INSTITUTE OF PARTICLE PHYSICS

TRIUMF PMT Test Facility

H. A. Tanaka (UBC/IPP)

3rd Open Meeting for the Hyper-Kamiokande Project

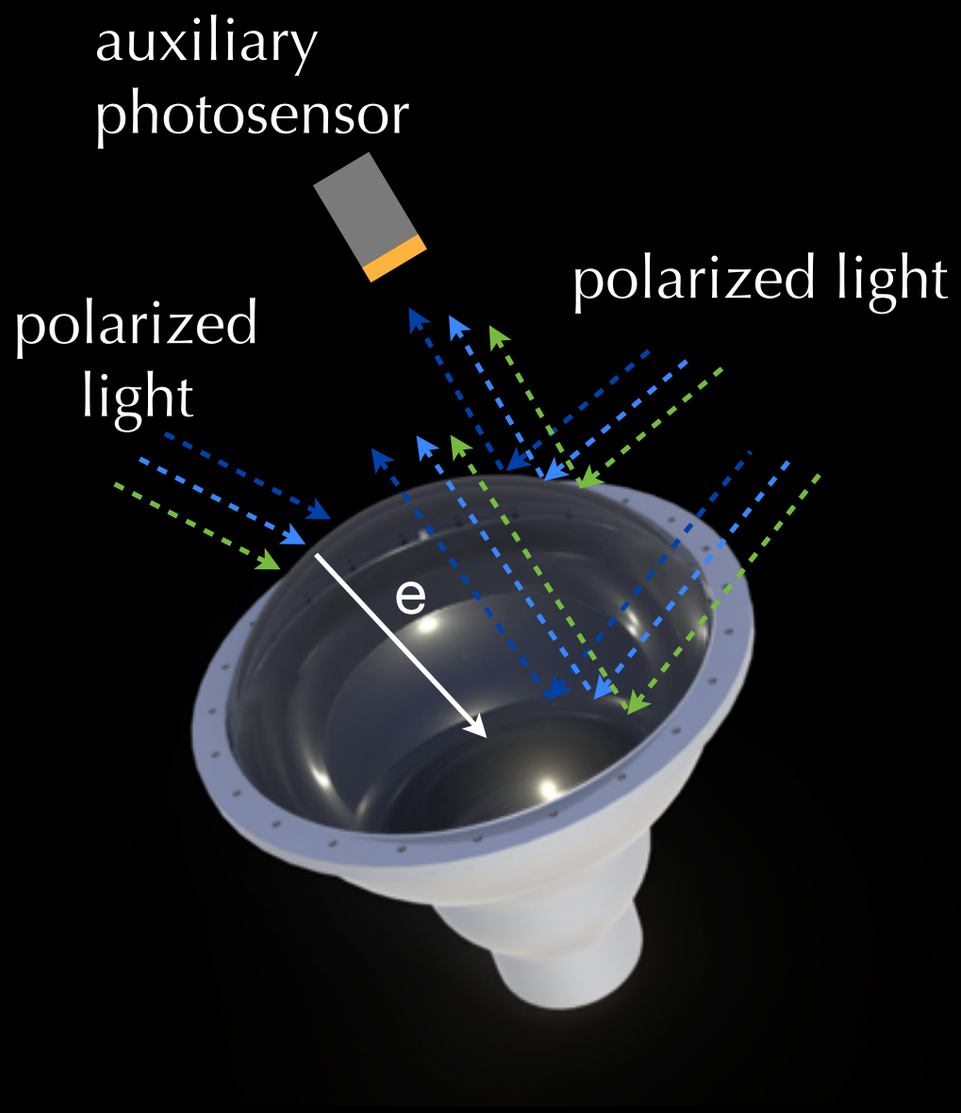
Motivation

Error source	$\sin^2 2\theta_{13}=0$	$\sin^2 2\theta_{13}=0.1$
Beam flux & ν int. (ND280 meas.)	8.5	5.0
ν int. (from other exp.)		
$x_{CCother}$	0.2	0.1
x_{SF}	3.3	5.7
p_F	0.3	0.0
x^{CCcoh}	0.2	0.2
x^{NCcoh}	2.0	0.6
$x^{NCother}$	2.6	0.8
x_{ν_e/ν_μ}	1.8	2.6
$W_{\rm eff}$	1.9	0.8
$x_{\pi-less}$	0.5	3.2
$x_{1\pi E_\nu}$	2.4	2.0
Final state interactions	2.9	2.3
Far detector	6.8	3.0
Total	13.0	9.9

- Relative uncertainty in the number of ν_e candidates (S+B)
- Flux (5%) + ν interaction
  - additional NA61 data
  - better ν interaction modeling
  - refined near detector analysis
- Far detector (3%):
  - data/MC differences in control samples (ATM, "hybrid π^0", etc.)
  - combination of detector modeling and ν interaction uncertainties

In my opinion, aggressive effort is needed on all fronts to achieve "2%" uncertainty in HK LBL analysis

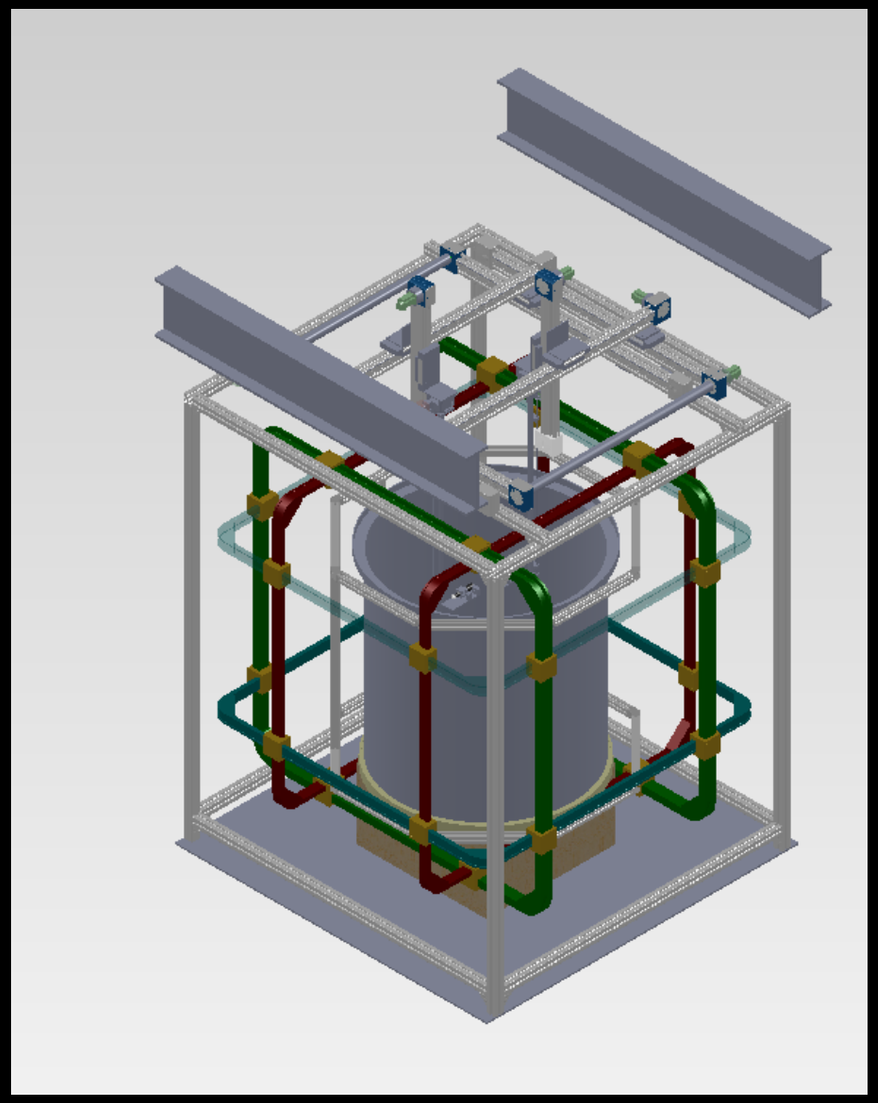
PMT test facility (PTF)



- Study response of large area photosensors to light (in water) across:
  - wavelengths (330-550 nm)
  - incident angles to surface
  - locations on the PMT
  - polarization
- Light reflected from the PMT affects response of other PMTs (in water)
- Study reflectivity of photosensor across same parameter space,

Goal: provide parameterized model of PMT response and reflection that can be “fit” with *in situ* data (somewhere in between calibration/photosensor development)

