

Large Electron Multiplier Time Projection Chamber for direct Dark Matter search

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Direct Dark Matter search

- Direct search means that the Weakly Interacting Massive Particles (WIMPs) interact in the detector.
- The detector is a (sensitive) target of ordinary matter.
- The signal is the recoil of a target nucleus induced by the elastic scattering of the WIMP.
 - Small energy released in the detector.
 - Small interaction rates.
 - Suppression/rejection of background.

Target: argon (liquid)

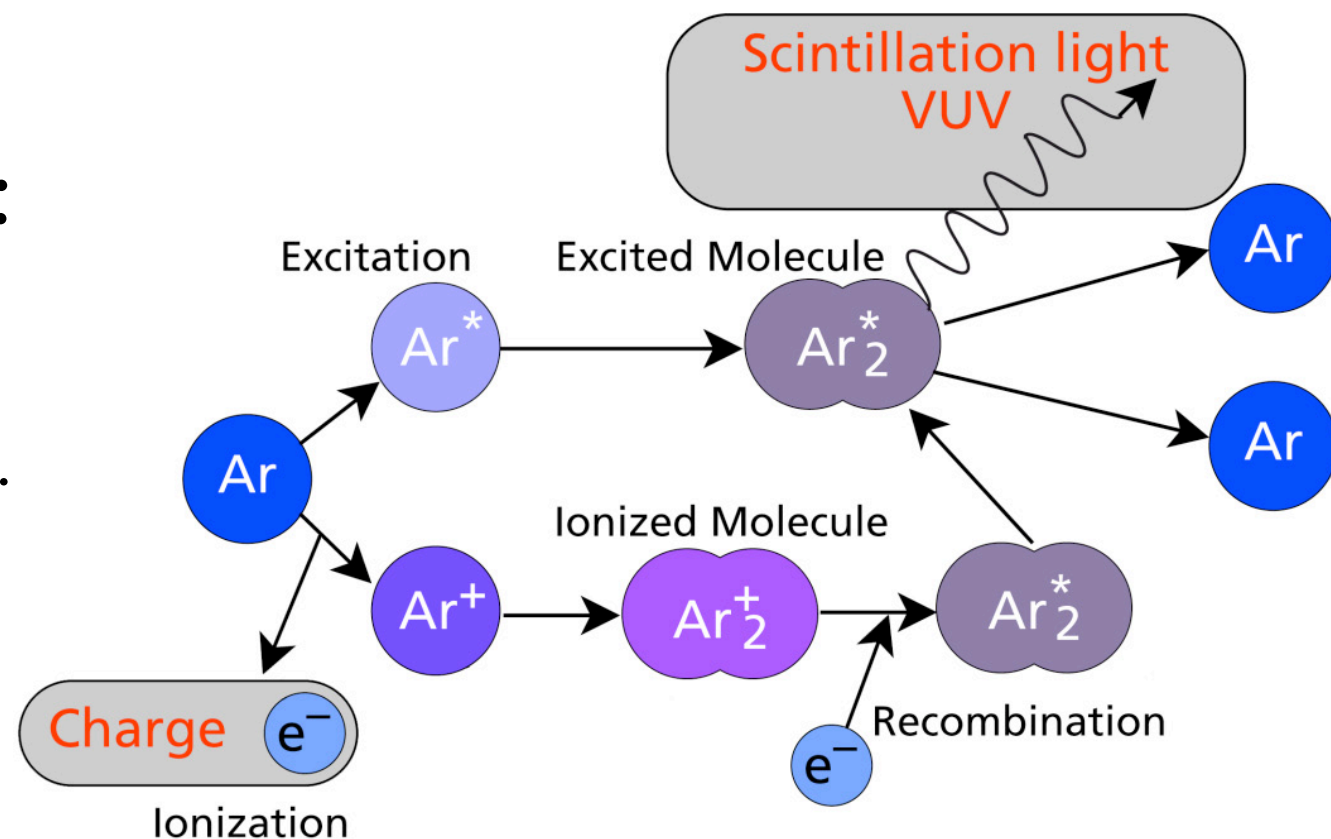
- WIMPs (elastic) scatter on argon nuclei.
- Nuclear recoils (<200 keV) excite and ionize surrounding argon atoms.

