The COUPP Collaboration

Principal Investigator:
Juan Collar
(spokesperson)

Graduate Students:
Nathan Riley
Matthew Szydagis

Undergraduates:
Luke Goetzke
Hannes Schimmelpfennig

KICP Fellows:
Brian Odom

University of Chicago

Wilson Fellows:
Andrew Sonnenschein

Staff Scientists:
Peter Cooper
Mike Crisler
Martin Hu
Erik Ramberg
Bob Tschirhart

Fermi National Accelerator Laboratory

Principal Investigator:
Ilan Levine

Undergraduates:
Earl Neeley
Tina Marie Shepherd

Engineers:
Ed Behnke

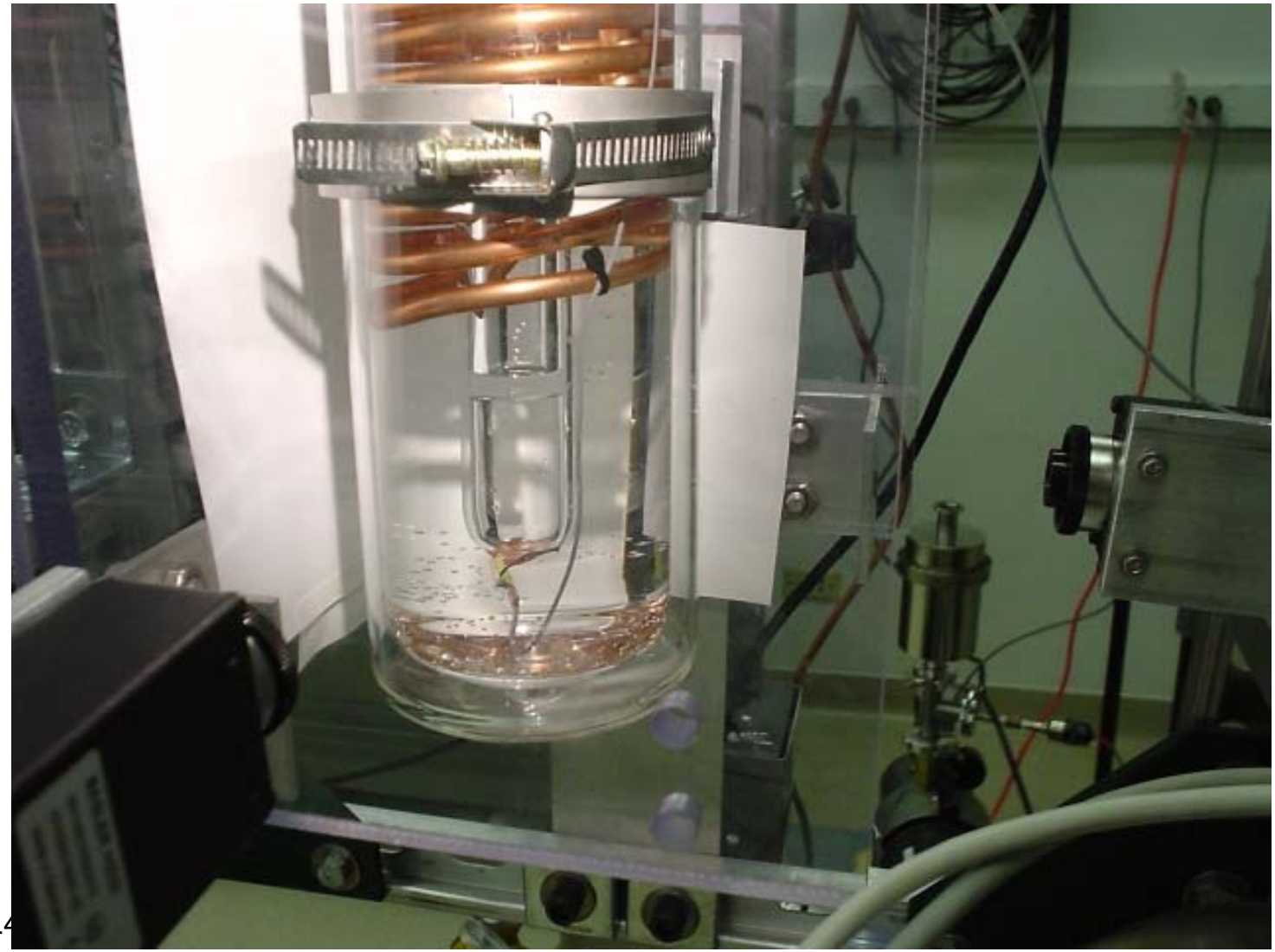
Indiana University South Bend

Funding

National Science Foundation
Kavli Institute for Cosmological Physics
Department of Energy

