The Cathode preparation and transport system for the Gatling Gun

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Overview

- Motivation and key objectives
- Cathode preparation chamber-step by step design
- Heat cleaning and Activation
- The Cathode storage and transport system to the Gun
- Conclusion and future plan

Motivation

The proposed eRHIC project requires an electron source with the following main parameters :

- High Average Current: 50 mA
- High polarization: P $>$ 80%

50 mA from one cathode for one week = 15,300 C
State of the art charge lifetime = 1000 C.
50 mA distributed over 20 cathodes = 2.5mA per cathode for one week = 765 C Charge lifetime!

The Funnelling Principle

Our main objectives are:

- To investigate the status of one cathode i.e. change in QE, lifetime etc., in the vicinity of another operating cathode.
- To funnel multiple bunches to one common axis using a rotating magnetic field.

For Phase 1 of the experiment, we aim to combine two bunches from two bulk GaAs photocathodes.

The Gatling Gun

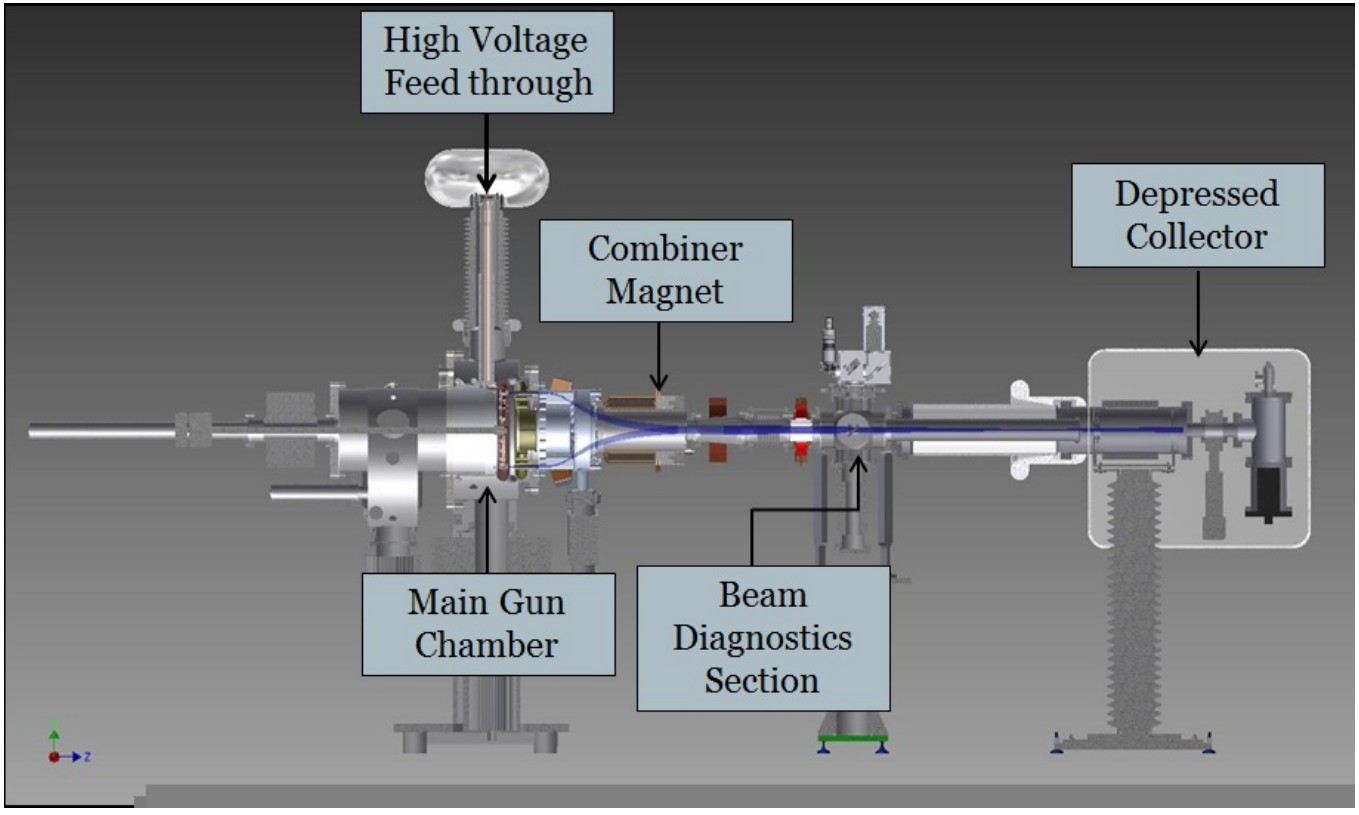
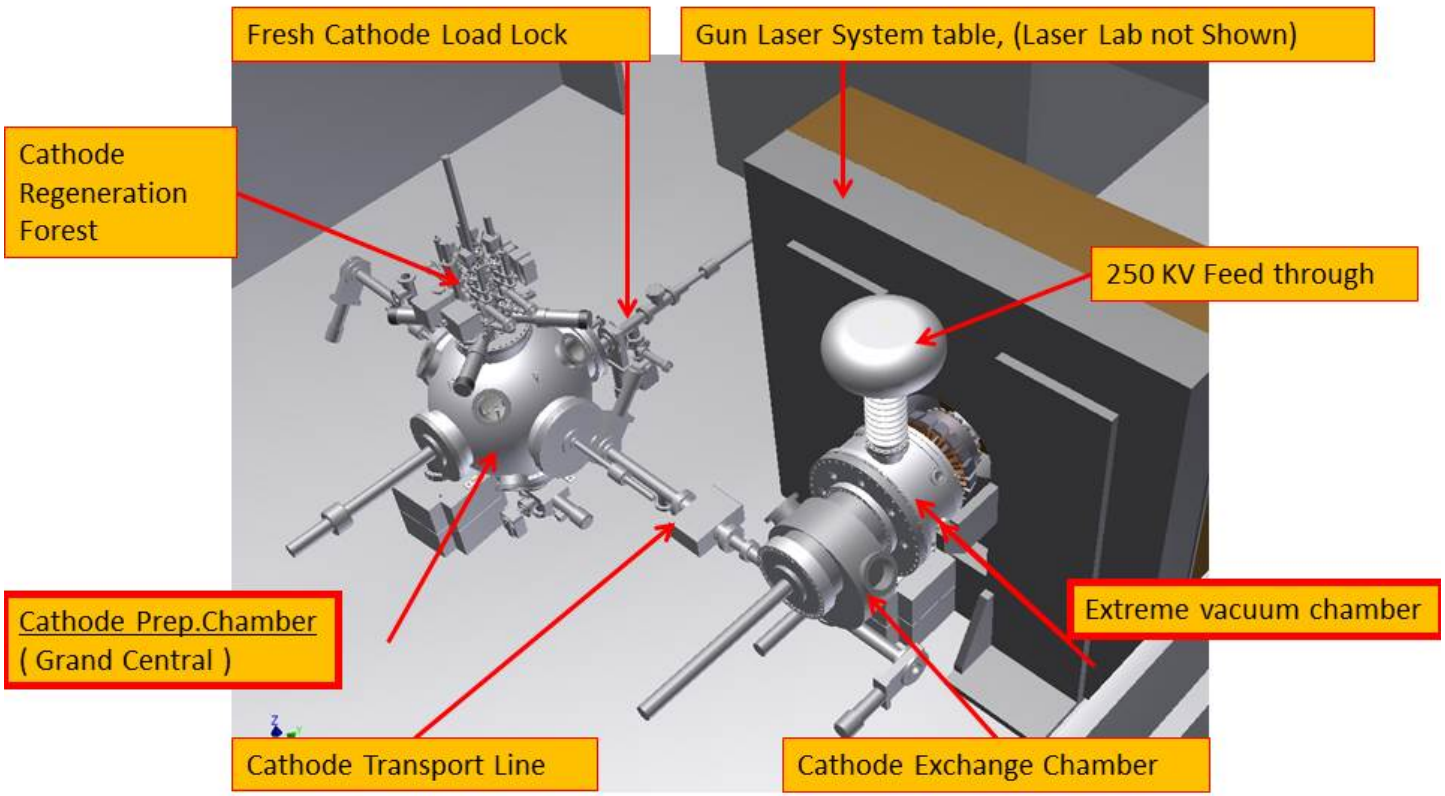


Figure: The Gatling Gun side view, details at E. Wang's talk

Grand Central and The Tree



- Image courtesy: John Skaritka

GaAs

GaAs: Estaibled and widely used source of polarized electrons
Bulk GaAs: Maximum 50% polarization
Superlattice GaAs: More than 80% polarization

Highly senstive to vacuum!

