DarkSide 10 kg Prototype at Princeton

Distillation Column for Depleted Argon at Fermilab

DarkSide 50 at Gran Sasso

Two-phase Depleted Liquid Argon TPC:

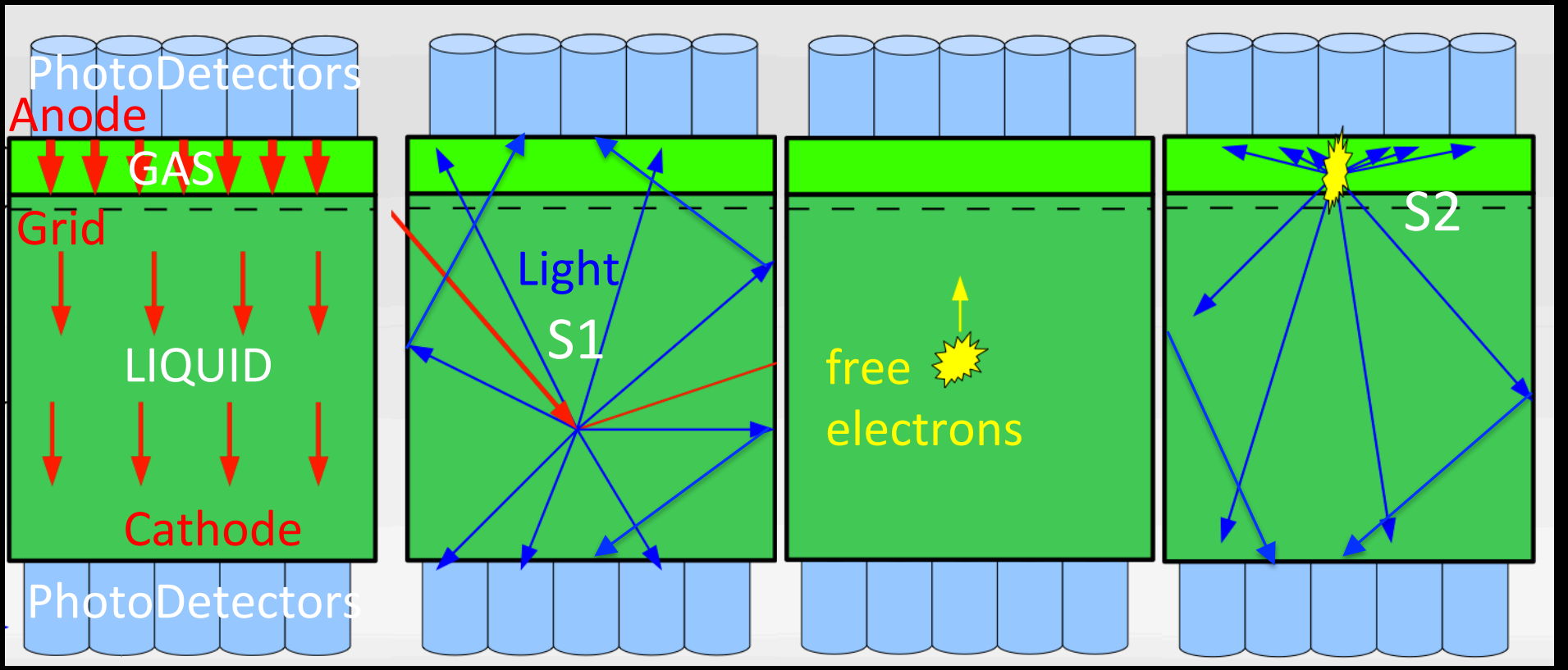
Features: Depleted Argon from CO_2 Wells (Ar39 < 1/25 x Atmospheric

Borated Scintillator for Neutron veto

QUPID (Quartz Photon Intensifier Device) low radioactivity photo-detector

China– Italy– Russia – USA Collaboration

Argon produces scintillation light and allows long (meters) free electron drift.



