Status and plans with 6m^3 at CERN

A. Marchionni, ETHZ

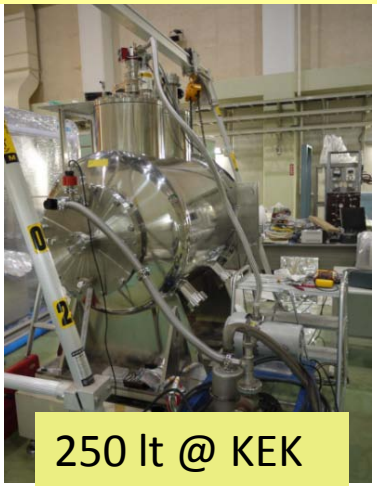
GLA2011, Jyväskylä, Finland, June 2011

- **Towards a m^2 scale readout of a double-phase LAr TPC**
  - Large Electron Multipliers, Micromegas,…
  - the building block of larger size detectors
- **Test beam exposure of a Liquid Argon TPC Detector at the CERN SPS North Area**
  - 0.5-5 GeV/c beam
- **Conclusions**

GLACIER Roadmap

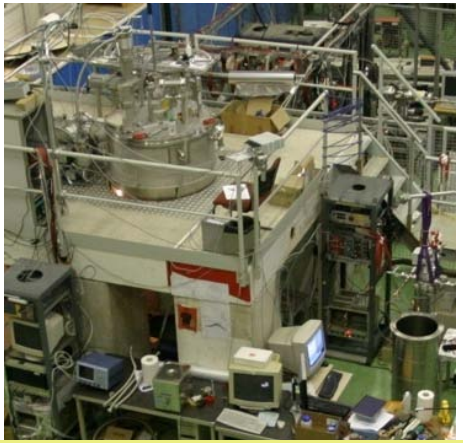
@ CERN

small test setups for readout devices, electronics



250 lt @ KEK

low energy K test beam @ J-PARC

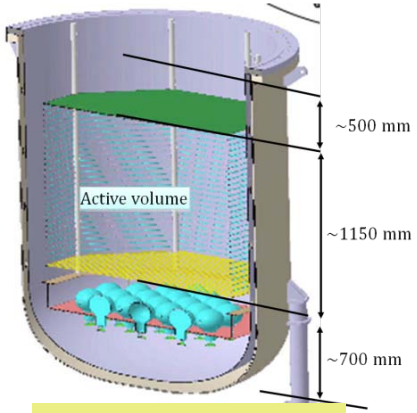


ArDM (RE18), presently @ CERN

1 ton LAr, Cockroft-Walton, LAr recirculation and purification, industrial electronics, safety, optimized for dark matter searches, in operation

