

# *CANDOR*

## *Chromatic Analysis Neutron Diffractometer or Reflectometer*

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NIST Center for Neutron Research*

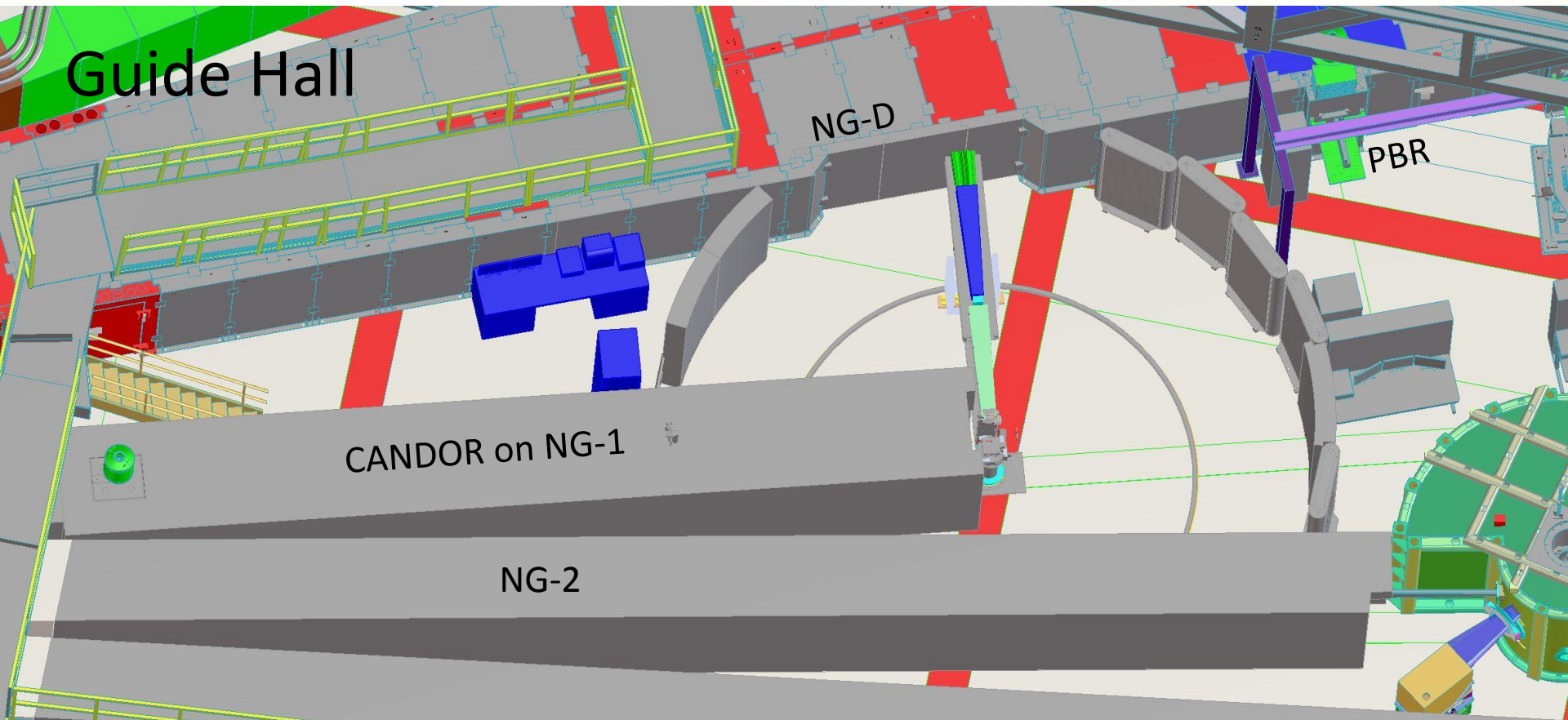




## ● Overview

- *Instrumentation*
- *Shielding*
- *Scope / Price Changes since May, 2009*
- *Schedule*
- *Budget*

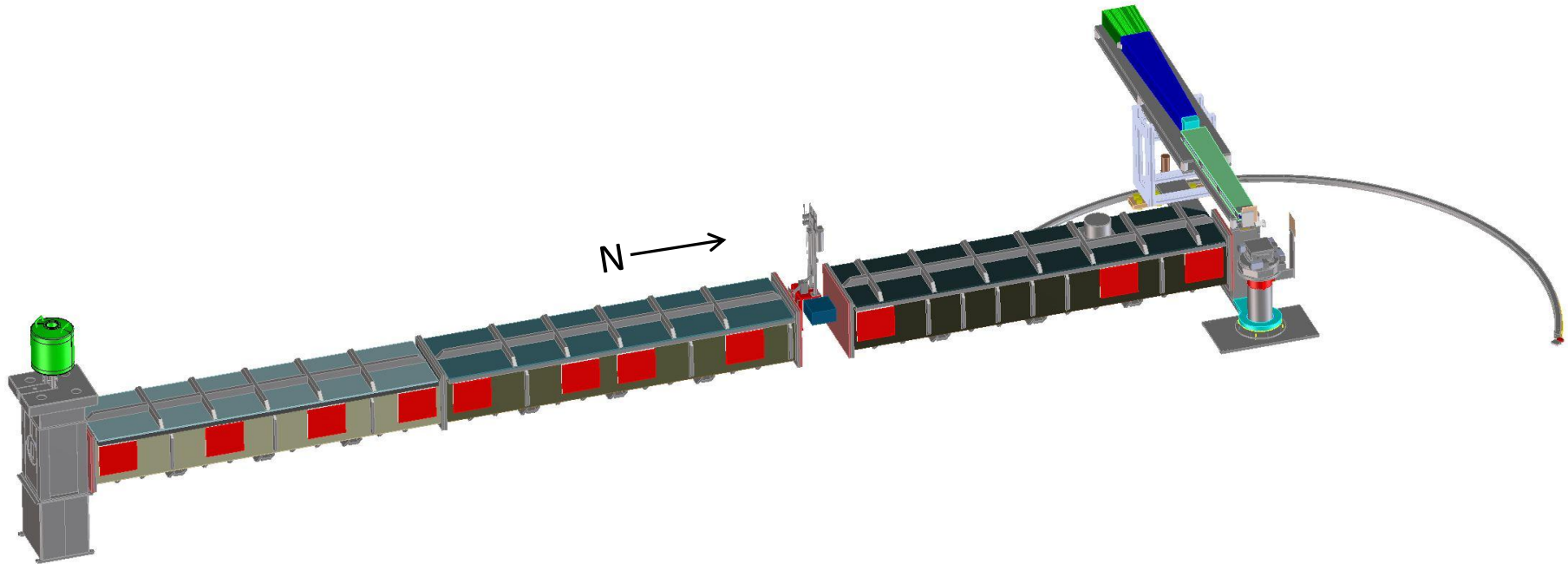
# CANDOR Instrumentation



- How does CANDOR fit in at the NCNR?