- Detection of scintillation light:

- VUV 128 nm photons.
- Wavelength shifter converts to visible light.
- PMTs.

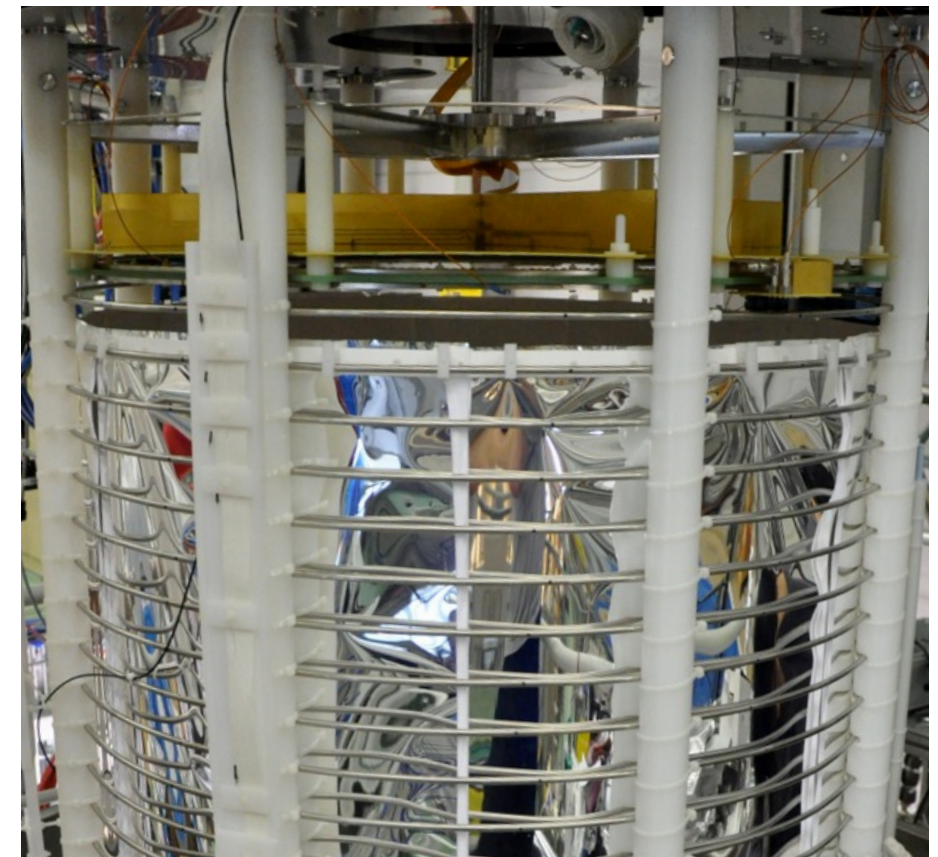
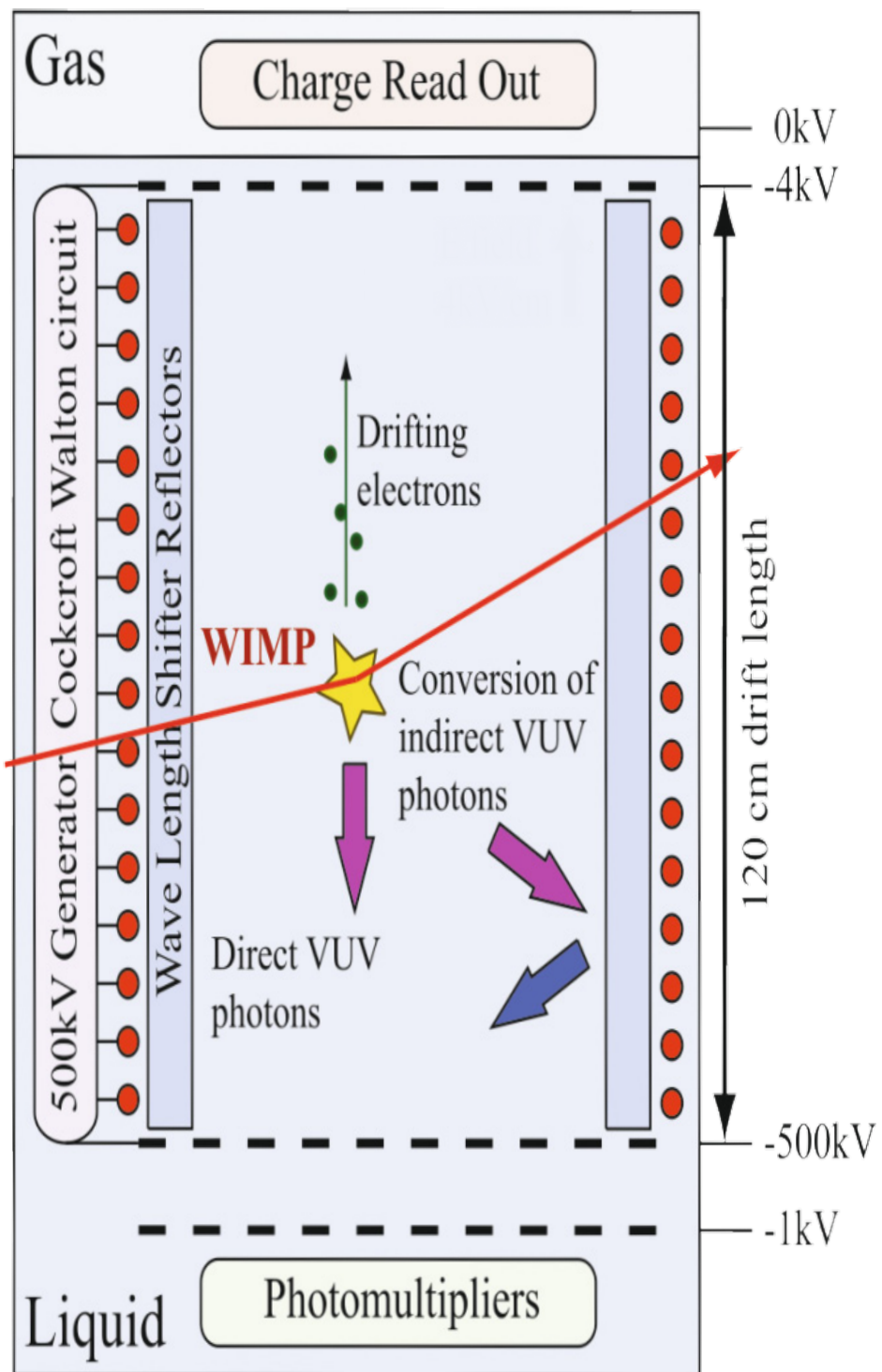
- Detection of ionized charge:

- e^- are drifted towards the liquid/vapor interface.
- The charge is extracted to the vapor phase.
- The charge is **amplified** and readout.



Argon Dark Matter (ArDM)

Ton scale detector under construction at CERN



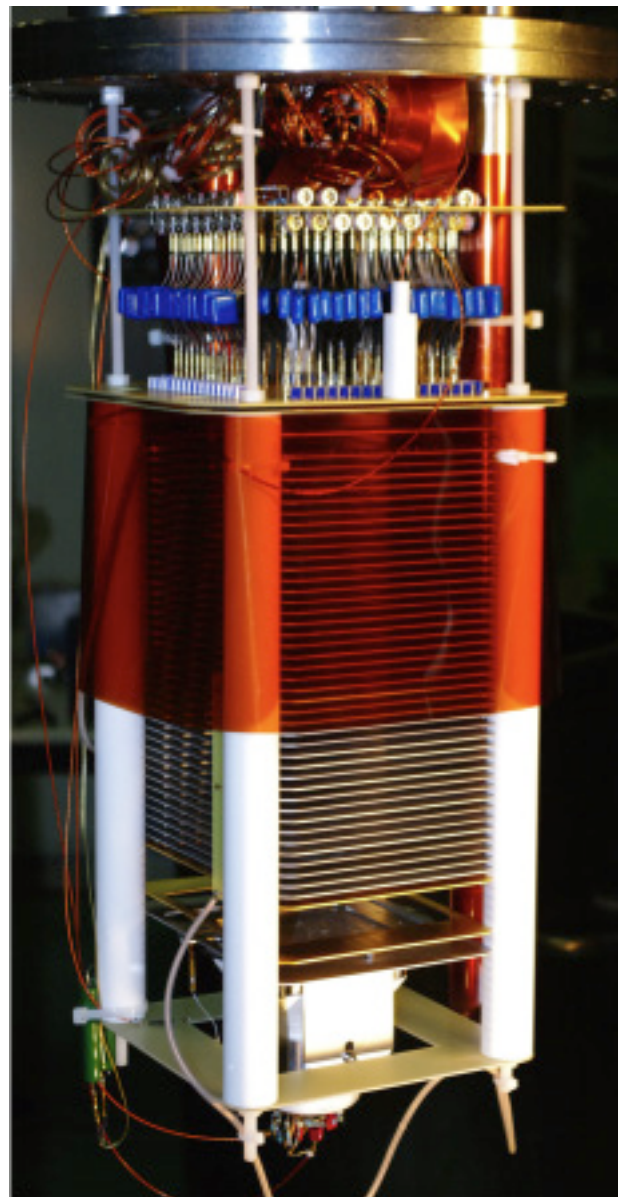
Charge readout prototype

Large Electron Multiplier (LEM)

