

Vacuum Tight Metal to Ceramic Joining

Presenter – Vardanyan Vahagn

Conclusion for Step 1

Yerevan 26.03.2015



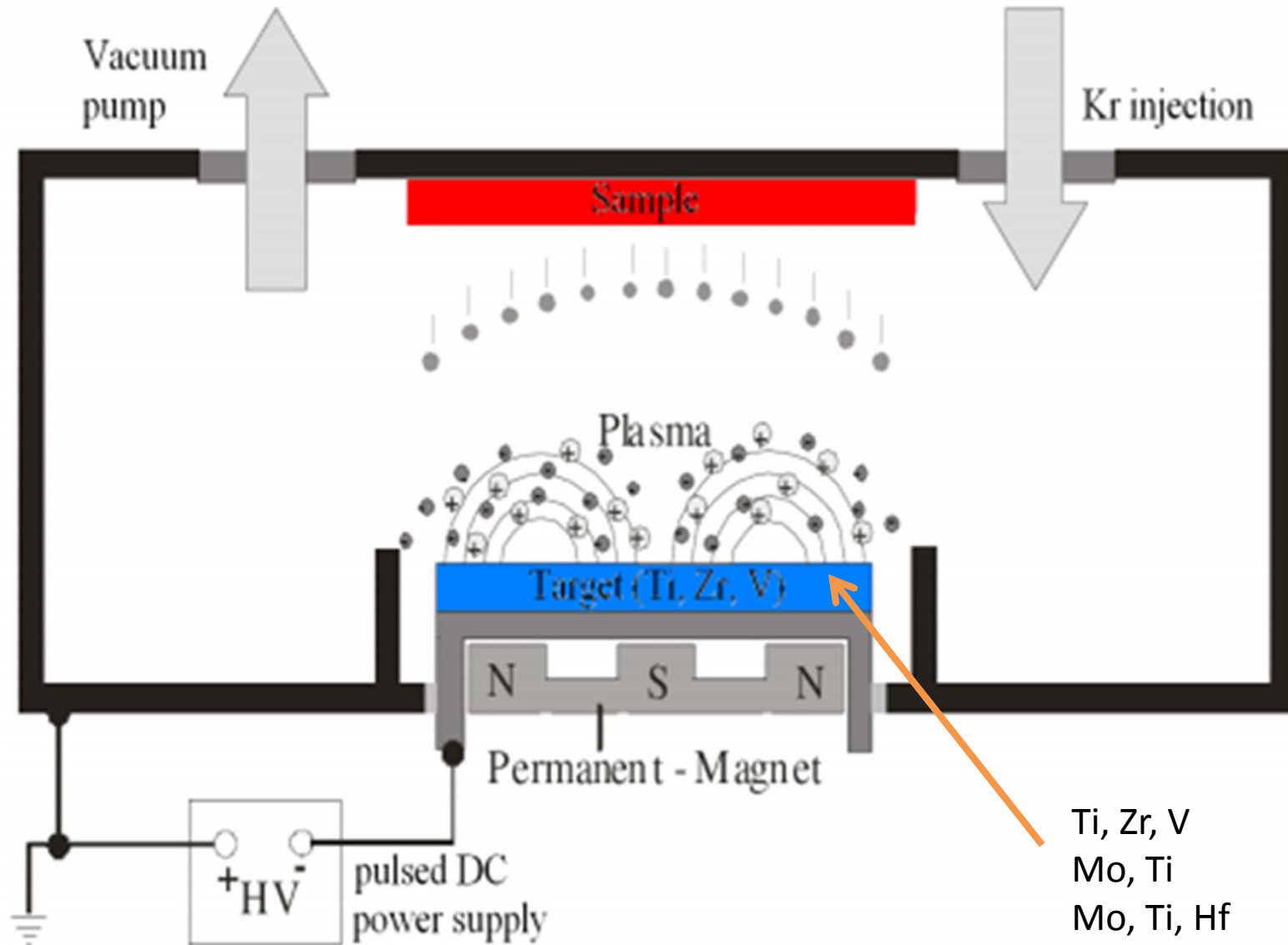
- Review – methods, advantages and disadvantages, structures, developments, etc.
- Preliminary experimental plan,
- Preliminary experiments – cutting, grinding, polishing of Alumina,
 - metalization - moly-manganese method in vacuum,
 - brazing with Stainless steel using silver solder,

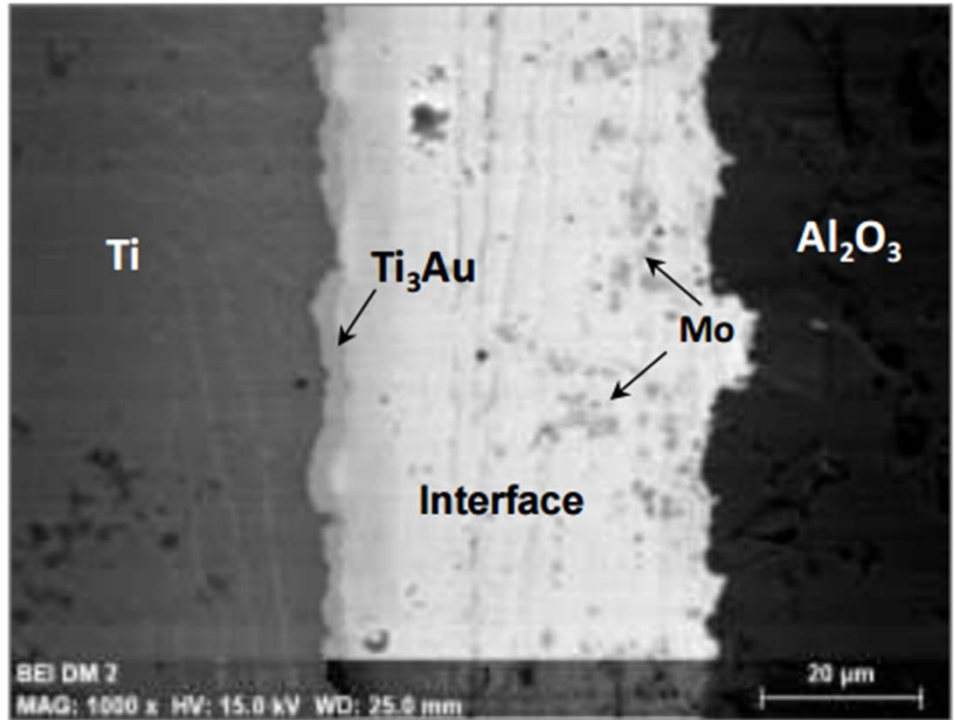
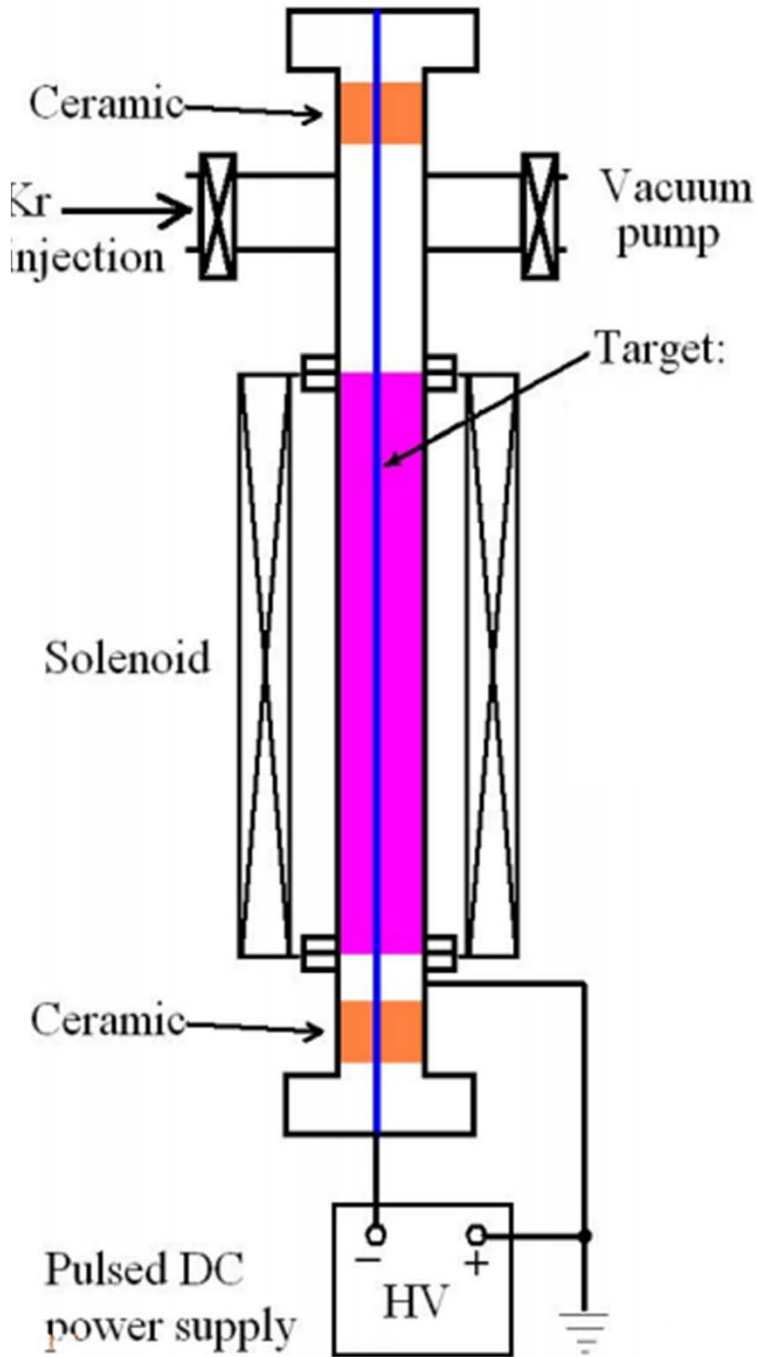
**Developing new methods for bonding ceramic to metals - with magnetic materials
for Vacuum Tight Parameters - without magnetic materials**

1. Conclusion of experiments in vacuum – advantages, disadvantages and developing,
2. Repeat moly-manganese method in Hydrogen furnaces,
3. Time schedule for design, calculation, review, experiments, etc.,
4. Review and experiments for Alumina,
 - surface analysis (roughness, hardness, etc.),
 - metallization processes (Hydrogen furnaces, etc.),
 - Galvanic layers- Ni,
 - active brazing (Ti, Zr, etc.),
 - silver solders brazing,
 - mechanical calculations, simulations,
 - microscopy references analysis,
 - mechanical testing,
 - thermal testing,
 - vacuum tight testing,
 - etc.

Different methods for metallization and brazing of ceramics

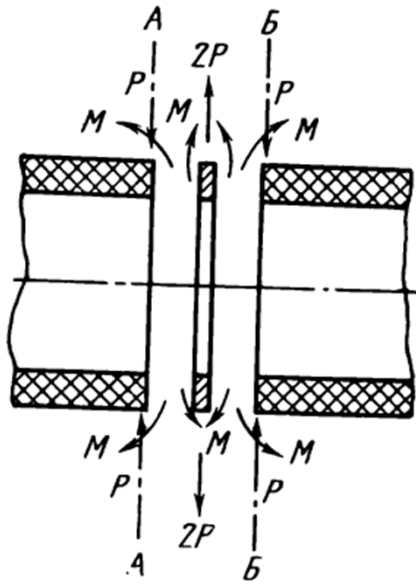
Magnetron Deposition



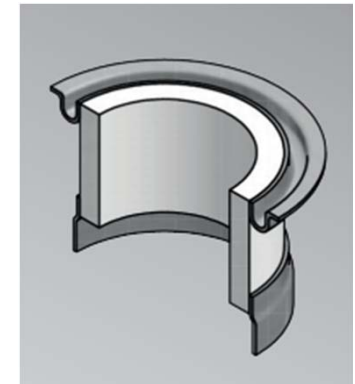
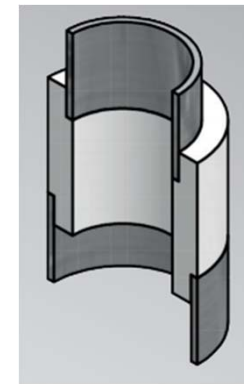
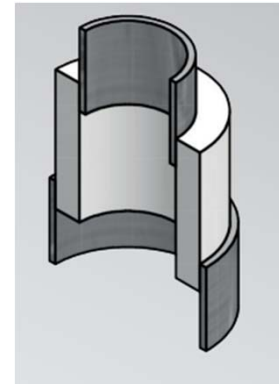
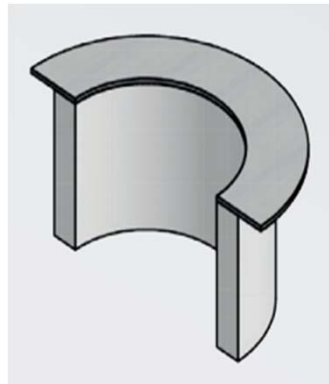
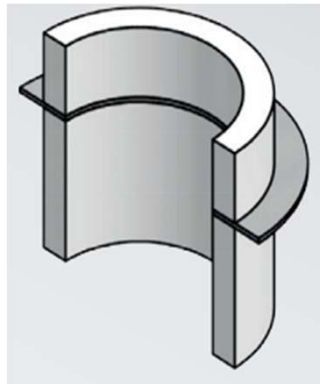
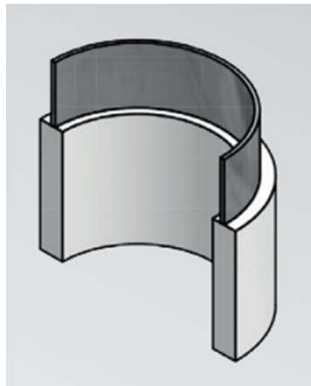