Requires "Activation" before photoemission.

Step by step construction of the tree

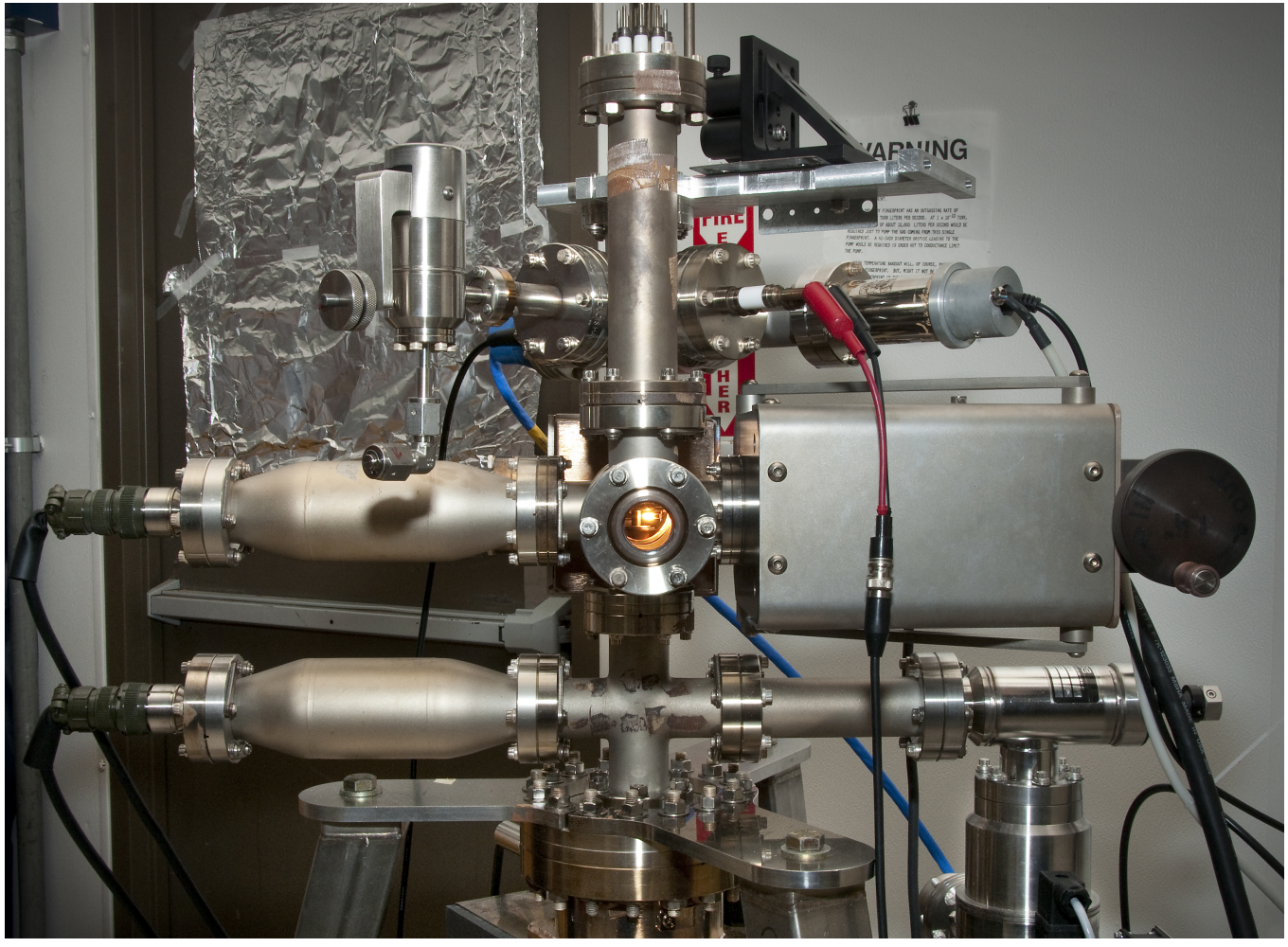


Figure: Front view of the actual tree

Step by step construction of the tree

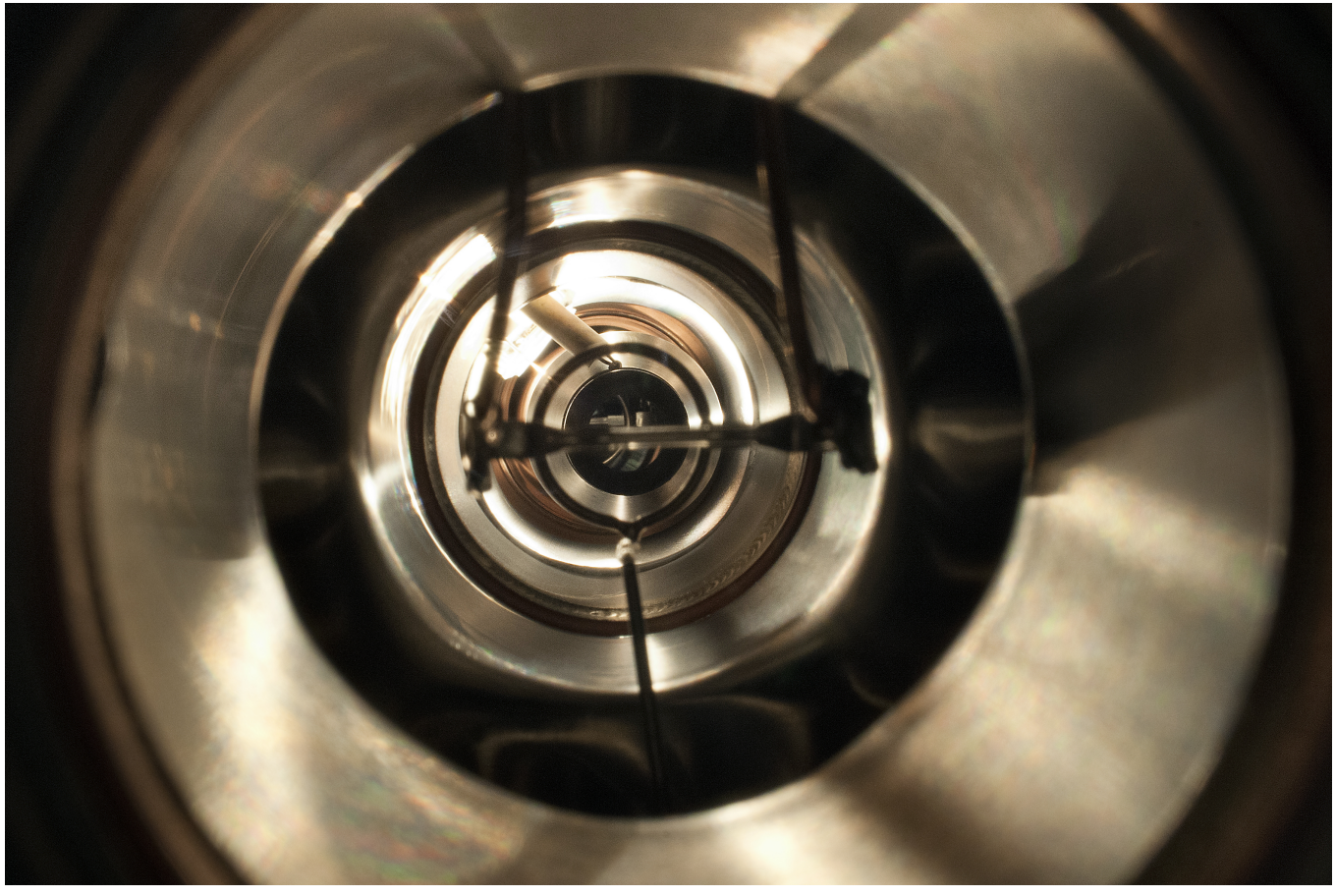


Figure: View through the top window

Step by step construction of the tree