Conceptual Design



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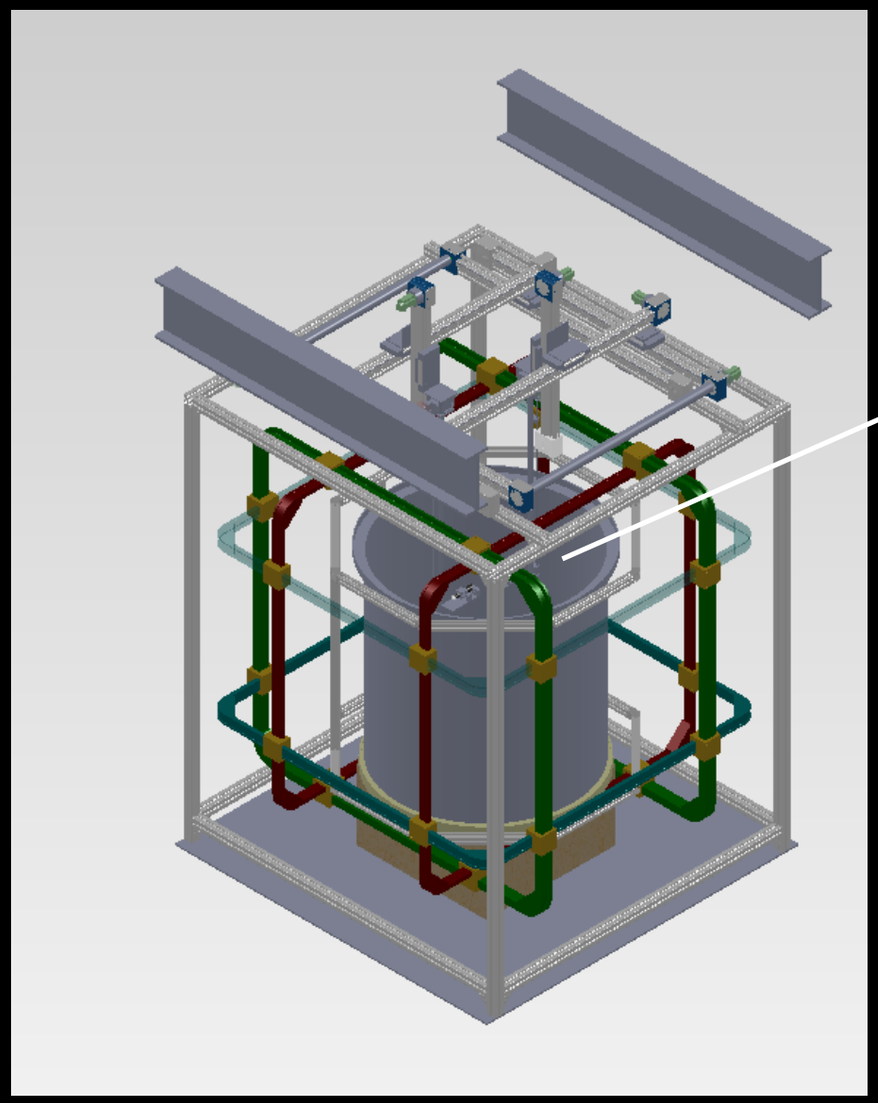

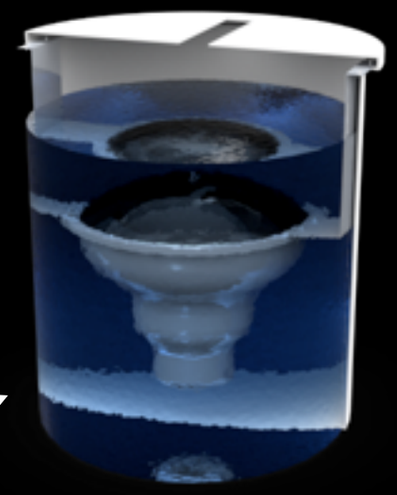

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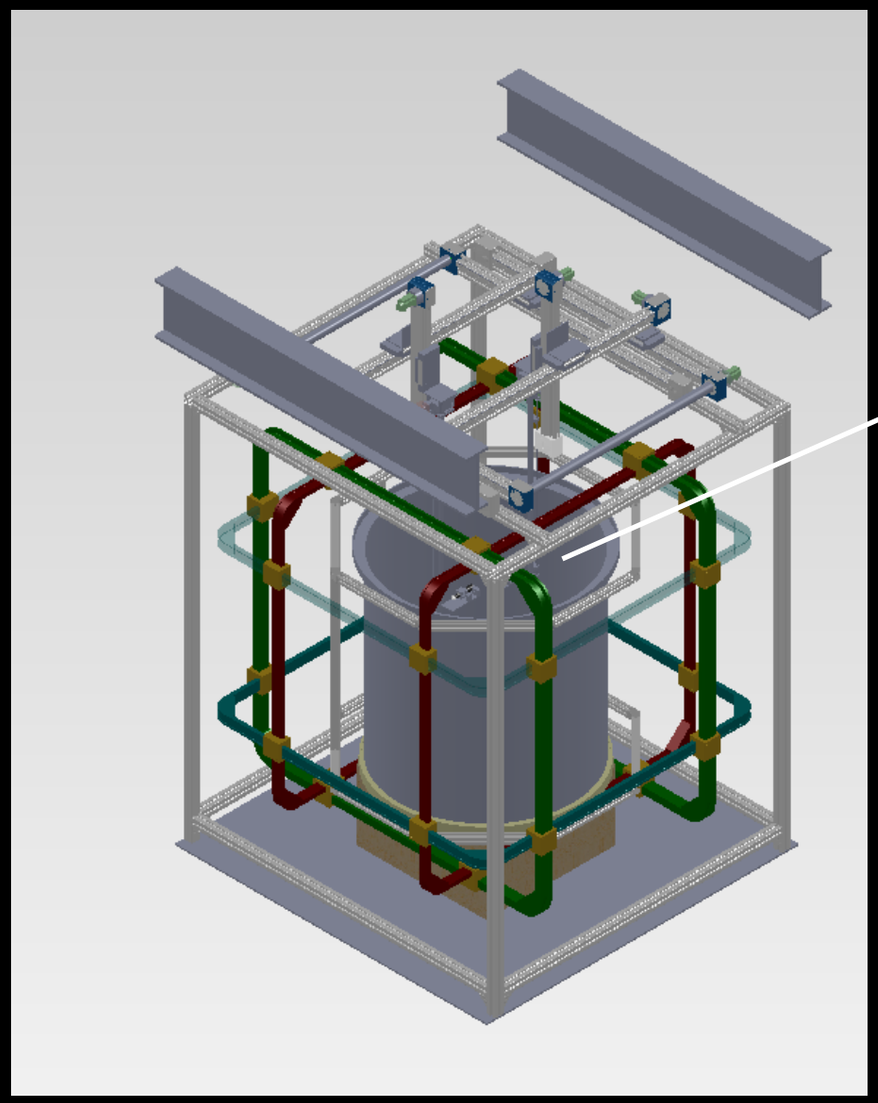

