

Refurbishment of the plasmatron **VISION I** for plasma wall interaction studies at **SCK•CEN** with deuterium/tritium plasma

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- **History**
- **“To refurbish or not to refurbish”**
- **Status refurbishment**
- **Planning**

History

- Part of **ETHEL**, JRC-Ispra, Italy
 - European Tritium Handling Experimental Laboratory
- Designed for **PWI studies**
 - retention/recycling of hydrogen isotopes
- ETHEL was **closed down** about 10 years ago
- Due to the **decommissioning** of the ETHEL buildings, the plasmatron had to be dismantled or evacuated

Original Condition: 1993

Plasmatron in glove boxes



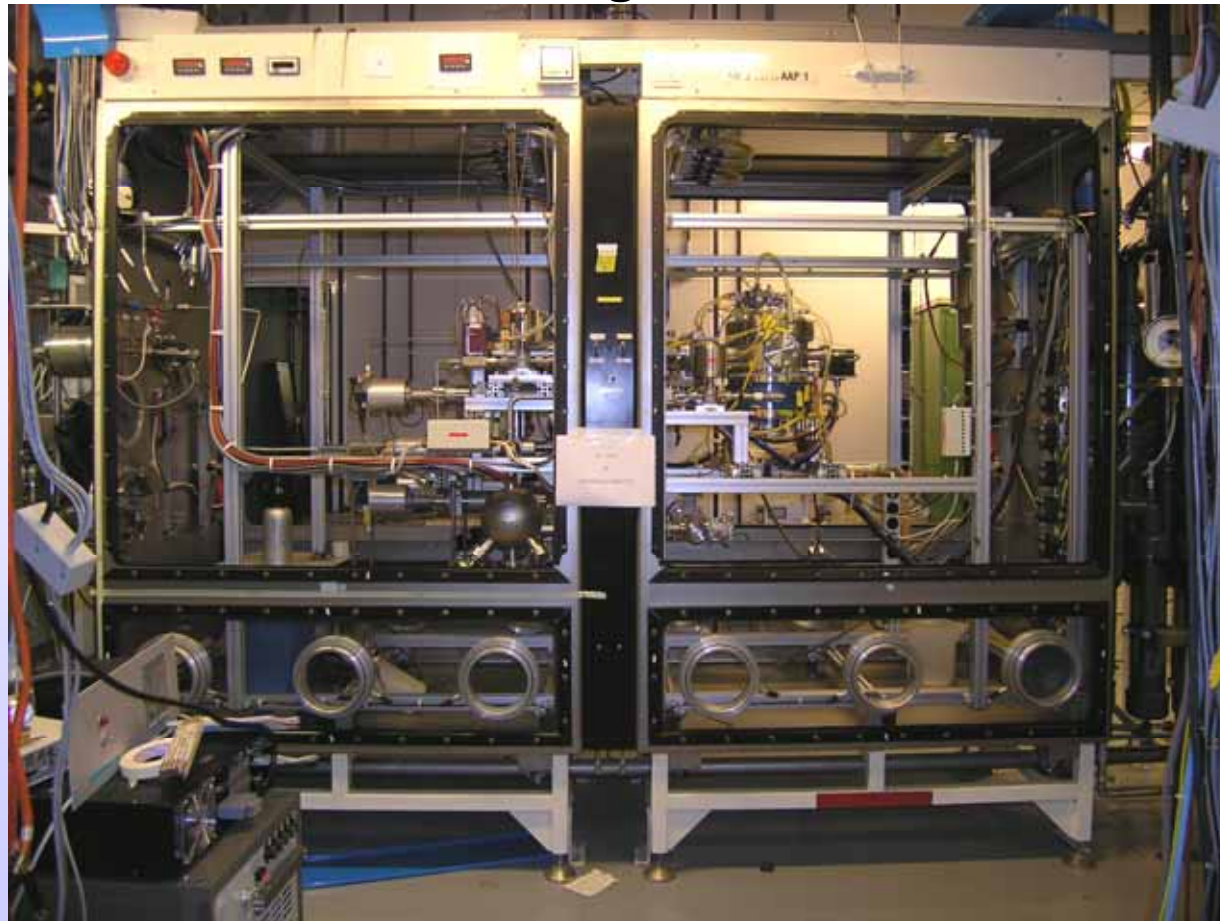
Original Condition: 1993

Original control cabinet



Condition before shipping: 2007

Plasmatron in glove boxes



Condition before shipping: 2007

Remains control cabinet

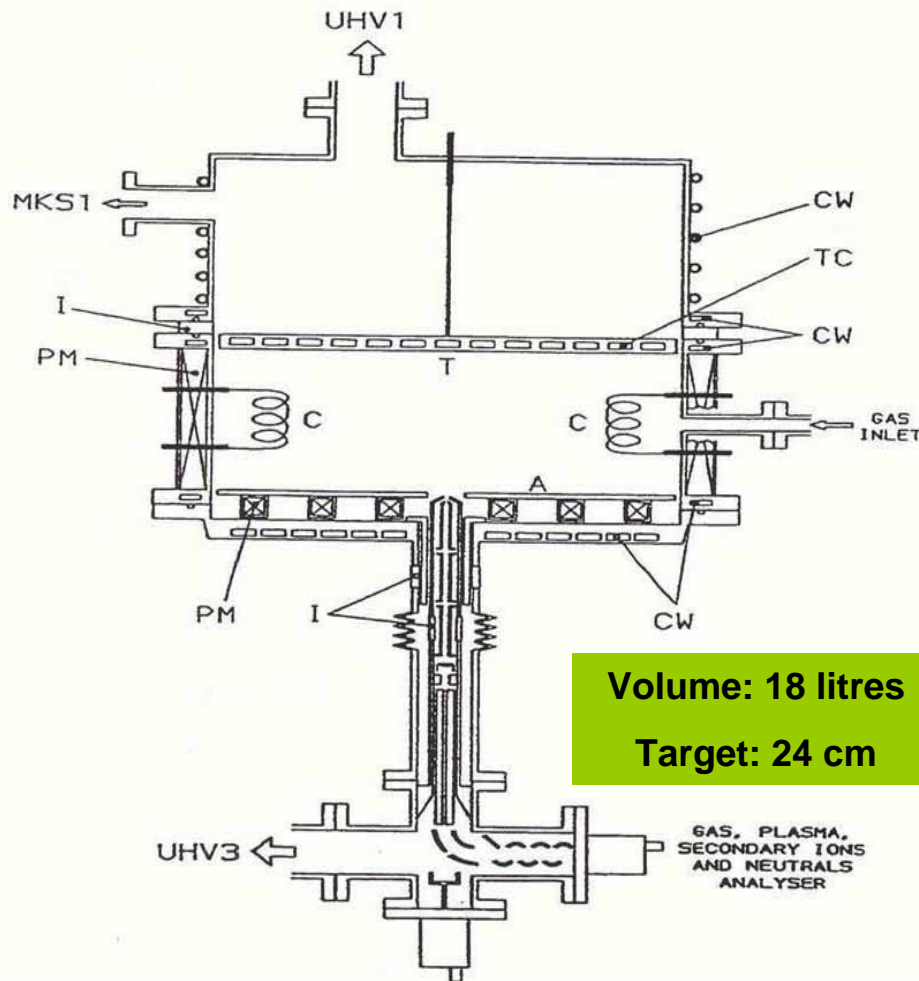


To refurbish or not to refurbish ?

