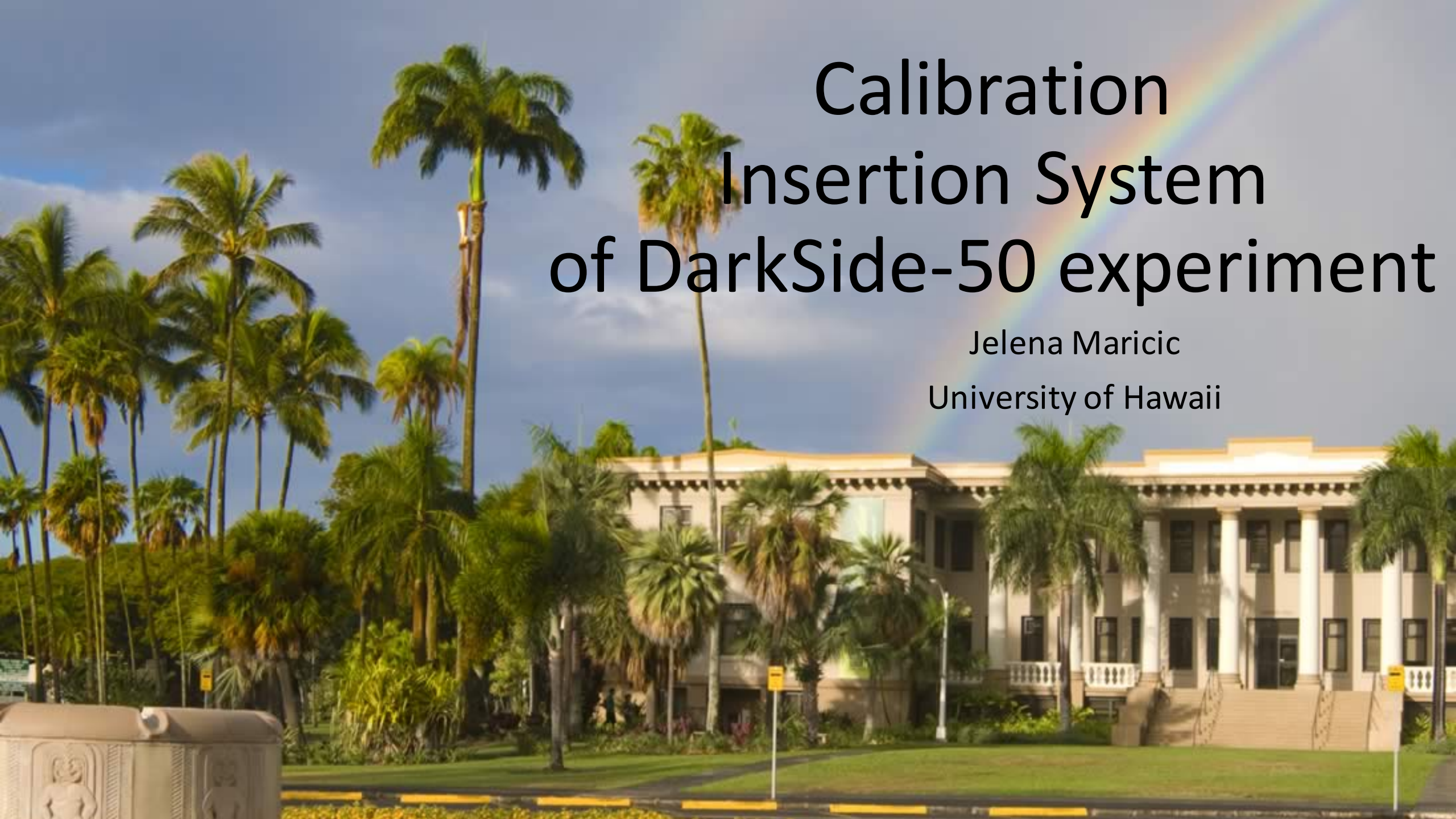


Calibration Insertion System of DarkSide-50 experiment

Jelena Maricic

University of Hawaii

Introduction

- Between 2014 – 2017 we have designed, fabricated, commissioned and deployed calibration system for the DarkSide experiment called CALibration Insertion System (CALIS).

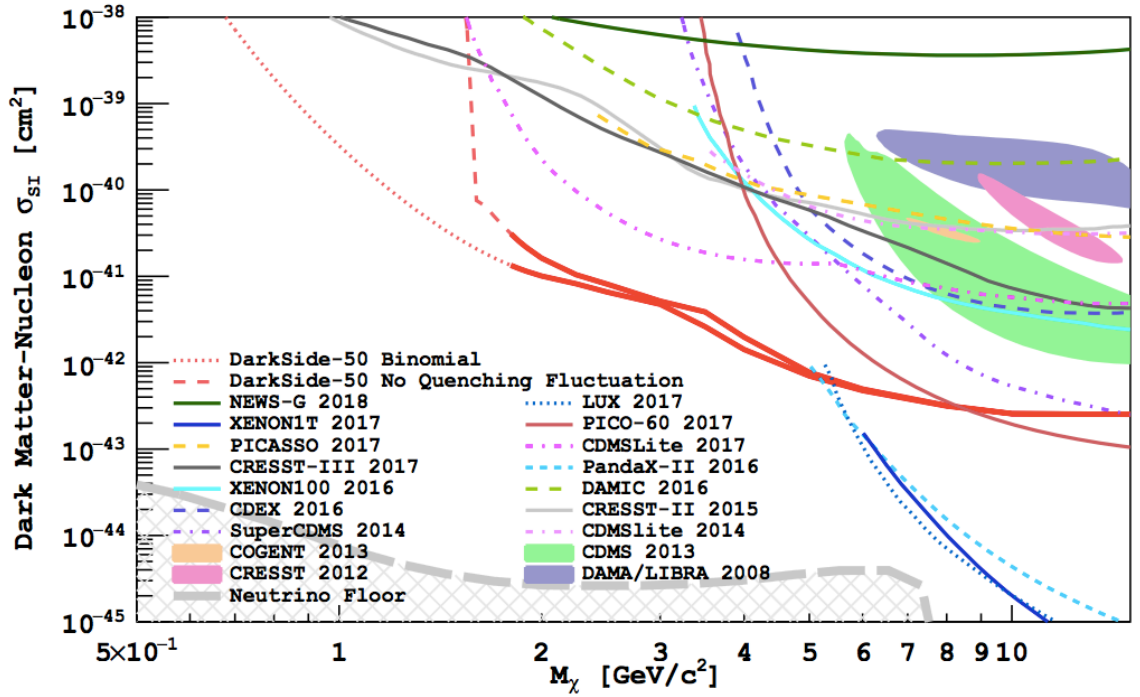
- During this period, several calibration campaigns have been executed: AmBe, AmC, ^{137}Cs, ^{133}Ba, ^{57}Co, ^{22}Na