Liquid Phase;
Gas Pocket above;
Electric Field in both.
<1kV/cm (L), few kV/cm (G)

WIMP interacts;
Nucleus Recoils
Argon produces light and free electrons

Electrons drift in liquid and are extracted by field of few kV/cm

into gas region where they produce secondary fluorescence (S2), proportional to number of e's.

Rejection of e-m background/Identification of nuclear recoil based on:

Ionization density in nuclear recoil > ionization density from electron

- Time distribution of S1 signal
  sensitive to ionization density – light from 2 states with different lifetimes

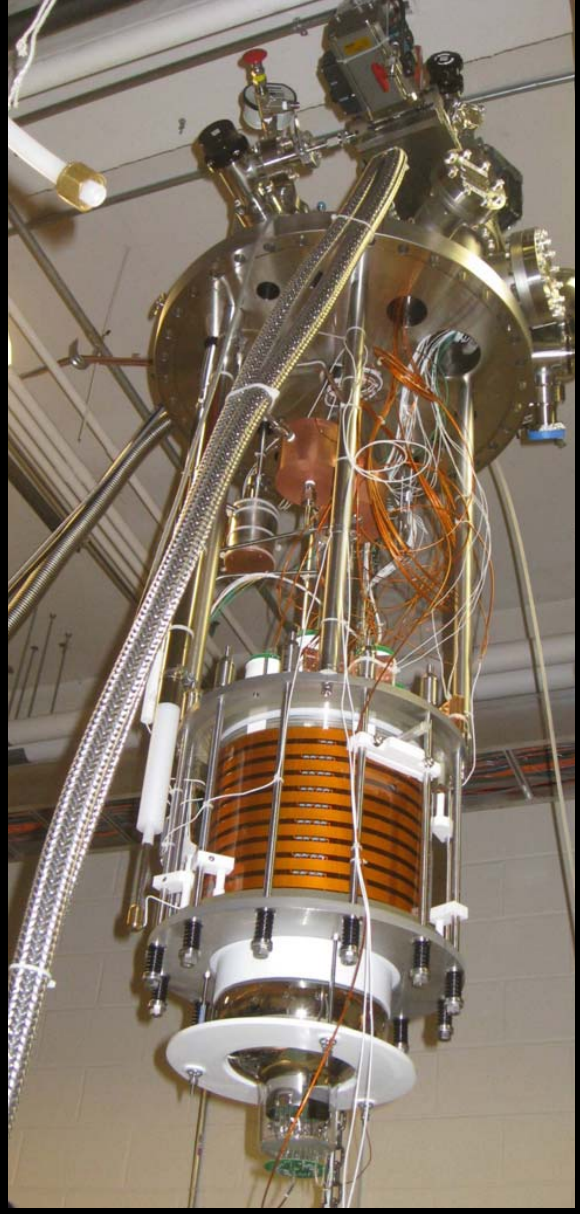
- Ratio of S1 to S2
  measure of free electrons after interaction – again sensitive to ionization density

S1 (only) is available in single-phase detectors

S2 rejection expected to be ~100; S1 rejection ~10^8 depending on light yield

10 kg – no field version

Test: PMTs, Reflectors, Cryogenics, Light Yield (S1), Gas Pocket formation, Acrylic at 90 K, transmission of ITO films (used as odes)