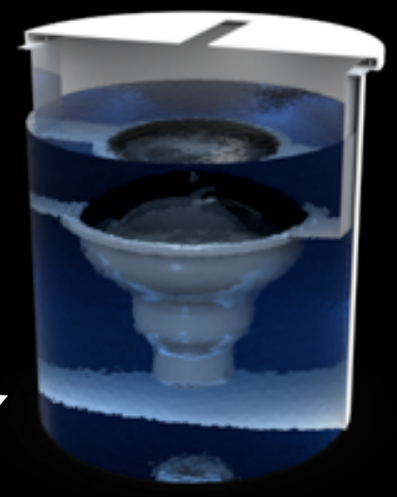

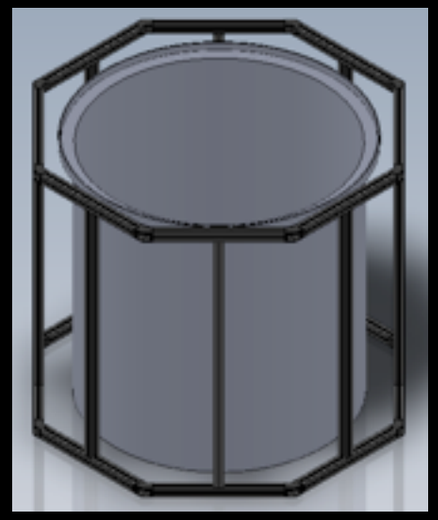

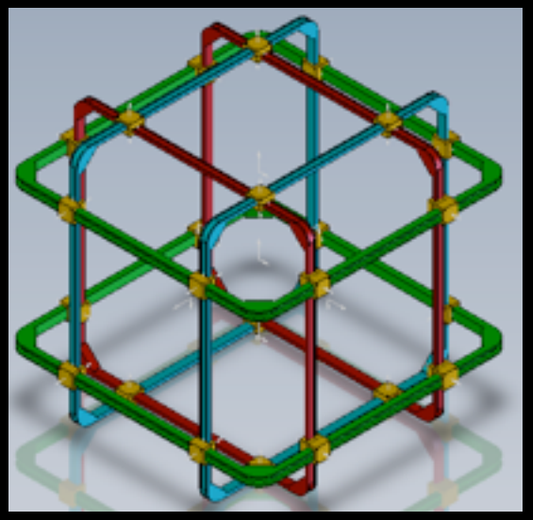

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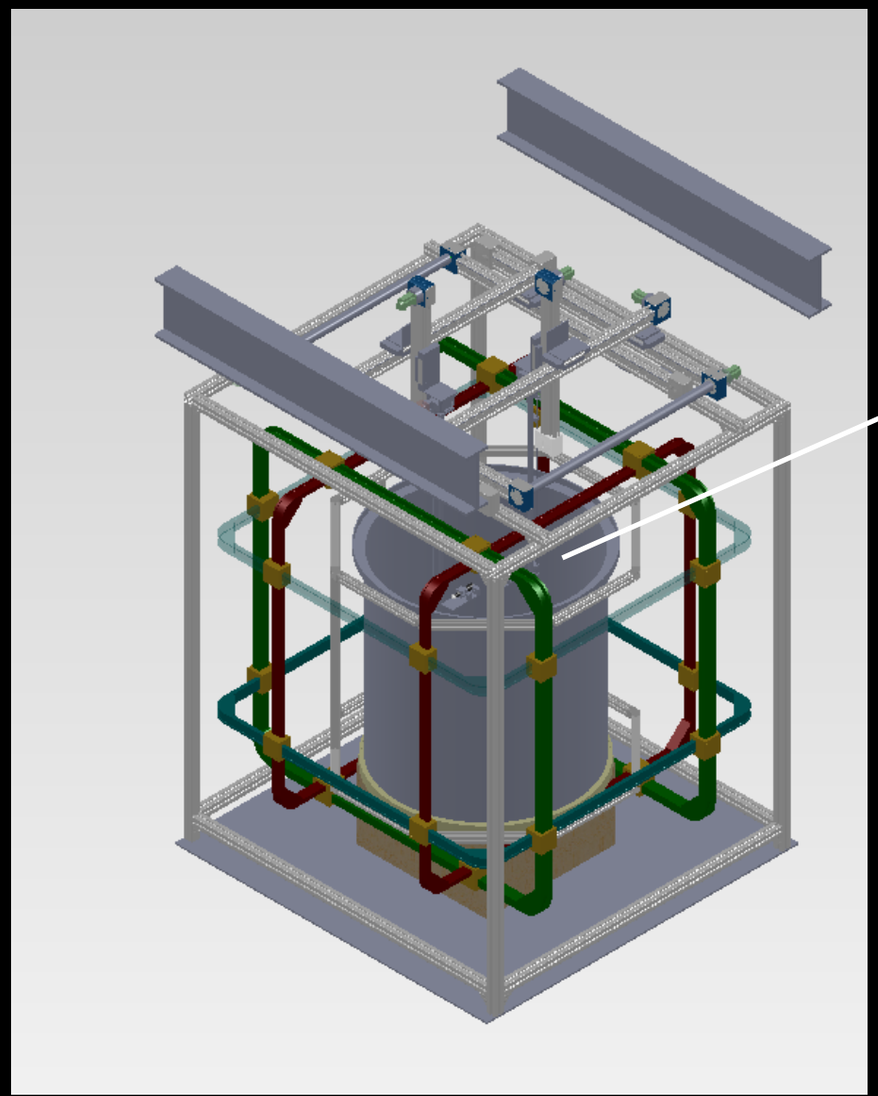

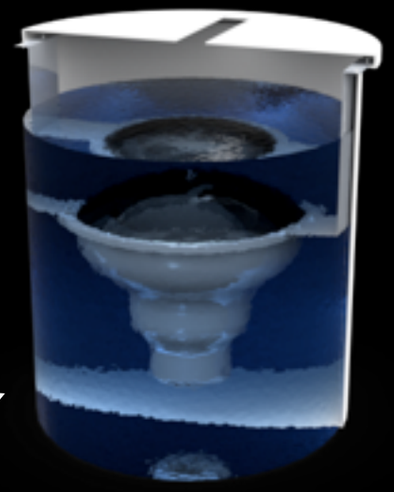

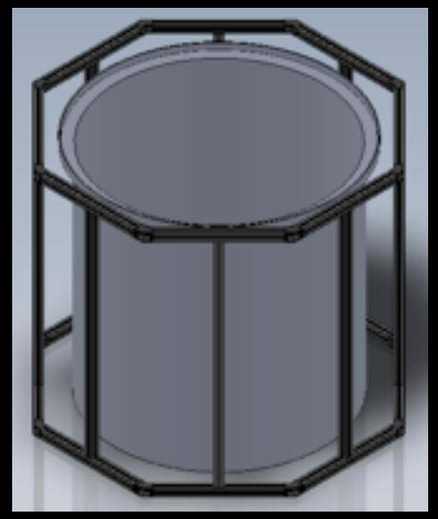

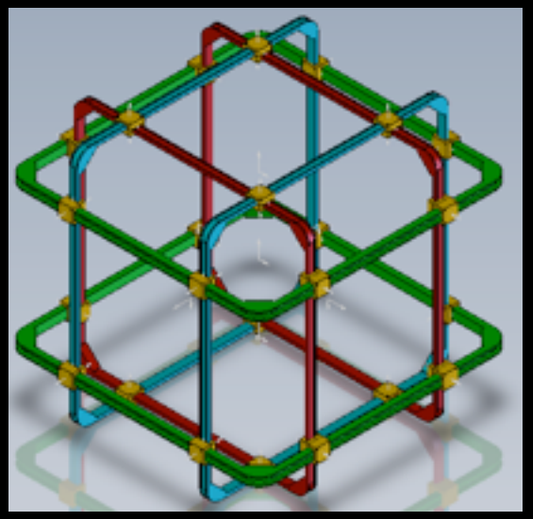

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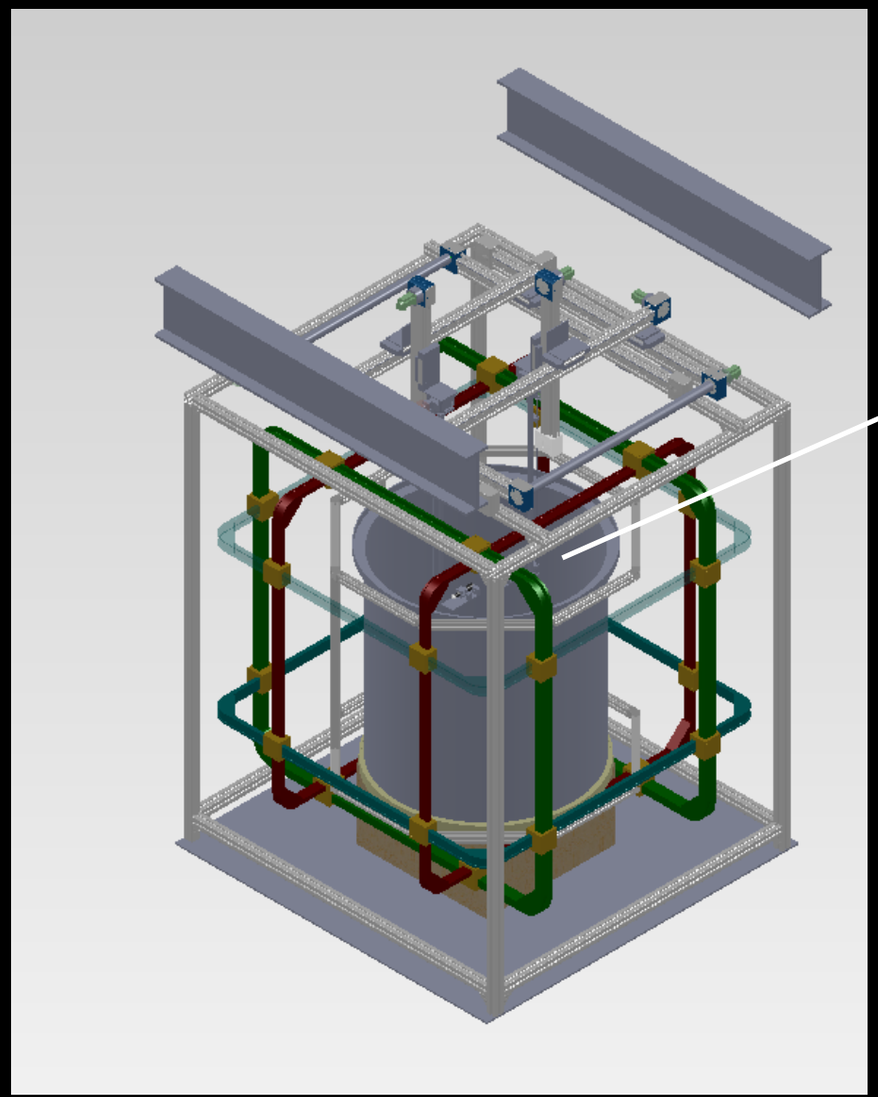