- Engineering design came from Cary Kendziora (Fermilab engineer), while fabrication, assembly and testing were carried out at Hawaii and FNAL, prior to commissioning at GranSasso in the DarkSide veto.

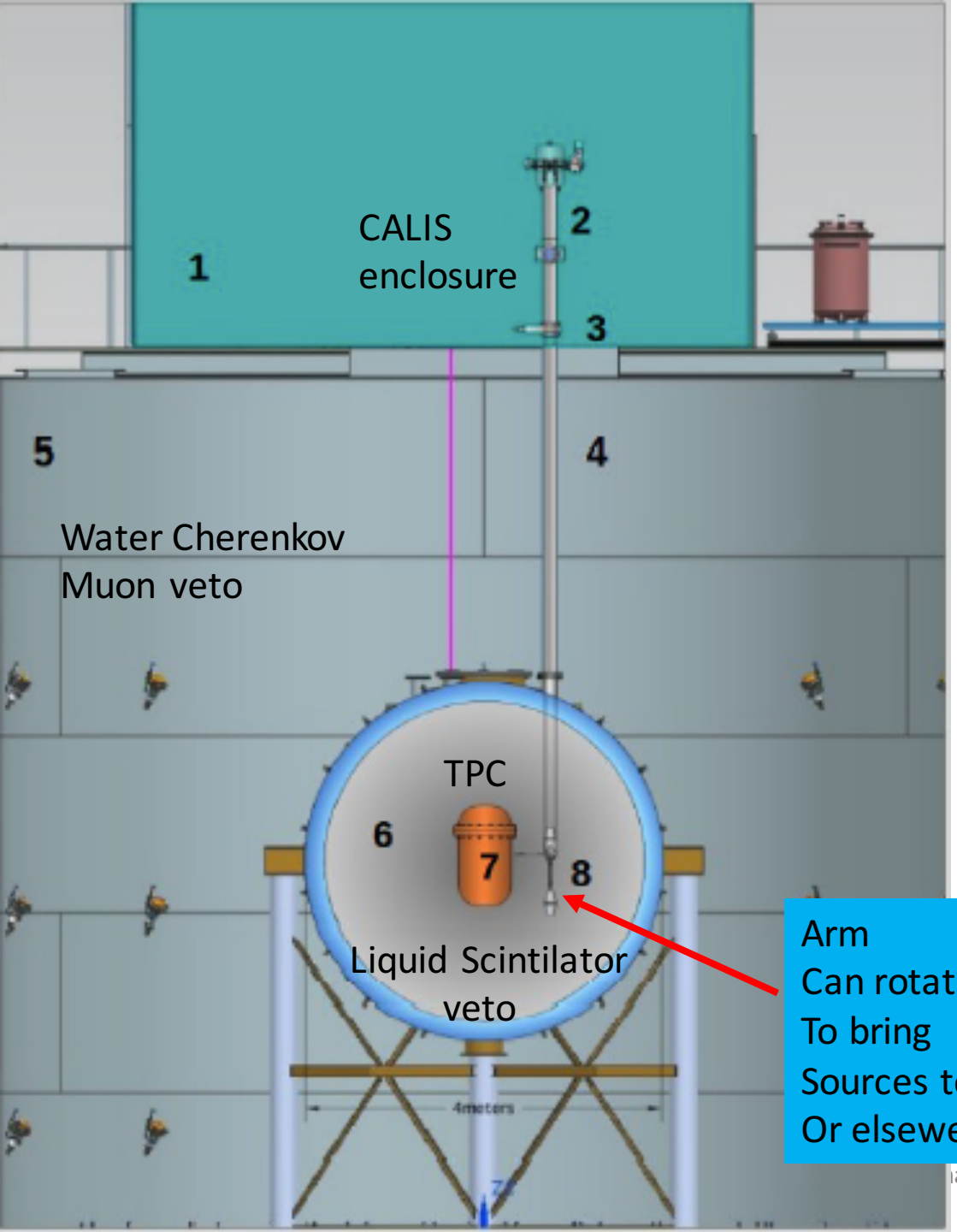
- Material and fabrication cost were very modest $20k (engineering cost not included). Also utilized university paid machinist and CNC machine capabilities – only material cost incurred.