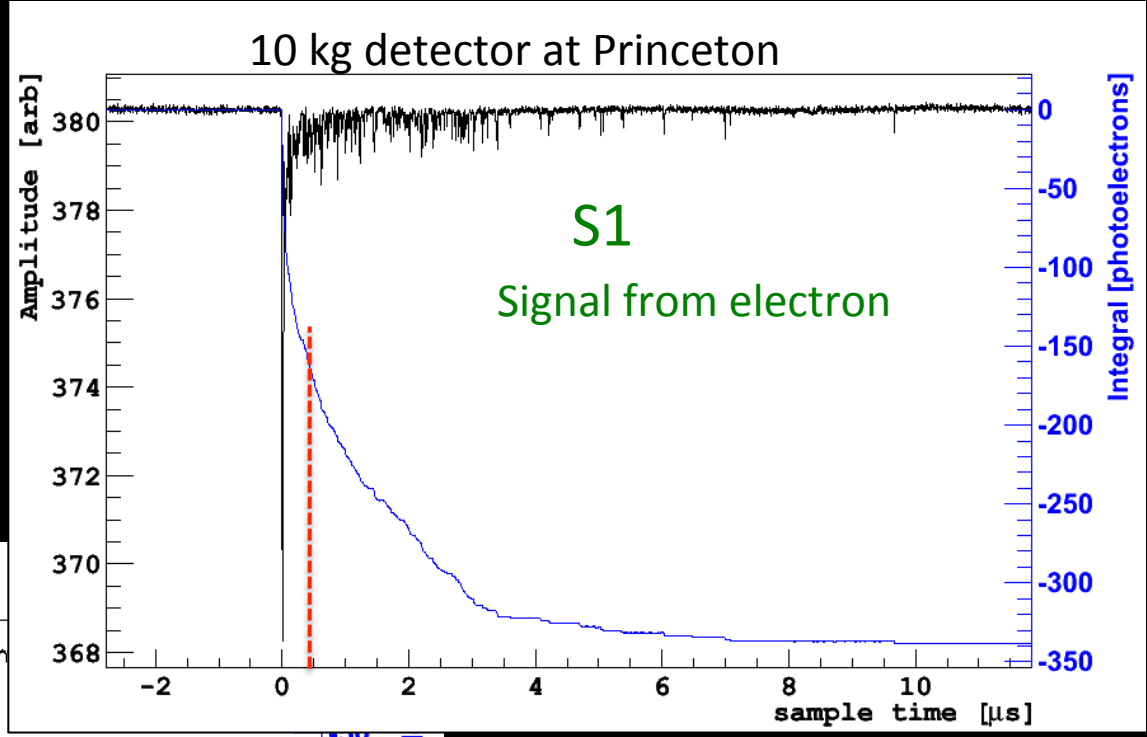


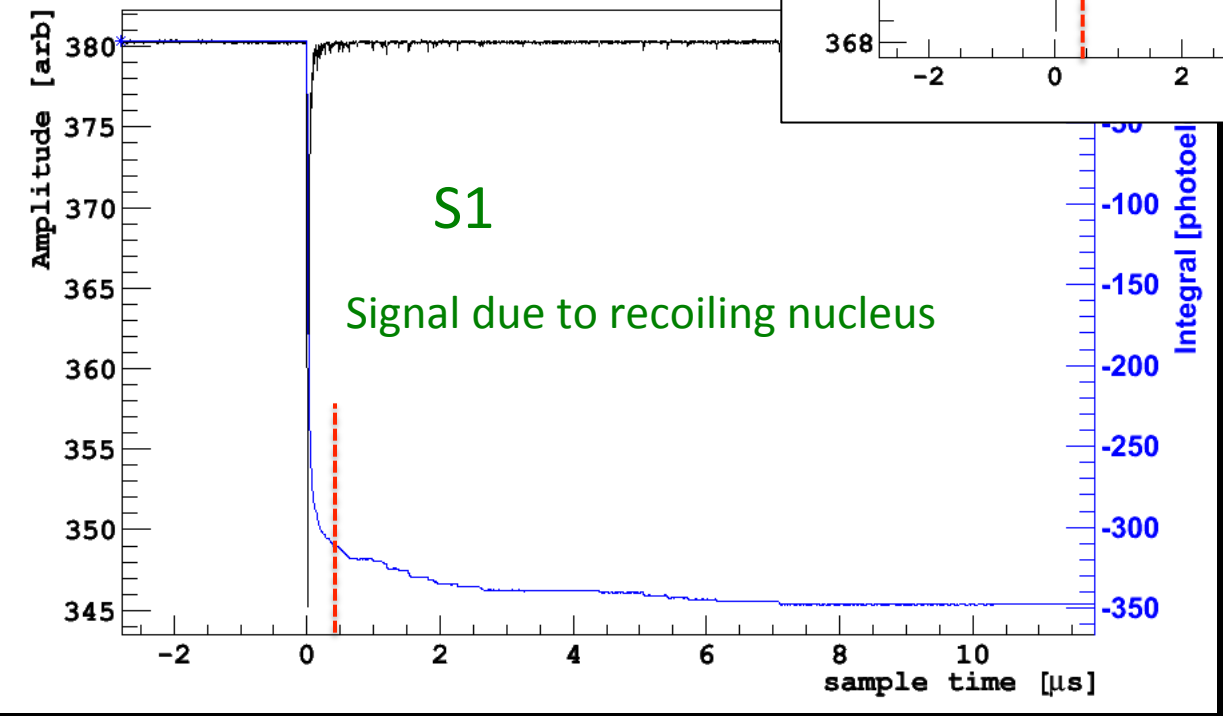
10 kg – full field version

S1 signal shapes for

Electron event →

Nuclear recoil event ↓





