
UPDATE

POLARIZED TARGET
-&-
RUN GROUP C

Chris Keith, JLab Target Group

Run Group C

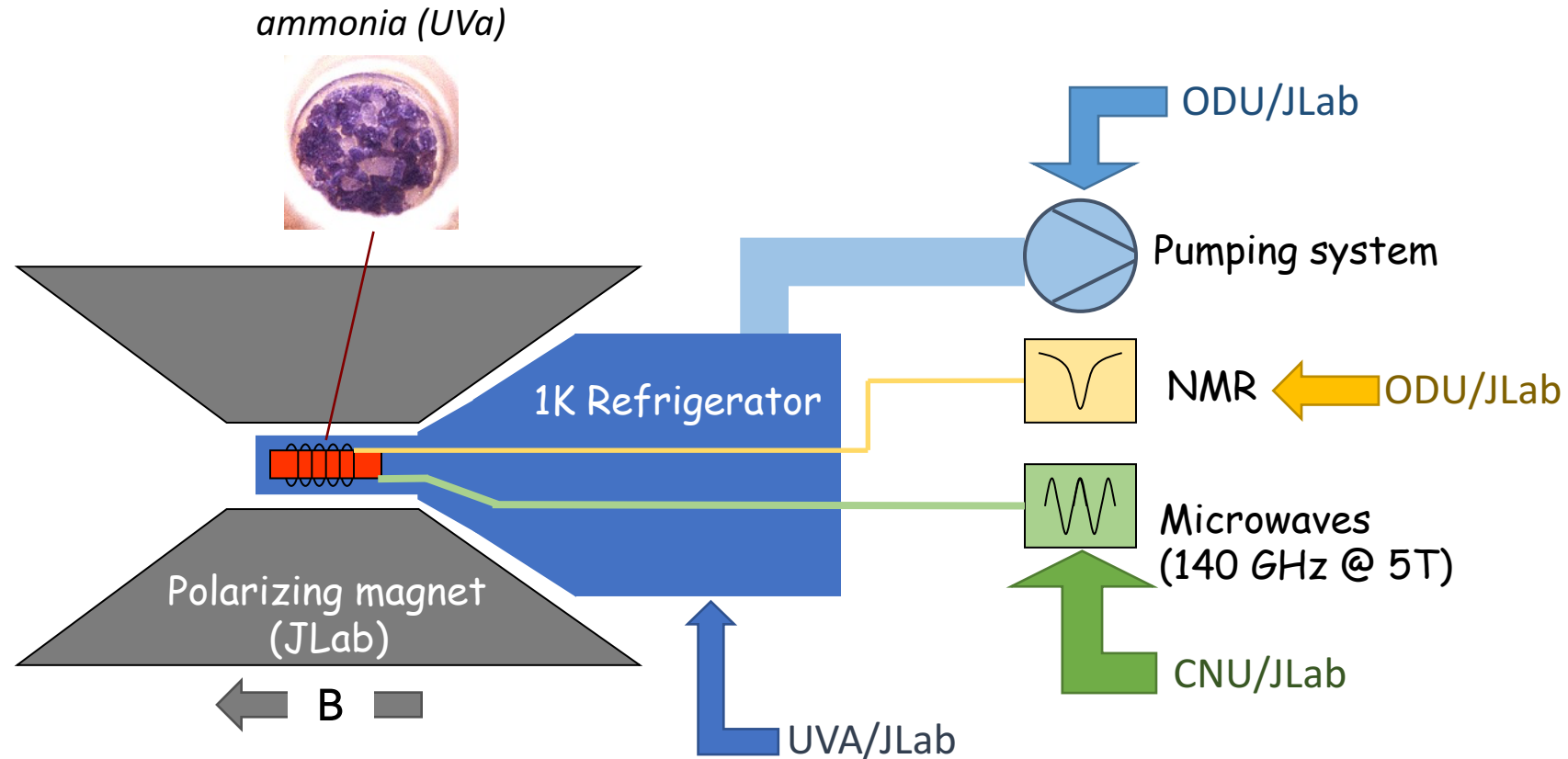
E12-06-109: *Longitudinal spin structure of the nucleon*
E12-15-109a: *DVCS on the neutron with a longitudinally polarized deuterium target*
E12-06-119: *DVCS on a longitudinally polarized proton target with CLAS at 12 GeV*
E12-07-107: *Spin-orbit correlations with a longitudinally polarized target*
E12-09-107b: *Study of partonic distributions using SIDIS K production*
E12-09-009: *Spin-orbit correlations in kaon electroproduction with polarized targets*

All experiments utilize a longitudinally polarized target
(protons & deuterons)

We hope, assume, and plan for installation in Summer 2020

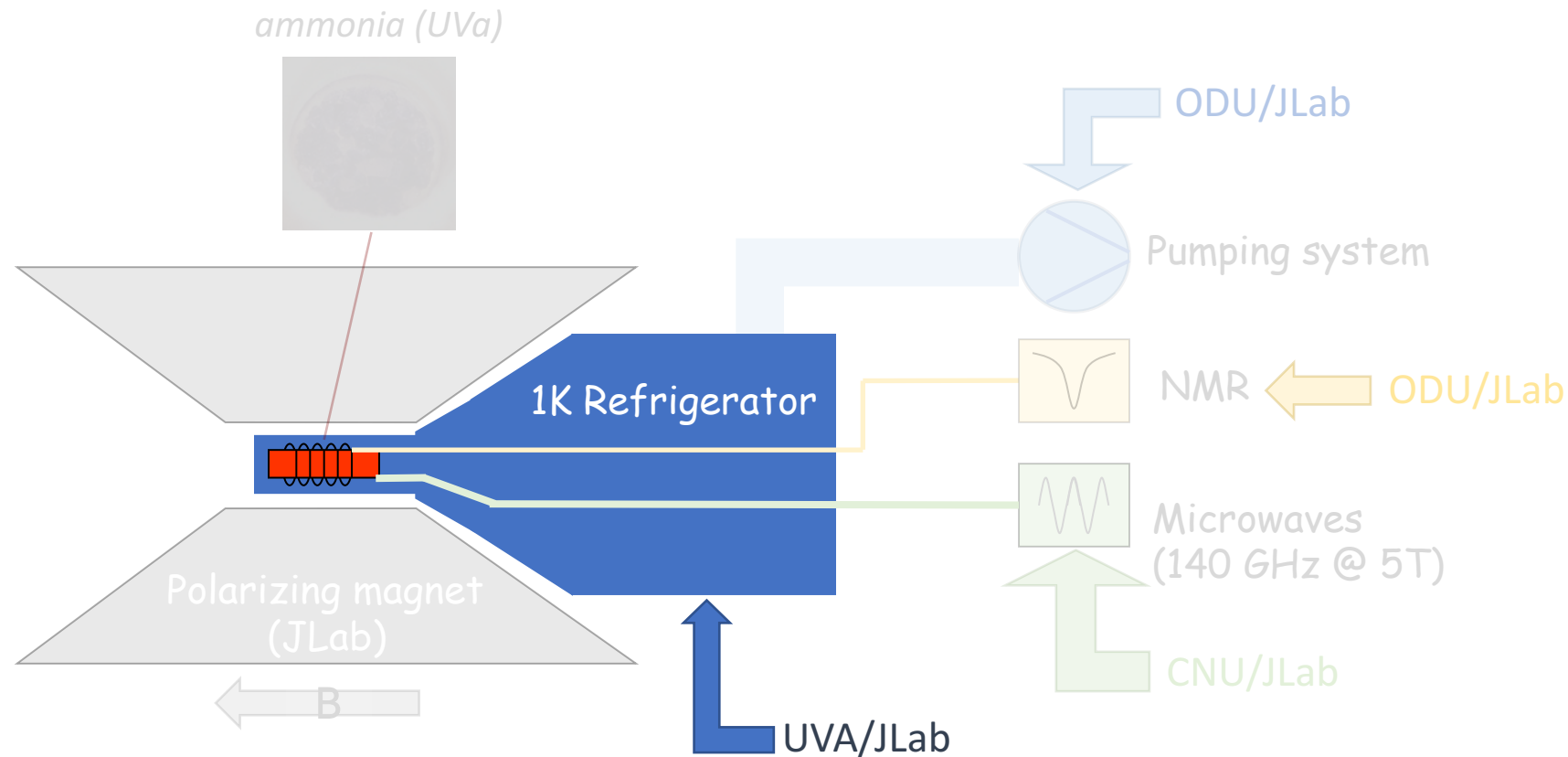
Longitudinally Polarized Target

The polarized target is a collaborative effort between *ODU, CNU, UVa & JLab*



Longitudinally Polarized Target

Remaining item is the 1 K refrigerator, now under assembly.