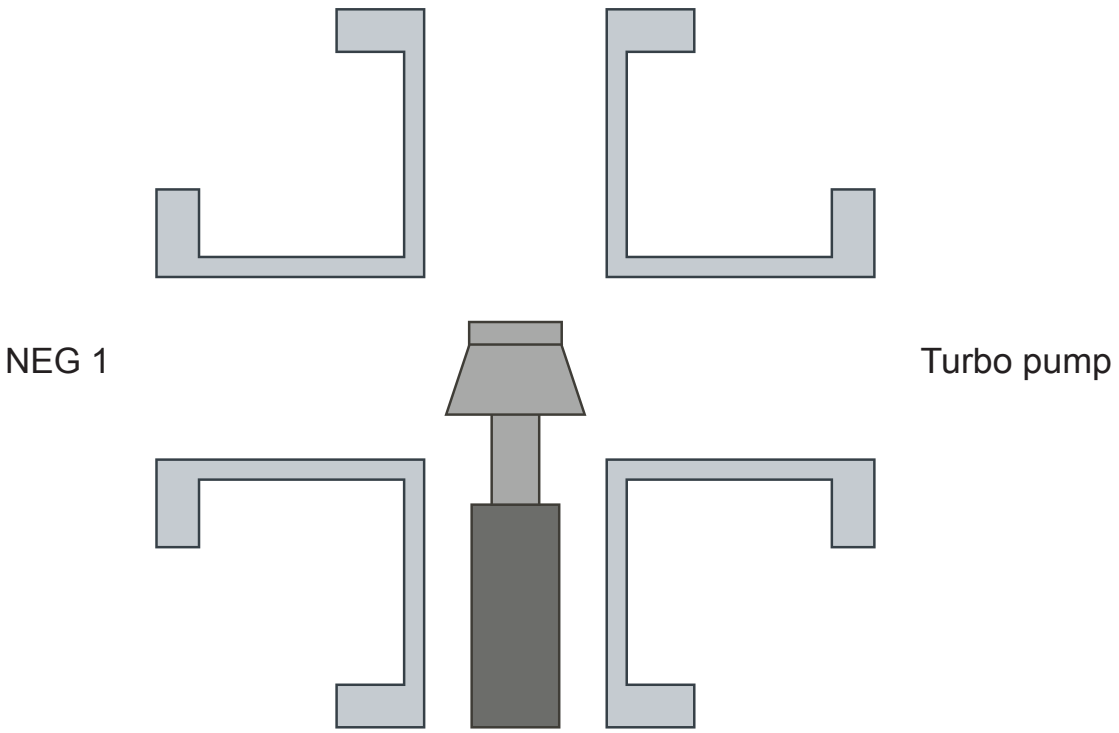


Figure: Lower Cross includes Turbo line and NEG

Step by step construction of the tree

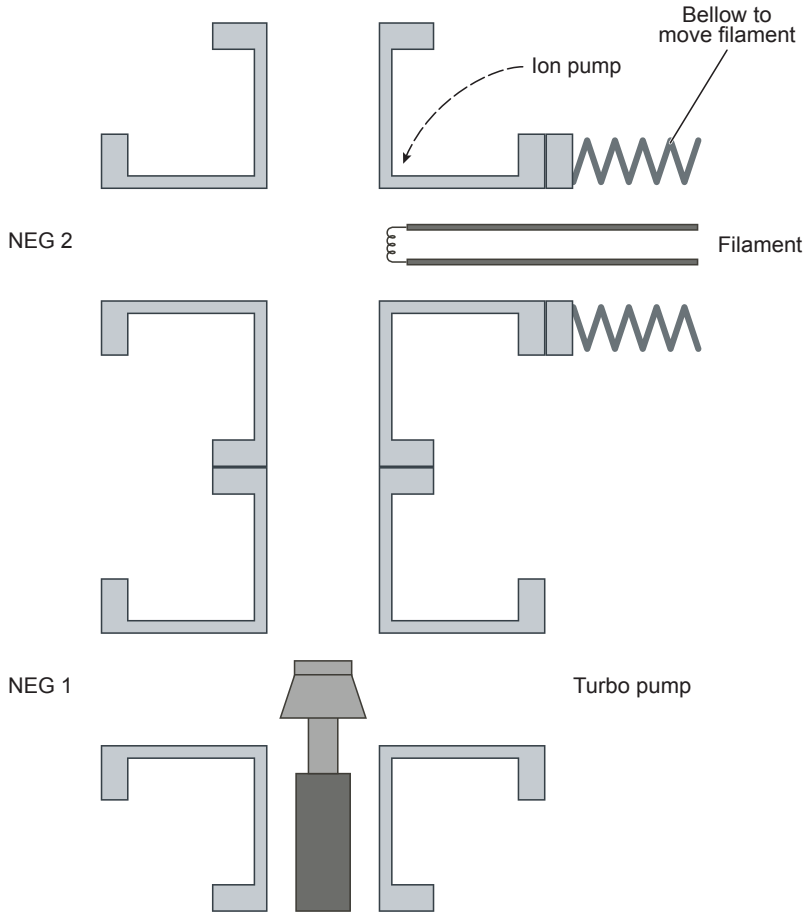


Figure: Second Cross includes NEG, Filament assembly, window and Ion pump

Step by step construction of the tree

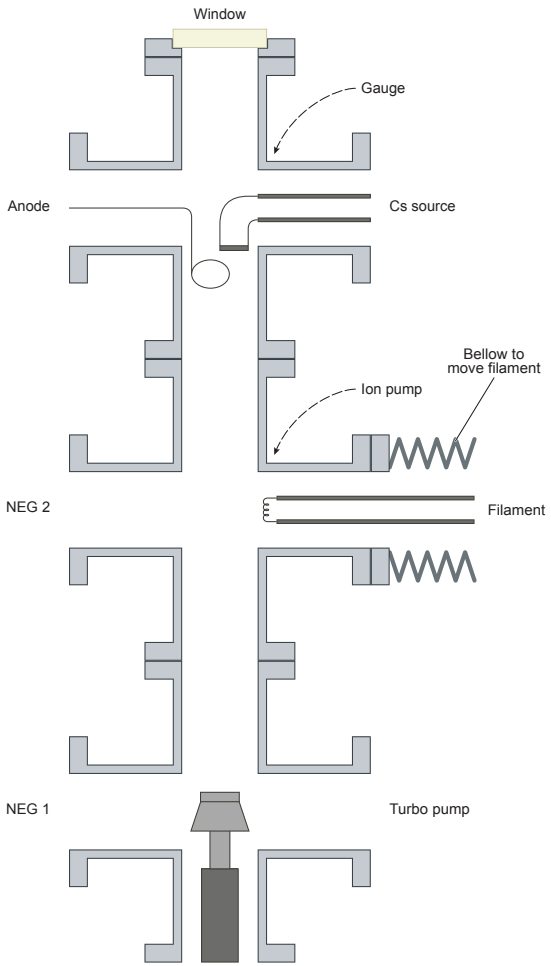
