Calibration: Design Status

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Calibration Scope

Calibration of the ND LAr TPC with photoelectron laser that also includes calibration of the light readout system: calibrate position and charge throughout LAr TPC fiducial volume with precision better than 4 mm and energy resolution better than FD.

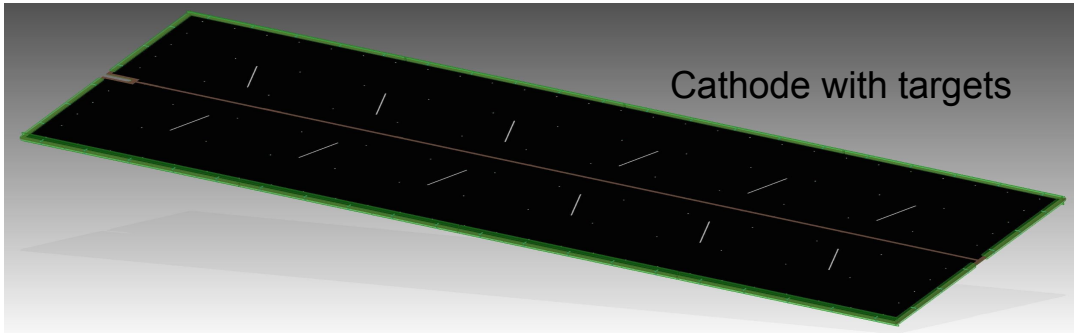
Calibration system is composed of the following parts:

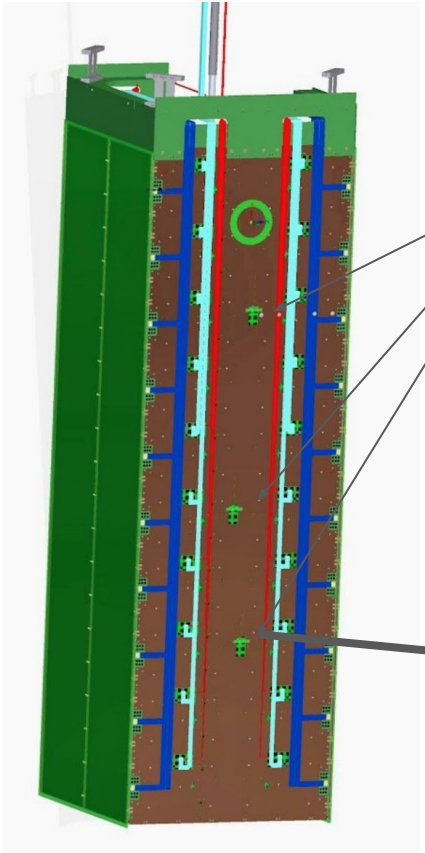
- Photoelectric targets on the cathode
- 266 nm Nd:Yag laser that provides light for target illumination
- Laser beam to optical fiber interface
- Multiplexer used to switch between fibers for light injection into different modules
- Optical fibers to guide light from multiplexer into cryostat and behind anode tile
- Light illumination via optical fibers through small holes in the anode plane

Scope table can be found at:

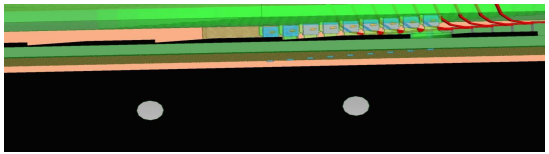
https://docs.google.com/spreadsheets/d/14UJ-33KGB6XQvI4PmmUwzkGBmTfmMh_QHRmioHTEeNg/edit?usp=sharing

