upgrade”, in Proc. IPAC'22, Bangkok, Thailand, Jun. 2022, pp. 2792-2795. https://doi.org/10.18429/JACoW-IPAC2022-THPOTK011

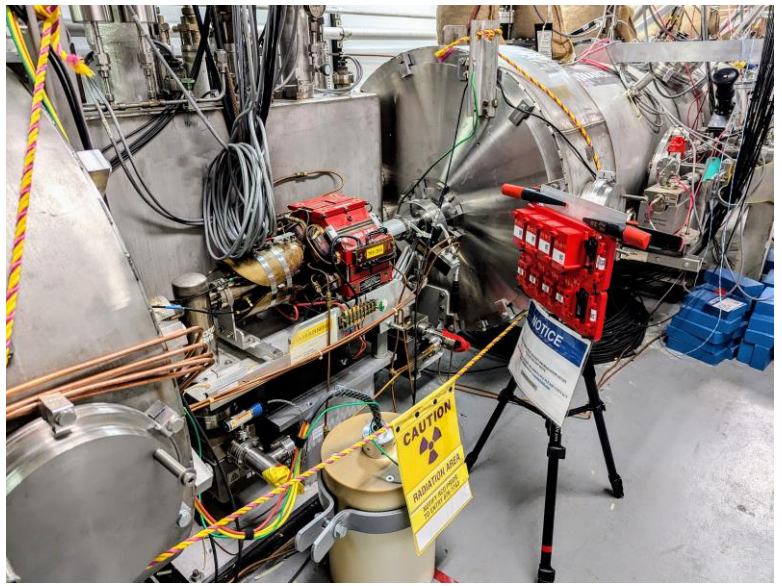
The Measurements

- 30 sites around CEBAF enclosure (540 magnets)
- Mobile measurement system for in-situ measurements (~1920 measurements/session)
- Access to tunnel during maintenance days
- Teslameter + 3D printed measurement rig to make three point measurements (one per plane) for single samples and pair assemblies
- Helmholtz Coil and Fluxmeter to measure magnetic moment
- Data collected in custom DAQ