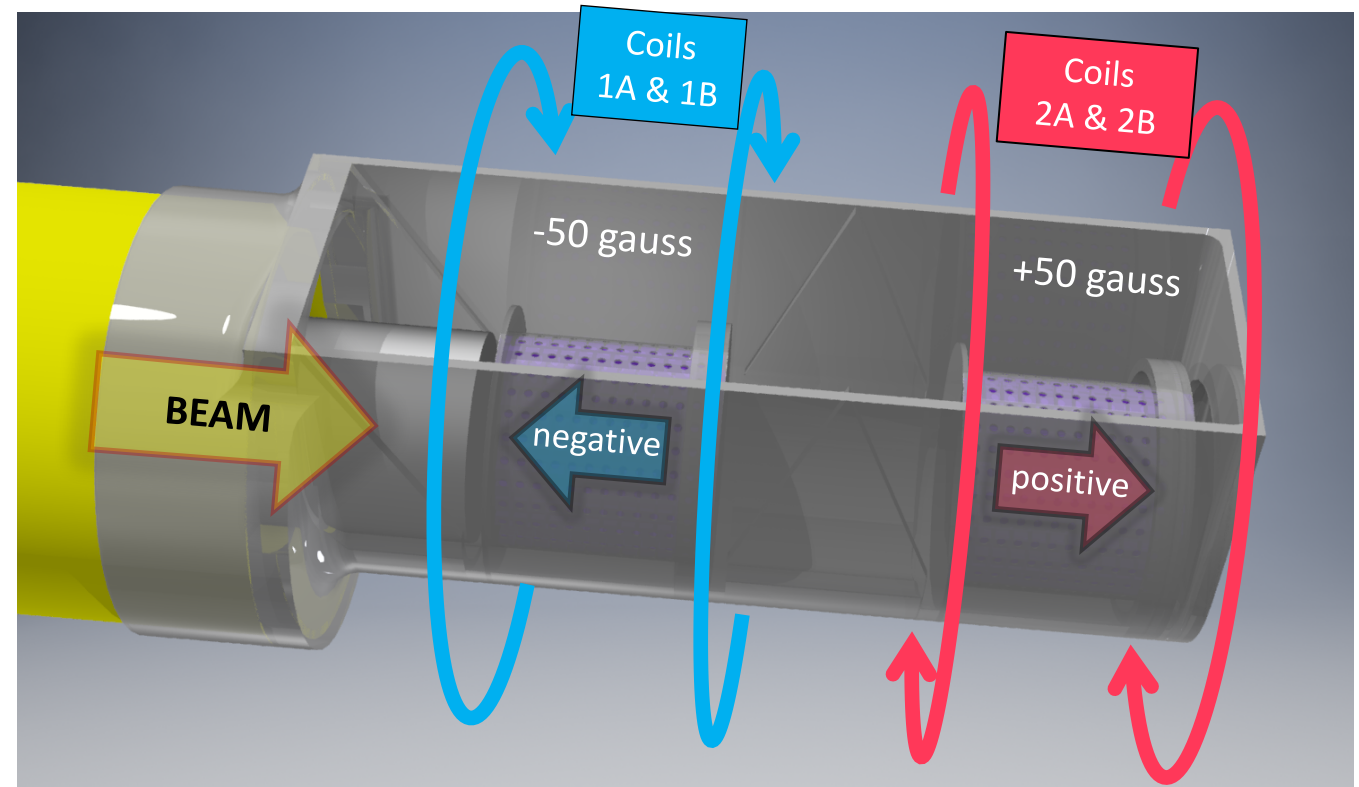
Double cell polarization

DNP tests at 5 T and 77 K James Maxwell + Victoria Lagerquist (ODU)

Demonstrate polarization (in opposite directions) of two target cells using low-field shim coils

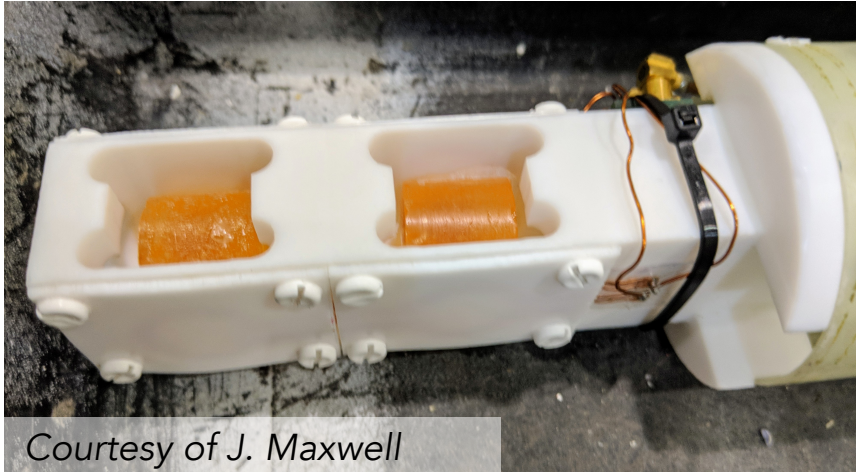
Microwaves are tuned halfway between the normal (+) and (-) polarization frequencies:

- high field sample will polarize (+)
- low field sample will polarize (-)

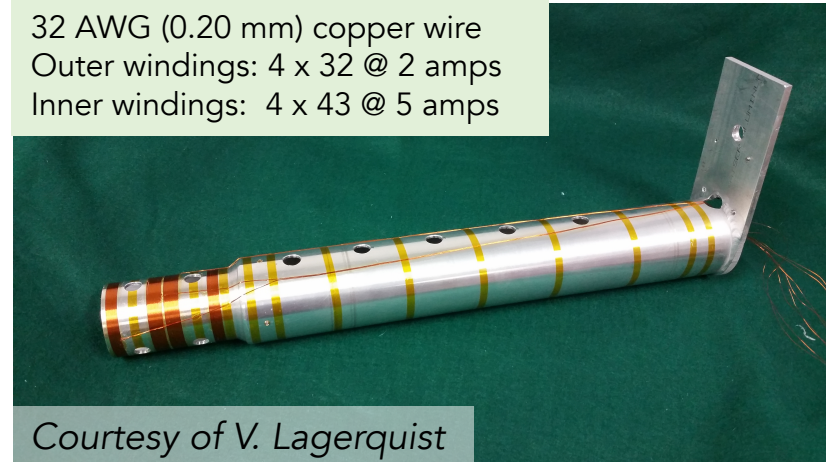


Double cell polarization

DNP tests at 5 T and 77 K James Maxwell (Target Group) + Victoria Lagerquist (ODU)



32 AWG (0.20 mm) copper wire
Outer windings: 4 x 32 @ 2 amps
Inner windings: 4 x 43 @ 5 amps



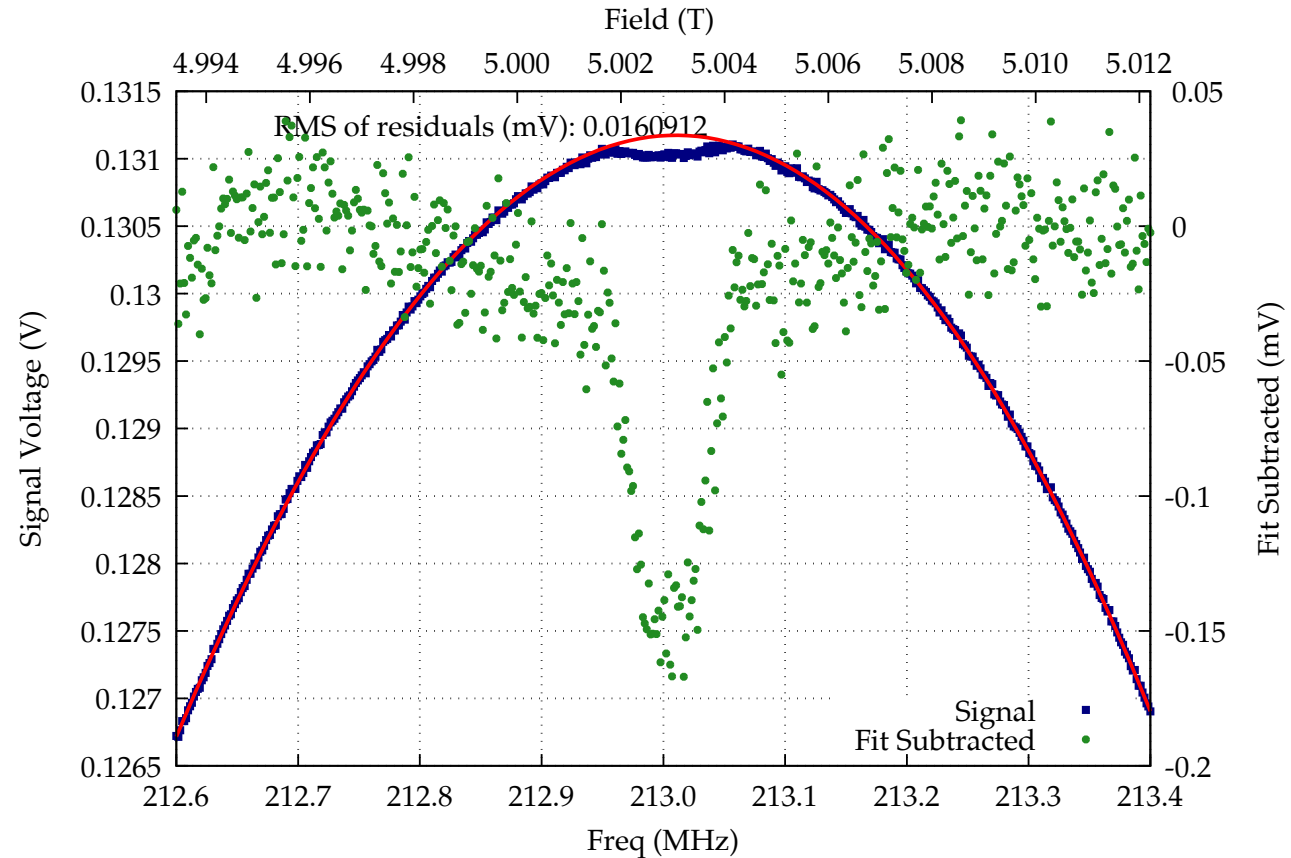
- Samples are 5-minute epoxy doped with TEMPO radical
- Two samples
- One NMR coil



Double cell polarization

DNP tests at 5 T and 77 K James Maxwell (Target Group) + Victoria Lagerquist (ODU)

