



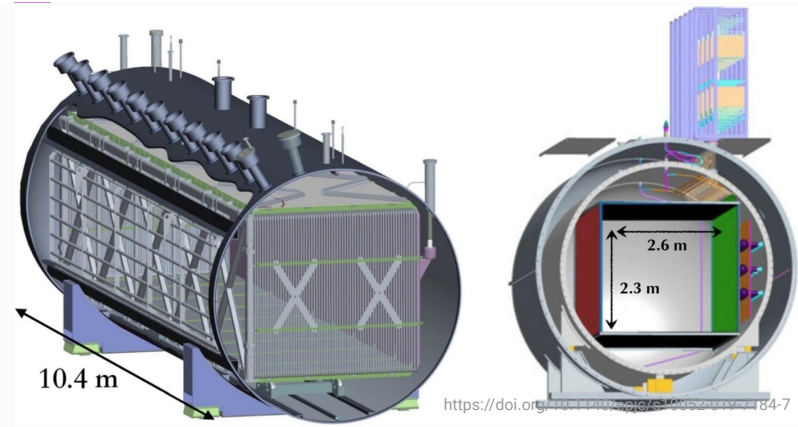
## UV Laser Calibration System: A probe to Determine Electric Field Distortion inside Liquid Argon Time Projection Chambers

Monthly meeting- INTENSE  
March 30 , 2022

Supervisor:

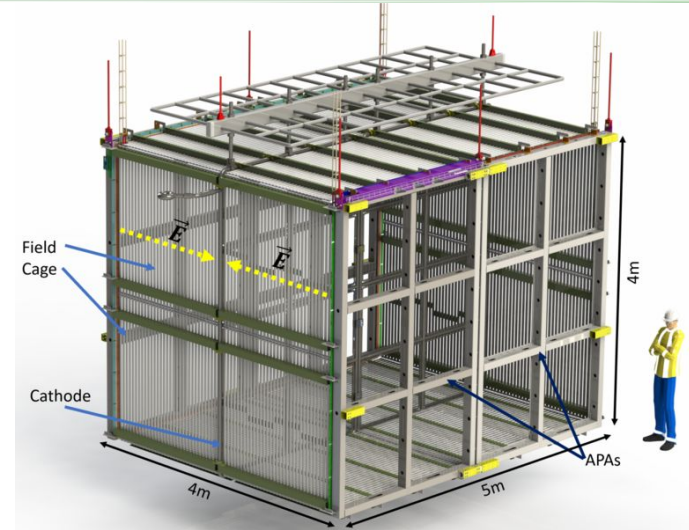
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## MicroBooNE:

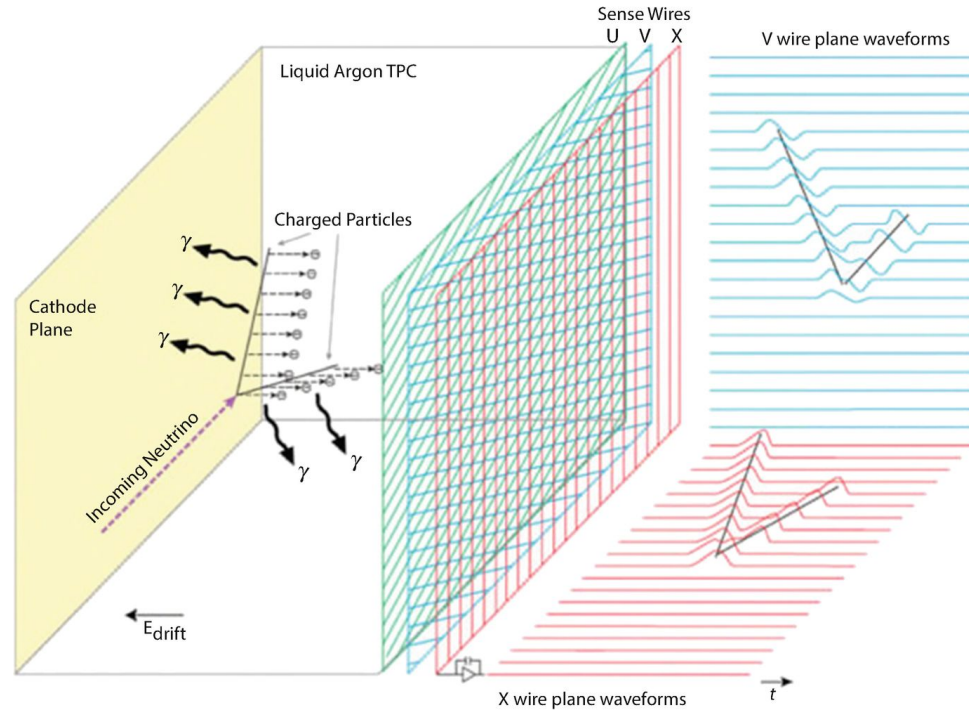
- 470 meters from the Booster Neutrino Beam target.
- 80 tons of liquid argon in the active volume.
- Single tpc (2.6 m x 2.3 m x 10.4 m)
- Two UV laser system for E field calibration.