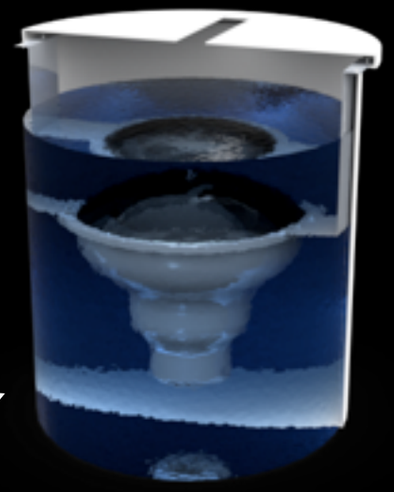

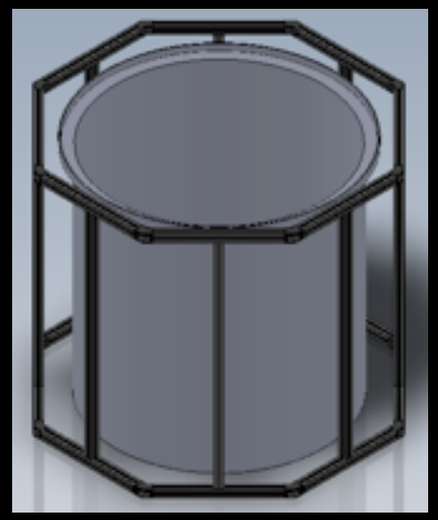

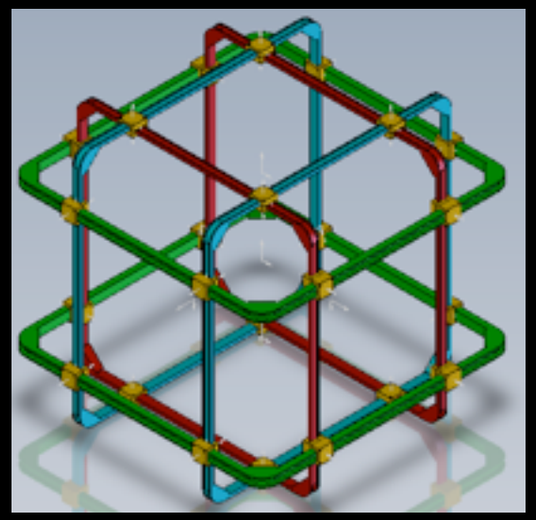

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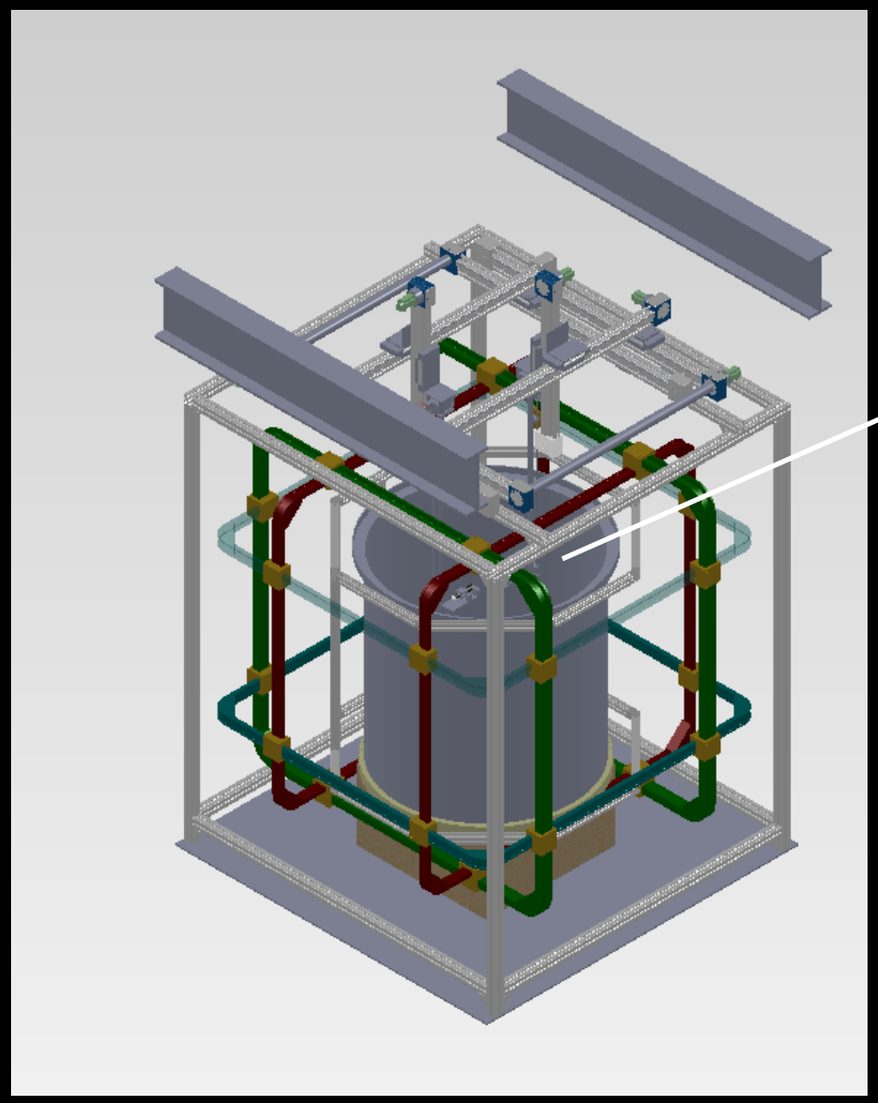