# CANDOR

## Instrumentation



- *Primary Engineering Effort thus far...*
  - *Be/Bi Filter through Sample Stage*

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## Instrumentation



### Major Assemblies

- Be/Bi Filter
- Vacuum Jackets
- >6 Angstrom Deflector
- Mezei Polarizer
- *Instrument Shutter*
- *RF Flipper*
- 6 Slit Aperture
- Double Converging Guide
- Single Slit Aperture
- Sample Stage
- Shielding
  - Thermal Neutron Beam Dump
  - Along Pre-sample Instrument
  - Peripheral



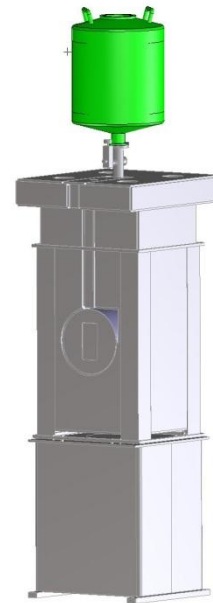
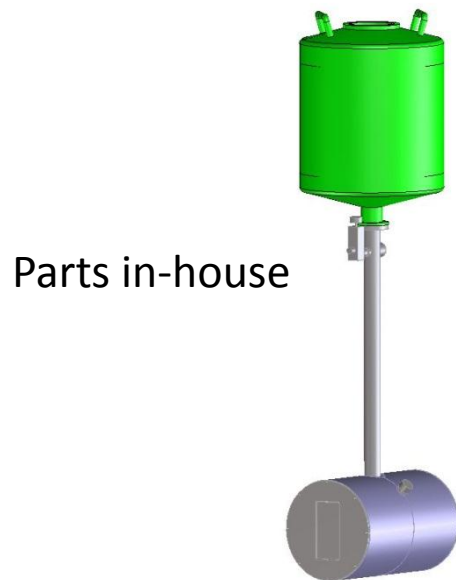
# CANDOR

## Instrumentation



### ● Be/Bi Filter

- Cooled to liquid nitrogen temperatures
- 8 inches Beryllium – eliminate  $< 4$  Angstrom
- 8 inches Bismuth – eliminate gamma rays



Shielding design not started



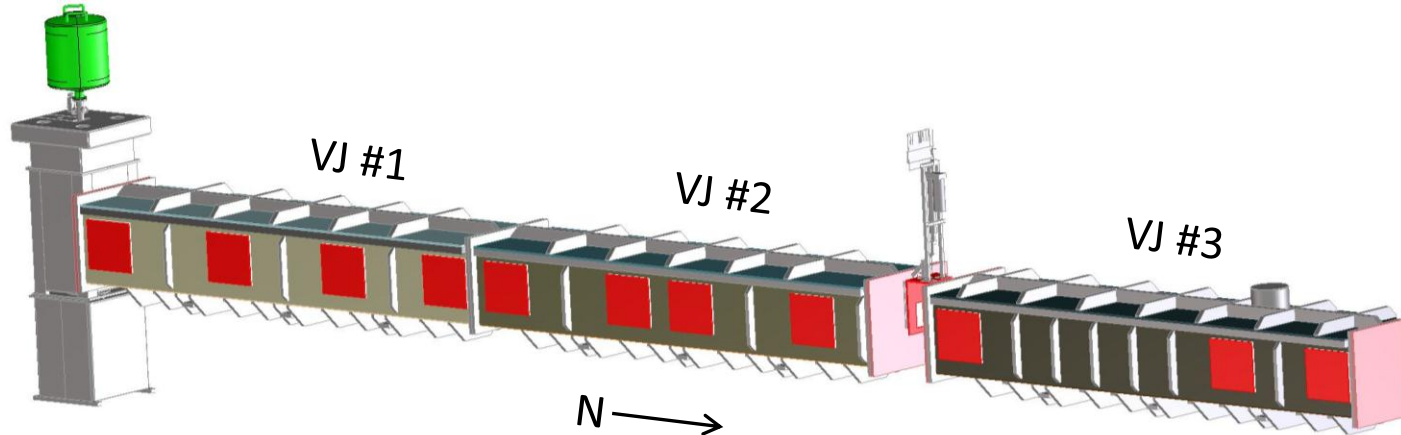


# CANDOR

## Instrumentation

### 3 Pre-sample Vacuum Jackets

- Alum plate (0.5") - 2 sealed volumes due to Instrument Shutter
- Magnesium windows on ends
- Windows added for guide adjustment/alignment
- High level design / FEA complete
- Next step – detailed design

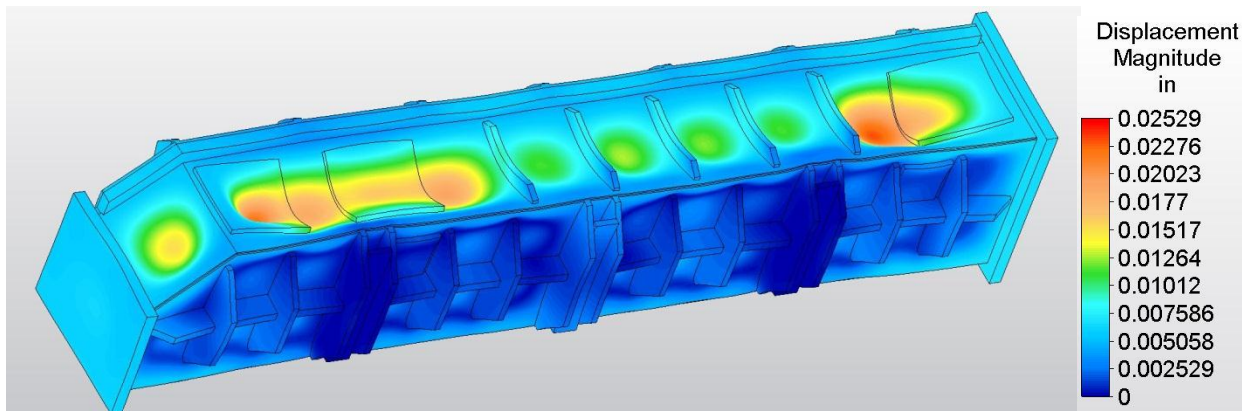
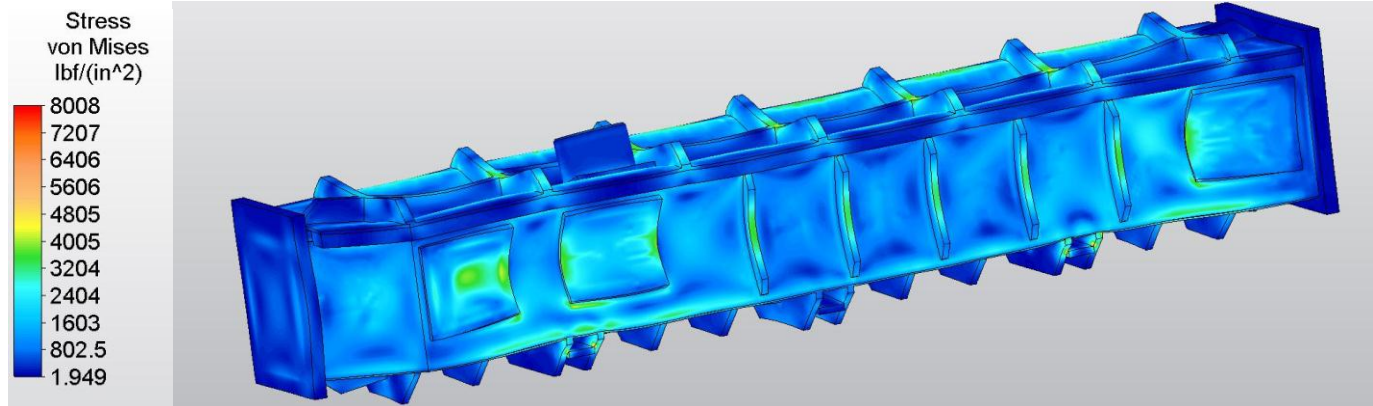


