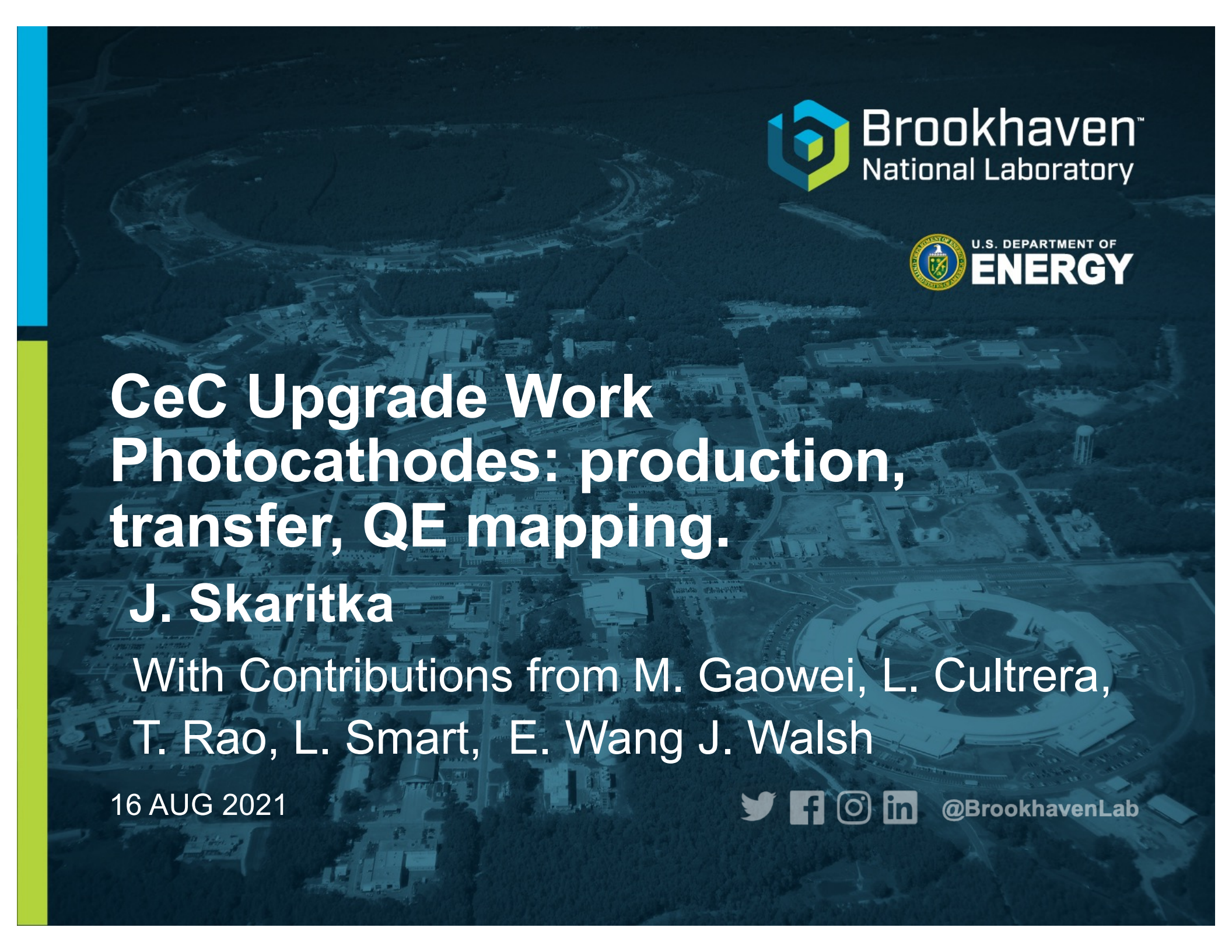
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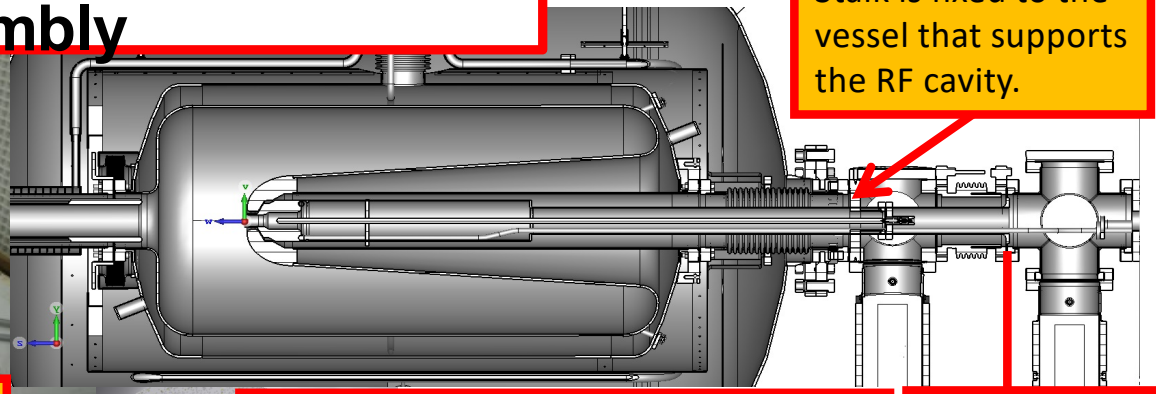
ENERGY
CeC Upgrade Work
Photocathodes: production,
transfer, QE mapping.
J. Skaritka
With Contributions from M. Gaowei, L. Cultrera,
T. Rao, L. Smart, E. Wang J. Walsh
16 AUG 2021
@BrookhavenLab

SRF Gun Stalk assembly



Stalk is fixed to the vessel that supports the RF cavity.

Low emissivity gold over high conductivity copper plating over stainless steel

Water cooled stalk end cools cathode. Design prevents collision with cathode

Stalk Alignment Mechanism

76mm Dia

Stalk Nose Spider

1329mm long

51mm Dia.

Integrated Cantilevered Stalk vacuum System

Cooling Loop Terminations

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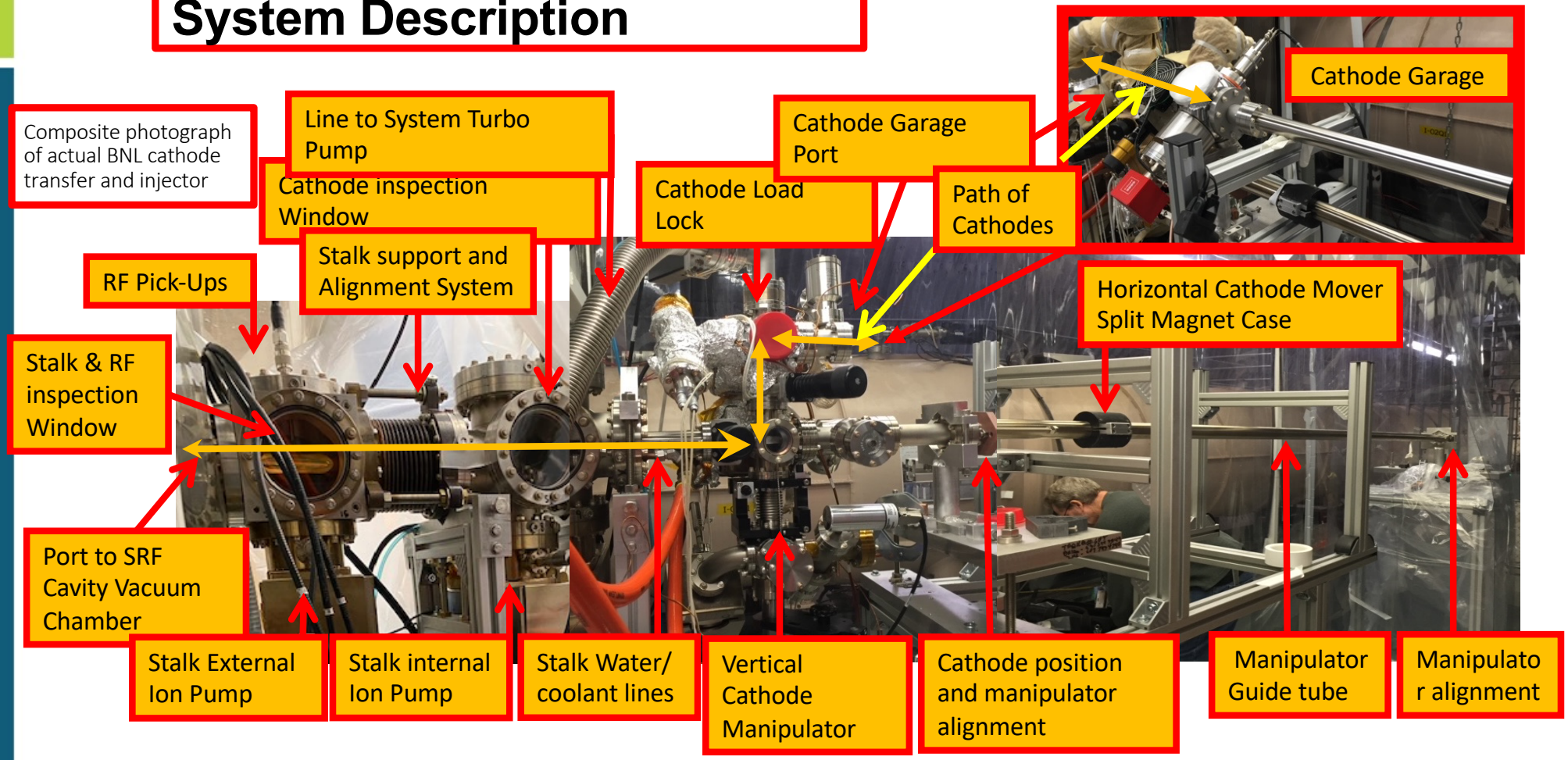
SRF Gun Cathode Injection System Description



