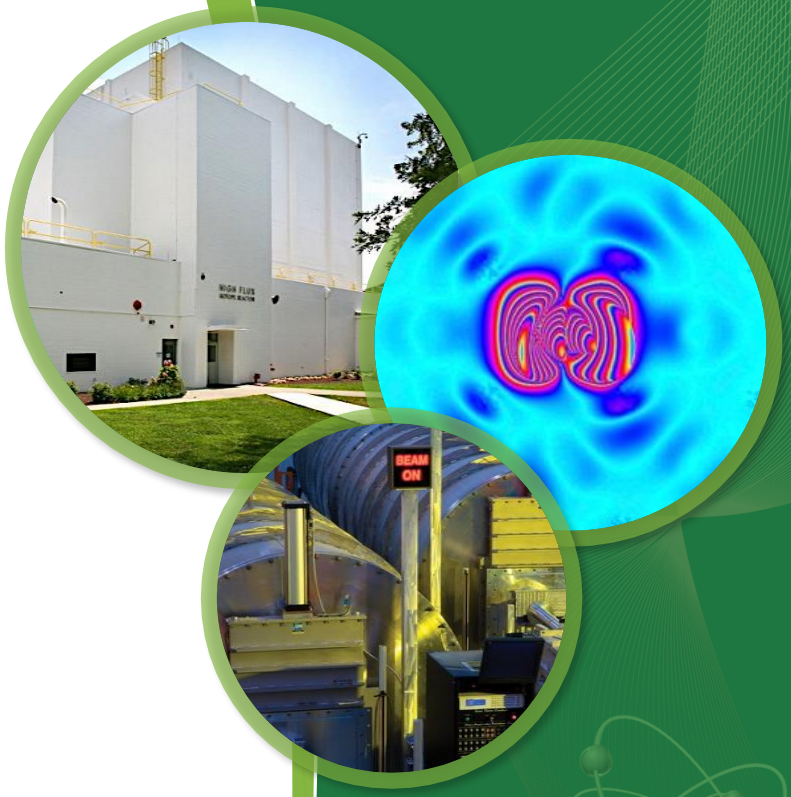
HFIR Instruments

Georg Ehlers

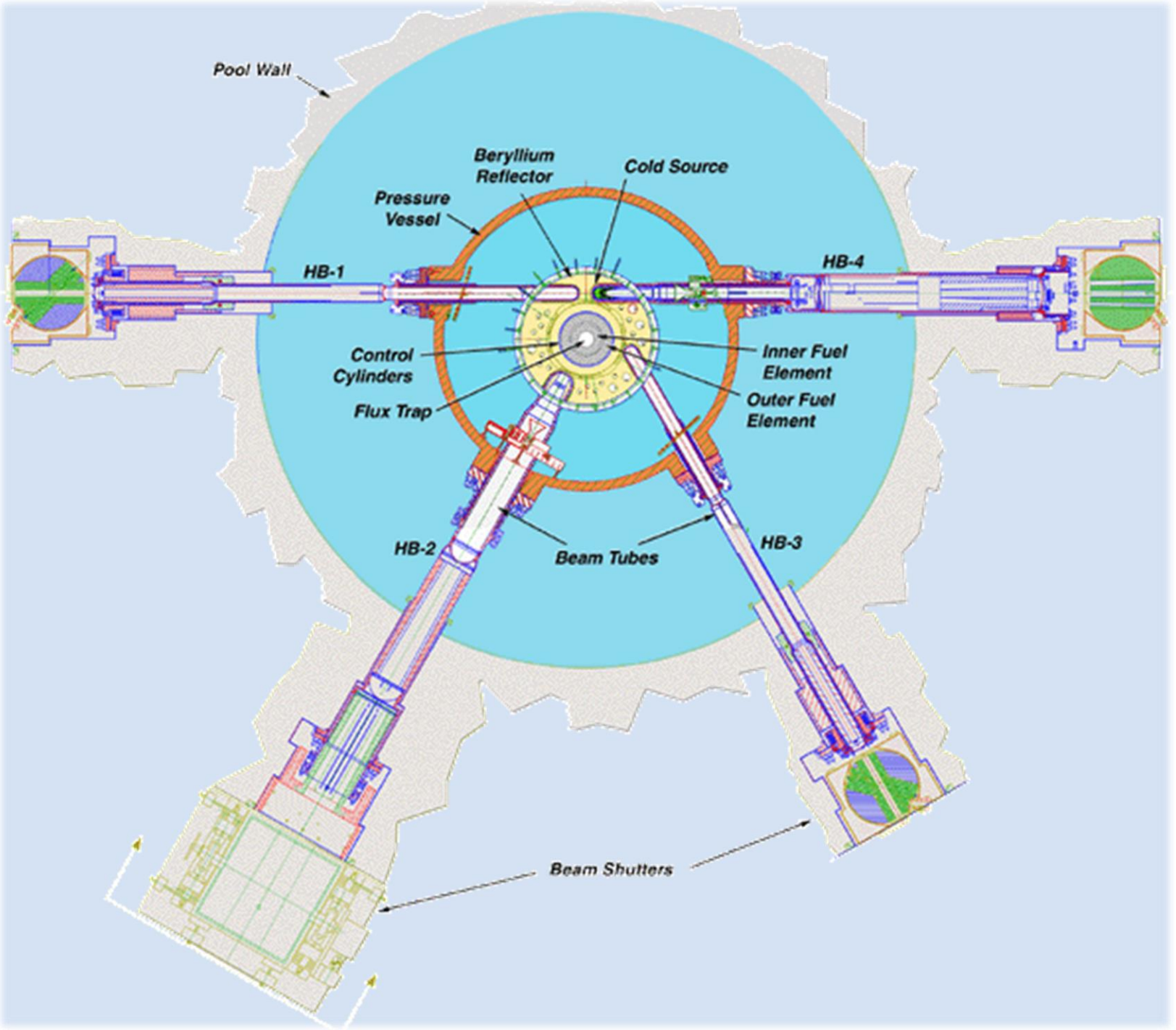
Neutron Technologies Division



Neutron Day

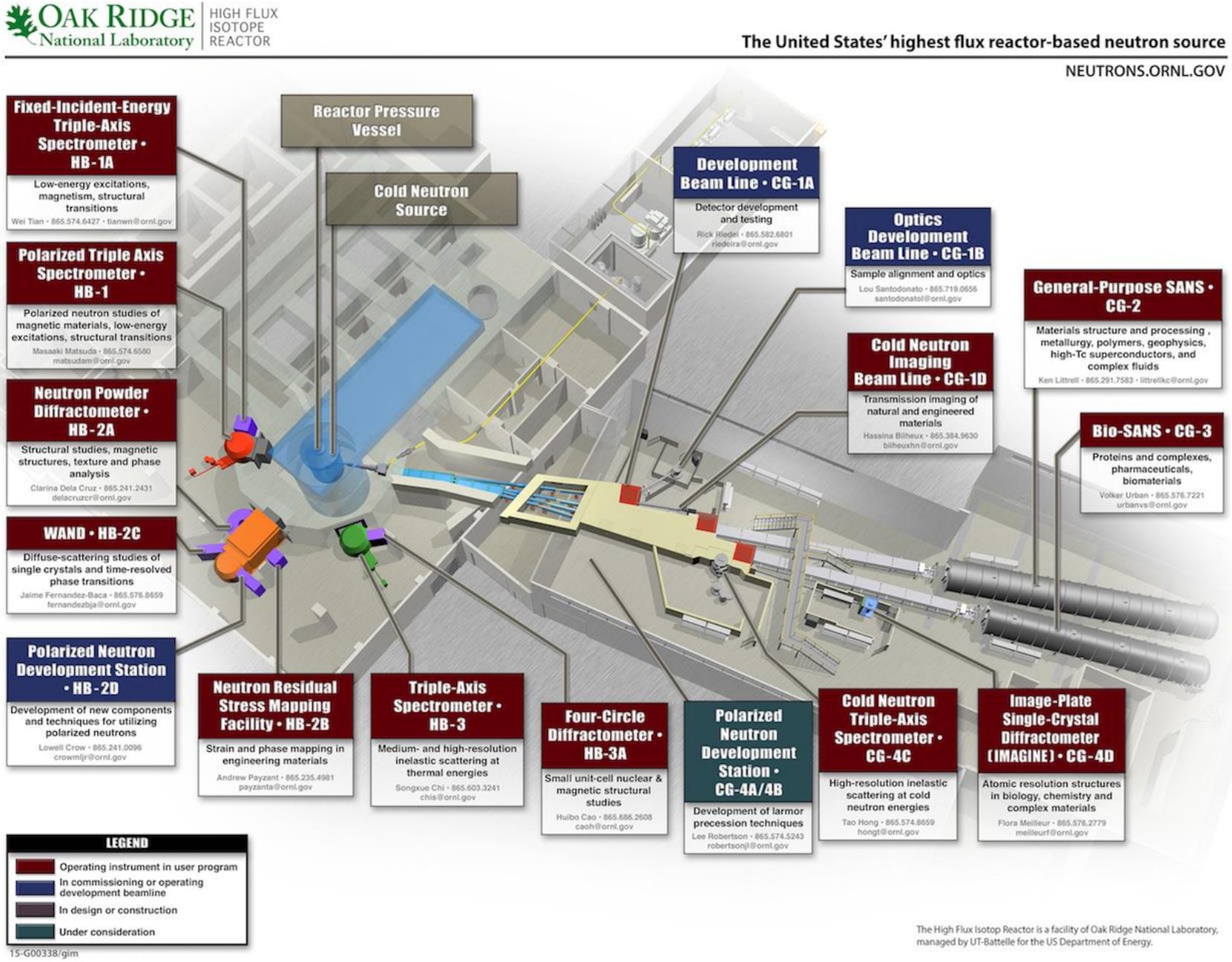
April 26, 2018

HFIR Core



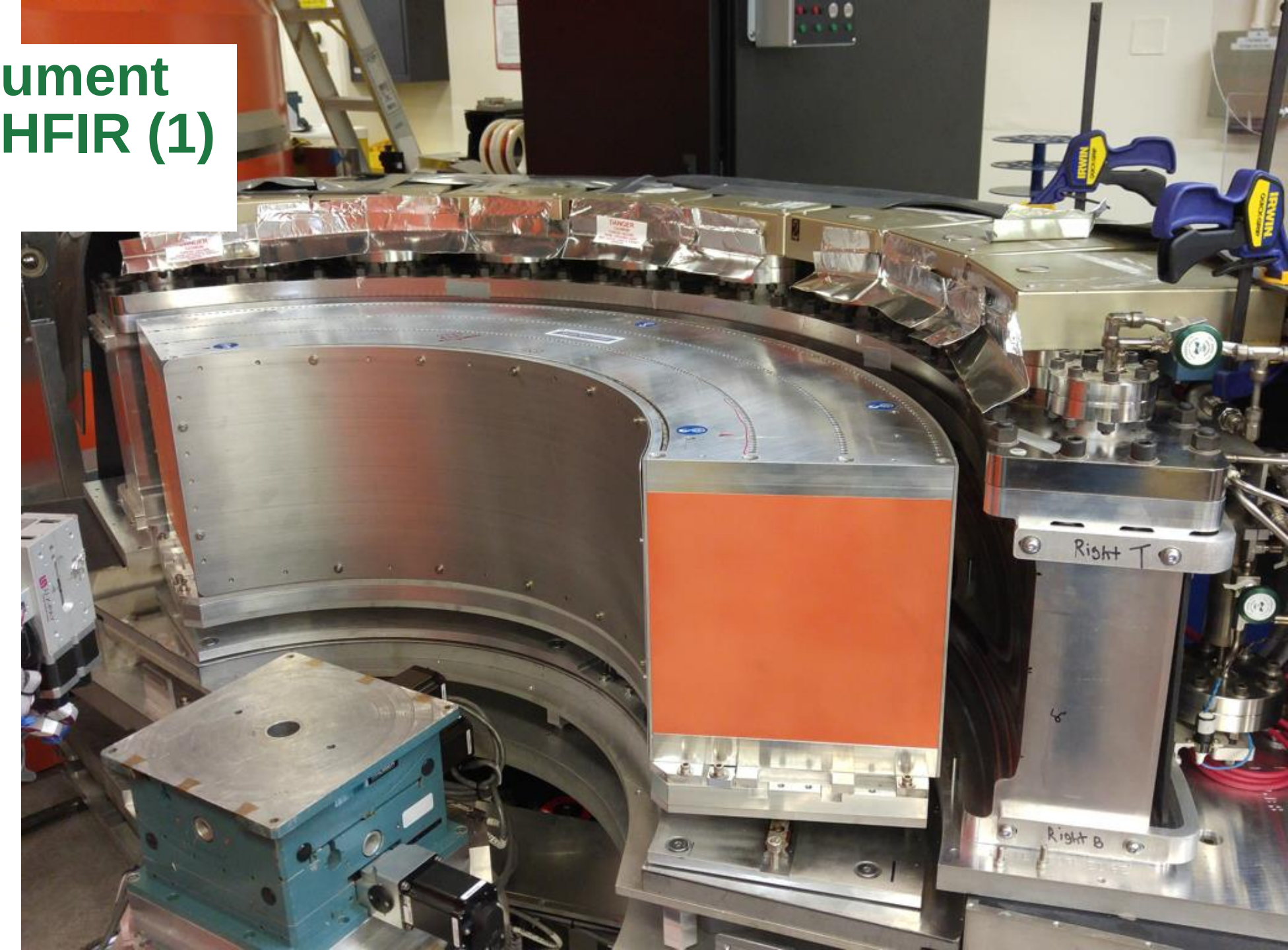
Courtesy: Lowell Crow

HFIR Instruments



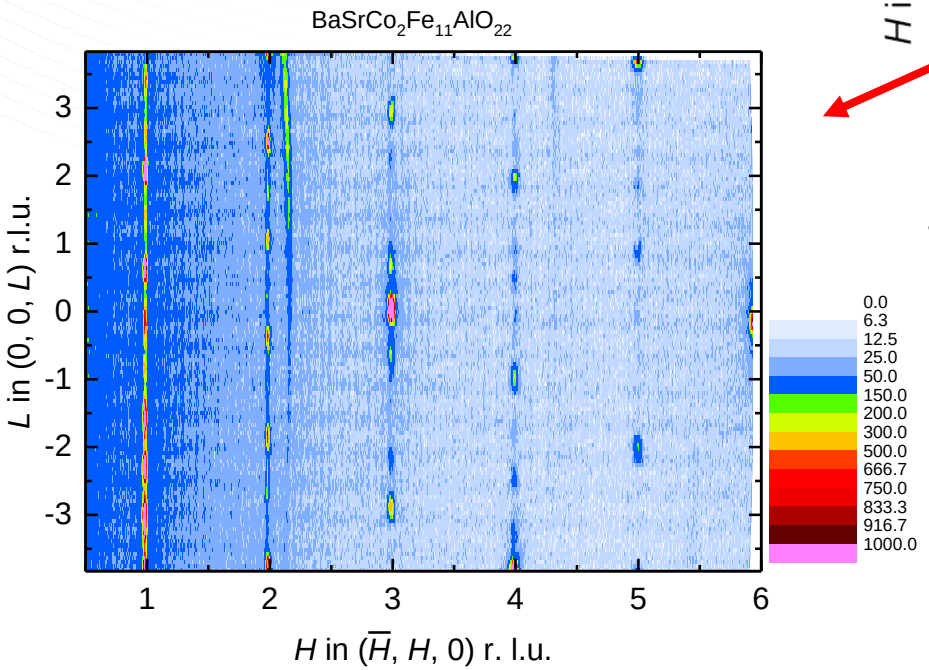
https://neutrons.ornl.gov/

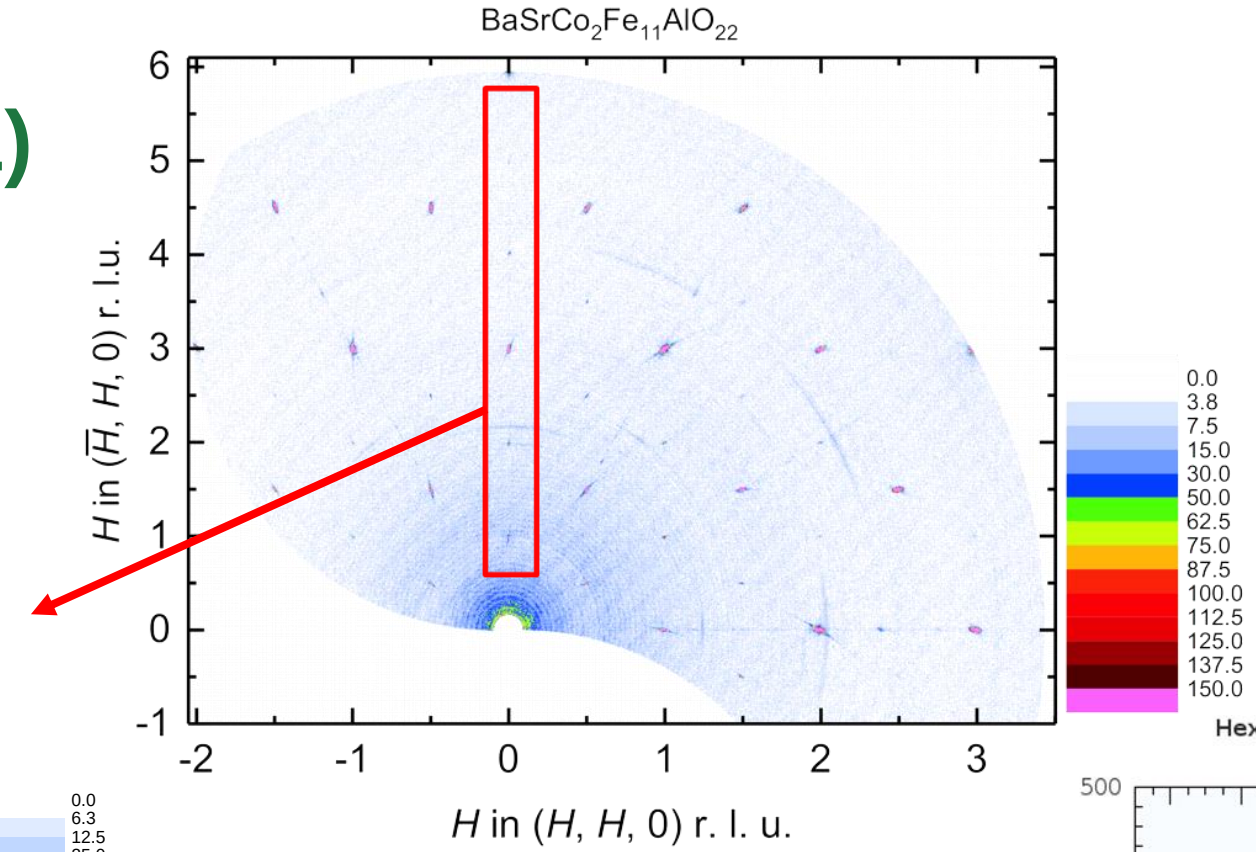
Current Instrument Upgrades at HFIR (1) – WAND²