DarkSide-50 experiment

- DarkSide-50 experiment is dual phase argon TPC located in Gran Sasso Italy.
- Is the direct dark matter search experiment.
- Looks for nuclear recoils as as signature of WIMP recoil in the detector.
- Background free high mass WIMP search.
- Currently holds the best low energy WIMP limit.

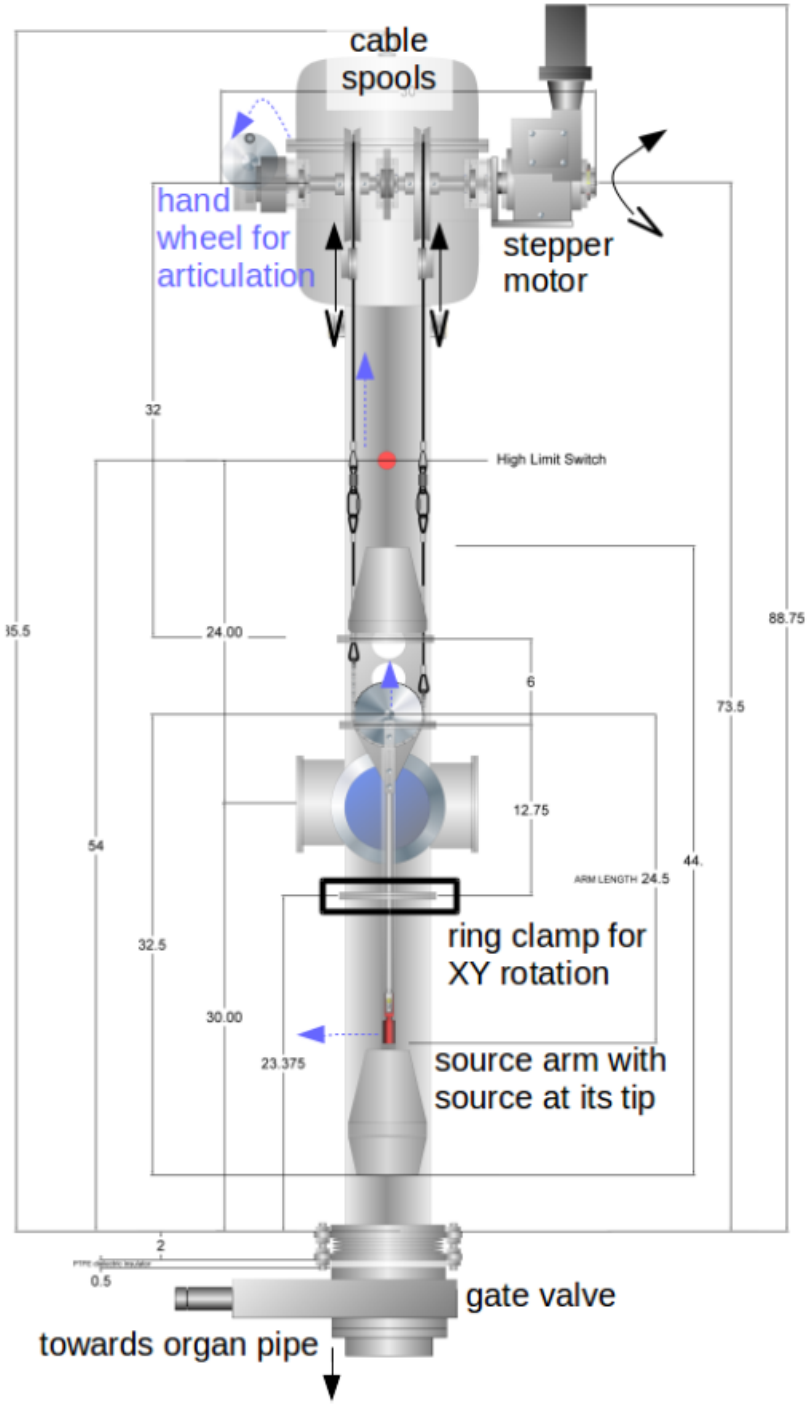


CALIS in DarkSide-50

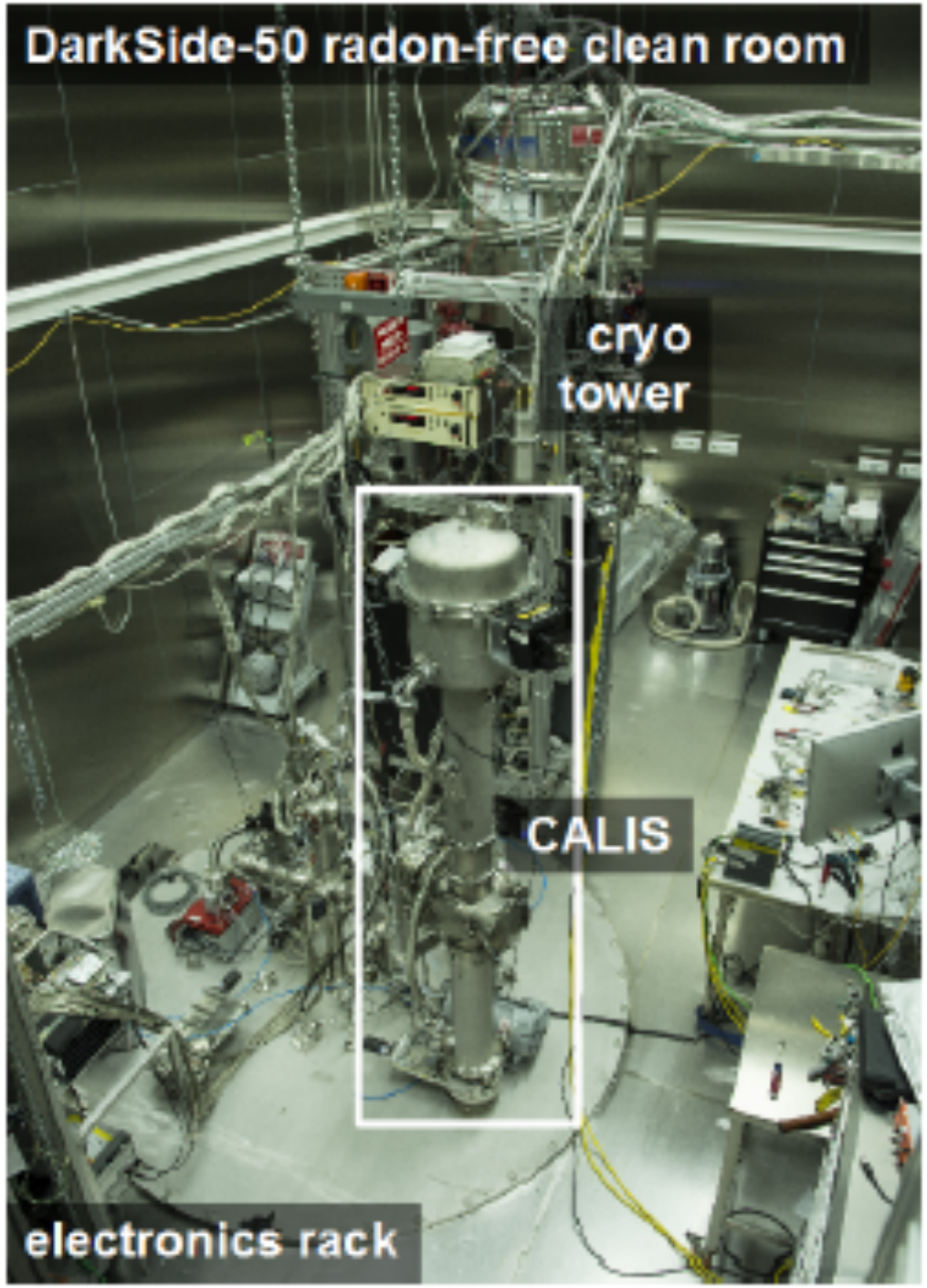


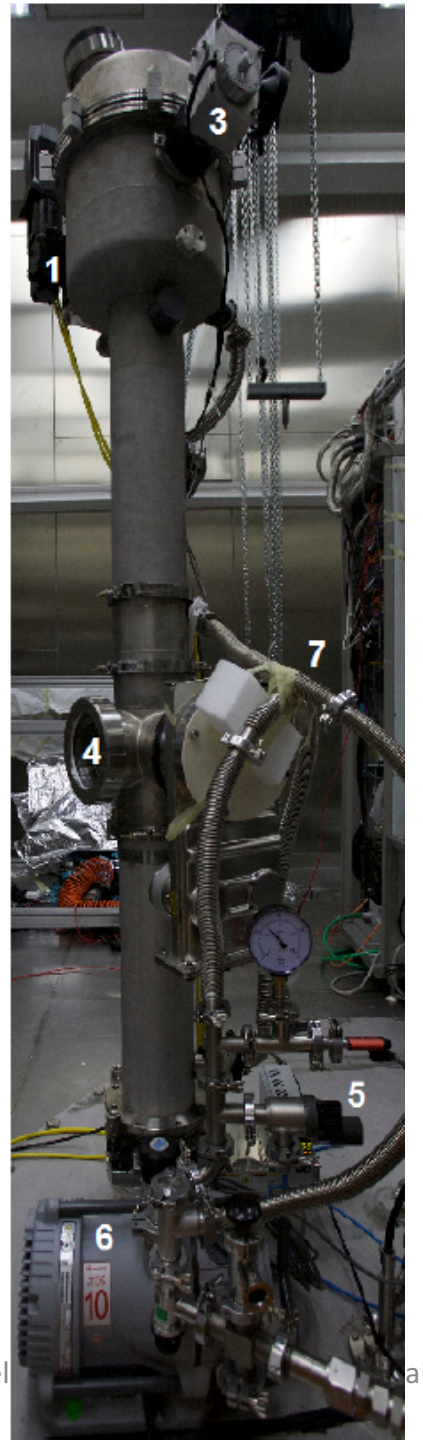
- Vacuum tight enclosure located on the top
- Gate valve at the top to seal the detector while not in use
- Source is mounted at end of the arm
- Arm can be rotated to bring source to different locations during single deployment.

CALIS design



- Two cables mounted on two spools are connected at the bottom with a chain that goes over the disk.
- The source is mounted on the tip of the arm
- Arm is rigidly mounted on the center of the disc.
- After the source is mounted, gate valve is opened, and source is deployed to desired z position, while two cables unwind in parallel with stepper motor.