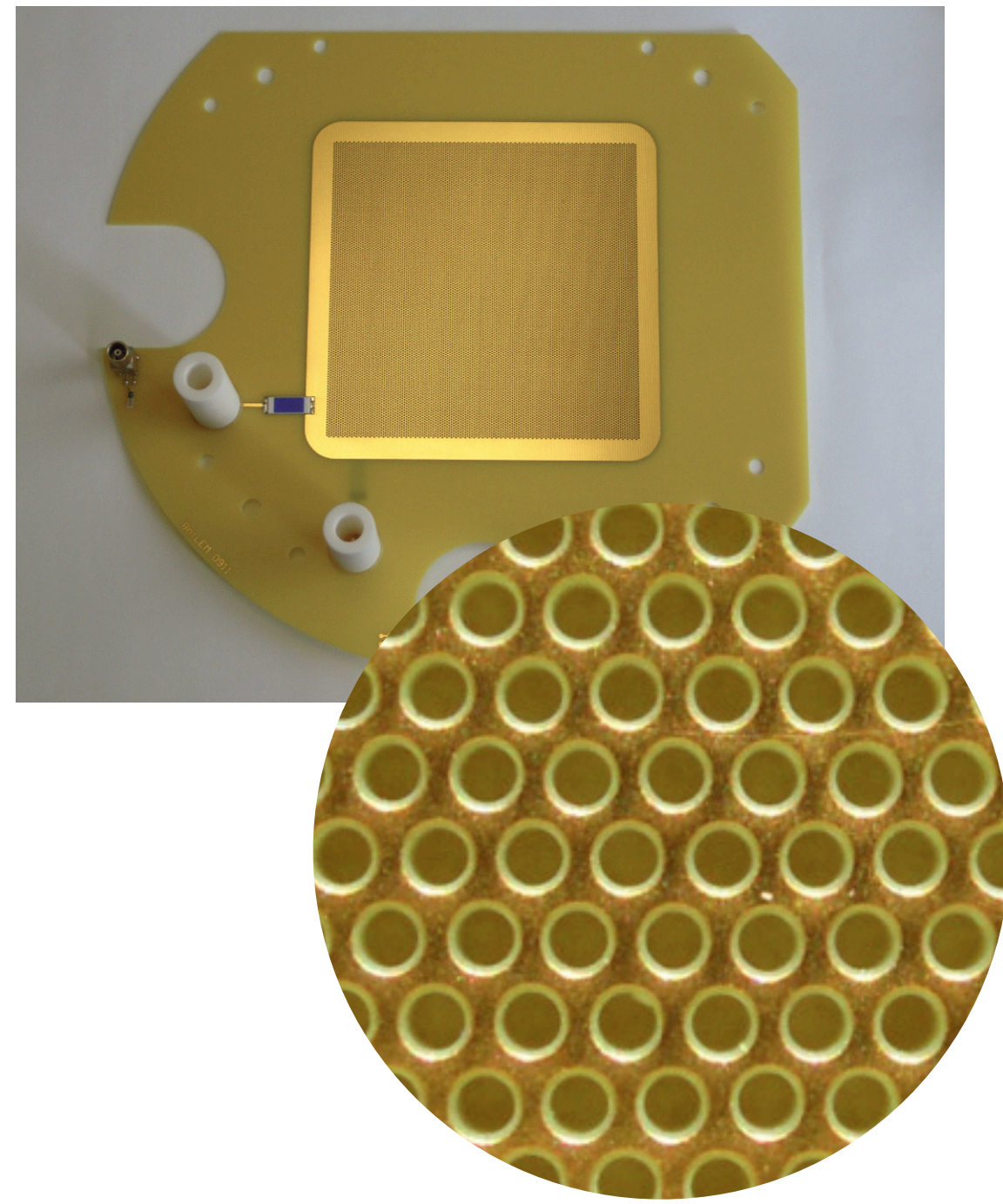
Setup



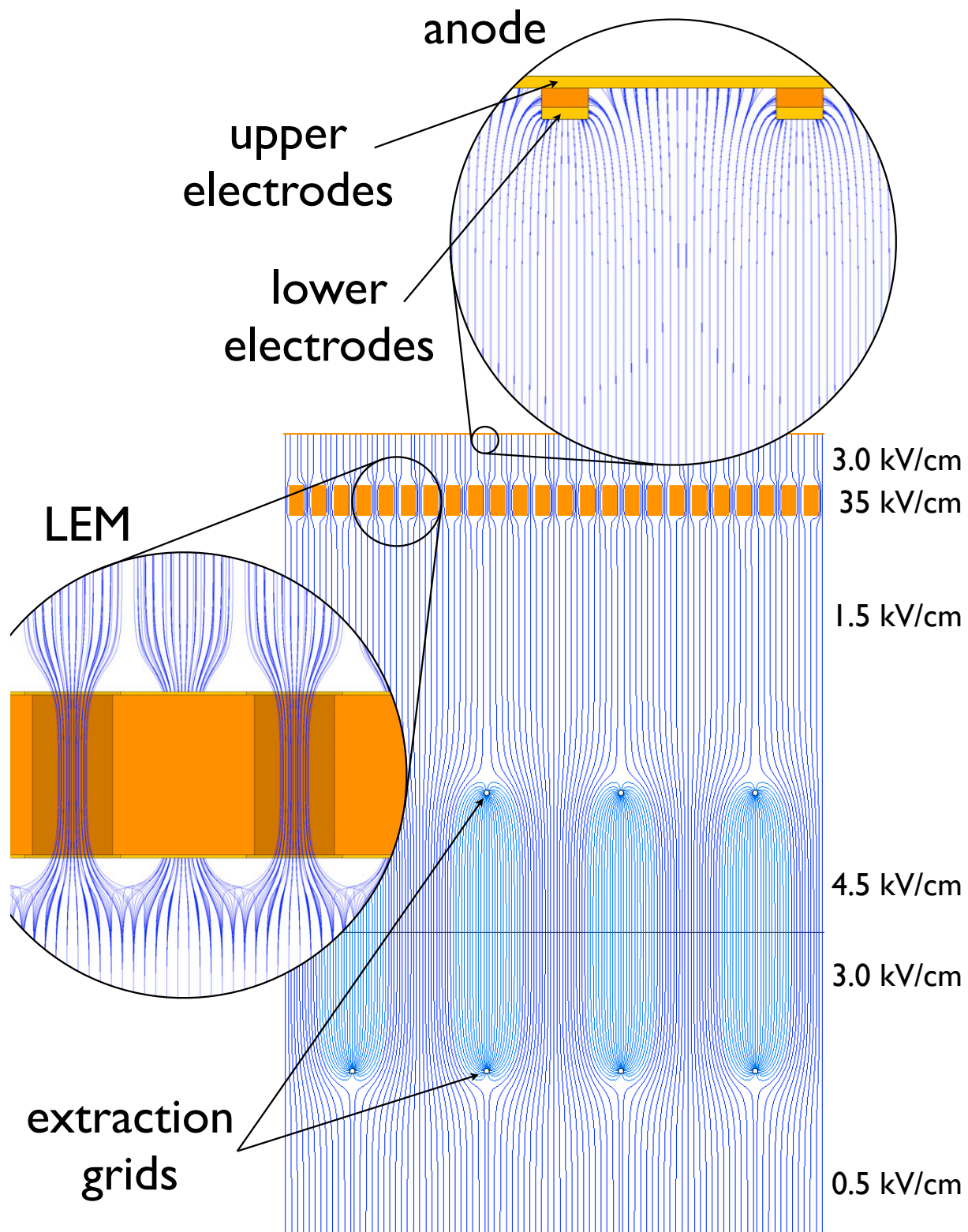
Detector



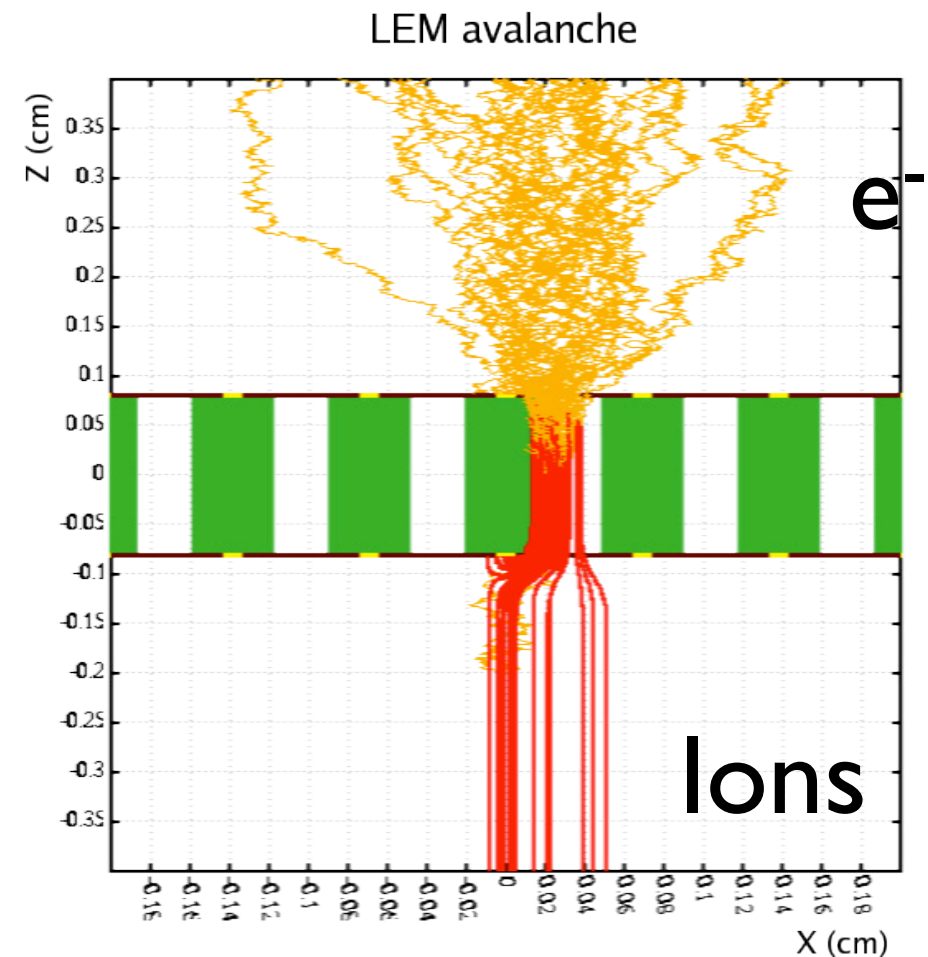
LEM



