Xenoscope: a full-scale vertical demonstrator for DARWIN

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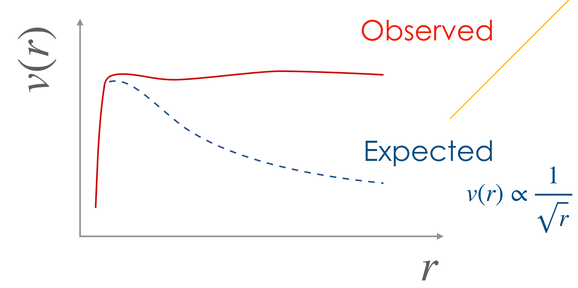
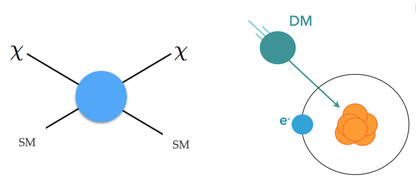
Dark matter direct detection

Evidence

Direct detection on Earth

Exemplary rotation speed curve of an arbitrary galaxy

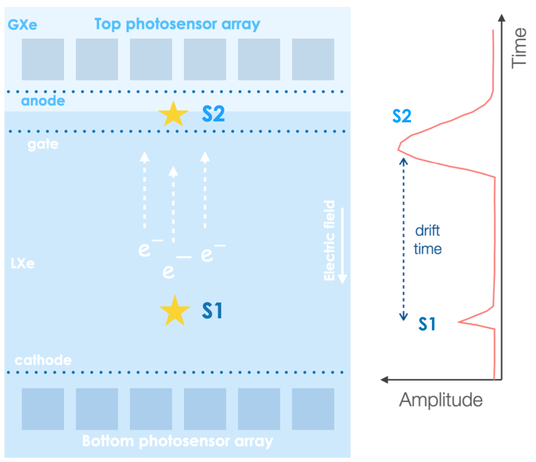




- Direct dark matter detection experiments aim to detect **W**eakly **I**nteracting **M**assive **P**articles (WIMPs) via nuclear recoils caused by WIMP-nucleus elastic scattering in an Earth-bound detector

The detection technology:

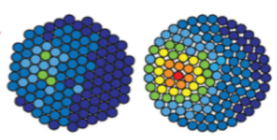
Dual-phase Time Projection Chamber (TPC)



- Prompt scintillation signal (**S1**)
- Delayed secondary signal from ionisation electrons (**S2**)
- Energy determination

$$E \propto W \cdot \left(n_\gamma + n_{e^-}\right)$$

- x - y from **S2** hit pattern
- z from **S1-S2** time delay

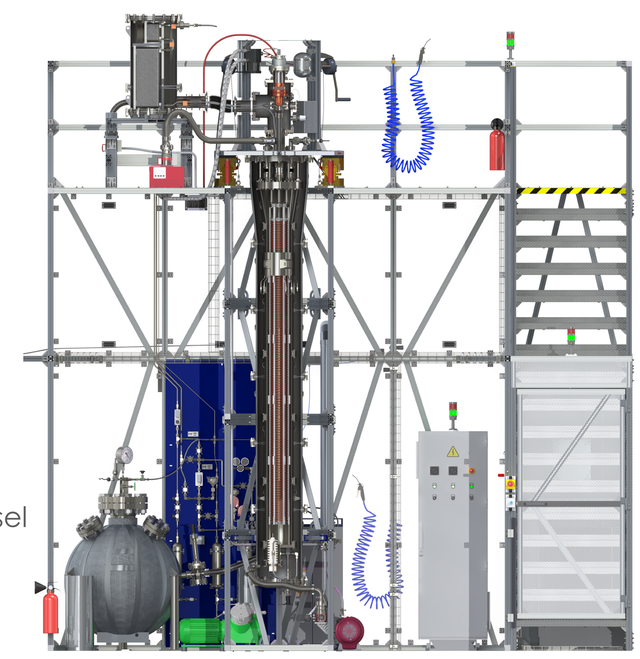


The Xenoscope R&D platform

Proof of principle of **electron drift** over **2.6 m** LXe. To achieve this goal, the system requires:

- Excellent Xe purification system
- Efficient High-Voltage system
- Electric field uniformity

R&D opportunities:
- Custom-made HV distribution
- Electron cloud diffusion
- Light attenuation measurements
- Test of various light sensors