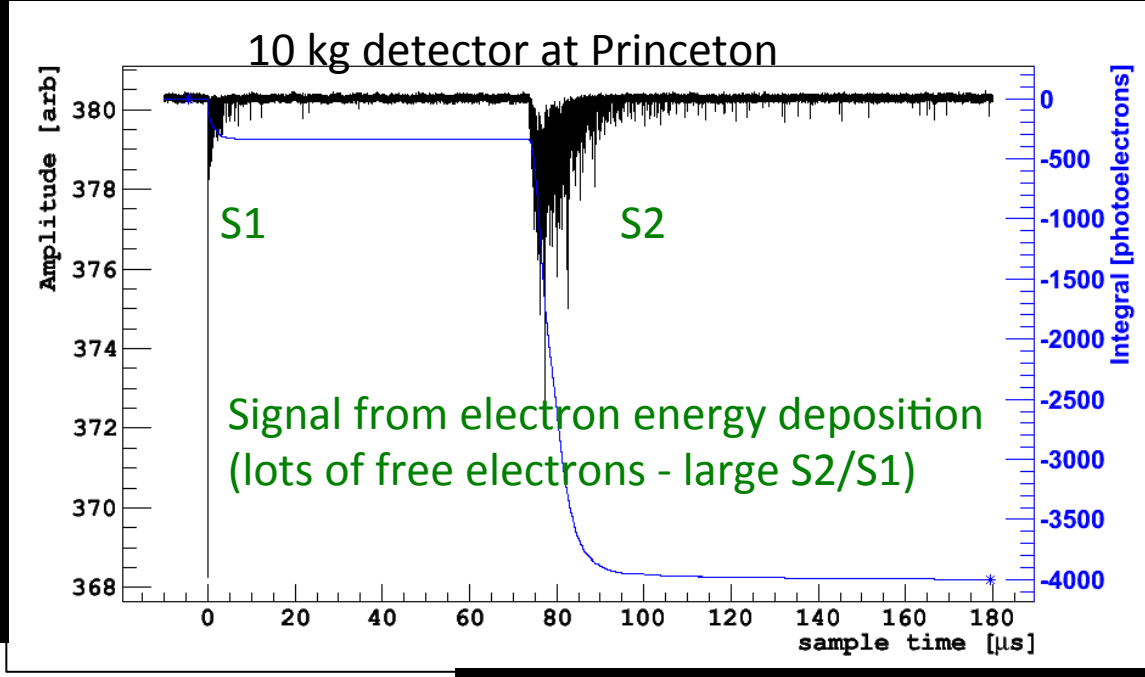
Define **f90** =

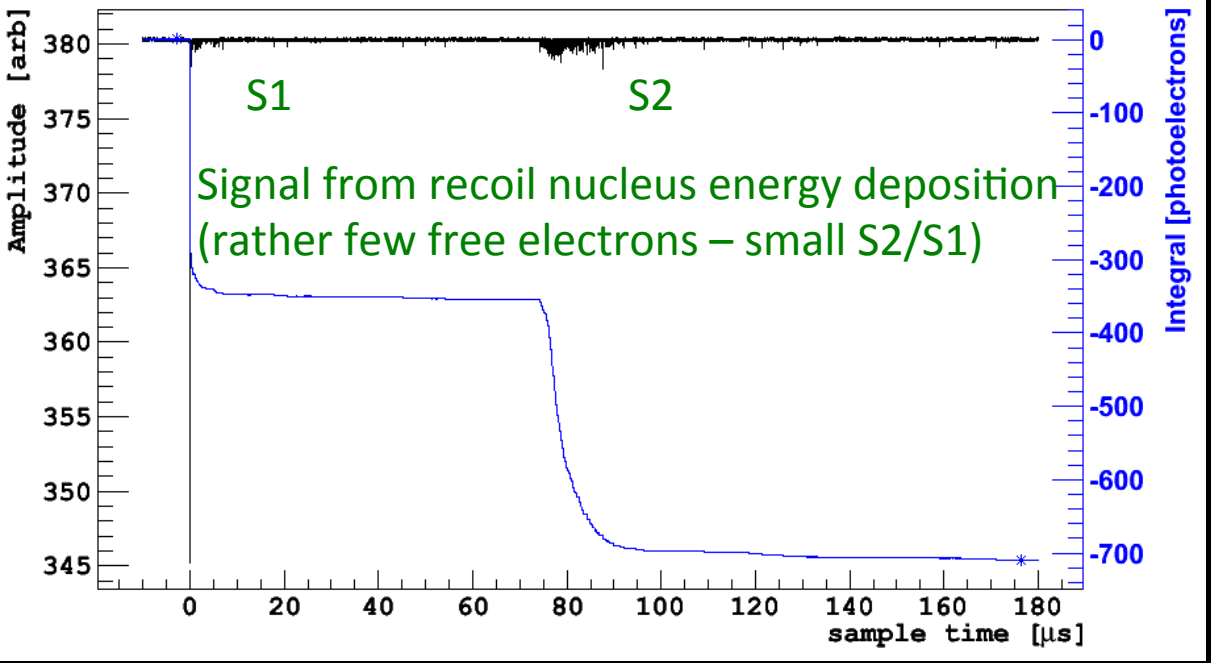
Fraction of integral in first 90 ns

S1 & S2 signals