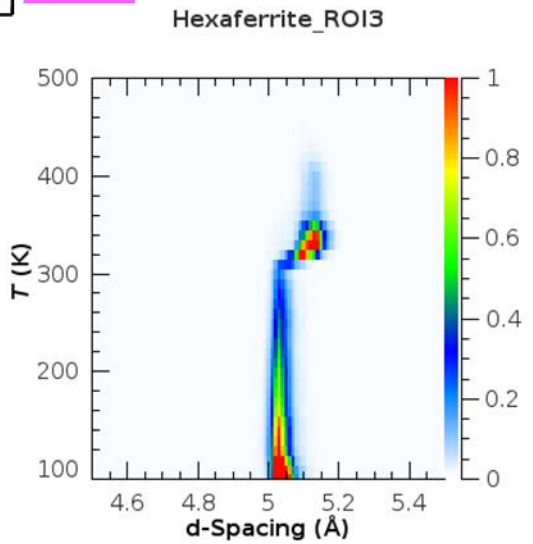
Courtesy: Matthias Frontzek

Current Instrument Upgrades at HFIR (1) – WAND²





- Out of plane coverage will help solving complex crystallographic and magnetic structures
- Event mode allows filtering after the experiment



Courtesy: Matthias Frontzek

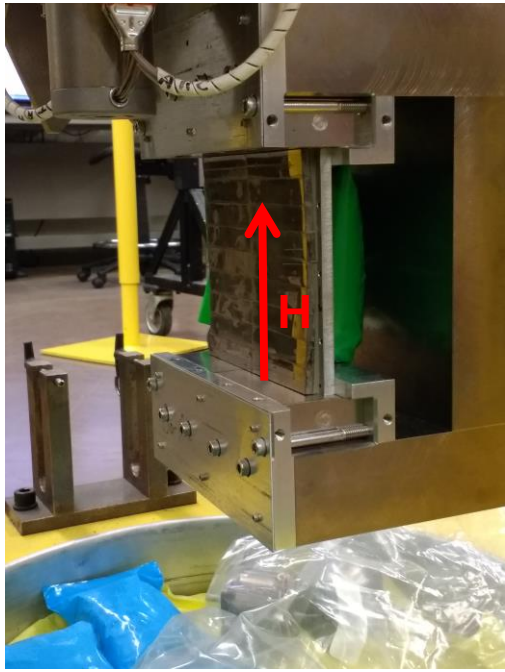
Current Instrument Upgrades at HFIR (2) – HB-1

current

- Vertical focus (fixed)
- Inadequate Heusler crystals
- Low flipping ratio (<15)
