An Isotope Separation System (ISS) will provide LLE with a flexible tritium fuel supply:
- Ensures the purity of the tritium fuel supply meets LLE’s baseline ICF program requirements
- Recover tritium from existing, unusable spent DT fuel
- Eliminate the need to ship tritium to/from external cleanup facilities
- Provide LLE with the ability to examine fusion reactions at D–T ratios other than 1:1

The ISS will reside in the Tritium Laboratory.
The core system, LN2 cooling, and glovebox purification

There are four subsystems:
1. The gas handling system feeds isotope-enriched tritium to the core system and provides temporary storage for purified tritium
2. The core system decomposes the mixed hydrogen isotopes (HT and DT) and separates them to isolate pure tritium gas
3. The glovebox cleanup system provides a secondary containment for any tritium in the ISS
4. Control system

The ISS comprises four subsystems: gas handling, core system, LN2 cooling, and glovebox purification.

Both columns sort hydrogen isotopes according to mass but use different mechanisms:
- Pd6 column separates and decomposes molecules based on differences in the hydrogen isotope isotopes
- Molecular sieve column separates molecules based on differences in the hydrogen isotope residence times on cold mole sieve

The Gas Handling System comprises a uranium and a palladium storage bed:
- Both beds have a maximum working inventory of 5 liters of hydrogen gas
- Beds have a secondary containment
- The bed design permits the option for circulating gas through the “getter” medium
- The uranium bed will be used for tritium storage
- The palladium bed will be used to move “pump” tritium inside the gas handling loop
- The palladium bed will be used to separate decay helium from the tritium gas

H, D, T, 3He, and mixed isotopes are measured by gas chromatography at the μL aliquot level using two carrier streams:

\[ \text{Separation of HT}_2 \]
\[ \text{Detection of } \text{He} \]
\[ \text{Avoids fragmentation to simplify signal deconvolution} \]
\[ \text{No trimmers} \]
\[ \text{Very simple analysis of isotopic mixtures with low tritium content} \]
\[ \text{Less expensive than mass spectrometry} \]

\[ \beta \text{ detection relies on a unique "wall-less" 5-cc ionization chamber configured to encourage slug flow through the detection volume} \]

\[ \text{Near-baseline separation of the hydrogen extracted from the gas target can be achieved} \]

The LLE Assay System relies on three diagnostics:
- Thermal conductivity detector
  - H/D/T detector, ppm detection limit
  - dual filament, differential operation, flow through
  - nozzle to increase sensitivity to hydrogen and allow flow detection
- Pulsed-discharge detector
  - trace impurity content of the hydrogen (air, organics, and helium)
  - ppb detection limit, helium carrier, operating temperature 200°C
- Wire-cage ionization chamber
  - active hydrogen species
  - calibrated to operate over a broad range ppm to pure tritium
  - 5-cc detection volume, bakeable to 300°C

Key milestones for 2012:
- ISS operational readiness tests late Oct
- De-prototone primary fuel (50/50 DT) mid Nov
- Recovery “T” from spent 10% T in DT early Dec
- Purity pure tritium (36% ~ 99.0%) mid Dec
- Fills using 99.2% T Jan 2013

The GC is installed in an air-ventilated box and effluent is collected with a ZrFe getter

The separation of H2/DT2 mixtures has been demonstrated using 3/8-in. diam. columns:

- Automated room monitor alarms for tritium release, oxygen deficiency
- LN2 supply dewar will be ventilated to the environment
- Laboratory is 0.05-in. H2O negative relative to adjacent labs
- 3.2-C1 release limit
- Real-time monitoring of laboratory air and stack effluent

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