Calibrating the world's largest LArTPC detector Mattia Fanì - Los Alamos National Laboratory

on behalf of the DUNE Collaboration

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The Deep Underground Neutrino Experiment

The next generation long-baseline experiment for neutrino physics

• An ambitious scientific programme:

- Measure δ_{CP} (probe matter-antimatter asymmetry)
- Neutrino mass hierarchy
- Supernovae and solar physics
- Nucleon decay
- BSM searches



The two ProtoDUNE detectors (770 tons each) are the largest LAr-TPCs ever built A single DUNE-FD module will be 20 times larger than one **ProtoDUNE detector**



— EST.1943 —

Calibrating DUNE

• Top-level calibration requirements for the physics goals:

- GeV-scale oscillation physics: energy scale uncertainty < 2% for leptons and 5% for hadrons
- MeV-scale low-energy physics e.g. supernovae, solar: energy scale uncertainty < 5%
- Calibration challenges for DUNE
 - Stringent physics requirements
 - Deep underground location, low stats for cosmic rays
 - Challenge due to huge size
 - Highly segmented detector: 4 drift volumes, hundreds of cathode/anode planes, etc

Getting outstanding performances from a huge-size detector for ambitious physics goals



Dedicated calibration systems are needed





Calibration systems for DUNE Far Detector

Introducing the DUNE Ionisation Laser System

- Calibration systems:
 - **Radioactive sources**
 - 9 MeV gamma rays
 - **Pulsed Neutron Source**
 - 6 MeV gamma rays from capture (see talks of **Y. Bezawada** and **J. Huang**)
 - Ionisation Laser System
 - Multi-purpose calibration system
 - Provides an independent fine-grained measurement of detector parameters e.g. drift velocity, electric field
 - Diagnose the detector e.g. tilts/shifts of anode and cathode, high voltage issues
 - Planning for multiple laser systems on DUNE with ~15 m spacing
 - Two designs planned to avoid shadowing from detector components: field cage (FC) profiles, I-beams, resistor plates etc.
 - For the central ports, field cage penetration is planned for improved coverage



A top view of one DUNE-FD module





DUNE-IoLS - The DUNE Ionisation Laser System

An overview of the hardware design

• The system is composed of:

- One laser system, with a laser (Nd:YAG, 266 nm) and a laser box, including an optical bench
- One optical feedthrough and periscope system, required to drive the laser light inside the liquid argon volume
- A laser beam location system will independently verify the beam position uncertainty requirement of 5 mm over 10 m distance requirement for precision









DUNE-IoLS - The DUNE Ionisation Laser System

An overview of the hardware design



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Laser coverage of DUNE

Laser coverage simulations are actively ongoing to optimise the laser system design and distribution of lasers on most realistic scenarios





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Thank you for your attention