- Low intensity
- 150 mm (W) × 135 mm (H)

new

- Vertical focus (fixed)
- High quality Heusler crystals
- High flipping ratio (>20)
- High intensity (2 times)
- 150 mm (W) × 150 mm (H)
- Crystals from ILL



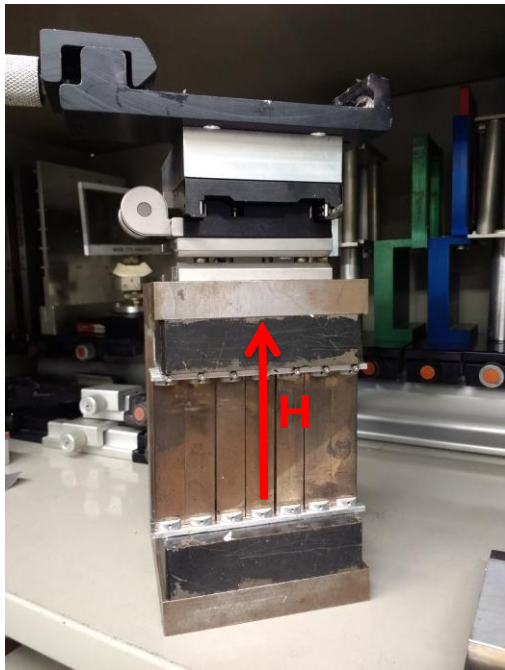
Heusler monochromator

current

- Flat
- 100 mm (W) × 75 mm (H)
- Low intensity
- Crystals on loan from NCNR

new

- Vertical focus (fixed)
- Large: 120 mm (W) × 100 mm (H)
- High intensity (>2 times)
- Crystals from Tohoku Univ.

