THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

MAJORANA DEMONSTRATOR Simulations (Geometry)

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On Behalf Of The

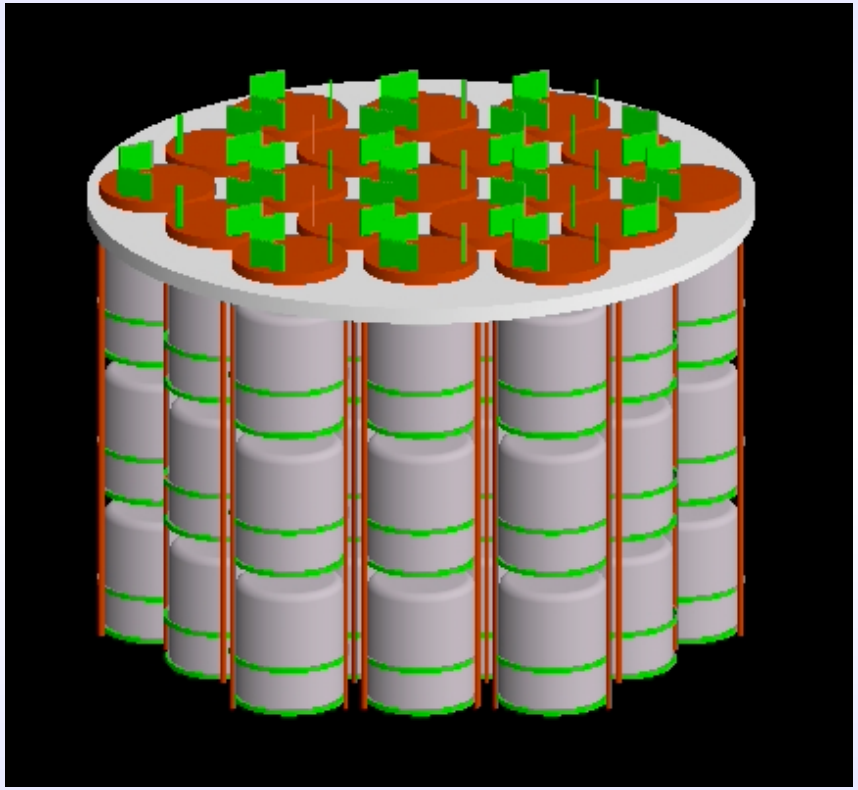
MAJORANA Collaboration

Outline

- Previous Work
- The problem: The DEMONSTRATOR Geometry
- Coding Issues

MAJORANA "Reference Design" Simulation (2006)

Simulated Geometry
Shields & Cryostat Removed



Simulation Includes:

- 57 Enriched crystal w/ deadlayers.
- LFEPs
- Support Rods
- Ge Trays
- Contact Rings
- Cryostat
- Shields:
  - Inner, Outer Cu
  - Inner, Outer Pb
  - Neutron shield.
  - Room, rock wall.
- 45,000 CPU hours, 12,000 jobs, 2TB of data.
- Thanks to PDSF:

NERSC
NATIONAL ENERGY RESEARCH SCIENTIFIC COMPUTING CENTER
Advancing Computational Science of Scale—Producing Real Results

Initial Simulation Campaign based on 'Reference Design'

- Simulate spectrum from sources in all detector components.
- Apply heuristic analysis cuts:
  - Granularity
  - Segmentation.
  - Pulse shape discrimination estimator
  - 3D Reconstruction (highly-segmented detectors).
  - Use clustering of energy deposits
  - Modified electrode