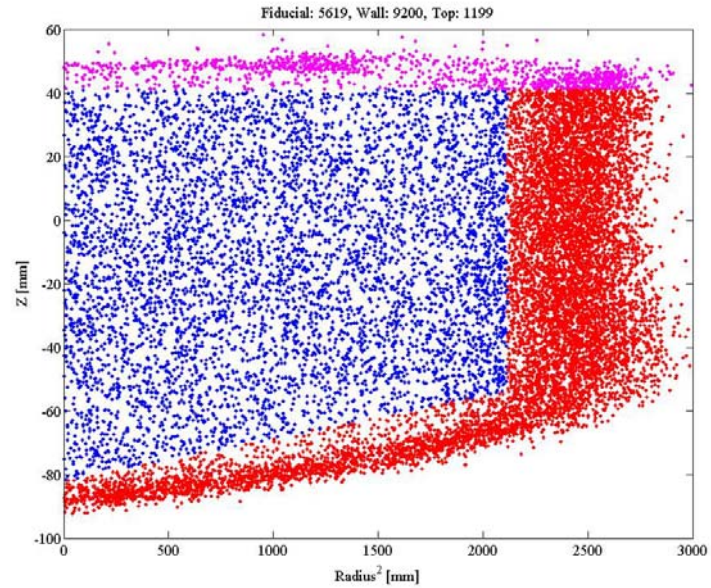
12 mL Test Tube Chamber at U. Chicago, 2003.

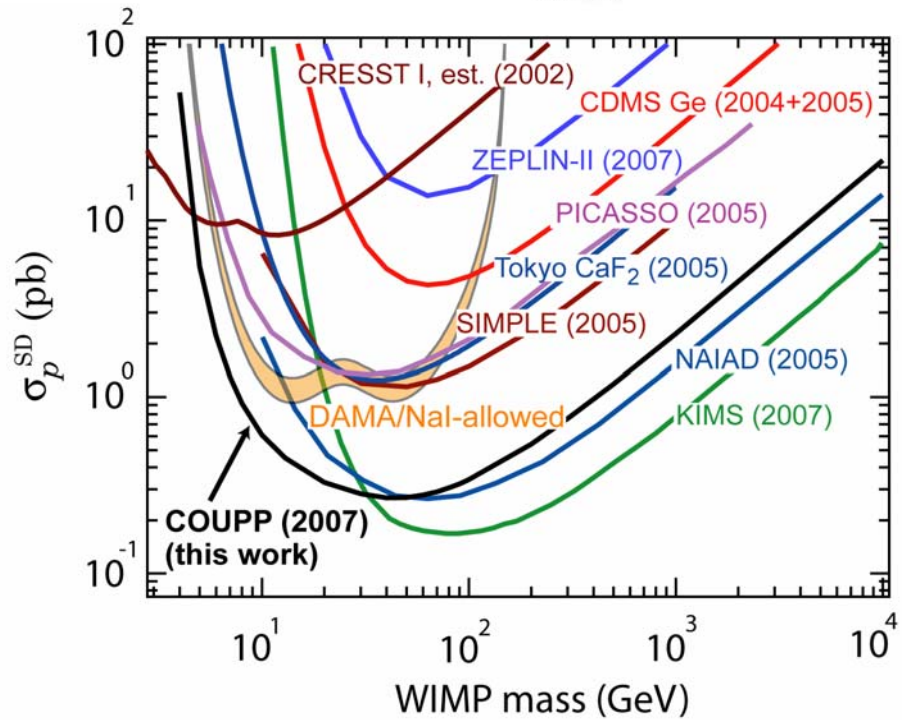
~ 20 grams of CF_3Br
~ 5000 events/kg day background (mostly neutrons)