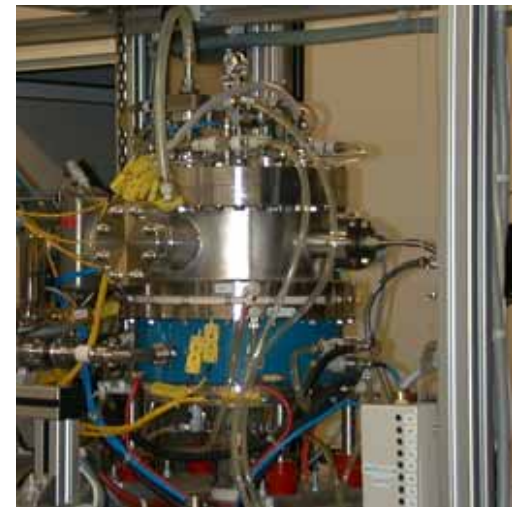
Aspects to consider

- Technical
- Scientific
- Financial

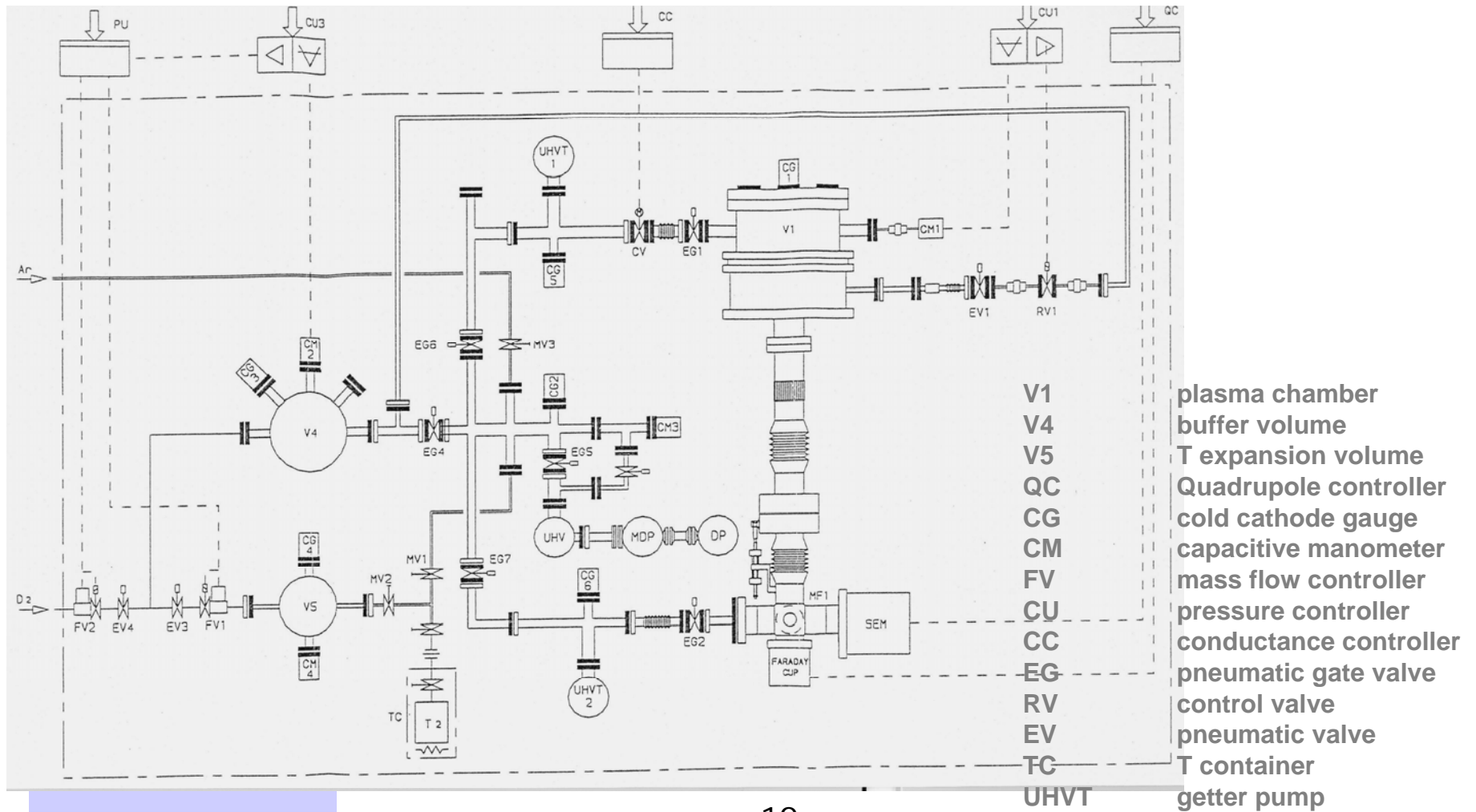
Plasma Chamber



A	Anode
C	Cathode
CW	Cooling water
I	Electric Insulation
MKS1	Capacitive manometer
PM	Permanent magnets
T	Target
TC	Temperature control
UHV1	Main pumping unit
UHV3	Differential pumping unit