- Cross-section of Al_2O_3 -Mo/Au/Ti interface for samples joined at $1100^\circ C$ for 2 μm of Mo-coating for 5 minutes

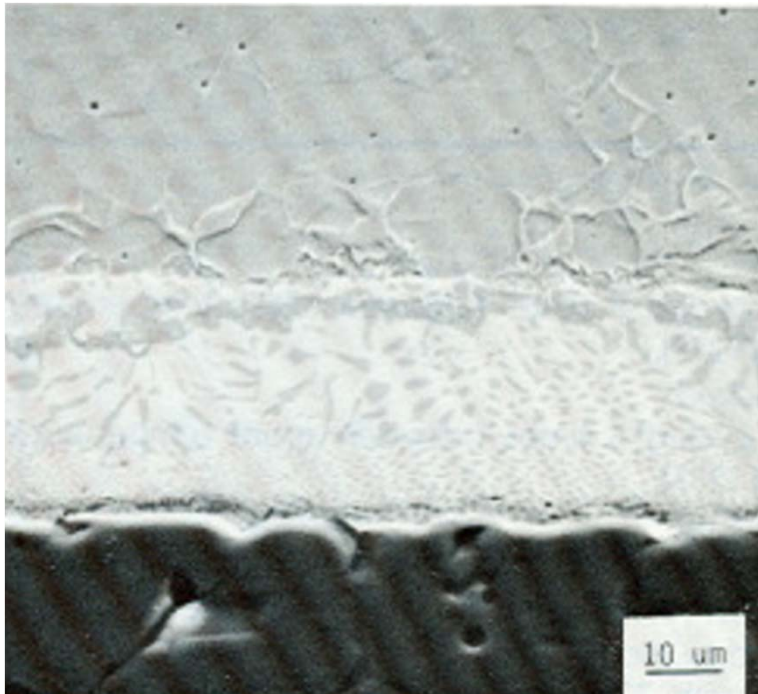
Mechanical stress calculation of metal - ceramic junctions



- Review of methods,
- Design – calculation – simulation,
- Experiment,
- Testing



Active Direct Bonding Technology

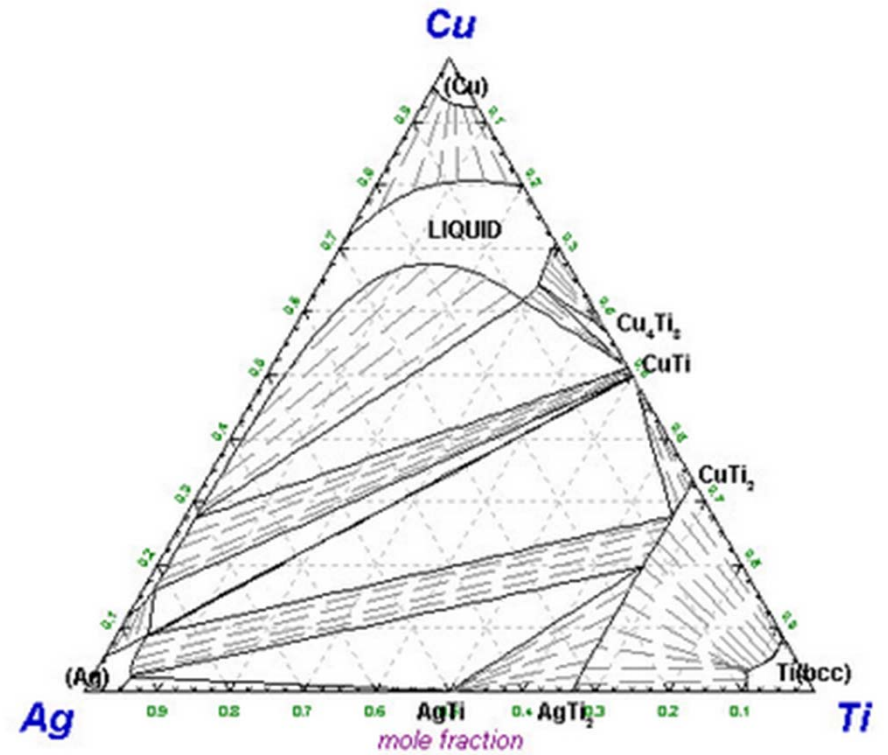


Kovar

AgCuTi

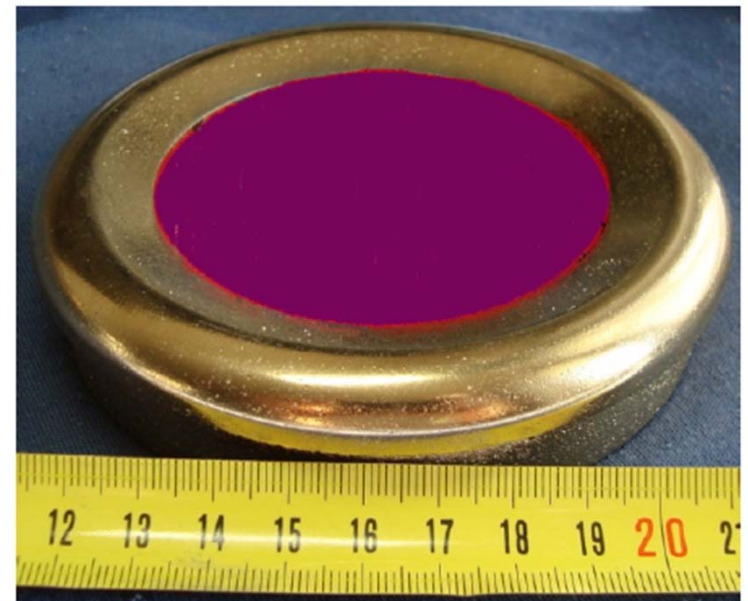
Alumina

Cu - Ti - Ag - 900°C

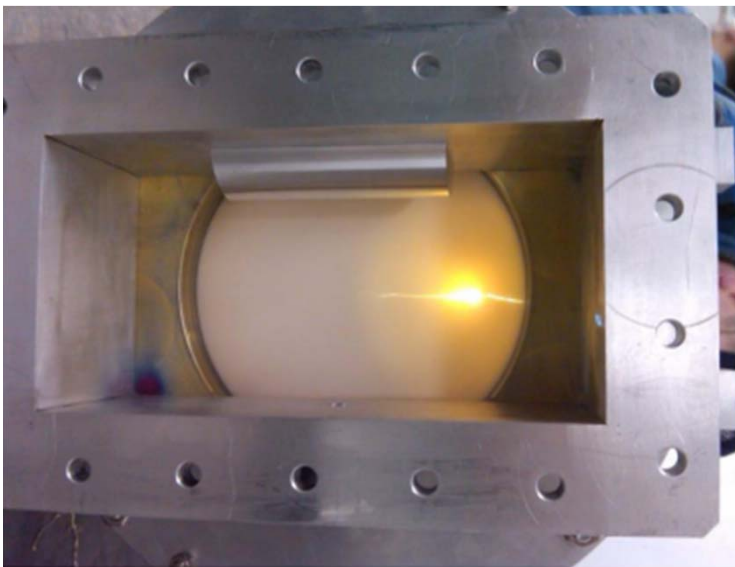
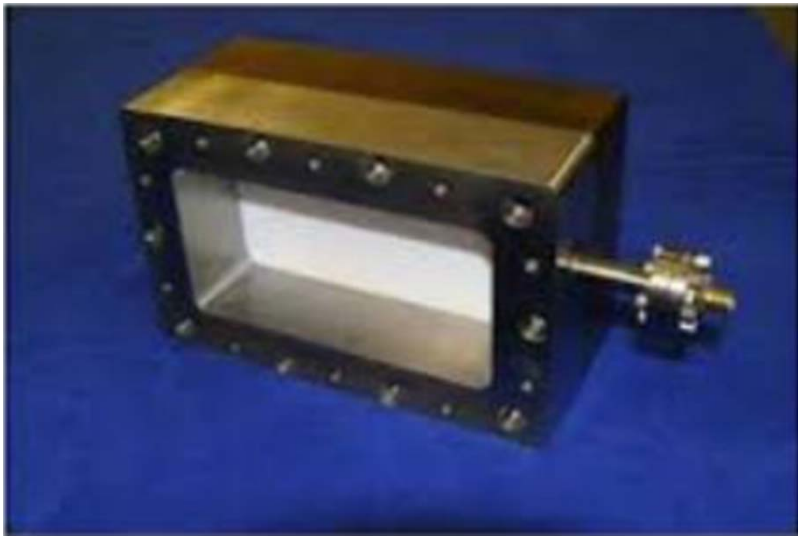


Phase Diagram Cu - Ti - Ag

NEW METAL/CERAMIC CATHODS



RF Windows

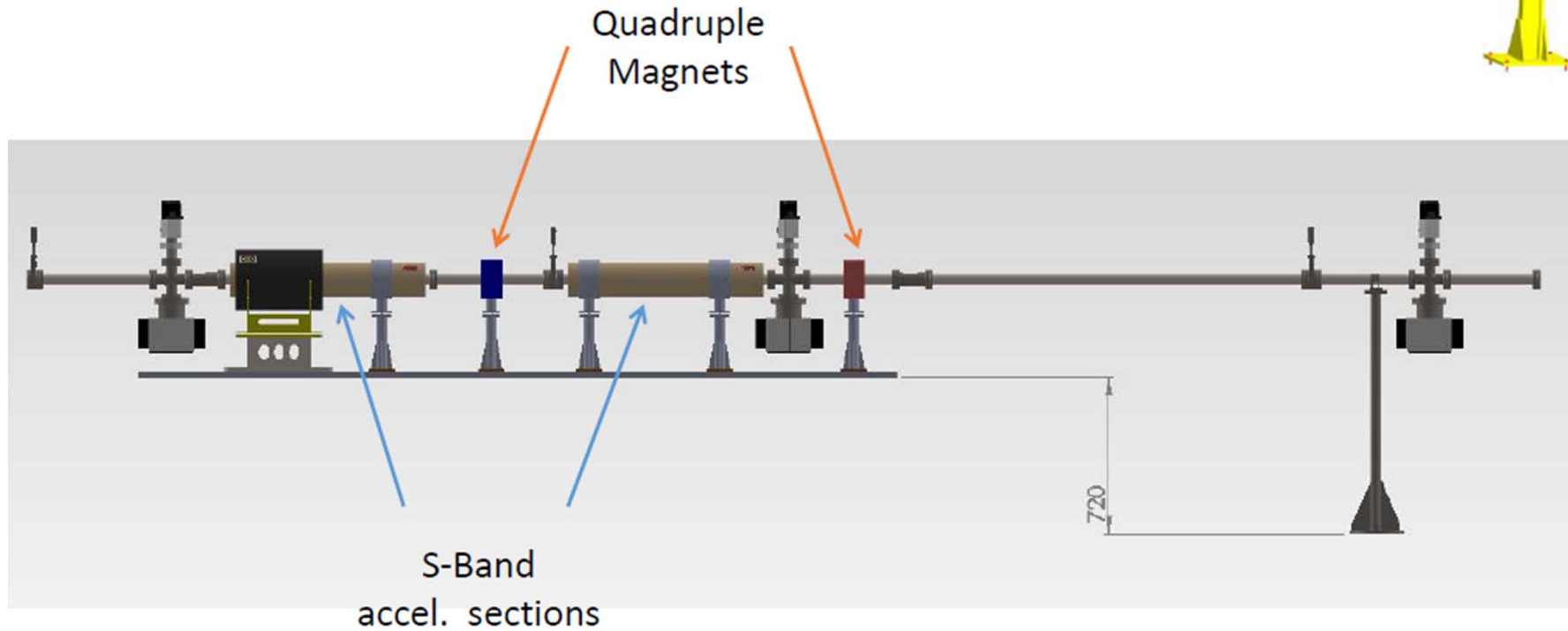
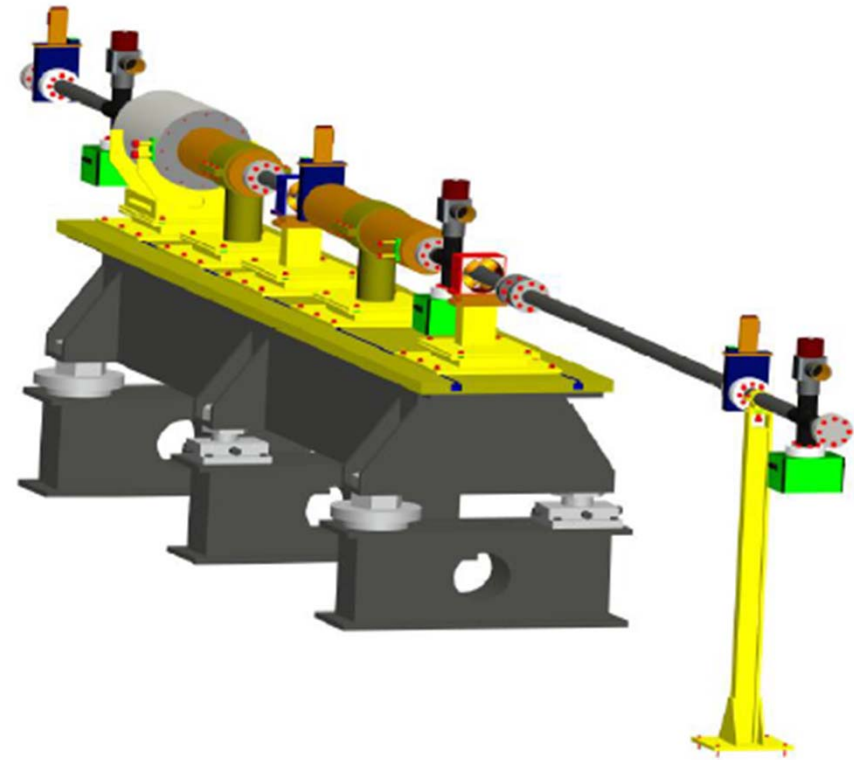