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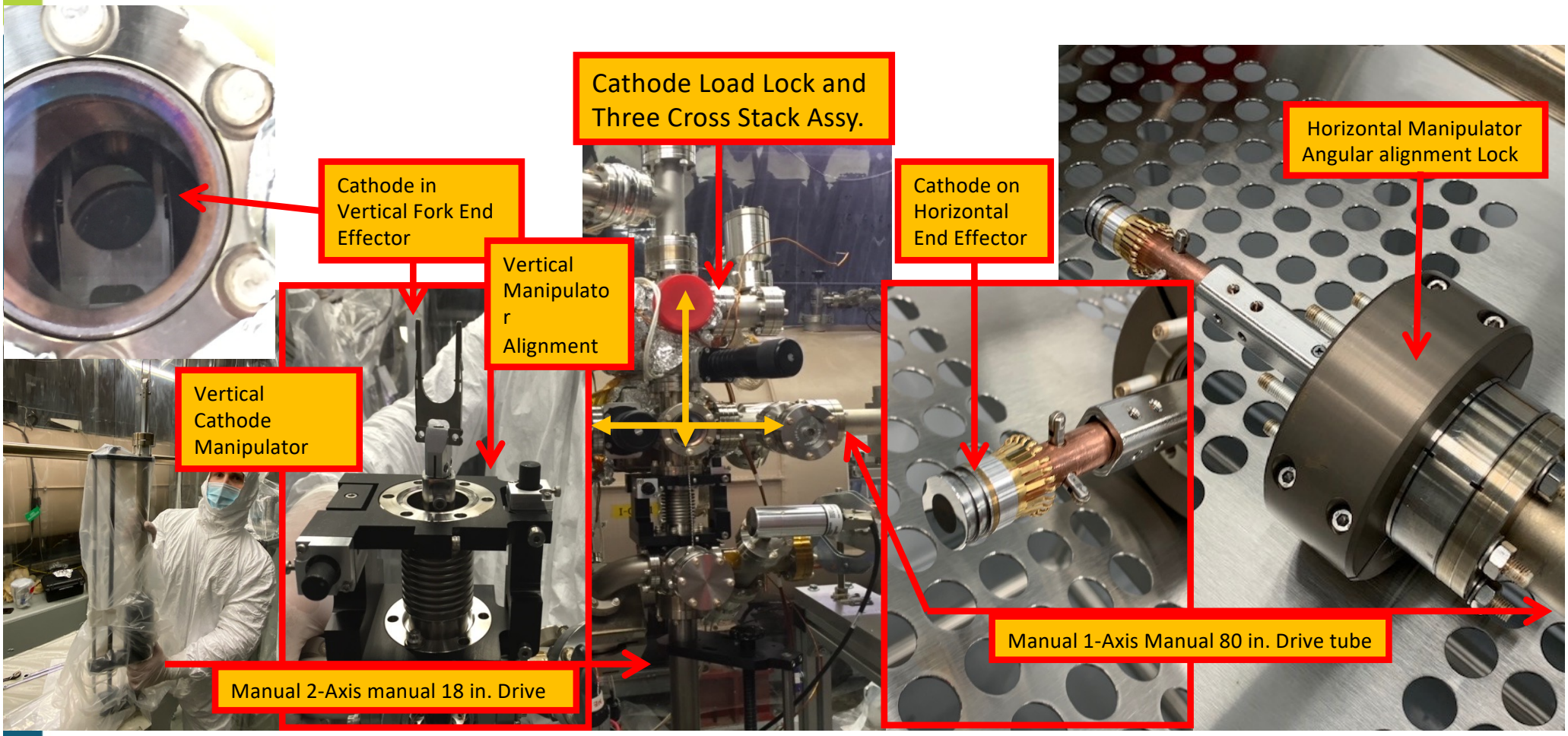
Load Lock Manipulators and End Effectors to be replaced or upgraded



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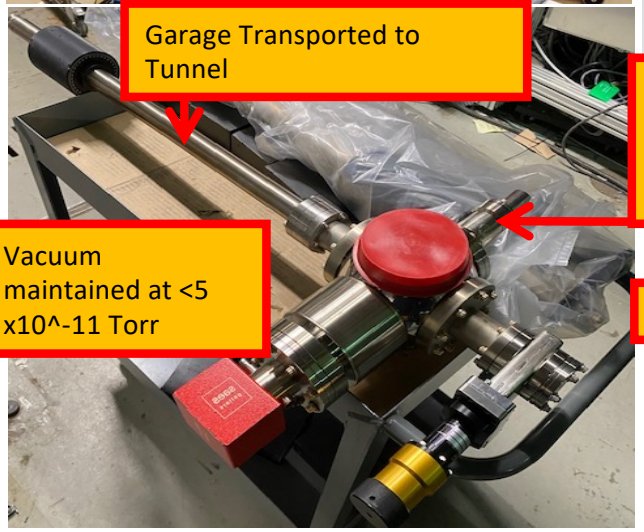
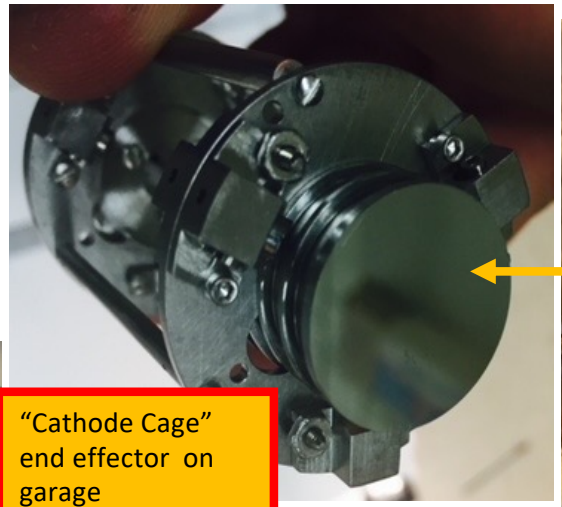
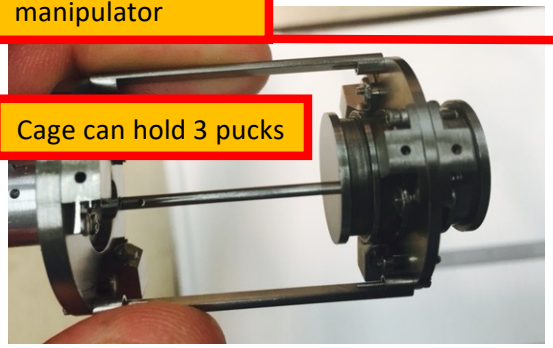
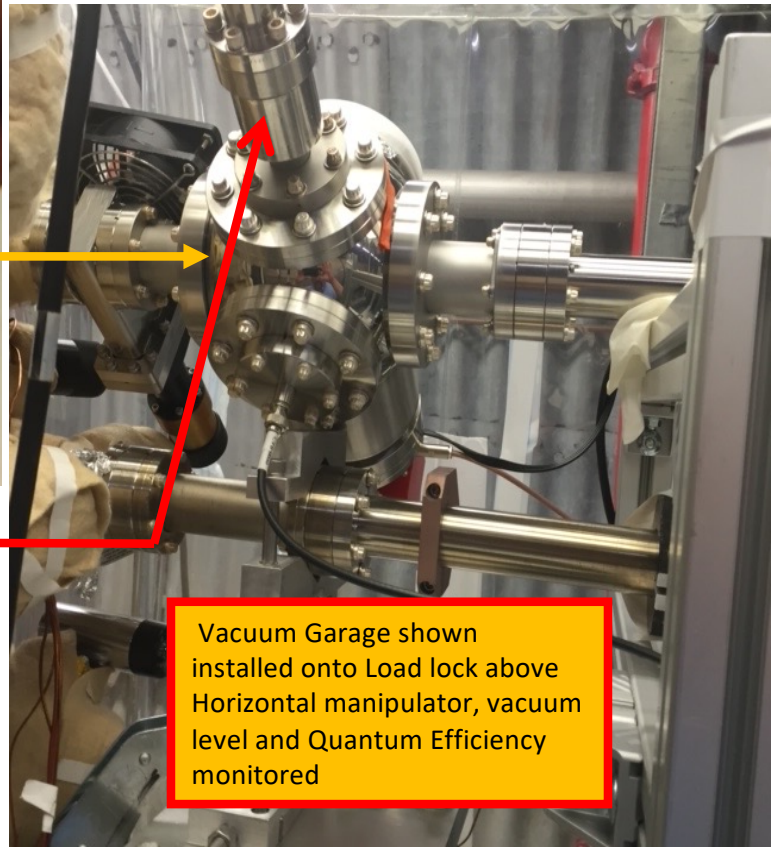
Portable UHV Vacuum Suitcase “Three Cathode Garage (1 puck+ 2 Cathodes) to by converted to a 1 puck + 4 Cathode Garage









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CeC SRF Gun Up Grade “Garage”

To effectively use GaAs photocathodes vacuums into 10^-12 Scale will be needed.

The work will involve improving the vacuum levels in the garage, load lock and reduce particulate in the cathode transfer system

Improvements to the garage:

- Increase capacity from 2 to 4 cathodes + one puck place holder
- 3-point cam follower type cathode capture mechanism, rolling contacts to reduce particulate.
- Vacuum fire all stainlesssteel components (reduce H2 content)
- Use new SAES Z-500 NexTorr pumps, 2X pumping capacity while reducing particulate.
- All metal VAT Valves.and a Kelrez MDC valve will be tested
- Develop a lifting system to eliminate shocks/pressure spikes loads during transport and installation

Initial results show that an all-metal valve is prosing for a XHV Garage.