Mobile Measurement Setup



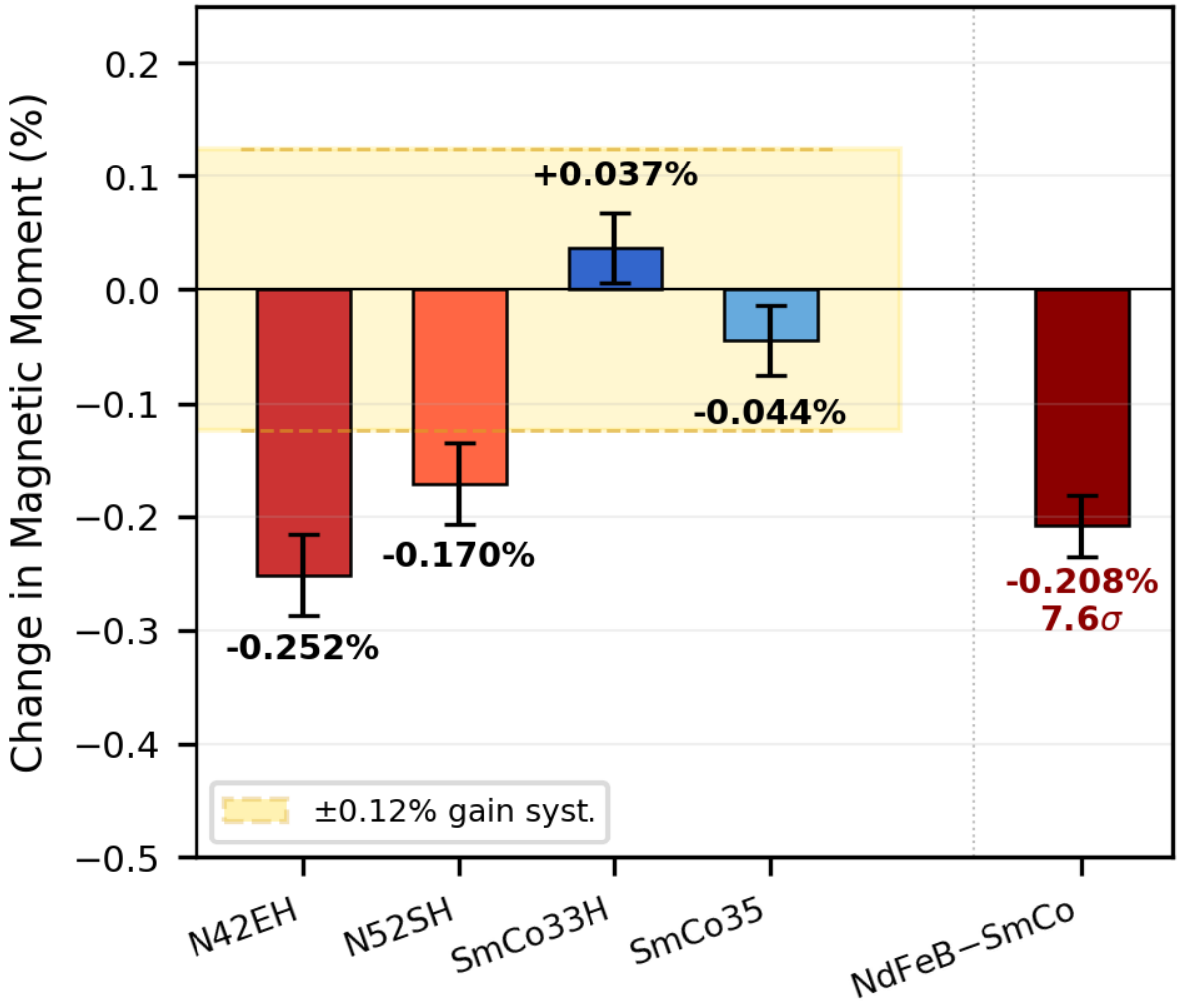


Findings After Approximately 6 Months of Beam

- Helmholtz Coil measurements more successful so far
- NdFeB degrading more than session-to-session gain drift systematic
- SmCo not degrading, statistically

Key Feature of our study: gain-immune differential measurement!

- Four sample types randomly placed on each plate
- Measured at same time with same equipment – gain drift cancels by design
- Subtract mean SmCo from mean NdFeB on measurements taken at same time with same equipment