Vacuum Laboratory

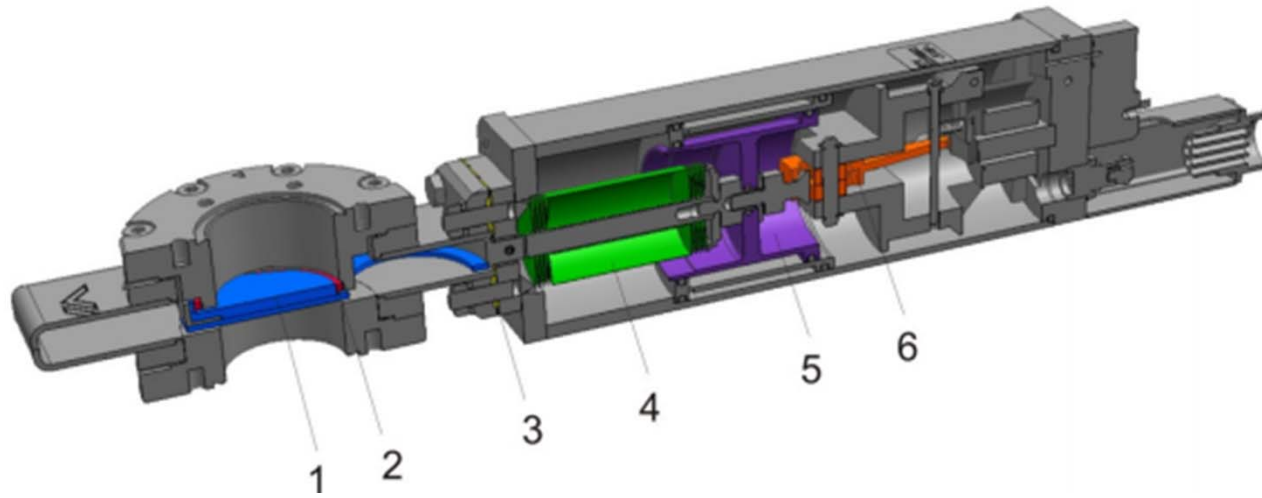
Vacuum Laboratory

- 1. Testing** UHV systems, electrical systems(PLC , DAQ systems), pneumatic systems, shutters, vacuum gauges, welding, brazing junctions, new getters, NEG coating, NEG getters, absorption systems, etc.
- 2. Training** – student, personal qualification.
- 3. Experiments** - Developing new welding, brazing technology, New cathods, high and low temperature testing, spectrial analyzer testing, new materials developing, RF Gun UHV testing, new mover systems for UHV, new absorption systems, new vacuum chambers, etc.

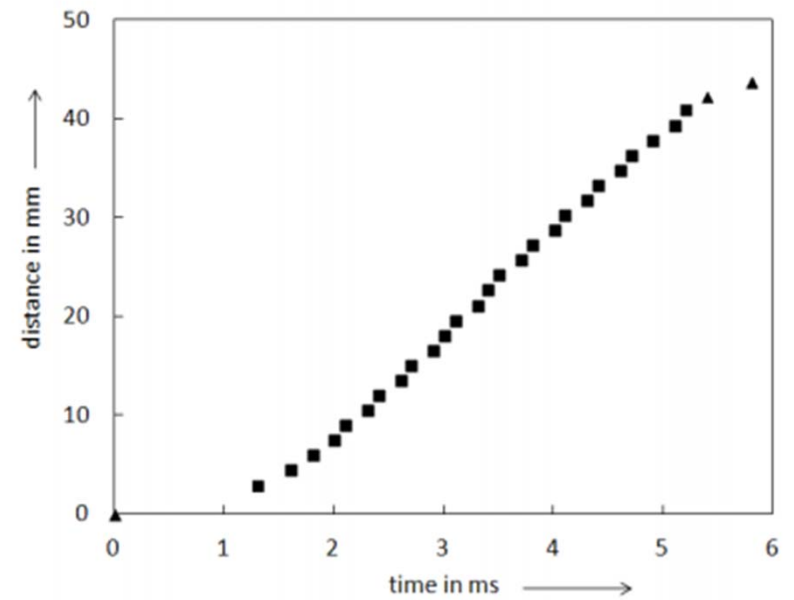
Developing steps of vacuum systems

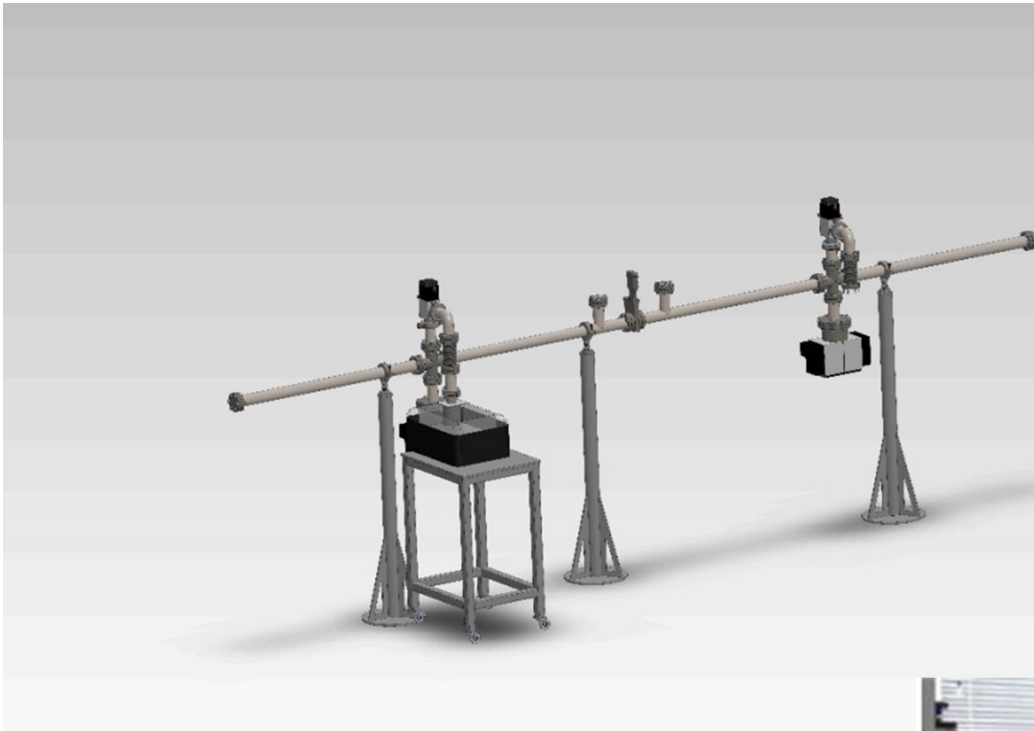


Very Fast Shutters



Resolution on time scale is 0.1 ms.



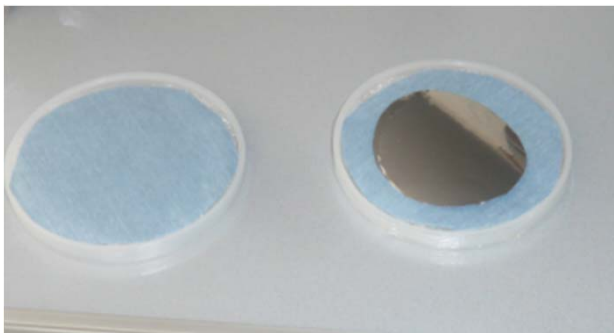
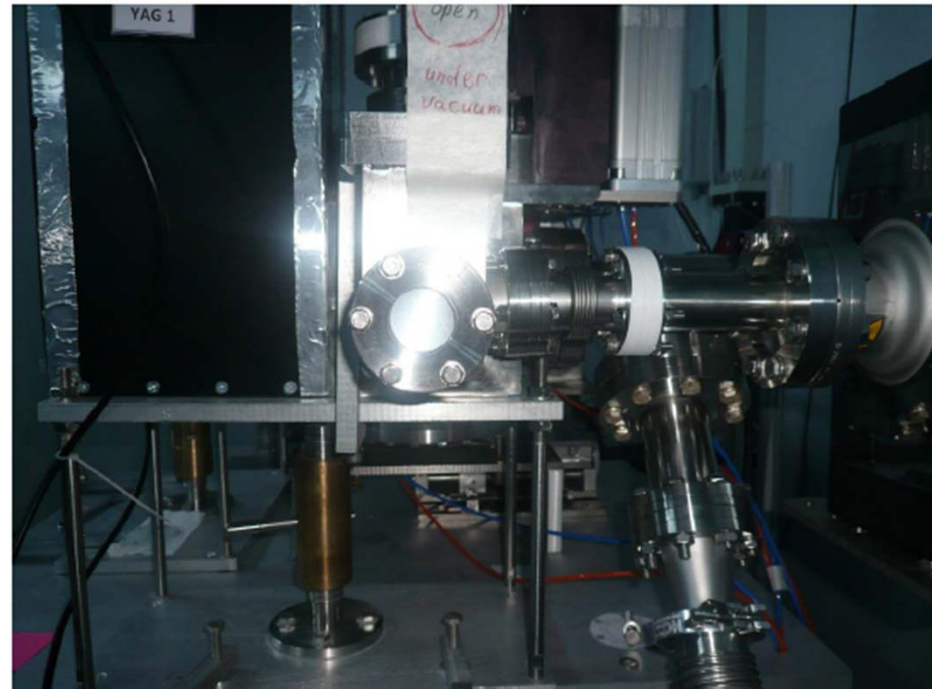
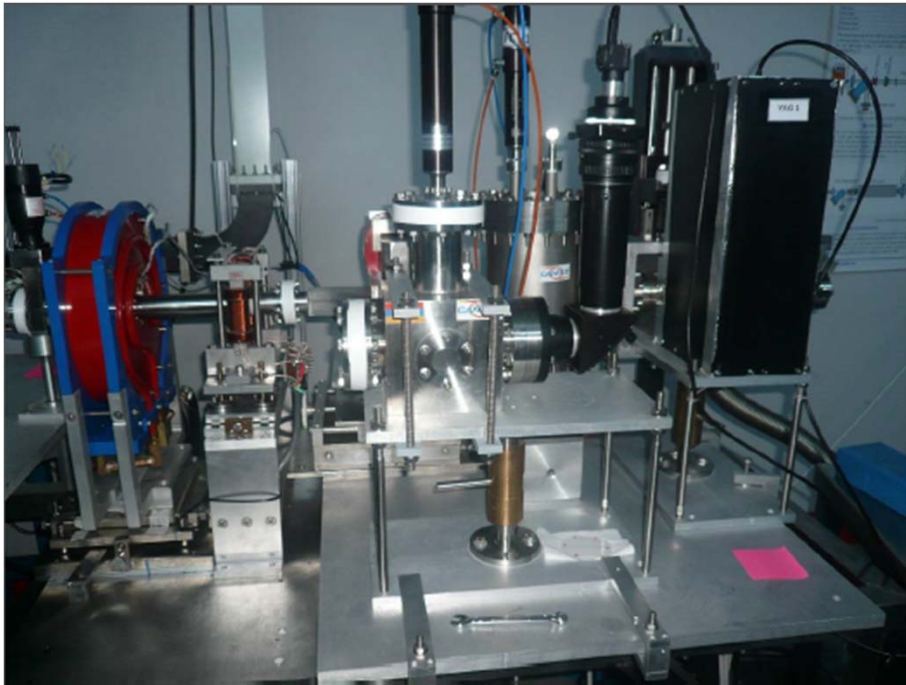


