Design and construction of a PW Experimental system of HV chamber adaptable, modular and stable

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Abstract

In the recent years, the number of high power lasers devoted to particle acceleration has increased in Europe. Additionally to this, some synchrotrons and accelerators are integrating these lasers in its lines, increasing the scientific synergies. The HP laser must be transported in HV. The use of HV also permits good cleanliness in the optical set up. As addition, is necessary to create an adaptable and modular design where several chambers could be assembled together. One additional constrain is the stability. A new model of HV chambers is presented. These consist in a frame where the walls are exchangeable panels, which make easier the introduction of a new configuration of ports. The system was designed as construction blocks. For a proper connection of the chambers a new interior fixation and pushers system was designed. Thanks to this, coupling new HV chambers, the volume total can be also easily modified. Finally, a third generation decoupled system is integrated inside, consisting of a stable breadboard, this supported by six columns that implement a preloaded kinematical mount, providing both an outstanding stability and a fine regulation (1st RM: 77Hz).

Specifications

The main requirements Experimental system has to achieve:

Vacuum chamber:

- Modularity: Easy modification in ports distribution and connection between chambers
- Minimal internal dimensions: 2500x1500x1200 mm
- Materials: AISI 304/304L and AL 6000 series
- Vacuum level: $5 \cdot 10^{-6}$ mbar
- Cleanness: Max. Partial pressure of Hydrocarbons < 1% Max. Partial pressure

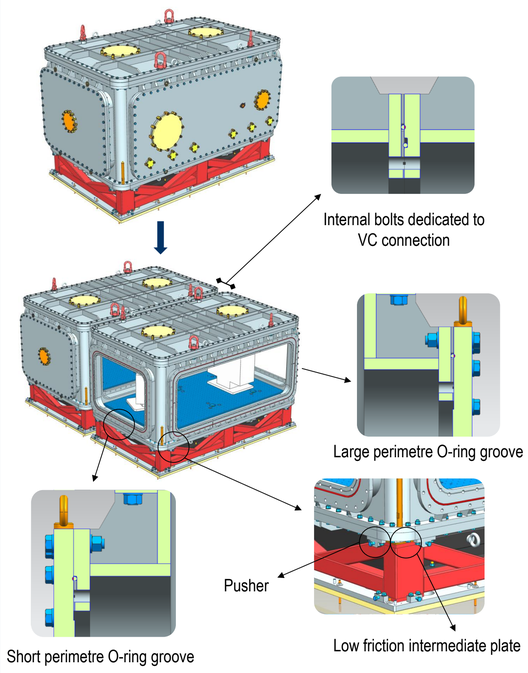
Breadboard:

- Minimal dimensions: 2450x1300x60 mm
- Materials: AL 6000 series or AL5083
- Breadboard levelling regulation: ±10 mm
- Breadboard stability: 4 μm
- Breadboard flatness: 50 μm

Design

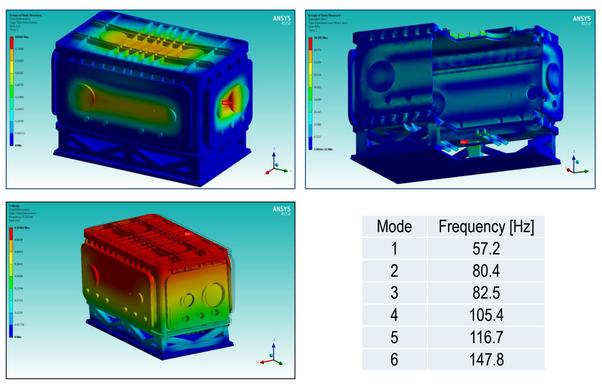
Vacuum Chamber

- Modularity. Connection of several chambers and exchangeable covers
- Alternated O-ring grooves



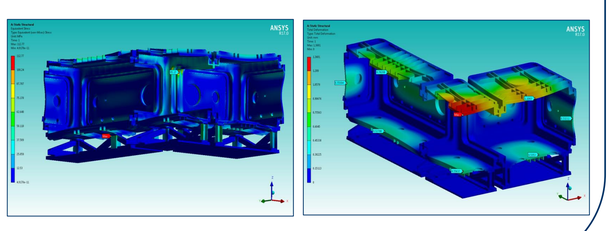
Materials: Top, walls and bottom AISI 304
Lateral covers: AL 6082 T6
Support and base plates: S-275 and S-235

- Max. stress: 78.5 MPa
- Max. deformation: 0.84 mm
- 1st resonance mode: 57 Hz



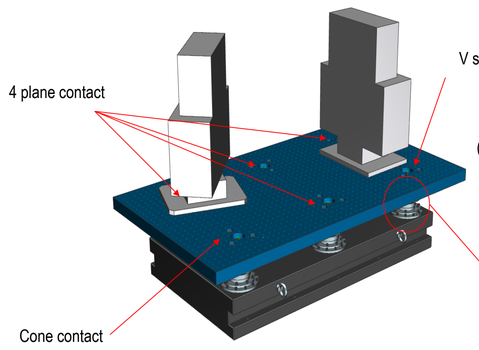
Mode	Frequency [Hz]
1	57.2
2	80.4
3	82.5
4	105.4
5	116.7
6	147.8