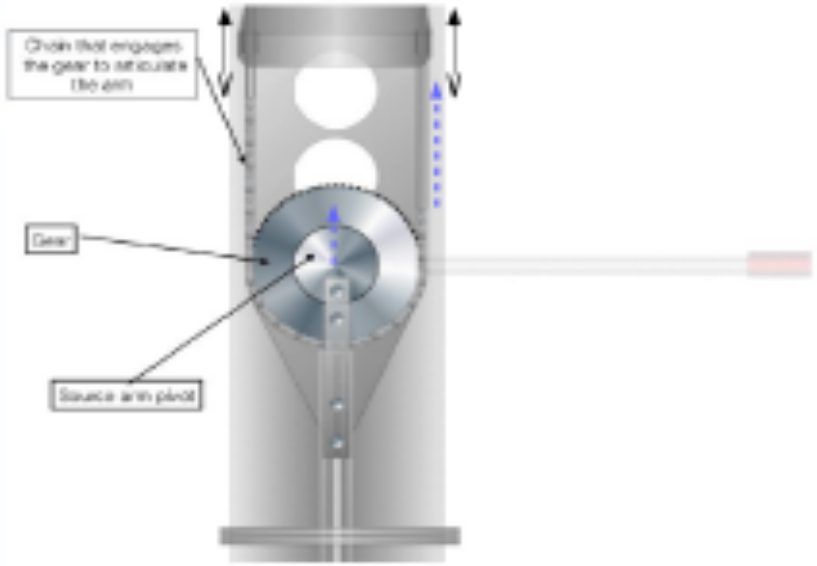


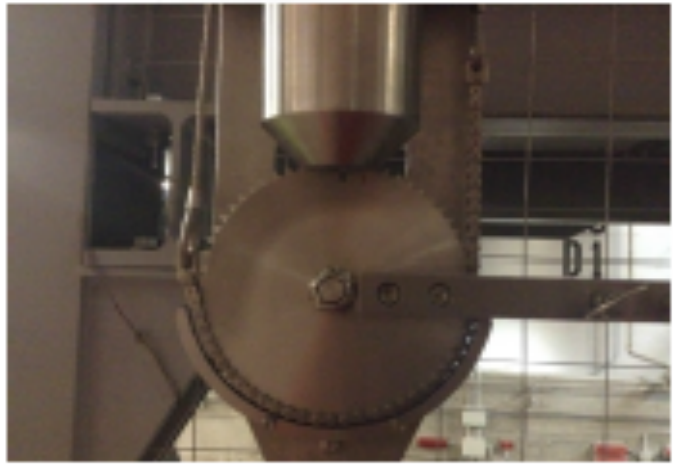
System as built

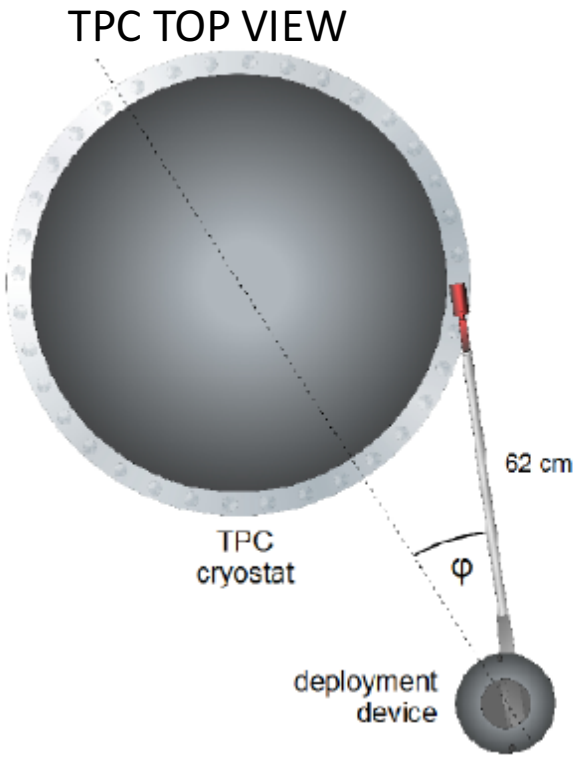
Efficient purging by multiple cycles of nitrogen and Filling and vacuum pumping.

Important to eliminate residue scintillator after deployment, as well oxygen and humidity prior to deployment