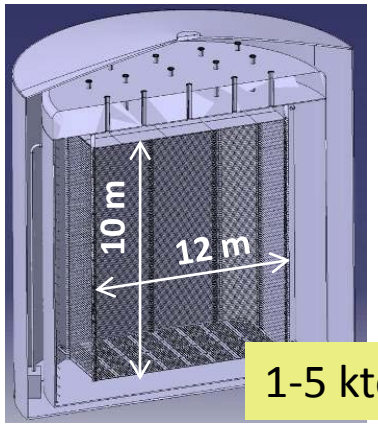
ArgonTube@ Bern

5 m drift, 0.4 ton under assembly



6 m^3 @ CERN

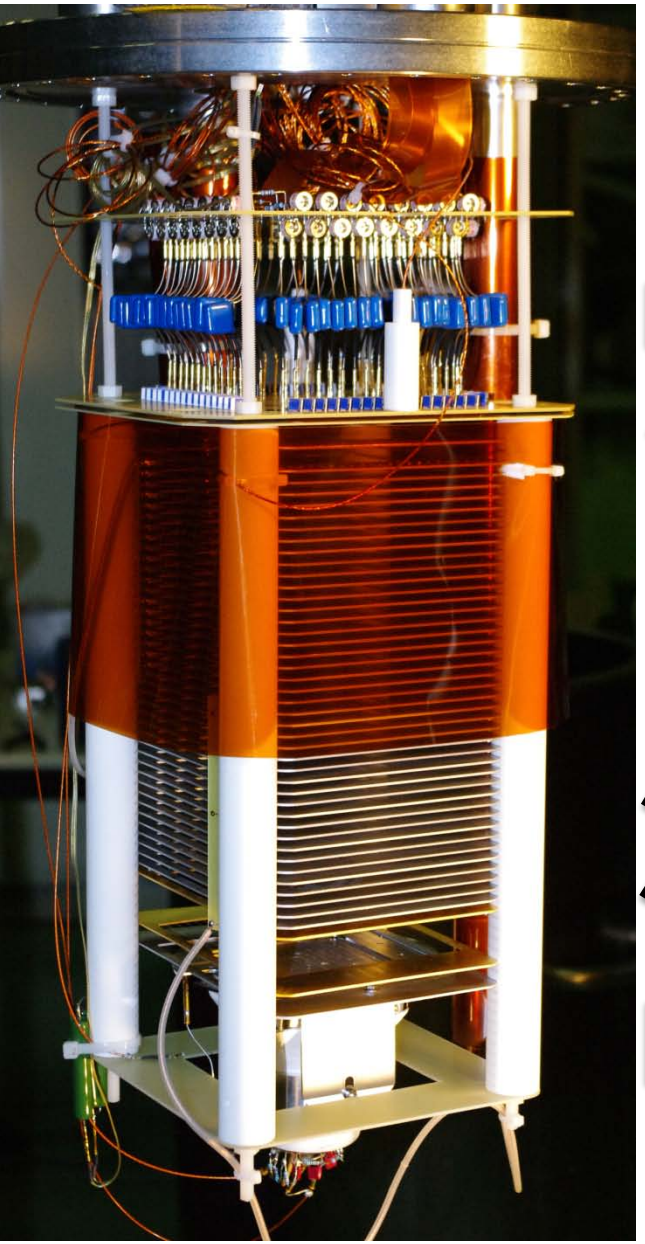
to be proposed for test beams in NA @ CERN

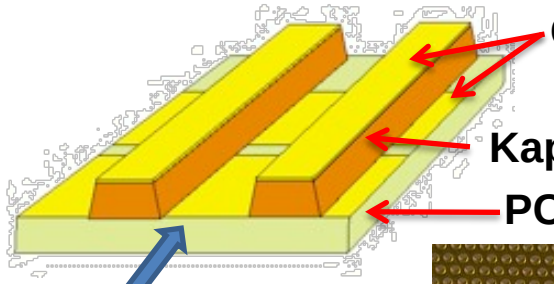


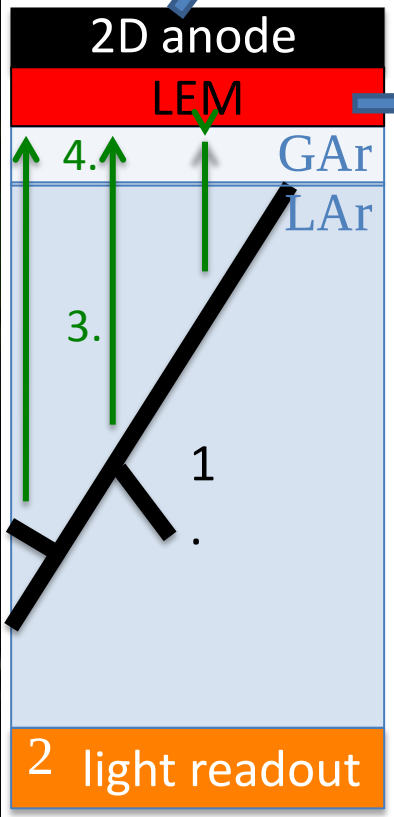
1-5 kton

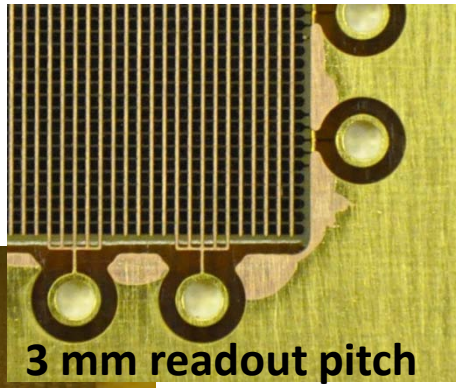
full engineering demonstrator for larger detectors + physics