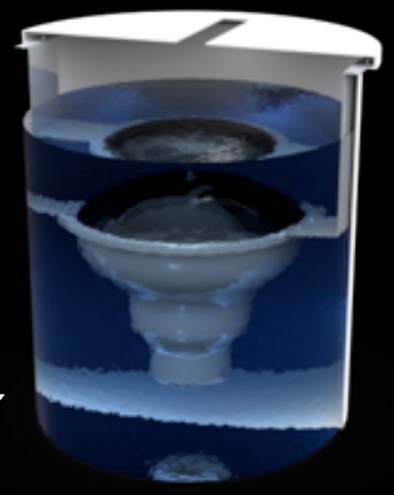

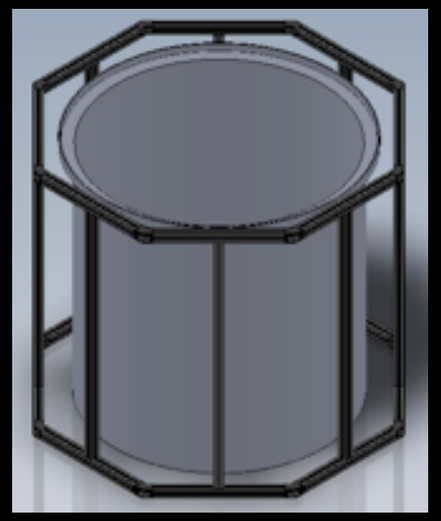

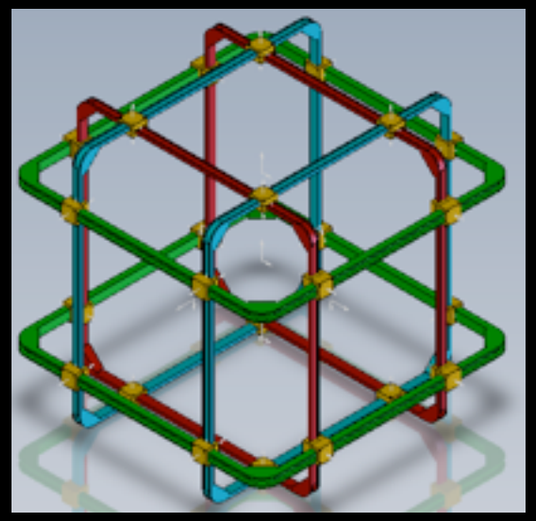

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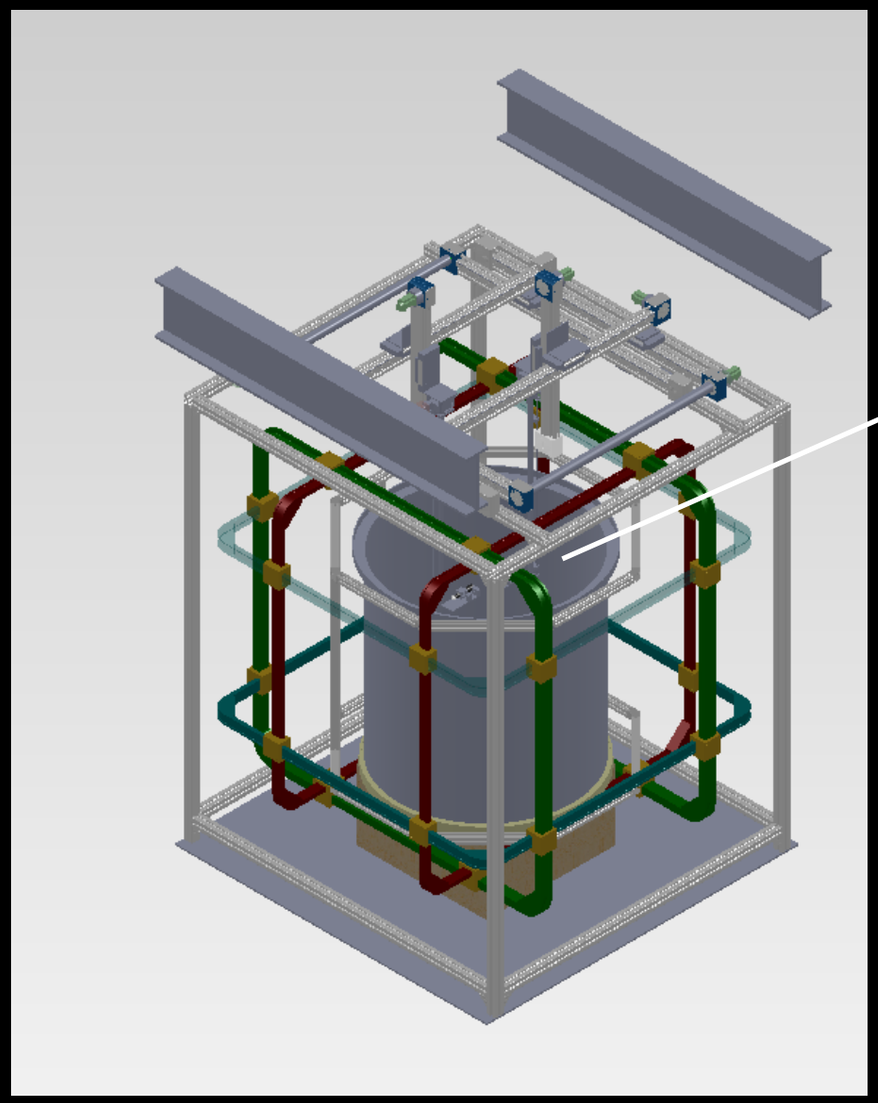

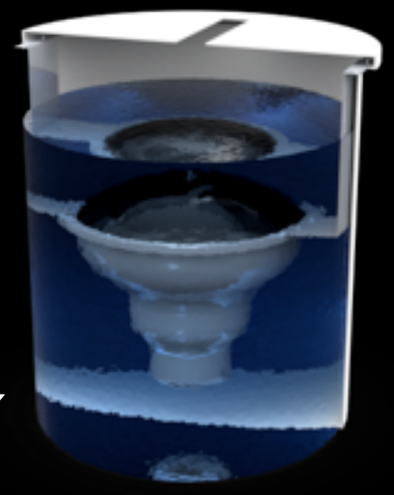

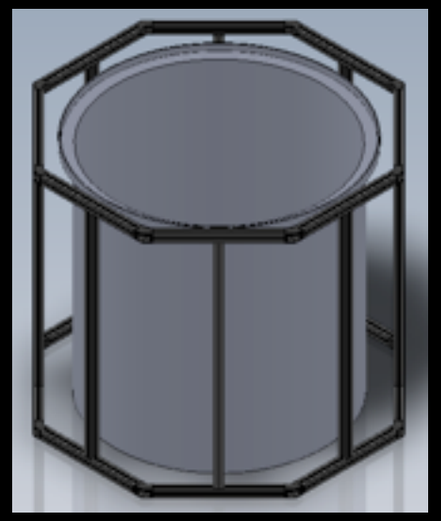

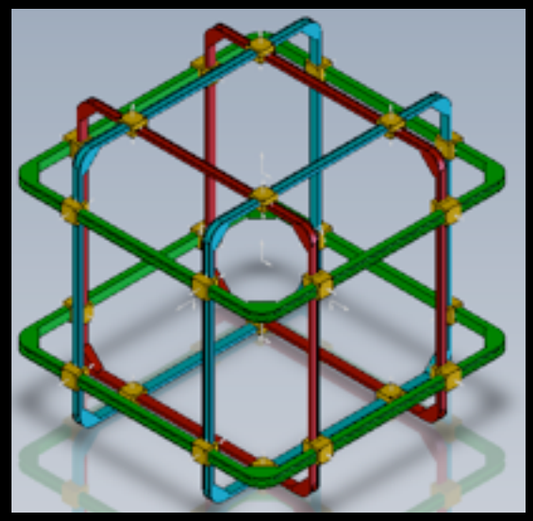

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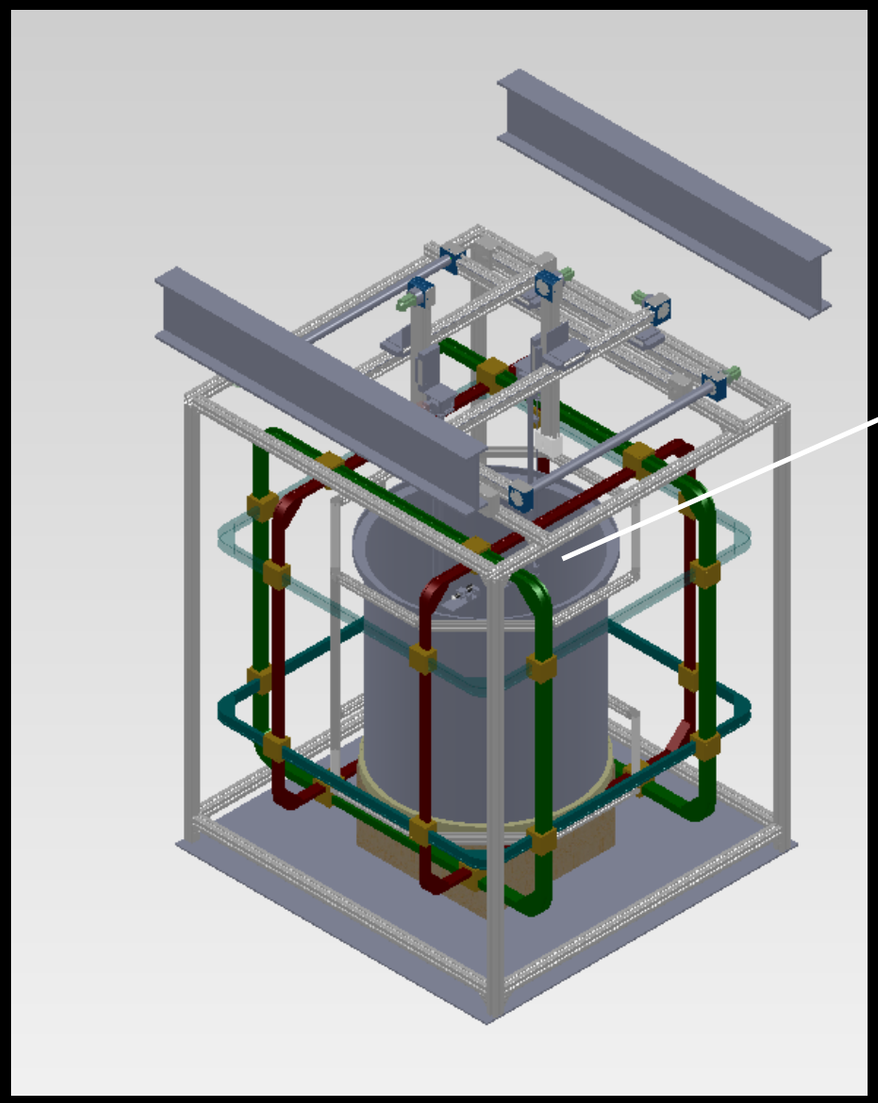