CeC SRF Gun Up Grade “Load Lock”

Disassemble, clean and vacuum fire all bakeable Stainless Steel components. Reduce H2 outgassing load

Replace 20lt/sec ion pumps with 1000 lt./sec. Z-1000 Nextorr pumps. For 2+ decade improvement

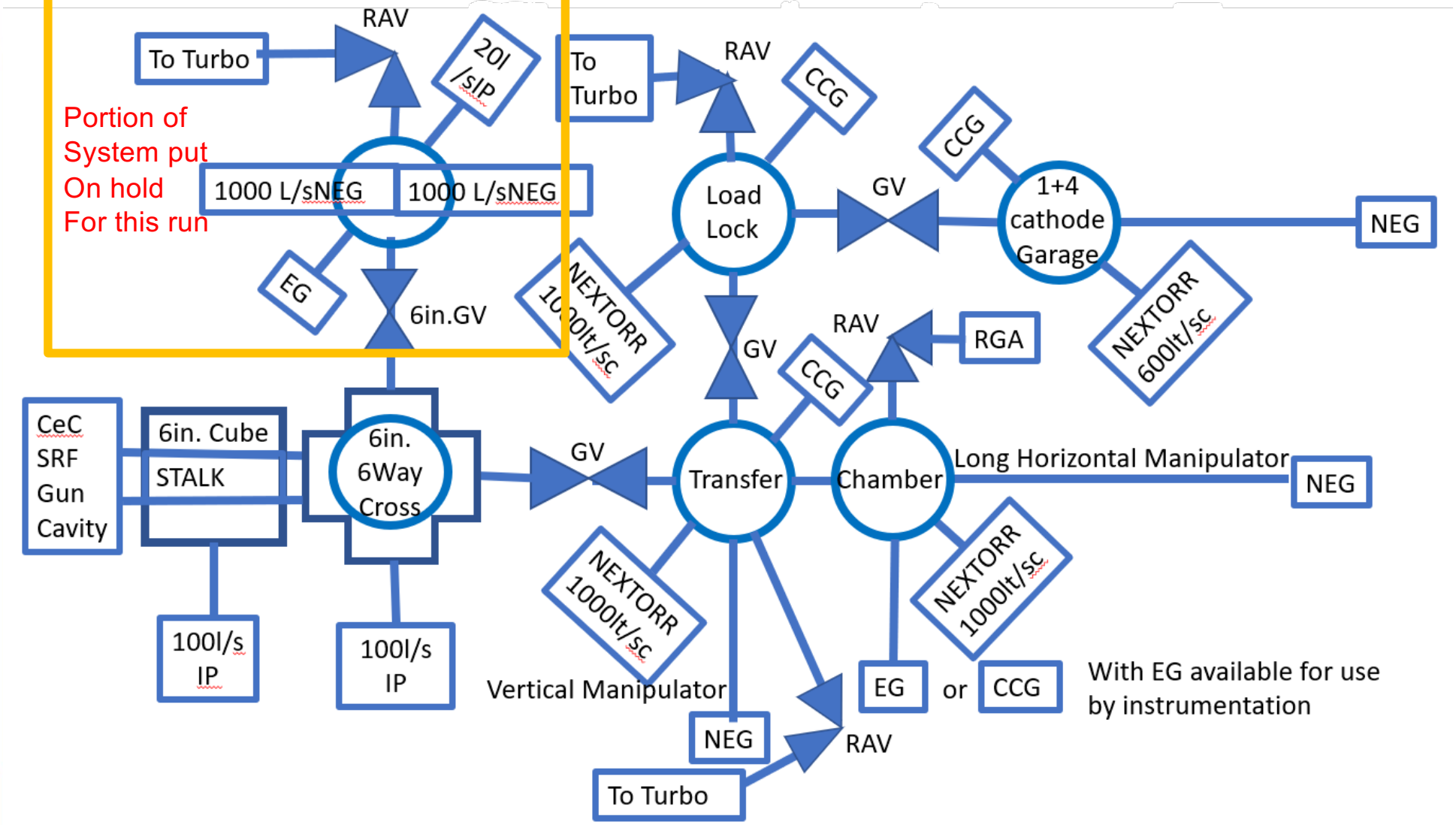
Investigate Kimball Physics type spherical chambers and vacuum fired with >100 hour post bake at 500C.

Larger illuminated windows for better viewing of cathode exchange and easier operation

Upgrade horizontal manipulator to 3 axis operation.

- Easier, more reliable particle free cathode exchange.
- 360 degree inspection, more flexible injection.
- Add inline stiffer bearings and Nextorr pump to intercept gas load from horizontal manipulator

CeC XVH Cathode Injection Upgrade Schematic 2.1



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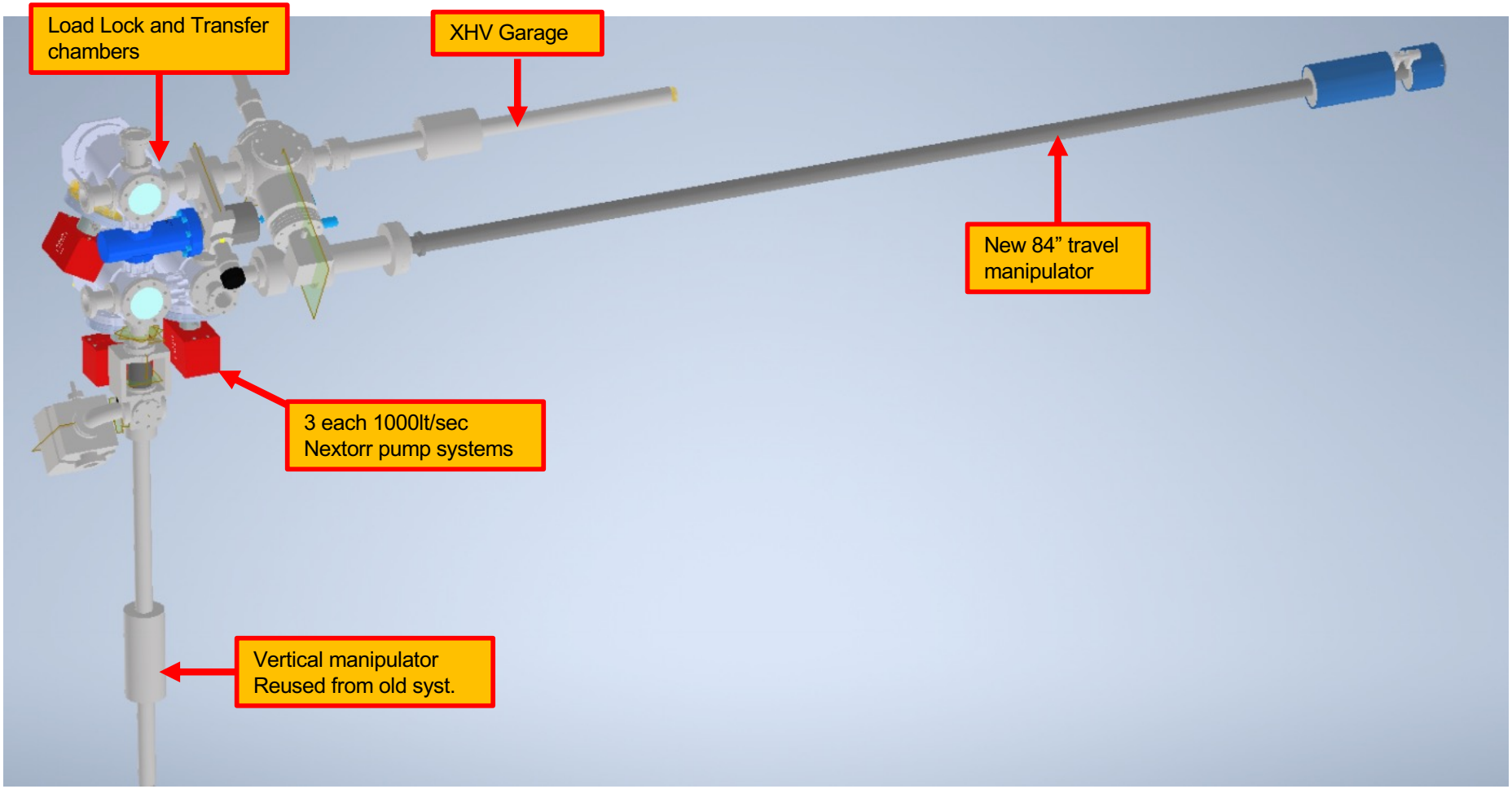
New XHV Cathode injection System



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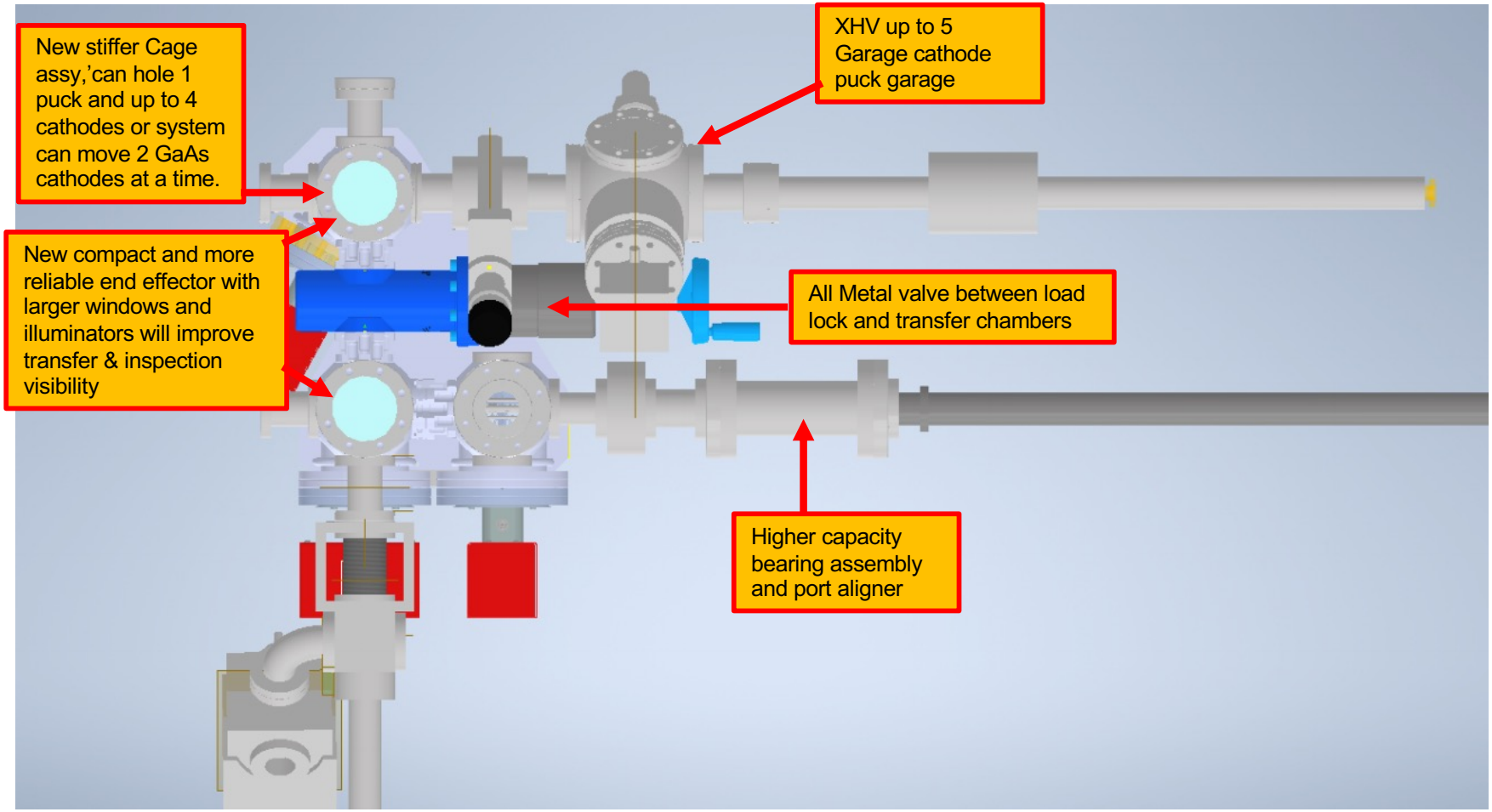
Cathode Transfer System Core components