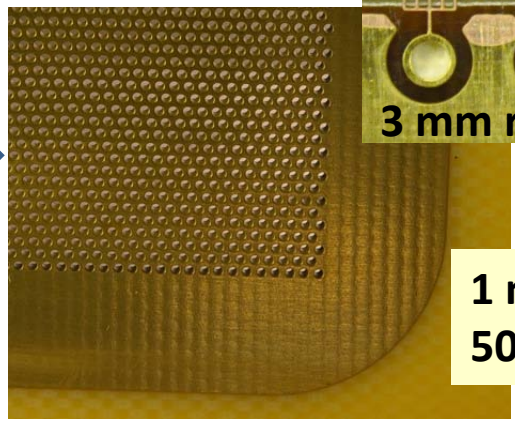
Charge readout in double phase



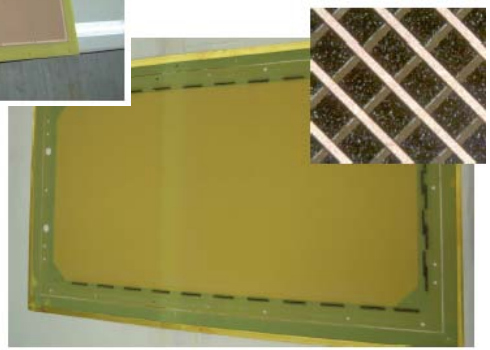








40x76 cm^2
Largest ever constructed



A. Badertscher et al., NIM A641 (2011) 48

Test beam exposure of a Liquid Argon TPC Detector at the CERN SPS North Area Abstract #82

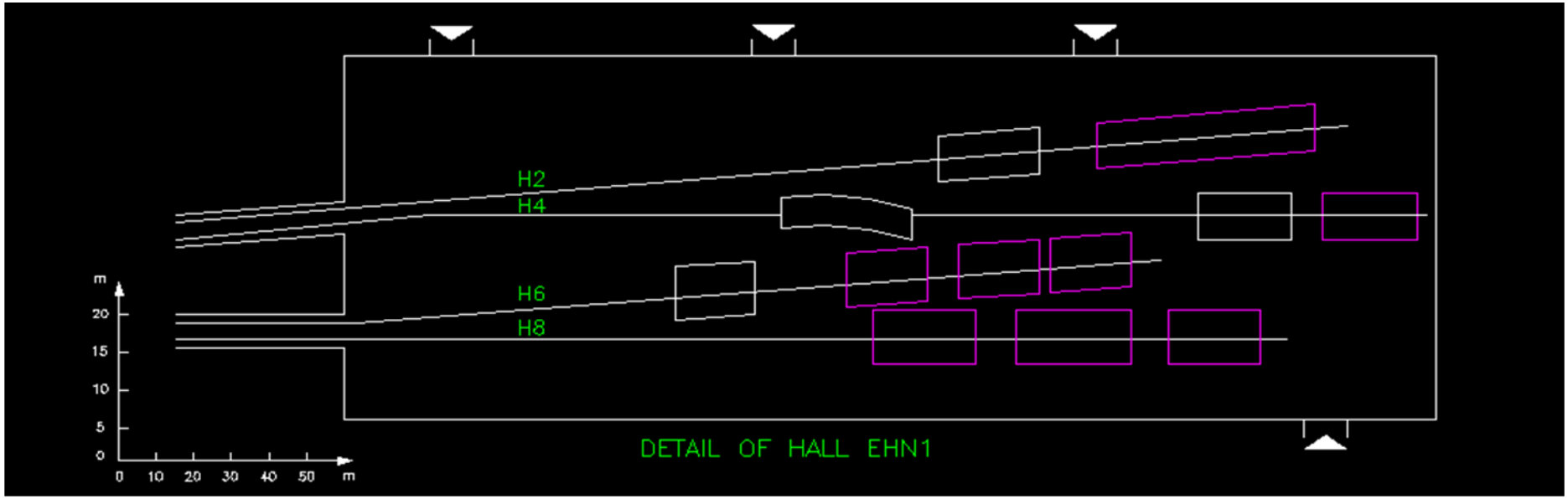
D.Autiero[a], A. Badertscher[b], G. Barker[c], Y. Declais[a], A. Ereditato[d], S.Gninenko[e], T. Hasegawa[f], S. Horikawa[b], J. Kisiel[g], T. Kobayashi[f], A.Marchionni[b], T. Maruyama[f], V. Matveev[e], A. Meregaglia[h], J.Marteau[a], K. Nishikawa[f], A. Rubbia[b], N. Spooner[i], M. Tanaka[f], C.Touramanis[j], D. Wark[k,l], A. Zalewska[m], M. Zito[n]