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## Instrumentation



### Vacuum Jacket FEA Results

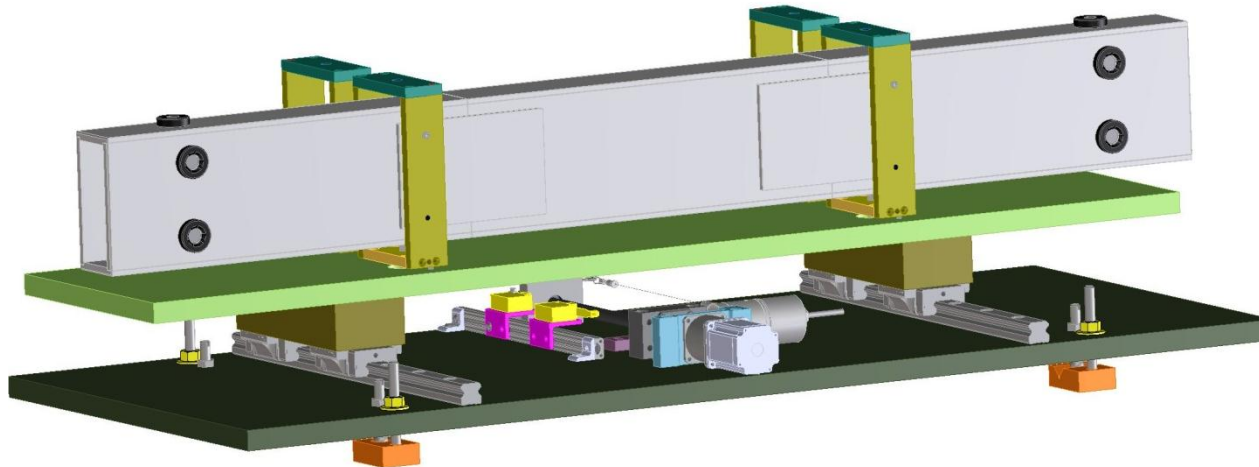




# CANDOR

## Instrumentation

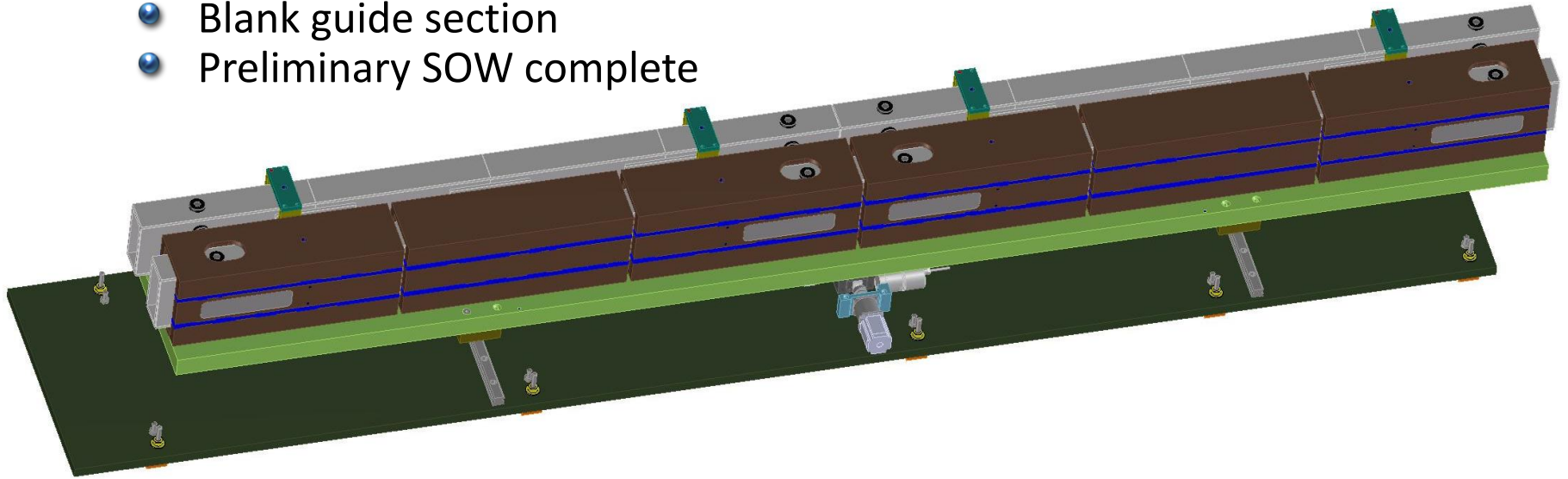
- X-Deflector - wavelengths  $> 6$  Angstroms
  - Simulation and analysis performed by Jeremy Cook
    - X-shape of inner silicon substrate optimal with large angle to beam and  $m=3$
  - Eliminated  $>10$  Angstrom deflector
  - Preliminary SOW complete



### Contents of Vacuum Jacket #2

#### Mezei Polarizer

- Design based on Spin Echo Demonstration Piece
  - Double-V configuration, nonmagnetic substrate,  $m=3$
- Polarization perpendicular to direction of beam
- Maximum length=3.5M, made in 2 sections
- Blank guide section
- Preliminary SOW complete

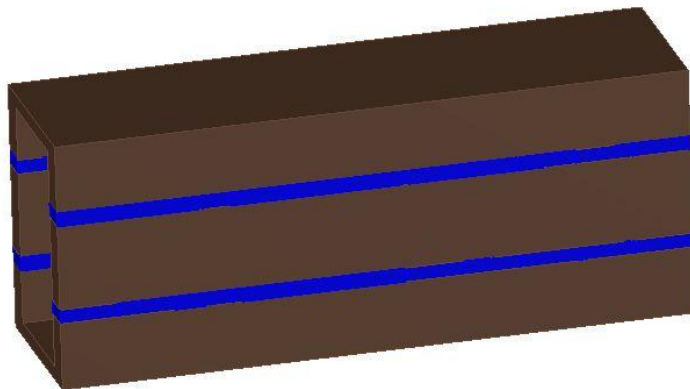


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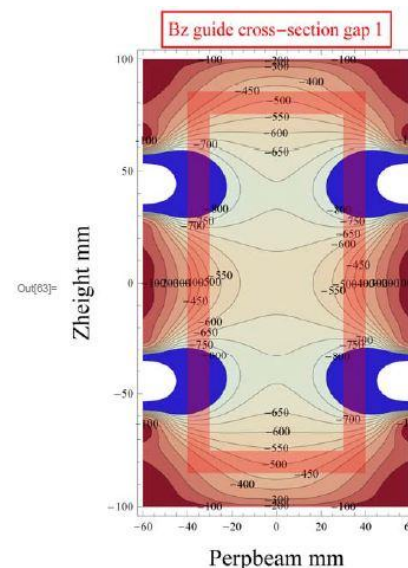
## Instrumentation