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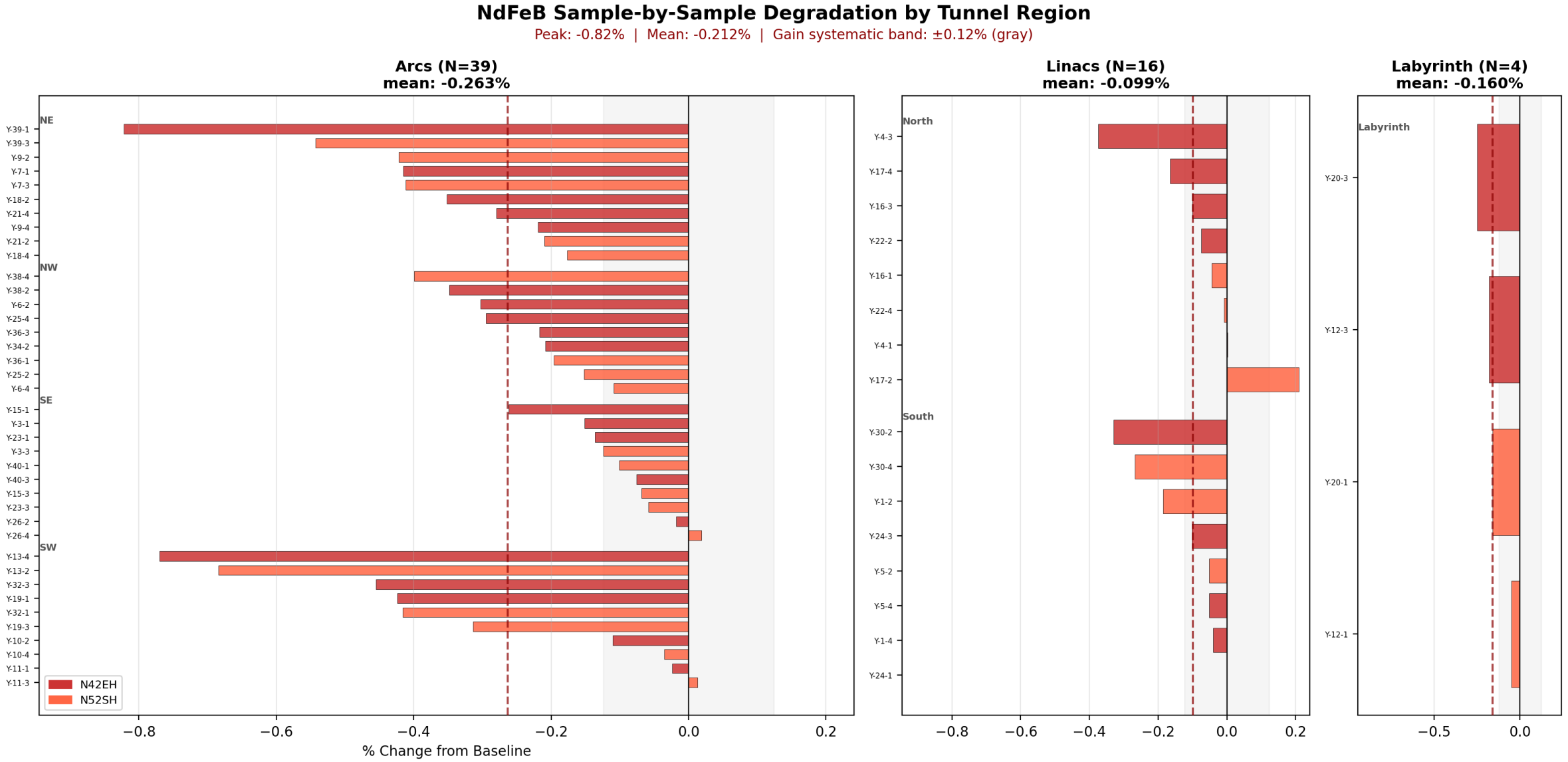
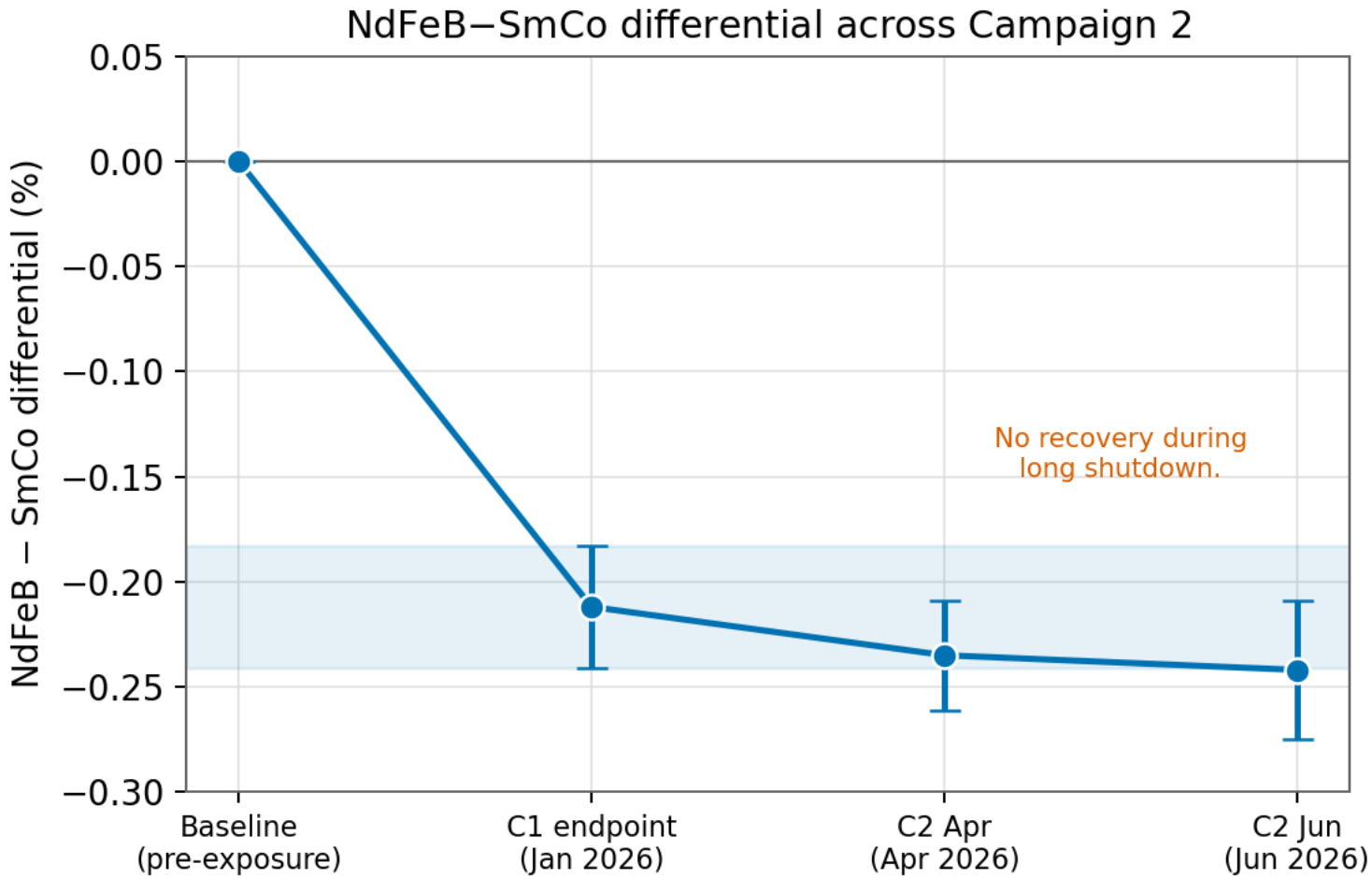


No Recovery in Measurement Campaign 2

- Long scheduled accelerator maintenance period without beam
- No signs of recovery from loss
- First half of C2 run low energy and low current beams
- Signs of degradation continue, even with low doses



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QUESTIONS?

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