Vacuum System



High density, Low ion temperature Plasma Simulators

	PISCES-B	Magnum- PSI	Pilot- PSI	NAGDIS- II	PSI-2	Plasmatron VISION I	ITER
n_e (m ⁻³)	10 ¹⁷ -10 ¹⁹	10 ¹⁹ - 10 ²¹	10 ¹⁹ -10 ²¹	<10 ²⁰	10 ¹⁷ -10 ²⁰	NO DATA	10 ¹⁹ -10 ²²
T_e (eV)	~4-40	~0-10	~0-7	~5-10	~1-20	NO DATA	Div: ~3 MidP:~100
T_{ion} (eV)	0.1-0.5 T_e	~ T_e	~ T_e	1-10	0.5-0.6 T_e	20-500	Div: ~15 MidP: ~500
σ (m ⁻² s ⁻¹)	10 ¹⁹ -10 ²³	10 ²³ -10 ²⁵	<2.10 ²⁵	<10 ²³	10 ²² -10 ²³	10 ²⁰ -10 ²¹	10 ²⁴ -10 ²⁵
τ (s)	Steady state	Steady state	3-10s	Steady state	Steady state	Steady state	300-500s - steady state
Preheat Target	Plasma heating	Plasma heating	Plasma heating	Room temp.	Room temp.	20-600 °C	Bake temp. < 230 °C
P_n (Pa)	5 10 ⁻⁴ -10 ⁻²	<1	~1-10	~0.1-4	0.01	0.05 – 0.5	1-10
B (T)	0.015-0.05	<3	0.4 - 1.6	<0.25	0.1	0.2	5.3
Target material	C, W, Be, metals, mixed	C, W, metals	C, W, metals	C, W, metals	C, W, metals	C, W, Be, metals, mixed	C, W, Be, mixed
Be	Yes	No	No	No	No	Yes	Yes
T	No	No	No	No	No	Yes	Yes
Nuclear	No	No	No	No	No	Yes	Yes

n_e = electron density/ T_e = electron temperature/ T_{ion} = ion temperature/ σ = Ion flux density/ τ = pulse length/ P_n = neutral gas pressure/ B = magnetic field/ Div = detached divertor area / MidP = midplane

Potential Scientific Applications

- **Plasma Wall Interaction (PWI) on:**
 - Plasma Facing Materials (Be, W, C)
 - First mirrors
- **Material surface interaction:**
 - **Retention / recycling / implantation / trapping / erosion / diffusion**
(long term studies, influence of hot surfaces, effect of surface temperature and gradients, mixed layers & interlayers, mixed plasma (D, T, H, Ar seeding, ...) fluxes, neutron irradiated materials, tritium influence on chemical erosion, ...)
 - **In-situ Tritium removal techniques**
(e.g. oxidising plasma, glow discharges, laser treatment, ...)
 - **Dust formation**
(dust characterization, co-deposition layers & alloy formation, removal techniques, influence on mirror performances, ...)

Conclusion

Refurbishment is worthwhile if

1. Deuterium/Tritium
2. Be/C/W/Metal targets
3. Irradiated specimens

A New Name

June 2007

Transfer of plasmatron from
JRC-Ispra to SCK•CEN

Plasmatron VISION I

Versatile Instrument
for the **Study of Ion Interaction**

Refurbishment Process

Empty Lab (21/01/2008)