- Polarizer – Magnetic Field Cavity
  - Analysis performed by Ross Erwin
  - Gauss – 500+
  - Magnets at 1/3 – 2/3 height



- Neodymium magnets
- Soft steel plates



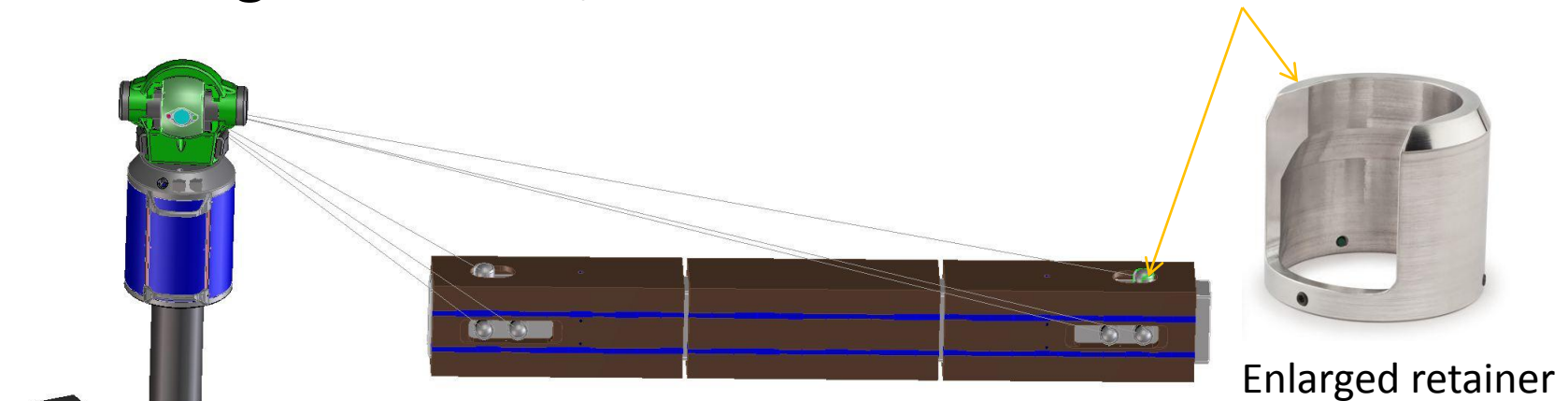
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## Instrumentation



### ● Polarizer Guide Alignment

- Faro laser tracker
- Nonmagnetic SMRs, nests and aluminum retainer



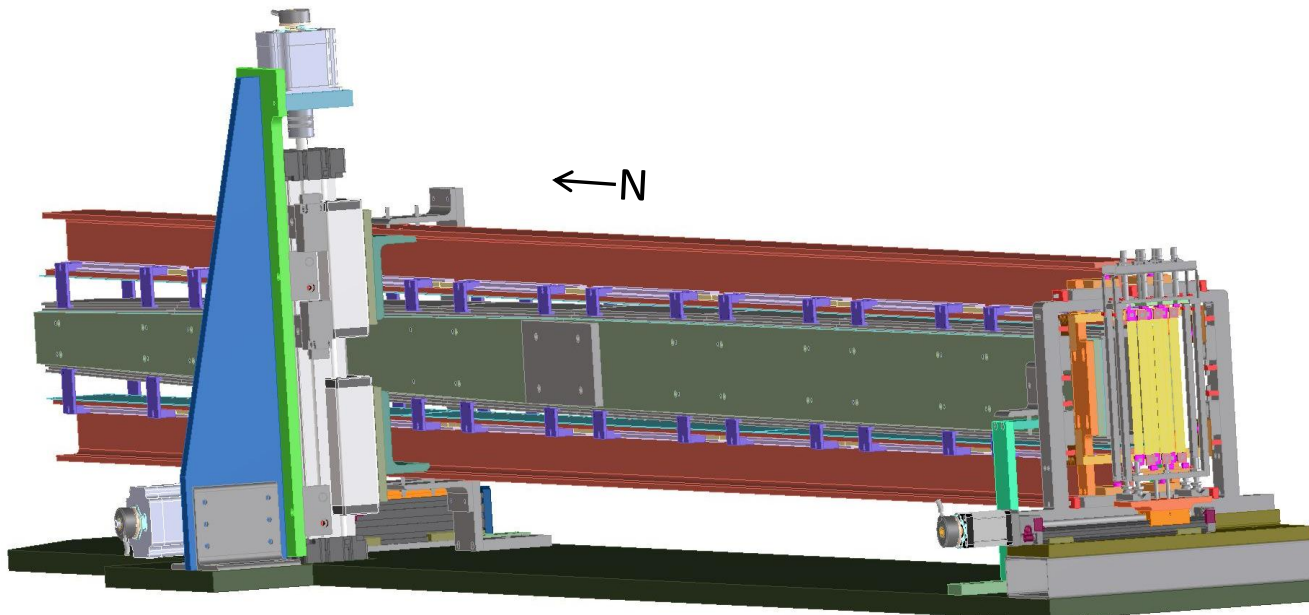
Enlarged retainer

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## Instrumentation



- Contents of Vacuum Jacket #3
  - 6 slit aperture
  - Double converging guide

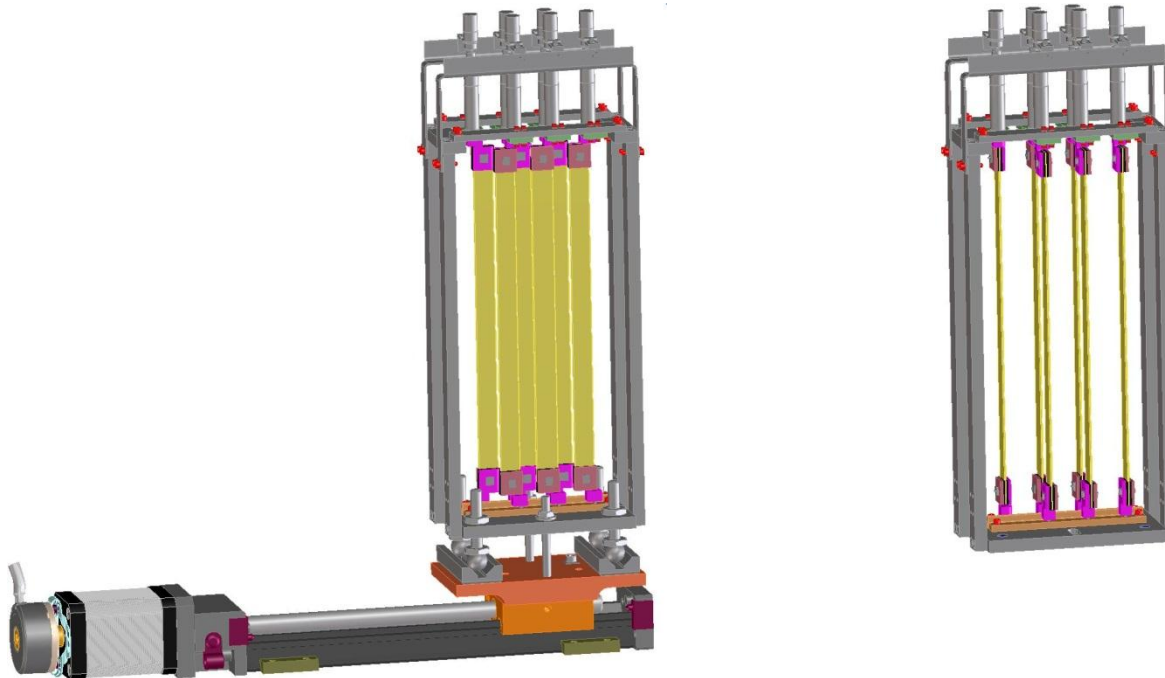


# CANDOR

## Instrumentation

### ● Six Slit Variable Aperture

- Slits – 1mm thick  $^6\text{Li}$  glass
- Each slit rotates independently
- Entire assembly translates in and out of beam
- Next step – build prototype