(a) IPN Lyon (b) ETH Zurich (c) University of Warwick (d) Bern University (e) INR, Moscow (f) KEK/IPNS (g) University of Silesia (Katowice) (h) IPHC Strasbourg (i) University of Sheffield (j) University of Liverpool (k) Imperial College (l) RAL (m) IFJ-PAN, Krakow (n) CEA/SACLAY

New Opportunities in the Physics Landscape at CERN
May 10th-13th 2009
CERN, Geneva, Switzerland

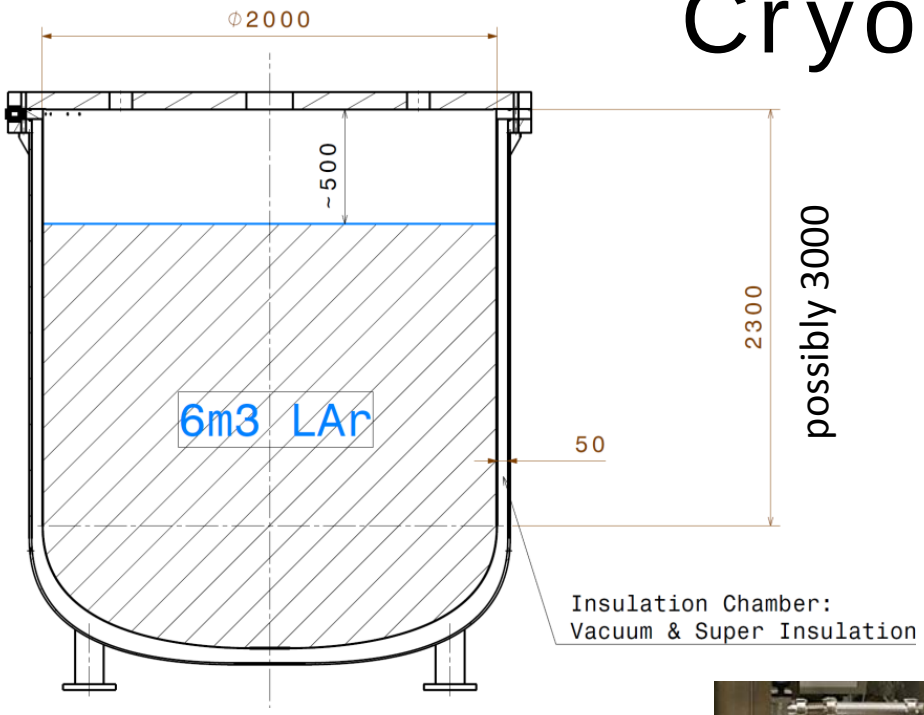
The beam

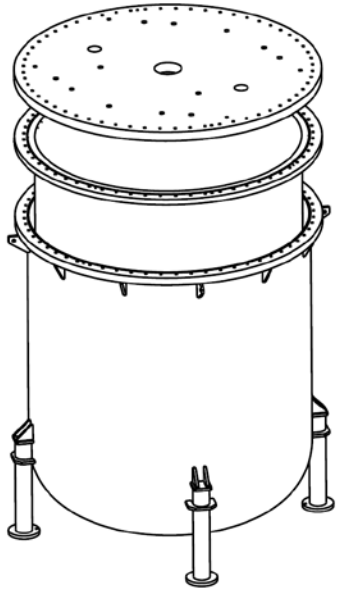
- Tertiary beam at the CERN SPS North Area in the H8 line



- 0.5-5 GeV/c e/μ/π/p with well defined momenta. The possibility to reach lower momenta (200, 400 MeV/c) is being investigated
- synergy with AIDA (Advanced European Infrastructure for Detectors at Accelerator: neutrino detectors R&D tests on the CERN H8 beamline
- investigating also possibilities at the CERN PS