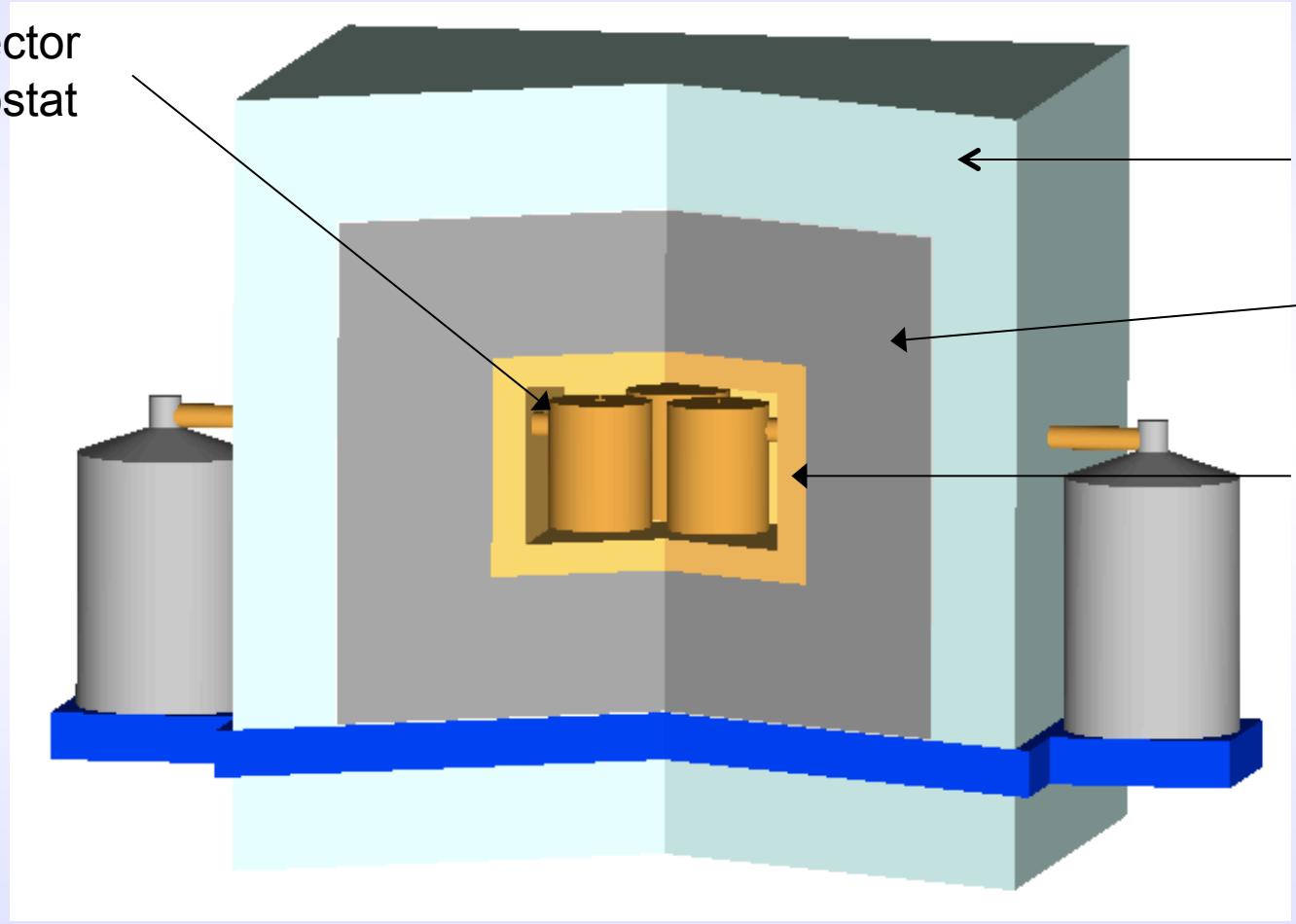
Sources

- Crystals Internal:
  - ^{68}Ge, ^{60}Co, ^{214}Bi, ^{208}Tl :
  - $2\nu\beta\beta$, $0\nu\beta\beta$:
- Support Rods: ^{208}Tl, ^{214}Bi, ^{60}Co.
- Ge Trays: ^{208}Tl, ^{214}Bi.
- Contact Rings: ^{208}Tl, ^{214}Bi.
- Cabling: ^{208}Tl, ^{214}Bi.
- LFEPs: ^{208}Tl, ^{214}Bi, ^{60}Co.
- Cryostat, ^{208}Tl, ^{214}Bi, ^{60}Co:
- Crystals Surface: Rn daughters (alphas). U/Th dust
- Inner Cu shield: ^{208}Tl, ^{214}Bi, ^{60}Co.
- Other Shielding.
- Alphas