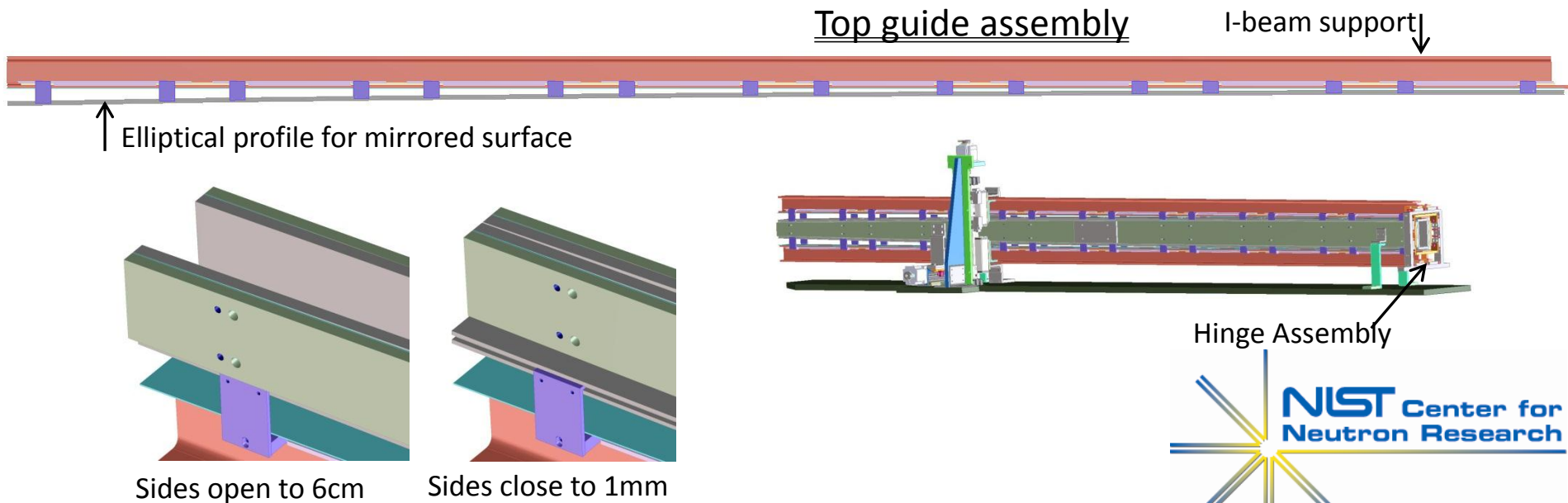
# CANDOR

## Instrumentation



### Double Converging guide

- 3.9 meters long
- Elliptical configuration not finalized
- Top, Bottom and Sides are 4 stand alone assemblies
  - Mirrored aluminum
  - 8 flat guide plates per assembly
    - Use of adjustment screws and laser to align each plate
- Sides assemblies rotate in and out
- Top and bottom assemblies are stationary but capability remains to rotate them in future

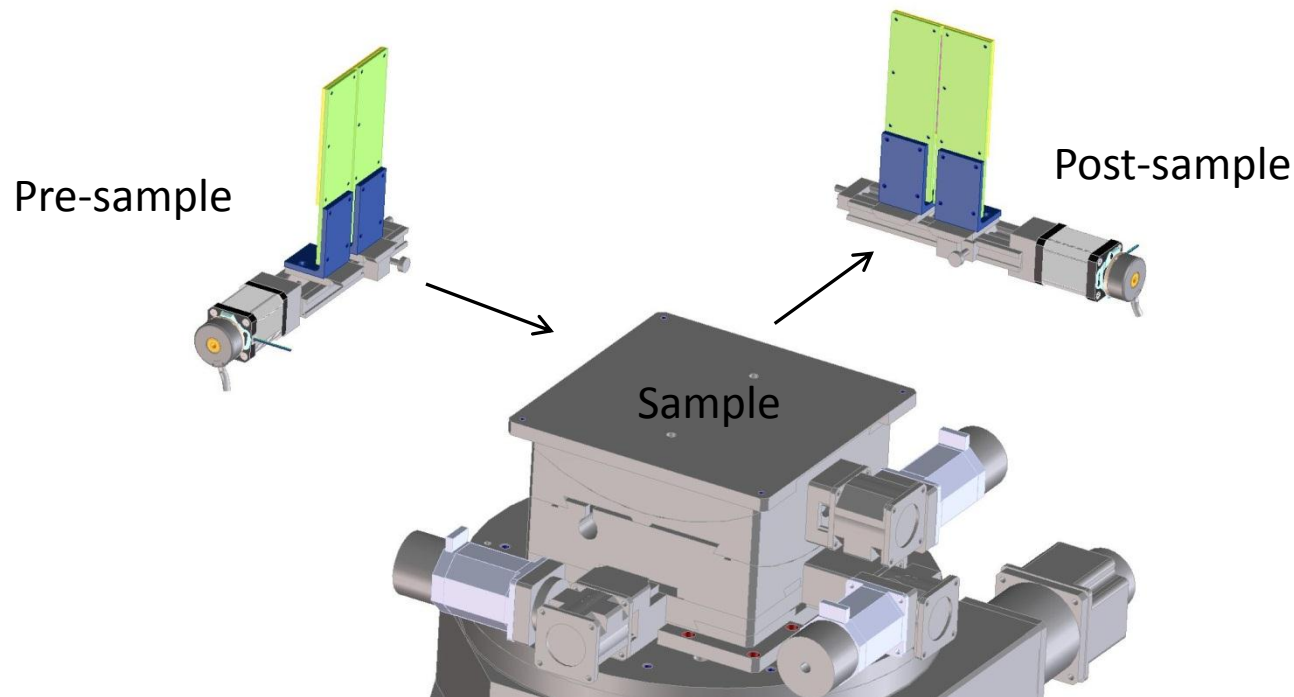


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## Instrumentation

### ● Single slit aperture

- One pre-sample and one post sample
- Slits -  $^6\text{Li}$  glass encased in magnesium (due to radioactive tritium)