First Vacuum Test Stand

First Experience



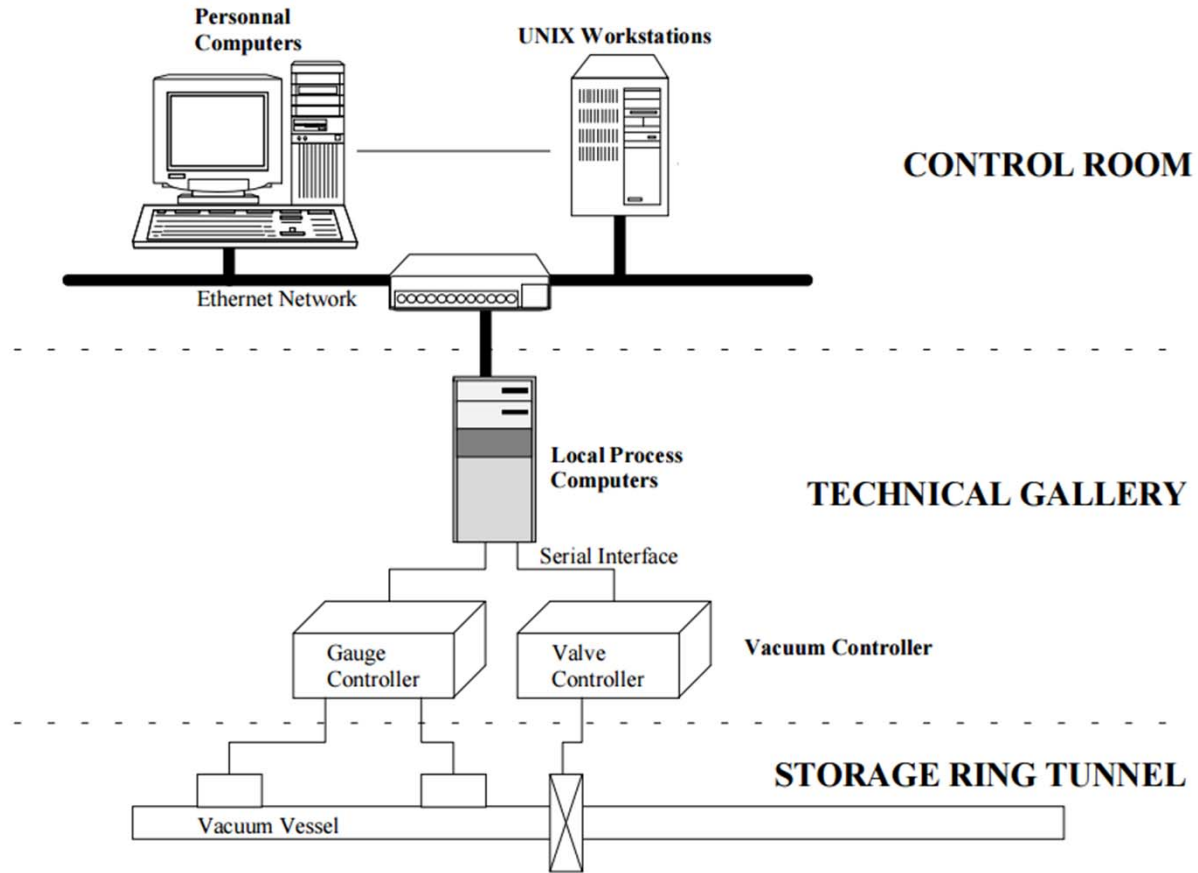
UHV System for AREAL – Advances Research Electron Accelerator Laboratory



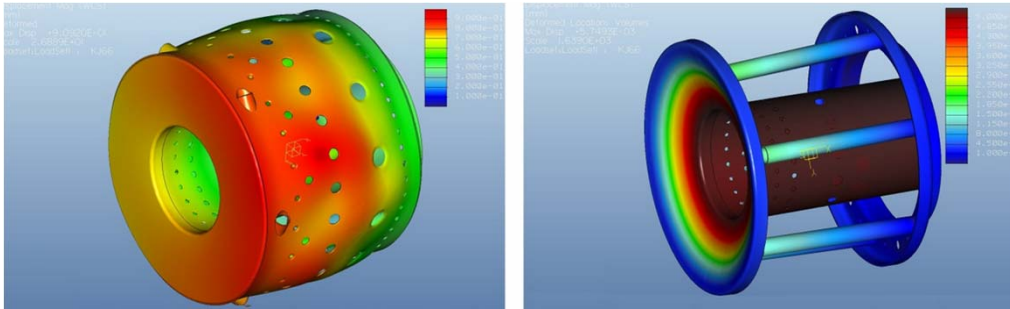
Titanium Foil



UHV Systems Testing

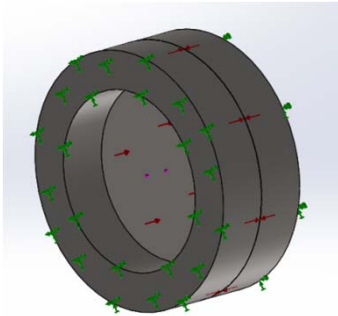
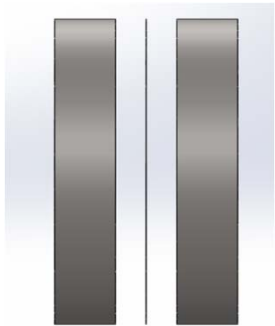


UHV Systems Design

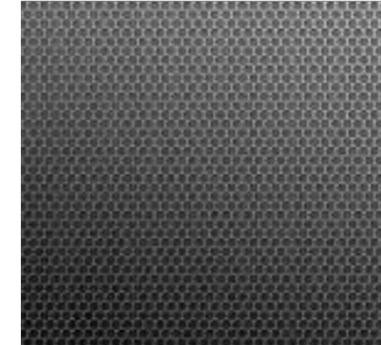


vacuum - cryogenic chamber

Ti – windows mechanical simulation (50 μm)



Metallic grid

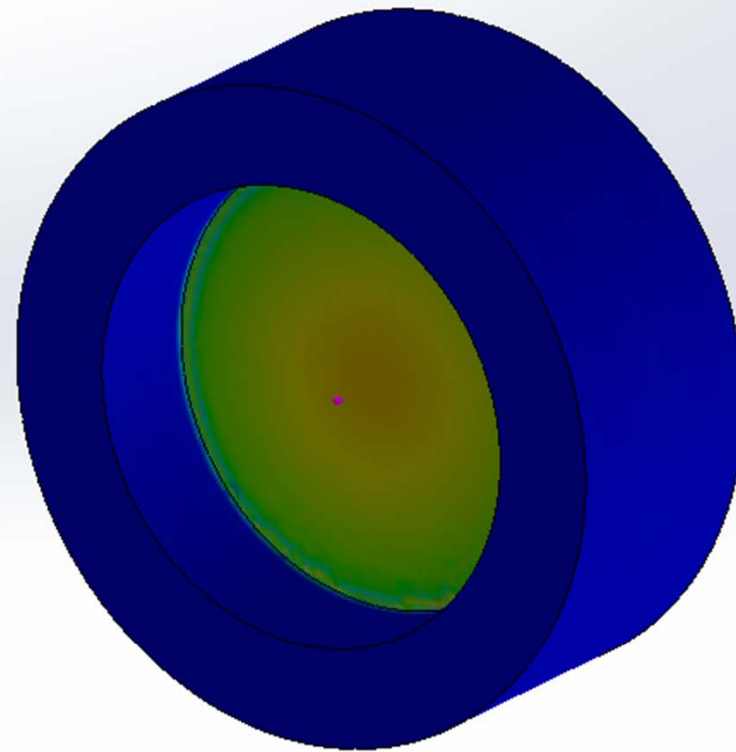


Property	Value	Units
Elastic Modulus	1.9e+011	N/m ²
Poisson's Ratio	0.29	N/A
Shear Modulus	7.5e+010	N/m ²
Density	8000	kg/m ³
Tensile Strength	517017000	N/m ²
Compressive Strength		N/m ²
Yield Strength	206807000	N/m ²
Thermal Expansion Coefficient	1.8e-005	/K
Thermal Conductivity	16	W/(m·K)
Specific Heat	500	J/(kg·K)
Material Damping Ratio		N/A

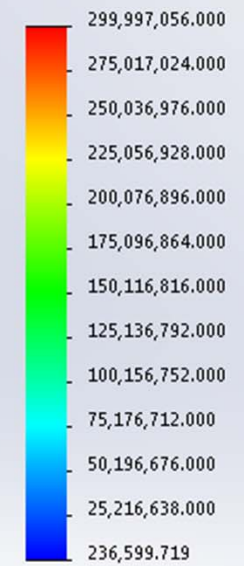
Property	Value	Units
Elastic modulus	1.05e+011	N/m ²
Poisson's ratio	0.33	N/A
Shear Modulus		N/m ²
Mass density	4510	kg/m ³
Tensile strength	485000000	N/m ²
Compressive Strength		N/m ²
Yield strength	345000000	N/m ²
Thermal expansion coefficient	9e-006	/K
Thermal conductivity	21.79	W/(m·K)
Specific Heat		J/(kg·K)
Material Damping Ratio		N/A

Stress

Model name: Ti window
Study name: Static 1(-Default-)
Plot type: Static nodal stress Stress1
Deformation scale: 1

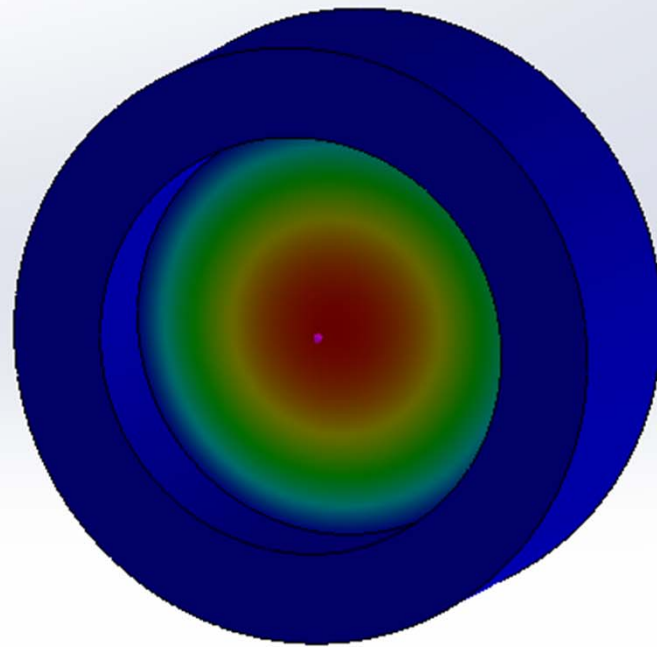


von Mises (N/m²)

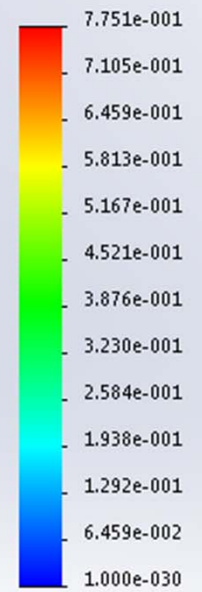


Displacement

Model name: Ti window
Study name: Static 1(-Default-)
Plot type: Static displacement Displacement1
Deformation scale: 1

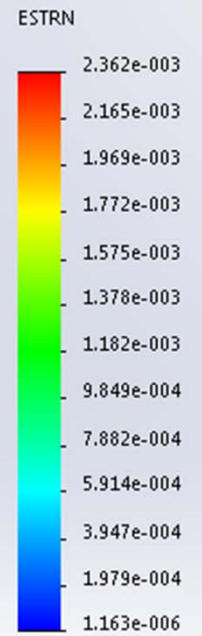
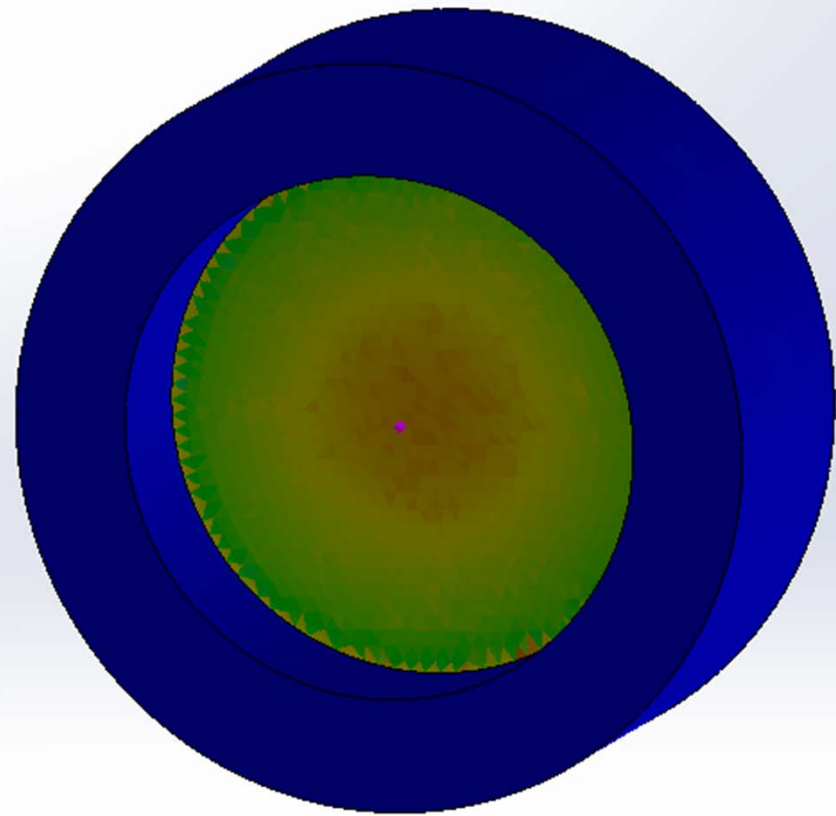