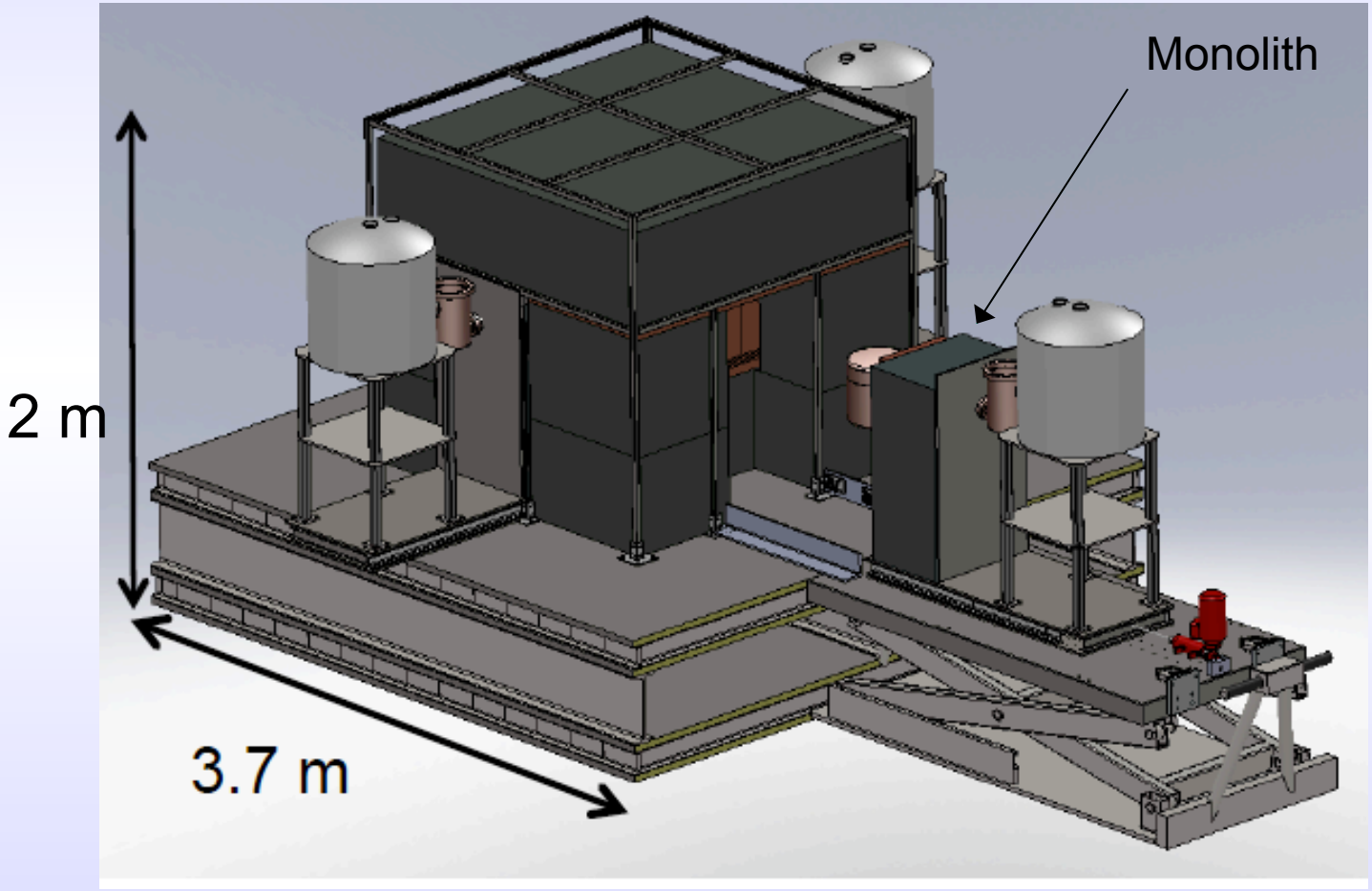
Basis for background estimates to date and detector choice.