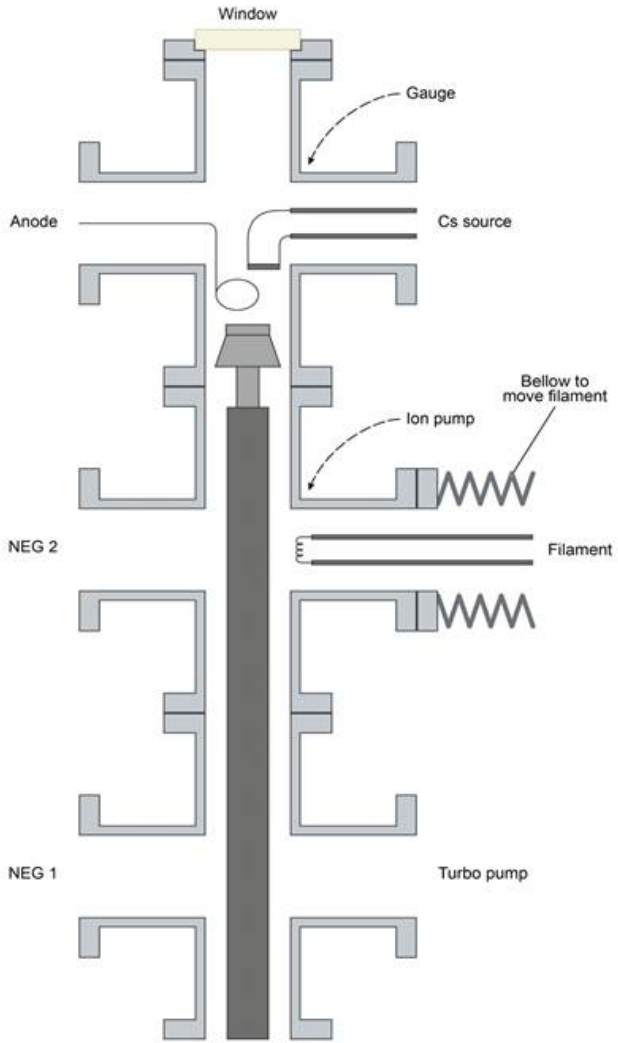
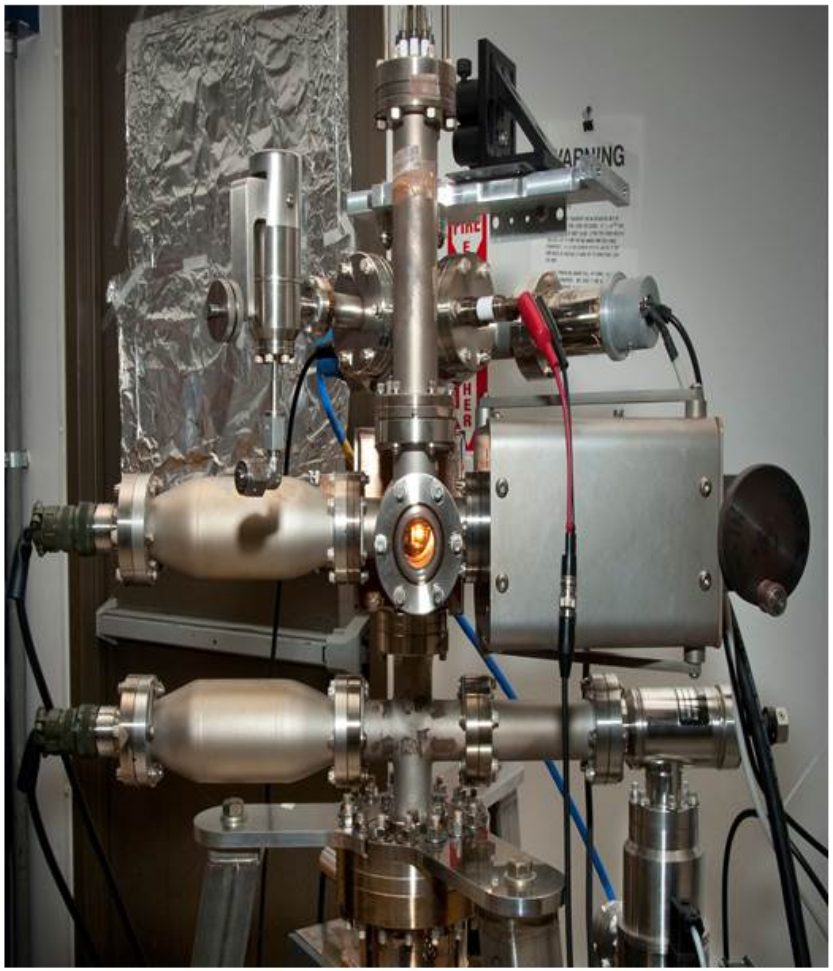


Figure: Third Cross includes Anode, Cs Source, Window, Oxygen valve and Gauge

Step by step construction of the tree

So all together





Pressure

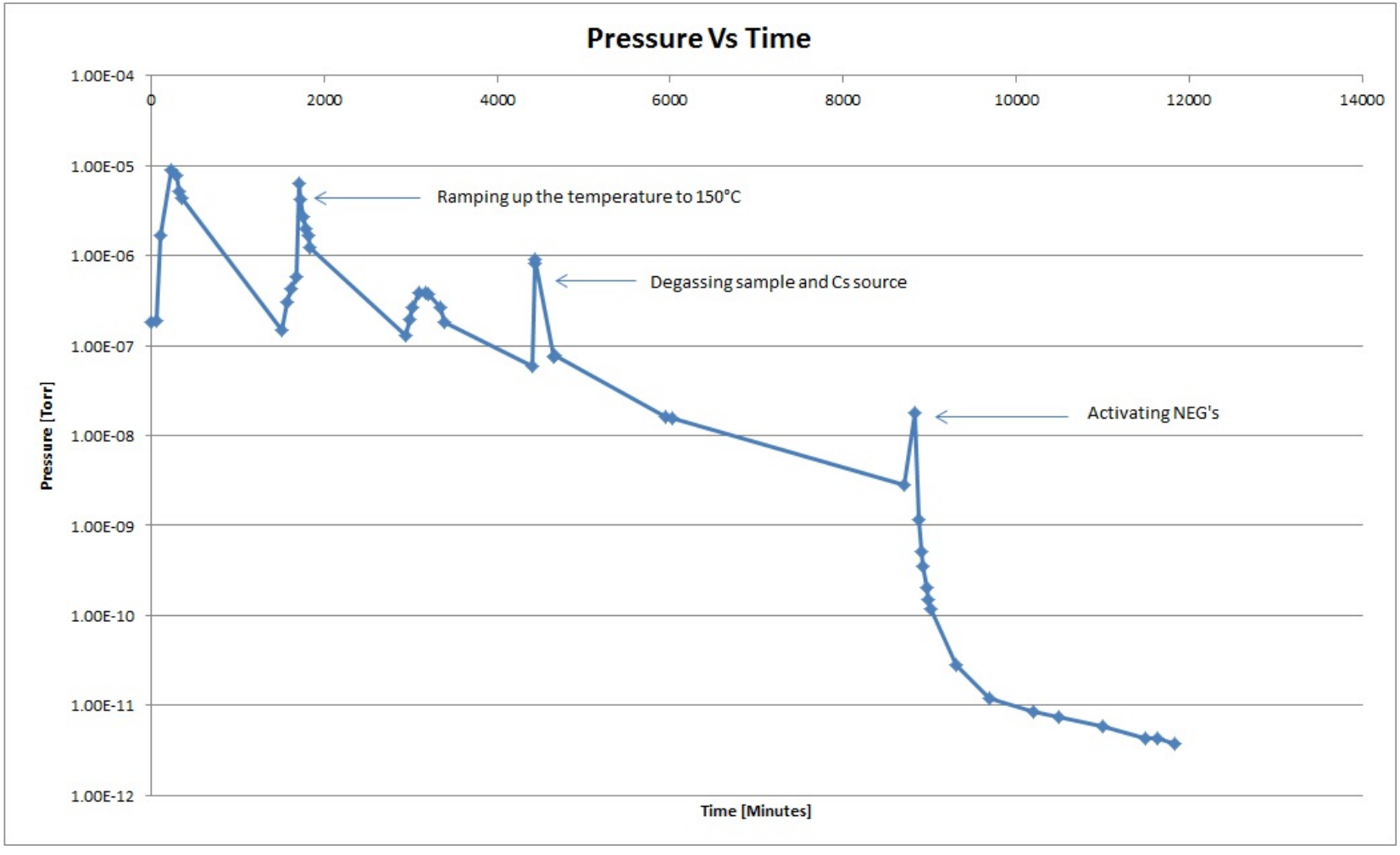
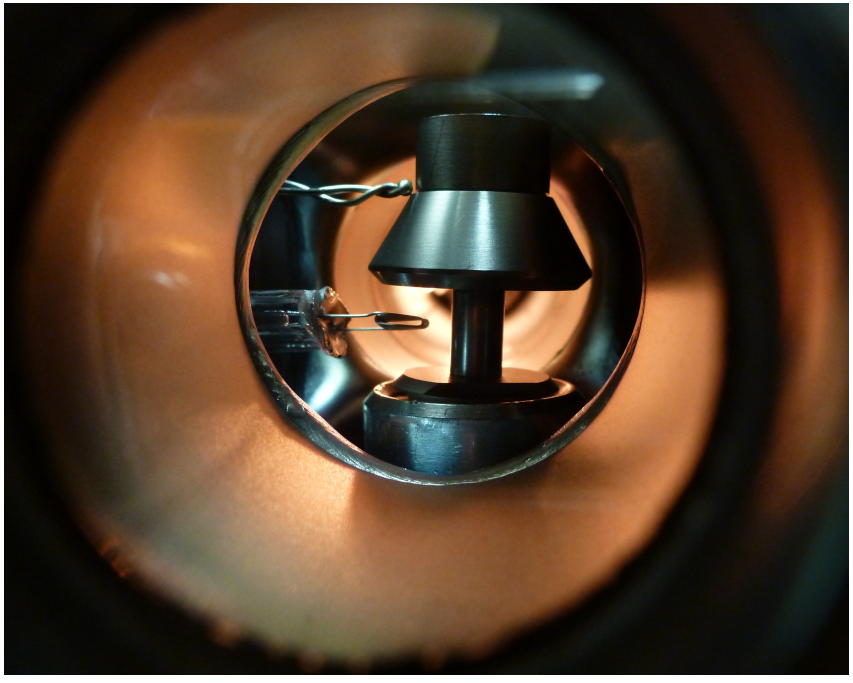