Cryogenics





Gas recirculation system from ArDM

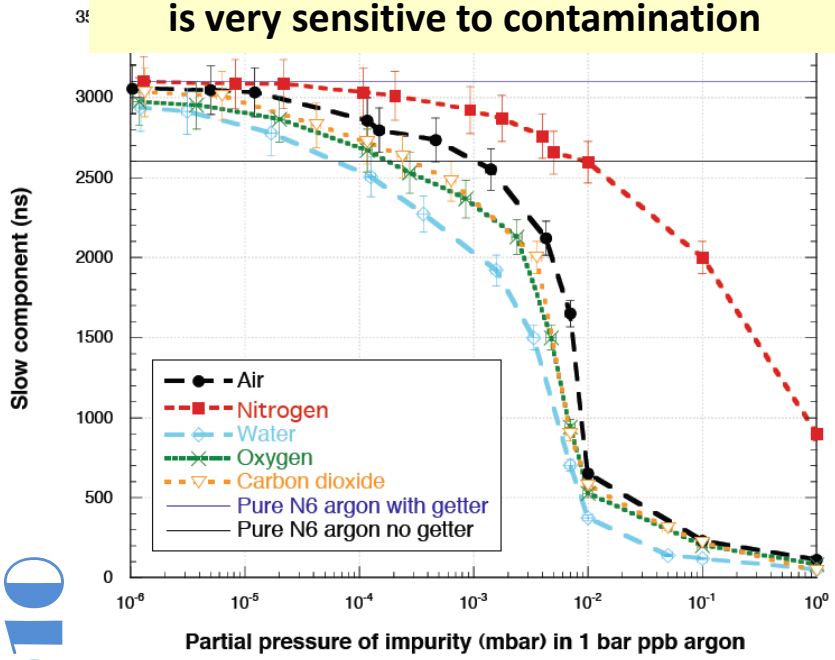
- Vacuum insulated dewar
- LAr filling starting from a non-evacuated vessel
- Re-condensation of evaporated gas by cryocoolers

- non-evacuated dewar fully equipped with detector
- purge with warm Ar gas (remove water)
- cool with cold Ar gas, while operating GAr recirculation and purification system
- fill with LAr
- LAr recirculation and purification with a LAr pump immersed in LAr