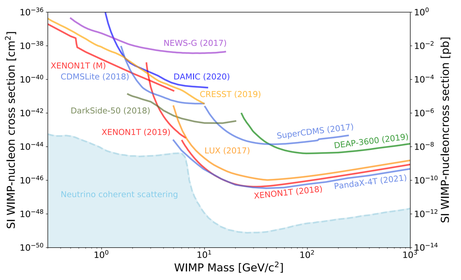


Measurement campaign in 2 stages

Phase one: 0.53 m Purity monitor → Spring 2022

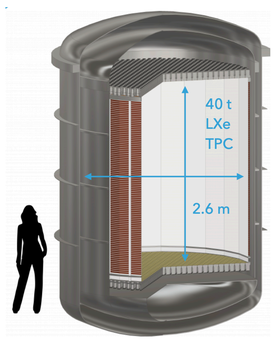
Phase two: 2.6 m Dual-phase TPC → 2023

The future DARWIN observatory



- Proposed next generation **dark matter detector**
- Search for WIMPs with unprecedented sensitivity [1]
- Dual-phase TPC: 2.6 m Ø, 2.6 m height
- **50 t** of Liquid Xenon (LXe)

Supernova neutrinos | Direct dark matter searches | Low-energy solar neutrinos | Coherent neutrino nucleus scattering | DARWIN | Neutrinoless double beta decay ^{136}Xe | Galactic ALPS dark photons | Solar axions



Multi-tonne scale LXe TPCs require R&D test platforms

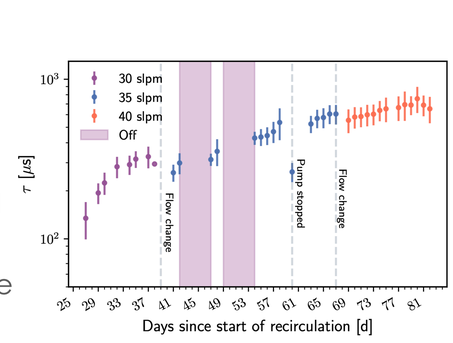
- **Full-scale vertical demonstrator at UZH [2]**
- Full-scale horizontal demonstrator at Uni Freiburg

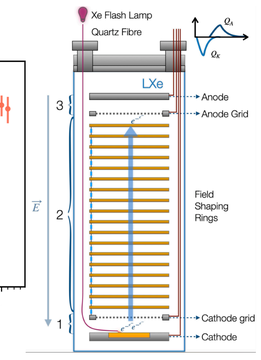
Goal: Test full-size detector subsystems under real conditions in LXe

First results from the purity monitor

Goal: Investigate the LXe purity as a function of the recirculation speed

- Drift length: 0.53 m
- Pulsed xenon flash lamp
- Charge readout on top (Q_A) and bottom (Q_C)
- Ratio of signals proportional to the e-lifetime τ_e

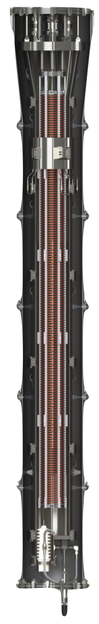




$$\frac{Q_A}{Q_C} = e^{-t_d/\tau_e} \qquad \tau_e > (660 \pm 50)\ \mu s$$

PM was successfully operated under stable conditions for more than 70 days

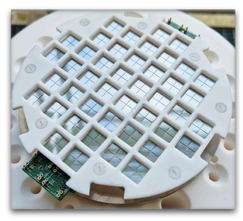
Towards a 2.6 m TPC at UZH



For the following phase the PM will be converted to a dual-phase xenon TPC. Three major upgrades will be implemented:

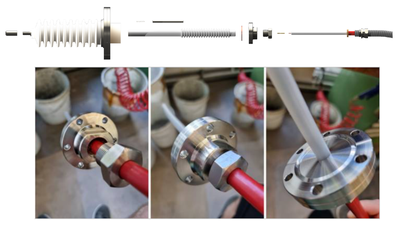
SiPM array

For light signals readout



High-voltage system

Generation and transmission of nominal voltage



Liquid gas interface and level control

Real-time monitoring and setting of the liquid level

Stay tuned for upcoming results!

References:
[1] DARWIN collaboration, J. Aalbers et al., DARWIN: towards the ultimate dark matter detector, JCAP 11 (2016) 017.
[2] L. Baudis et al., Design and construction of Xenoscope – a full-scale vertical demonstrator for the DARWIN observatory, JINST 16 (2021) P08052.

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DARWIN darwin-observatory.org

Would you like to know more?

Come and join the effort!

SCAN ME

UZH Baudis Group