THE DEMONSTRATOR GEOMETRY

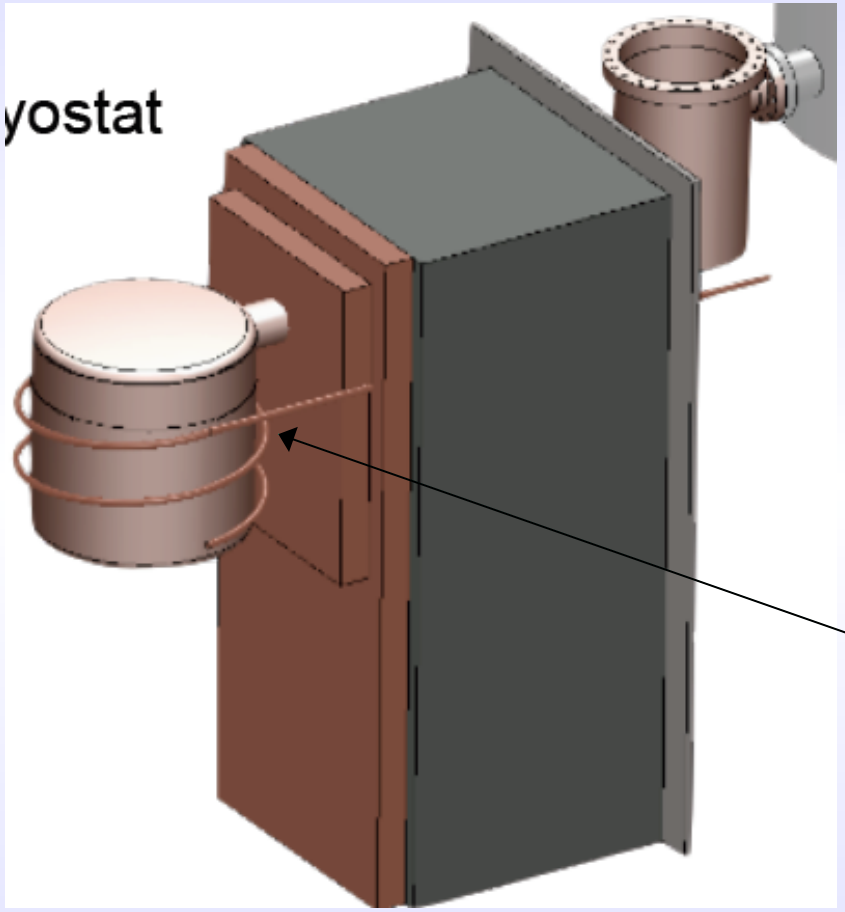
Conceptual Design



Demonstrator Engineering Design

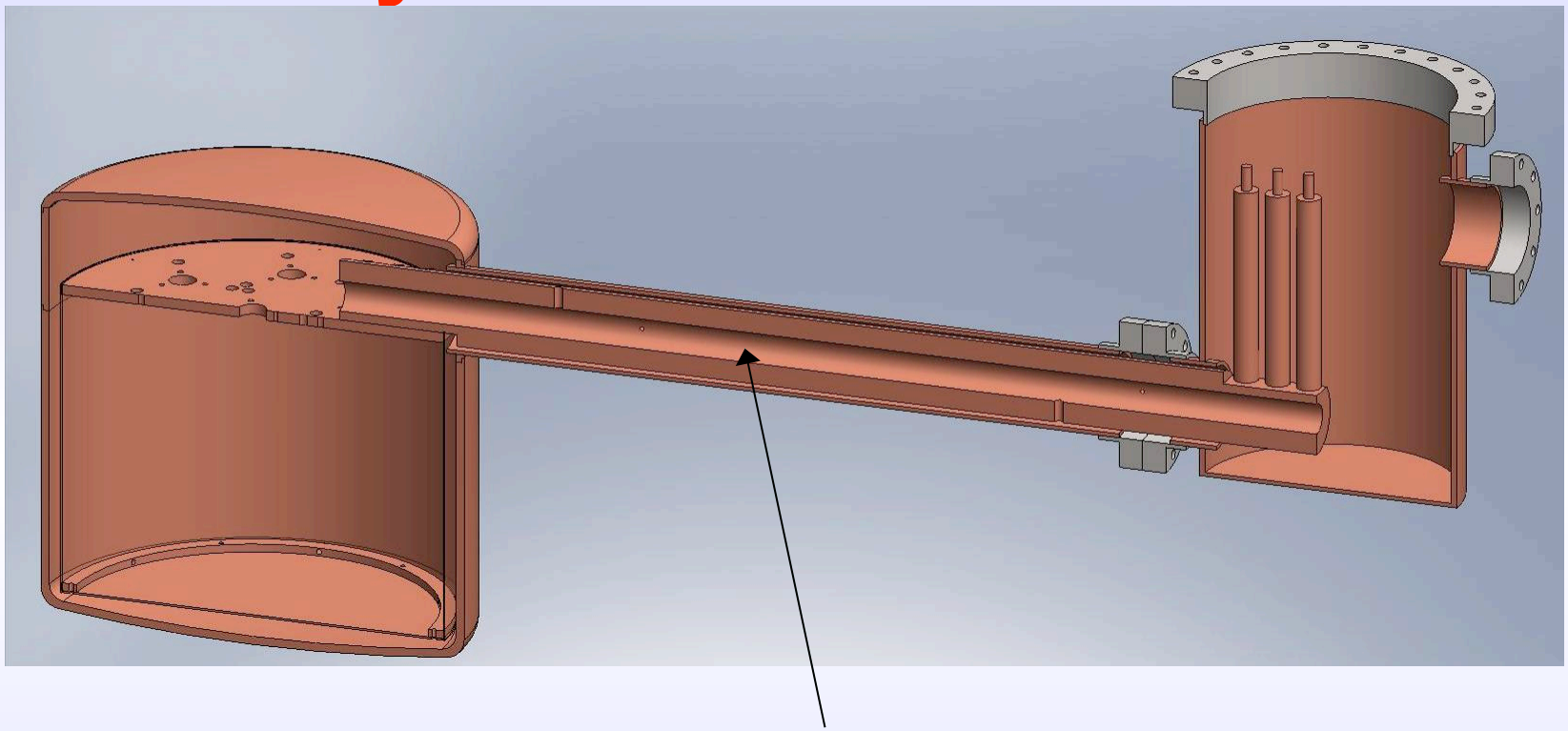


