Support for Dark Matter Experiments at Lab 3

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With discussion and input from

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Benefits of Clean rooms for DM Experiments

- Cleanliness is critical for work on inner DM detectors

- Temperature and humidity control not as important

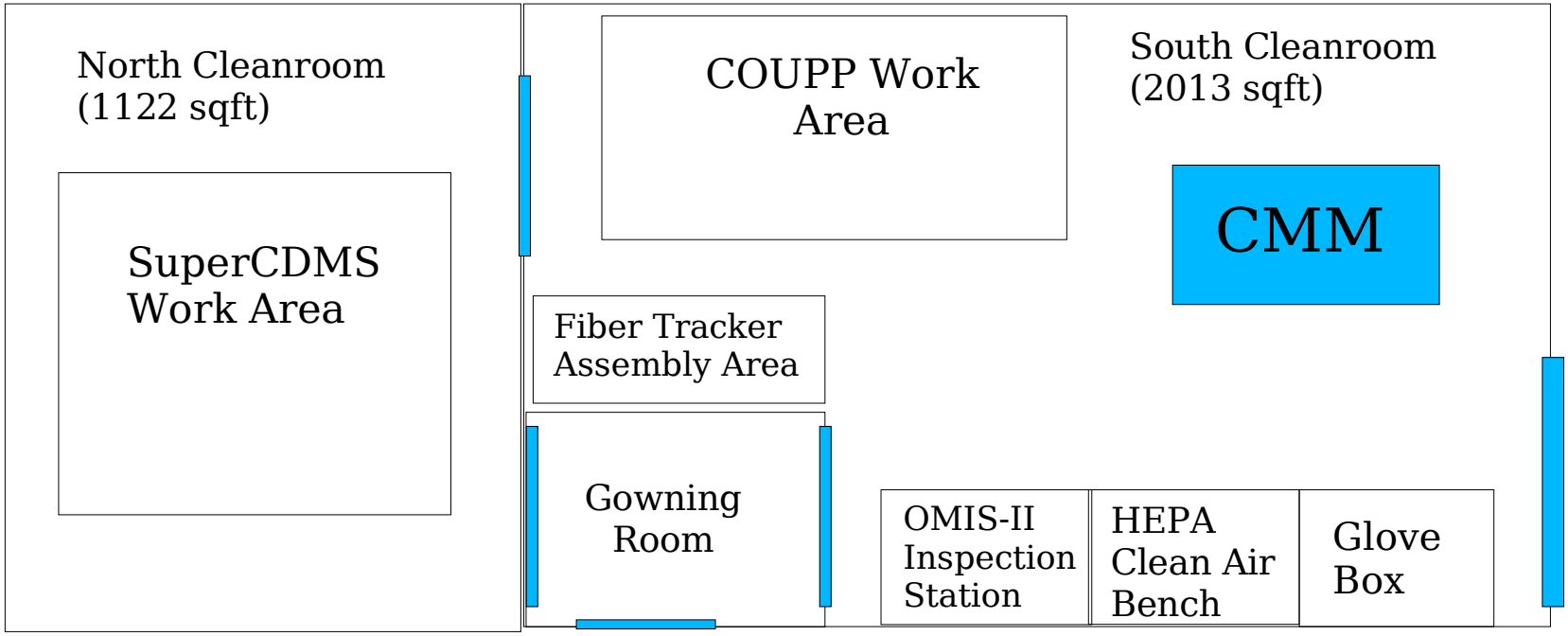
- Air flow is tightly regulated. This allows for additional conditioning of air volume to improve air-borne radioactivity and cleanliness.

- Controlled Access Area. Helps in establishing and maintaining cleanroom procedures.

Lab 3 Clean Rooms

- Achieved Class 10000 during construction of D0 fiber tracker

- Major Customers are SuperCDMS and COUPP



* For Comparison, Lab C Clean room size is 3150 sq. ft.

Outline

- On going SuperCDMS and COUPP work at Lab 3
- Recent changes to Lab 3
- Proposed New Infrastructure

SuperCDMS Cryogenics in Lab 3

- Pulse tube cryocooler testing (July-December 2007)
  - Evaluate thermal performance
  - Study vibrations and mechanical isolation techniques
  - Use to study thermal joints at 77K and 4K

- Setup and test old Oxford Dilution refrigerator (Sept 2007 - Sept 2008)
  - Use for thermal design of SuperCDMS cryogenics sytem
  - Help to determine specs for new cryogen-free fridge