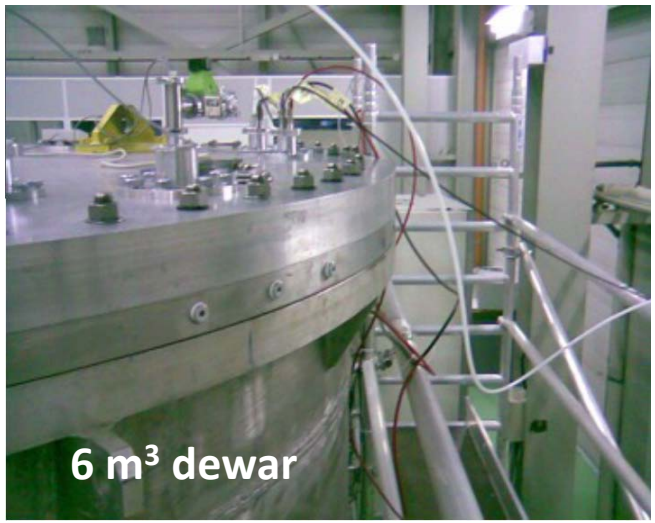
Purity in a non-evacuable 6m^3 dewar

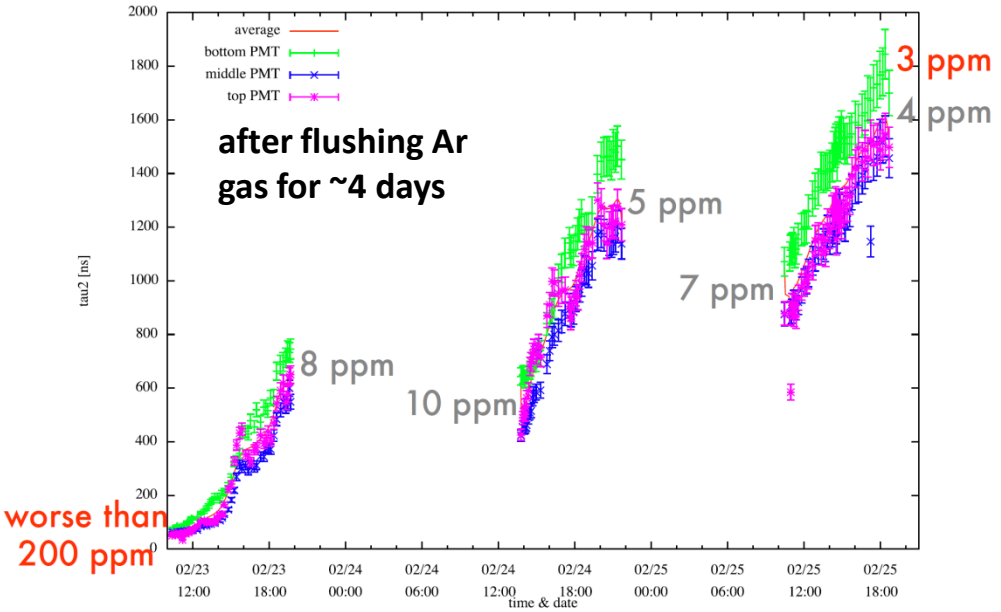
Slow component of Ar scintillation light is very sensitive to contamination

A. Curioni et al, arXiv:1009.4073



- purging air with Ar gas (piston effect)
- % level O_2 monitors + 3 PMTs each with a 40 kBq Am source to monitor Ar scintillation light
- Reached **3 ppm** O_2 equivalent via flushing
- Closed gas recirculation and purification under construction → **< 1 ppm** O_2 equivalent
- Then test in LAr phase