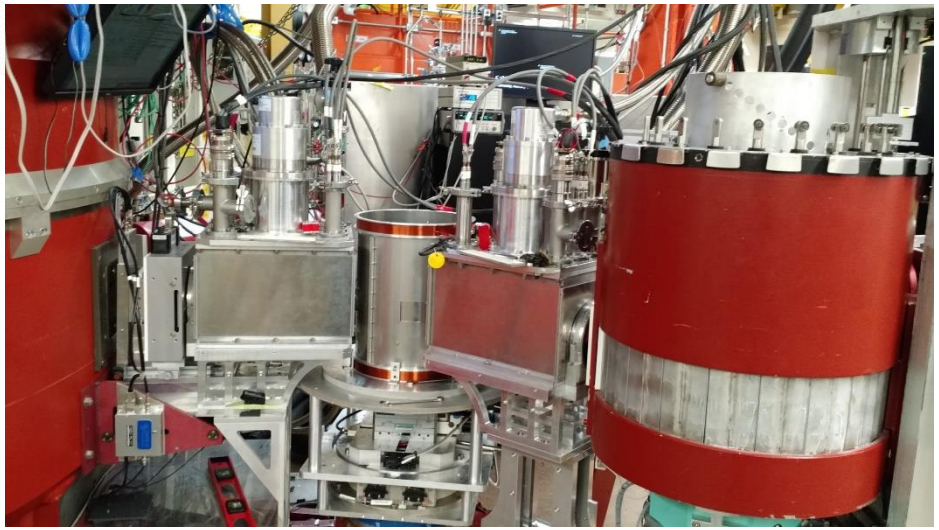


Heusler analyzer

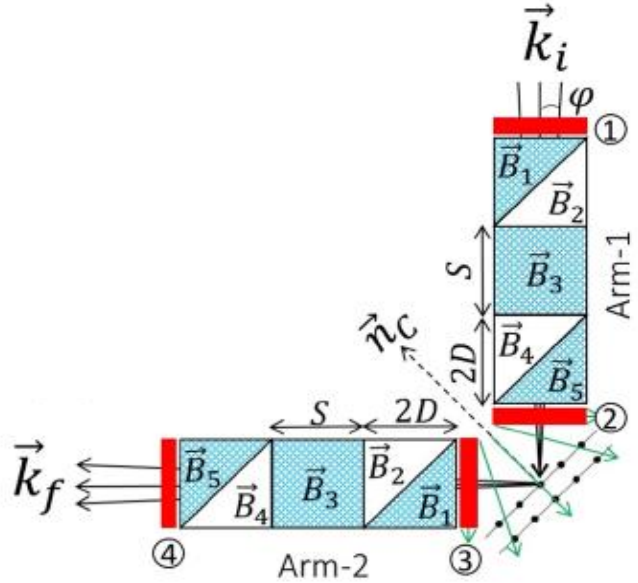
Courtesy:
Masaaki
Matsuda

Current Instrument Upgrades at HFIR (2) – HB-1

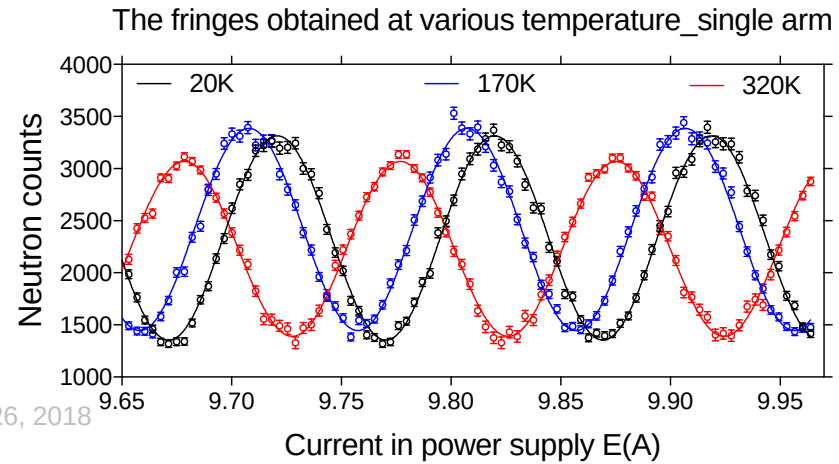
Wollaston Prism @ HB-1 (LDRD: 2014-2016)



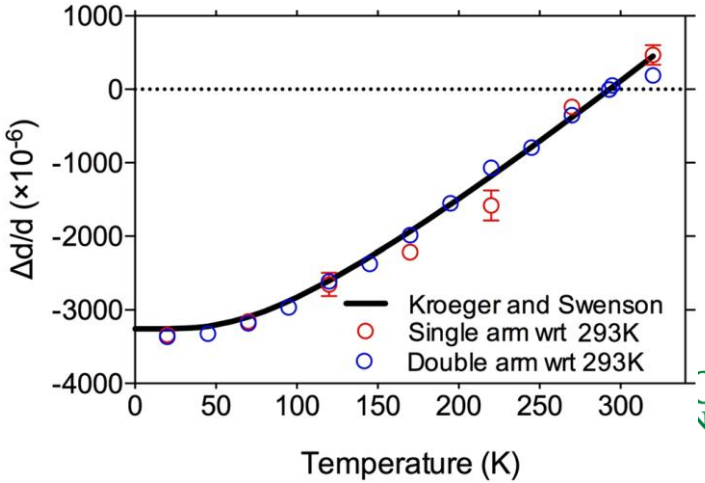
Scientific Reports 7, 865 (2017)



Larmor Diffraction $\Delta d/d \sim 1.4 \times 10^{-5}$

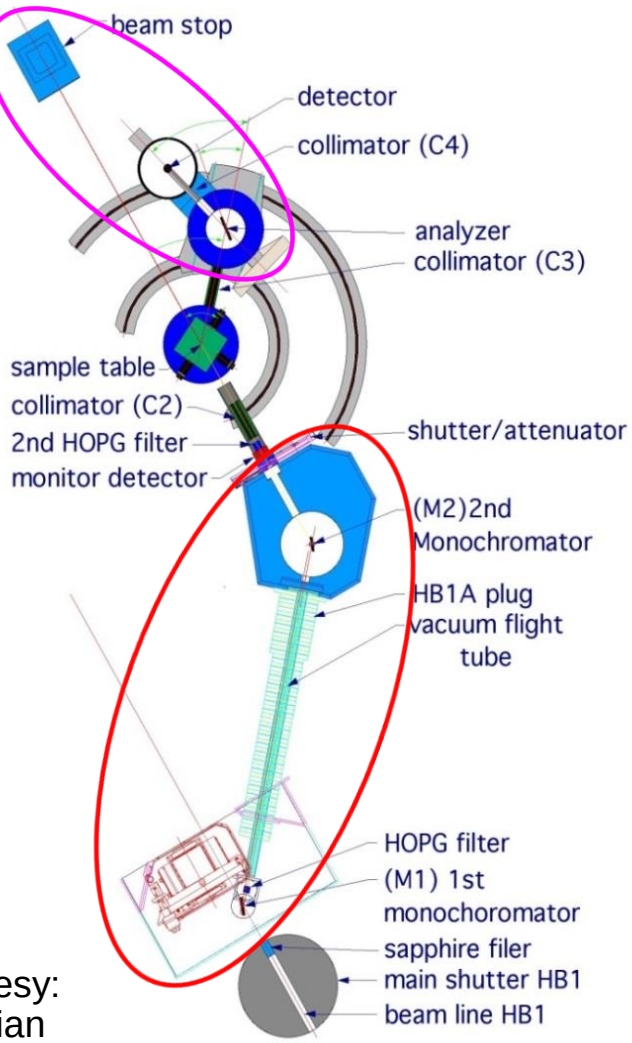


Thermal expansion of Copper



Courtesy:
Masaaki
Matsuda

Current Instrument Upgrades at HFIR (3) – HB-1A



Courtesy:
Wei Tian

Backend upgrade: replacing the analyzer-detector assembly

- ✓ Complete rebuild
- ✓ The new assembly needs to be compact due to space limitation in the beam room
- ✓ Front-end beam optimization is critical