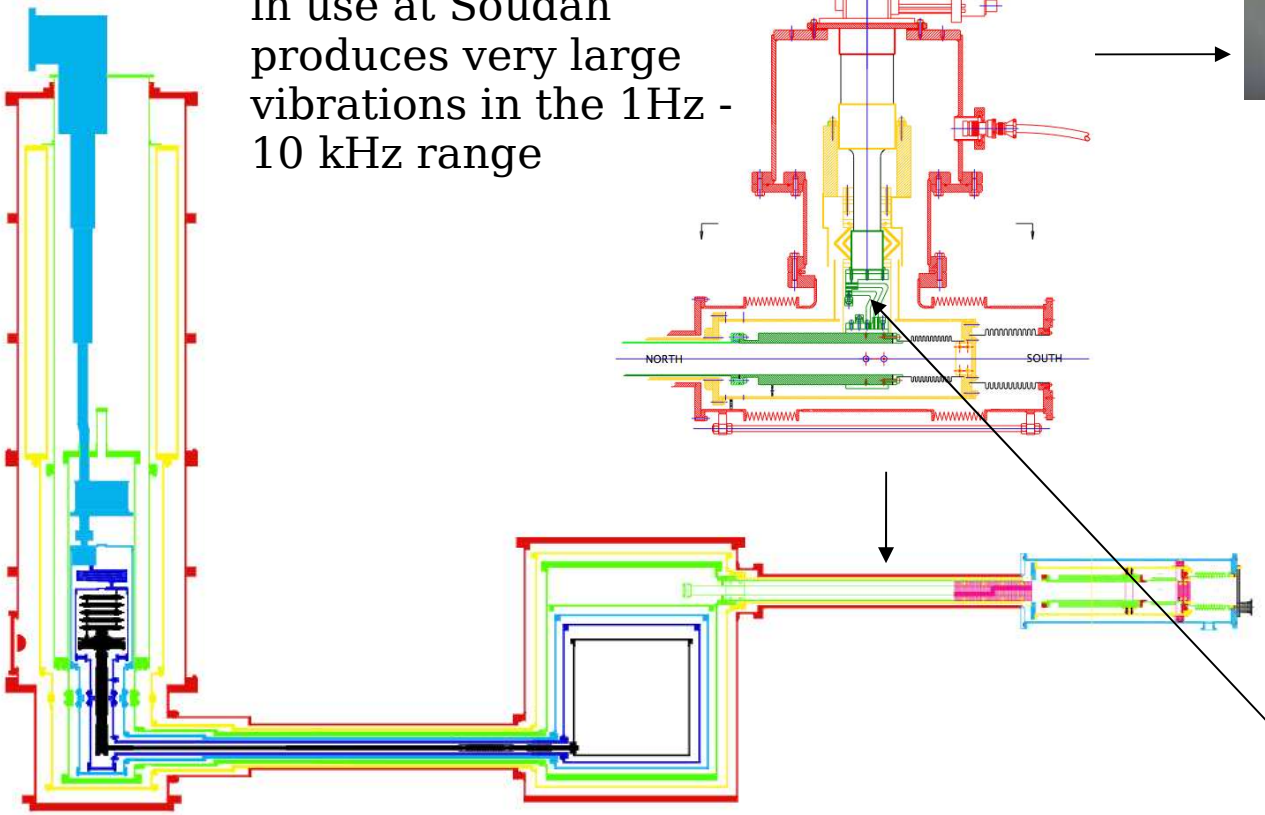
- Systems test
  - Setup complete SuperCDMS cryogenics, shield
  - Test thermal, mechanical aspects
  - Maybe even full detector, electronics checkout

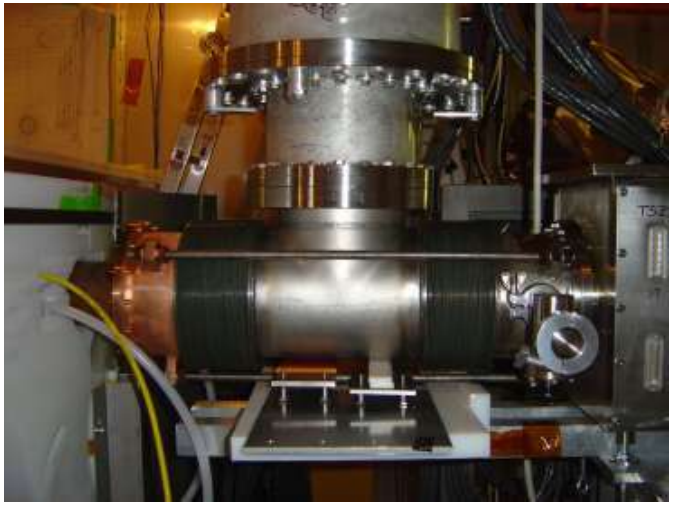
D. Bauer

Cryocooler Used for CDMS II at Soudan

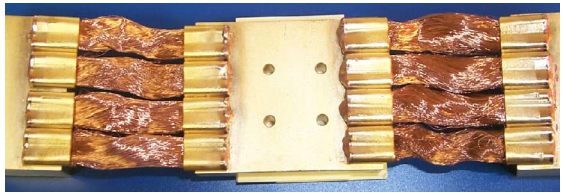
Cryocoolers needed to intercept heat loads at 77K and 4K in CDMS cryogenics systems

