

adapted from C.Galbiati PAC presentation 11/09

DarkSide and MAX

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Image Credit: Fermilab

Darkside and MAX Program

- Bring together techniques that offer the best characterization and rejection of background in noble liquid detectors

The DarkSide program introduces 3 innovative technologies crucial for achievement of zero background in very large detectors

1. Depleted Argon from underground sources
2. 3" QUPID photosensors
 - no background detected in best Ge
 - new Bialkali-LT photocathode from Hamamatsu for high QE at liquid argon temperature
3. High efficiency borated liquid scintillator neutron veto (>99%)

DarkSide and MAX

DarkSide Collaboration : UMass Amherst, Arizona State, Augustana College, Black Hills State, Fermilab, Houston, Notre Dame, Princeton, Temple, UCLA

- **DarkSide-50 (50 kg, 10^{-45} cm²)**

DarkSide + XENON = MAX Collaboration

UMass Amherst, Arizona State, Augustana, Black Hills State, Coimbra, Columbia University, Fermilab, Houston, INAF, LNGS, MIT, Münster, Notre Dame, Princeton, Rice, Shanghai Jiao Tong, Temple, UCLA, Virginia, Waseda, Zürich

- **5t Depleted Argon and 2.5t Xe TPCs (10^{-47} cm²)**
- **S4 Funded Project**
- **Possible change in baseline (25t DAr, 10t Xe) if DUSEL delay to 2016-2017 confirmed**