Electron event →

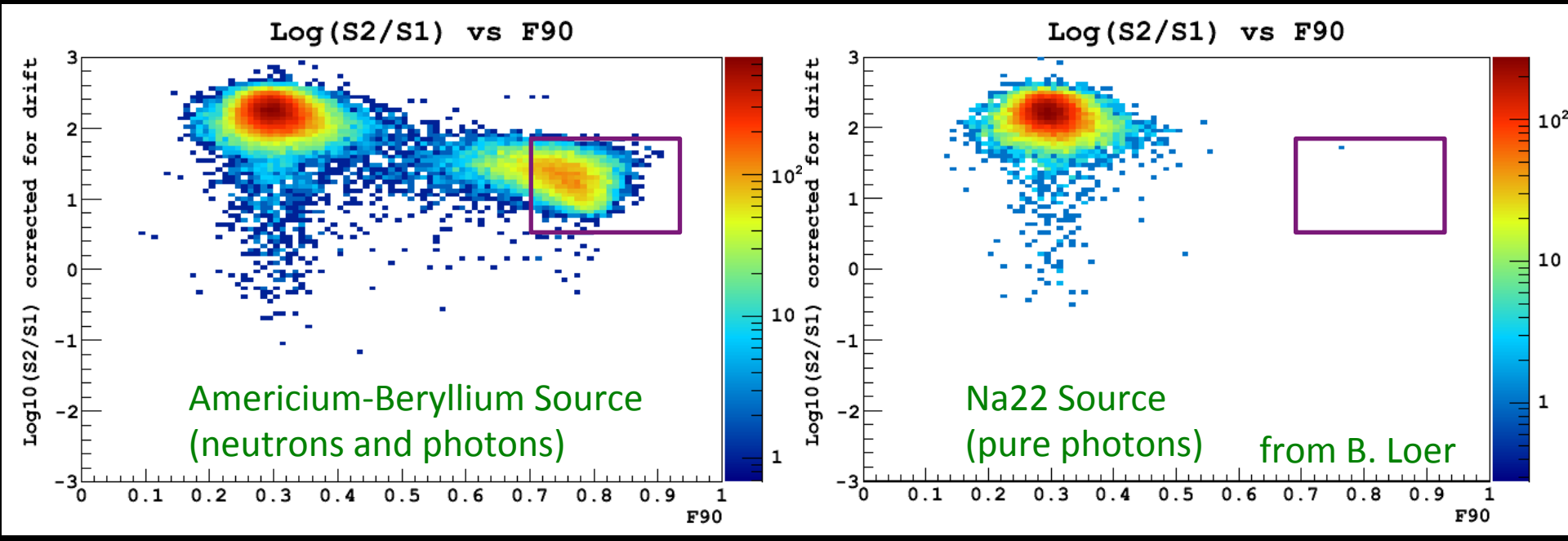
Nuclear recoil event ↓





Use **log(S2/S1)**
as discriminant

10 kg Prototype at Princeton



Full data set:

2 events in signal region out of 46,000 Na22 events

– off to Gran Sasso with prototype

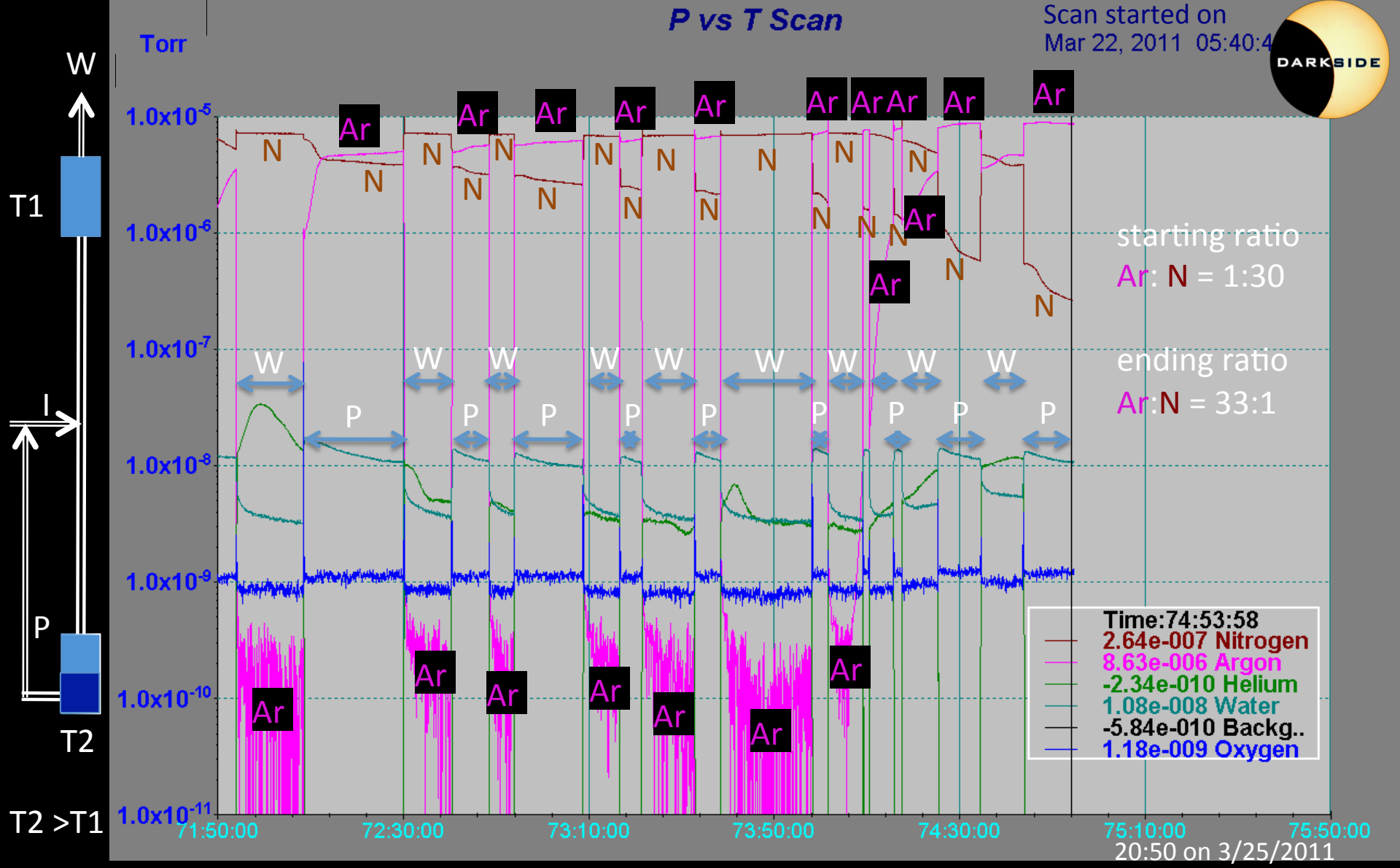
Distillation Column at the PAB.

