Considerations on the module vacuum

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•Summary

–Specifications: P

–Key points: Gasloads

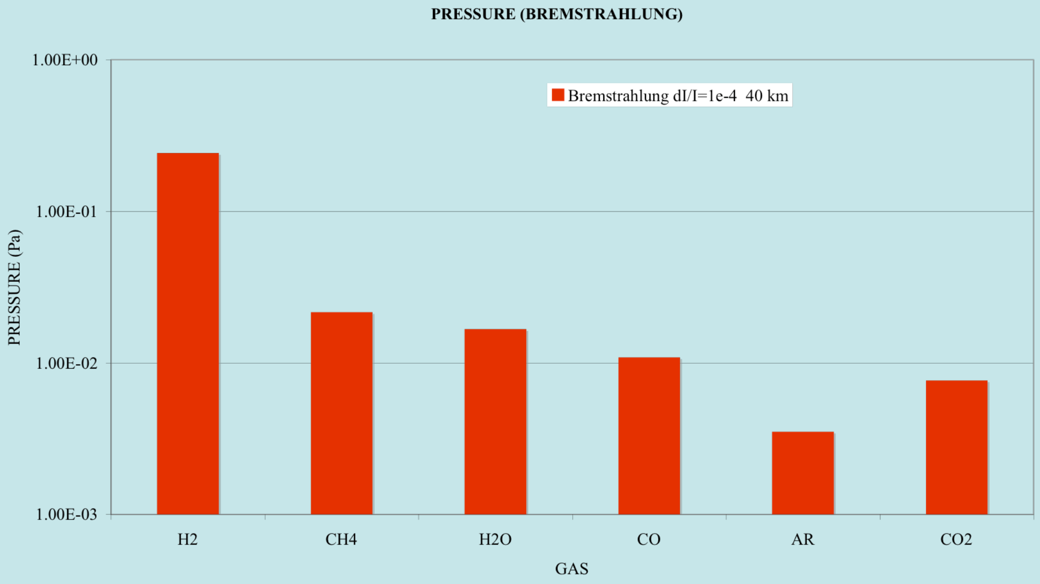
–A scheme for the vacuum system

What Pressure??