Monolith Design



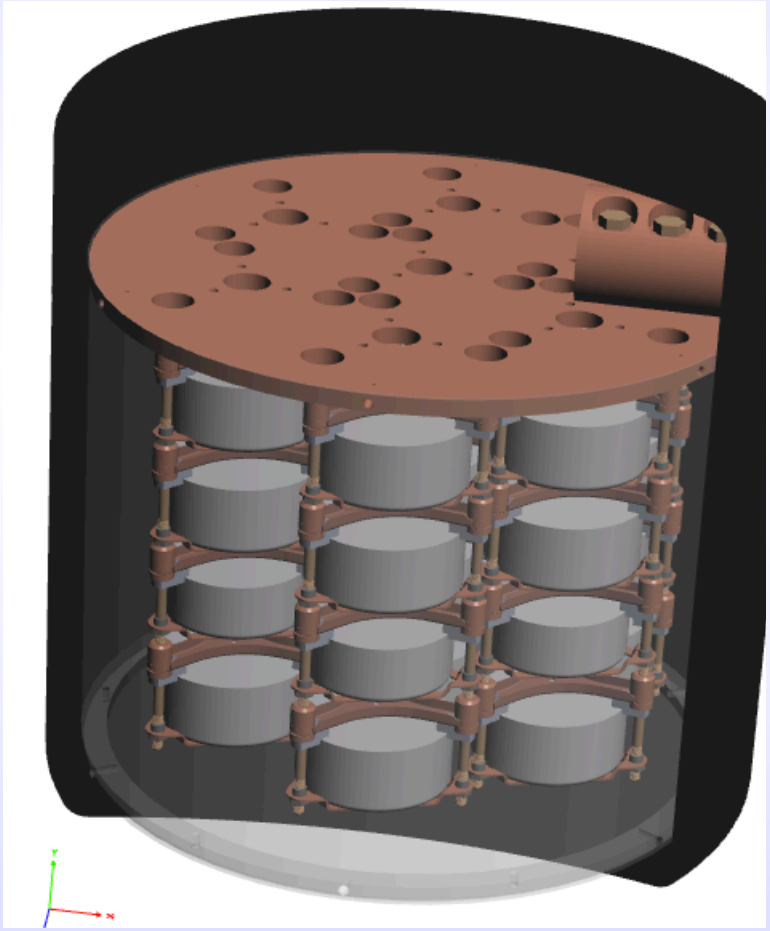
- Simulation Issues:
  - Shield Thickness
  - Cracks in Shield
  - Calibration System
  - Contamination in shield