Used to separate Argon from underground C02 wells from its accompanying Nitrogen and Helium.

Atmospheric Argon has 1 part in 10^{15} of Ar39 formed by cosmic rays. Lifetime is 388 yrs; end point 536 keV. Depletion lower limit is 25.

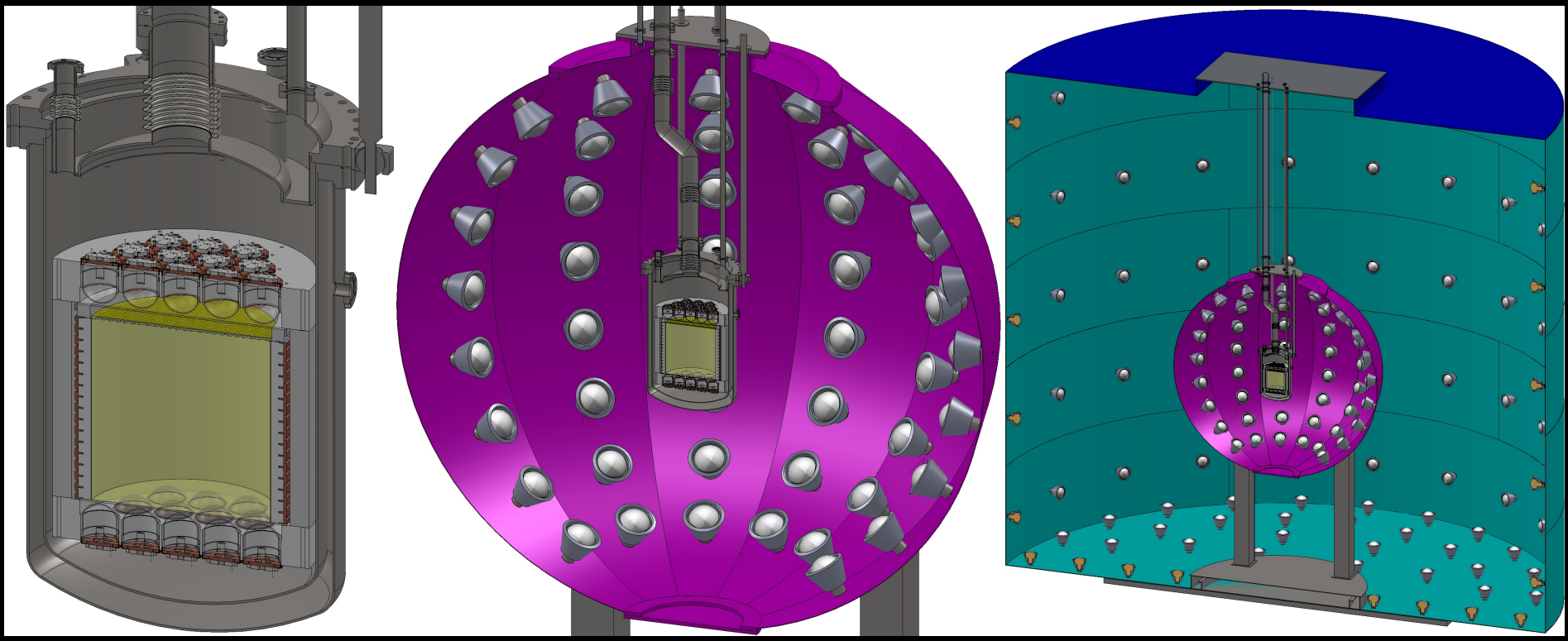
Column has been assembled and has had first operation. It achieved a concentration of 1000 in terms of Argon to Nitrogen ratio.