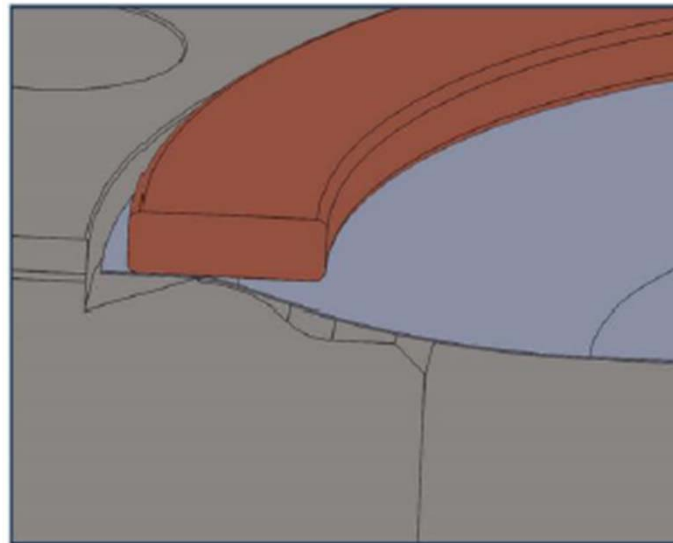
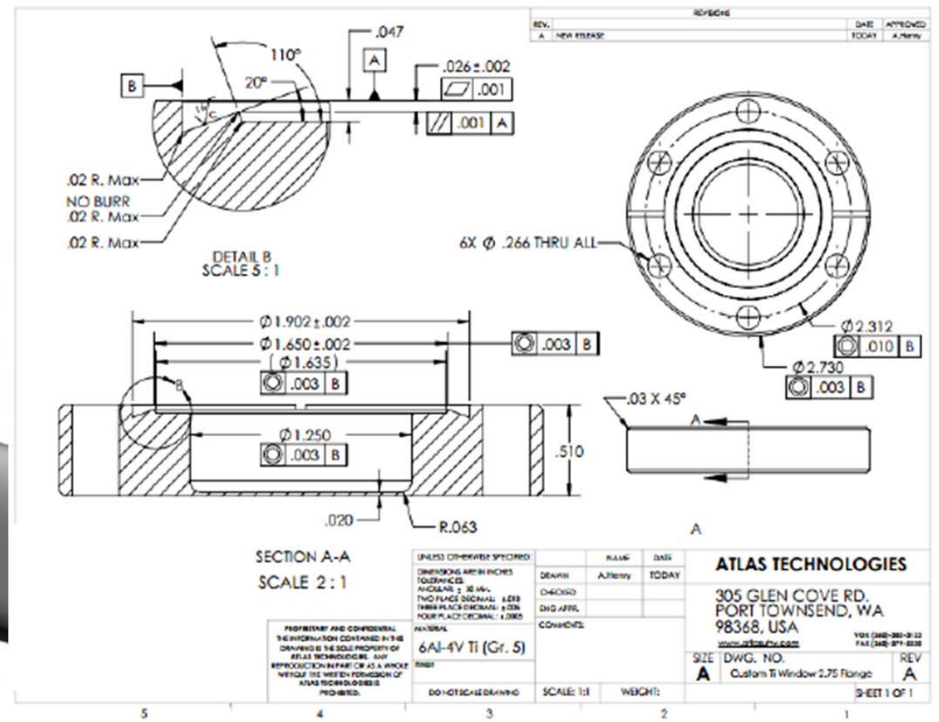
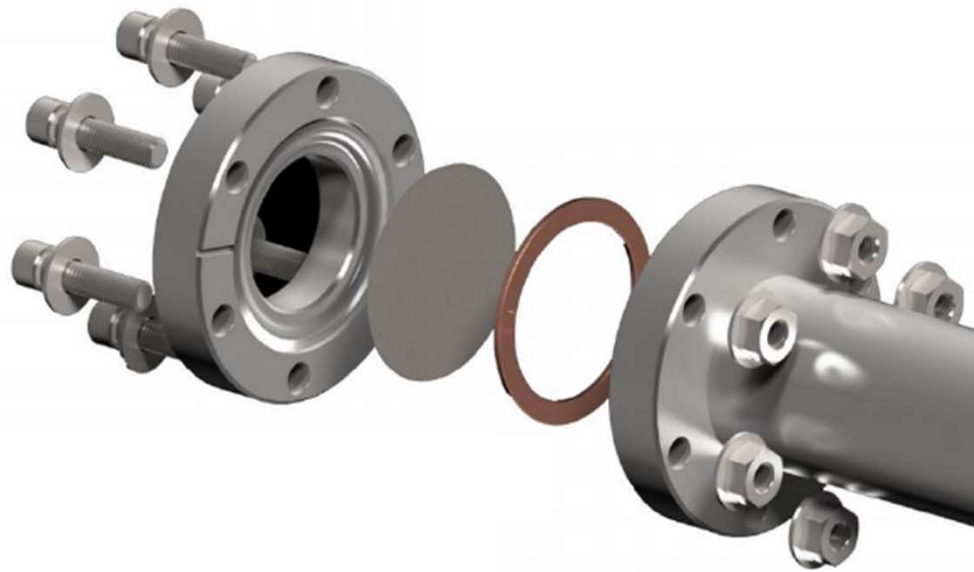
URES (mm)



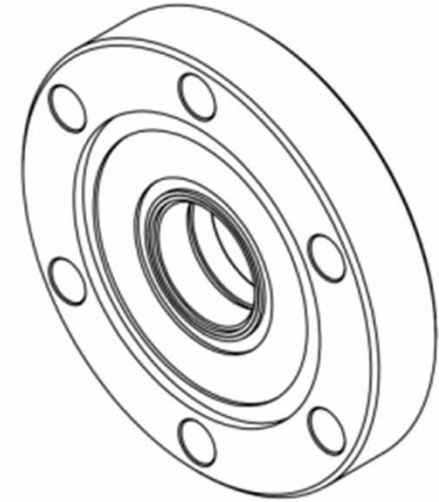
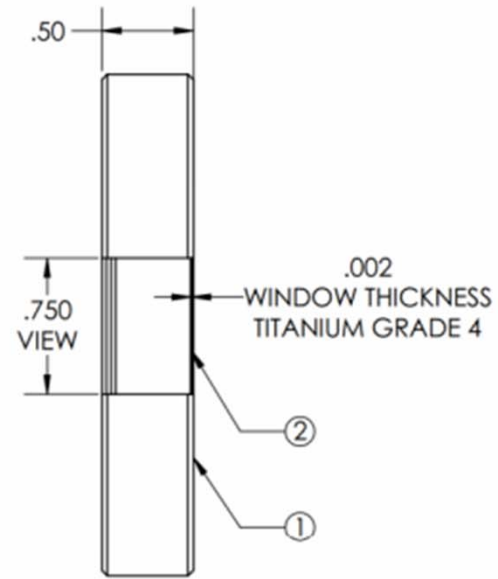
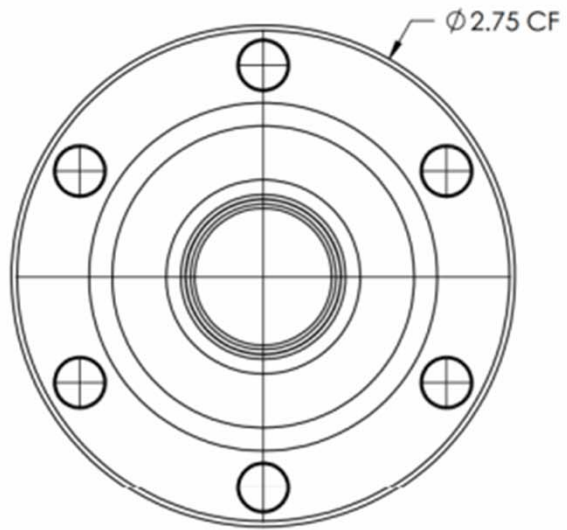
Static Strain

Model name: Ti window
Study name: Static 1(-Default-)
Plot type: Static strain Strain1
Deformation scale: 1