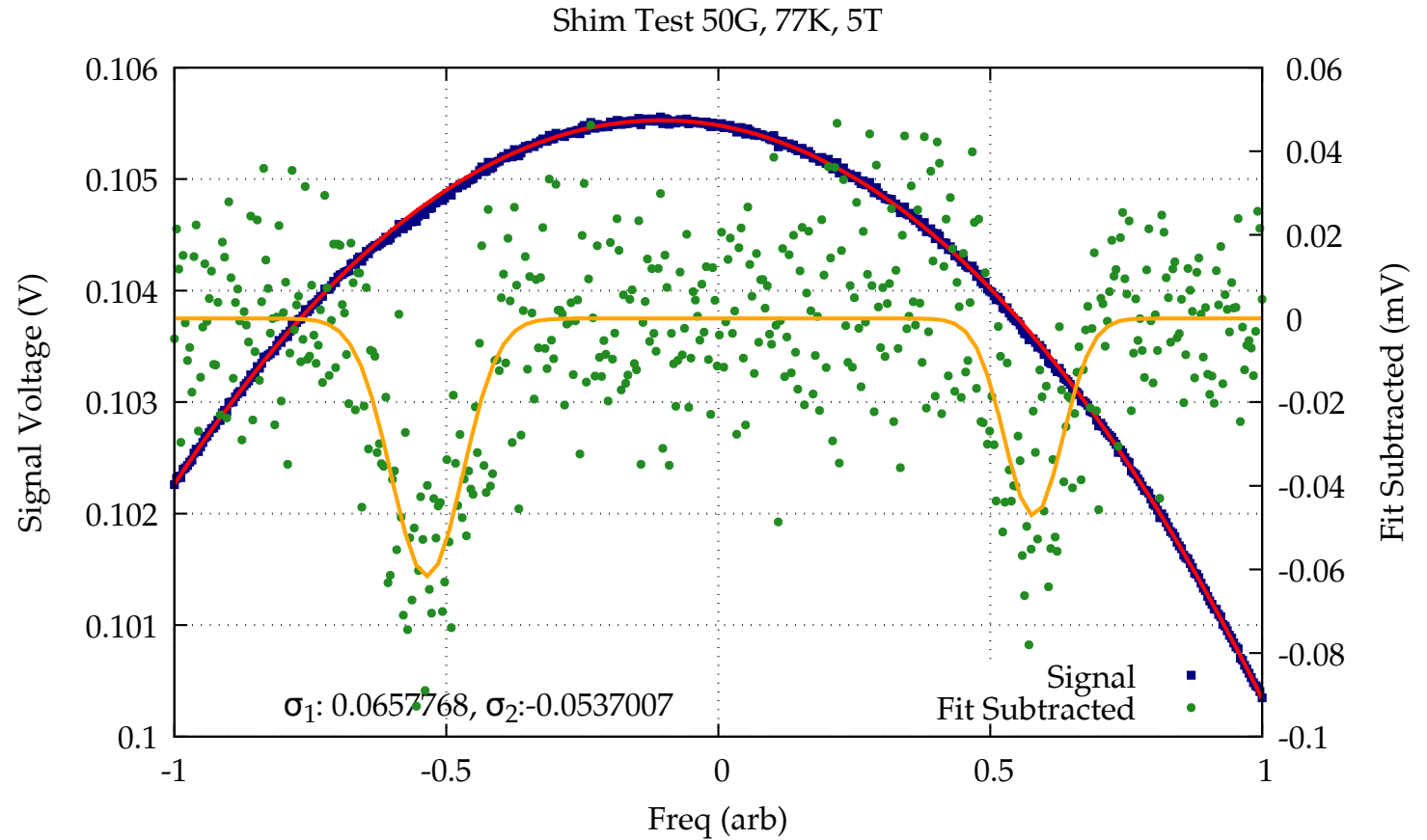
Shims OFF
Microwaves OFF



Double cell polarization

DNP tests at 5 T and 77 K James Maxwell (Target Group) + Victoria Lagerquist (ODU)

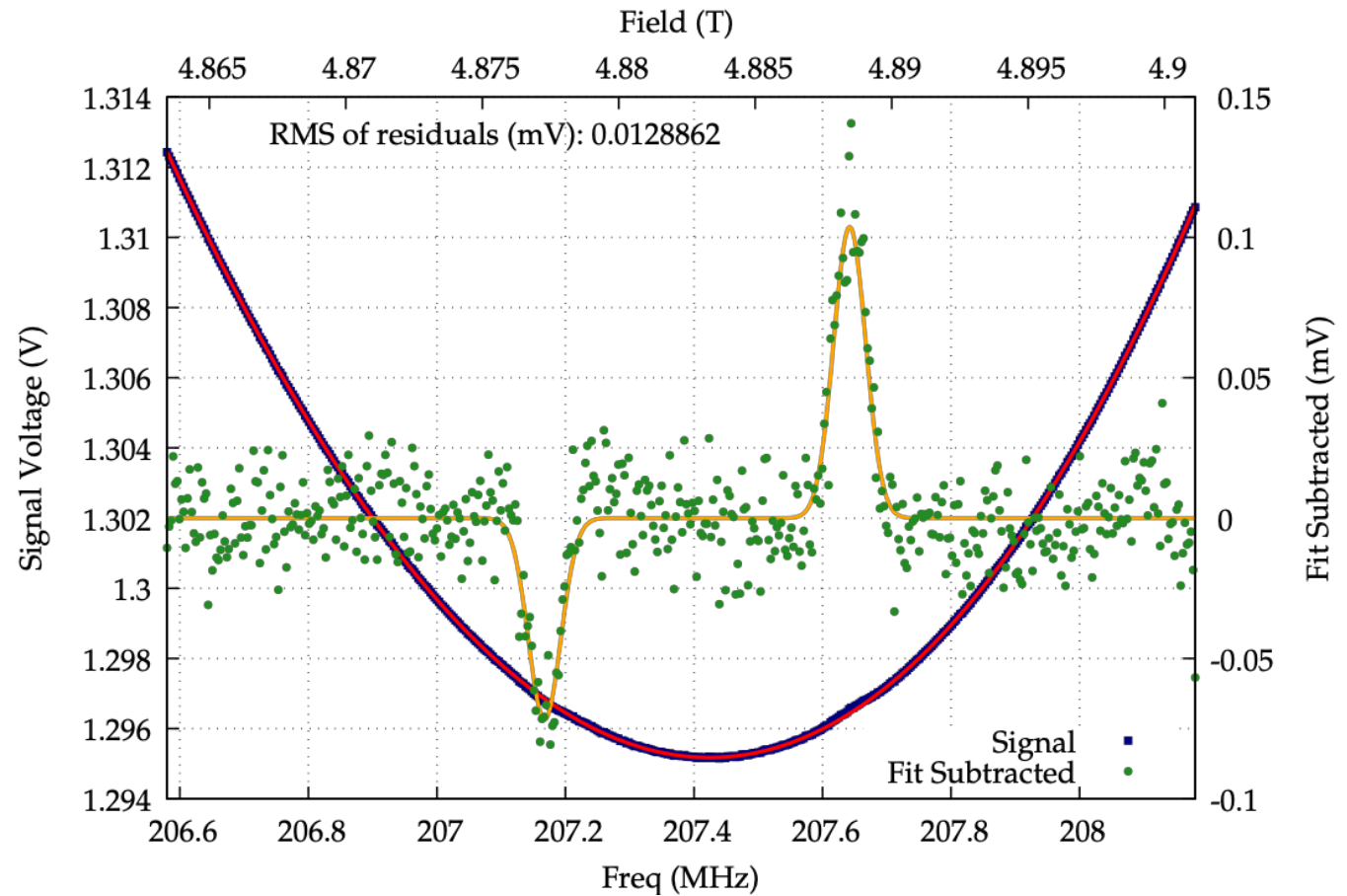
Shims ON
Microwaves OFF



Double cell polarization

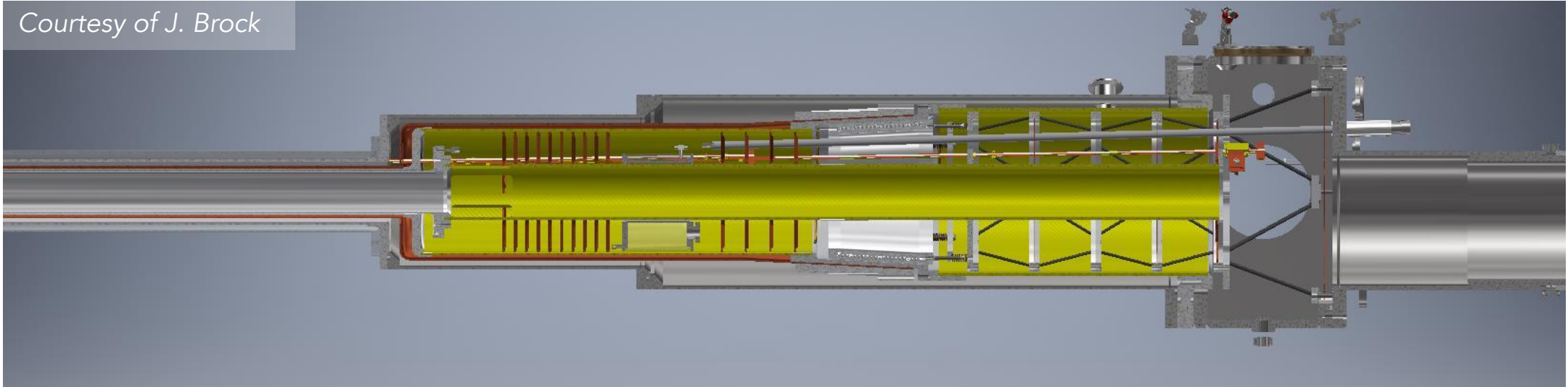
DNP tests at 5 T and 77 K James Maxwell (Target Group) + Victoria Lagerquist (ODU)

Shims ON
Microwaves ON



1 K Refrigerator

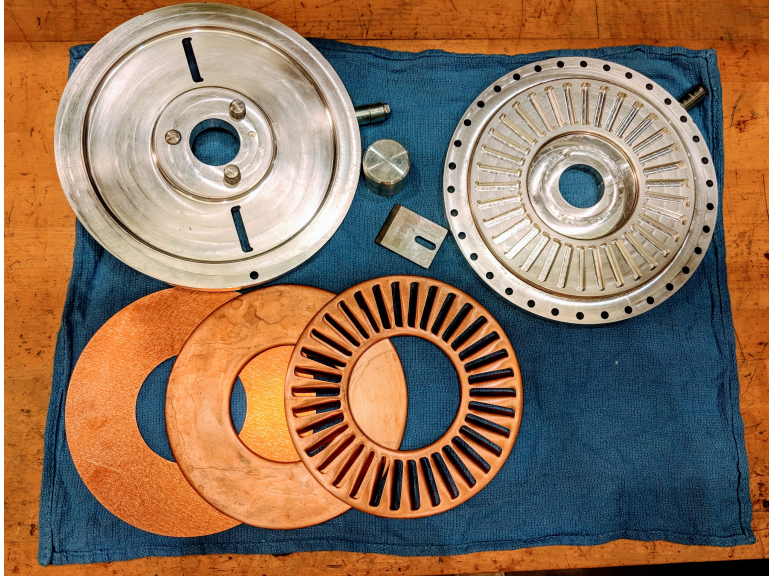
Courtesy of J. Brock



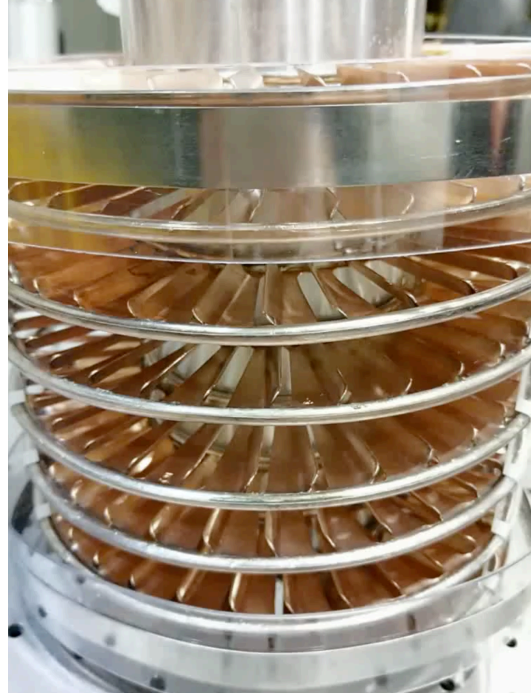
Considerable progress

- All major components have been fabricated (heat exchangers, valves, shields, vacuum chamber, etc)
- Assembly underway – estimated completion is mid-January