DarkSide-50

dual-phase TPC

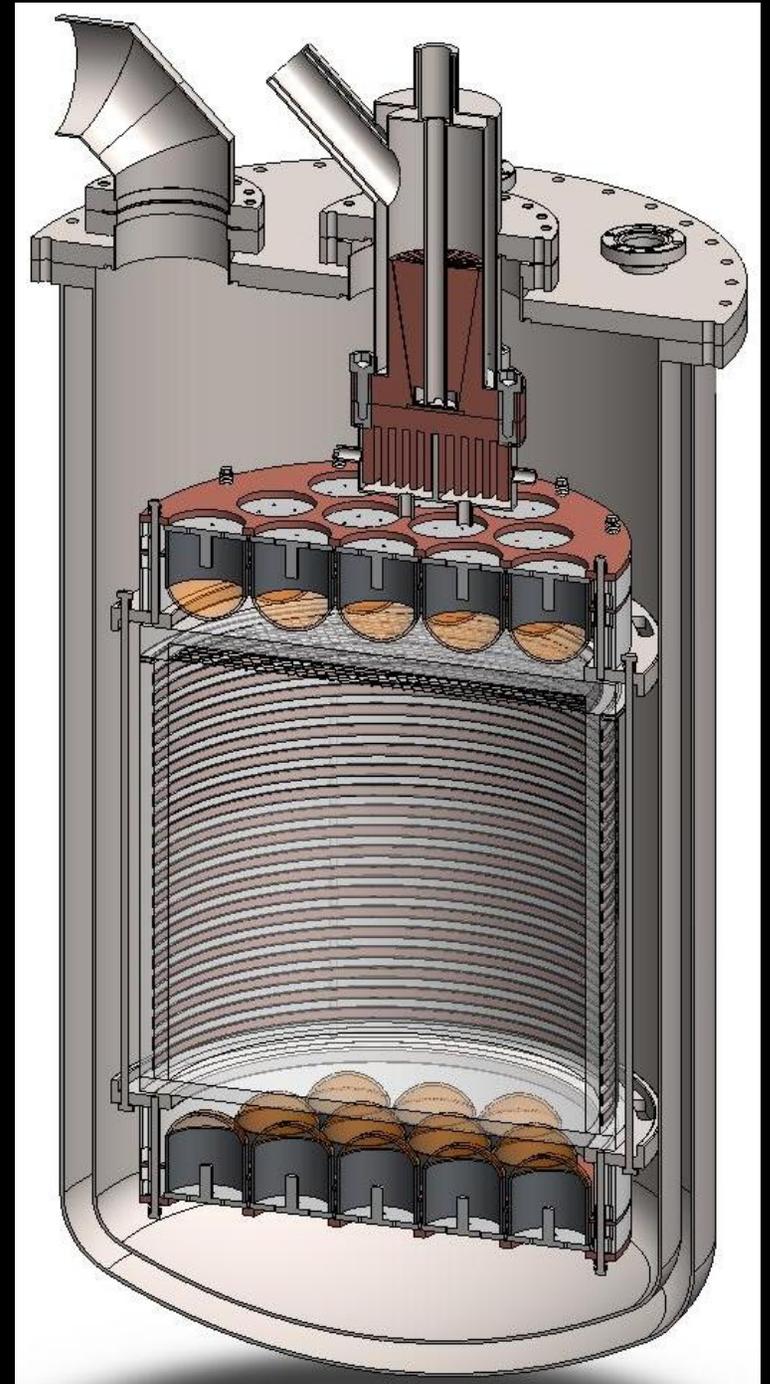
50 kg active mass

background-free for 3 yrs

sensitivity 10^{-45} cm²

Test for three advances crucial
to achieve zero background:

- 1) depleted argon
- 2) QUPIDs at LAr temp
- 3) active liquid scintillator
neutron veto



Why depleted argon?

- Atmospheric argon has specific activity 1 Bq/kg ($^{39}\text{Ar}/\text{Ar}$ ratio 8×10^{-16})

Limits size (and sensitivity) of detectors using atmospheric Argon to 500-1000 kg due to ^{39}Ar events pile-up

- ^{39}Ar produced by cosmic rays in atmosphere (beta decays, $Q = 565$ keV, $t_{1/2} = 269$ years)
- ^{39}Ar -depleted argon available via centrifugation or thermal diffusion, but expensive at the ton scale!
- ^{39}Ar production by cosmic rays strongly suppressed underground

Princeton Prototype Plant for Industrial Scale Depleted Argon
Production from underground gas (CO₂) wells (NSF PHY-0811186)

