Helium Recovery at the National High Magnetic Field Laboratory

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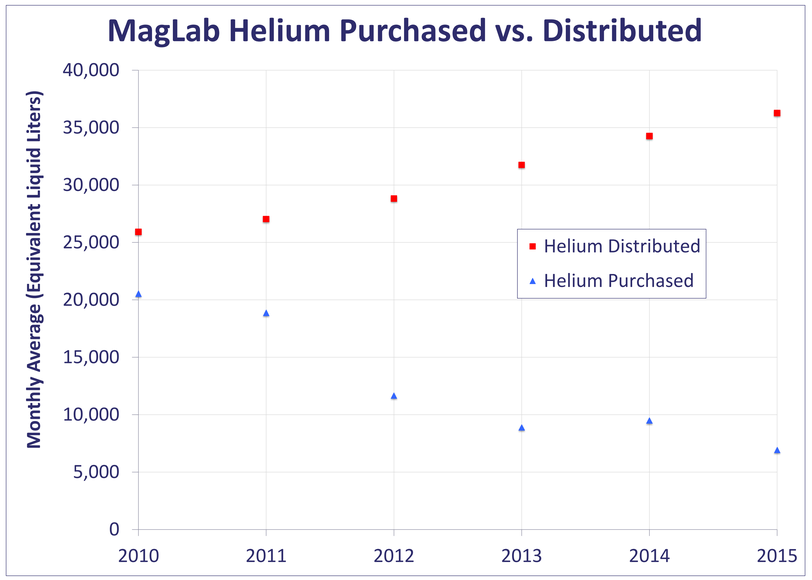
Introduction

The National High Magnetic Field Laboratory (Mag Lab) is the largest and highest powered magnet laboratory in the world. Every year, hundreds of scientists (internally referred to as "users") perform research at the Mag Lab for free, thanks to funding from the National Science Foundation, the Department of Energy and the State of Florida.

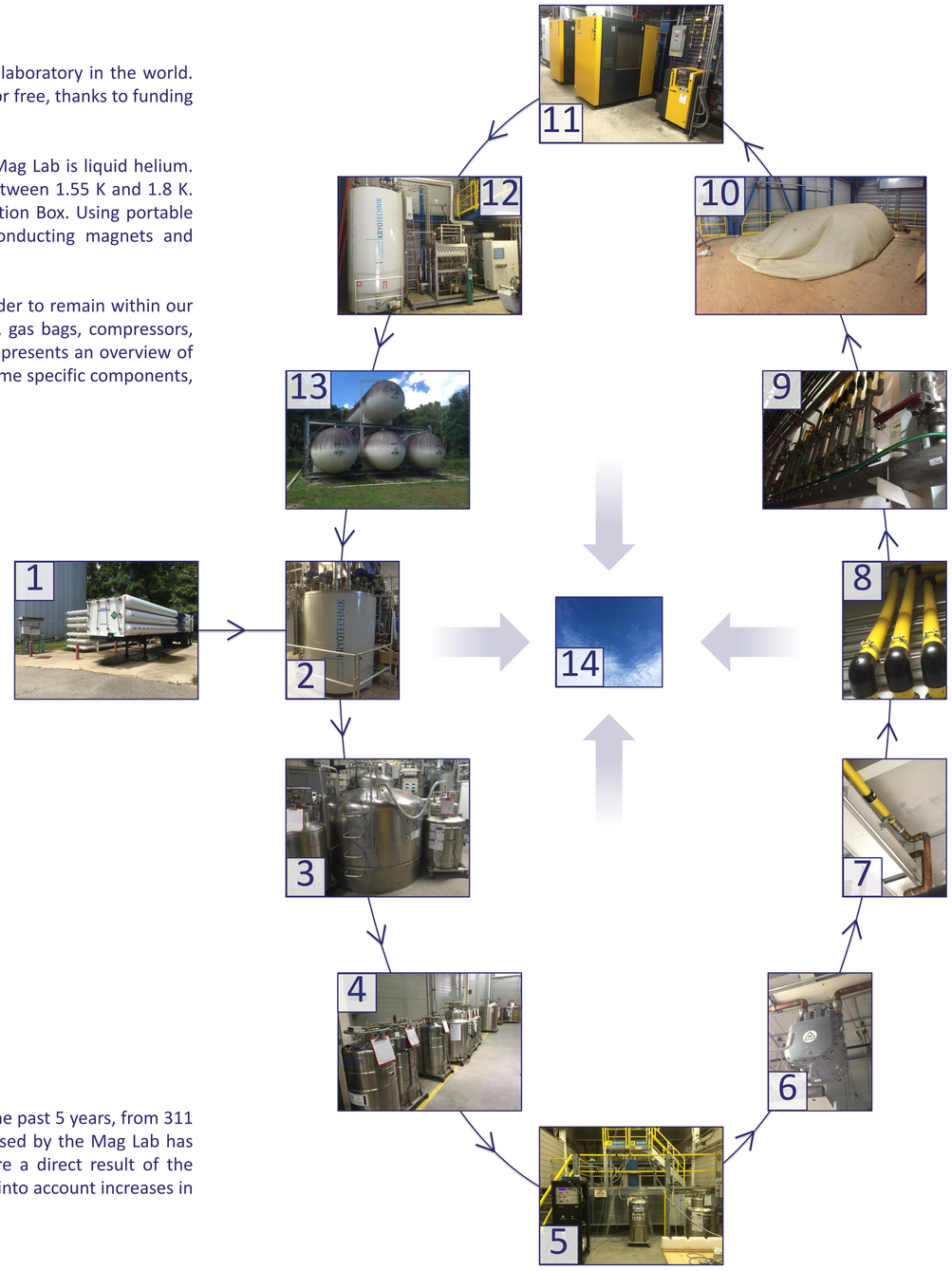
Next to electricity, one of the most significant costs associated with the research performed at the Mag Lab is liquid helium. The 45T Hybrid Magnet requires roughly 650 L/day of LHe to maintain its operating temperature between 1.55 K and 1.8 K. The 45T Hybrid is directly connected to our Linde LR280 helium liquefier through a Central Distribution Box. Using portable dewars, another roughly 1,200 L/day are distributed throughout the lab to cool other superconducting magnets and experiments.