Older (Gifford-McMahon) cryocooler in use at Soudan produces very large vibrations in the 1Hz - 10 kHz range





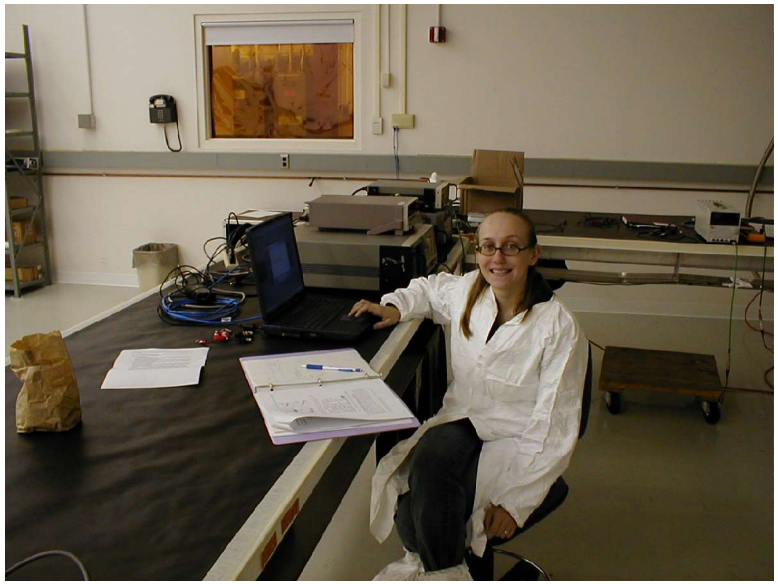
- Add vibration isolation straps from Janis between electronics stem and cryocooler
- Successfully reduced vibrations by x100
- Residual vibrations still have small effects on some detectors

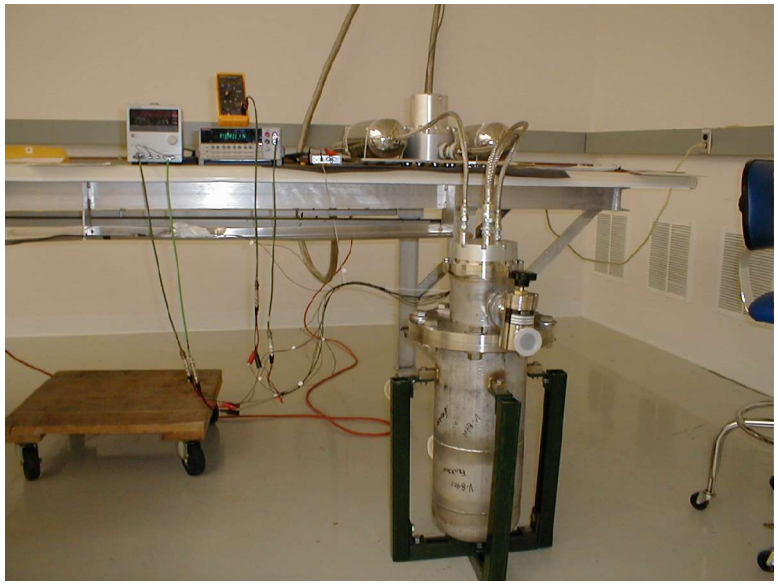


D. Bauer

Testing new pulse-tube cryocooler in Lab 3

- Dan Bauer, Lauren Coutant (summer intern), Bruce Lambin, Rich Schmitt
- Cryocooler seems to be operating properly, although need to improve thermometry
- Initial measurements confirm that pulse-tube vibrations mostly > 1 kHz
- Need to study ways to reduce these vibrations in 1-50 kHz range