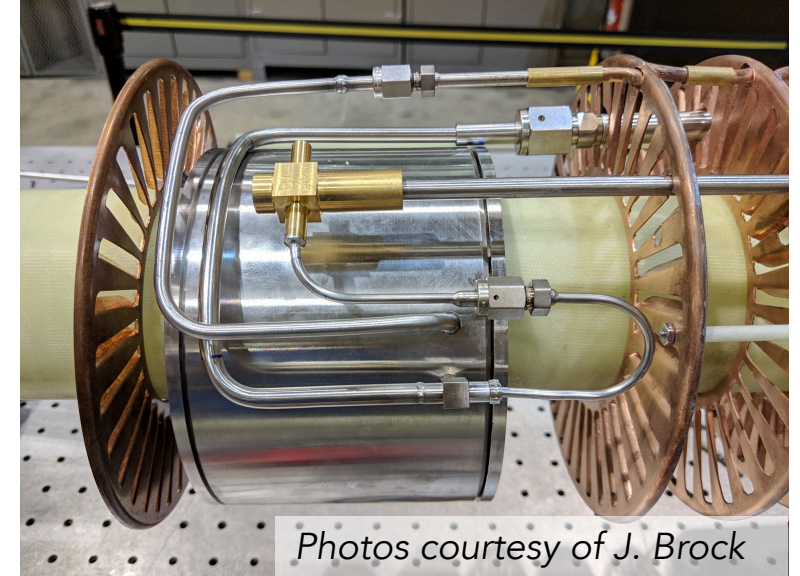
1 K Refrigerator



Construction of heat exchanger elements



Heat exchanger assembly



Separator and needle valve

Considerable progress since last meeting

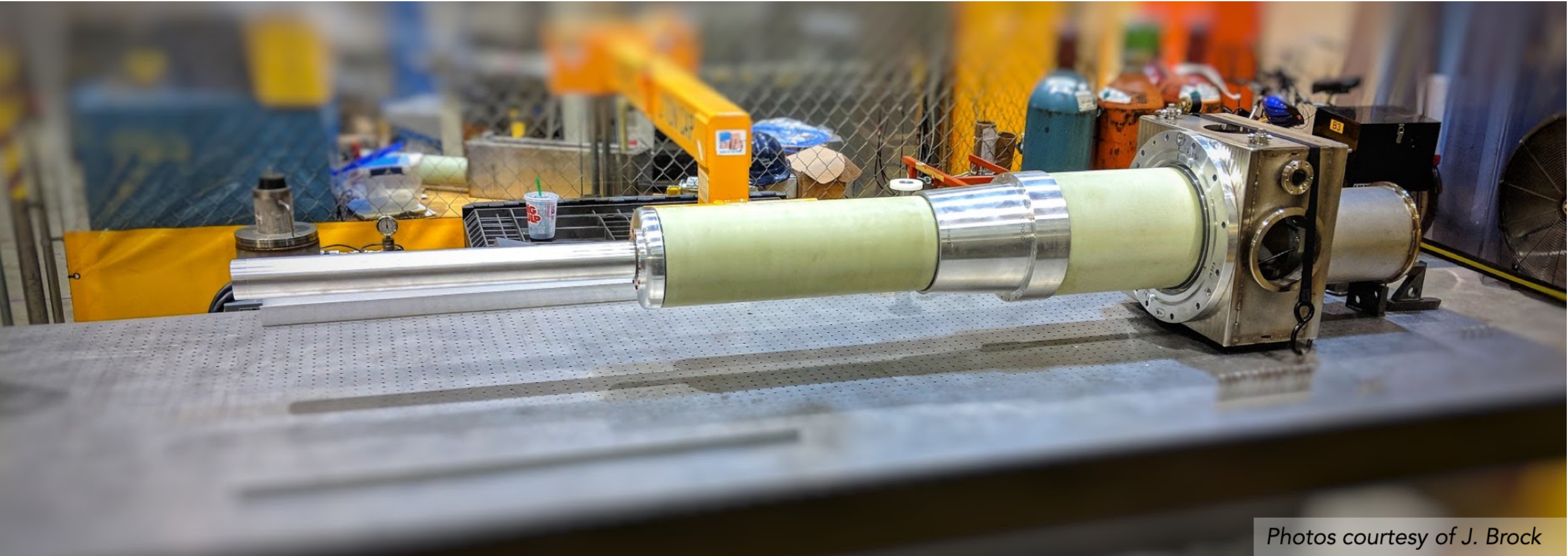
- Almost all major components for the refrigerator have been fabricated (heat exchangers, valves, shields, vacuum chamber, etc)
- Assembly is now underway – estimated completion is mid-January