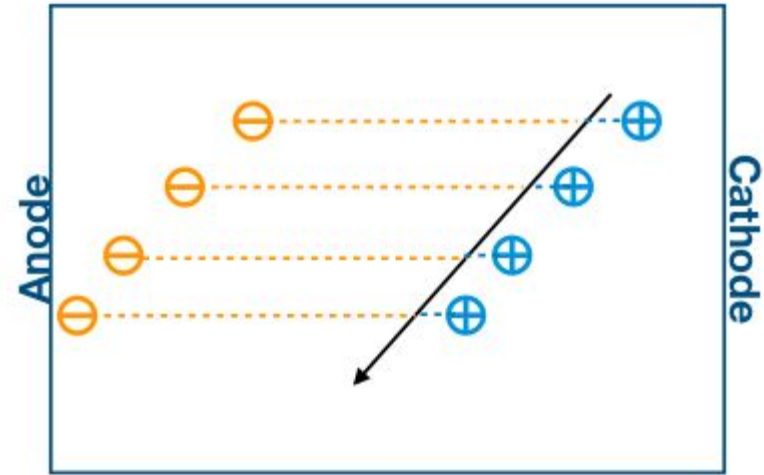
## SBND:

- 110 meters from the Booster Neutrino Beam target.
- 112 tons of liquid argon within the active volume.
- 2 TPC system. (Each tpc is 2m x 4m x 5m)
- 4 UV laser system.

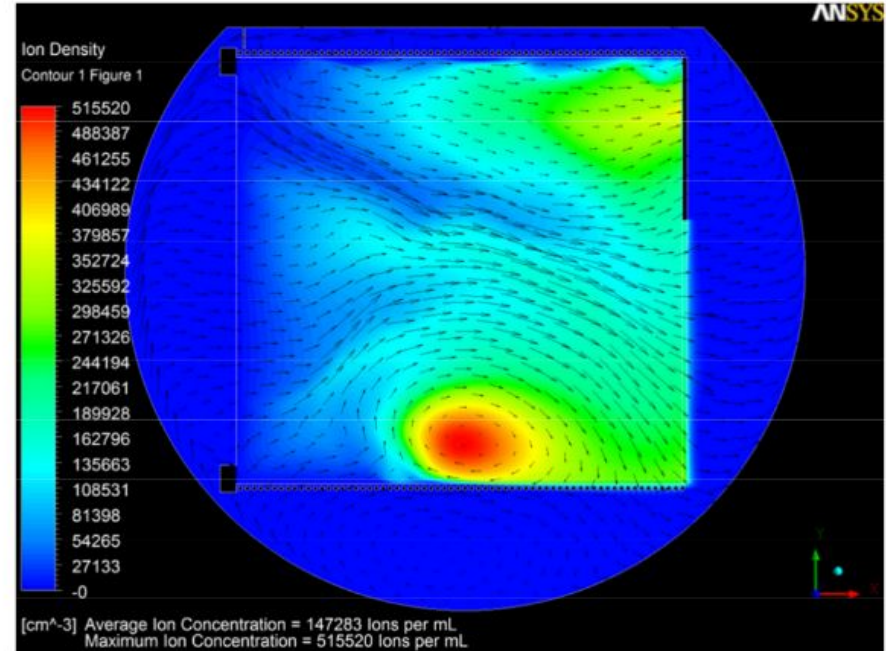
- Electric field is set up by cathode-anode plan
- Interaction in LAr produce scintillation light and ionization electrons.
- Scintillation light is detected by PMTs
- Due to Electric field  $e^-$  drift towards anode.
- At anode, the  $e^-$ . Induce charge in induction planes and are collected on the collection plane.
- 2D spatial coordinates readouts from the collection plane along with time of flight is used to reconstruct 3D true position.