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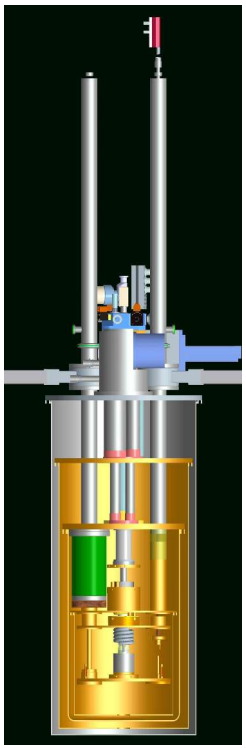
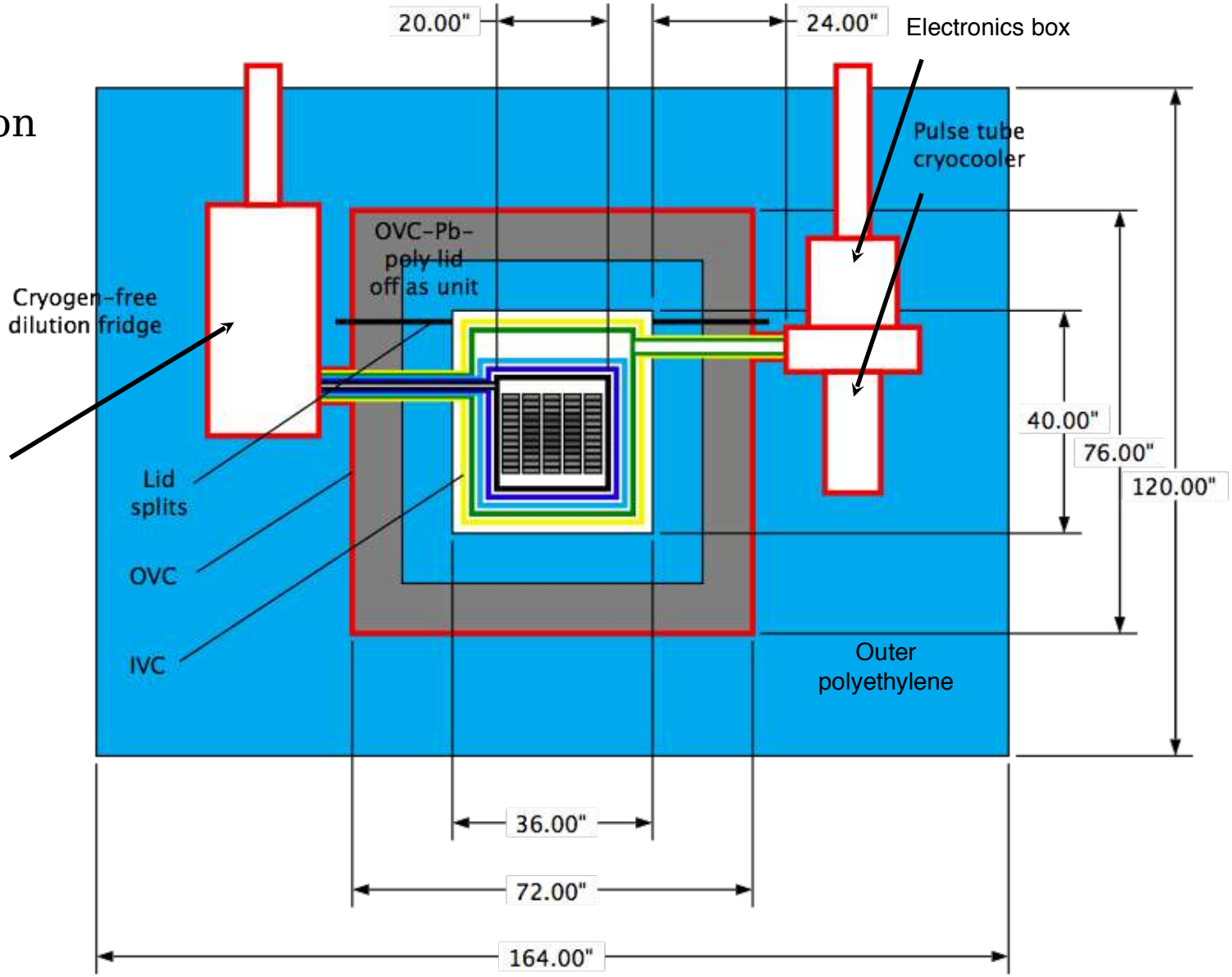
Lab 3 systems tests needed to validate thermal and mechanical design of cryogenics, shielding