Refurbishment Process

Glove Box 1



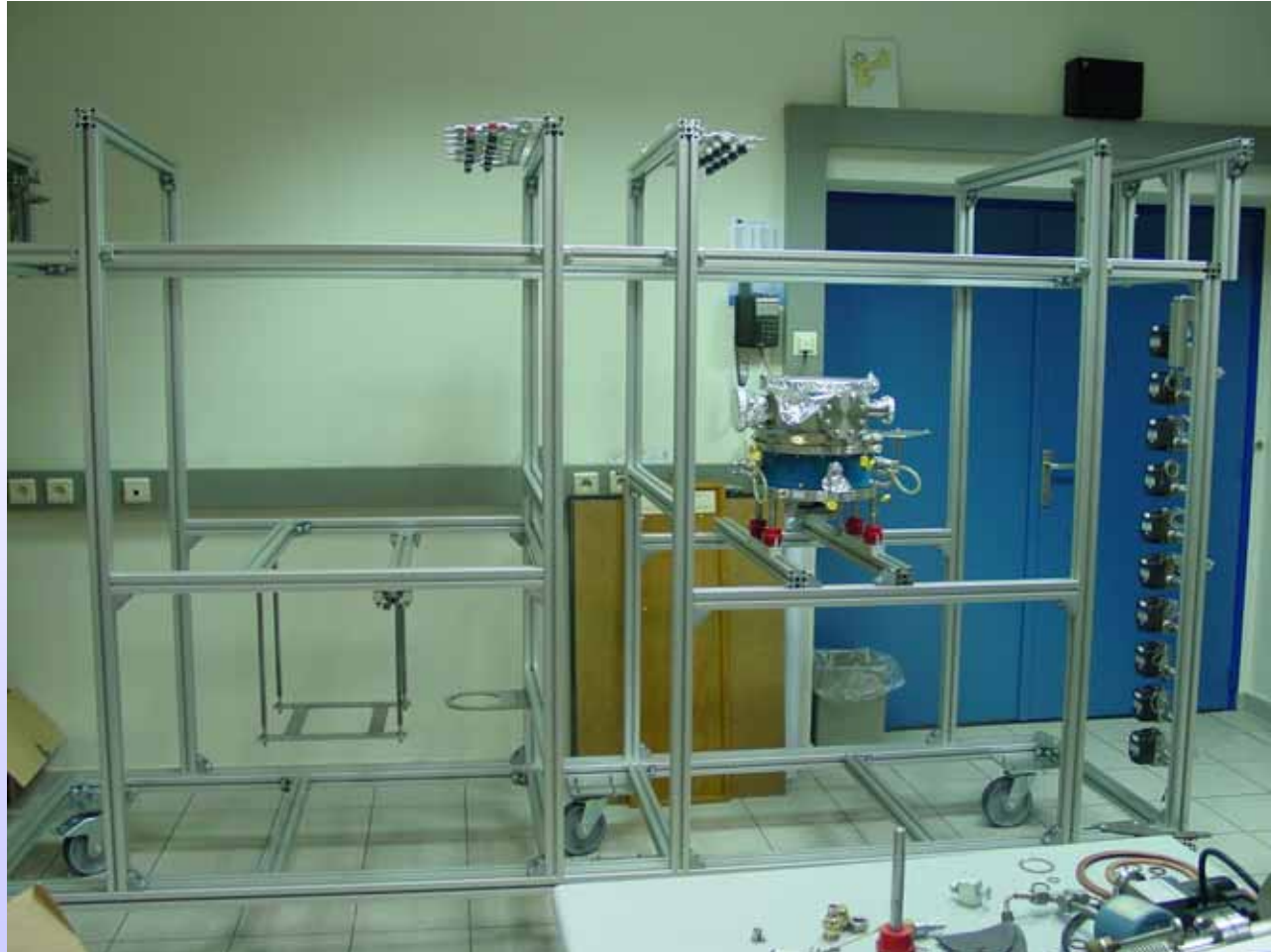
Glove Box 2



Dismantled plasmatron



New Supporting Frame



Status Vacuum System

- **“First Vacuum” on 11/07/2008**
- **Pressure plasma chamber: 5×10^{-7} mbar**
 - **No bake-out**
 - **Getter pumps not installed**



Status Control Cabinet

- **Hardware is nearly completed**
 - **Circuit breakers, switch gear, PLCs**
 - **Pump controllers, power supplies**
 - **Vacuum sensors, water flow detectors**
- **In progress: control software**



Planning

June 2008

“First Vacuum”

Dec 2008

“First plasma” (He)

June 2009

Diagnostics (QMS, ion energy analyser)

Development of control and visualization software

Dec 2009

Installation of the plasmatron in a glove box

First scientific experiments with deuterium plasma

Dec 2010

Beryllium, tritium, low-activated specimens licensed

M51: Question Mark Nebulae