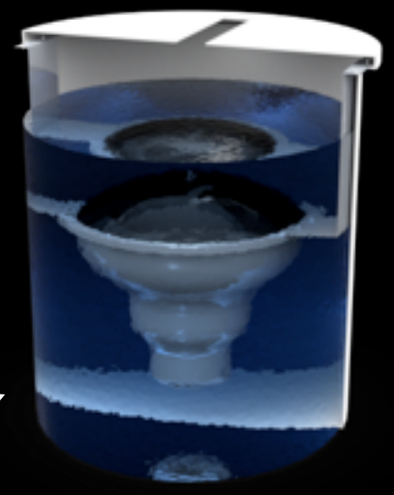

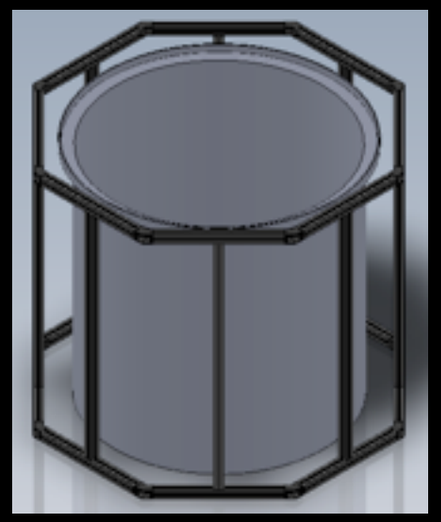

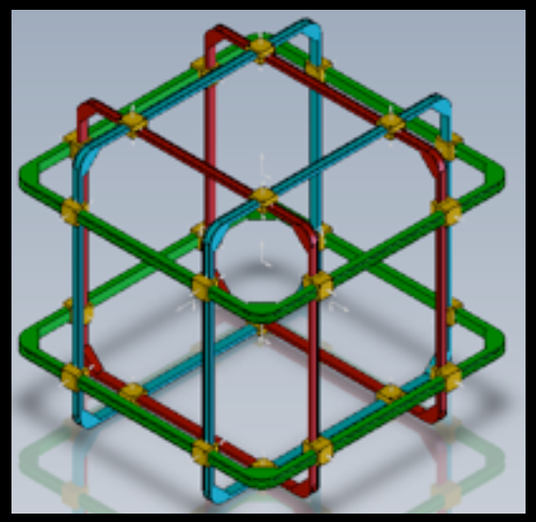

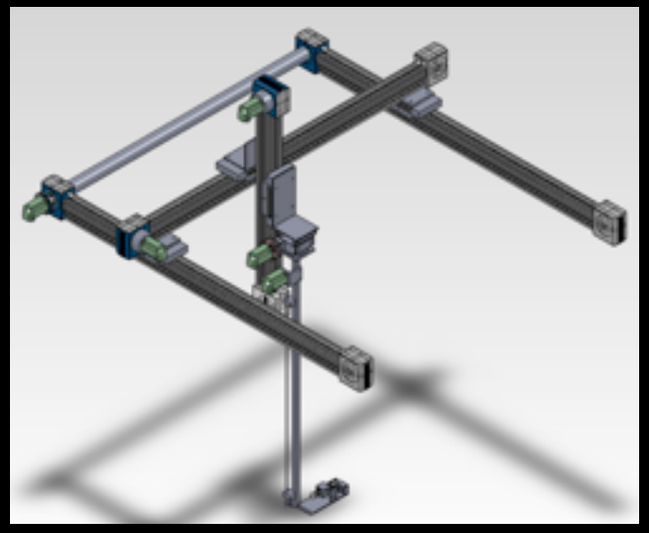

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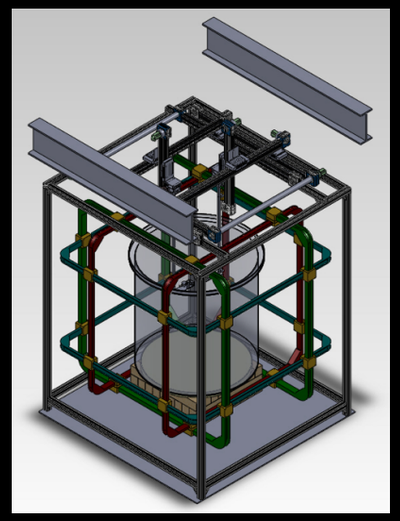
Recent Developments

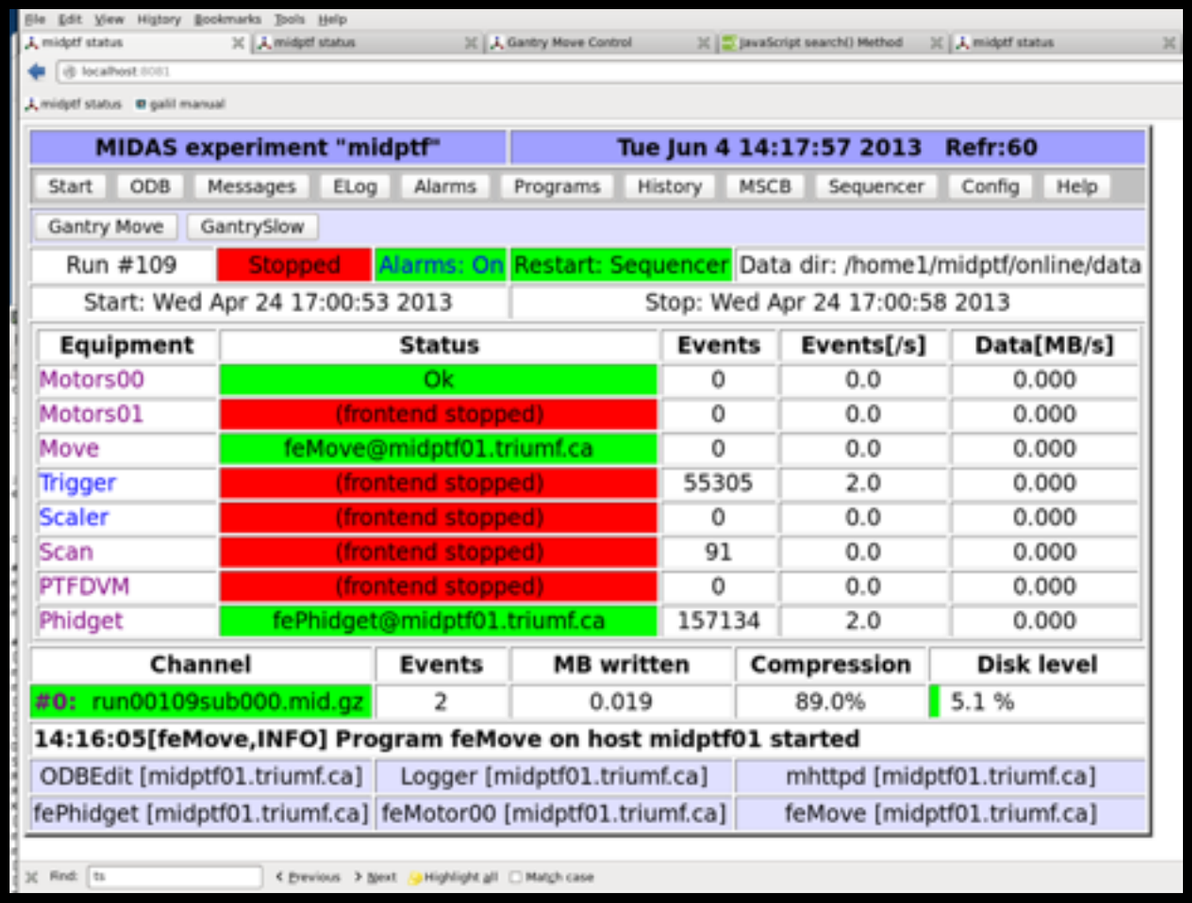
- Mechanical system fully designed and assembled
- Moved into new (permanent) laboratory space
  - renovation courtesy of TRIUMF Science Division
- MIDAS-based controls system developed
  - position either arm into desired position/angle
  - collision avoidance logic
  - motion sequencing to perform multiple runs
  - reproducibility to < 1 mm and < 1° demonstrated
- Magnetic field survey without coil/shielding performed
  - 3D magnetic probe readout into MIDAS
  - use sequencing to automatically position the arm in various locations to map out magnetic field
- Auxiliary photosensor linearity measurements
  - small PMTs used as reference and to detect reflected light.