Argon LEM-TPC



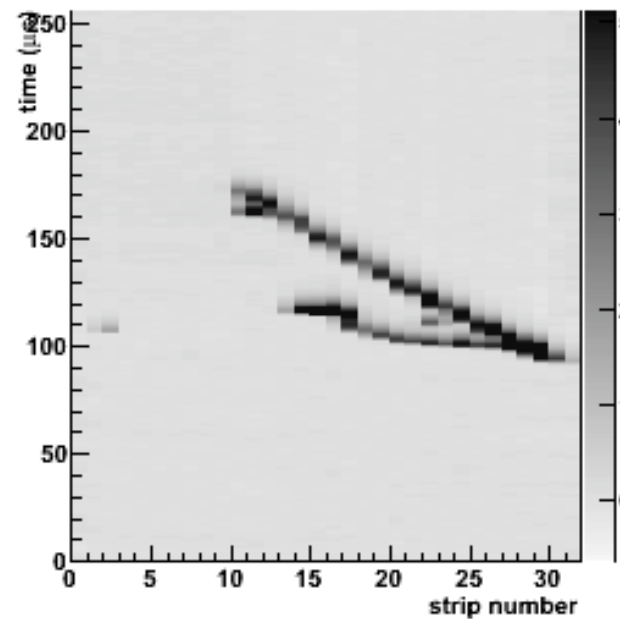
- e^- drift up to the liquid argon surface.
- e^- are extracted to the vapor phase.
- e^- are focused into the LEM holes.
- Townsend avalanche occurs in high electric field region (between two collision e^- gain enough energy to ionize argon atoms).