2 Kg Chamber at NuMI (2005-2008)

80 times more mass, 10^{-3} times background

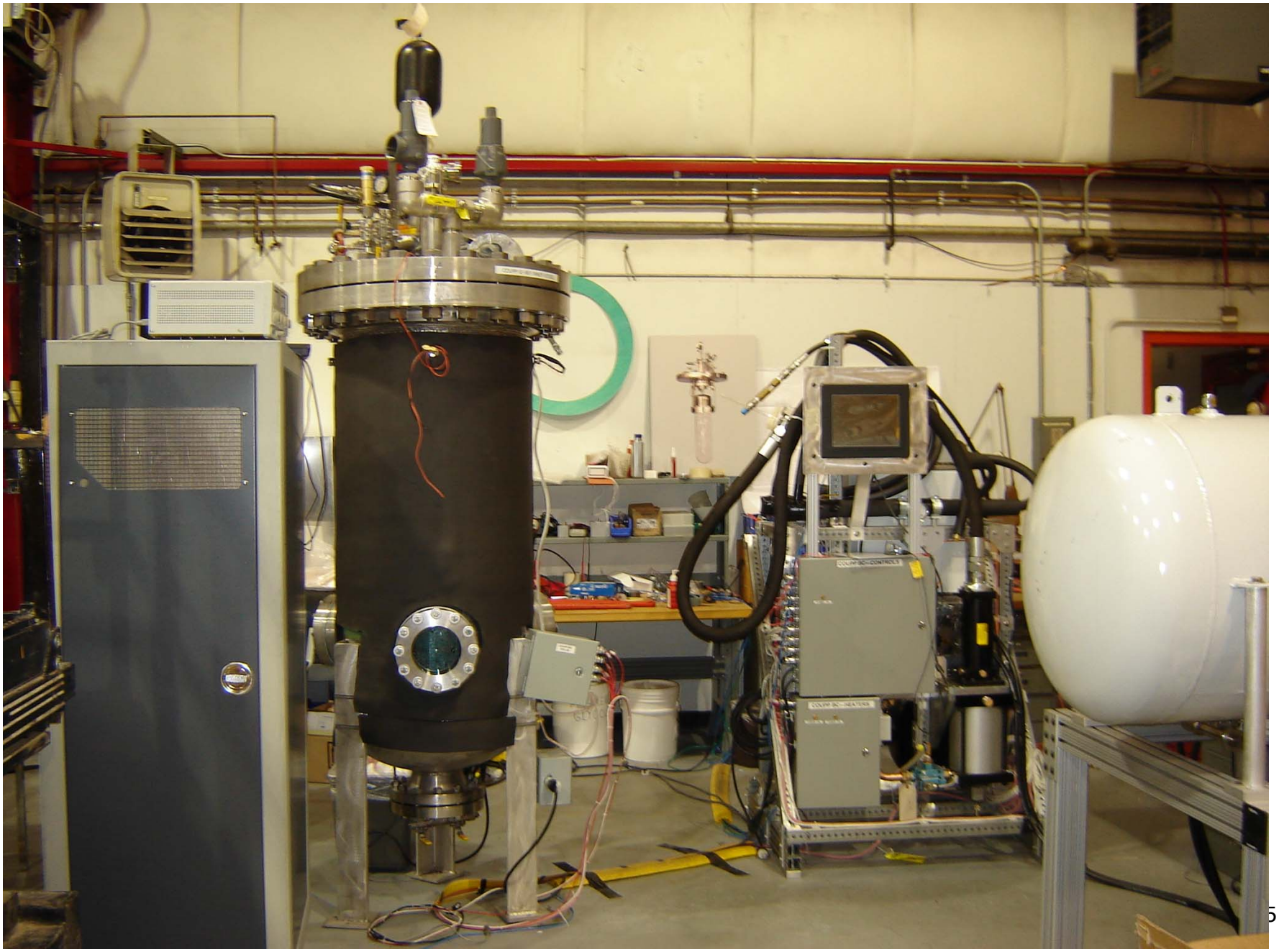




60 Kg Inner and Outer Vessels

- Experiment was approved in Nov. 2006, construction now about 70% finished.
- Expect physics running in 2009 at Soudan Mine (earlier tests at NuMI)

60 Kg Prototype Ready For Testing This Week



COUPP-60 Remaining Work

- Test bubble chamber functionality with prototype inner vessel. Starting this week!
- Finish video and lighting systems (smart cameras, LED array)
- Low radioactivity water production and filling system.
- Water tank.
- Build final high-purity inner vessel.