Mechanical Assembly

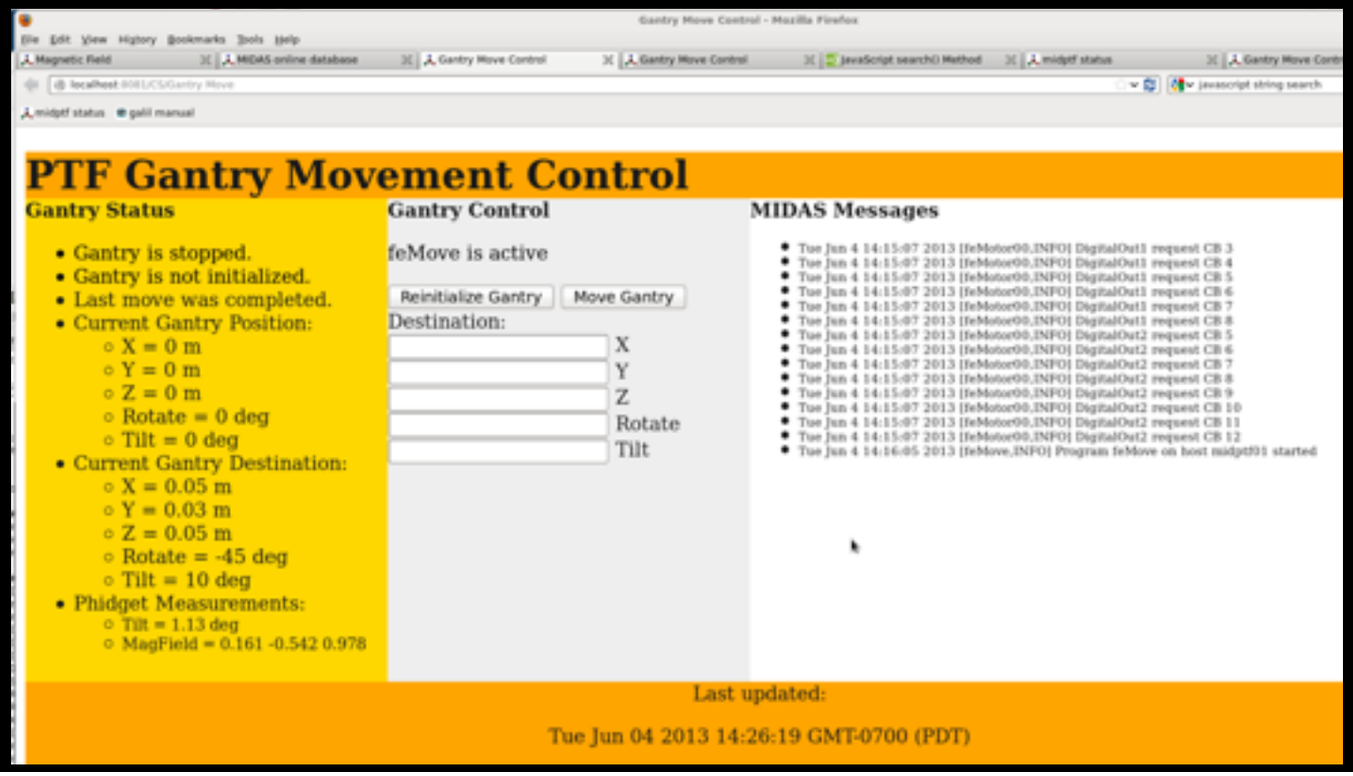


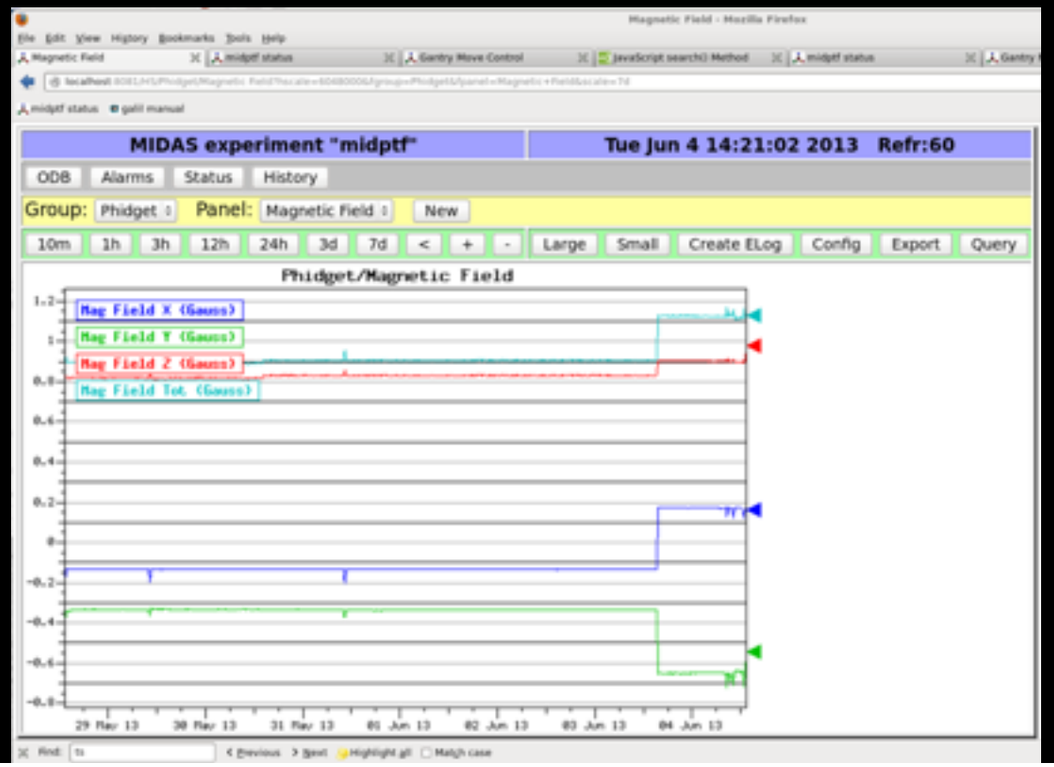
- Left: Solidworks rendition
- Above/Right: test assembly
- Bottom right: assmebly in new lab room
- Far Right: motor control system
  - each board controls up to 8 axes of motion (tran./rot.)