Achieved 1.5 kg/day (depletion >25), goal ~few kg/day in 2010

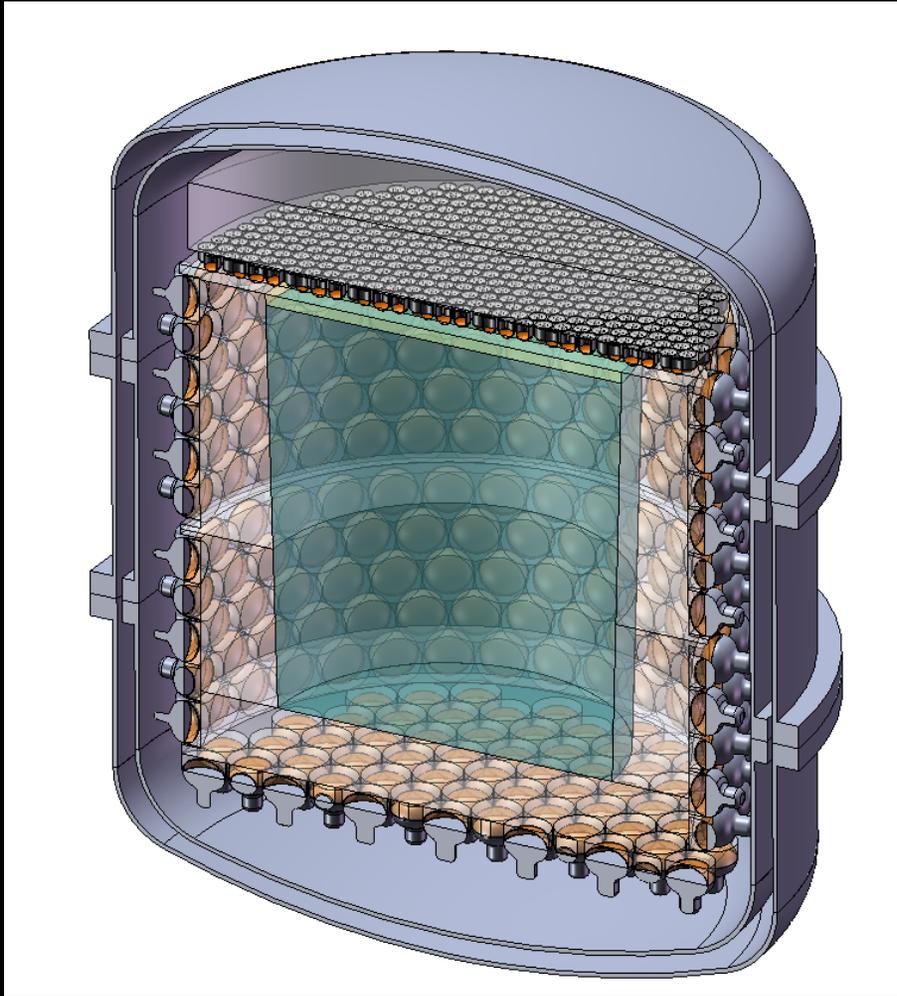


Extraction Plant
(Colorado)

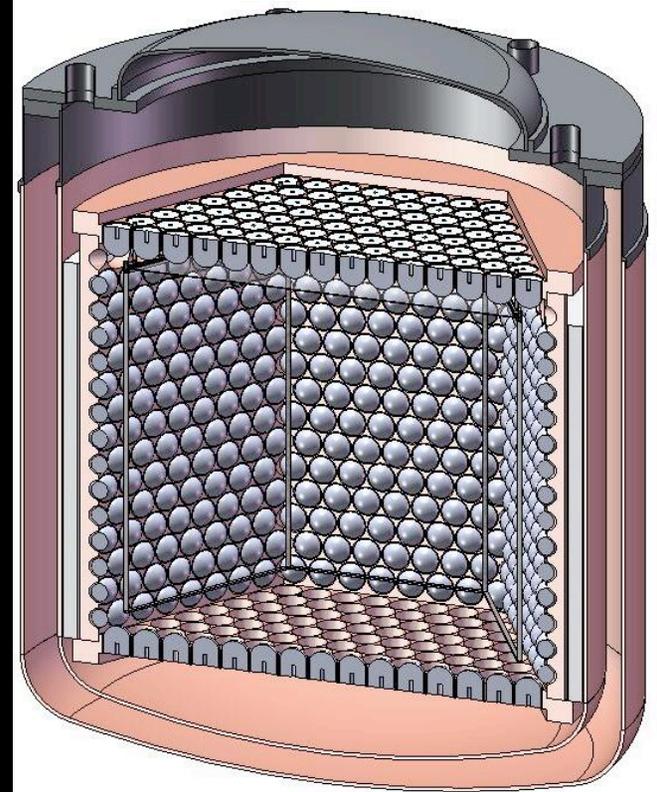


Distillation Column @FNAL

MAX Concept



5 ton DAr TPC



2.5 ton Xe TPC

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DarkSide-50

- \$1.7M estimated equipment costs
- Depleted Argon independently funded (NSF PHY-0811186)
- Proposal submitted to NSF Oct 2009 (Princeton, Temple, Houston, UCLA, UMass, Augustana) - requests 100% of equipment costs
- Proposal to DOE submitted by Princeton & UCLA, FWP in process at FNAL

MAX

- Funded NSF S4 effort for Engineering and R&D
(NSF University groups already staffed)
- DOE Field Work Proposal will request support for Engineering and R&D at FNAL

Synergies at FNAL

- LAr Neutrino Program (LBNE, MicroBoone, ArgoNeut)
 - Purification, DAQ, Electronics, Material Qualification, Wavelength Shifters, Optical Measurements and Simulations, Data Storage, Analysis, Electrostatics Design, HV Feedthroughs, Power and readout of QUPIDs and PMTs
- CDMS
 - Neutron Veto, Low Background Materials and Measurement, Cryogenics
- COUPP
 - Neutron Veto, Quartz Vessel

Fermilab Responsibilities

- DarkSide-50:
 - Cryogenic Simulations
 - DAQ and Electronics (w Houston)
 - Purification (w Temple)
 - Shielding and Muon Veto
- MAX:
 - See WBS of MAX S4 proposal

Facilities at Fermilab

- Possible operation of first prototype at moderate depth in NuMI tunnel (300 m.w.e)
- Material testing program at PAB
- Engineering in DAQ, Electronics, Mechanical, Cryogenics
- Distillation and characterization of underground Argon under construction