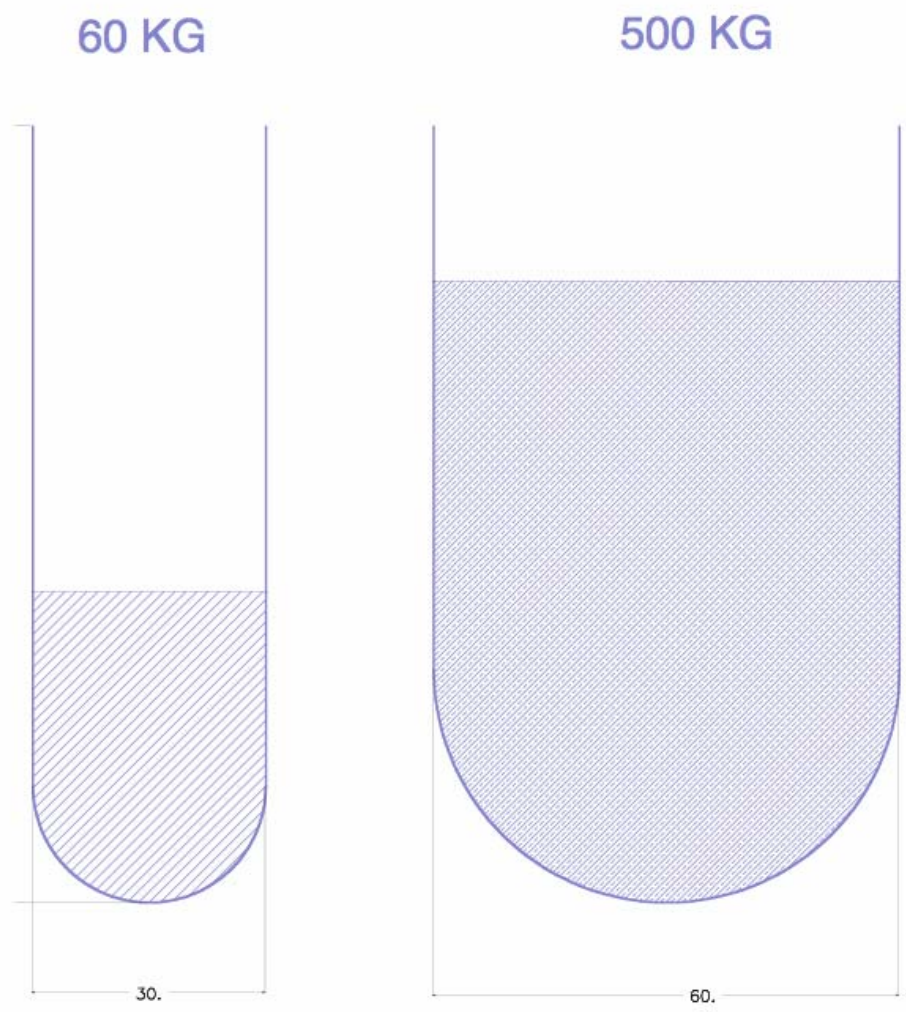
  Synthetic quartz arrives from vendor in September.
- High purity cleaning and clean room assembly. October 2008
- Muon veto system.
- CF_3I handling module.
- Install in NuMI tunnel December 2008
- NuMI run to check that backgrounds are under control, first physics.
- Installation in Soudan Mine Summer 2009?
- Soudan physics run.
- Radiopurity upgrades

  We want at least a 2 order of magnitude reduction in alpha backgrounds

500-Kg Chamber

- Synthetic quartz bell jar is the component that limits the possible size.
    - Due to ultra low radioactivity requirement, no known alternative materials.
- Jar for 60 kg chamber is 30 cm OD x 1 meter length. We use only bottom 40 cm.
- Largest possible jar from known sources is 60 cm x 1 meter.

    => About 500 kg possible



Large Diameter Outer Vessel in FY09

- Intermediate step towards a 500 kg device:
  - Large diameter outer vessel (~ 50 inches) capable of mounting either a 60 kg or 500 kg inner vessel.
  - Higher capacity pressure control system for larger glycol volume.
  - Higher capacity glycol degassing and filling module.
  - Video and lighting for larger volume.
  - Has few risks, since most unknowns are in the inner vessel and fluid handling.
  - Expect cost to be ~ 150 k$ (physicist's guess).
- Engineering can start in fall '08 as 60 kg chamber begins operations.
- If COUPP-60 quickly meets performance expectations, we will want to start work on a 500 kg inner vessel in late 2009.
- If COUPP- 60 needs inner vessel upgrades, we will use the large outer vessel to test 60 Kg inner vessel upgrades at NuMI while COUPP - 60 is running in Soudan.

