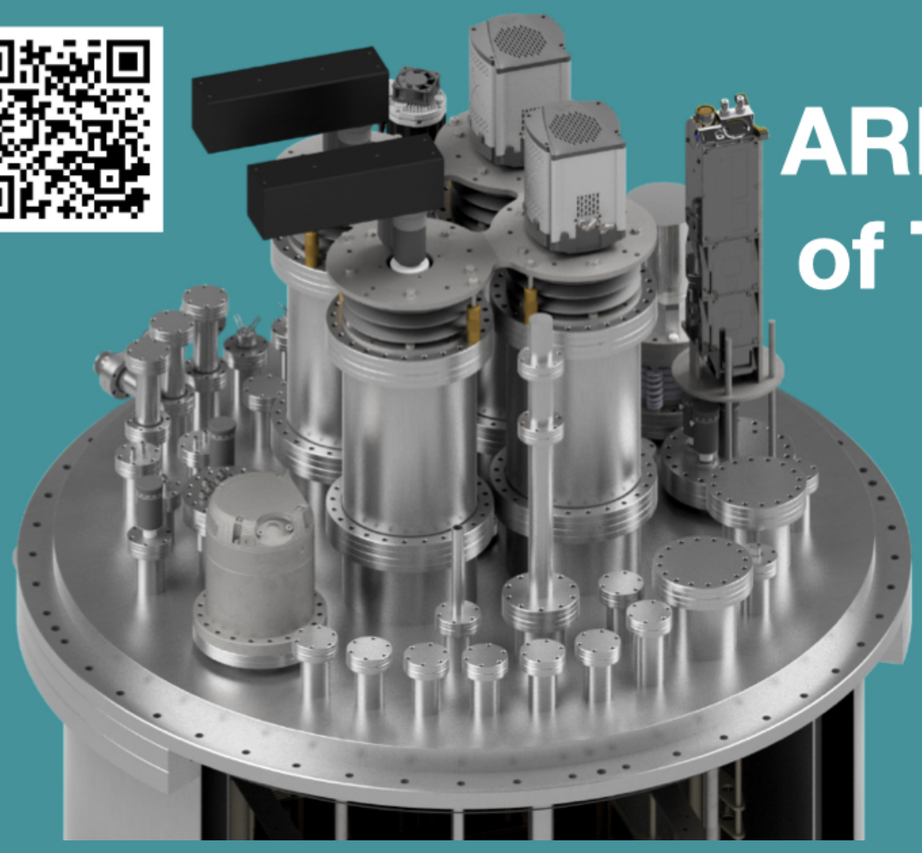

ARIADNE$^+$: Large-scale demonstration of TimePix3 optical readout with novel glassTHGEMs in a LArTPC at the CERN Neutrino Platform

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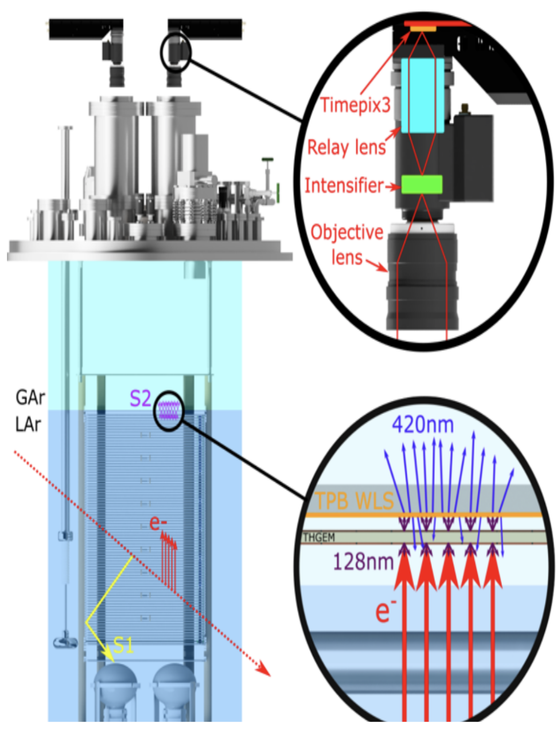
ARIADNE