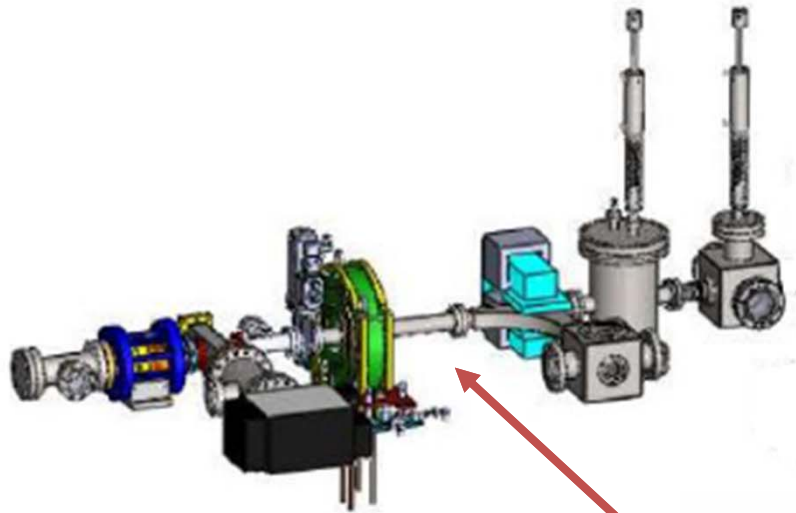


Titanium Windows at VACOM



ITEM NO.	DESCRIPTION	QTY
1	FLANGE 304 STN. STL.	1
2	SUB ASSEMBLY	1

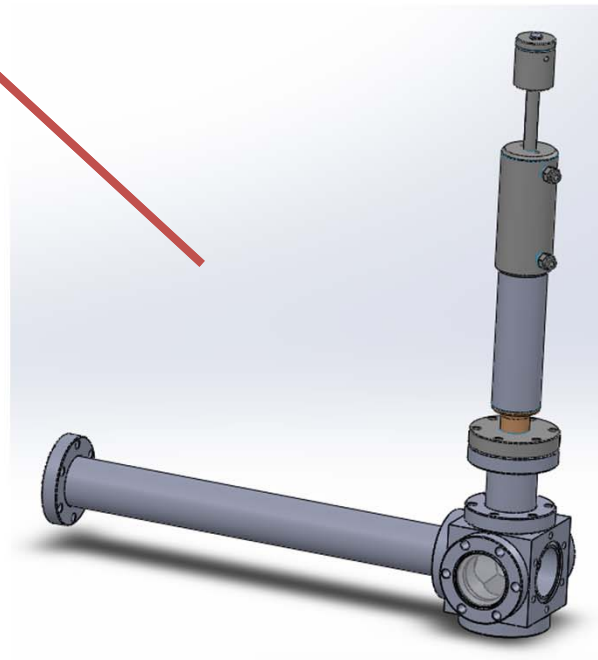
UHV system for AREAL Alignment



7056 Glass Viewport
Kovar sleeve



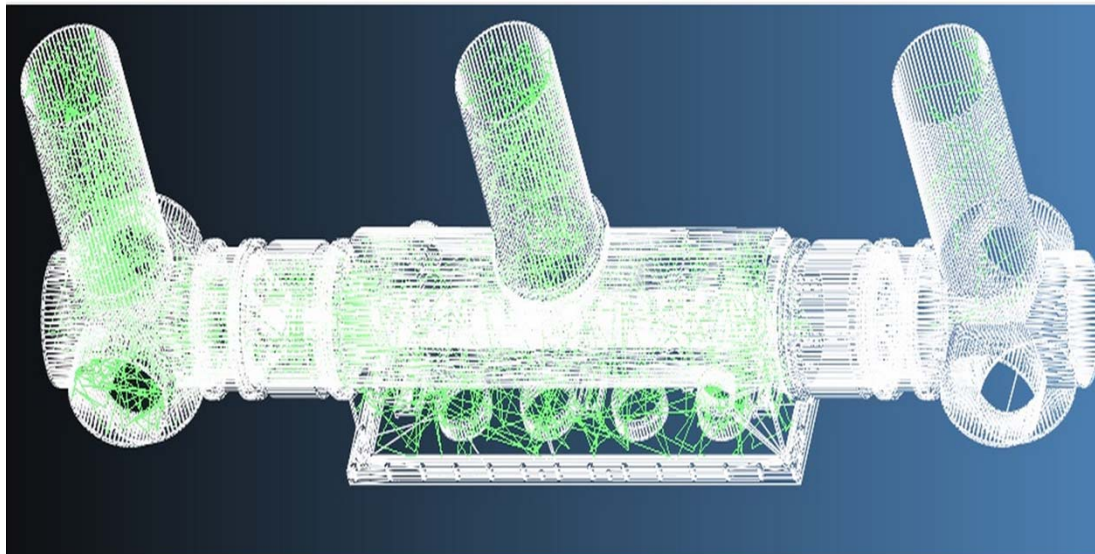
Design new UHV system



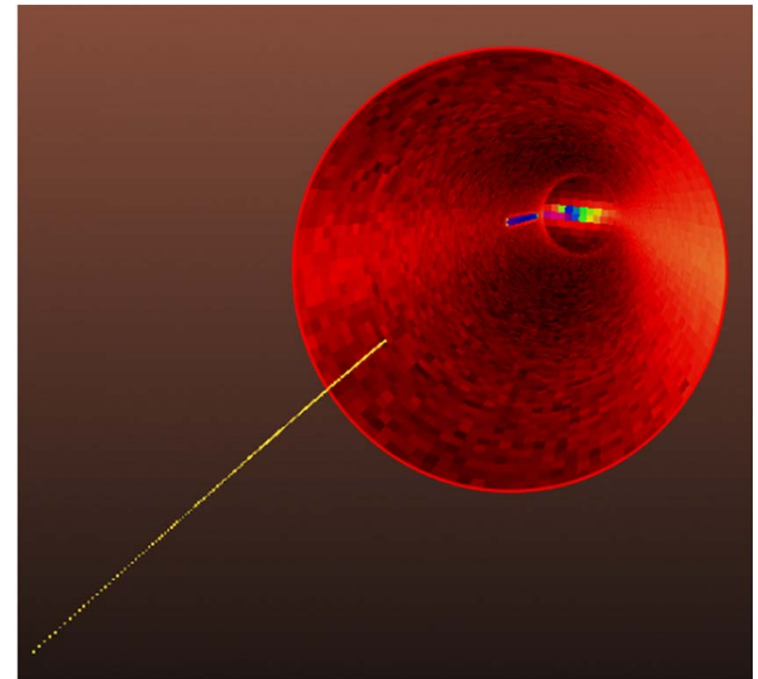
Glass to metal brazing
technology developing