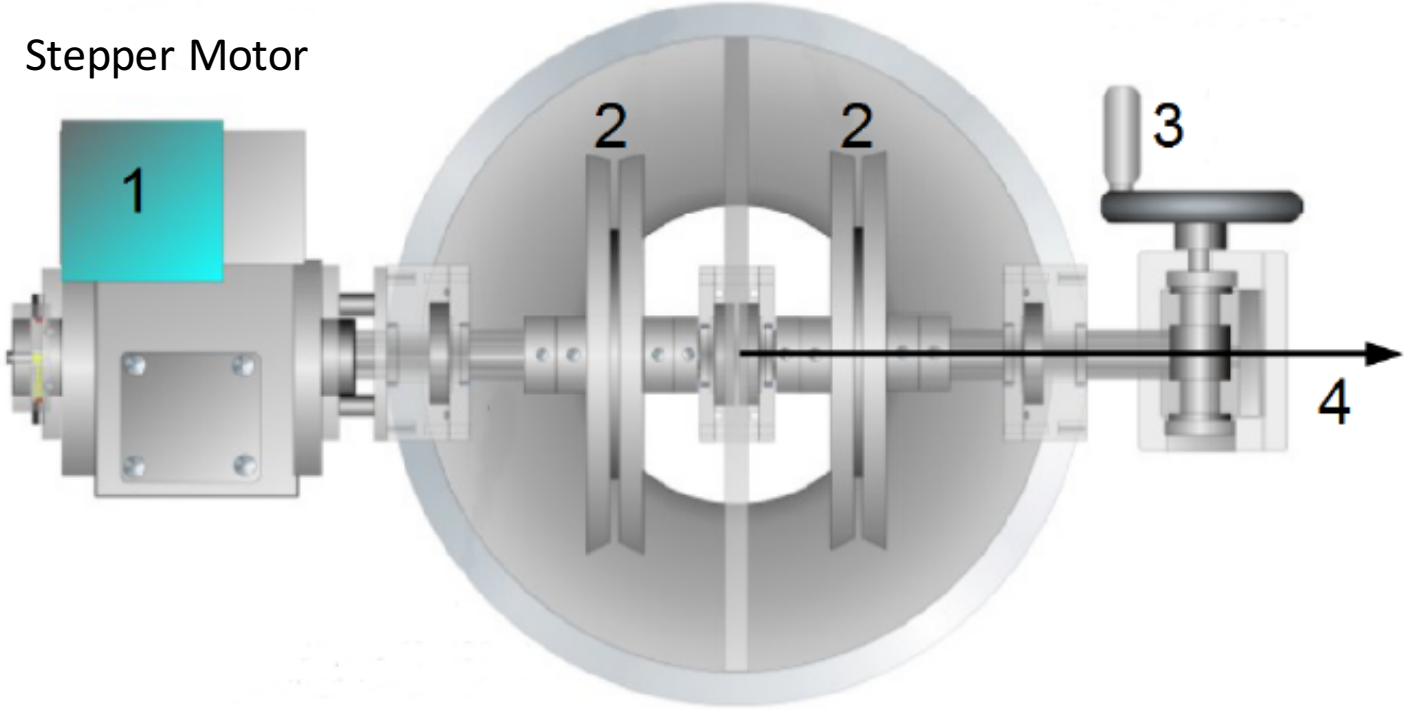
Detail of the Arm and Rotation





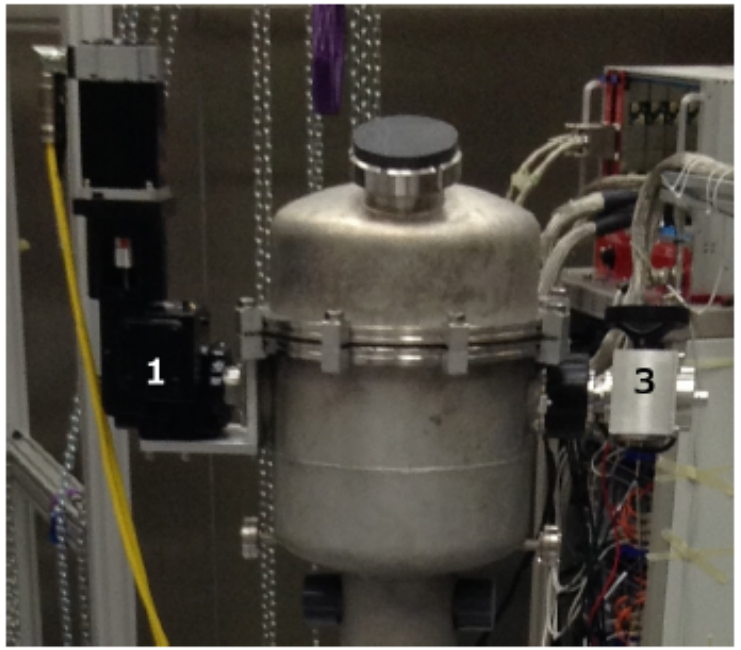


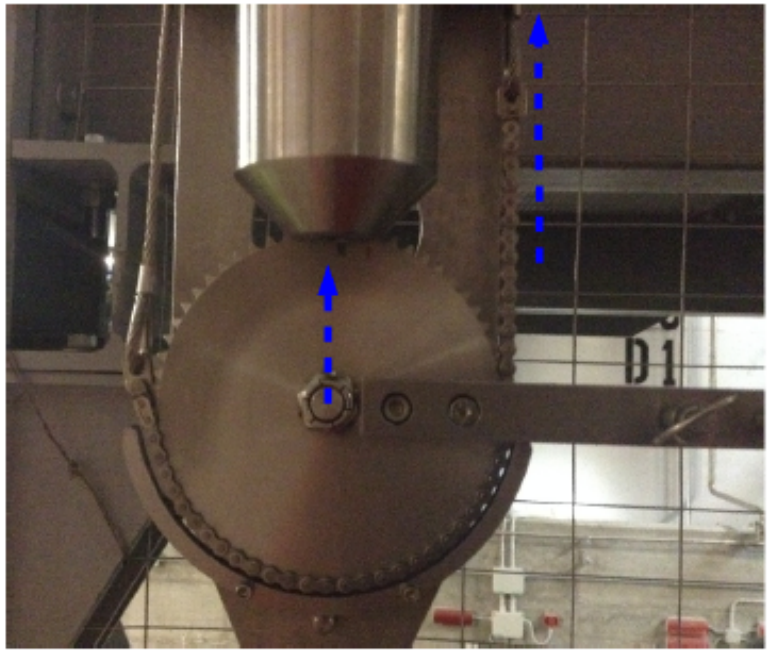
- Once in z position, one of the cables is shortened for ¼ cycle of the disc, rotating the disc, and placing the arm in the horizontal position, close to TPC.