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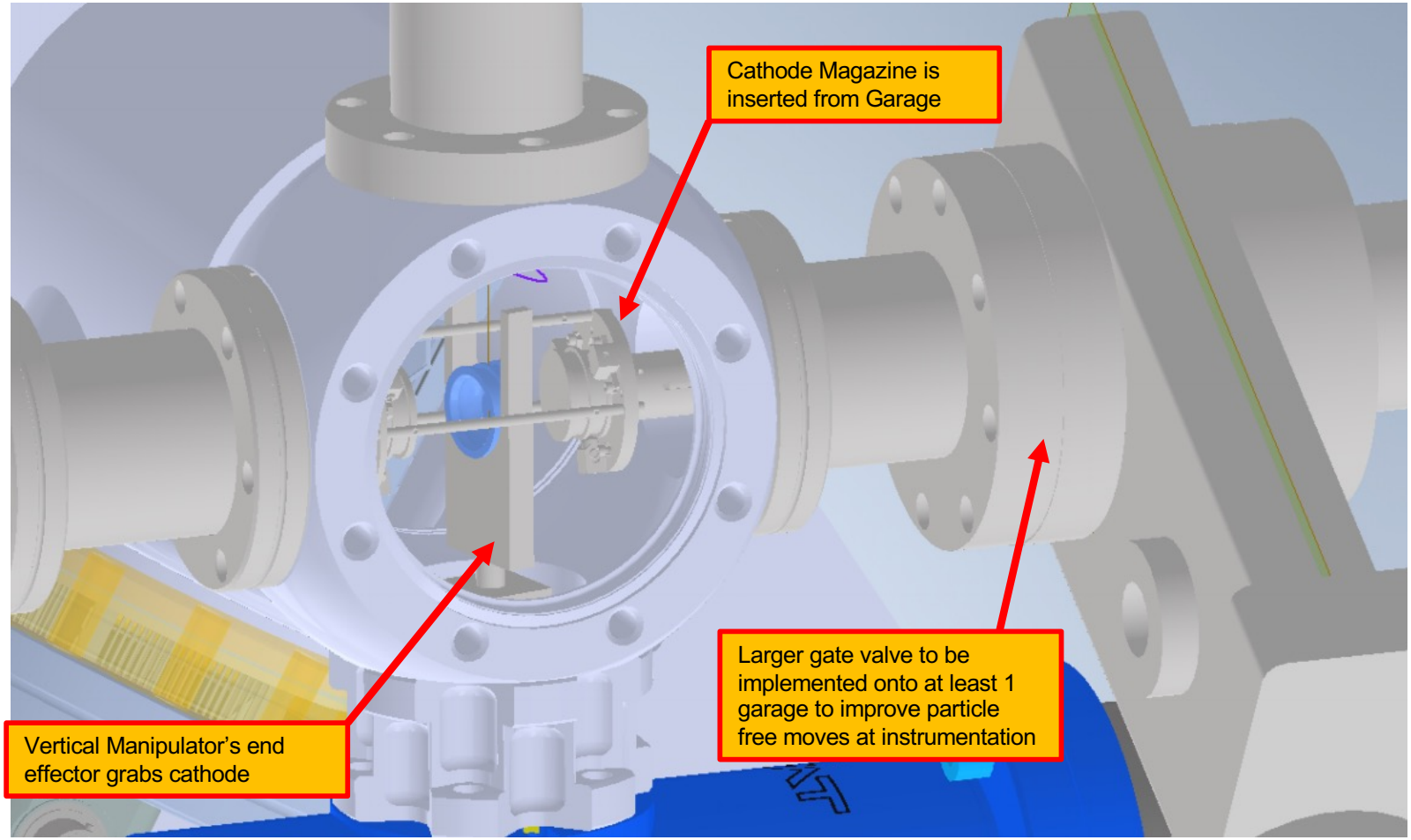
Vertical Manipulator capturing cathode from Garage Magazine



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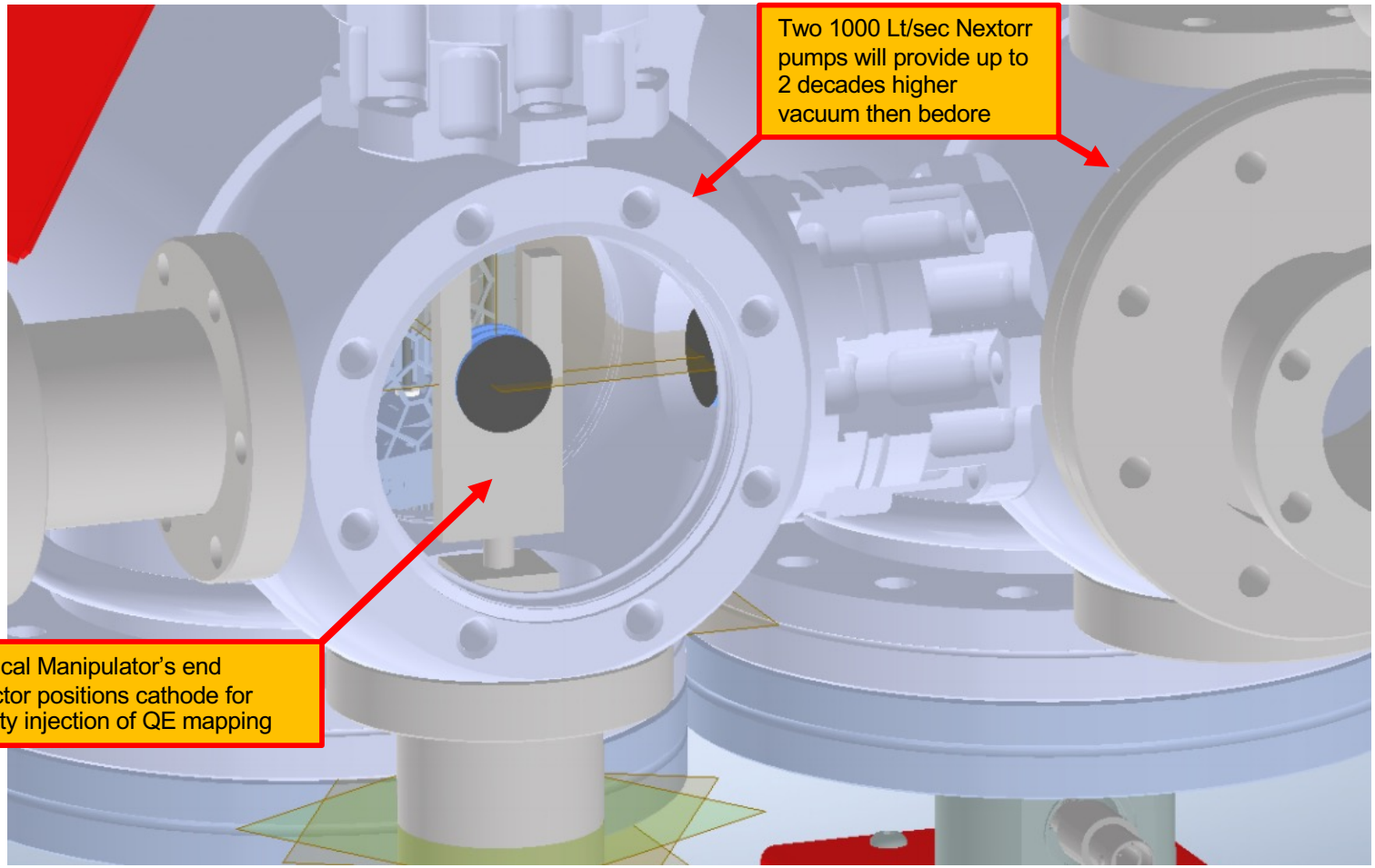
XHV Cathode Injection Cube