1 K Refrigerator



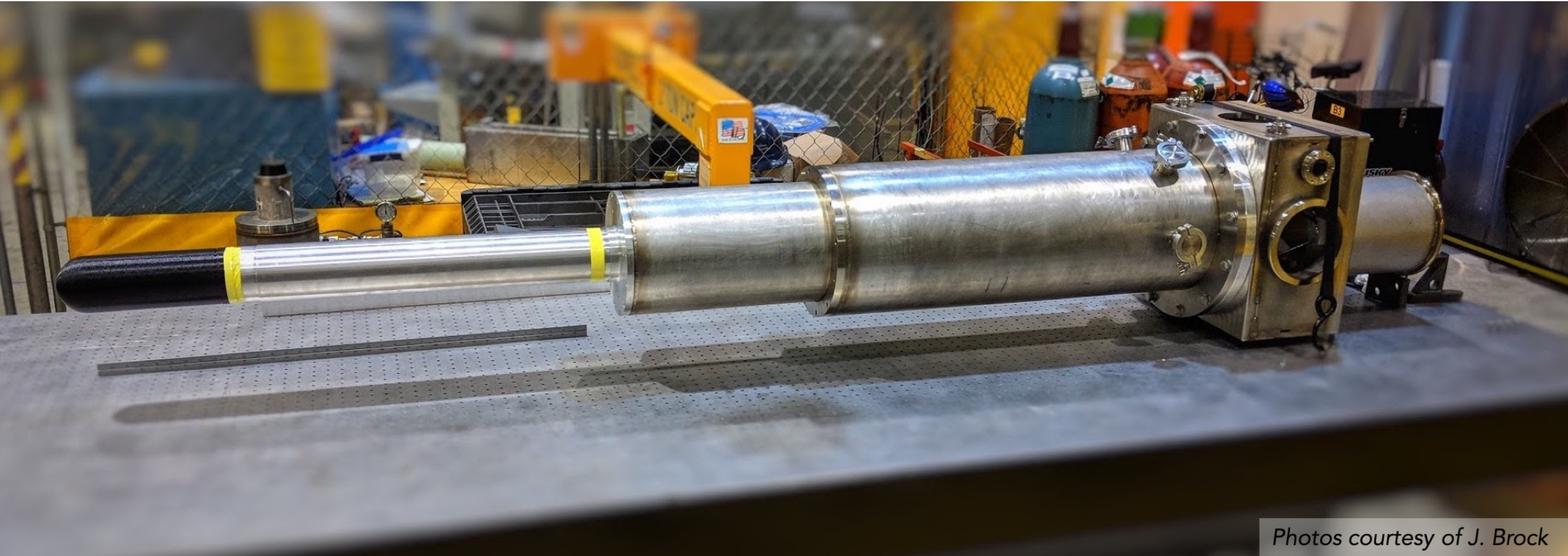
Photos courtesy of J. Brock

1 K Refrigerator



Photos courtesy of J. Brock

1 K Refrigerator

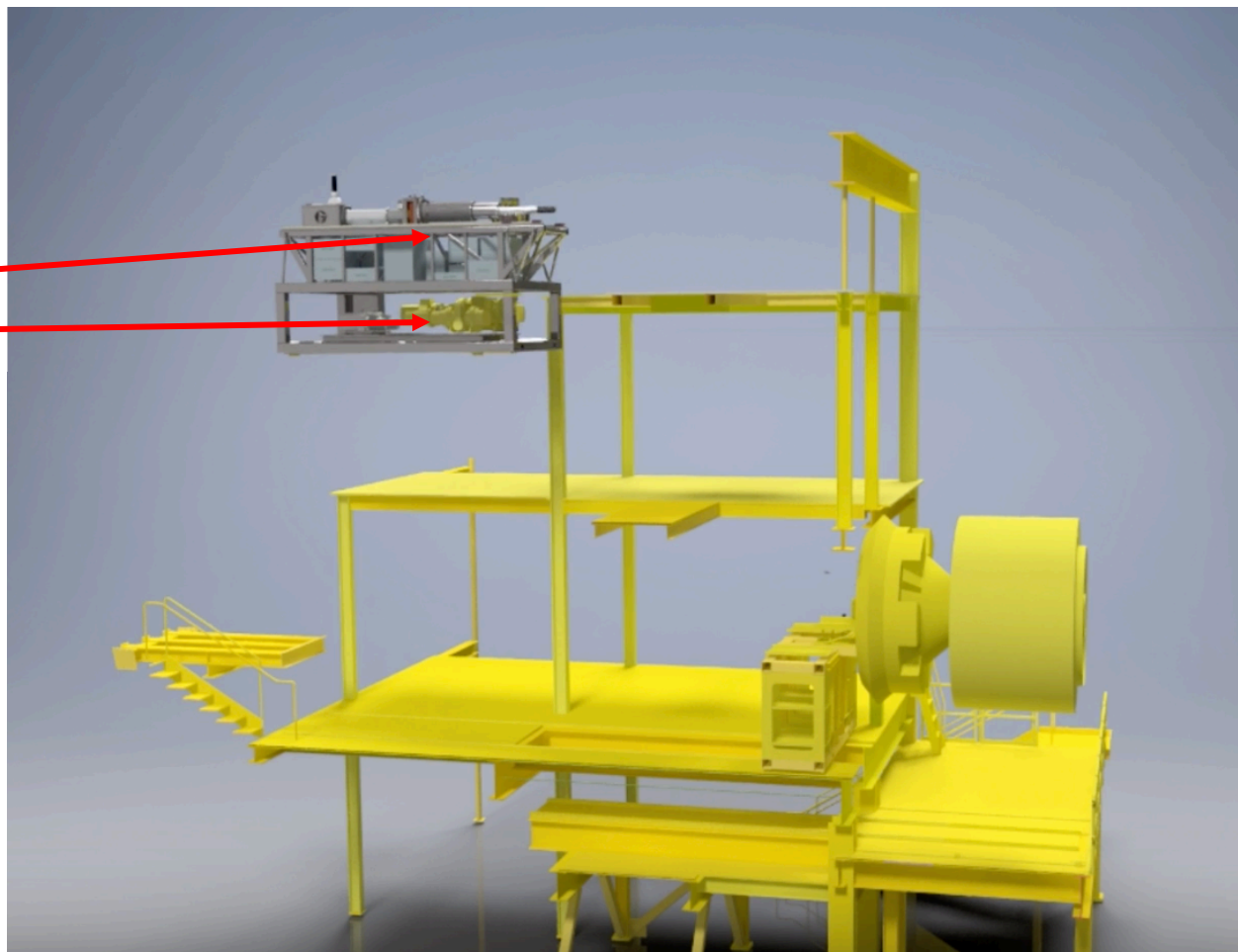


Photos courtesy of J. Brock

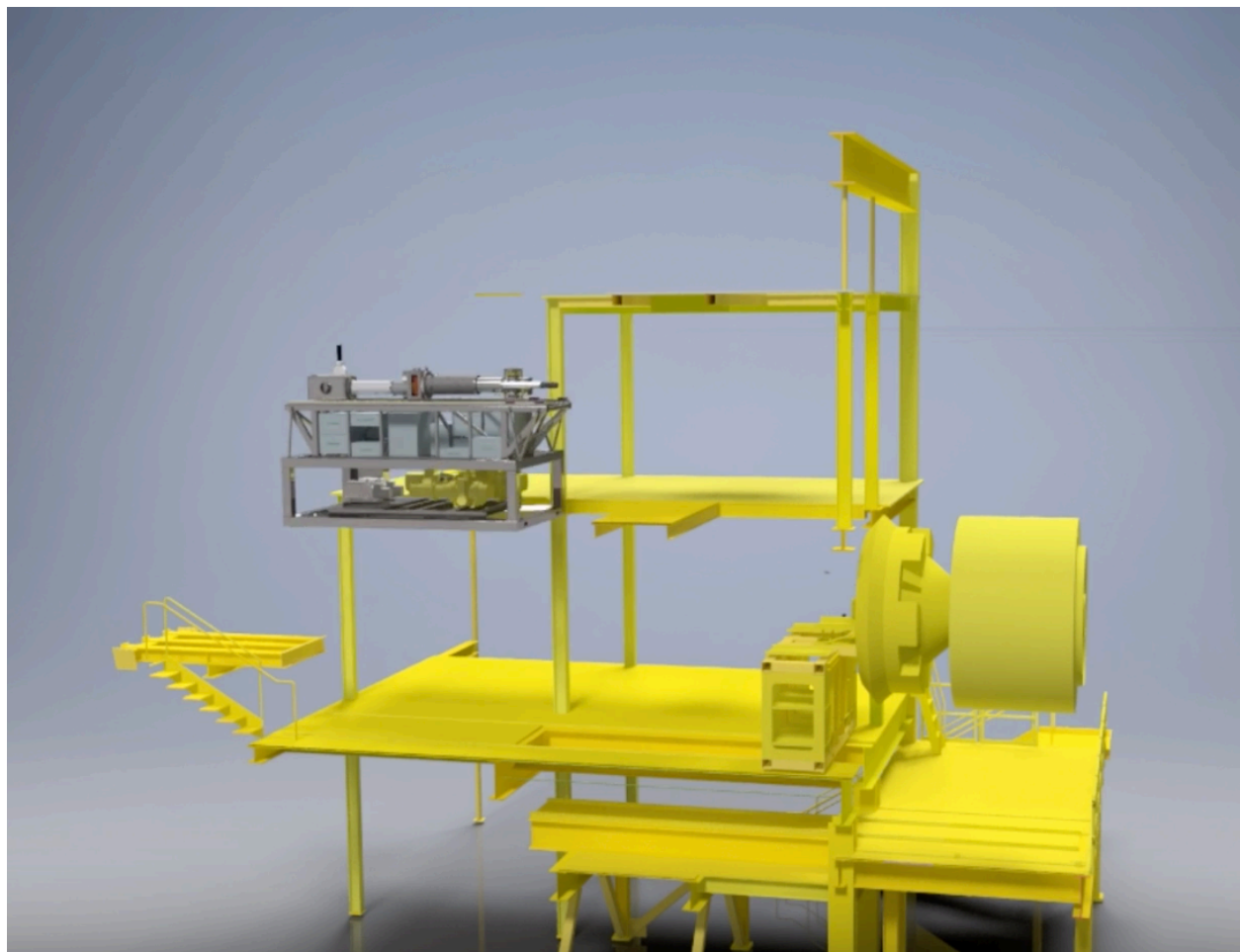
Insertion Cart

Designed to be a compact, two-tiered system:

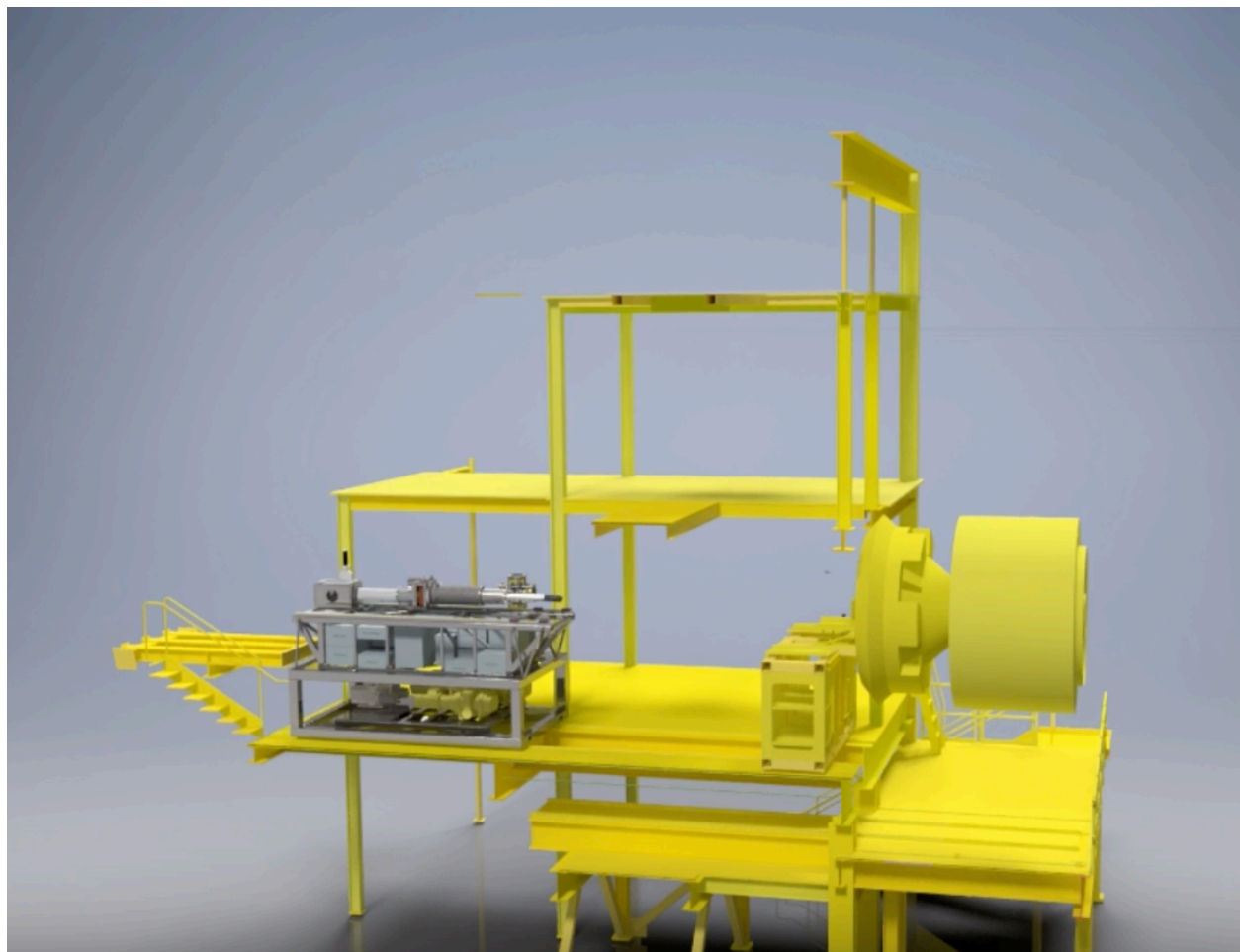
- target & electronics on top
- pumps on bottom