Figure: Sample Pressure Vs Time graph for the tree

Heat cleaning of the sample

Conventional heat cleaning using a readily available Tungsten filament from a 250W light bulb..... that costs $1.27.



However, the glass has to be machined off very carefully.

Heat cleaning of the sample

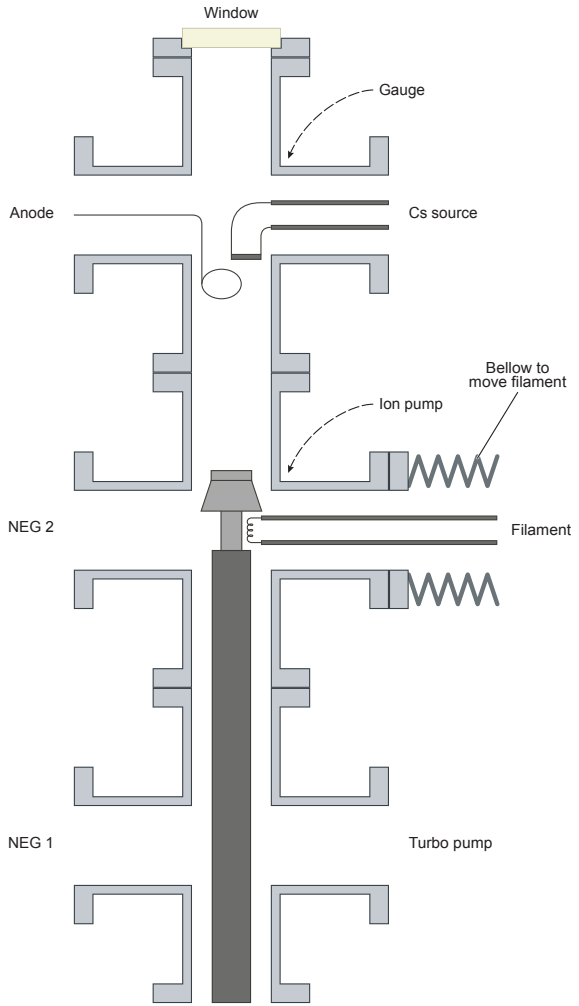
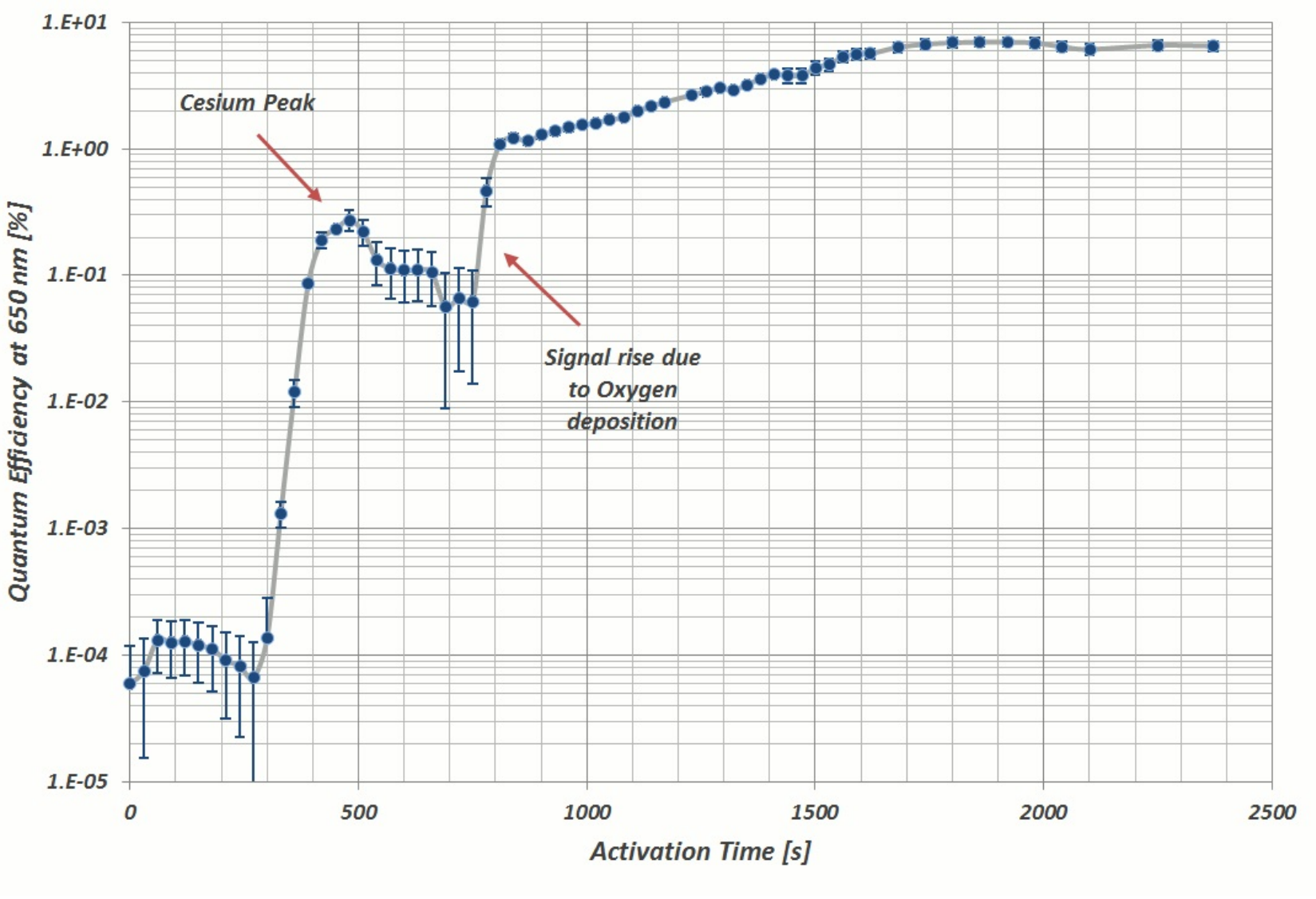