- $V_{e^-} > V_{Ar^+}$  : by 5 orders of magnitude
- Accumulation of  $Ar^+$  ions inside TPC :
- Average density of positive ions is much larger than that of electrons results in **Space Charge effect**.
- E- field distortion



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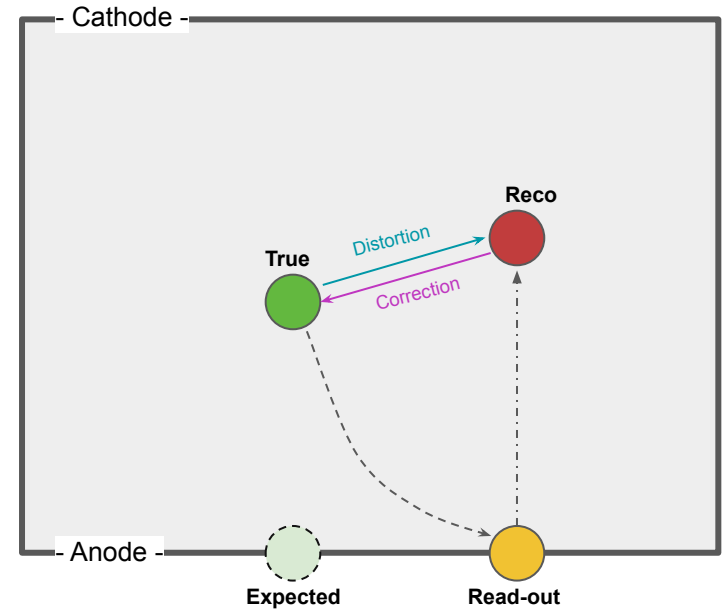


Eric Voirin: MicroBooNE-doc-1895-v4

- Discrepancies between true and reconstructed points.
- Reduces track and energy reconstruction efficiencies of the detector and introduces additional systematic uncertainties

Need a method to reduce such uncertainties:

### Ultra Violet (UV) Laser Calibration method.





## UV Calibration method :

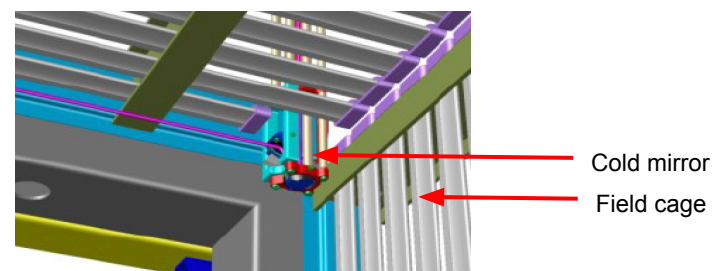
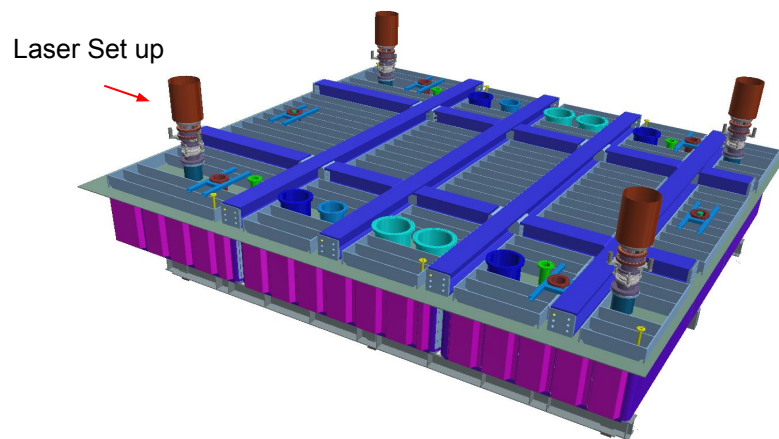
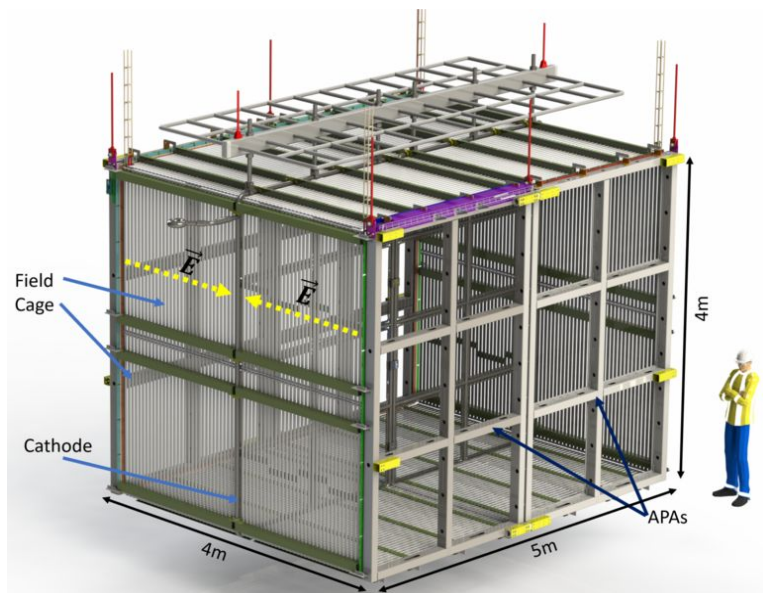
### What :

- Drive finely tuned energetic UV laser inside TPC, which ionises the Ar ion thus leaving a ionisation track.
- Compare expected (true) and reconstructed track points to calculate the E - field distortion inside TPC.