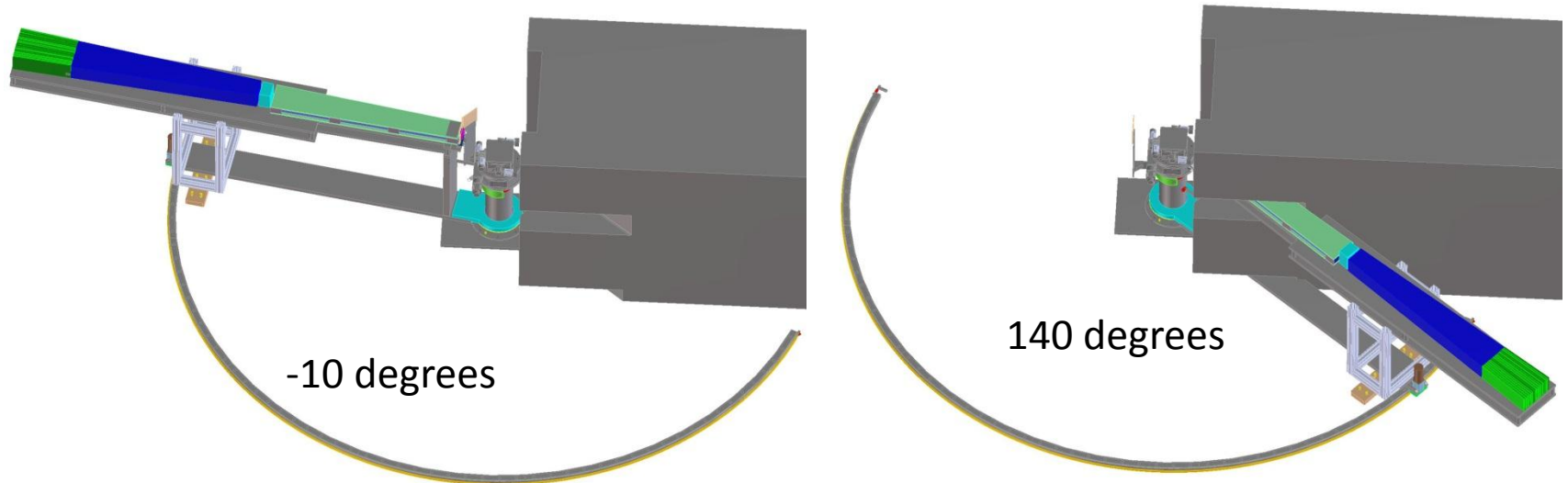
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## Instrumentation



### ● Detector Arm Rotation

- Rotation of -10 to 140 degrees
- Large bearing at sample stage
- Rack in pinion drive – design in process



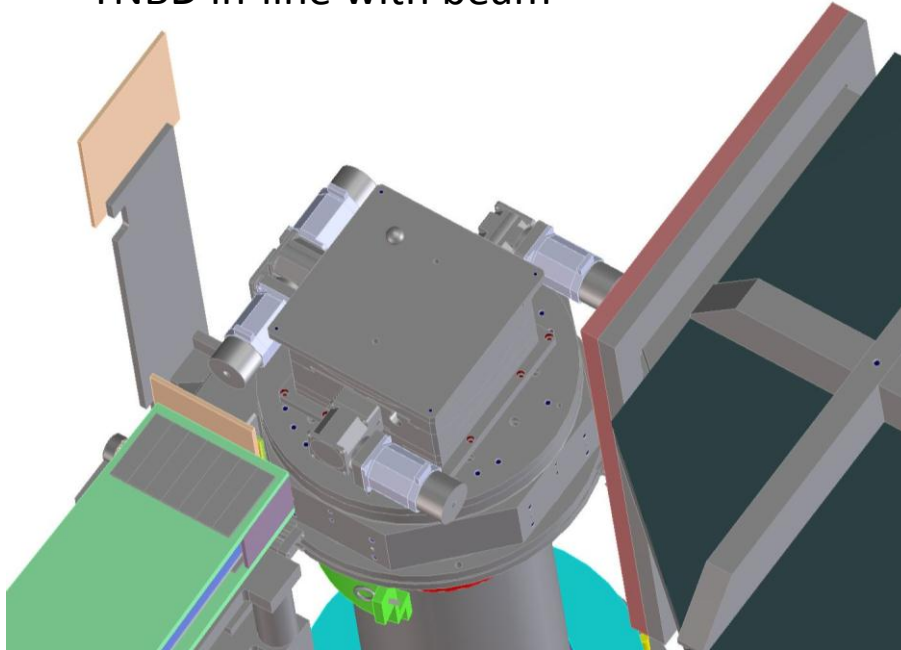
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## Shielding

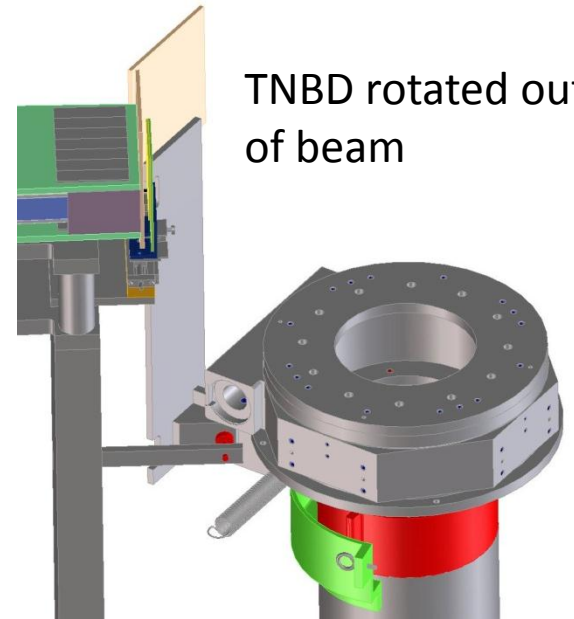


- Shielding Analysis – Jeremy Cook
- Thermal Neutron Bean Dump (TNBD)
  - $^6\text{Li}$  glass encased in magnesium
  - Spring assembly
    - Detector arm rotates TNBD out of beam