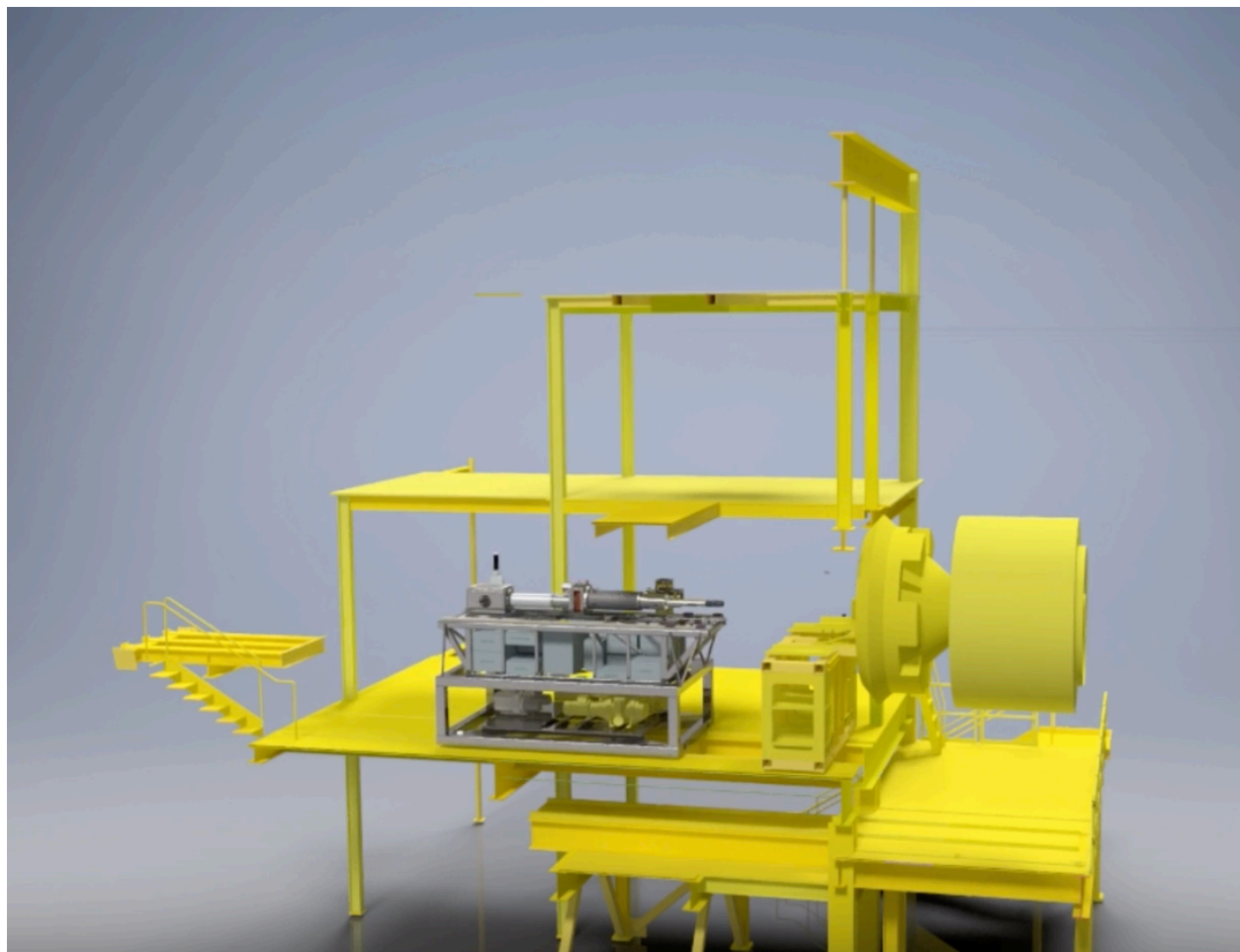
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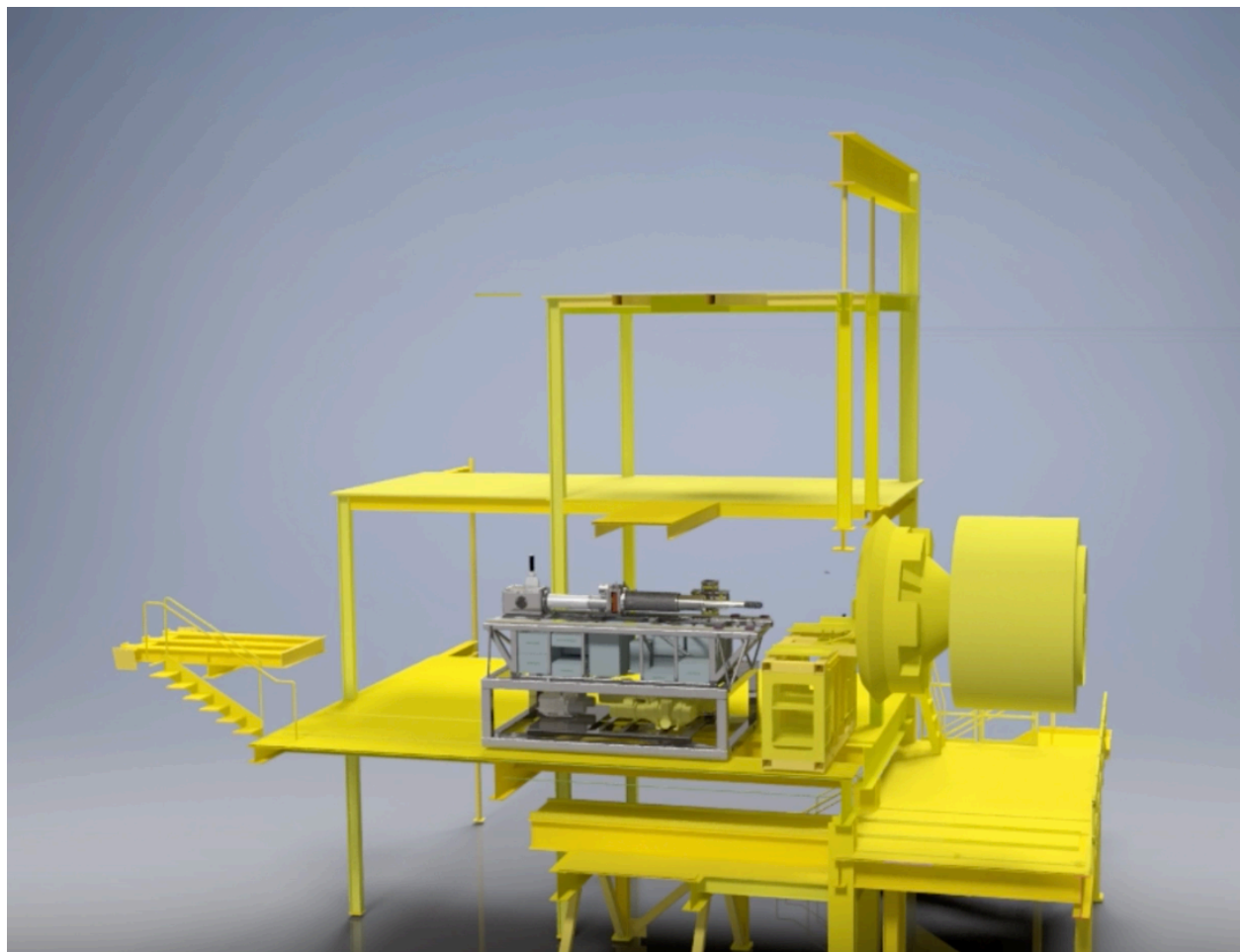
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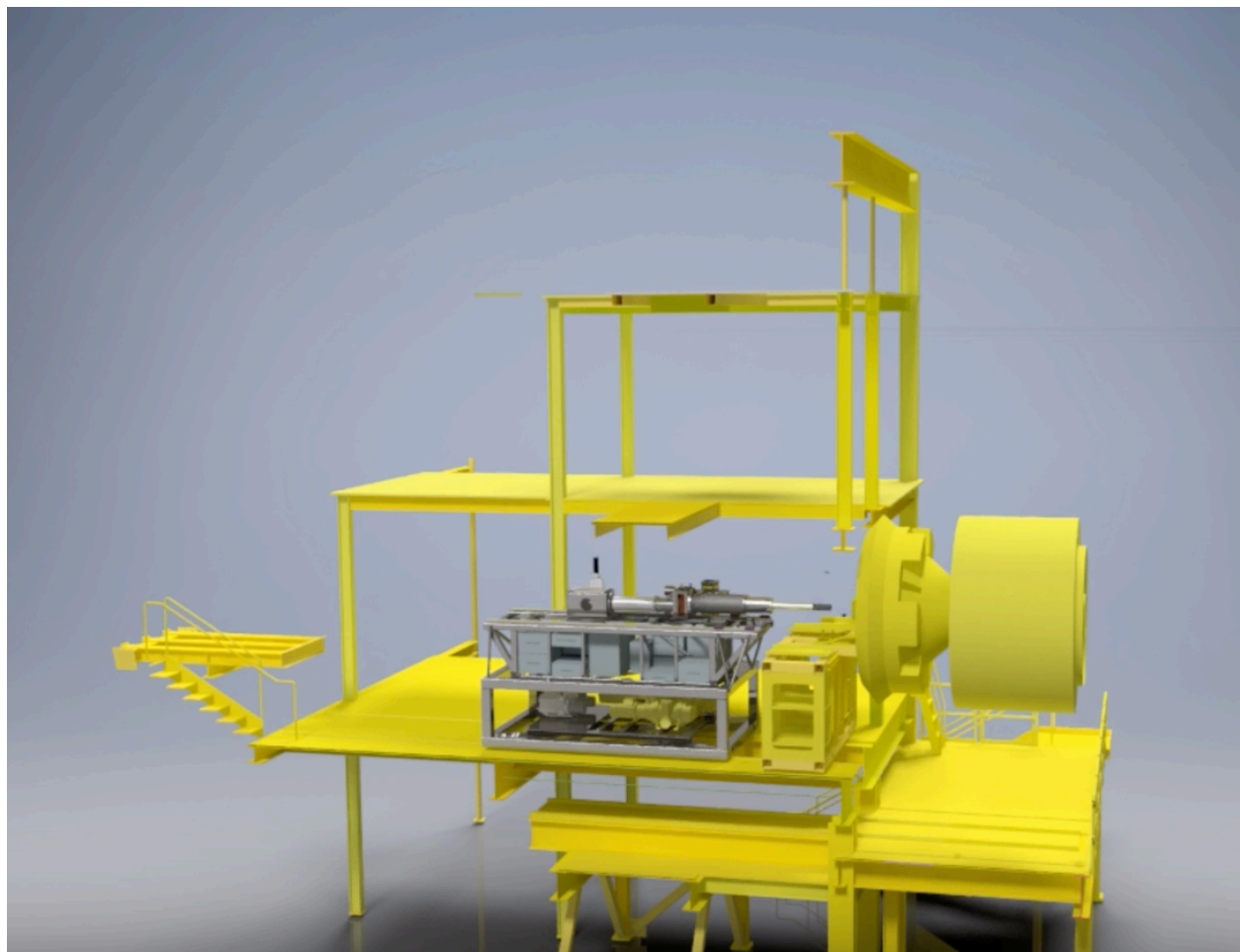
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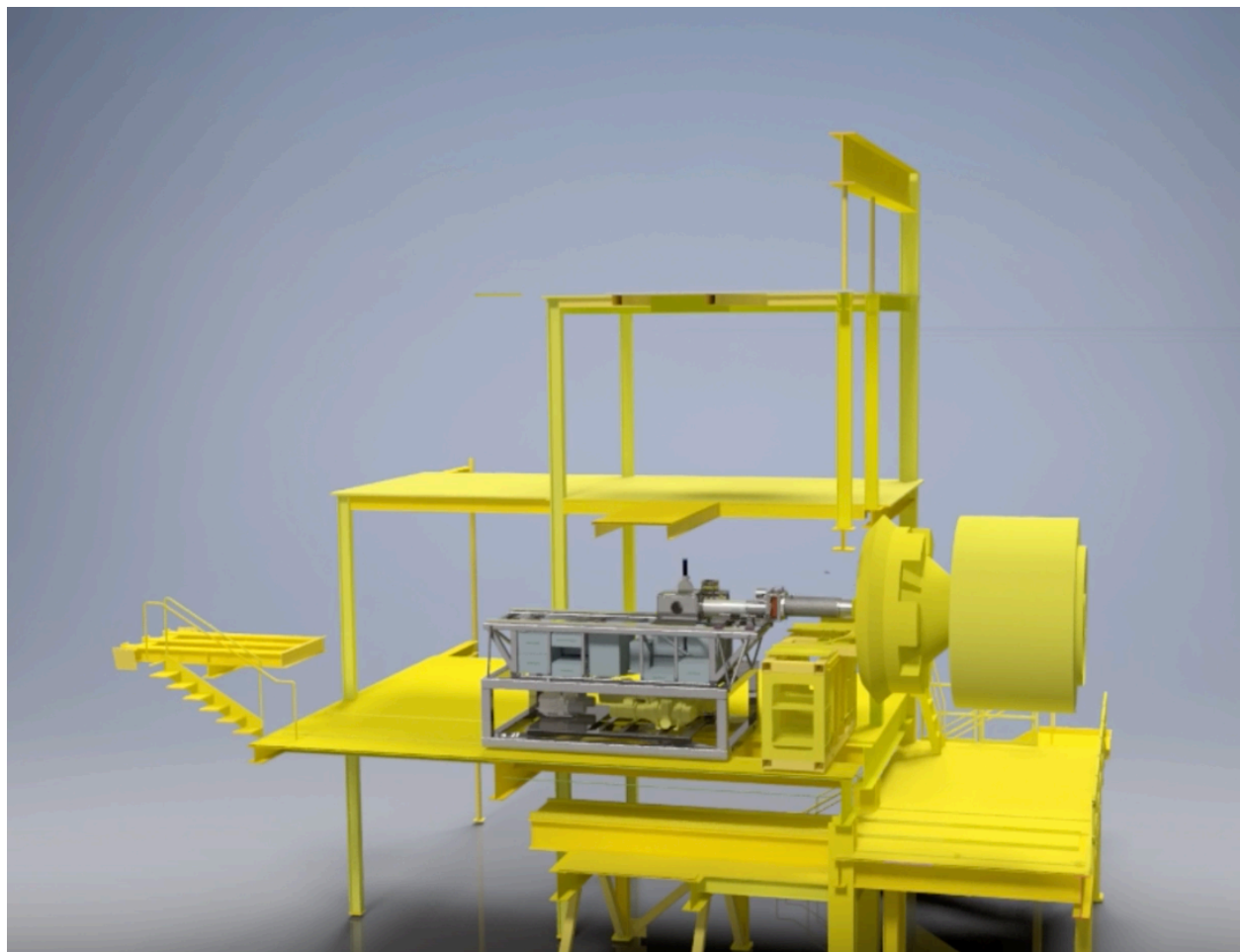
Insertion Cart