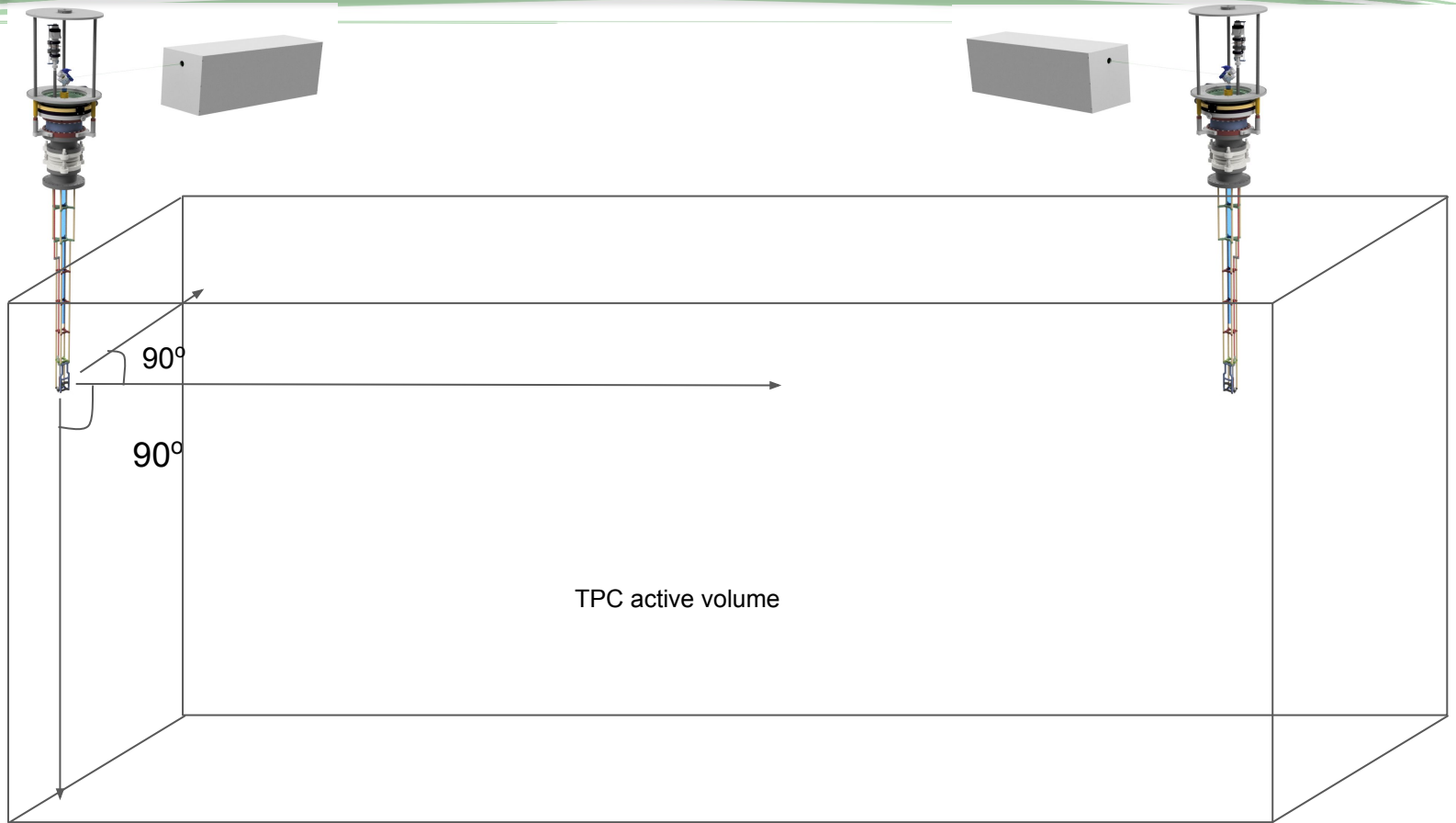
### Why:

- UV photon provides the correct energy to ionize the argon atom in liquid phase.
- laser beams do not experience delta ray emission in LAr.
- No multiple Coulomb scattering in LAr.
- Laser beams can also be repetitively pulsed in controllable directions
- UV laser system can be used to investigate detector failures, such as unresponsive or mis-configured wires in the read-out planes