Cryostat and Breakout

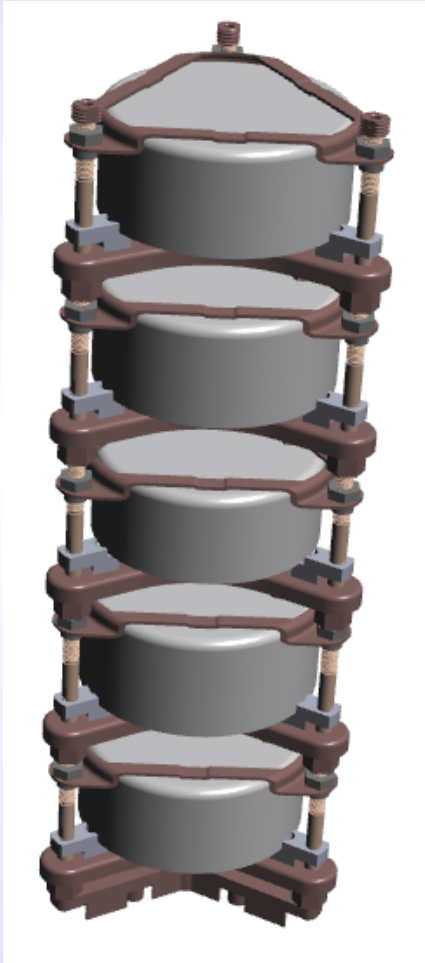


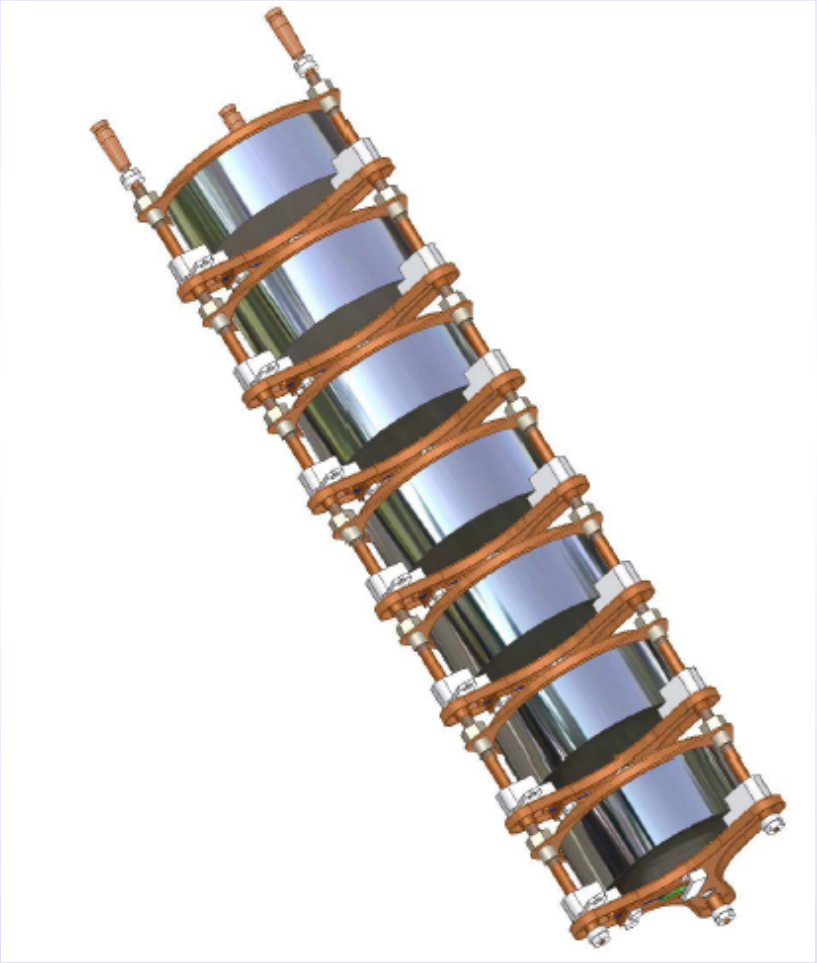
- Shine through cross-arm, contamination in cold-finger support, cables in cross-arm, contamination in cryostat, etc.