COUPP at Fermilab

Scientists (3 FTEs)

Brice
Cooper (CD)
Crisler
Ramberg
Hu (AD)
Hsu (FCPA)
Sonnenschein
Tschirhart (CD)
3.5 FTE
(2 in PPD)

Engineers

Rucinski
Schmitt
Pushka
Lindenmeyer
Kwarciany (CD)
1.6 FTE

Drafters

0.4 FTE

Technicians

Ruschman
Kendziora
Montes
Muranyi (AD)
Butler
Zimmerman
Korienek
Nebel
3.6 FTE

Total: 9 FTE (7.8 in PPD) in FY08

We expect to continue at about the same level in FY09

Possible Fermilab Role in Argon Dark Matter

- Fermilab role in argon TPCs for dark matter may make sense
  - Perhaps the best technology for large scale dark matter, due to enormous background discrimination power.
  - Synergies with liquid argon neutrino detector effort.
    - Purity, electron drift length, cryogenics, DUSEL
  - Synergies with other dark matter detection activities
  - Not supported by other national labs in US.
- First steps
  - Collaboration with Princeton, Temple, Notre Dame, Houston +…
    - Princeton has NSF funding for underground argon collection.
      - Production capability of ~ 1 kg/day recently demonstrated.
    - LOI to SUSEL Lab for ~100 kg prototype device.
  - DUSEL R&D proposal for ^{39}Ar counting.
  - Jeff Martoff (Temple U.) sabbatical at Fermilab, 2009-2010
  - Expect to propose 100 kg device to NSF, DOE and Fermilab in fall.
    - Demonstrate low ^{39}Ar and efficient light collection.
    - Would lead to ~ 10 ton DUSEL MREFC

Report from June PAC

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

LOI to Sanford Lab

(pre-DUSEL lab at Homestake)

- ~50 kg argon TPC
- Interesting physics reach if deployed in next two years
- Argon from underground

  Depleted in 39-Ar
- 4π light collection.
- Prototype for ~10 ton DUSEL experiment
- NSF, Fermilab proposals to be submitted in fall.

QuickTime™ and a
TIFF (Uncompressed) decompressor
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Possible Fermilab Responsibilities for Sanford Lab Experiment

Mechanical, thermal and electrostatic modeling of detector
- Other institutions will provide most of design
- Finite element analysis group will provide supporting calculations

Internal TPC Components
- wire grids, field shaping rings, high voltage feedthroughs

Argon Gas and Liquid Handling
- Gas transportation trailers
- Design of purification for gaseous and liquid argon.
- External purity monitor. Measure chemical purity, e.g. oxygen, nitrogen.
- Argon filling and emptying tubes, valves and instruments.
- backup recovery system for depleted argon

Argon Screening
- low activity 1-kg detector for measurement of 39Ar activity in depleted argon from underground sources. Will run at NuMI or in Soudan, eventually at SUSEL.

Electrical and Control
- Control system.
- Underground electrical distribution (boundary to be negotiated with SUSEL)
- High voltage power supplies and cabling for TPC and PMTs

Safety
- Safety analysis for electrical, fire, cryo, pressure vessels, oxygen deficiency, other mechanical hazards. Will use standing laboratory safety committees for review.

(Possible) Engineering Support for Liquid Argon

Pre-proposal (through December '08)

Engineer, finite element analysis, 0.5-1 FTE
Will help with analysis of Princeton cryostat design.

Engineer, process/cryo 0.2 FTE
Conceptual design, cost estimation for gas handling system

Designer, 0.2 FTE
Ion chamber for Ar-39 counting, charge collection grids

Technician, 0.2 FTE
Argon-39 counting system assembly

(total: 1- 1.5 FTEs)

After Fermilab and NSF proposals are approved (Jan. 2009- Jan 2011?)

Project engineer, 0.25 FTE
Process/ cryo engineer, 0.5 FTE
Engineer, other, 0.25 FTE
Designer/ drafter 0.5 FTE
Technician, 2-3 FTE

(3.5- 4.5 FTEs)