Monochromator optimization

- ✓ New M1 (flat, wider) – dimension determined by HB-1 beam tube size to capture the full beam, need new PG filter, need access to HB1 cubicle for installation
- ✓ Vacuum flight tube between M1 and M2 – need to be removed, thick aluminum window attenuates the beam, small opening (W 2” × H 6”) prevents the use of the full beam
- ✓ New M2 (fixed vertical focus, much taller) – need new M2 drum with larger beam port

Current Instrument Upgrades at HFIR (3) – HB-1A

M2 Drum

Flight Tube

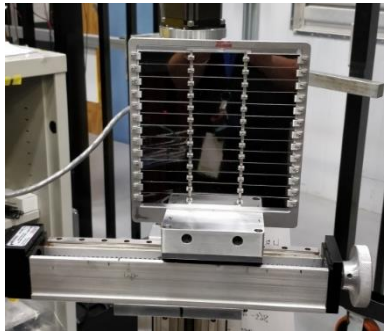
HB1 secondary shutter

M1 and PG filter installed downstream of the HB1 main shutter

M1 and PG Filter replaced during this outage:

Removed old M1,PG filter, and flight tube from HB1 cubicle

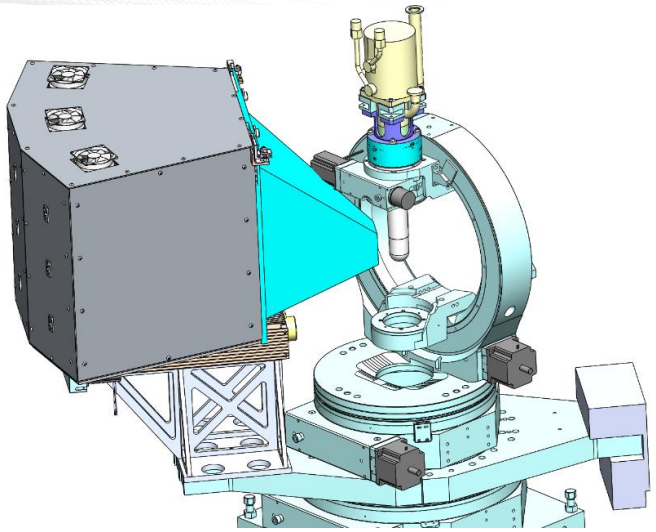
New M1 and PG filter installed



New M1 assembly

Courtesy:
Wei Tian

New look at HB-3A – Ready for mounting the large area detector



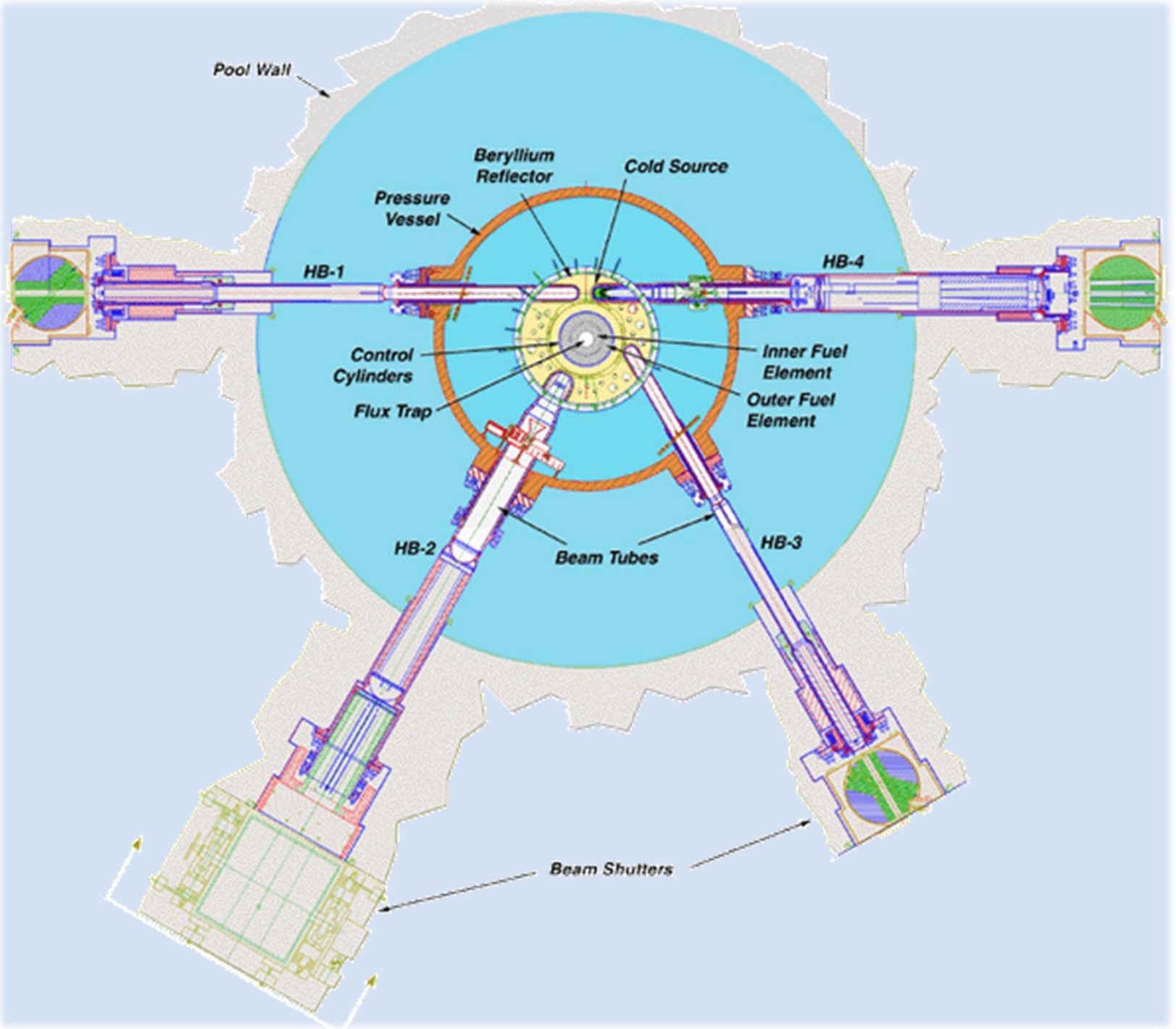
The HB-3A Four-circle single crystal neutron diffractometer is under the detector upgrade. In the past reactor outage, Jib crane (1/2 ton) has been installed, the instrument detector arm gets ready for mounting the large area detector, and the instrument area has been refigured to allow the sample environment access.

Upgraded HB-3A will allow single crystal neutron diffraction in the extended temperature range (50 mK to over 1000 K) and also under cryomagnetic field, it also allows half polarized neutron diffraction.

The large area detector is planned to be installed in August.