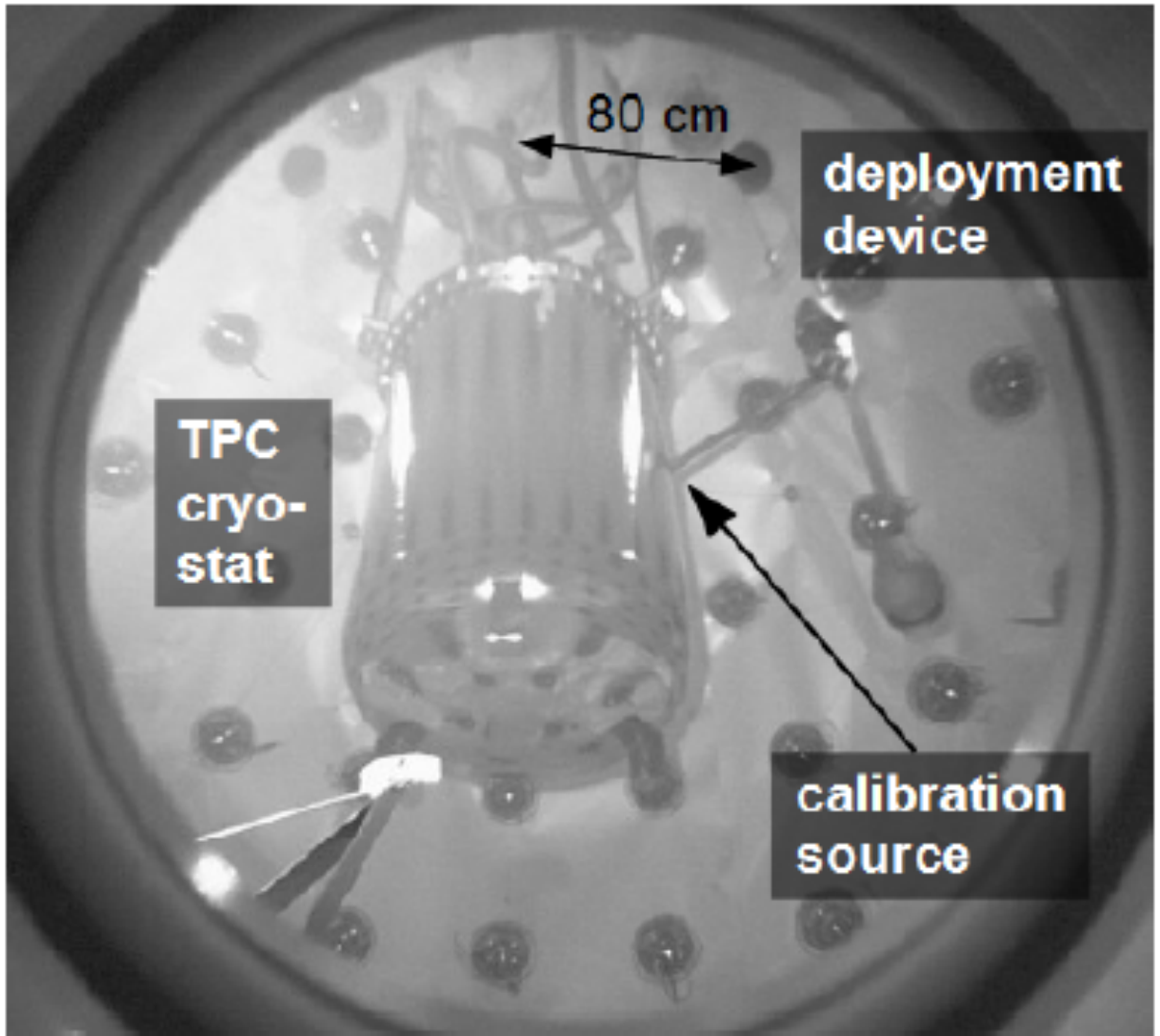
Spools and articulation

- In order to rotate the arm, small handle on the right spool is turned, turning the right spool and winding up the right-hand cable.
- As a result chain around the disc moves, rotating the disc and arm with source.