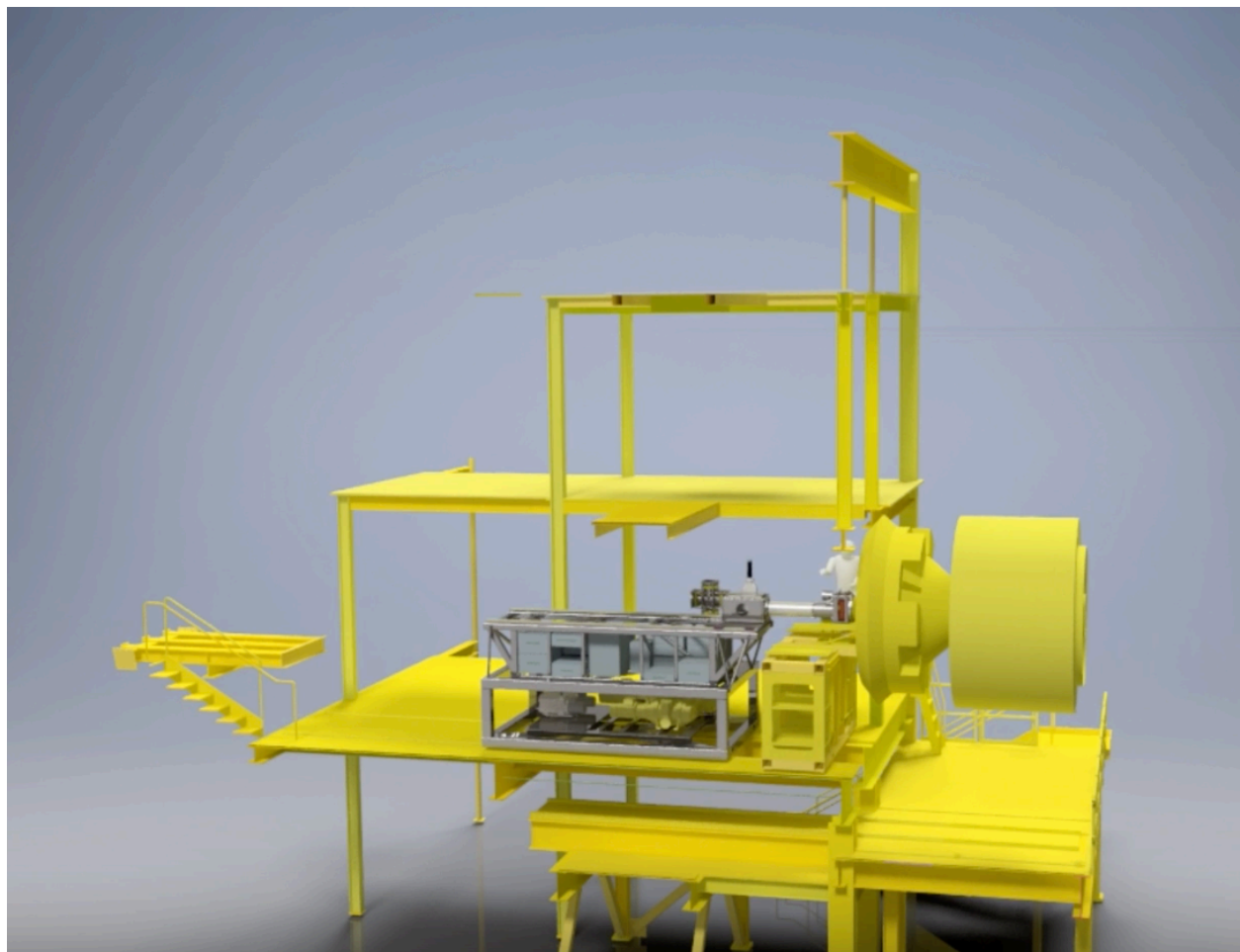
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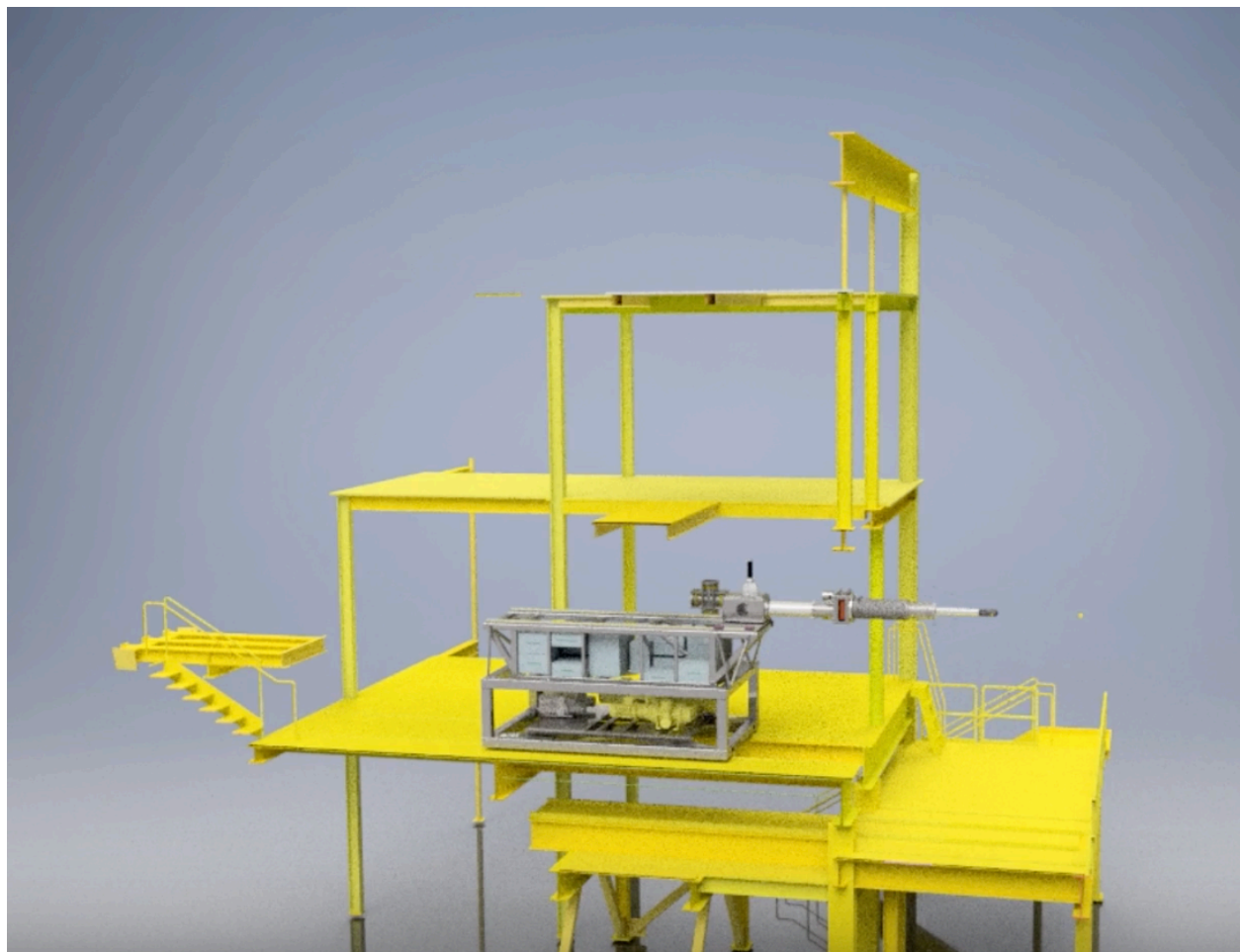
Insertion Cart