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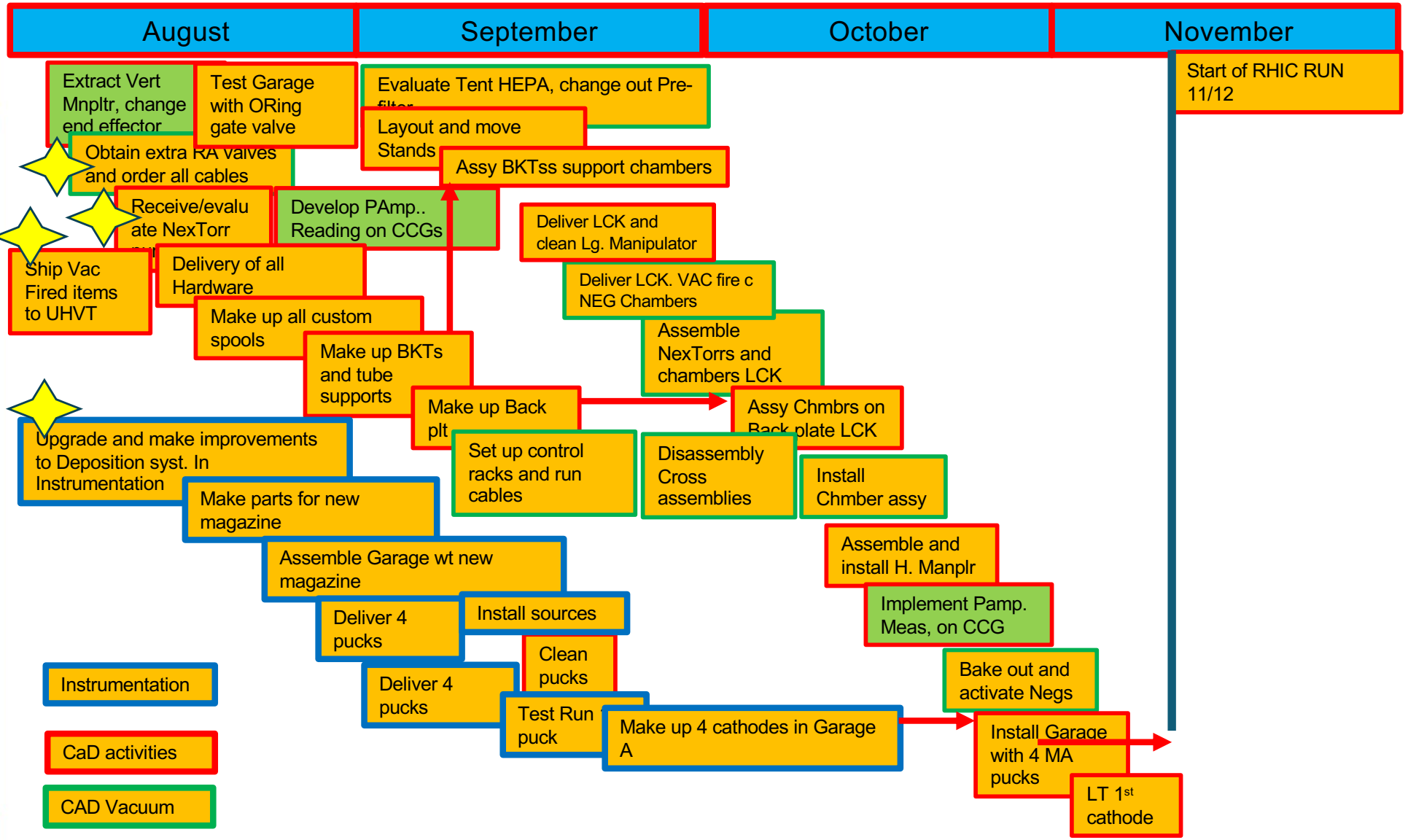
Near Term Program Schedule



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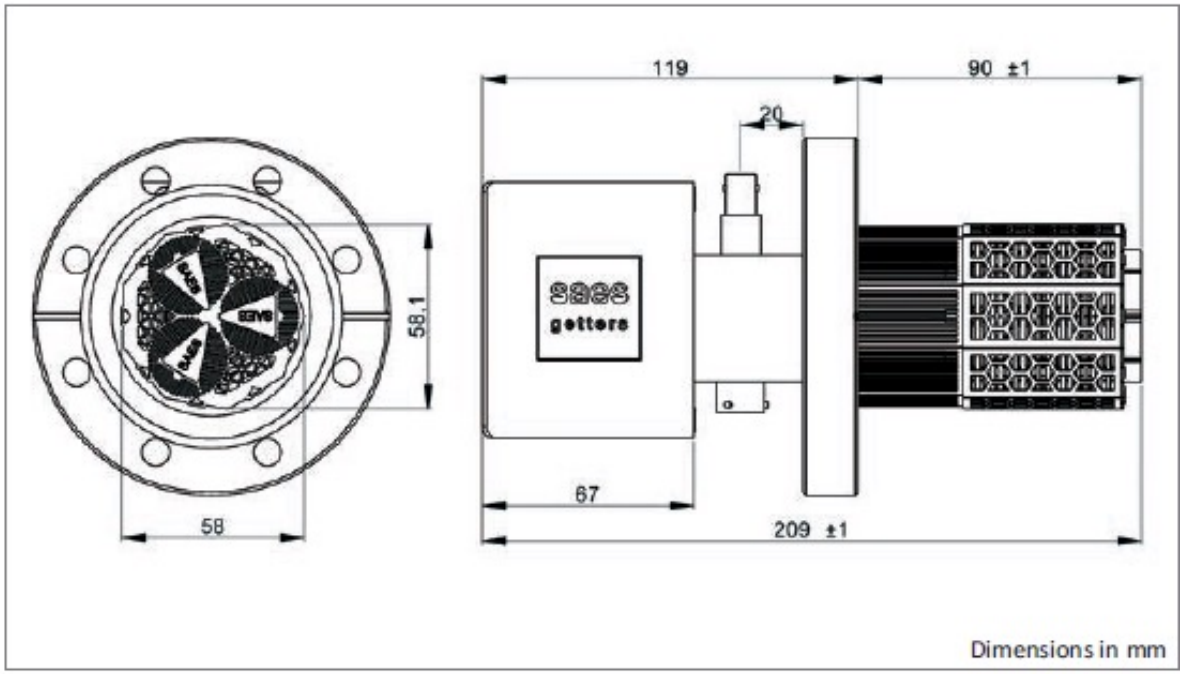
NEG NEXTorr D 500-5



Total pump weight (magnets included)	3.1 kg
Total pump volume	0.7 litre
Type of ion pump	Diode
Operation Voltage Ion Element	5.0 kVdc
Operation Voltage NEG Element	24 Vdc

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NEG NEXTorr D 500-5

NEG section	Getter alloy type	St 172
	Alloy composition	ZrVFe
	Getter mass (g)	68 g
	Getter surface (cm^2)	570
ION section	Voltage applied	DC+5kV
	Number of Penning cells	4
	Standard bake-out temperature	150 °C

1 Measured at $3x10^{-6}$ Torr. Unsaturated pump (saturated pump).

2 Capacity values with the NEG element at room temperature, corresponding to a drop of the pumping speed to 10% of its initial value. A drop to 50% has been considered in the case of CH_4.

3 Total capacity values for each single gas obtained after many reactivations (getter fully consumed). Capacity values for the various gases are not additive (a getter fully reacted with one gas specie will not sorb another gas).

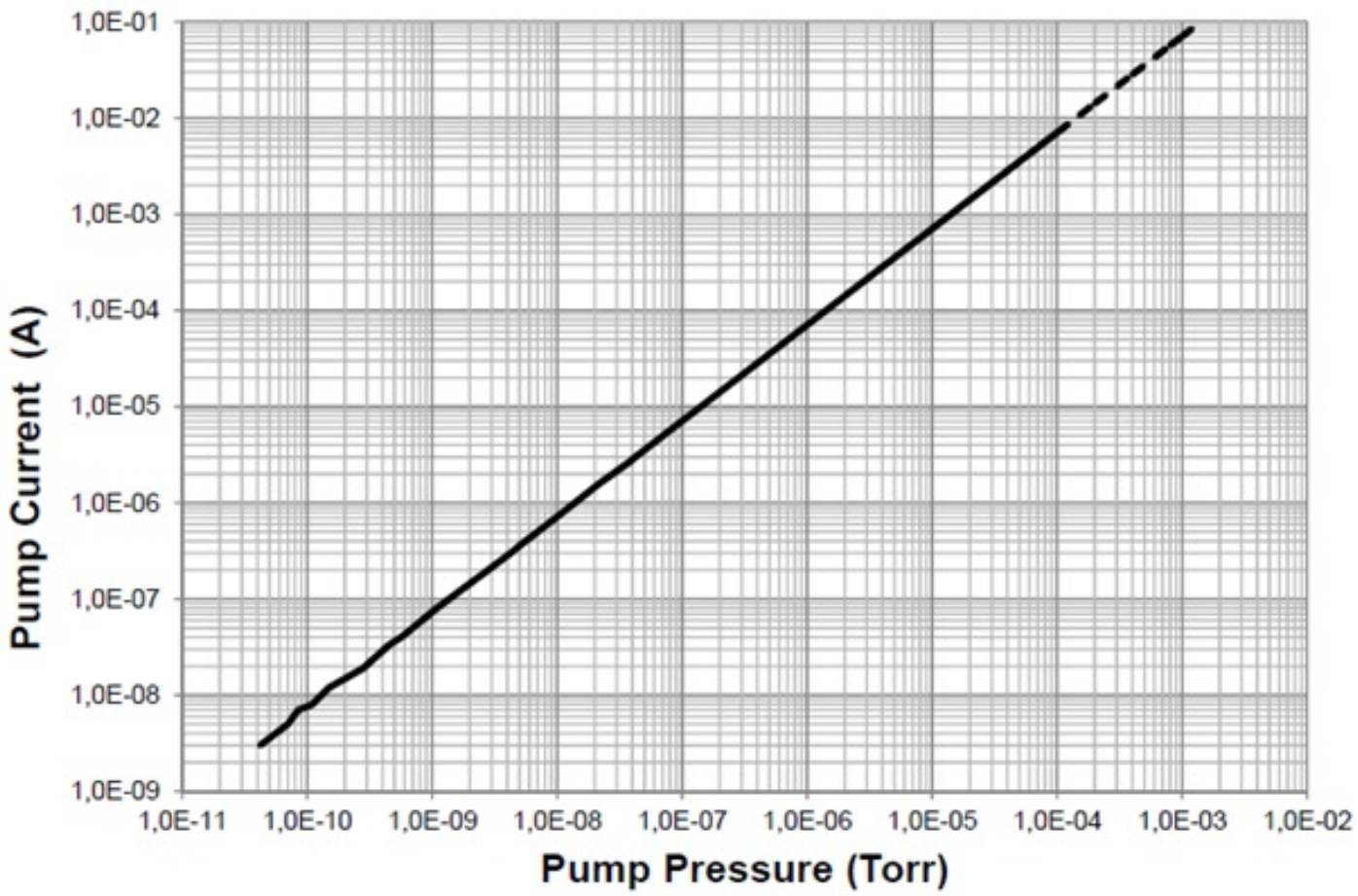
4 After the getter element has reached its room temperature H_2 capacity (680 Torr·l) it can be "regenerated". The regeneration process extracts the H_2 stored in the getter. After being regenerated, the pump can start pumping H_2 again.