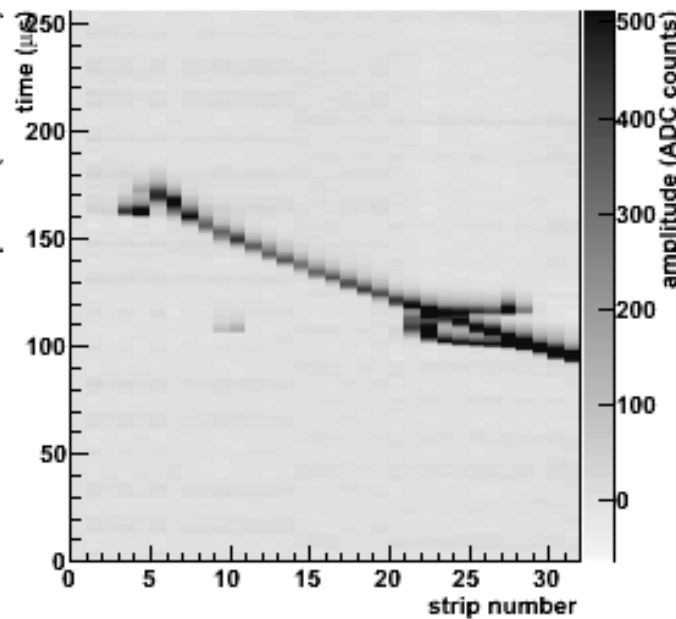
Muon events

Gain 27

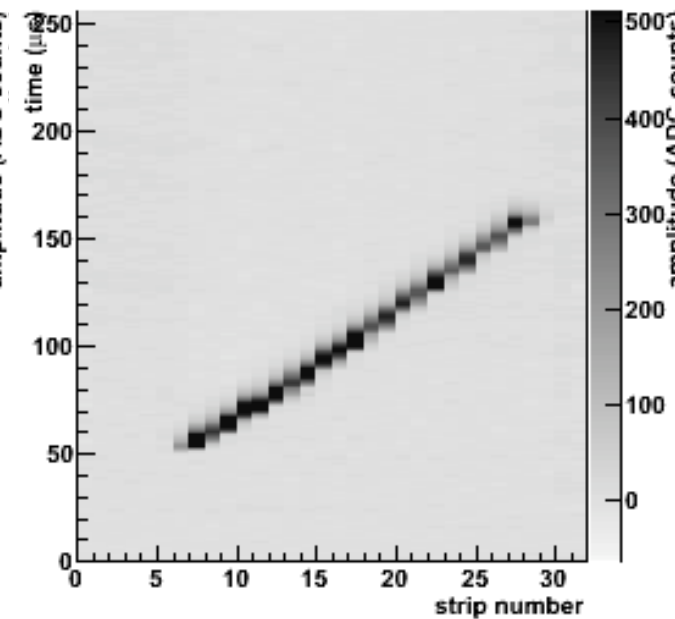
xView event display (event 1898)



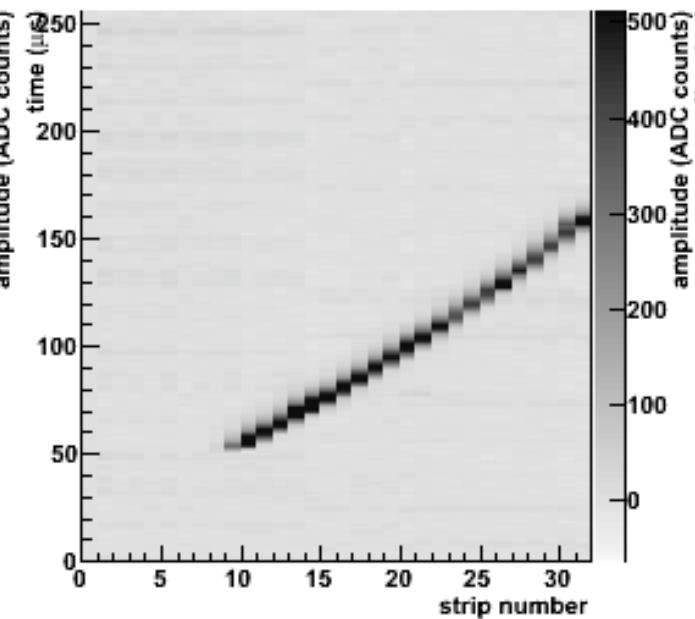
yView event display (event 1898)



xView event display (event 1765)