With this level of demand for liquid helium, it is necessary to employ a helium recovery system in order to remain within our operating budget. Helium recovery systems for research facilities generally include piping networks, gas bags, compressors, liquid and gas storage systems, liquefiers, and portable dewars. The paper accompanying this poster presents an overview of the helium recovery system for the Mag Lab, including usage and recovery statistics, system layout, some specific components, and examples of the challenges we've faced while developing the system.



Helium Consumption

Liquid helium usage (portable dewars only) at the Mag Lab has increased by about 7% per year over the past 5 years, from 311 m^3 to 443 m^3 annually (815 L to 1215 L daily). Over the same period, the amount of helium purchased by the Mag Lab has decreased from 226 to 84 equivalent liquid m^3 annually. The improvements in helium recovery are a direct result of the implementation of the new purifier and modifications to the recovery system. The data does not take into account increases in the overall system inventory, which has a very minor effect on an annual scale.



Mag Lab Helium Life Cycle

1. High Pressure Storage Tanks
   - 20 m^3 of permanent storage w/max 2000 psig
   - Vendor trailer 26 m^3, max 4000 psig for makeup gas
2. Linde LR280 Helium Liquefier/Refrigerator
   - Refrigeration: 1000 W @ 4 K
   - Liquefaction: 200 L/hr
3. 3,000 L Dewar
   - Used to fill portable dewars for researchers
4. Dewar Retrieval Station
   - 58 dewars are available
   - 14,800 L of total capacity
   - 100 L, 250 L, and 500 L sizes
5. Magnet Cell
   - Modular stations designed for ease of use
   - Quick connect coupling
   - Flex hose
   - Check valve to prevent back streaming contamination
6. Gas Meters
   - Monitor recovery rates from individual labs
   - Mostly bellows style, natural gas type meters
   - Rotary or thermal dispersion type for higher flows
7. Copper to HDPE Transition
   - Copper piping warms gas and handles thermal contraction
   - HDPE is less costly for the longer pipe runs
8. HDPE Piping
   - Designed for natural gas use, but helium leak tight
   - Has minimum bend radius of 27"-32"
   - Joints can be fused or fitted
9. HDPE to Stainless Steel Transition
   - Individual branches combine into a main header
   - Sample lines from the branches are used to check for contamination
10. Gas Bags
    - 3 gas bags collect the recovery gas
    - 10'x10'x25' (2,500 ft^3) low pressure bags
11. Compressors
    - Used to empty the gas bags and supply the purifier
    - Flowrates: 2.5 g/s – 18 g/s
    - Discharge pressure: 13.5 bara
12. Linde PUR10 Purifier
    - Parallel paths allow for constant operation
    - Design conditions: 10,000 ppm Air, 500 ppm Water, up to 18 g/s
13. Medium Pressure Storage Tanks
    - Four 145 m^3 tanks
    - Max pressure: 200 psig
14. Helium Losses
    - Can occur at any point in the life cycle
    - It is our goal to minimize these losses