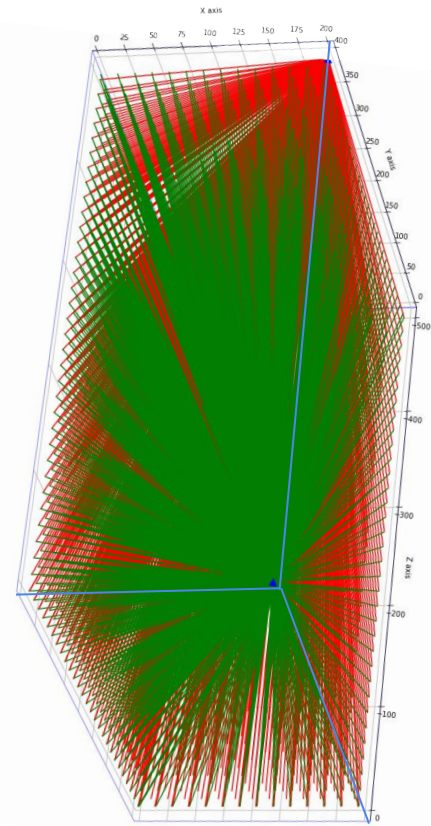
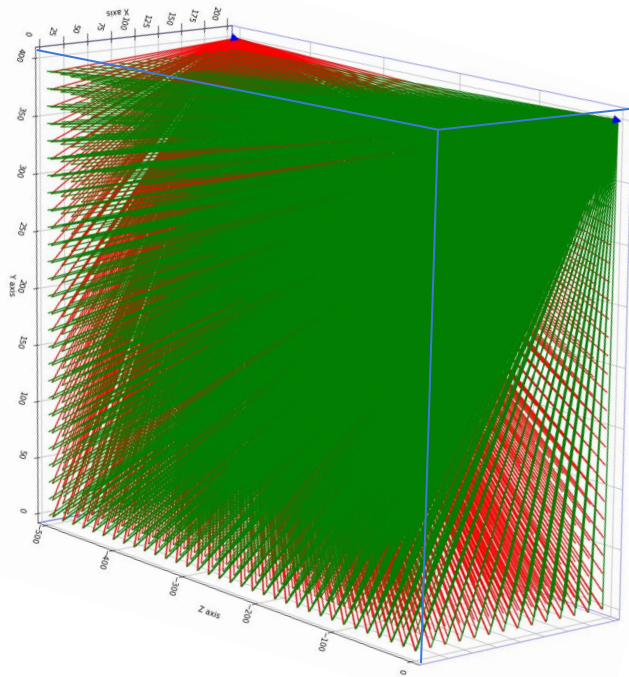
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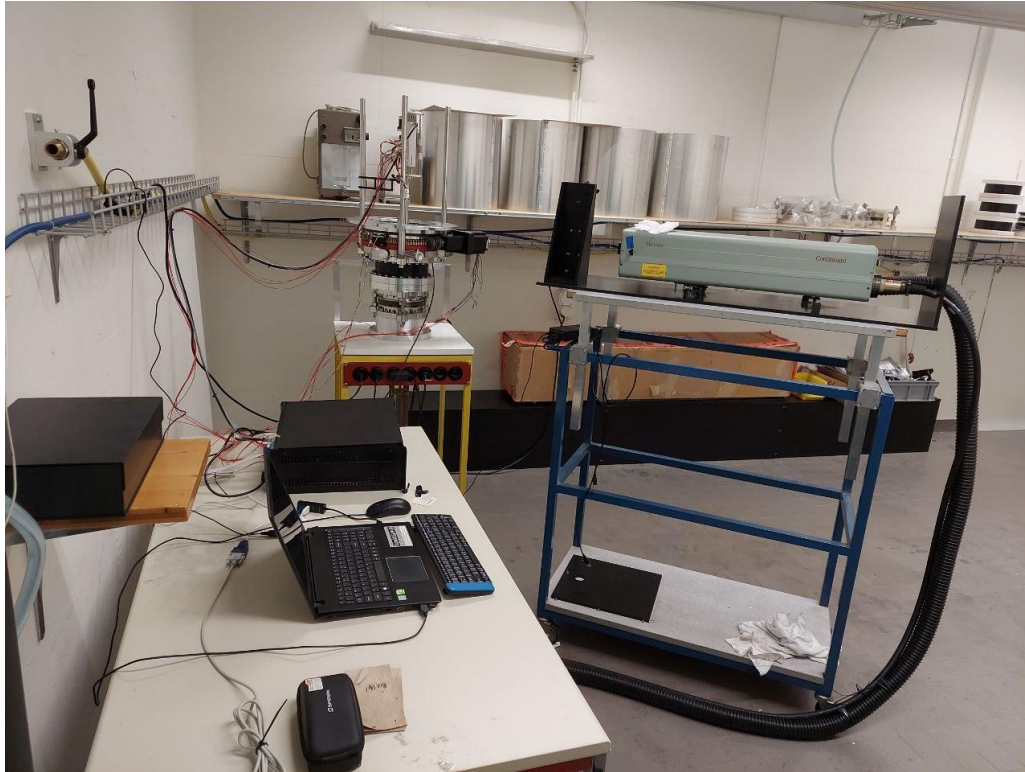




Expected Laser tracks in SBND Lar-TPC:



## Laser test facility at LHEP:



## Laser Accuracy test:

### Aim:

- To check the repeatability of laser points.
- Positional error.
- Directionality Influence. (Mechanical freedom)
- Software issues.