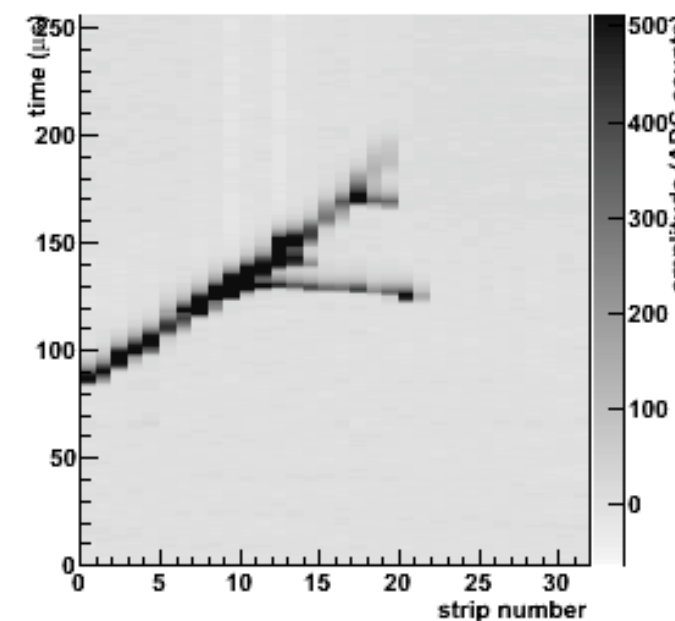


yView event display (event 1765)

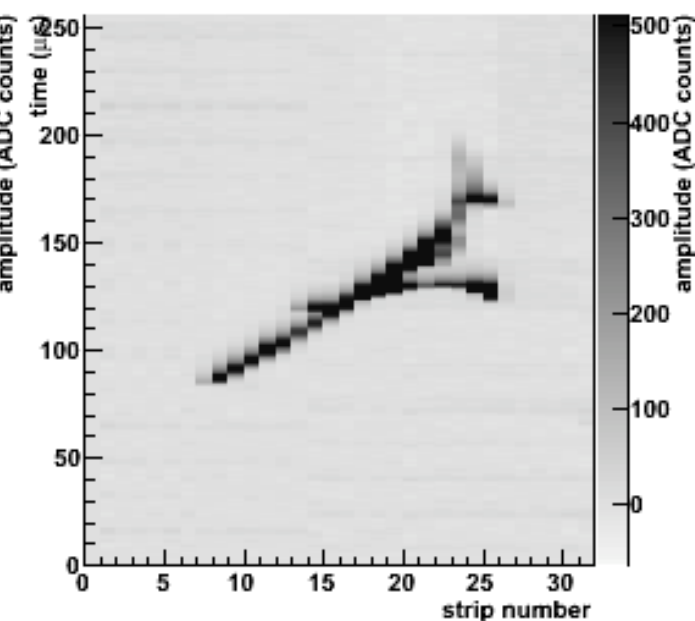


- Needed gains > 100 -500.
- The strategy is to use a double stage of amplification.
- Lower gains are interested for other research fields.

xView event display (event 1702)



yView event display (event 1702)



Argon as active medium

- Extensive experience as detector medium (neutrino experiments).
- Large volumes (sensitivity and self shielding).
- Event rate less sensitive to energy threshold than heavier noble gases.
- Cheap gas and easy to handle and purify.
- β/γ background rejection (scintillation PSD and charge/light).
- n background rejection (TPC: topology of the event).
- ^{39}Ar (β -active isotope, $T=268$ y, $Q=565$ keV, ~ 1 Hz/kg in natural argon).
- Enough background rejection power?
- Argon depleted of ^{39}Ar from underground wells.