Ordering Information

Product	Product description	Code
NEXTorr PUMP	NEXTorr D 500-5	5H0172
Pump power supply	NEXTorr PS NIOPS-04	3B0415
Power supply cables	NEXTorr KIT OF CABLES-04-06	3B0416
Power supply input cable	NIOPS INPUT CABLE	3B0398
Output cable ION element	NIOPS04-06 - OUTPUT CABLE ION - 3 MT	3B0418
Output cable NEG element	NIOPS04-06 - OUTPUT CABLE NEG - 3 MT	3B0419

SPC ion pump controller with NEXTorr ion pump

Current resolution is 1 nA, about 1e-11 Torr



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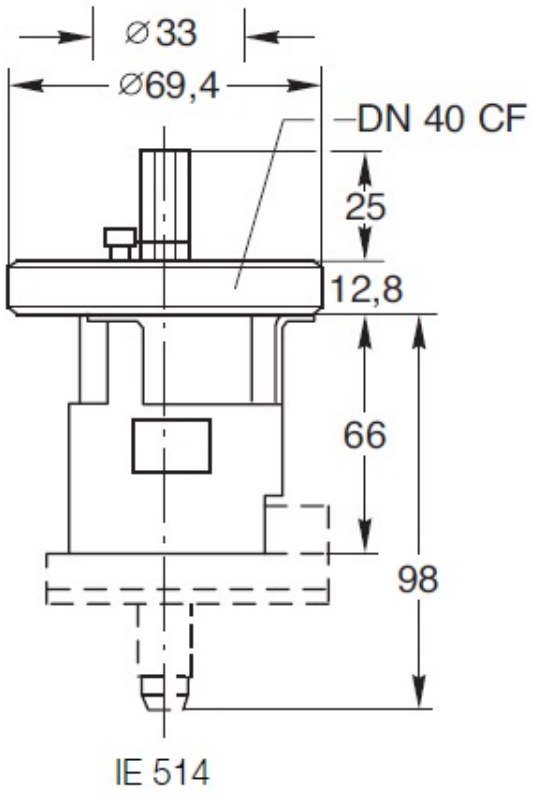
Extractor
x-ray limit <1e-12 mbar

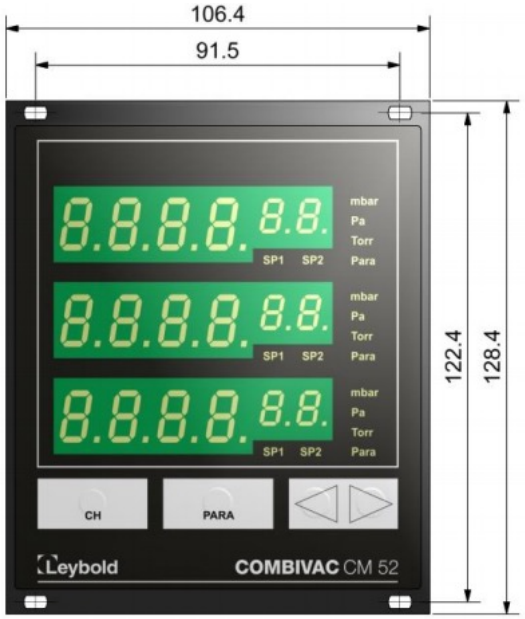
Measurement range:
Measurement inaccuracy:

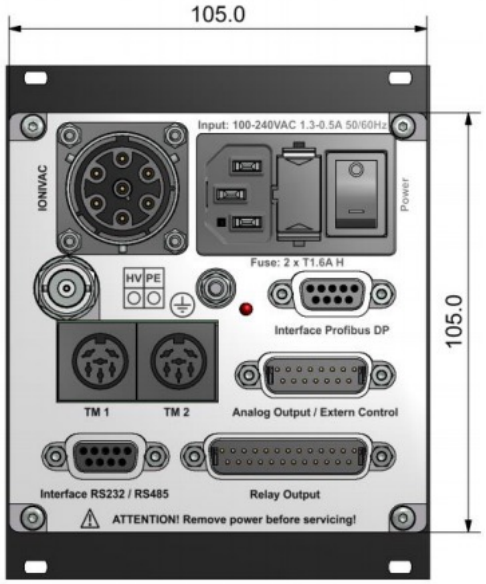
Extraktor (IE514)
$2 \cdot 10^{-12} - 1 \cdot 10^{-4}$ mbar
± 2% of measured value, $\pm 5 \cdot 10^{-13}$ mbar



Emission current (mA)	Pressure range (mbar)	Ion current (A)
1.6	$10^{-13} \ldots 10^{-4}$	$1.6 \times 10^{-15} \ldots 1.6 \times 10^{-6}$

Tab. 2-3 Measuring range of the Extraktor IE514





Extractor Cost $6k Per Sensor

230115	COMBIVAC CM52 with RS232 / 485	2,794.50
15867	IONIVAC-Sensor IE 514, DN 40 CF	2,016.00
15844	Sensor cable to IE414/514 5m bakeable	1,312.40
	COST PER SENSOR	**6,122.50**

Vacuum Group has Experience with reading CCG gauges by reading pico-Amps, could be done during cathode exchange periods.or use a RGA

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Vacuum Equipment

Gauges

- High Vacuum: MKS inverted magnetron cold cathode (re-use existing)
  - Examining use of separate electrometer for ion current.
- Rough vacuum: MKS convection-Pirani (re-use existing)
- XHV: Leybold extraktor hot filament ion gauge (ordered)
  - Extension cable material in-house.

Ion Pumps

- NEXTorr pump with Gamma SPC controllers (nanoampere min. current)
  - Enquired about picoampere custom SPC (Gamma/JLAB).

NEG Pumps

- New CF16 special cartridges
  - NEG-MINI-POWER controller ordered.
- NexTorr pump/cartridge with higher capacity
  - Controller and cables on order (Skaritka). (just came in)

Ion Pumps

- Cables
  - Existing bulk cables can be used
  - Order new manufacturer's cable for new pumps
- Controllers
  - Existing SPC controllers can be used for small pumps
  - 40 mA available output current


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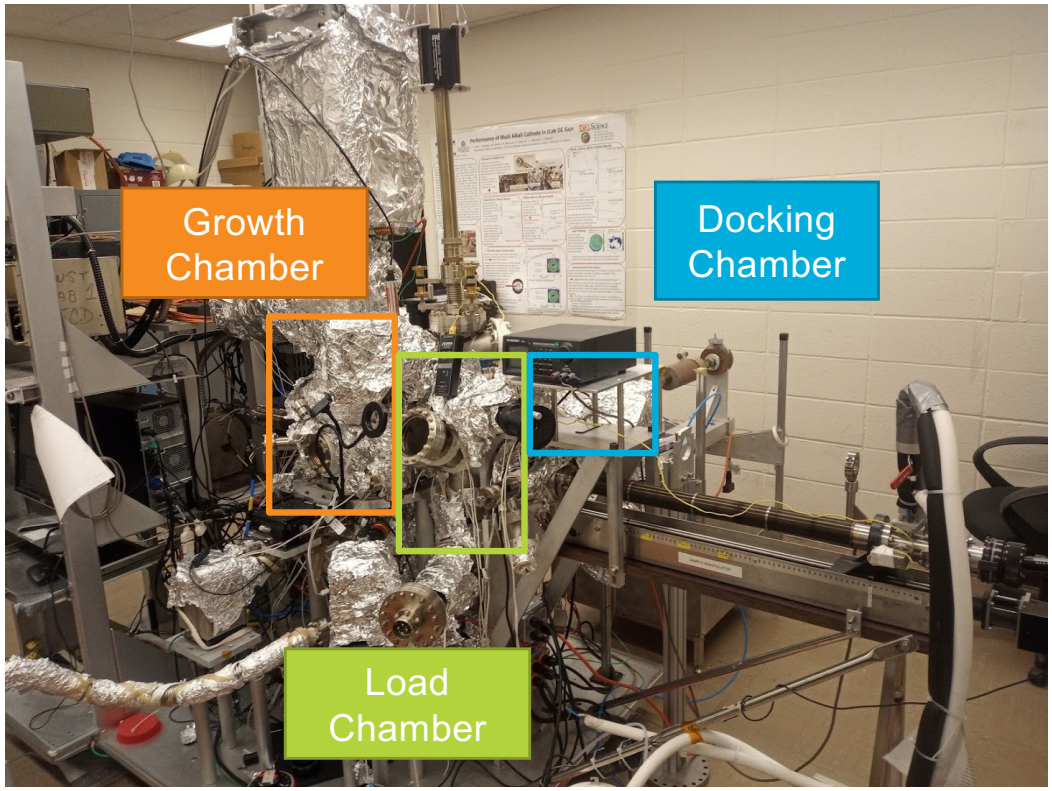
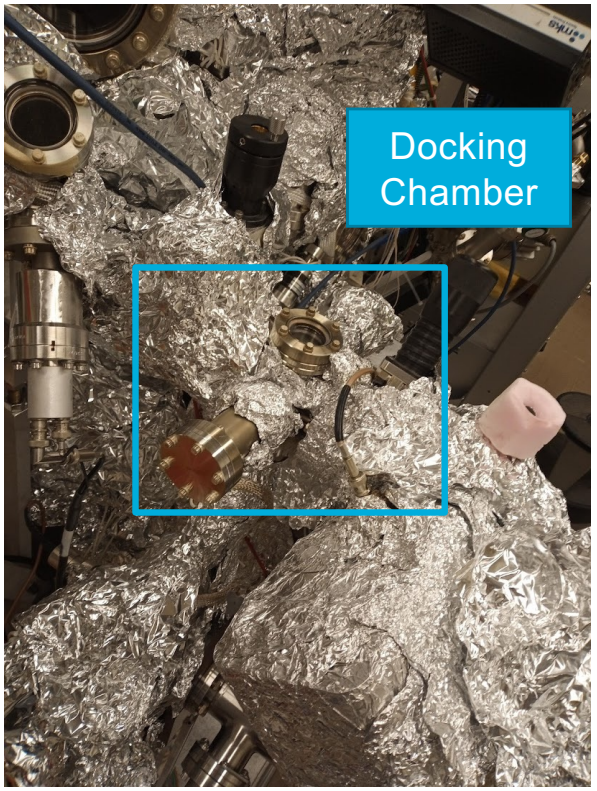
ENERGY
CeC photocathode growth system
L. Cultrera and T. Rao
for the photocathode group
Date 8/16/2021
@BrookhavenLab