UNIVERSITY OF LIVERPOOL

Detection Principle

The ARIADNE program aims to demonstrate optical readout as a viable alternative to charge readout for single/dual-phase TPCs. The benefits of ARIADNE technology could have a profound impact on proposed kiloton-scale neutrino detectors, such as the Deep Underground Neutrino Experiment (DUNE). The method for optical readout is as follows:

- Incoming particles ionise argon and create prompt scintillation light (S1)
- Electrons drift towards extraction grid situated above the liquid level
- A Thick Gaseous Electron Multiplier (THGEM) amplifies drift charge generating secondary light (S2)
- Wavelength shifting before imaging with Timepix 3 camera

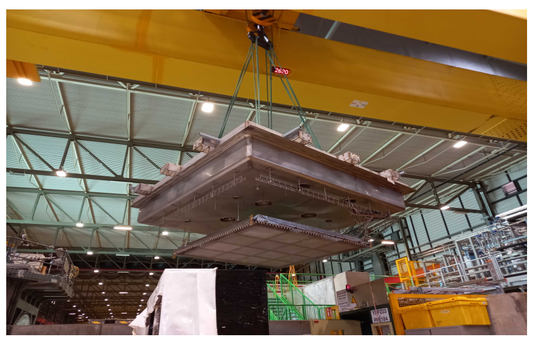


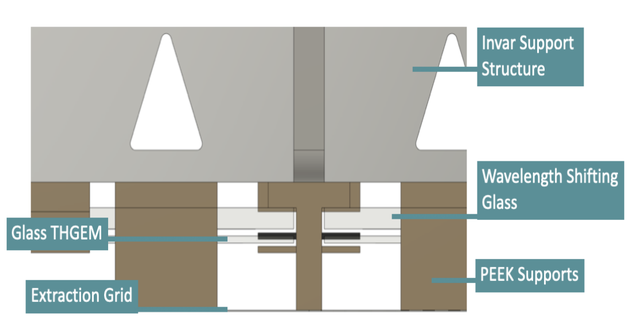
The ARIADNE Advantage

- High resolution (1.3 mm per pixel in ARIADNE)
- Raw data is natively 3D
- Easy access for swapping in/out technology
- Large readout rates
- Low energy sensitivity (100s of photons per ionised electron)
- Money saved from eliminating the need for preamps, digitisers etc.

The ARIADNE+ Detector

Based at the CERN Neutrino Platform is a 15 tonne LAr TPC that hosted the ARIADNE+ 2.3 x 2.3 m Light Readout Plane (LRP). The LRP was imaged using four Timepix 3 cameras; 3 imaging visible light and 1 Vaccum Ultraviolet (VUV) [1].





[1] https://cds.cern.ch/record/2739360?ln=en

Innovations within ARIADNE+

Not only does ARIADNE+ aim to demonstrate optical readout technology's potential for kiloton-scale detectors such as DUNE. The detector saw a number of TPC firsts including:

- Commonly used FR4 THGEMs were replaced with 16, Liverpool Patent Pending, glass THGEMs, made using an abrasive process produces 'hourglass' holes that collect charge over time and therefore increase light output

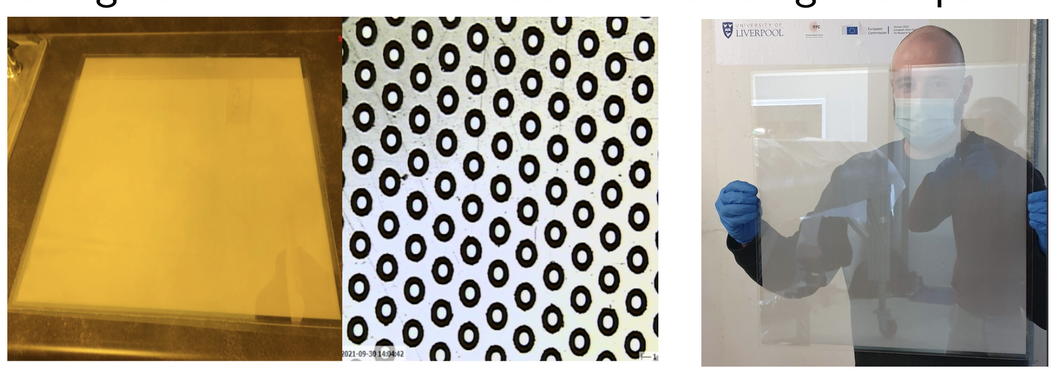
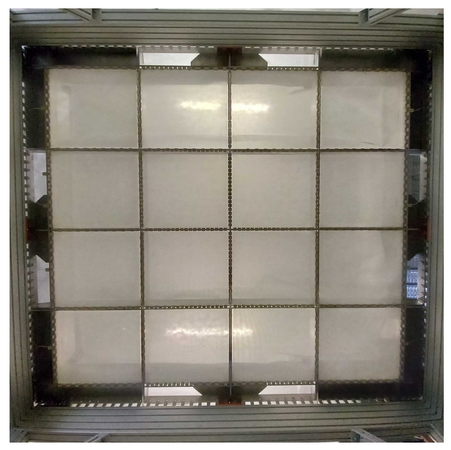