Required modification of Lab 3 cleanroom ceiling





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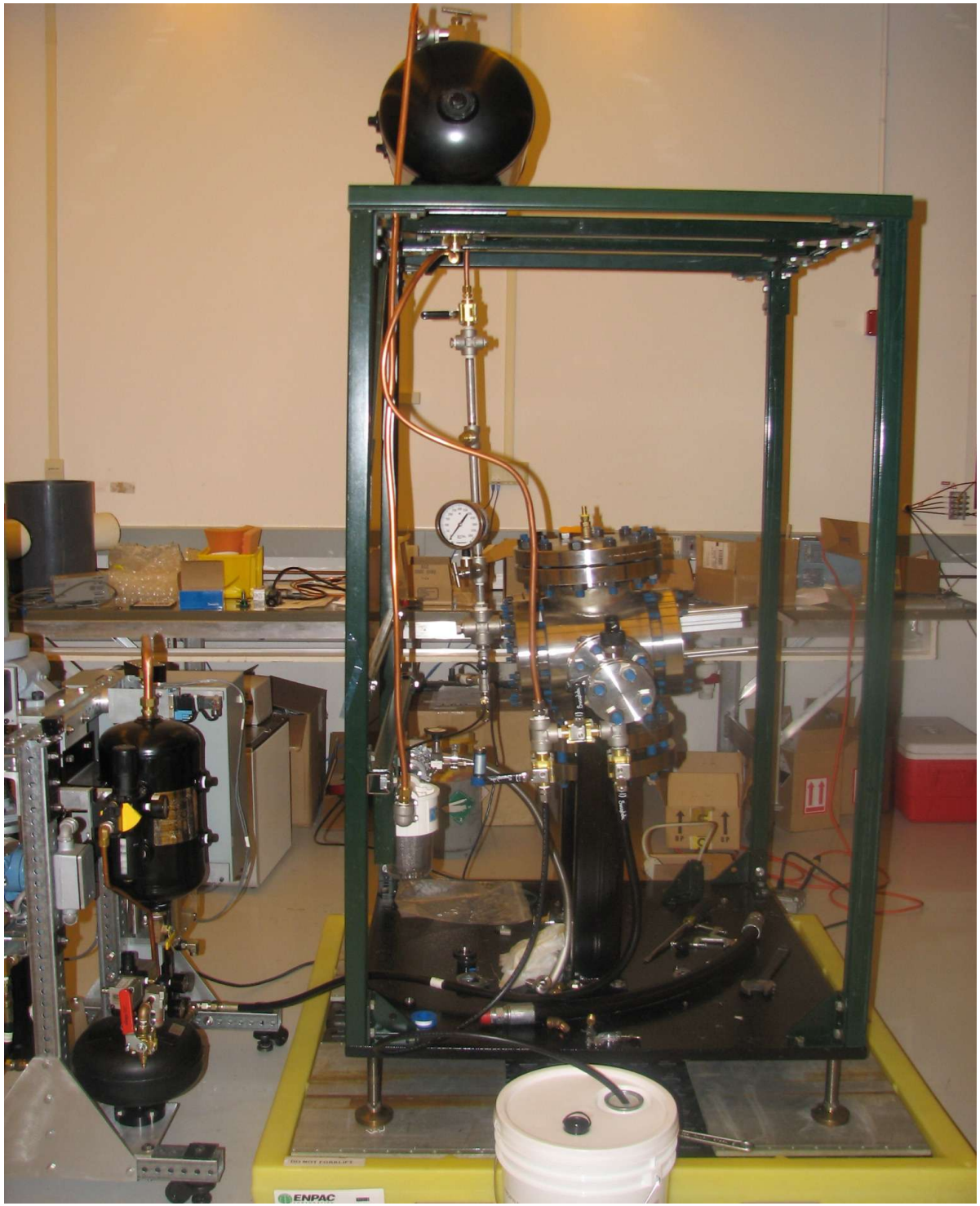


Commissioning the COUPP Pressure Vessel Controller at Lab 3

Recent Infrastructure Changes (FY06-FY07)

- Modified North Cleanroom ceiling to accomadate SuperCDMS dilution refrigerator. Added ceiling hoist for lifting dilution refrigerator components.

- Clean-room penetrations for cryogen transport

- Upgrade of “east-side” utility room (formerly the D0 fiber-tracker cosmic teststand):

- Electrical work for cryocooler compressors
- Exhaust ventilation for ODH mitigation and for radon “plate-out” teststand.