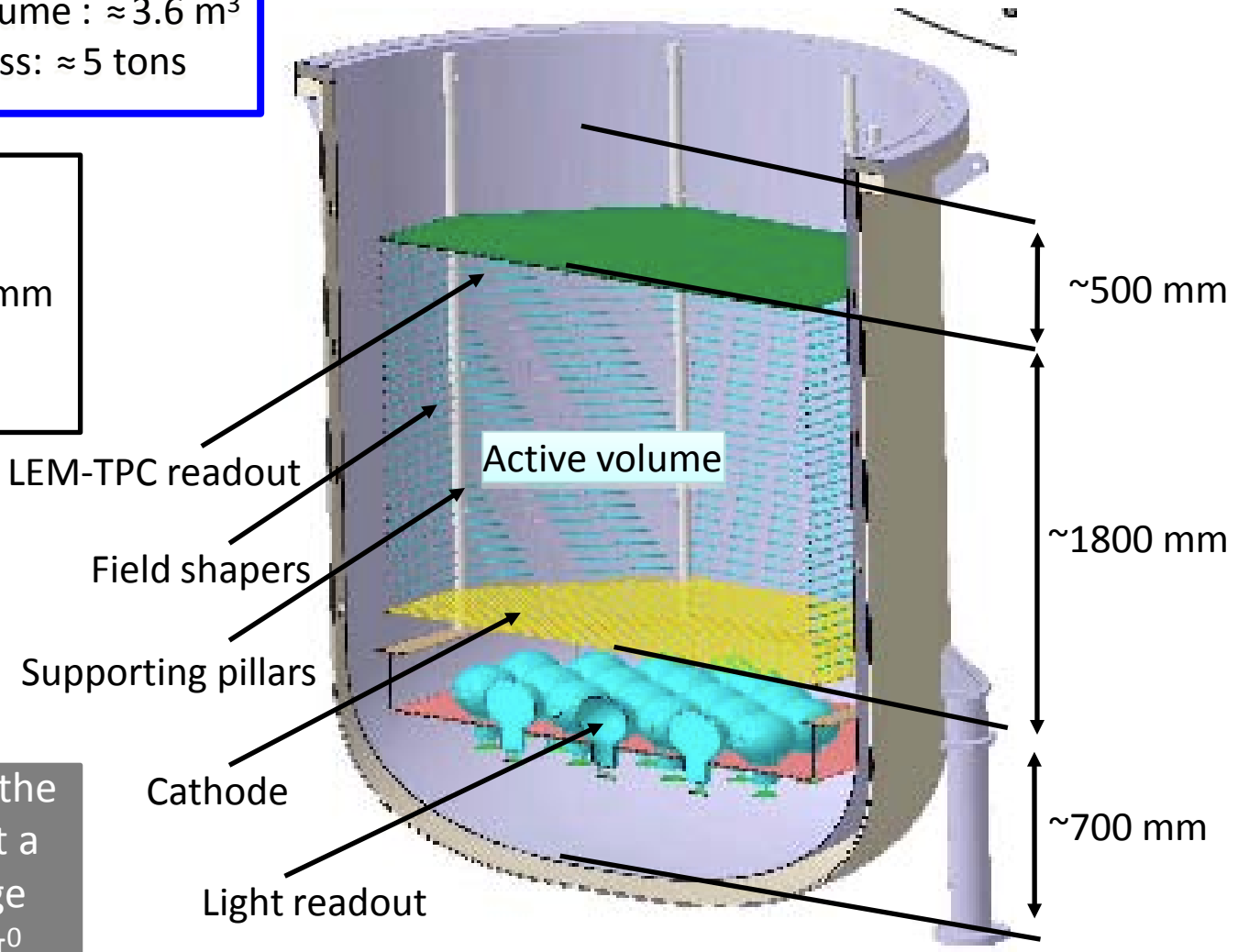
CLA 2010

Tentative layout of the detector

Readout area: ≈ 2 m^2
Drift length: ≈ 1.8 m
Instrumented volume : ≈ 3.6 m^3
Instrumented mass: ≈ 5 tons

Based on ArDM-1t design

Number of Rings: 45
Diameter Ring: 6 mm
Distance between Ring: 40mm
Number of Pillars: 8
Diameter of Pillars: 40 mm



hydrogenate target inside the detector in order to collect a significant sample of charge exchange events π^- p->n+π^0

Campaign measurements at CERN NA

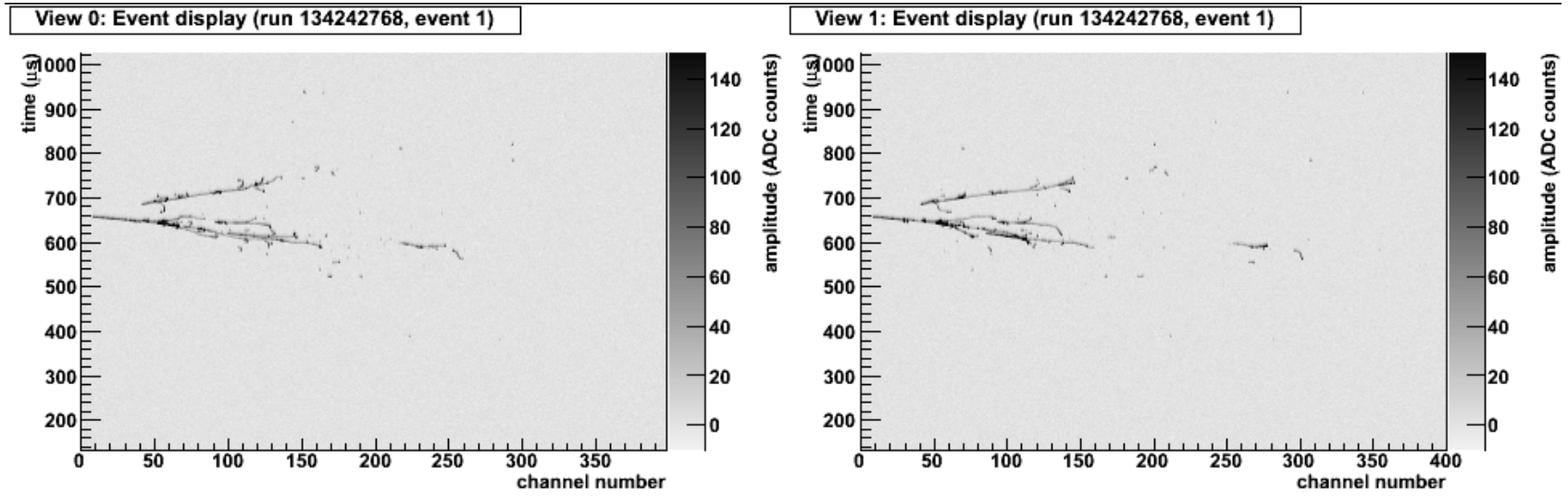
3 mm readout pitch, 1.8 – 2.5 m drift length