Courtesy:
Huibo Cao

HFIR Core



Courtesy: Lowell Crow

Critical Dates related to the Be-outage

- November 2017 – HB-4 fabrication started
- September 2018 – HB-4 design complete
- November 2019 – HB-2 fabrication starts
- March 2020 – HB-2 main shielding design start
- May 2021 – Lee Robertson retires
- September 2022 – removing the HB-3 monochromator starts the “Beam Room Clean-Out Campaign” (HB-3 and HB-2 go down, HB-1 continues)
- March 2023 – HFIR ceases operation after cycle 513
- January 2024 – HFIR resumes operation

IAB Recommendations given at close-out (1)

- **1. Build three new instruments at FTS**
  1. Venus
  2. Discover
  3. HRPD

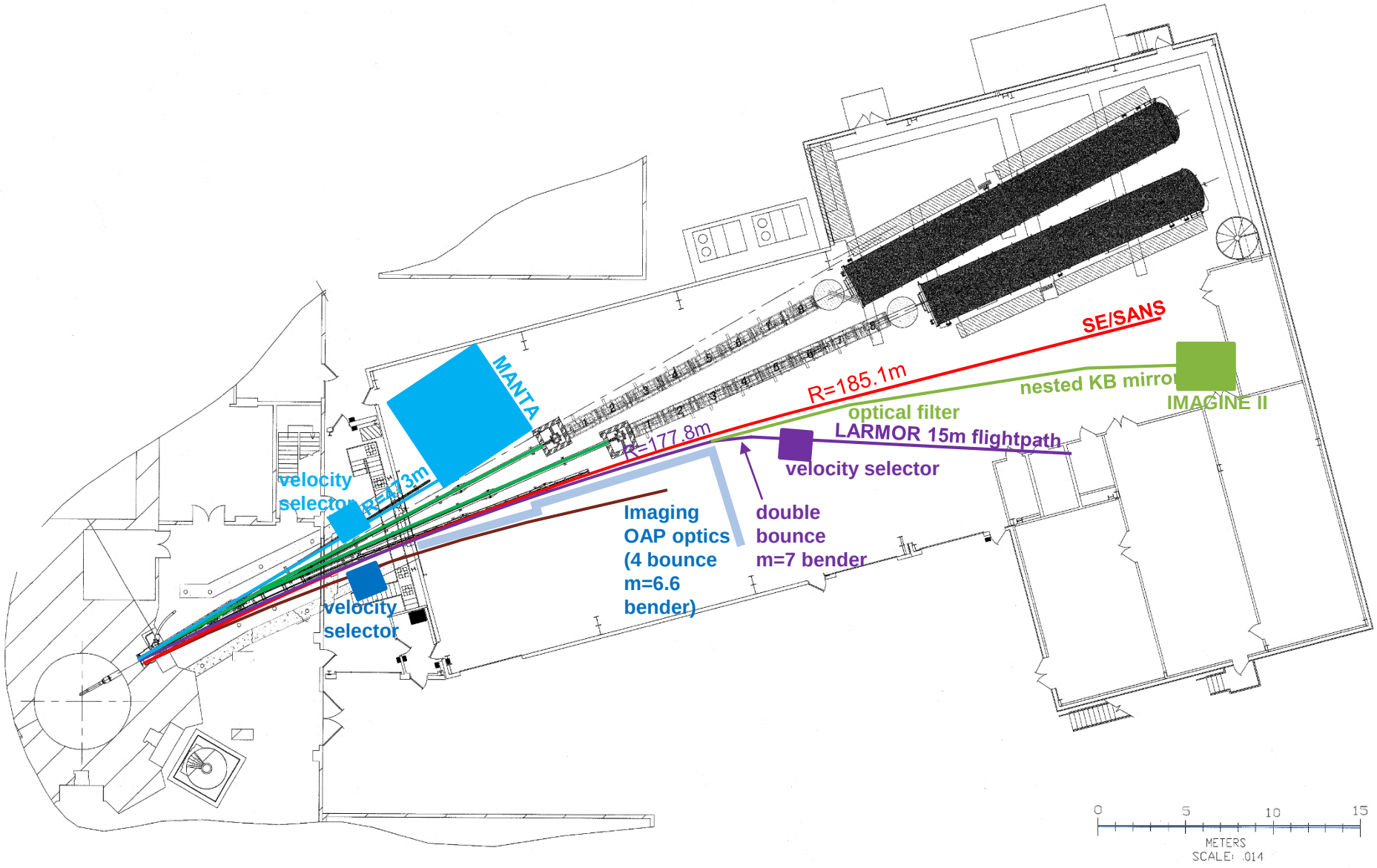
IAB Recommendations given at close-out (2)

- **2. Update the thermal neutron instrument suite at HFIR**
  1. fewer world class instruments over capacity
  2. need to consider instruments across three sources
  3. imaging?
  4. need detailed simulations

IAB Recommendations given at close-out (3)

- **3. Cold Neutrons at HFIR**
  1. NSE
  2. MANTA
  3. Imaging!
  4. SANS
  5. need detailed simulations