TNBD in-line with beam



TNBD rotated out of beam

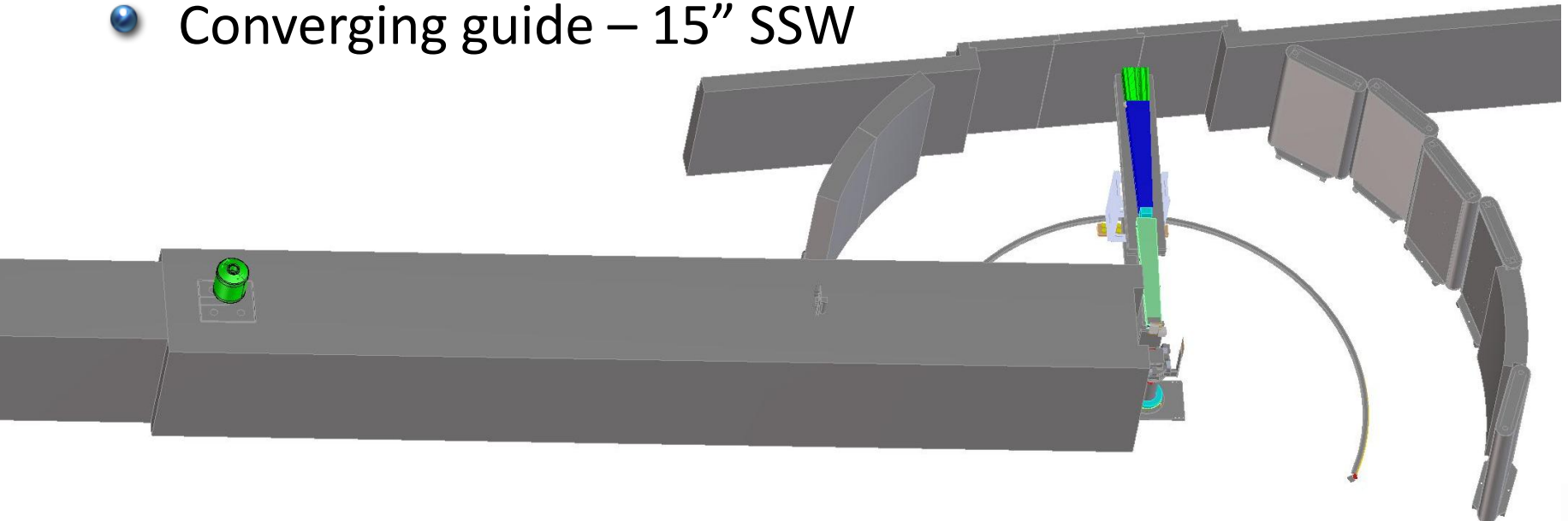


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## Shielding



- Pre-sample Shielding Along Beam
  - G100 wall to filter – 12" thick SSW & 4" thick HDPE
  - Filter  $\pm$  2' – 15" thick SSW
  - Deflector / Polarizer – 12" thick steel
  - Converging guide – 15" SSW

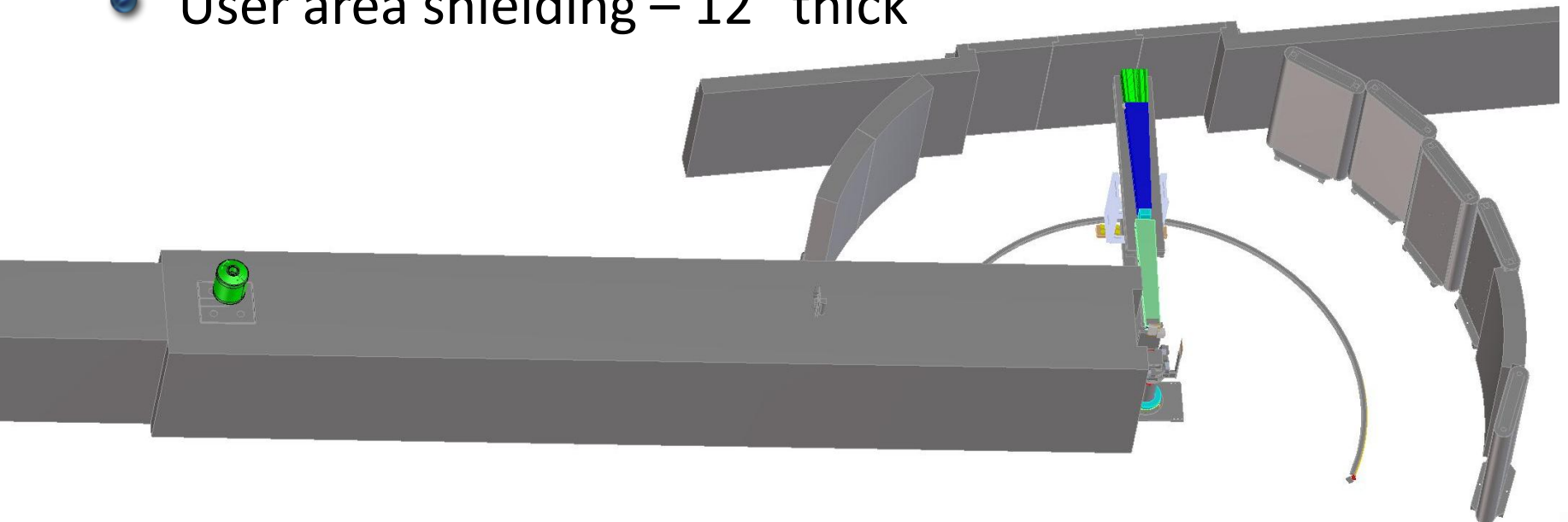


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## Shielding



- Peripheral Shielding
  - Shield inline with beam – 12" thick plus enhanced gamma shielding
  - Arc of shielding added – North End – 6" thick
  - User area shielding – 12" thick





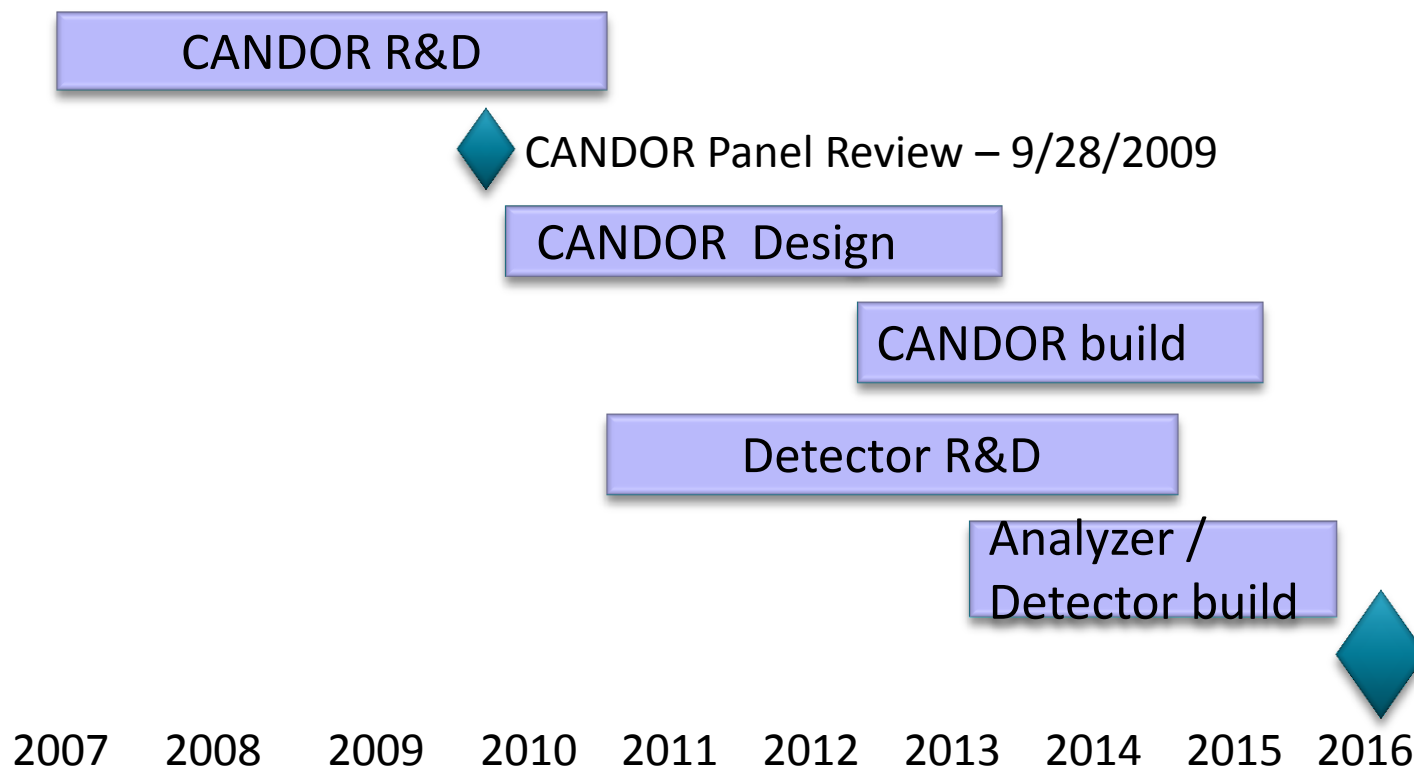
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## Scope and/or Price Changes Since 2009