Helium lines penetrate into North Clean room

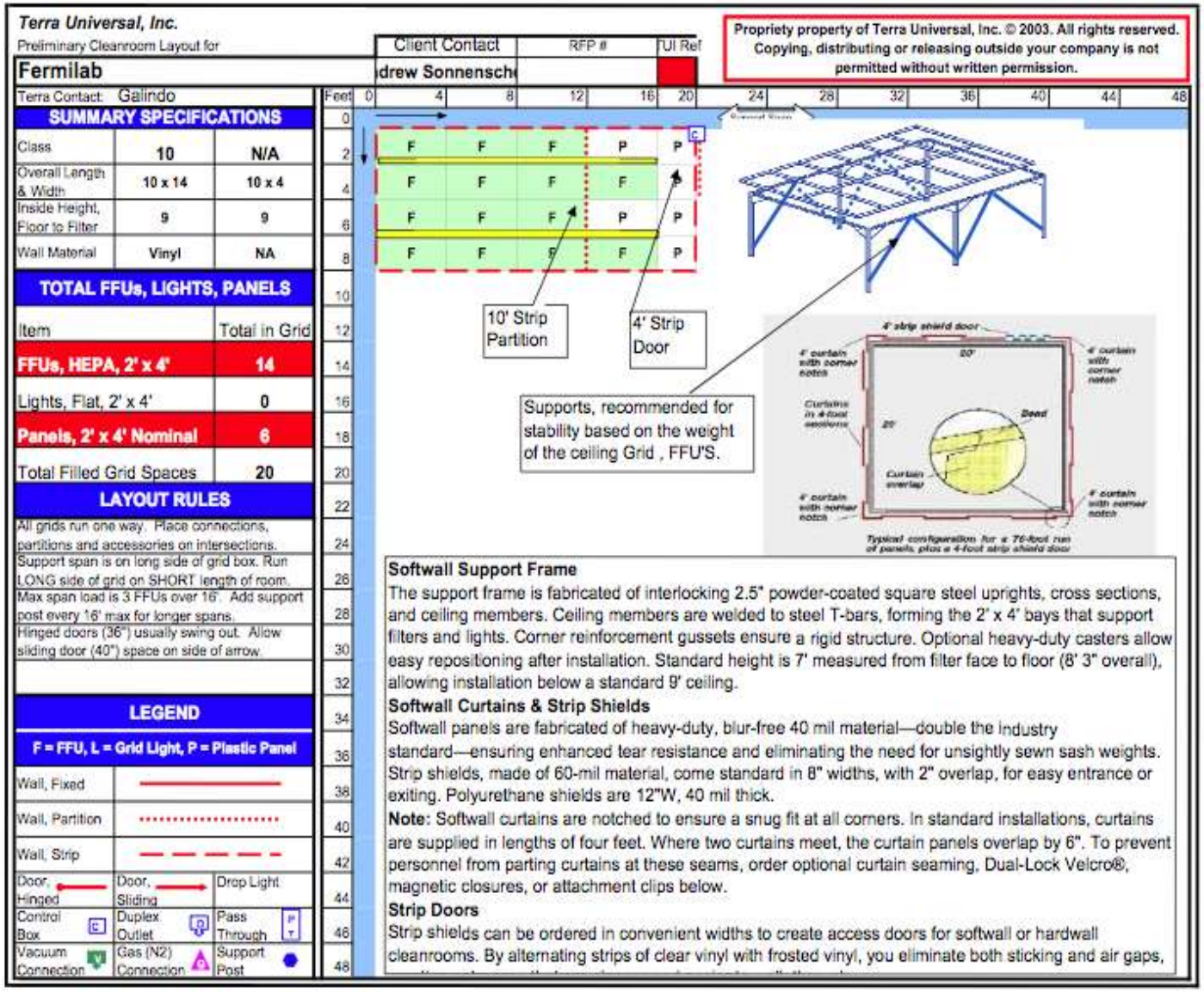
New Fan in Utility Room

Cryocooler compressor and heat exchanger in East utility room

Radon Plateout Chamber

Proposed COUPP Class 10 Clean Room

- Soft-wall clean room inside the Lab 3 south clean room
- ULPA filters
- 8' x 12' work area for 30L COUPP inner vessel assembly
- Similar room in AD achieves Class 10
- Commercially available item from Terra-Universal
- Could house low-background counting facility in collaboration with SuperCDMS (see later slide)