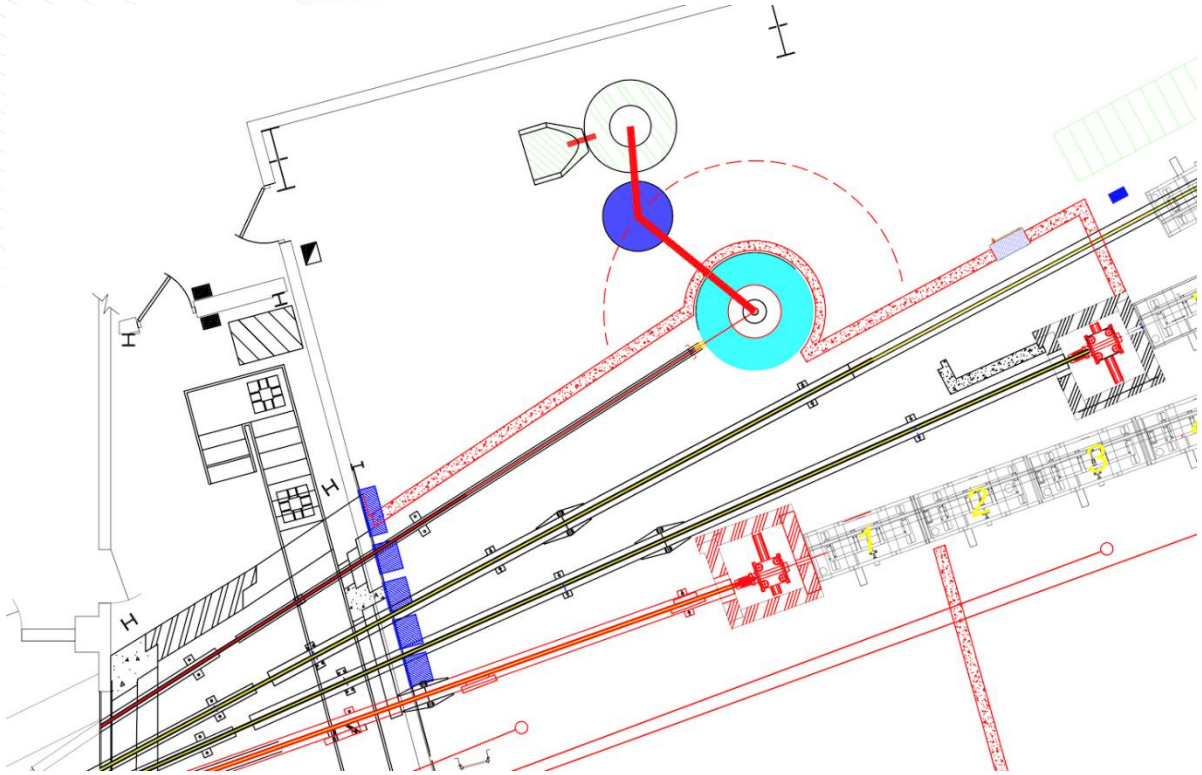
Guide Hall Today vs. 2025



Courtesy: Lee Robertson

New Instrument at HFIR – MANTA

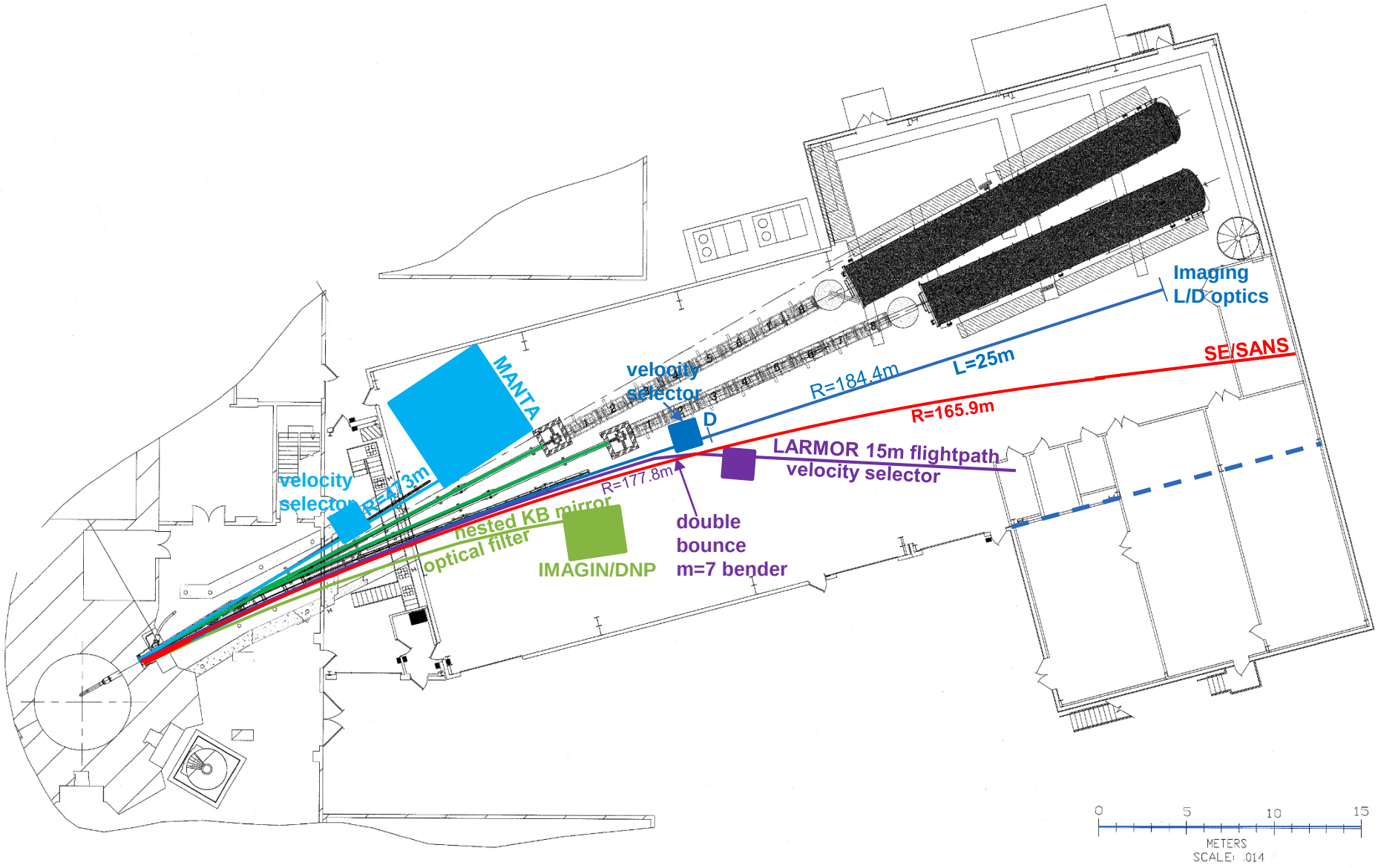
- Layout, Guide Hall



- Schedule
  - Start procurement of guides late 2018
  - ~2023 Beryllium Reflector Plug change
  - ~2025 Install new guides, monochromator and shield, & polarization optics
    - Reuse CTAX Sample, Analyzer, Detector
    - Leverage existing Wollaston Prism system
  - ~2028 Commission New *Multi-Analyzer*