Examples of MIDAS control



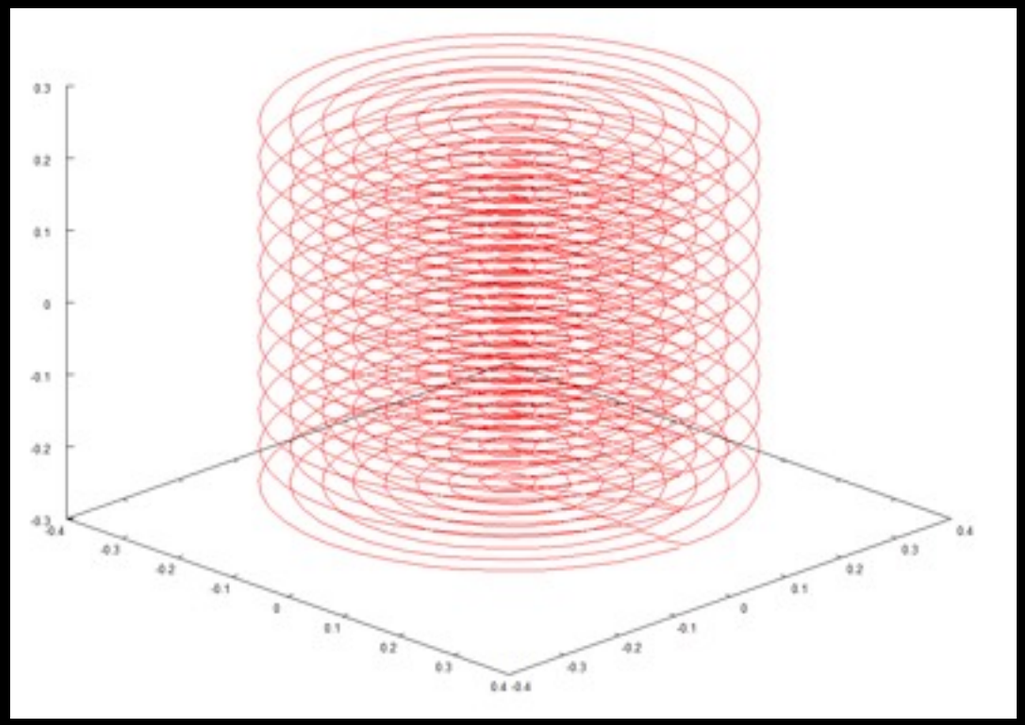
- Top:
  - overall run control for single position run
- Bottom left:
  - gantry motion control interface with status messages
- Example of live B-field monitoring and recording

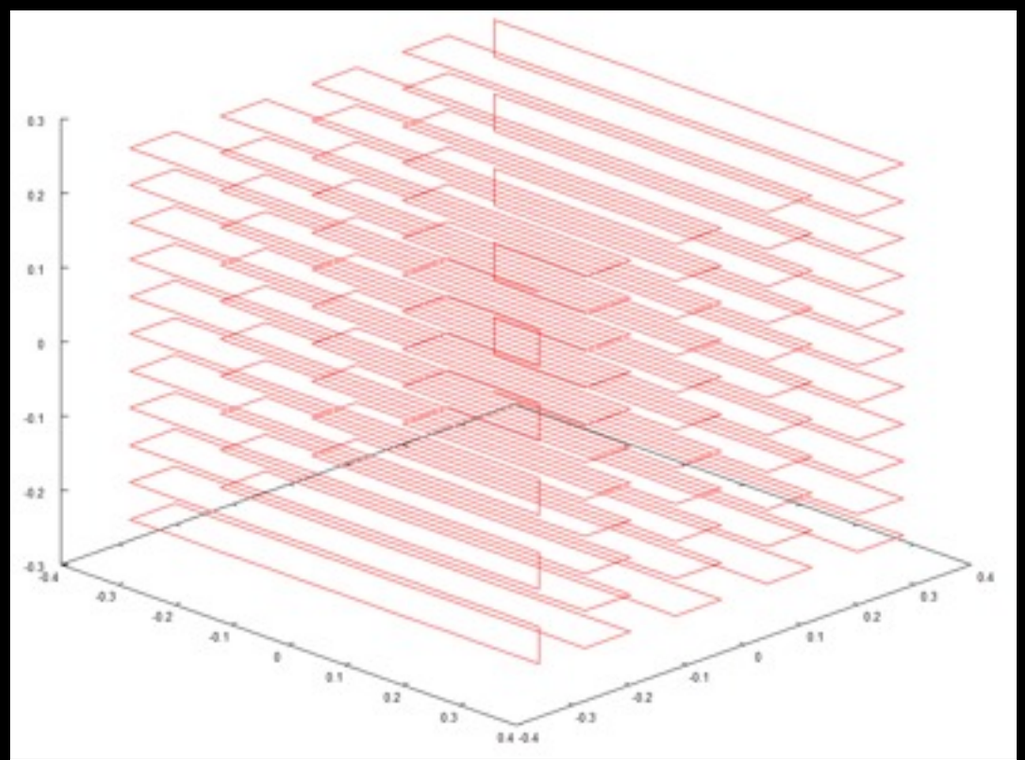




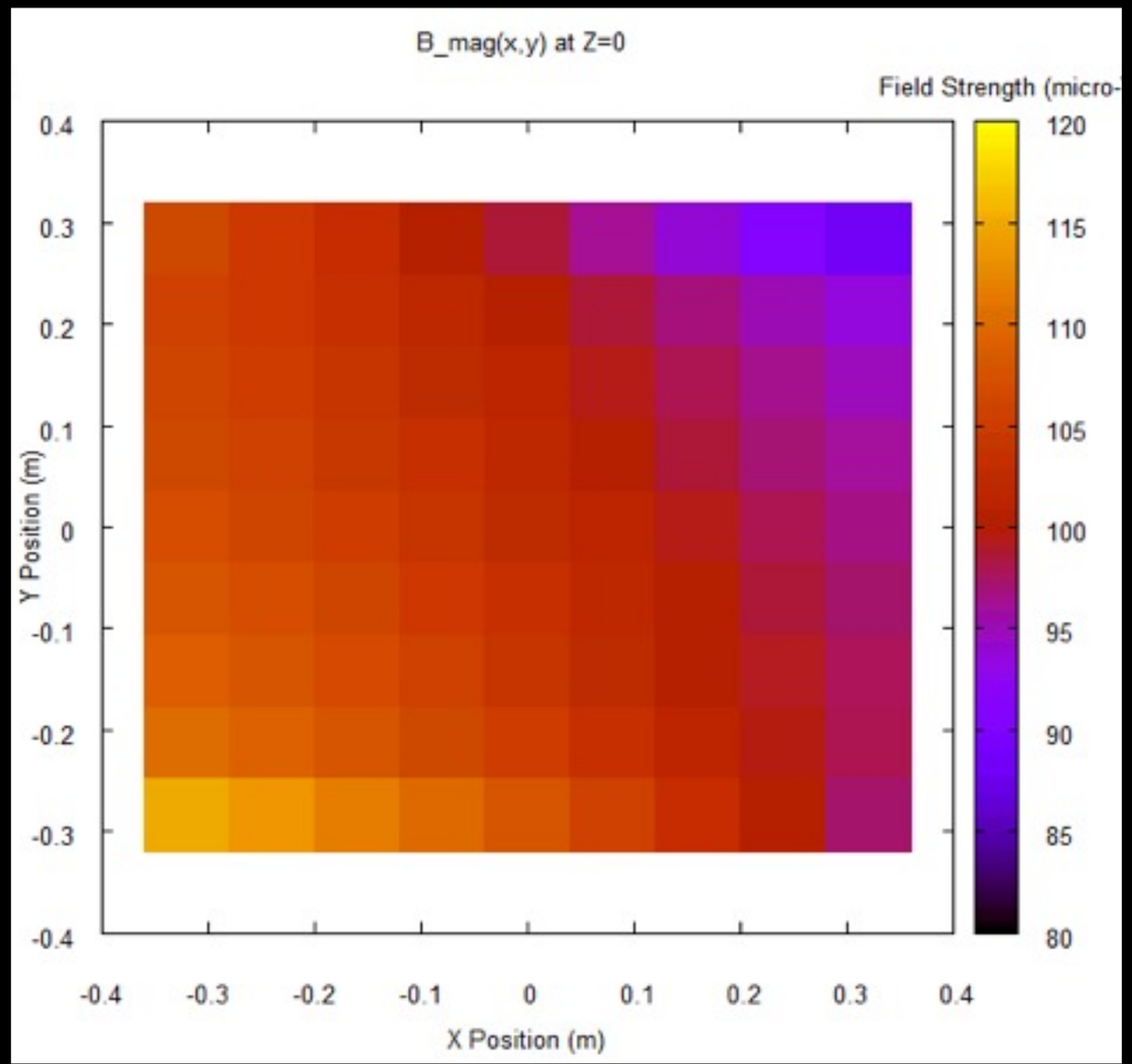
Example Motion

Motion sequencing





- Left: examples of sequenced motion/ measurements for field map
- Bottom: example slice of B-field measurements at z=0



Next Steps

- Test Helmholtz coils and GIRON shielding (~summer)
  - see if target shielding is achieved (<10 mG in PMT region)
- Conclude tests of reference PMT (~summer)
  - signal/HV cable feedthrough in arm to optical head
  - test housing and operate in water.
- Other items (dark curtain, cabling, etc.)
- Develop optical system (summer + fall)
  - laser fiber feedthrough in arm to optical head
  - polarization/collimation optics
  - test in water
- Assemble/test water filtration system
  - need to finalize degassification system
- We welcome collaboration and applications!