A. Sonnenschein

Proposed COUPP Low- Radioactivity Water System

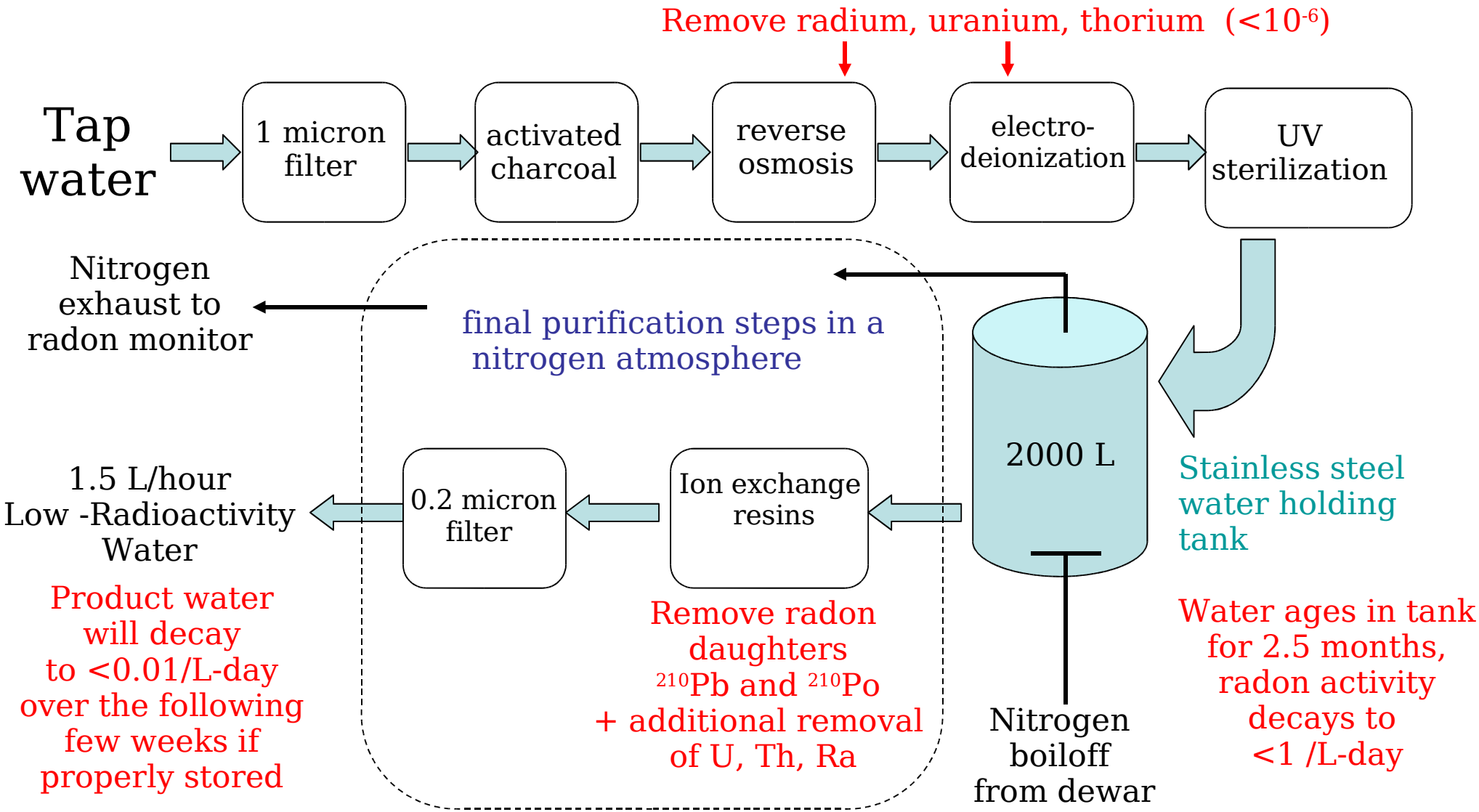
Radioactivity of Winfield Tap Water	Alpha Rate (decays/Liter/day)
Radium	5000
Radon	100000
Uranium	10000
Thorium	50
Polonium	500
COUPP Goal	**<0.01**

Alpha activity reduction factor of ~10^7

- Comparable to water purification requirements of Borexino and SNO.
- Much SMALLER volume throughput (1.5 Liter/hour)
- Important aspects of this problem are already understood.

A. Sonnenschein

Proposed COUPP Low-Radioactivity Water System



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Proposed Low-Background Counting Facility