- Five chamber cross-connection
- Max.stress: 113 MPa
- Max. deformation: 1.4 mm
- 1st resonance mode: 73 Hz

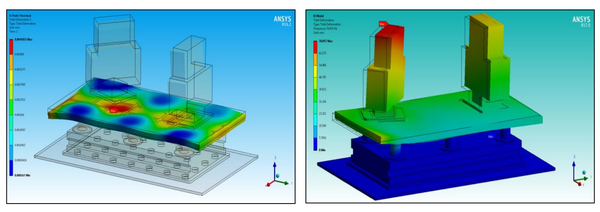


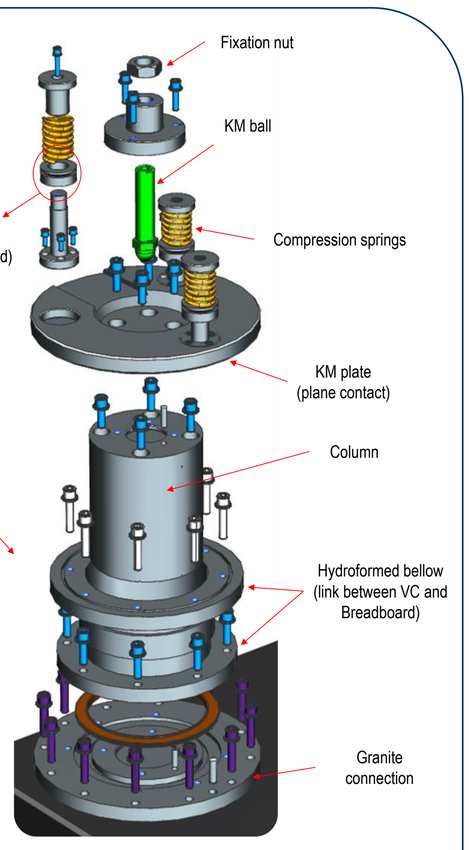
Breadboard

- Preloaded kinematical mount



- Max. deformation: 0.004 mm
- 1st resonance mode: 77 Hz
- Breadboard vibration amplitud: <1 μm (Expected)
- Levelling regulation linear: 50 μm
- Levelling resolution angular: 30 μrad
- Flatness: 50 μm



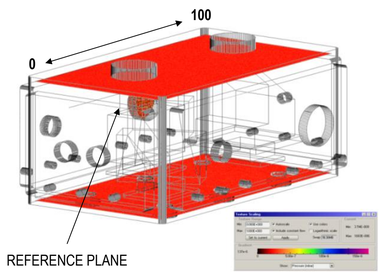


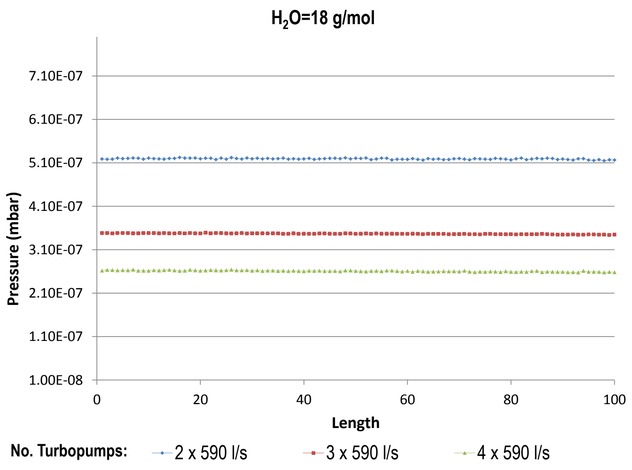
Materials: Breadboard AL 5083 HX6
Components: AISI 304 and AISI 420-B
Granite: Black natural Impala
Base plates: S-235

Vacuum

Boundary conditions:

- Outgassing: $K_{ss}=9 \cdot 10^{-10}$ mbar·l/s·cm^2
  $K_{Al}=1.68 \cdot 10^{-9}$ mbar·l/s·cm^2
- M_{H_2O}= 18 g/mol



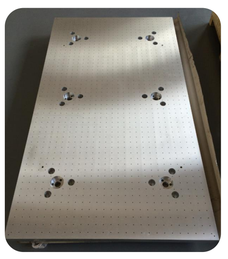


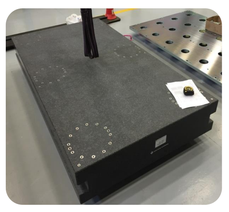
- Pump-down time to 10^{-7} mbar: 1 hour
  (500 m^3/h primary pumping and 3x590 l/s turbopump)

Construction & Tests

VC currently under Factory Acceptance Tests.

- FAT performances:
  - Mechanical functionalities
  - Vacuum chamber covers deformations
  - Vacuum level, cleanness and pump-down time
- Breadboard Tests
  - Assemblability
  - Stability





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