Figure: Schematic diagram of heat cleaning

Activation

- Set up the necessary instrumentation i.e. laser, electrometer, battery etc.
- Evaporate Cs from by flowing current through the source.
- After 350 Seconds, the first real signal is seen.
- After 500 seconds, Cs peak and current starts to fall
- Open Oxygen valve as current is falling, it starts to rise again
- Adjust leak valve to obtain maximum rate of increase
- Close leak valve and turn off Cs as current saturates

Typical Activation Curve



The Cathode Storage AKA Grand Central

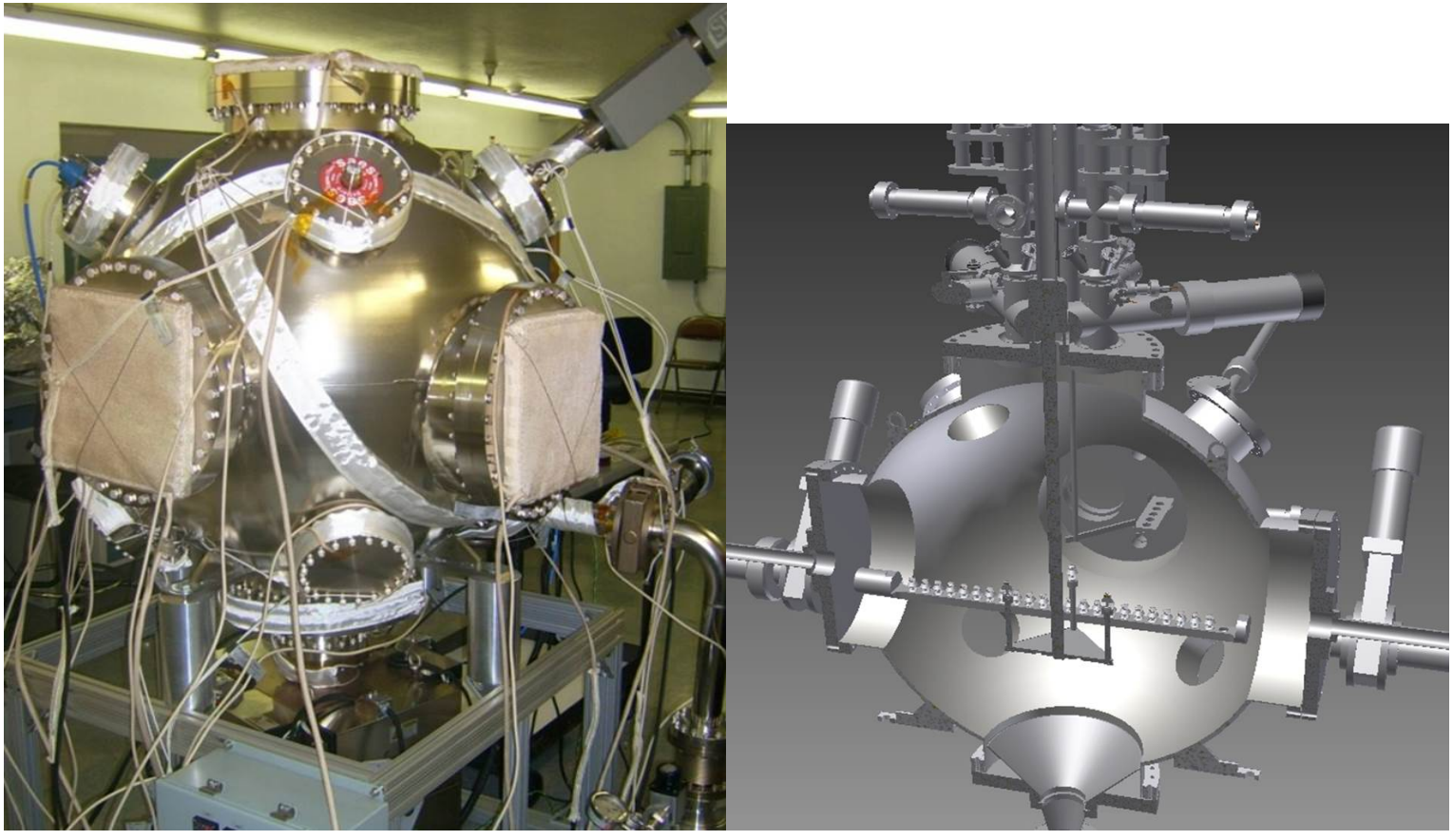
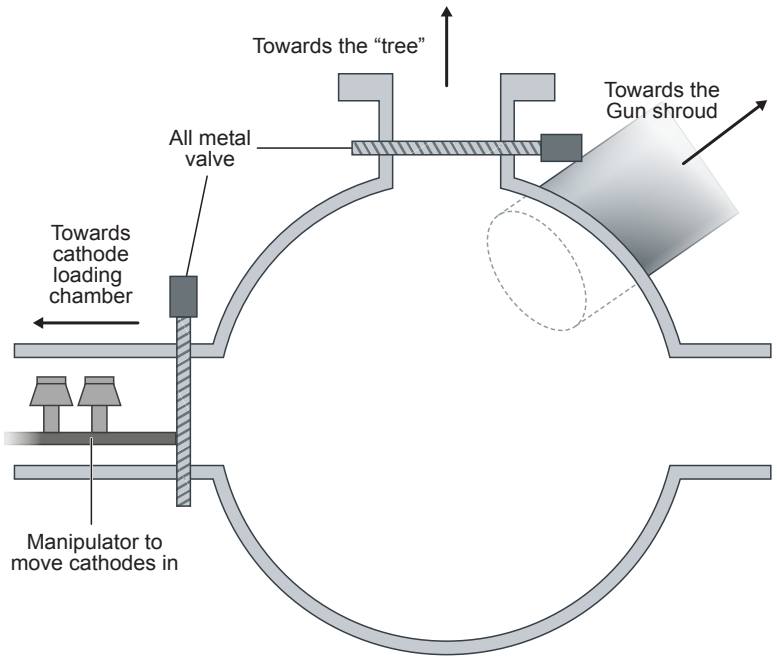