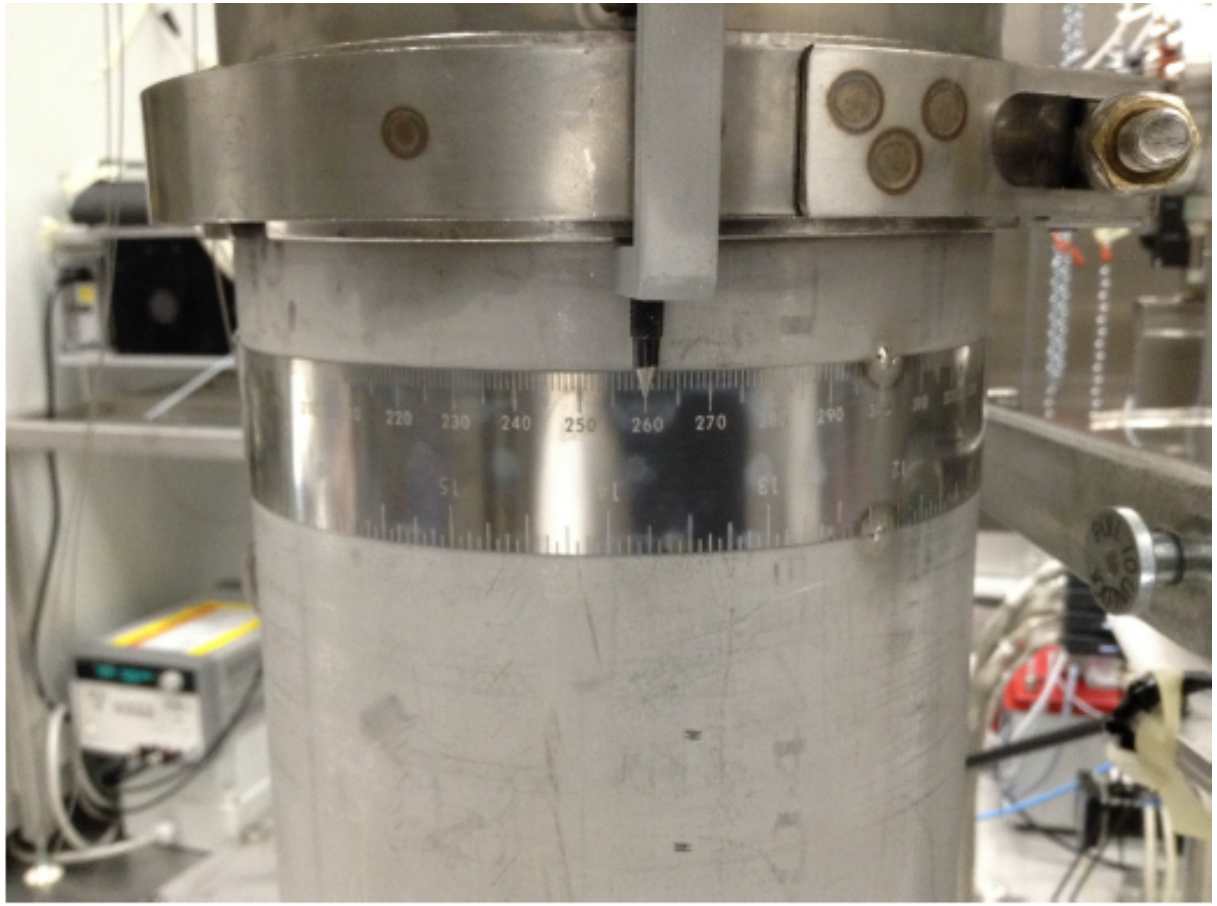




Rotation in vertical plane toward TPC



Phi rotation in the horizontal plane



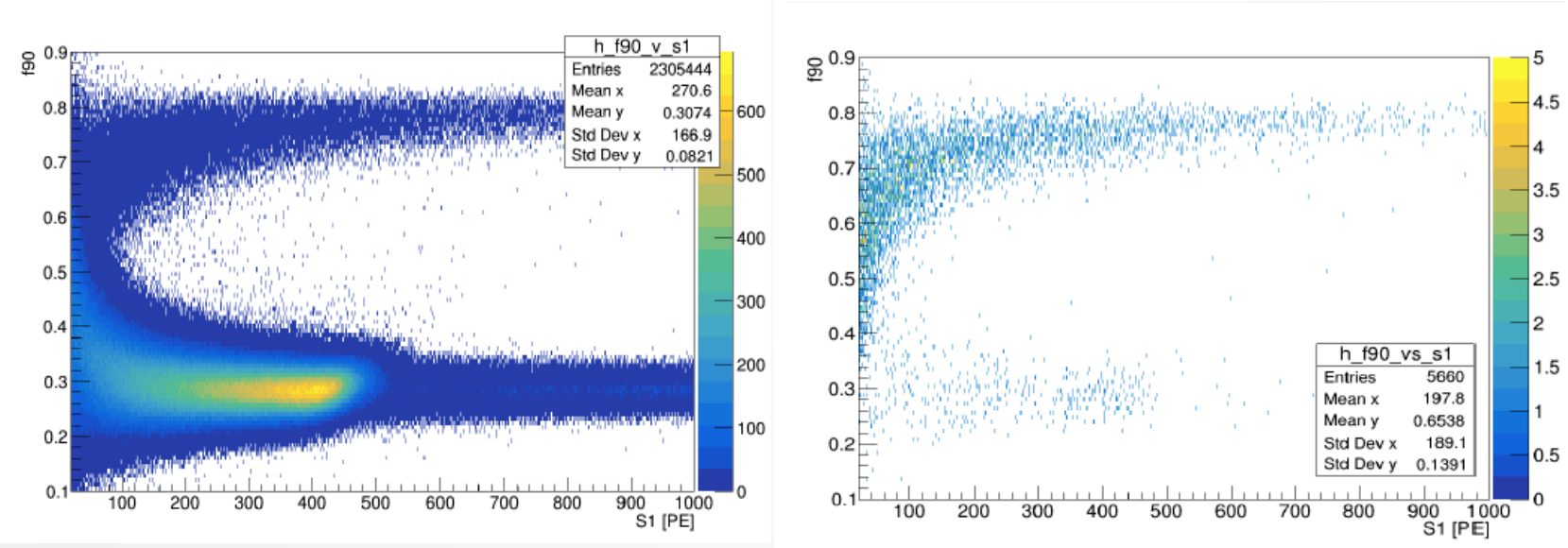
- Performed manually.
- Allows full 360◦
- System rotates easily and does not leak.
- Helium leak test checked.

Safety features

- Motor features absolute encoder, so position is NEVER lost.
- Possibility to retract the cable manually in case of cable failure.
- Multiple push buttons and stranded cables used to secure the source to the disc of the calibration system
- Hardware limit switches installed:
  - Cuts power to the motor, if arm rotation is attempted in the pipe, prior to reaching the veto.
  - Cuts power to the motor, if arm is not rotated back to vertical position, prior to retraction to the top.
  - Cut power to the motor, if the number of steps sends the system higher than home position.

Summary - calibration insertion system

- CALIS allows good range of deployment positions in xyz.
- Built with very modest funds.
- Inside clean room
- This system can be modified for DUNE FD as needed.
- The most important at this point are INTERFACES of calibration with other systems: flange on the veto… & available overhead space



AmBe before and after neutron selection cuts