2021 Maintenance and Upgrade





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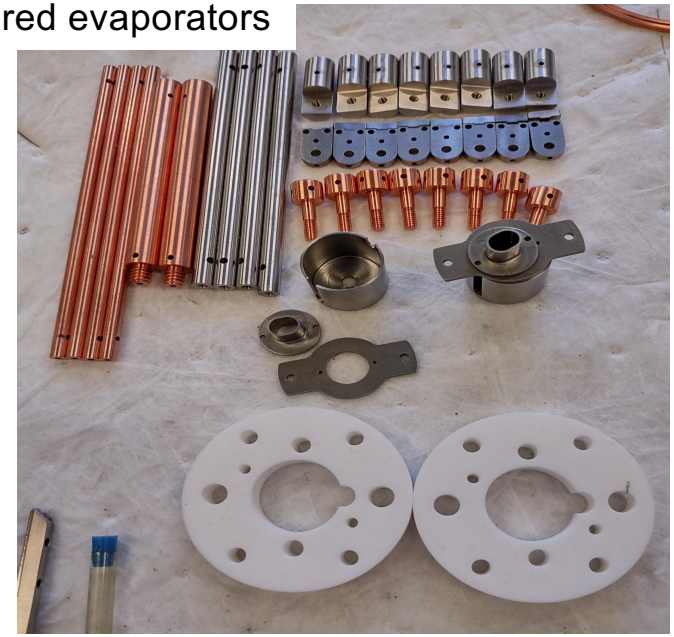
Main growth chamber

- Replace the main UHV chamber to allow
  - Hosting two cluster of sources (better alignment, co-deposition);
  - 2 additional port for future R&D on other protective coatings;

Internal parts

Clustered evaporators



Cathode heater housing

Installation of the new evaporators assembly will likely be delayed because of delays in the supply of vacuum components required for the two assemblies

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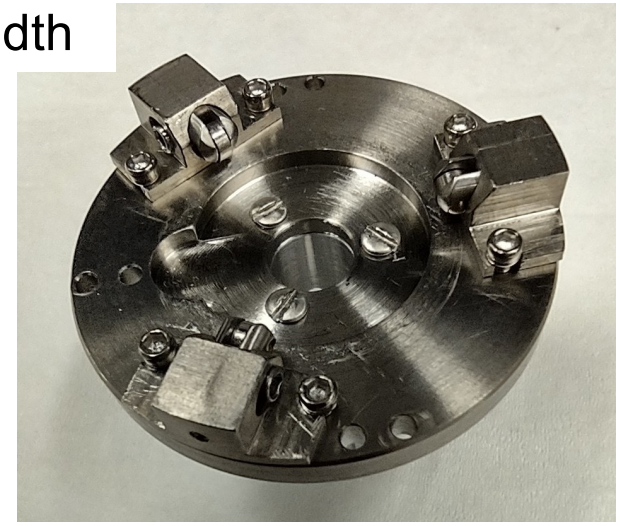
New magazine and forks

New forks with reduced width



New magazine holder with roller plungers

- New capture mechanism will improve ease and reliability of cathode transfer while reducing particle generation.

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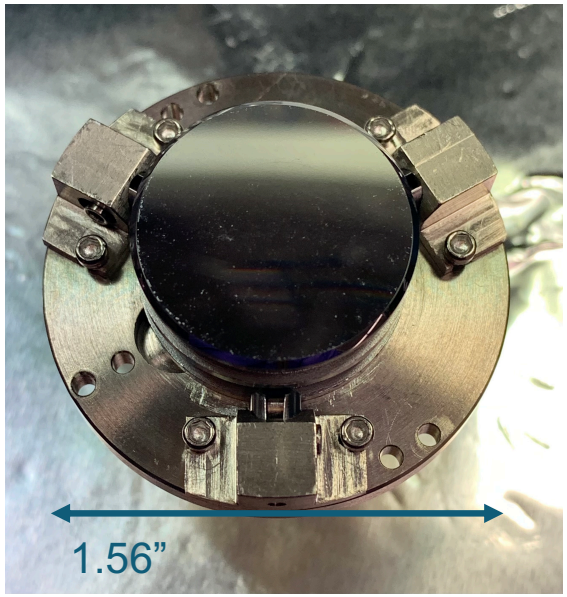
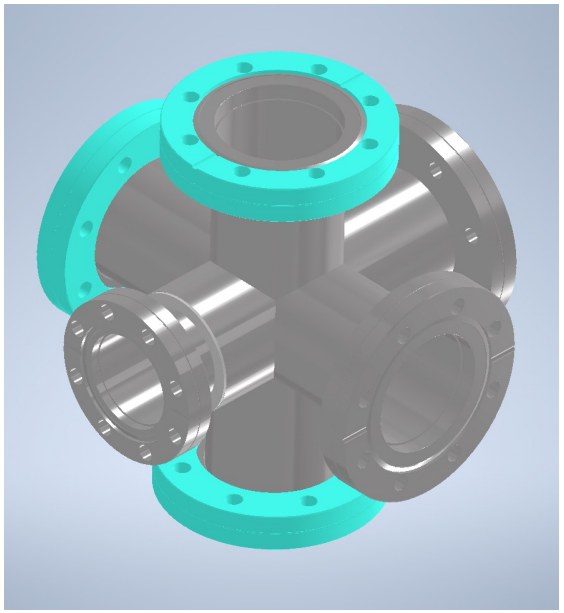
New Magazine and docking chamber





Docking cross with 3.375” flange

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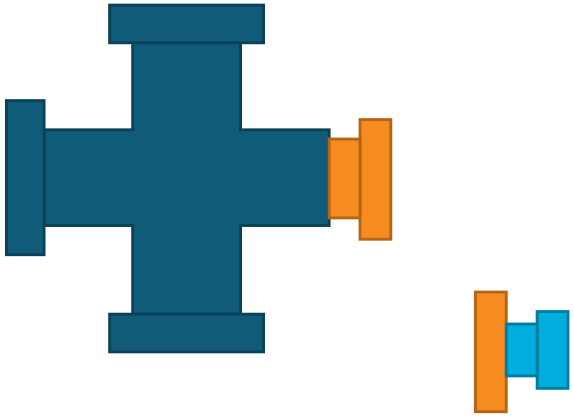
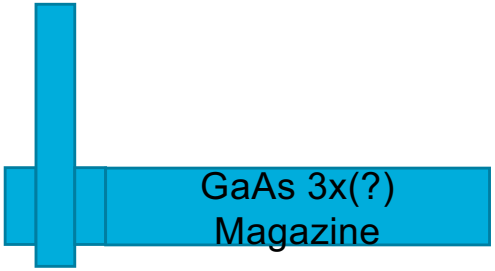
New Magazine and docking chamber adapter should two garages one XHV and one UHV be needed

Docking chamber
Based on 6-way cross
2.5” OD tubes
4.5” flanges
Modified to have one 3.375” port with 2” OD tube



3.375” to 2.75” adapter to reduce docking flange to allow GaAs Magazine connection

2” Gate Valve ID
Kalrez o-ring seal
Magazine OD 1.56”



1.500” Gate Valve ID
All metal VAT Gate Valve
Magazine OD 1.375”

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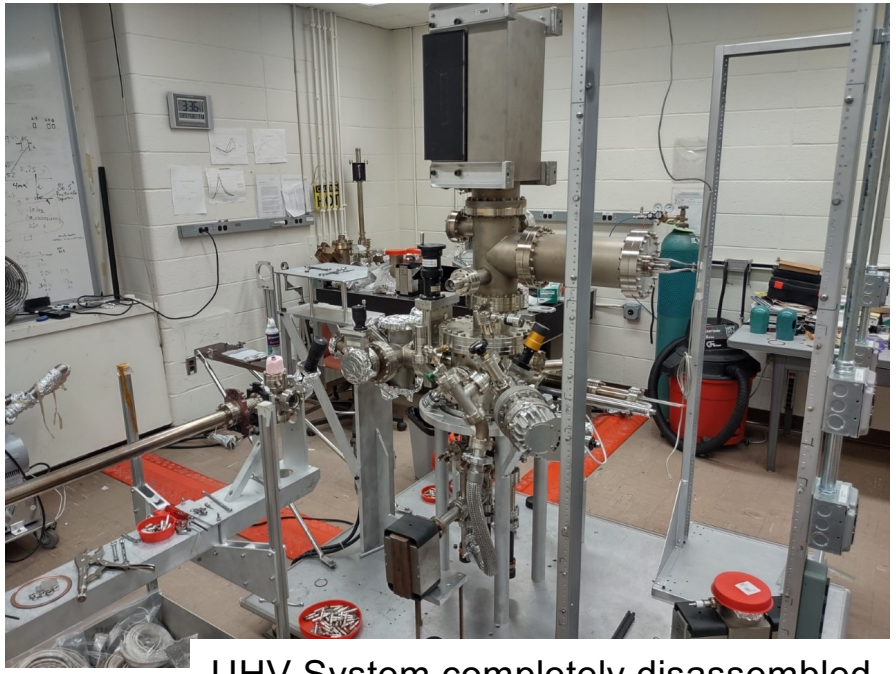
During past weeks