We have a moderate list of improvements to increase throughput and improve monitoring of column temperatures.



Batch Distillation to separate Argon and Nitrogen – Argon accumulates at bottom (P)
Nitrogen escapes at top (W)

DarkSide 50 at LNGS



DS-50 with QUPIDs	in Scintillator Veto	in Borexino Water Tank

Mechanical Design in Process – start installation in summer 2012

1.5 x 10^{-45} cm^2 in 3 year background-free run

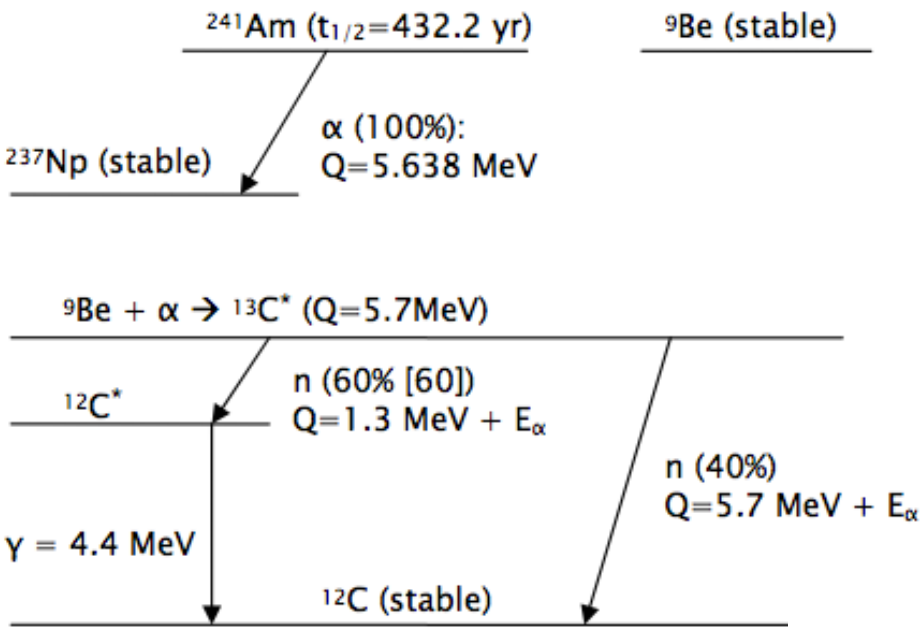
Fermilab Involvements in DarkSide 50 (if Field Work Proposal granted):

Design and construction of Argon system
(cryogenics, purification)

Data Acquisition Architecture

Project Management

Americium – Beryllium Source Decay Scheme



Na 22 Decay Scheme