Figure: 50 cm glass THGEM and hole pattern (Left) A glass THGEM before installation at CERN (Right).

- VUV intensifier - imaging the THGEM directly without the need for any WLS
- Invar support structure - Uniquely low coefficient of thermal expansion, ideal for reducing stress on glass THGEMs and WLS

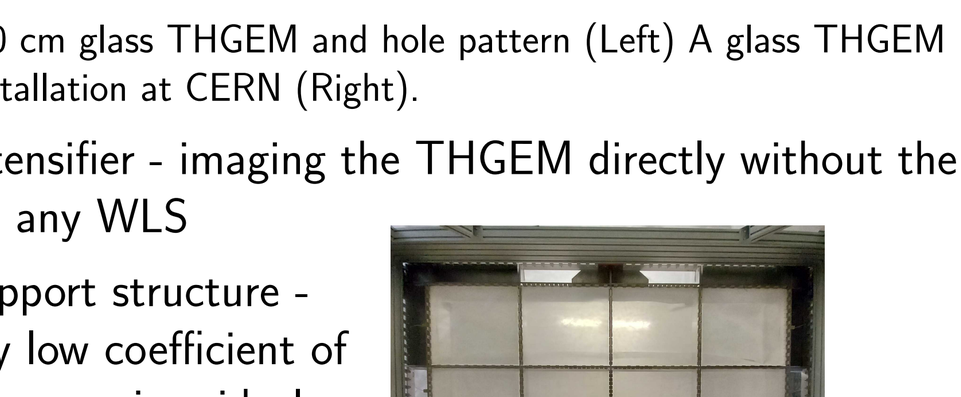


Preliminary Analysis

Looking at events that passed through the THGEMs and the majority of the TPC drift length (20 cm):

-Energy conversion: 199.10±1.73 ADU/MeV

-Energy resolution: 16.73±0.16%



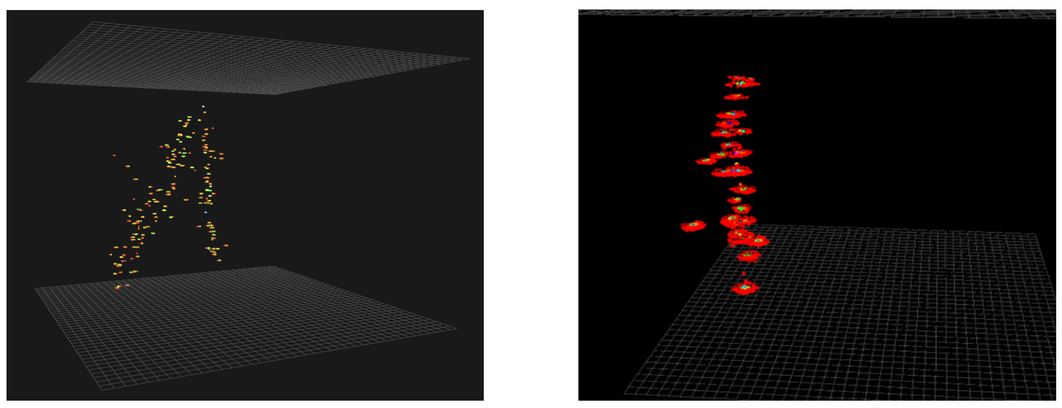


Figure: Visible light event (Left) and VUV light event (Right)