SCOPE AND/OR PRICE CHANGE	SCHEDULE IMPACT	BUDGET IMPACT
HOPG CRYSTALS FOR ANALYZER	----	\$360,000
ELECTRONICS FOR DETECTOR	----	\$610,000
VACUUM JACKETS	11 WEEKS	\$350,000
SHIELDING (HAD ASSUMED USE OF EXISTING SHIELDING)	13 WEEKS	\$400,000
CONVERGING GUIDE– ALUM/ELLIPTICAL	2 WEEKS	\$115,000
DETECTOR ARM ROTATION	7 WEEKS	\$50,000
THERMAL NEUTRON BEAM DUMP	4 WEEKS	\$10,000
RF FLIPPER	MINIMAL	\$5,000
POST SAMPLE DIVERGING GUIDES – HELIUM FLOW THRU	2 WEEKS	\$20,000

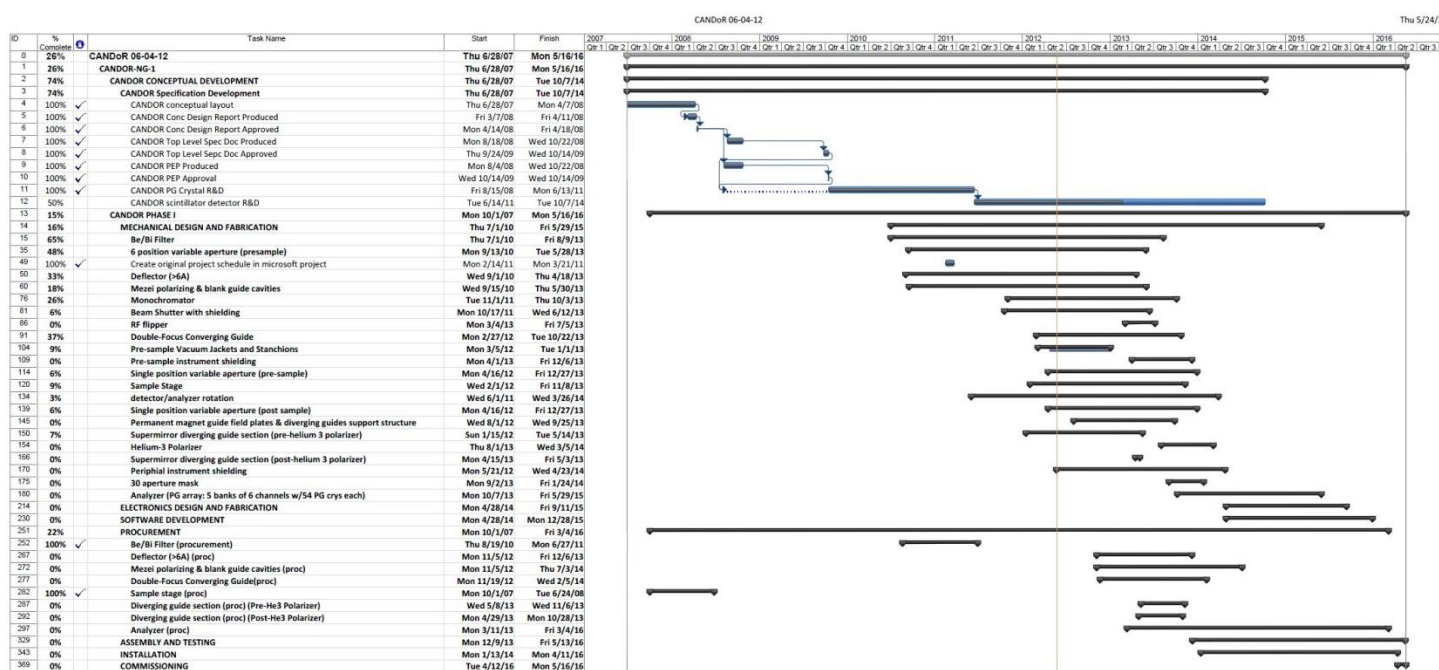


## ● Scope changes are not critical path



# CANDOR Schedule

- Long lead time items – All guide elements, Detector R&D
- Mechanical Design and Fabrication – 6/2015
- Phase I Completion - 6/2016



# CANDOR

## Budget

CANDOR Budget Summary		6/5/2012
Be/Bi Filter with Shielding		\$87,000
Deflector (> 6 Angstroms) w/translation		\$120,000
Mezei Polarizer with Magnetic Cavity & Blank Guide w/translation		\$230,000
Beam Shutter and Shielding		\$90,000
RF Flipper		\$15,000
6 Slat Variable Aperture with translation		\$50,000
Double-Focus Converging Guide		\$190,000
Pre-sample Vacuum Jackets & Stanchions		\$400,000
Pre-sample Instrument Shielding		\$350,000
Pre and Post Single Slit Aperture		\$20,000
Sample Stage		\$147,000
Detector Arm Rotation		\$50,000
Post-sample Diverging Guides w/Magnetic Field		\$130,000
Helium-3 Polarizer w/translation		\$100,000
30 Aperture Mask		\$20,000
Detector / Analyzer Support/Shield /Helium Enclosure		\$65,000
Detector / Analyzer Module Breakdown		
Scintillator	\$715	
Fiber Optic	\$165	
Mechanical Structure	\$4,400	
HOPG	\$20,350	
Electronics	\$31,350	
<i>Total Price Per Module</i>	\$56,980	
Detector Analyzer Module * 30 Modules		\$1,709,400
Peripheral Shielding		\$50,000
<b>Total</b>		<b>3,823,400</b>



# CANDOR

## Budget



TIMELINE	CANDOR COMPONENTS	BUDGET
2007	SAMPLE STAGE (HUBER GONIOMETERS)	\$107,000
2010	BE/BE FILTER	\$42,000
2013	BE/BI FILTER SHIELDING, 6 SLIT APERTURE, >6A DEFL, MEZEI CAVITY MECH, BEAM SHUTTER, RF FLIPPER, DOUBLE FOCUSING MECH, SINGLE SLIT APERTURES, SAMPLE STAGE	\$440,000
2014	MEZEI GUIDE, DOUBLE FOCUSING GUIDES, VJ AND STANCHIONS, DETECT ARM ROTATION, DIVERGING GUIDES, HE3 POLARIZER, 30 APERTURE MASKS, SHIELDING	\$1,460,000
2015	DETECTOR / ANALYZER SYSTEM	\$1,774,000