Vacuum Simulation

MolFlow+

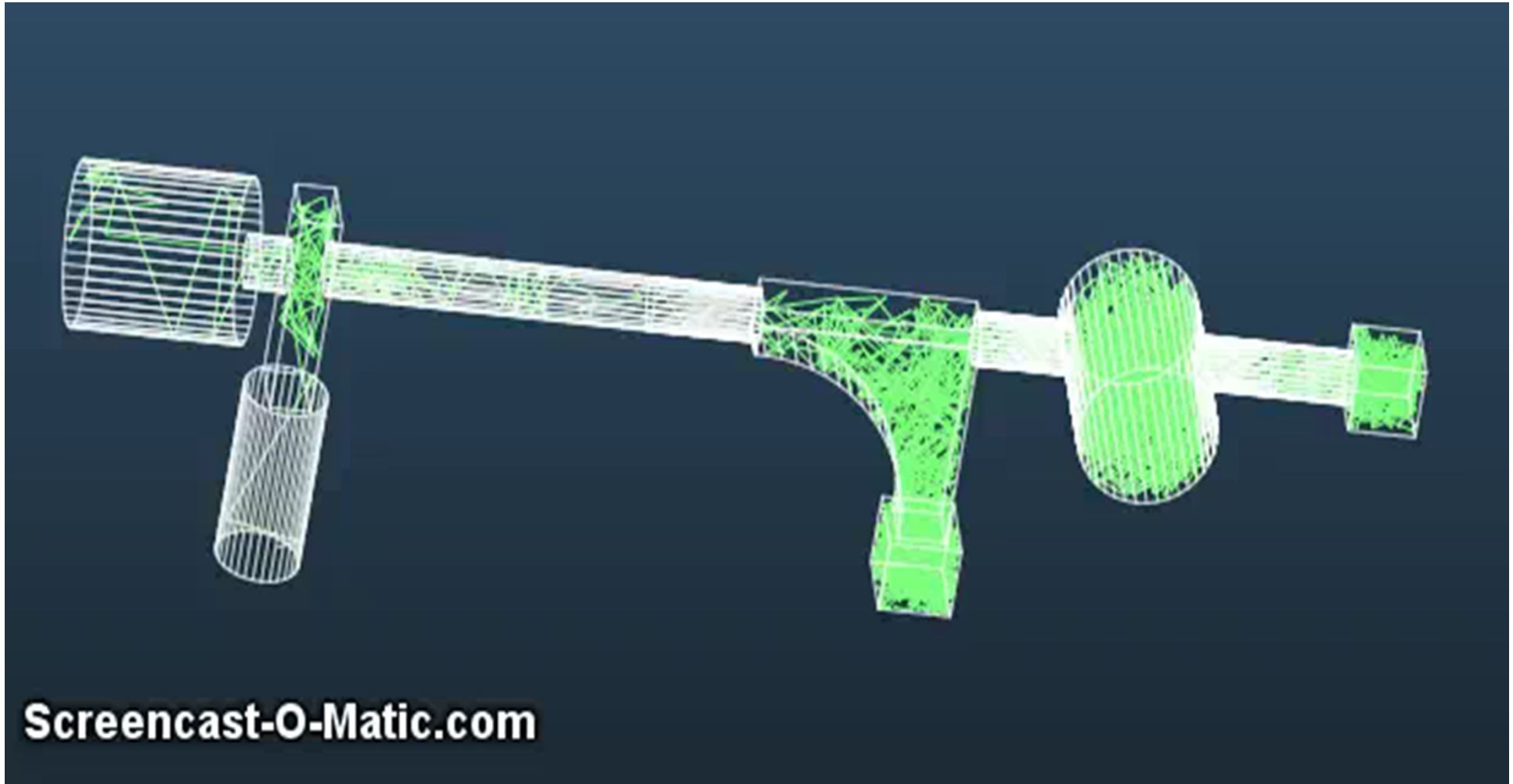


SynRad+

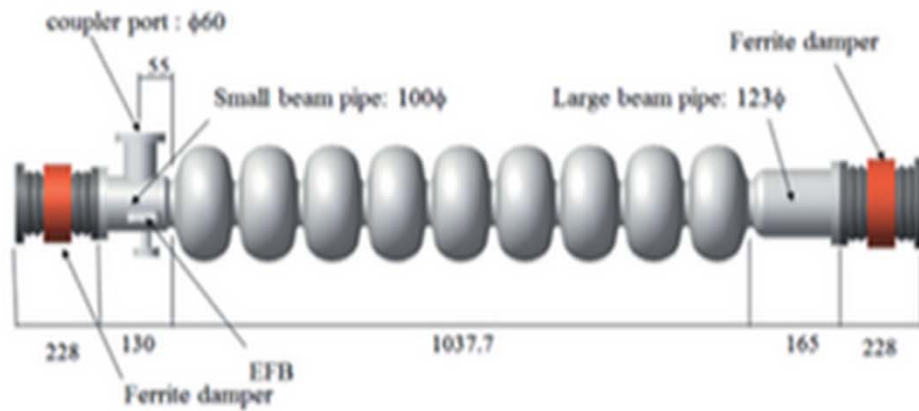


Photon generation
Generated photon energy: Emin: eV Emax: eV

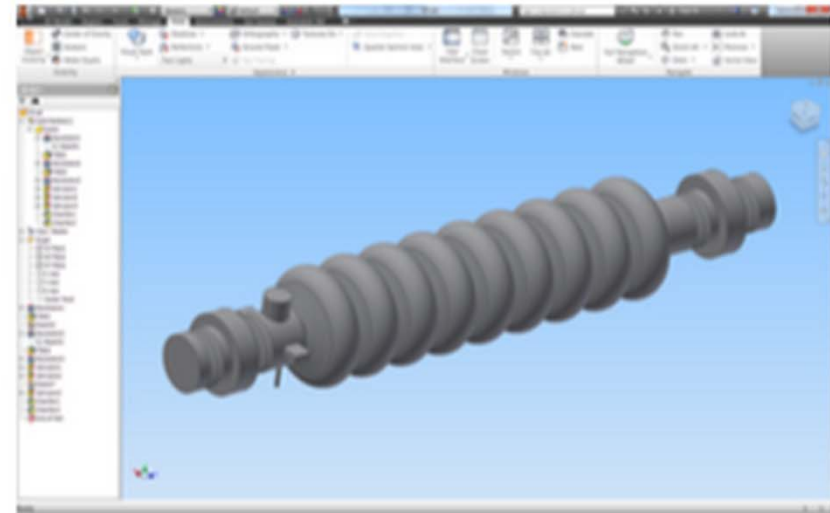
First MolFlow Simulation



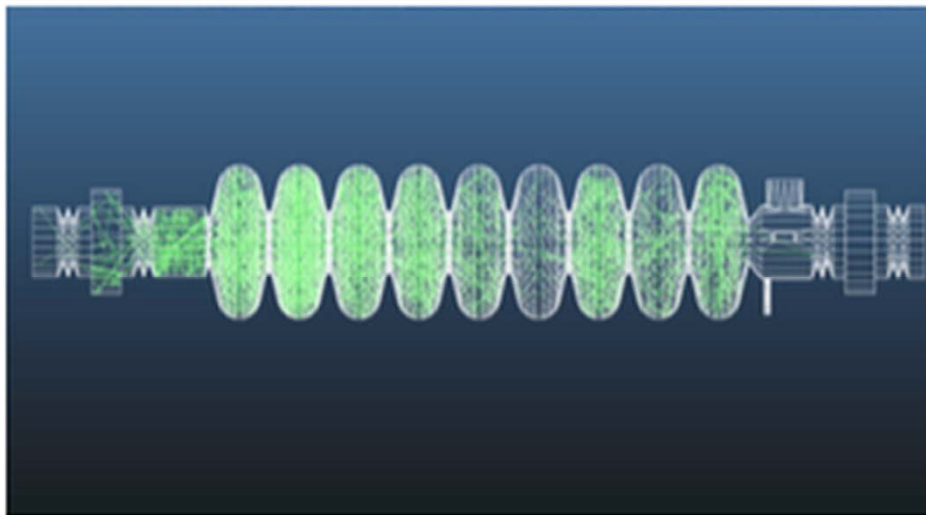
Experience at KEK



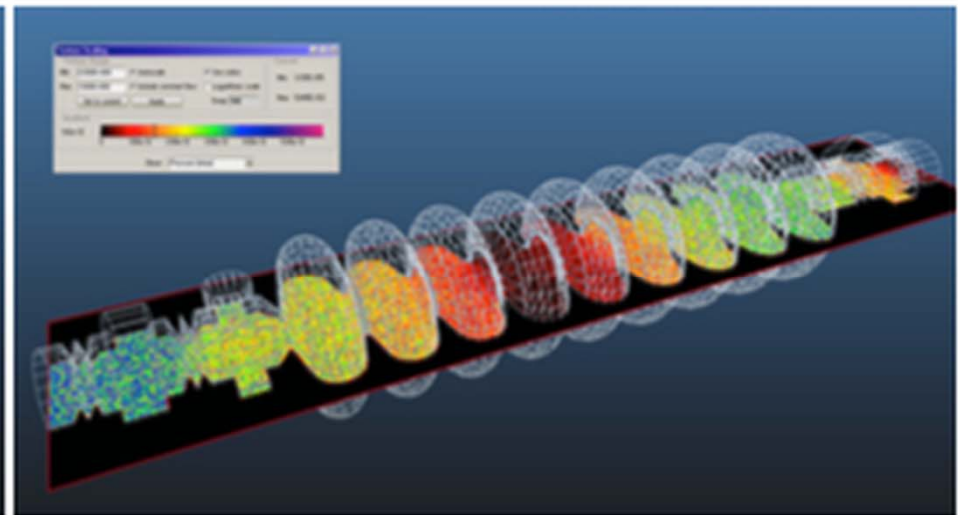
RF cavity



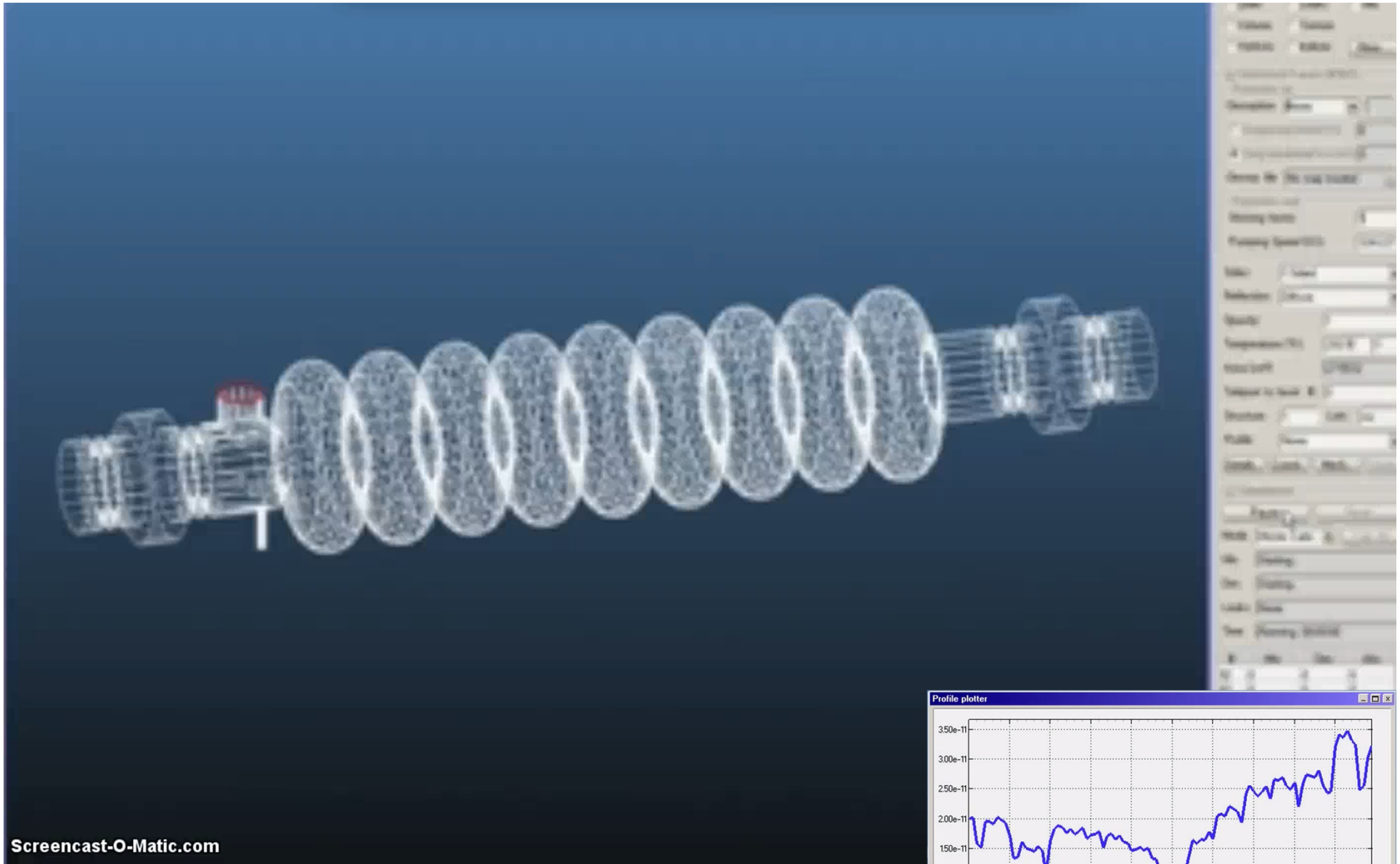
CAD model



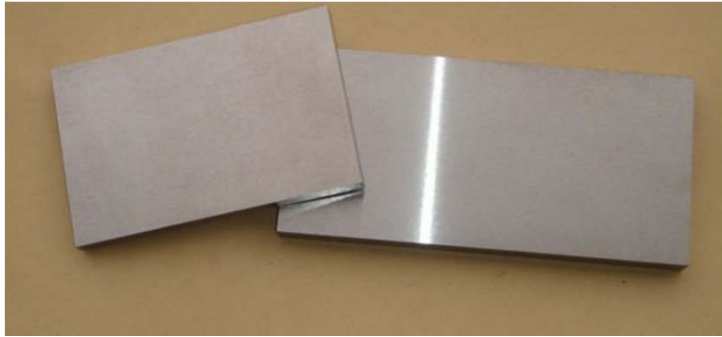
Monte Carlo simulation



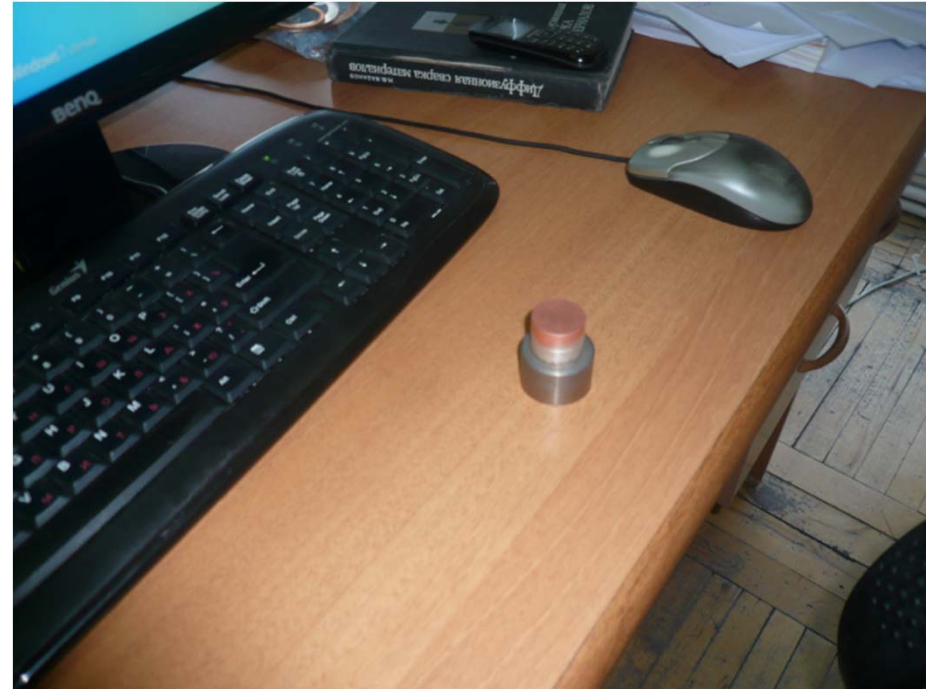
Pressure profile results



Diffusion Welding Laboratory



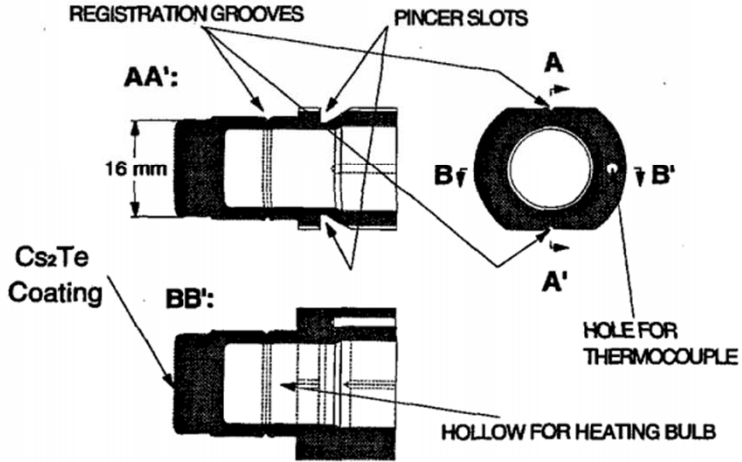
Niobium Welding Technology



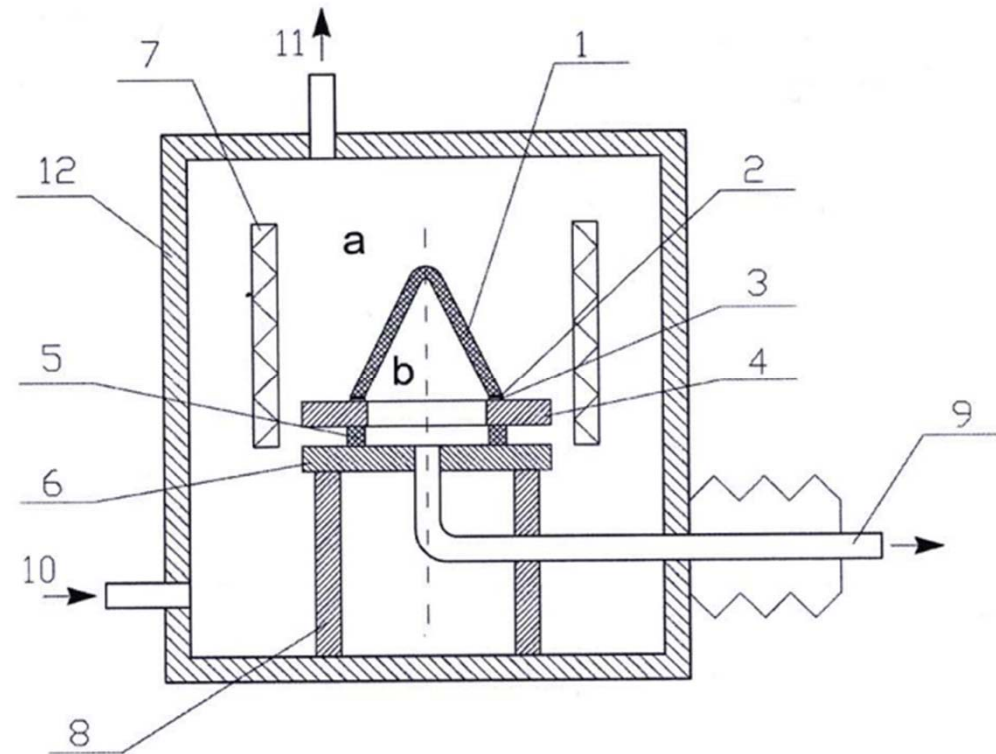
Cs₂ Te photocathods, etc.



CNC Turning Lathe Machine with **Vacuum Chamber**



New Diffusion Brazing method



Diffusion brazing methods of difficult geometry dissimilar details.