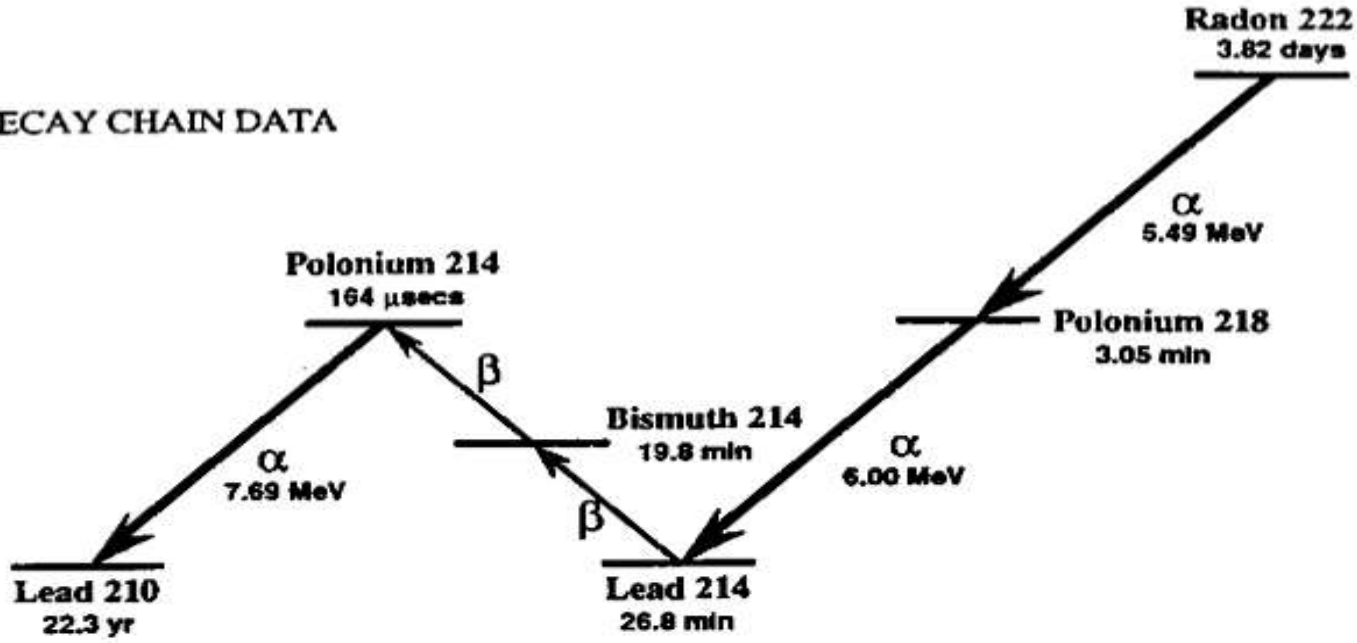
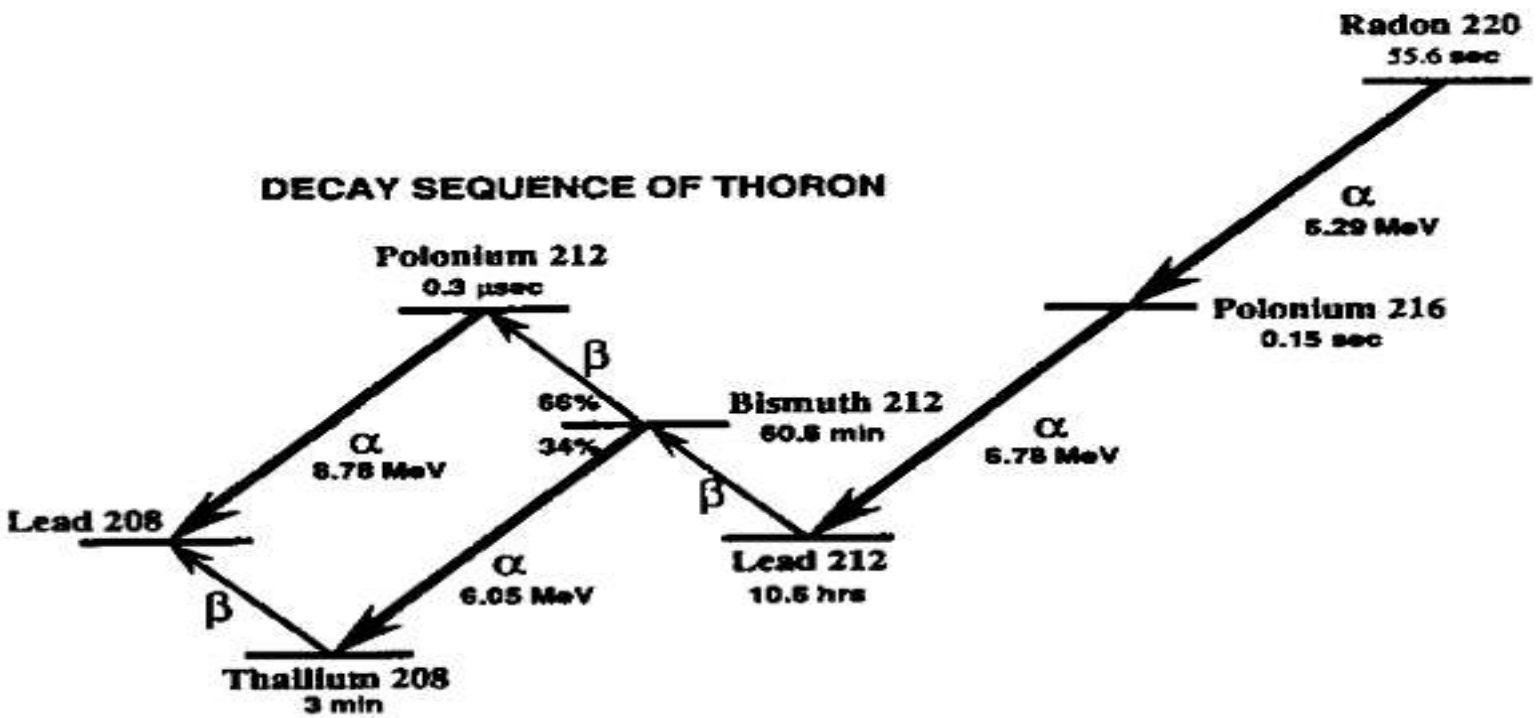
Minimizing background from radioactive contamination is critical

- Uranium decay chains mainly produce alphas, beta and gammas.
- Alphas are problem for COUPP, Betas and Gammas for CDMS
- Especially problematic are Radon and Pb_{210}

Facility Uses & Requirements

- To qualify materials for assembly into inner detector
- To study radon emanation and "plateout" (implantation of radon daughters into material surface)
- Need sensitive alpha detectors
- Radioactivity concentrators to increase sensitivity
- Class 10 clean room environment (possible collaboration between COUPP and SuperCDMS)

DECAY CHAIN DATA



DECAY SEQUENCE OF THORON