Figure: Actual Grand Central on the left,cross sectional view on the right

Transport of cathode from Grand Central to Tree 1



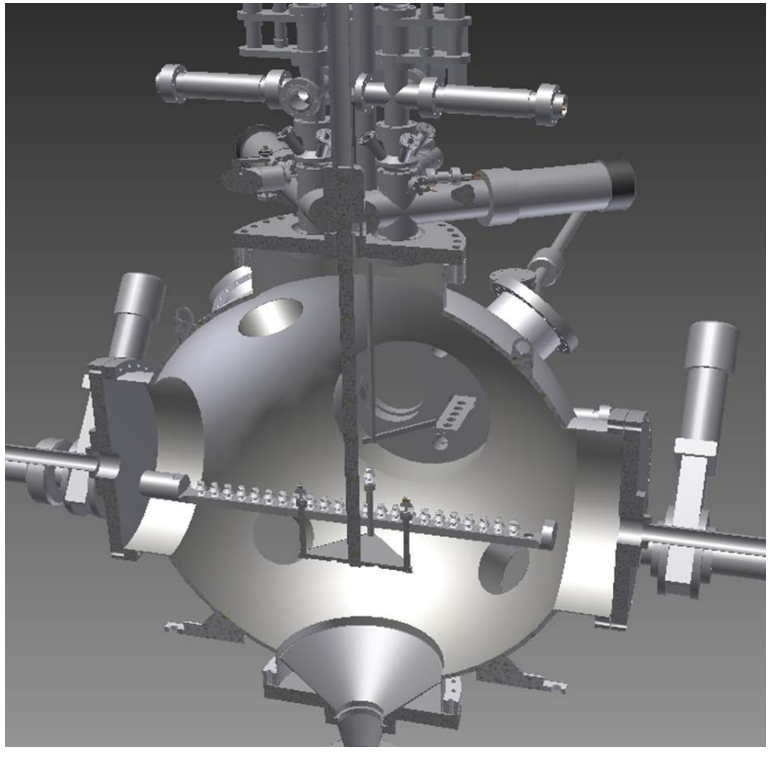
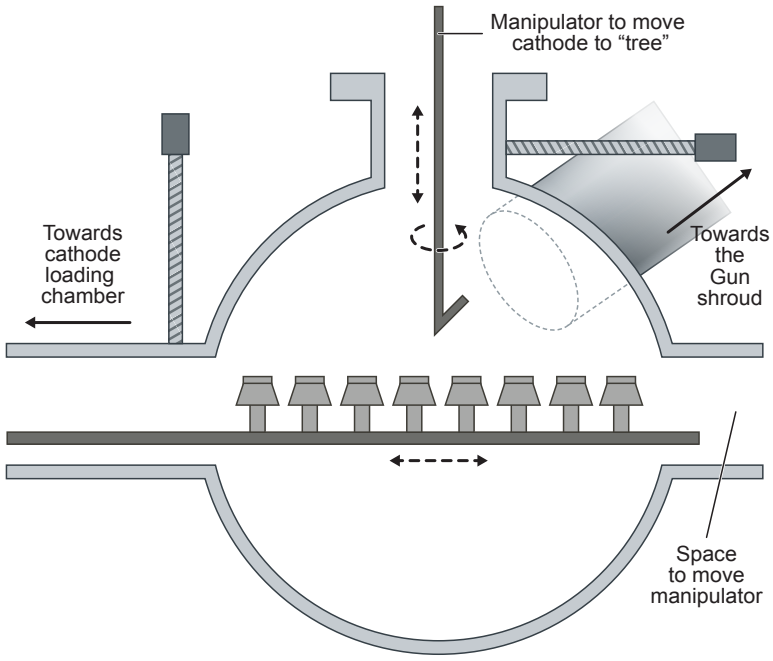


Figure: Cathodes are loaded in the load lock chamber which will be baked before the valve is open to Grand Central

Transport of cathode from Grand Central to Tree 2



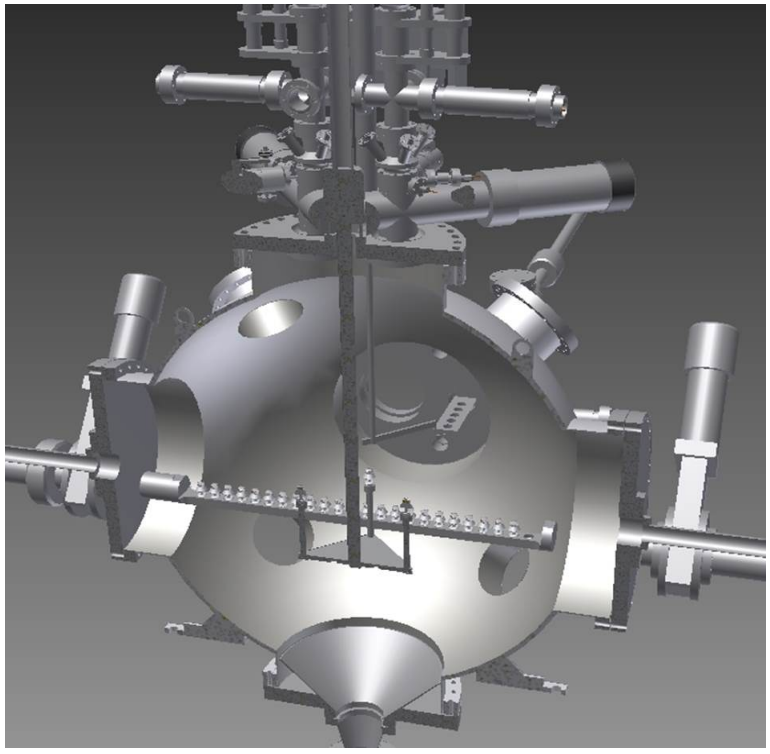
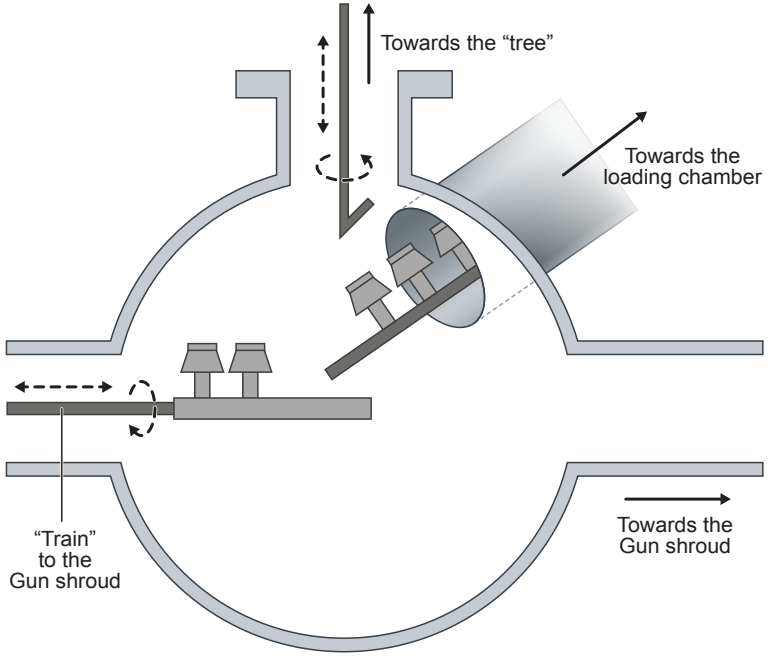


Figure: Once the load-lock chamber is in XHV, valve is opened and Cathodes are inside Grand Central. Using of a fork lift to bring the cathodes up to the tree

Transport of activated cathode from Grand Central to the Gun Shroud 1



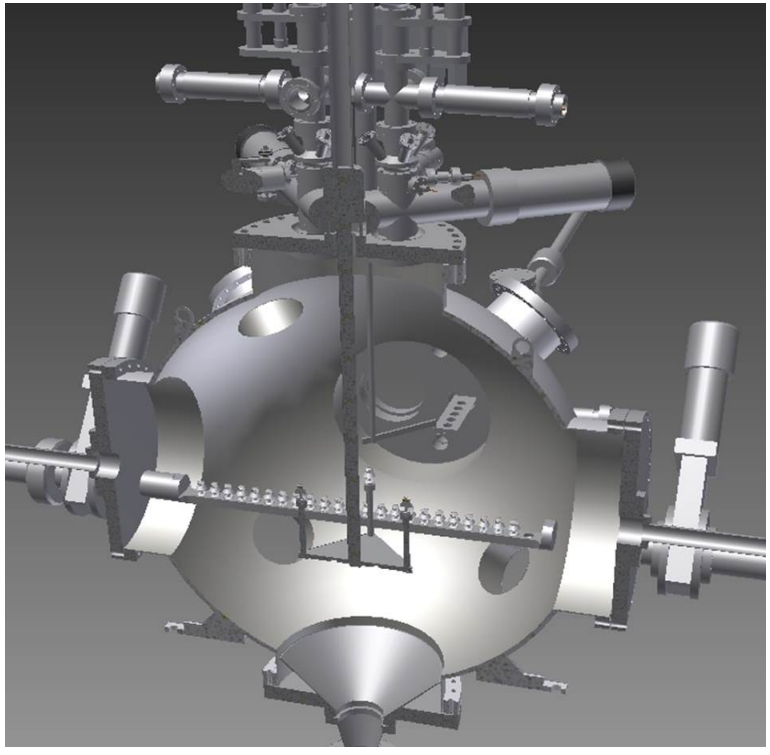


Figure: Activated cathodes are put on the train using the fork lift which is moved to the Gun Shroud