Patent number – AM201453

Vardan Shavarsh Avagyan, Vahagn Vanik Vardanyan

Intellectual Property Agency of the Republic of Armenia

Software



Molflow+

A Monte-Carlo Simulator package developed at CERN



NX
SIEMENS



SynRad+

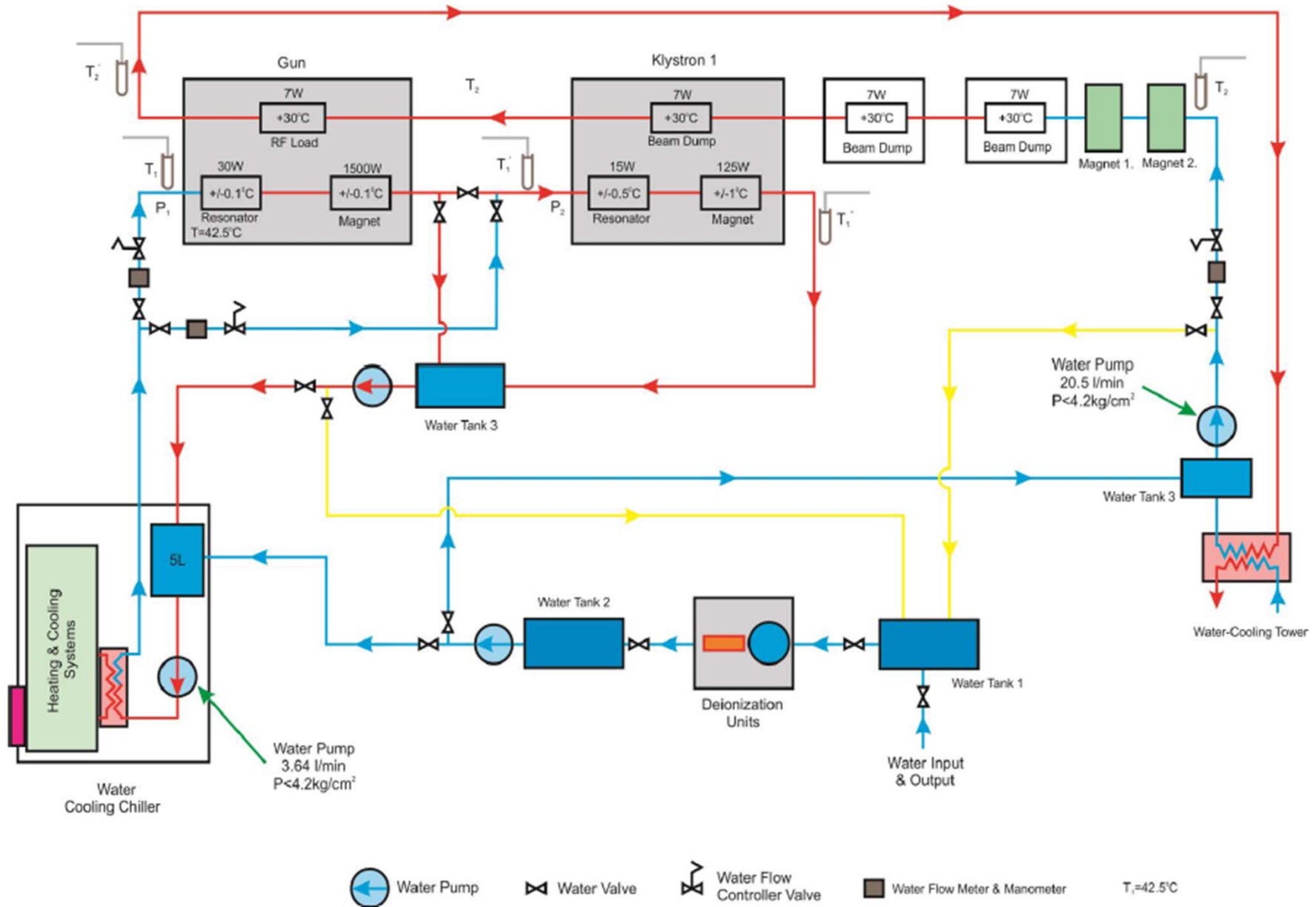
Mathcad®

UHV Test Stend

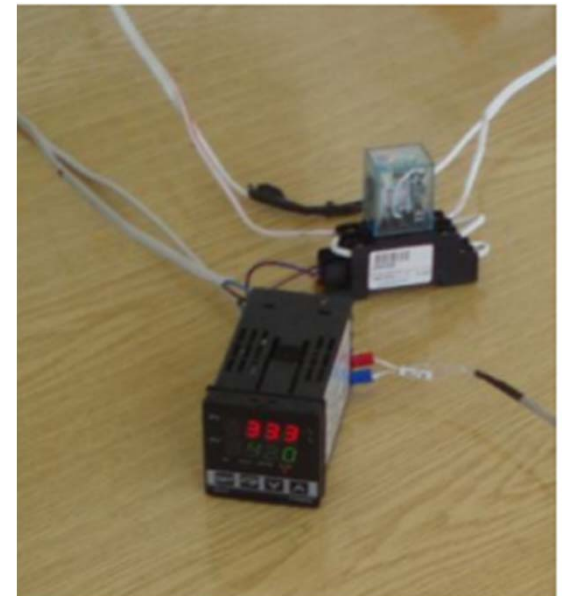
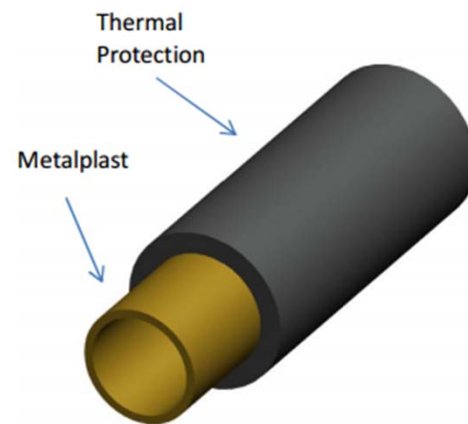
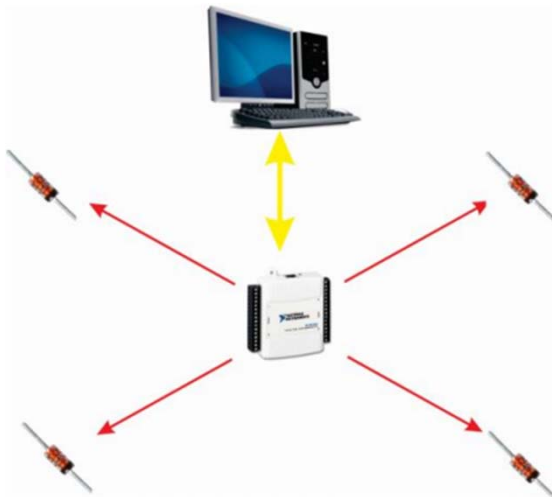




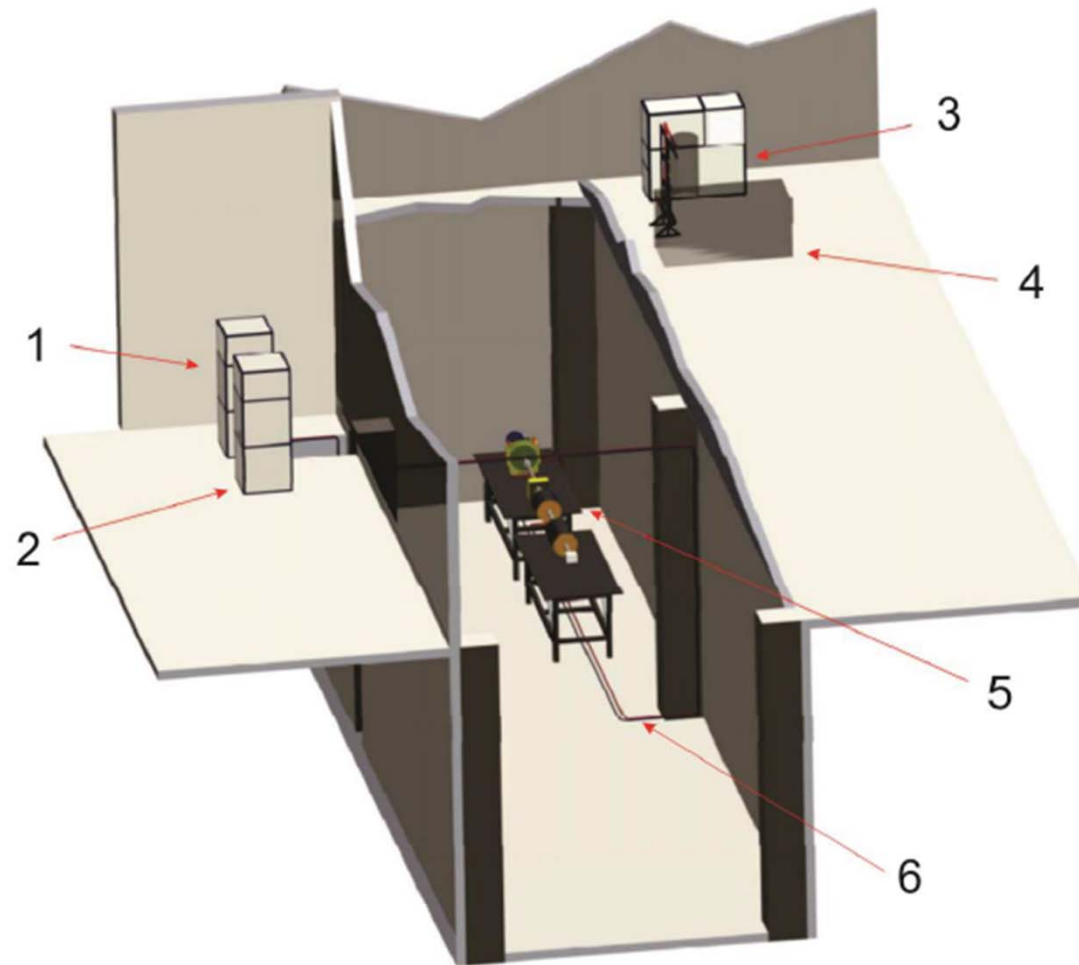
First Design for Thermoregulation System for AREAL



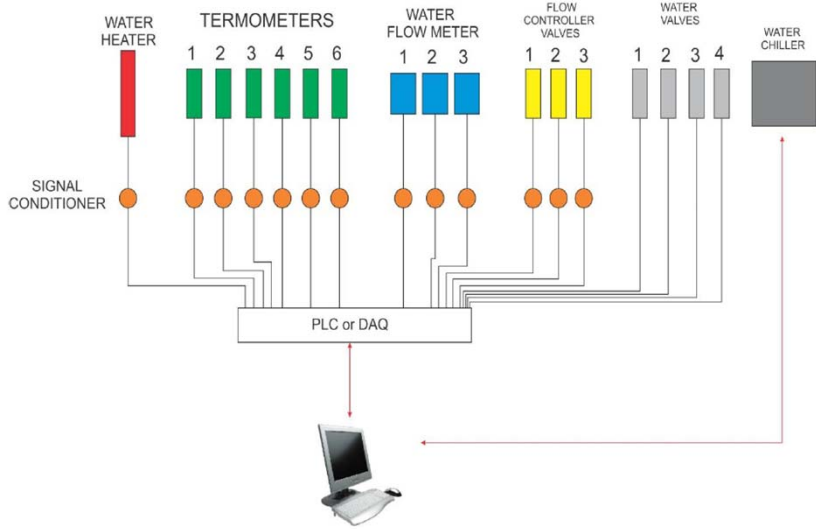
First Thermoregulation system for RF Klystron



Cooling Systems for AREAL Linear Accelerator



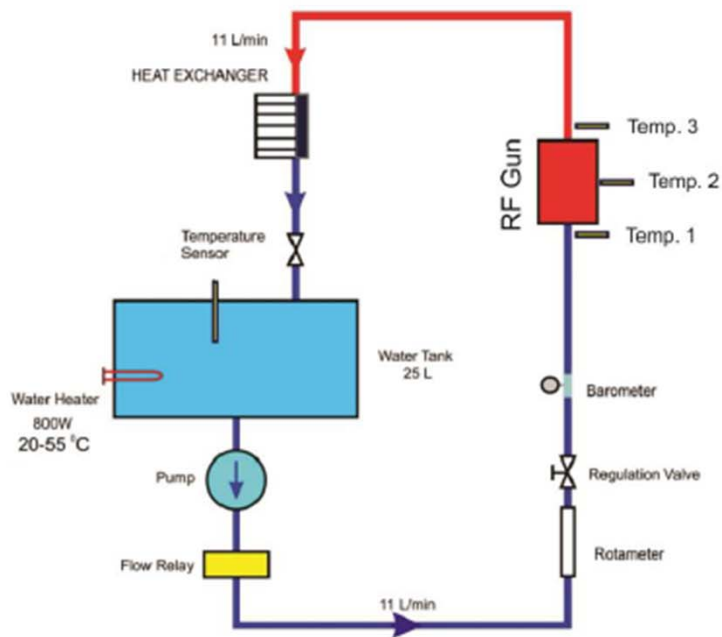
Cooling systems locations in AREAL main building. 1-cooling system of RF Gun, 2-cooling system of Solenoid magnet, 3- cooling system of Klystron, 4-Klystron, 5-AREAL Linear Accelerator, 6-feed water pipes for RF Gun and solenoid magnet.



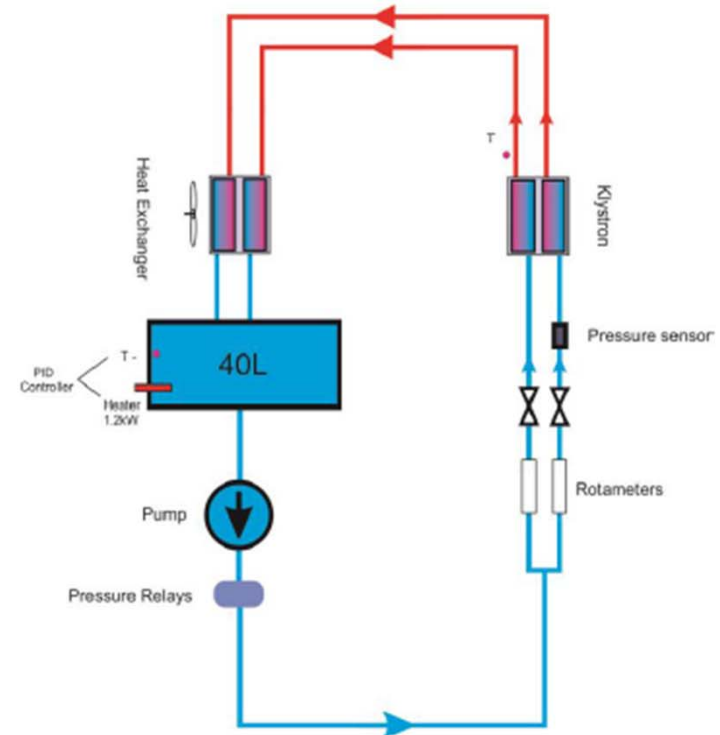
RF Gun Thermoregulation System



Klystron Thermoregulation System



Scheme of RF Gun Thermoregulation System



Scheme of Solenoid Magnet Cooling System



UHV Test Stend



Diffusion welding machine (induction)



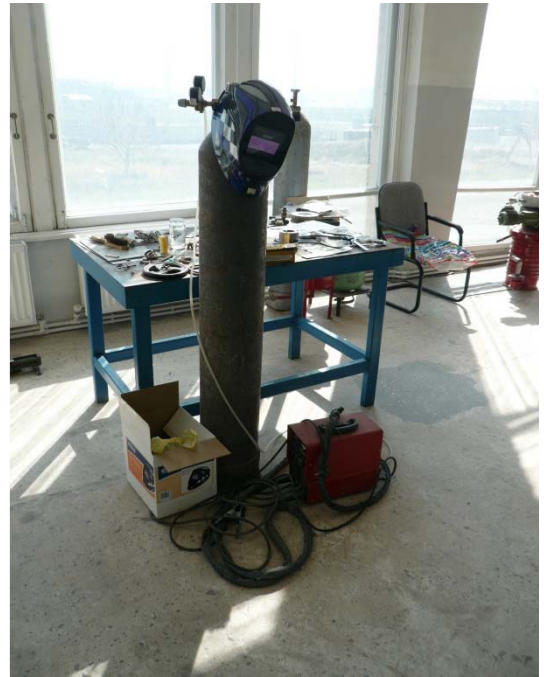
Diffusion brazing machine



Ceramic cutting machine



Cutting machines



TIG Welding



Diffusion pump



powder mix machine

Water Deionizer and Distiller



Water storage tanks



Ultrasonic Cleaning Unit



Water Pumps



Vacuum Technology Group

Responsibilities

- Design,- calculations, simulations, drawings, etc.
- Fabrication – Welding laboratory, Cleaning room, Workshop, etc.
- Installation,
- Commissioning,
- Maintenance,
- Modernization,
- Etc.

Thank You!