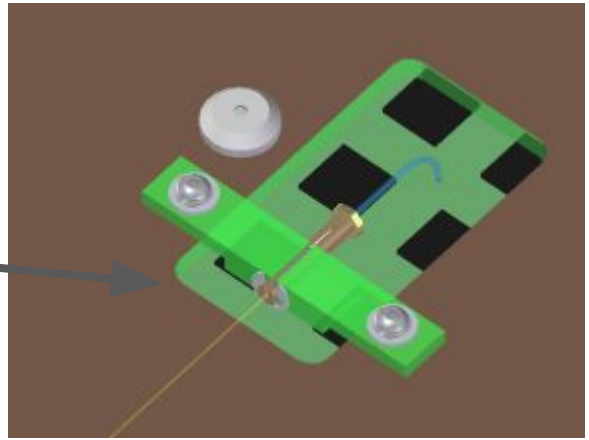
CAD drawings





Light injection locations





Scope table

Task/Item	Qty	Spares	Institutions	Funding Source	Funding Status	Detailed description
Laser	7	1	University of Hawaii	DUNE-US Project	Allocated	1 laser is allocated from R&D funds, but additional funds will be required for procurement of a spare laser
Laser safety enclosure box	7	0	University of Hawaii	DUNE-US Project	Not-allocated	Custom made box to enclose the beam
Powermeter	7	1	University of Hawaii	DUNE-US Project	Not-allocated	Commercial device used to monitor the pulse-to-pulse variation between laser pusles and overall power stability
Multiplexer	7	1	University of Hawaii	DUNE-US Project	Not-allocated	Multiplexer provides an interface between the laser/fiber and multple optical fibers leading to TPC module in sequential order. Available from a vendor.
Flanges	70	1	University of Hawaii	DUNE-US Project	Not-allocated	One flange with 3 optical feedthroughs for each side of each TPC module.
Quartz fibers (600 um core)	210	10	University of Hawaii	DUNE-US Project	Not-allocated	Quartz fiber 600 um (8 m long); 3 fibers per volume; 6 per module $47/m
Fiber holder	210	10	University of Hawaii	DUNE-US Project	Not-allocated	Custom-made holders to attach fibers inside TPC
Lenses and other optical elements	210	10	University of Hawaii	DUNE-US Project	Not-allocated	Focusing elements for laser beam - fiber interface
Photoelectric targets	10500	100	MSU	DUNE-US Project	Not-allocated	Photoelectric target design, production and assembly
Fiber routing between flange and TPC			MSU	DUNE-US Project	Not-allocated	Assembly
Wheel for fiber routing on TPC backplate	70	5	University of Hawaii/MSU	DUNE-US Project	Not-allocated	Desgin, fabrication and assembly
Assembly			University of Hawaii/MSU	DUNE-US Project	Not-allocated	Assembly
Packaging and Shipping			University of Hawaii/MSU	DUNE-US Project	Not-allocated	
Support during ND A&T			University of Hawaii/MSU	DUNE-US Project	Not-allocated	Technical/scientific support during TPC Module assembly and test program at the MATF, including travel.
Support during ND I&I			University of Hawaii/MSU	DUNE-US Project	Not-allocated	Technical/scientific support during TPC Module installation and integration at the DUNE Near Detector Sit including travel.

https://docs.google.com/spreadsheets/d/14UJ-33KGB6XQvI4PmmUwzkGBmTfmMh_QHRmioHTEeNg/edit?usp=sharing

Documents

Document	Status	Notes	Location
Requirements	Fairly developed	Needs update	Google drive
Manufacturing and Procurement	Immature	Technology selection dependent	EDMS
QA & QC	Immature	Basic information only	EDMS
Interface Charge Readout	Started/Immature	Target goals set, additional info pending	Google doc
Interface Light Readout	Started/Immature	Scope discussed, need to iterate	Google doc
Interface module structure	Started/Immature	CAD drawings exit, document needs to be compiled	N/A
Interface with cryostat	Lacking	Discussion initiated	N/A

Risk updates

Risk is described in detail in the risk registry document.

Some of the risk registry updates will be updated after calibration test run at SLAC single cube.

Prototyping plans

Run at SLAC Single Cube to:

- Establish quantum efficiency of the selected targets
- Verify whether the electron yield is sufficient to be registered by cold electronics
- Test laser - fiber interface
- Test operation and light distribution in LAr
- Addition of the radioactive targets for the extended scope study

Prototyping Plan Status

Expect to run the tests at SLAC Single Cube after the current test of the field cage are complete (approximately end of January)

In the meantime:

- Testing various photoelectric targets from MSU and made in-house in vacuum with 266 nm light: different materials, surface treatment, angles of illumination
- Manufacture targets attached to cathode + metalized cathodes for test
- Developing laser box for laser-fiber interface
- Investigation of the efficient light injection and R&D how to overcome, sparking, burning and damage to the fiber tip when focusing laser beam to fiber tip at full power
- Developed fiber holder for the SLAC CUBE
- Investigation of the quartz rods for the fiber-quartz rod interface
- Testing for light losses due to efficiency of light injection in the fiber, attenuation losses in the fiber, losses through flange, etc.
- Ordering parts in preparation for the SLAC CUBE (laser box partially assembled, laser ordered, fibers to be ordered)