All parts UHV cleaned



UHV System completely disassembled

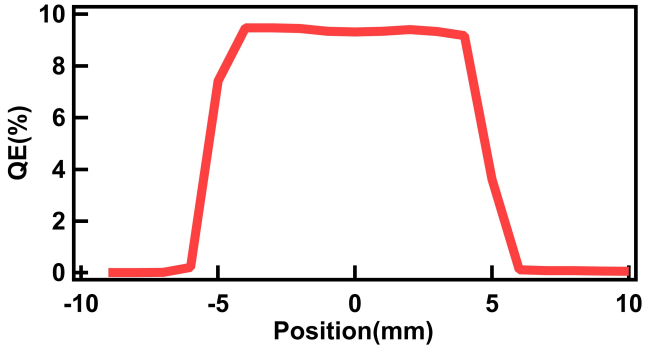
New base plate and support machined

QE mapping

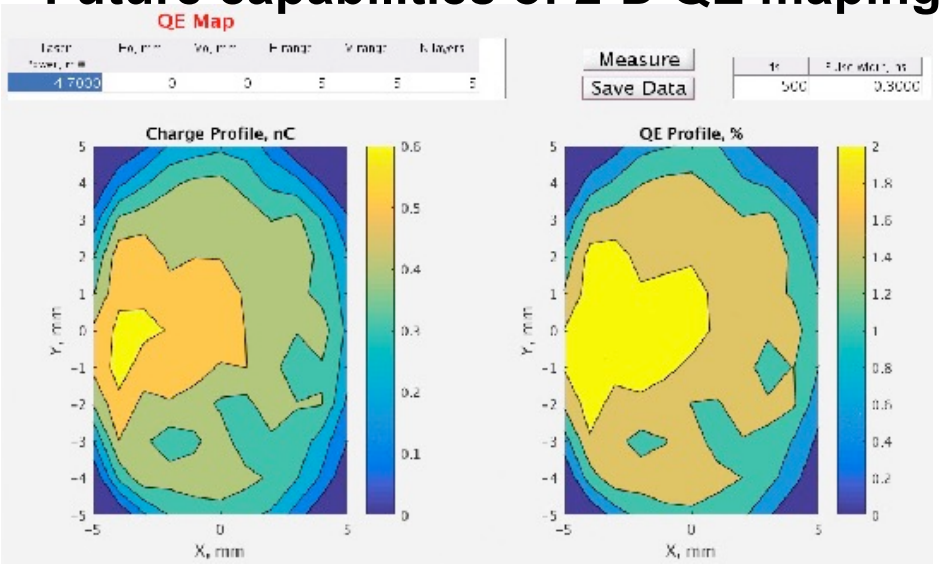
The hardware to scan the laser over the photocathode surface has been procured

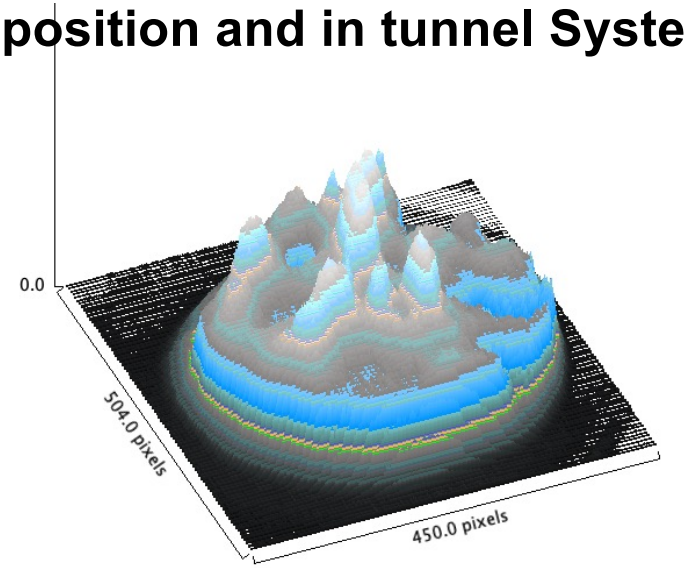
We are in the process of setting up the PC and Labview controls

Present 1-D QE mapping capabilities



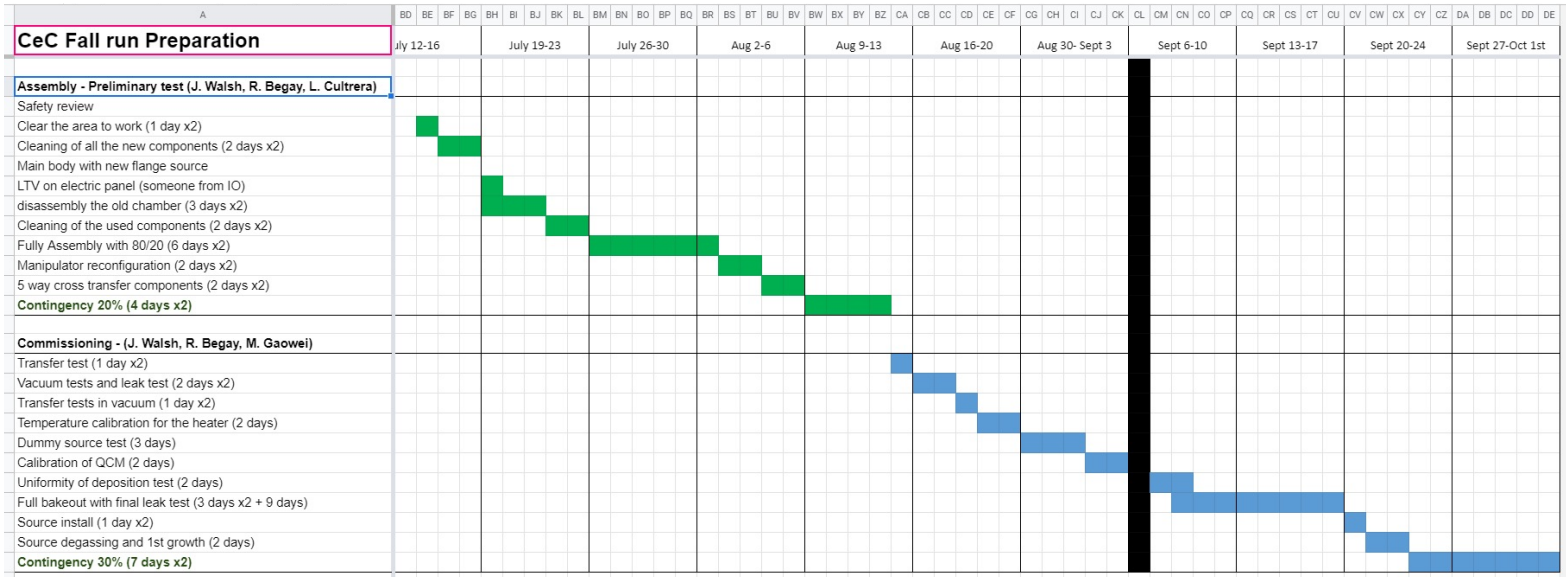
Future capabilities of 2-D QE maping in deposition and in tunnel Systems





Contingency plan

- Some of the vacuum components required for the original plan have yet to be delivered (we have experience *up to 6 weeks delay so far* for some components)
- *We have developed and currently executing a plan "B"* which will make use of the old evaporation sources until all the components for the new ones are delivered and we have sufficient time to test them.



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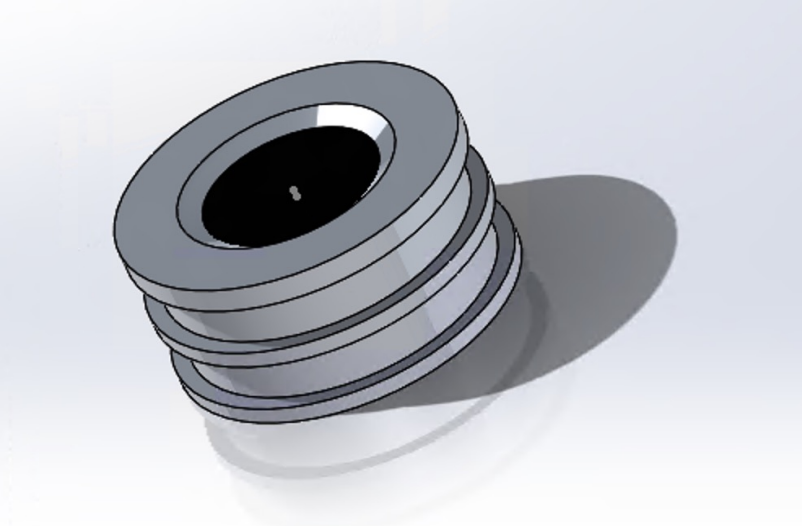
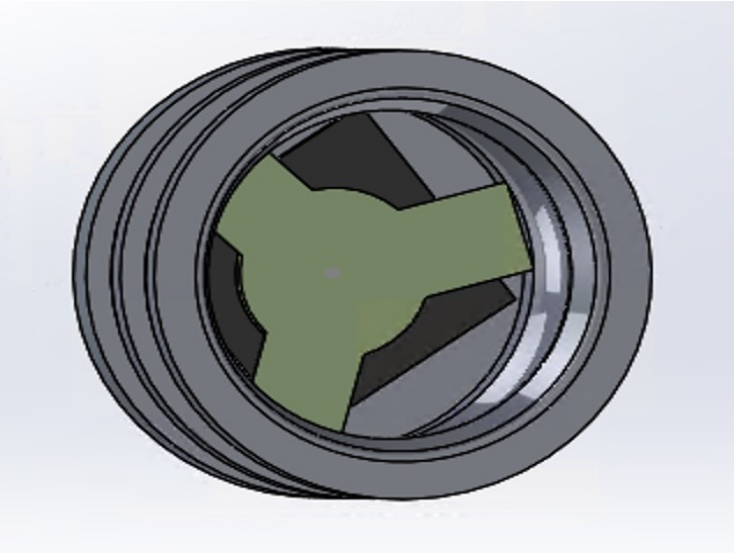
GaAs cathode puck

- Not change the transfer mechanism
- Hold the GaAs wafer using Ti sheet
- May have extra focusing, have to check with the beam dynamics
- Materials for these pucks have been received





Acknowledgements

- John Walsh
- Rudy Begay
- William Weldon

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Summary

All cathode transfer an injection system component have been designed, ordered and in an advanced state of manufacturing and deliveries of certain key systems have occurred. NexTorr's are here !

Should vendor schedules hold and no major issues encountered all new transfer systems components will be completed and ready for installation in early October cathode injection in early November.

Work is proceeding with a complete over-hall of the Cathode deposition system at instrumentation

A QA Mapping system is under design and parts ordered for system for integration at Instrumentation and eventual use in tunnel.