Module Design

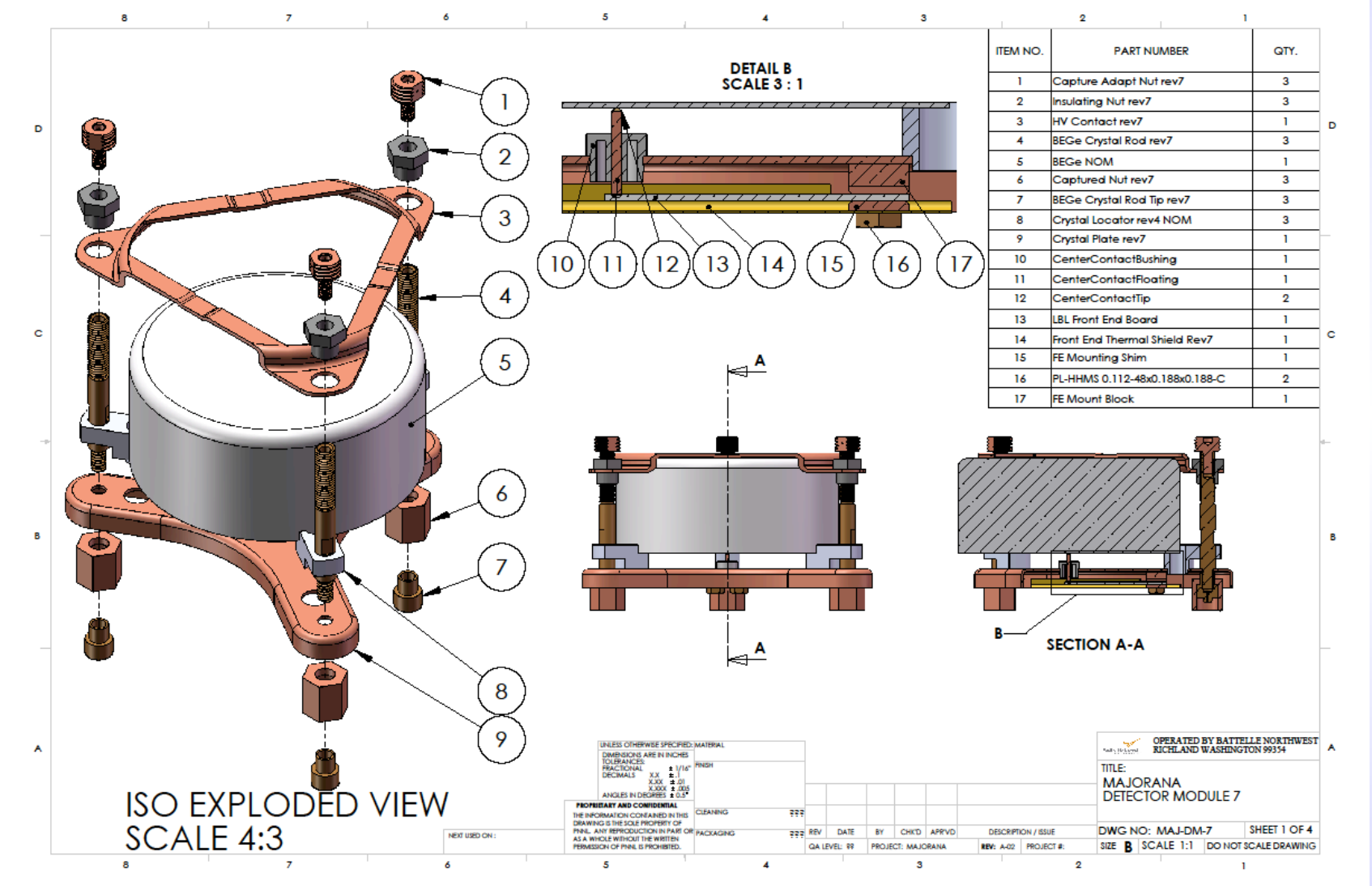


Candidate String Designs



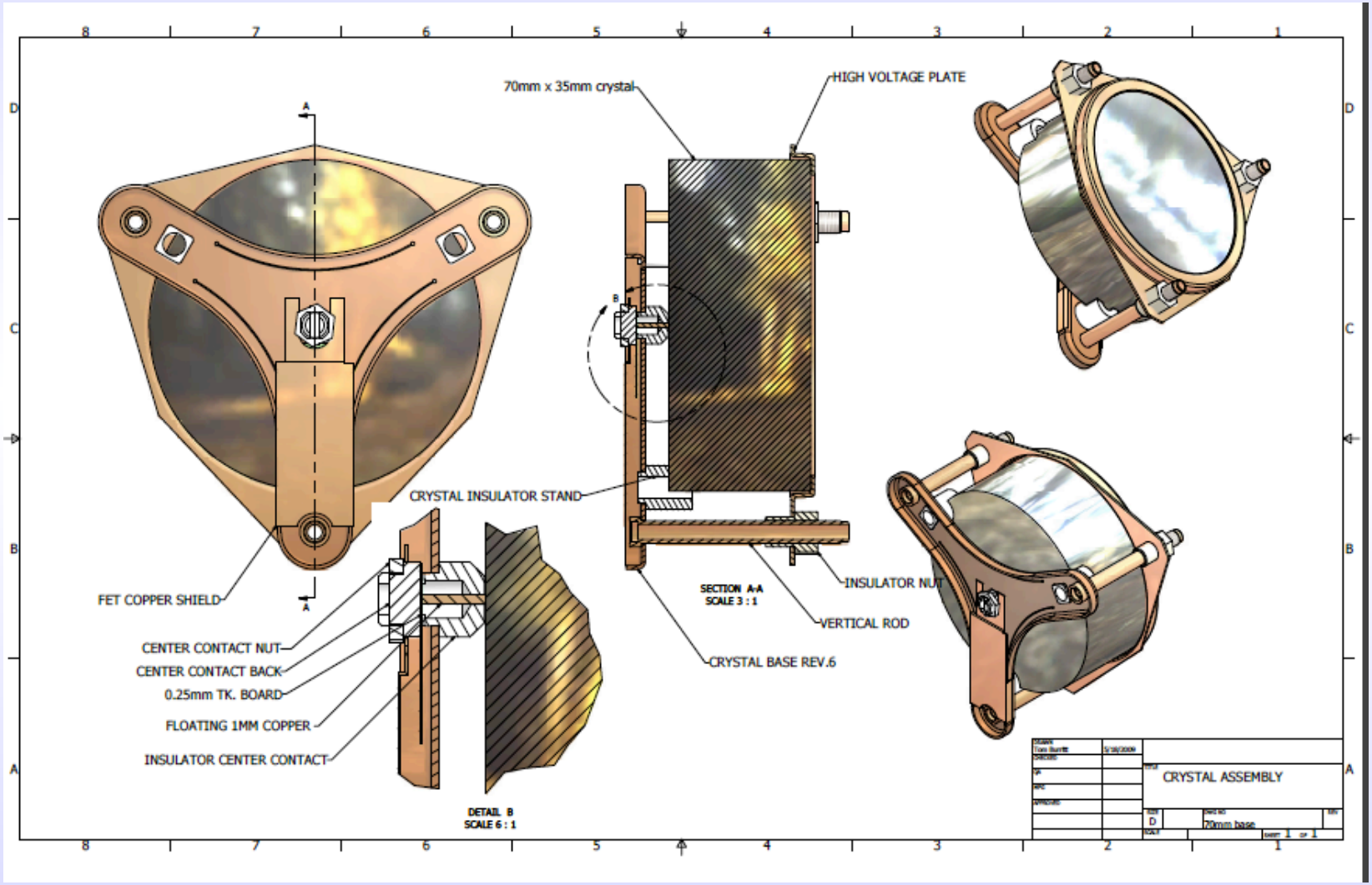


Candidate Crystal Mount Design (1)



ITEM NO.	PART NUMBER	QTY.
1	Capture Adapt Nut rev7	3
2	Insulating Nut rev7	3
3	HV Contact rev7	1
4	BEGe Crystal Rod rev7	3
5	BEGe NOM	1
6	Captured Nut rev7	3
7	BEGe Crystal Rod Tip rev7	3
8	Crystal Locator rev4 NOM	3
9	Crystal Plate rev7	1
10	CenterContactBushing	1
11	CenterContactFloating	1
12	CenterContactTip	2
13	LBL Front End Board	1
14	Front End Thermal Shield Rev7	1
15	FE Mounting Shim	1
16	PL-HHMS 0.112-48x0.188x0.188-C	2
17	FE Mount Block	1

Candidate Mount Design (2)



Conclusions

- LOTS of small parts to simulate in cryostat, many with high fidelity
- Hierarchical vs. flat geometry description
  - Flat easier to implement, but slower. Voxelization improves speed, but requires more memory.
  - Benefit to 64-bit build? Need to verify.
- GDML vs. hard-coding:
  - GDML ~3x slower. Issues with accuracy
  - Engineering dwgs vs. Monte Carlo do not have same priorities.
  - Engineering dwgs. Have mistakes that do not become apparent until construction.
- Geometry at micron scale important at contact. Also most complex part (do'h!)

Conclusions (2)

- Implement geometry yesterday. (Next 1-2 months)
- Contend with changing/competing designs.
- Basis for next simulation campaign (Alexis' talk).