

Accelerator Options and R&D for an Underground Accelerator Laboratory at DUSEL



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ALNA - Accelerator Laboratory for Nuclear Astrophysics Underground

Two accelerator based experimental areas were discussed in the November meeting in Washington DC

- The energy range of both accelerators should have an overlap for comparison between experiments over a common energy
- Combined both accelerators should cover beam energies from as low as 50keV up to 1 MeV/nuc for ion masses up to Mg (1.5/nuc for ^4He)
- The accelerators should have complimentary, flexible and exchangeable target and detector set-ups

The astrophysics community has assembled two white papers describing the science case and the hardware requirements, these white papers will have to be further refined for the S-4 process.

http://www.deepscience.org/TechnicalDocuments/Final/ualna_final.pdf, 2006

http://ecrgroup.lbl.gov/white_paper.htm Washington DC Workshop, November 2-4, 2007

1. A compact, high intensity low energy (50keV - 400keV) accelerator for forward kinematics reactions (complementary or expanding on LUNA activities, need priority list of experiments)

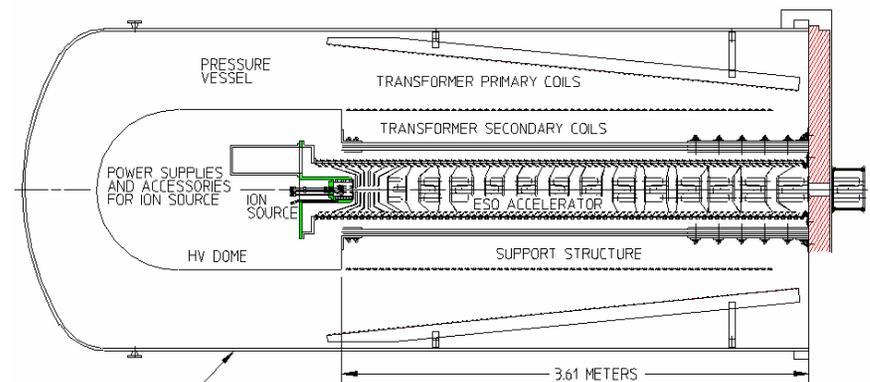
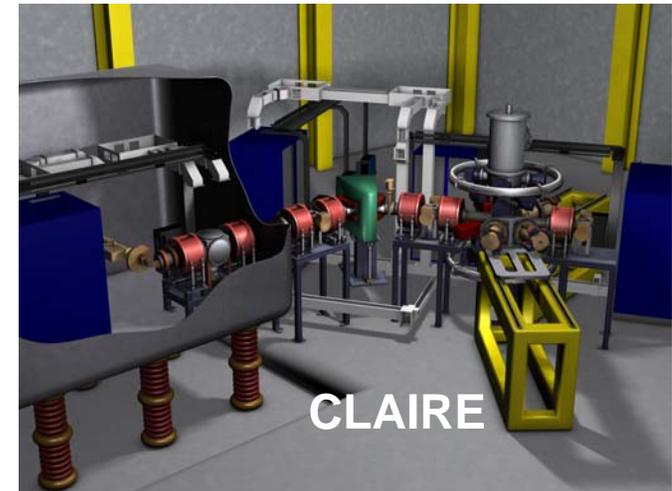
- CLAIRE (High current DC accelerator)

2. A versatile high intensity heavy ion accelerator for medium energies (.3 to 3MeV) for low energy alpha capture reactions and (maybe inverse kinematics reactions)