Insertion Cart



Insertion Cart



Construction & Testing

- Refrigerator completion date: Jan, 2019
- Refrigeration tests: Feb - March, 2018
 - ERR: March, 2019
- DNP tests: April - June, 2019
- Full system assembly in EEL: July – Dec., 2019
- Full system tests in EEL: Jan. – April, 2020
- Ready for installation: May, 2020

Run Group C Simulations

- Regular, monthly meetings on Thursday Mornings @ 9:30
- Usual suspects: A. Biselli, T. Forest, C. Keith, S. Kuhn, V. Lagerquist, S. Niccolai
- Focus on simulations for RG-C
- Current outstanding questions
 1. One target cell or two?
 2. Target length?
 3. Raster diameter?
 4. Forward Tracker ON or OFF?



The questions are not independent
of one another...

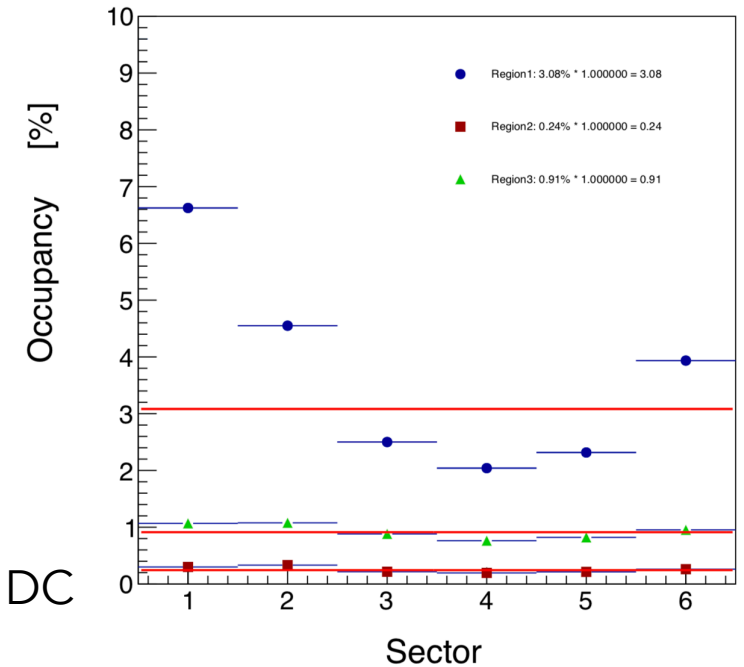
Run Group C Simulations

Courtesy of A. Biselli

Summary of Drift Chamber Occupancy for Clas12

FT	Micromega	Beam Shift	Occupancy of Sector 1	Average Occupancy (Region 1)
On	On	0 mm	~2.07%	2.07%
On	On	5 mm	~4.2%	2.40%
On	On	7.5 mm	~6.6%	3.06%
Off	On	0 mm	~2.45%	2.45%
Off	On	7.5 mm	~6.3%	3.54%
On	Off	5 mm	~5.6%	3.01%
On	Off	7.5 mm	~8.1%	3.49%

- Increasing raster diameter increases the occupancy of region 1 DC
 - But smaller raster means faster radiation damage to target
- Compensate with lower beam current
 - But this means a longer experiment
- Compensate with a long target sample
 - But this probably means lower polarization



Run Group C Simulations

Luminosity: $6.8 \times 10^{34} \text{ s}^{-1} \text{ cm}^{-2}$

(same as Run Group A)

1) Specify target/raster size & anneal rate

➤ Calculate beam current

2) Specify luminosity & beam current

➤ Calculate target length

Beam time before anneal: 24 hours

Target radius (cm)	Beam current (nA)	Target length (cm)
0.50	8.5	6.3
0.75	22.5	2.4
1.00	43.1	1.25

Beam time before anneal: 48 hours

Target radius (cm)	Beam current (nA)	Target length (cm)
0.50	4.2	12.6
0.75	11.2	4.8
1.00	21.5	2.5

Beam time before anneal: 1/2 week

Target radius (cm)	Beam current (nA)	Target length (cm)
0.50	2.4	22.1
0.75	6.4	8.4
1.00	12.3	4.3

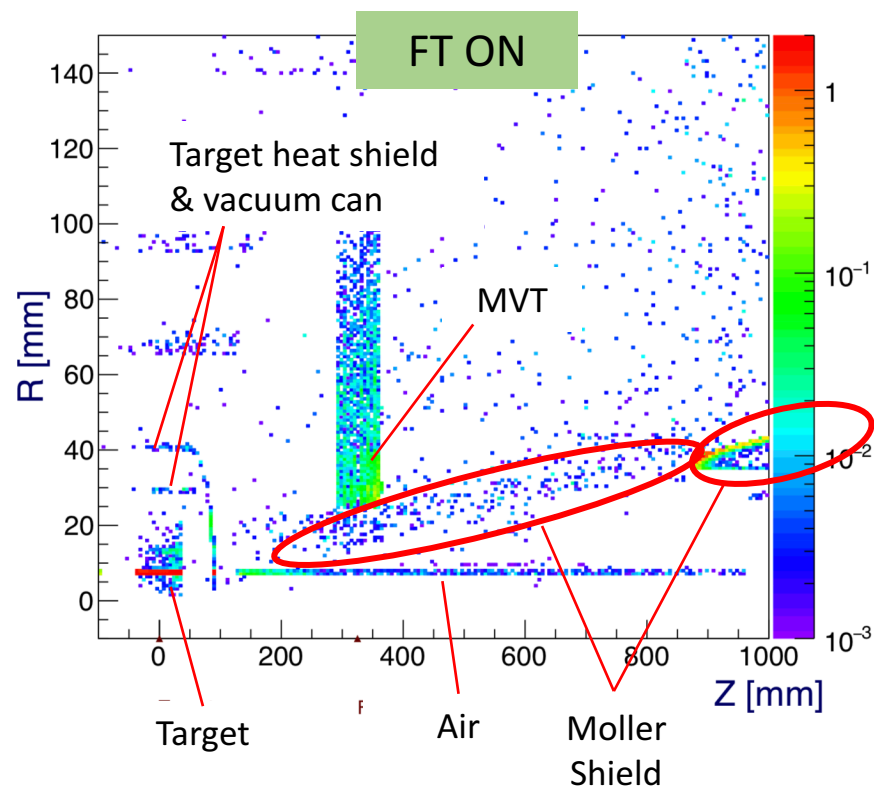
Beam time before anneal: 1 week

Target radius (cm)	Beam current (nA)	Target length (cm)
0.50	1.2	44.2
0.75	3.2	16.7
1.00	6.2	8.7

Run Group C Simulations

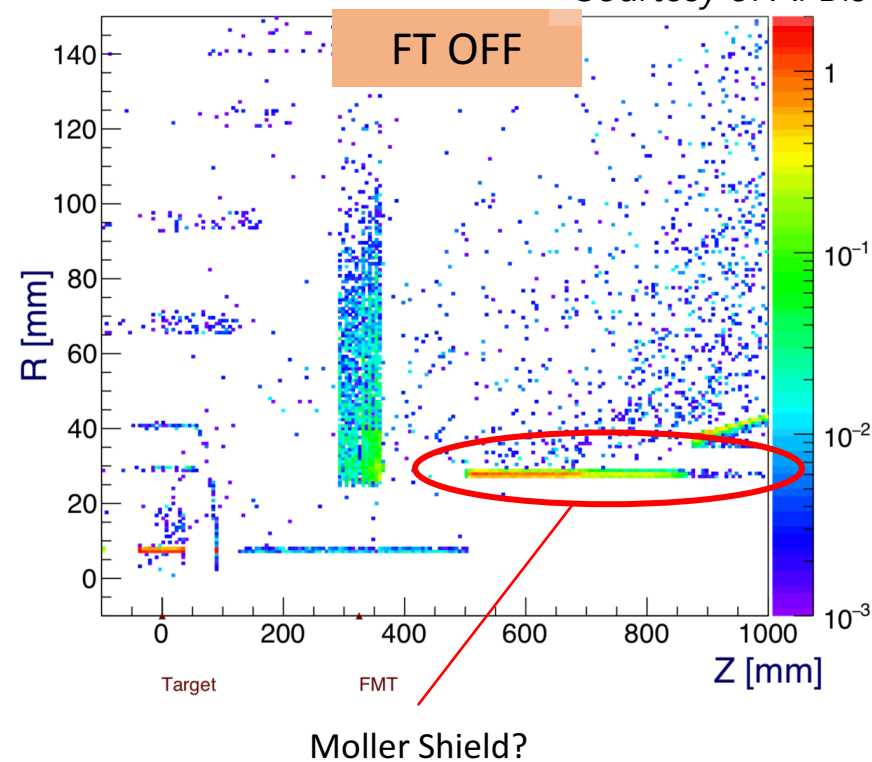
Beam offset: 7.5 mm

R vs Z vertex of tracks in region 1 for clas12



R vs Z vertex of tracks in region 1 for clas12

Courtesy of A. Biselli



Summary

- Final components for the CLAS12 longitudinally polarized target are under construction
- Estimated completion date is early 2019, tests to begin shortly thereafter
- Double-cell polarization with shimmed magnetic fields has been successfully demonstrated
- New, improved NMR Q-meter (prototype) from JLab Fast Electronics is expected by end-of-year
- Details of sample size are still undecided, requiring more simulation