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## Vertical Movement:

All Points with same encoder position reading



## Horizontal movement:



Sorry for messy representation of laser marks...



## Laser Accuracy test:

### Aim:

- To check the repeatability of laser points and Positional error. ✓
- Directionality Influence. (Mechanical freedom) ✓
- Software issues. ✓



All Points with same encoder position reading

## Vertical Movement:



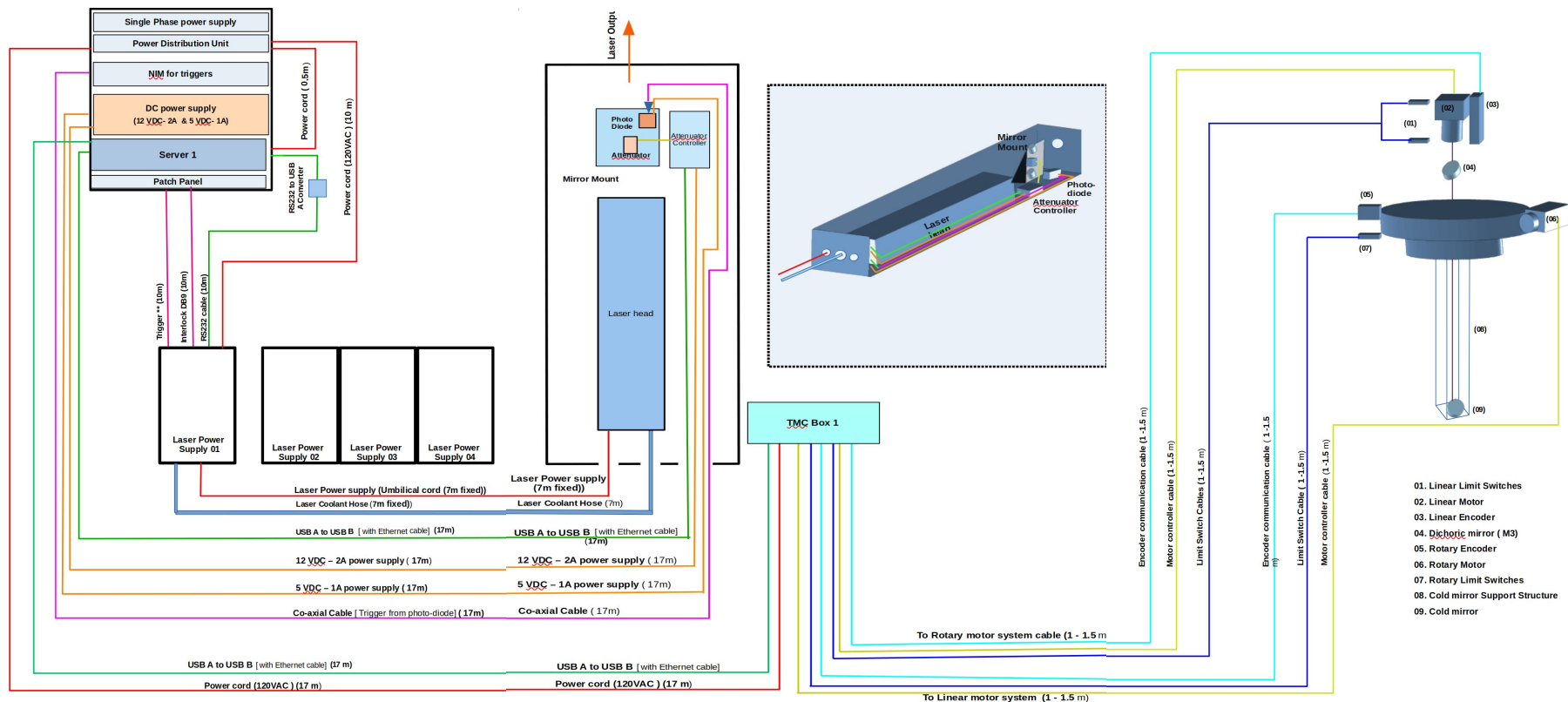
## Horizontal movement:



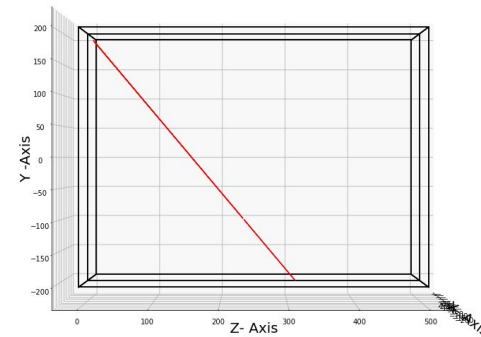
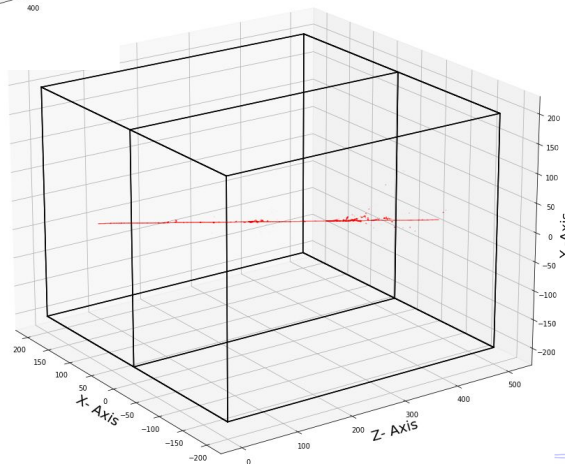
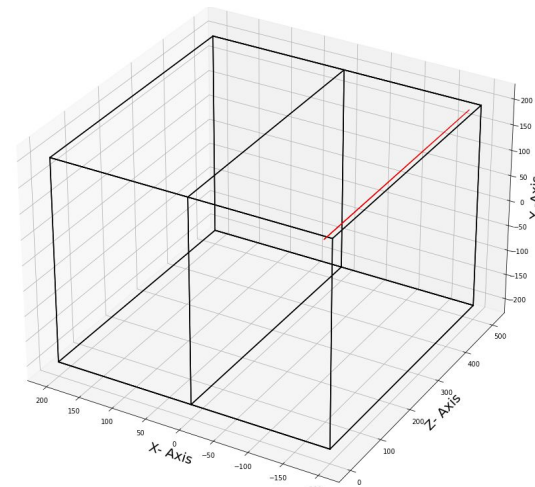
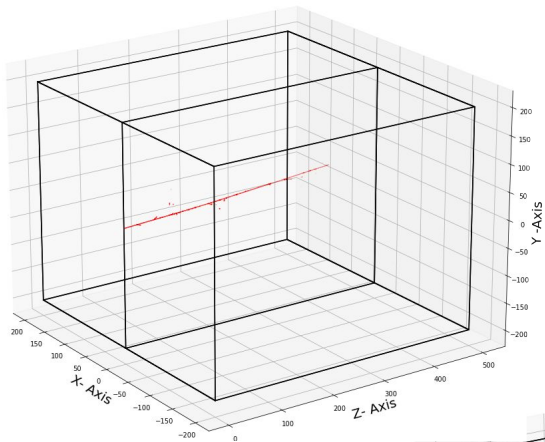
Sorry for messy representation of laser marks...



### Laser System, expected connection scheme:



# Laser Simulation:



Next..... ??????

- Simulation with Diffusion, SCE
- Reconstruction
- Cable production, Transportation.
- Laser Installation at Fermilab.

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**Thank You.....**