- RFQ LINAC
- Pelletron, Tandem
- Dynamitron, Singletron

3. Ion sources for both accelerators

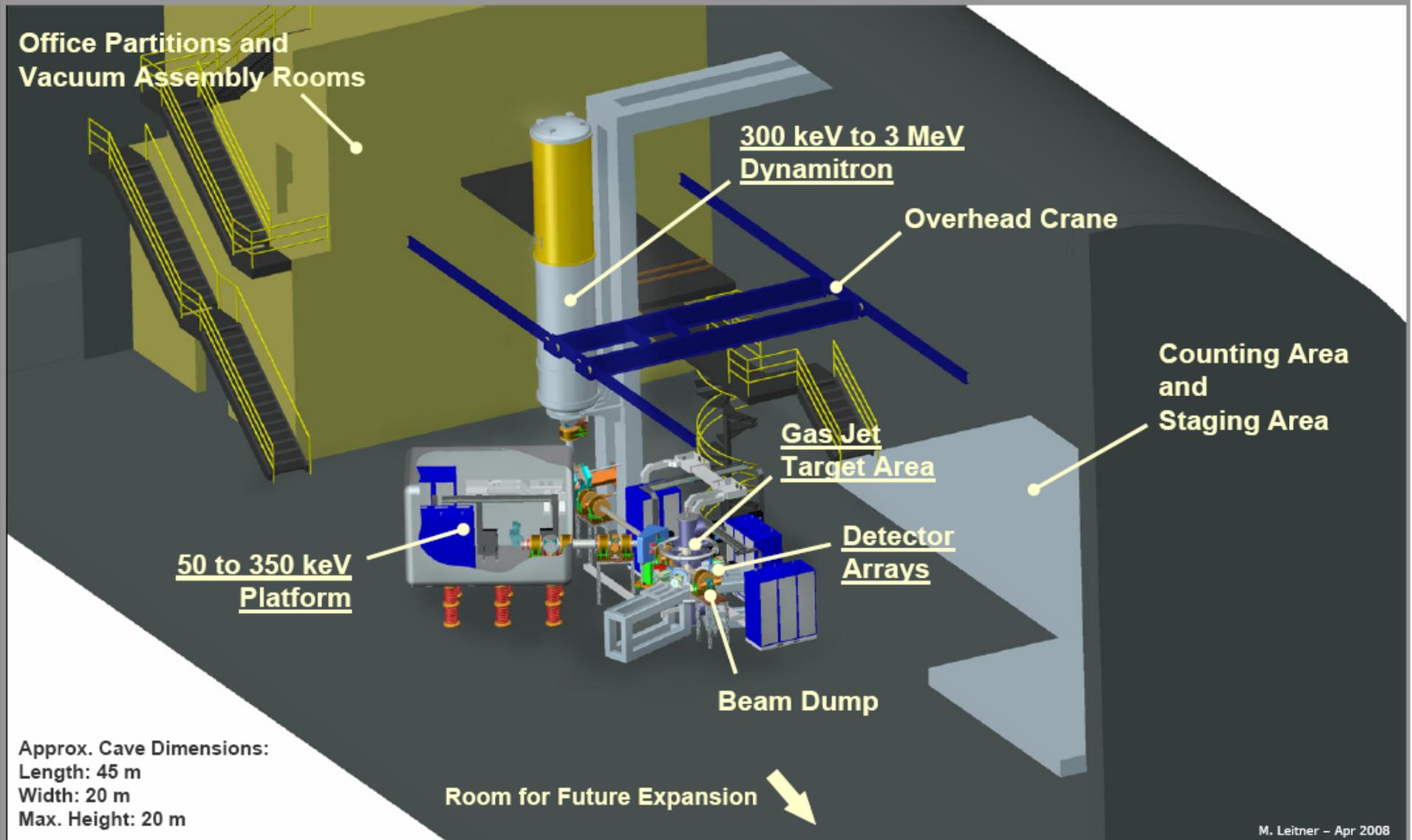
- high intensity 1+ ECR (up to 100mA)
- Medium intensity n+ ECR (.5mA)



ESQ DC accelerator

UNDERGROUND ACCELERATOR LABORATORY CAVE MODULE LAYOUT

1



The Underground Accelerator Laboratory

Deep Underground Science and Engineering Laboratory

Infrastructure

Space

One Standard Experimental Cavities of $50 \times 20 \times 15 \text{ m}^3$ are currently envisioned for the **4850 ft** level.

- Low energy accelerator: CLAIRE: $10 \times 8 \times 5 \text{ m}^3$
- High Energy Accelerator: $30 \times 20 \times 5 \text{ m}^3$, space for SF_6 (if needed)
- Experimental hall: $20 \times 15 \times 5 \text{ m}^3$ with additional space of $5 \times 10 \times 3 \text{ m}^3$ for housing the necessary power supply units for magnetic and electric beam optics systems.
- Control area, Counting area: $8 \times 8 \times 3 \text{ m}^3$
- Power supplies: $5 \times 10 \times 3 \text{ m}^3$
- SF_6 storage, Cooling water, Cryogenic equipment/cryogenics $10 \times 10 \times 5 \text{ m}^3$.

Above ground areas

- Machine shop area
- Above ground office space and counting areas
- Laboratory space for general use (experiment preparation, detector testing and target preparation)

Infrastructure for Accelerator and Experimental halls

- Overhead crane systems for transporting and positioning heavy equipment
- De-ionized cooling water
- Air conditioning
- Electrical power requirements 200kW (CLAIRE)
- Electrical power requirements, Medium Energy Accelerator (TBA, Engineering and R&D item, clean power)
- Cryogenics
- Vibration free transport

Auxiliary Equipment

- windowless re-circulating gas target (gas jet and gas cell)
- evaporator and target laboratory (a serious shortcoming at LUNA)
- a Ge-NaI or Ge-BGO detector array
- Segmented Ge or Ge strip detectors,
- a number of Si strip detector systems
- heavy ion recoil separator
- Neutron detector
- Beam Dump

R&D items and Status of the DUSEL Accelerator Planning

Design decision **Energy range, intensities, system flexibility**

CLAIRE

- **Preliminary Accelerator R&D has been conducted over the last three years (preliminary engineering design exists)**
- **Cost estimate cost estimate to DOE for long-range planning of capital equipment funding submitted**
- **R&D**
 - **Moveable high voltage gap**
 - **Neutralization of beam through the analyzing magnet for high intensity beams**
 - **Gas jet target/ ion beam interaction**

Medium Energy Accelerator

- **High intensity ESQ DC accelerator or traditional accelerator**
- **R&D**
 - **Ion optics design and current optimization over the wide energy range**
 - **Compact ECR ion sources for medium charge states in a high pressure dome**
 - **X-ray background from an ECR ion source**
- **Design/R&D study 3-4 people, 1 year should be conducted to arrive to an optimized design solution (S-4)**