Side view of the Grand Central with the manipulators

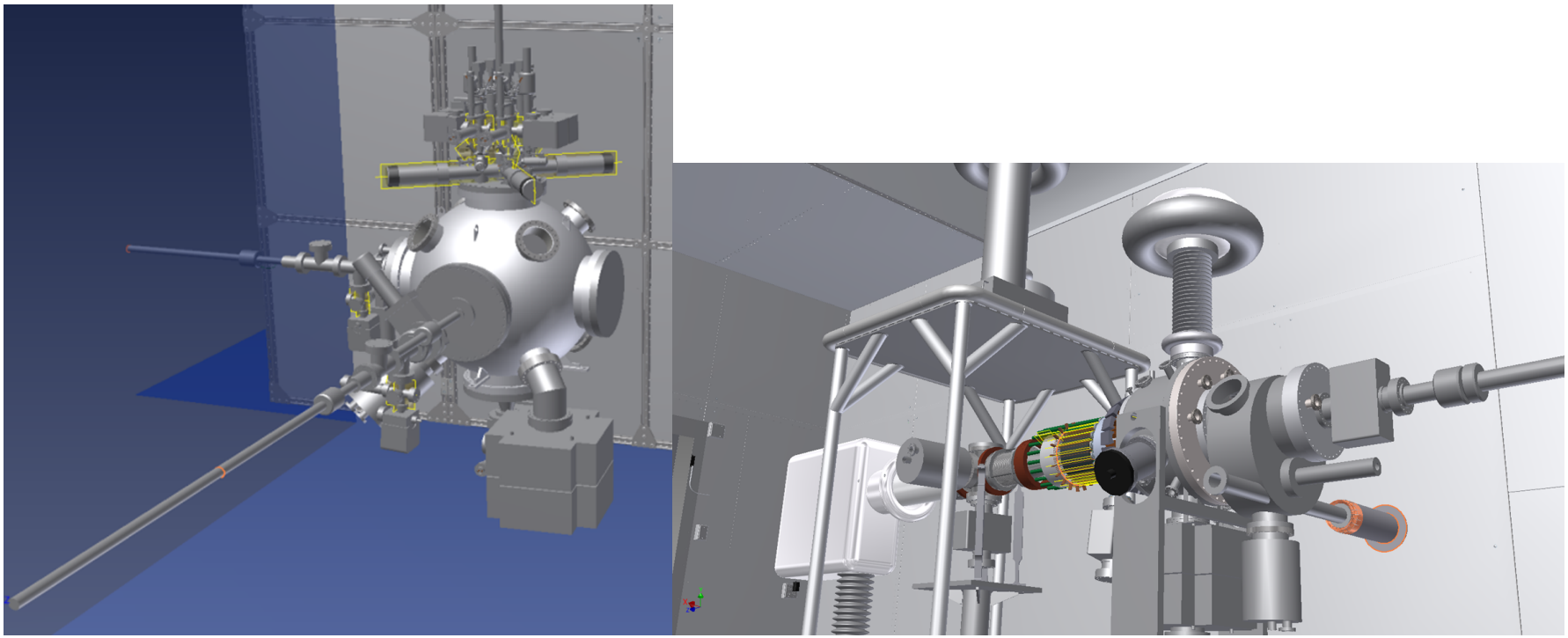
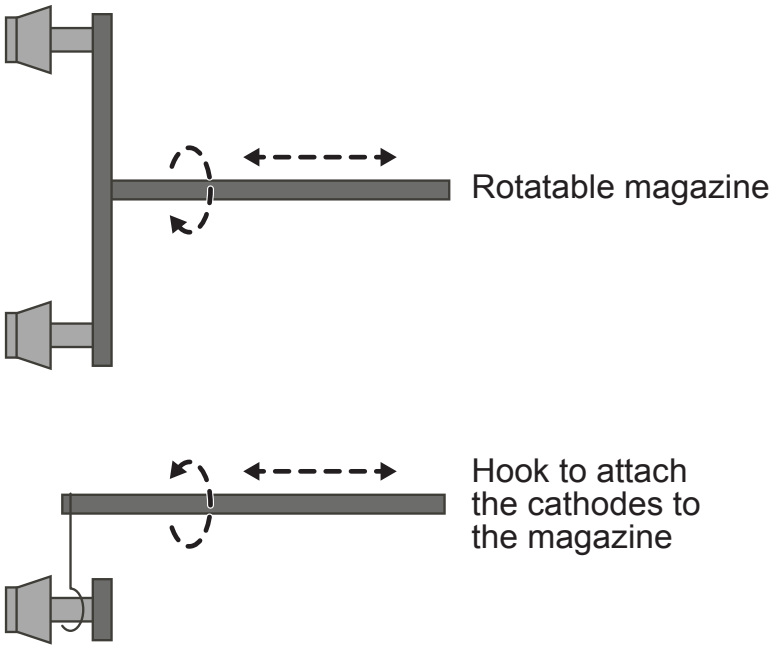
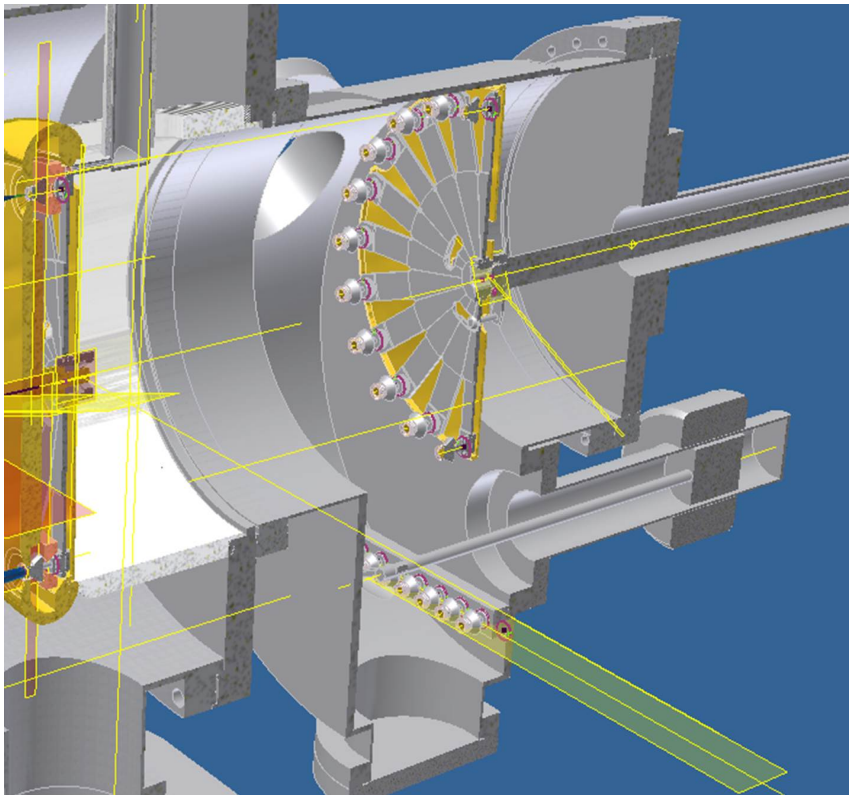


Figure: Side view of the Grand Central with the two manipulators to transport the Cathodes

Transport of activated cathodes from Grand Central to Gun Shroud 2





Conclusion

- Cathode chamber was assembled
- XHV achieved on a consistent basis
- Bulk GaAs activated with 8% QE
- Grand Central and Cathode transport systems are being built and are scheduled to be tested by the end of this year

Future Plan

- Optimize the design of the chamber
- Combine two beams to test funelling using bulk GaAs for low current in early 2014
- If successful, eventually use Superlattice GaAs to obtain highly polarized beam

Acknowledgment

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Thank you For you attention!

Side view of the Gun showing the transport line