- **Electron, neutral pion, charged pion, proton, muon reconstruction**: test particle identification capability
- **Electron/π0 separation**: measurement of electron identification efficiency and residual background from neutral pions
- **Calorimetry**: calorimetry with low energy particles (0.5-5 GeV/c e/mu/pi)
- **Hadronic secondary interactions**: study of pion secondary interactions and comparison of the data with MC models
- **Precision study of rate effects and space charge**

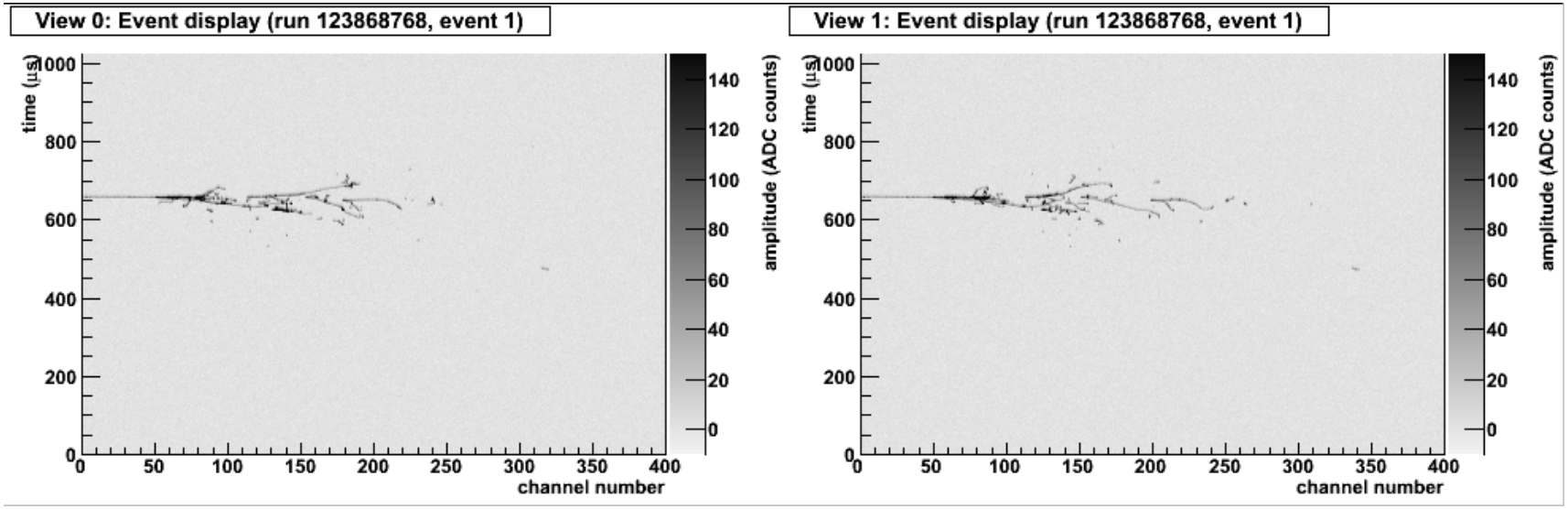
These results will play a fundamental role in future projects involving low energy neutrino beams or sensitive searches for proton decay and complement direct measurements in a low energy neutrino beam

Event simulation

1 GeV π^0



1 GeV electron



Conclusions

- We want to expose a **double-phase LAr TPC to a low energy (0.5 – 5 GeV/c) beam** in the CERN North Area
- a dewar of ≥ 6 m^3 is needed to house a **m^2 scale readout device**, which would be the building block of larger detectors
- test of **filling and purification of a non-evacuated dewar** , fully equipped with the detector
- test of particle identification, calorimetry, hadronic secondary interactions
- study of rate effects and space charge
- **results will be important to plan experiments for neutrino oscillations and proton decay searches**