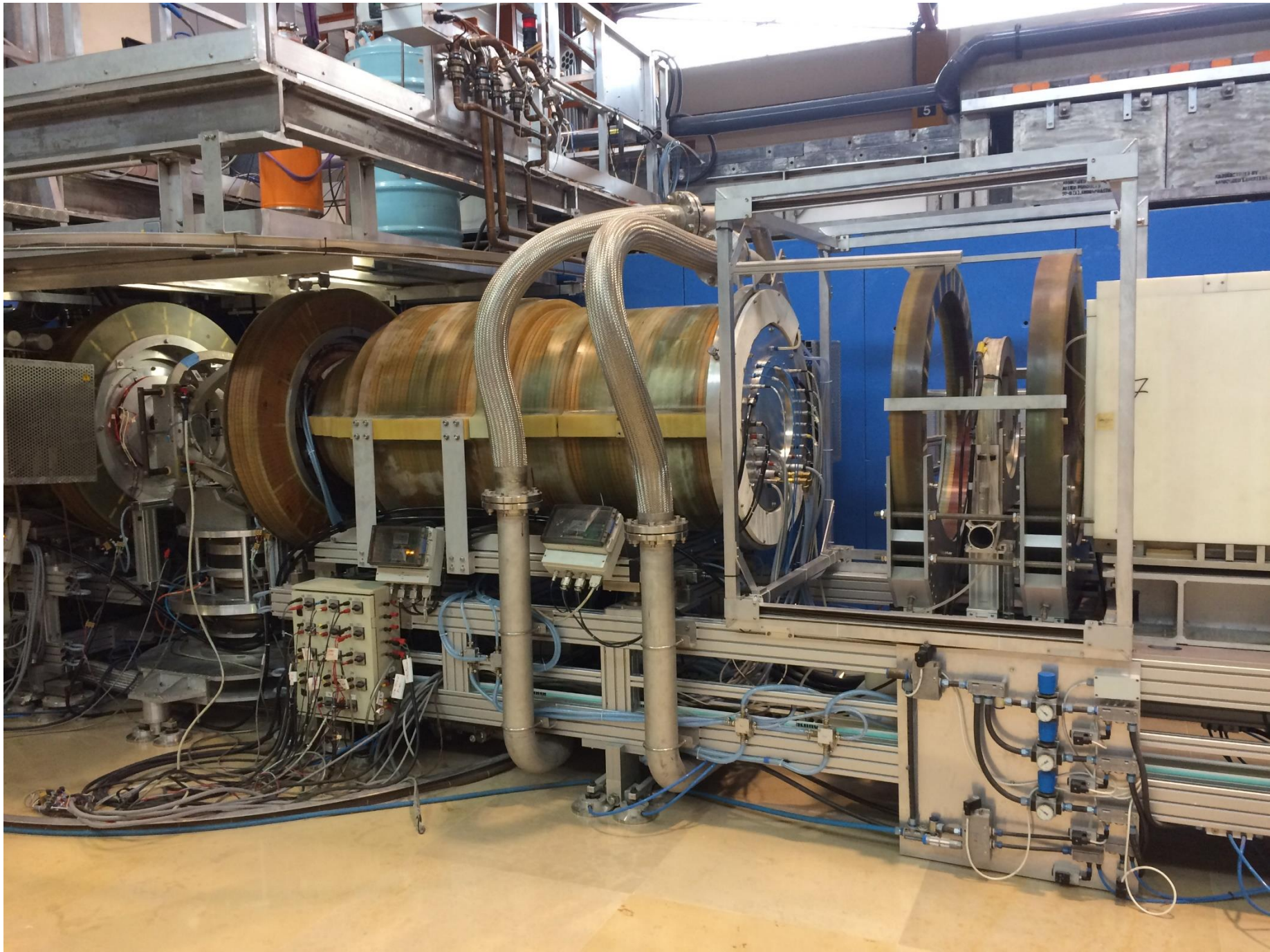
Courtesy:
Barry Winn

Guide Hall Today vs. 2025



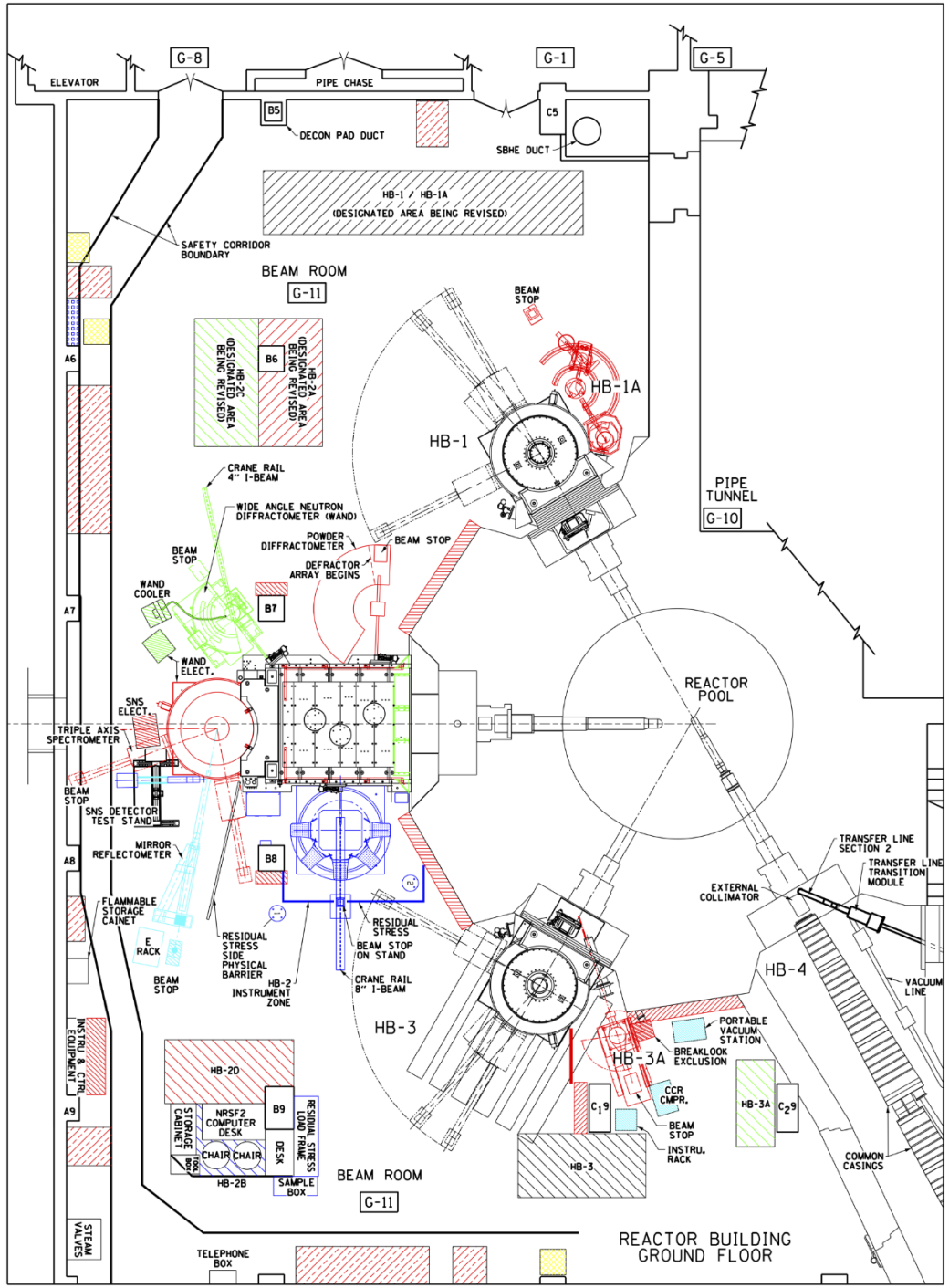
Courtesy: Lee Robertson

NSE Design Goal: IN15 (ILL)



Beam Room Today vs. 2025

- Beam Lines with biggest changes after Be-outage: WAND^2, HB-2A, (HB-1, HB-3)
- Semi-permanent Walls would serve two primary purposes
  - Reduce background
  - Enable interlocks and better access control



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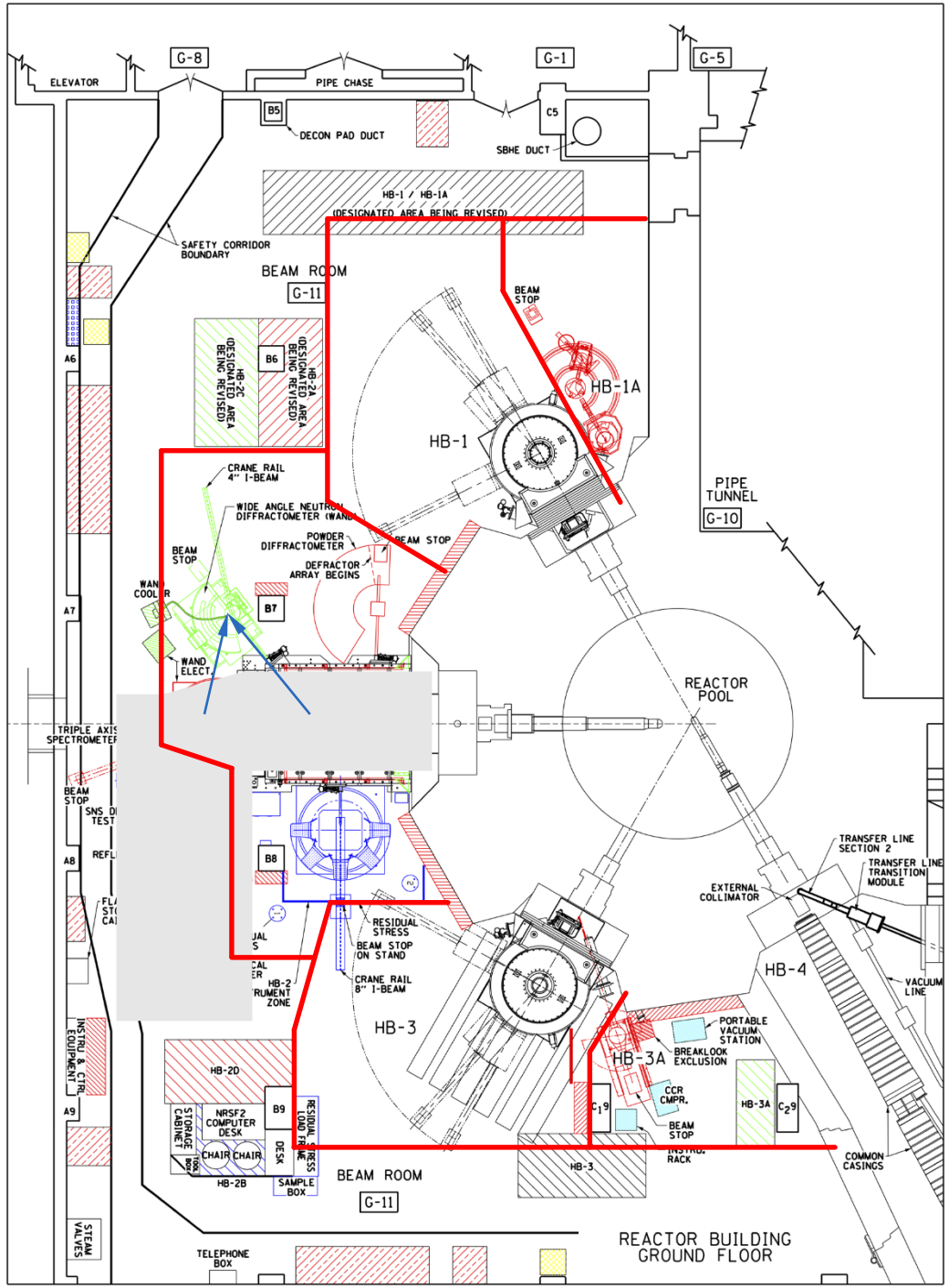

Next Steps

- HB-2A & WAND^2: need concept development and performance simulation
- All instruments should pursue their upgrade projects independently
- Shielding Walls in the Beam Room between Instruments:
  - Anticipate graded approach (i. e., they won't look the same everywhere)
  - Need high-E transport calculations (also for a HB-2 bulk shield redesign), to evaluate potential benefits *quantitatively*
  - Need a dialog with the operations side of the organization

DONE