See D. Schulte talk: Fast ion instabilities

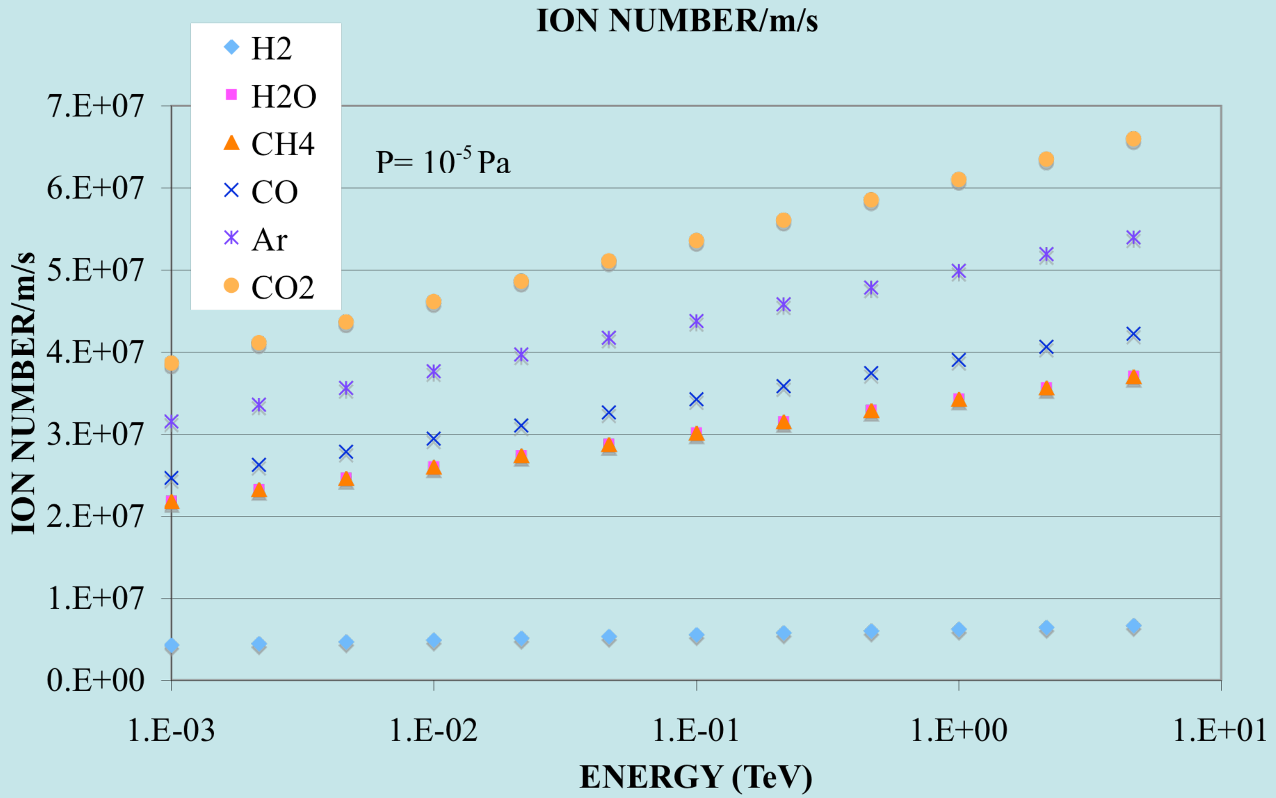
Drive beam: 1nTorr

Main beam: still uncertain



What Pressure??

- Production of ions (neutralisation)?

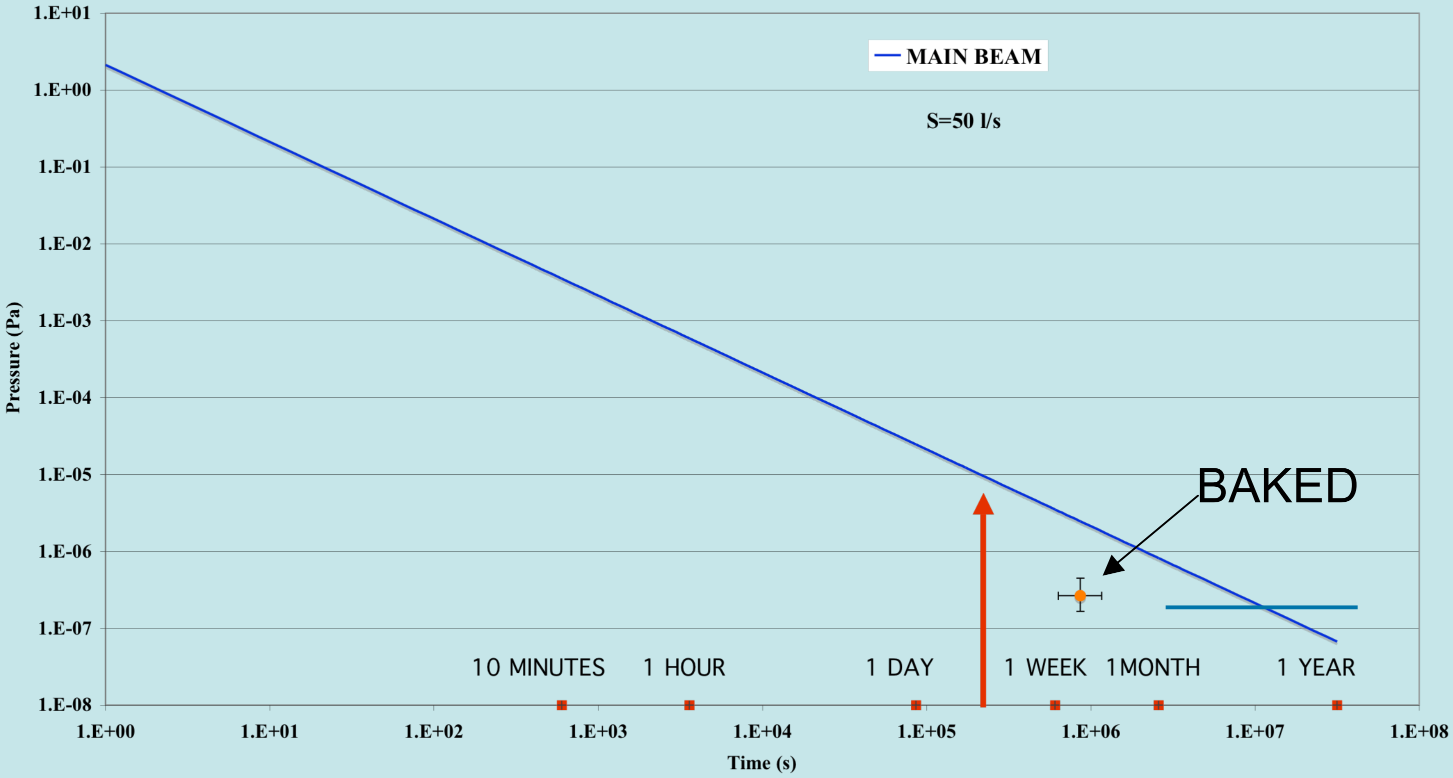


What Pressure??

- Users requirements: RF:
  - No influence of bake out on conditioning
  - Model developed for breakdown in agreement with experimental results: no vacuum depending parameters
  - Tradition?=> 10^{-6} Pa
  - Doubts with “Fast Ion Instabilities” 10^{-8} Pa?

GAS LOAD

- Unbaked system=> Water predominates
  - S~10 m^2/module MB ,S=50 l/s



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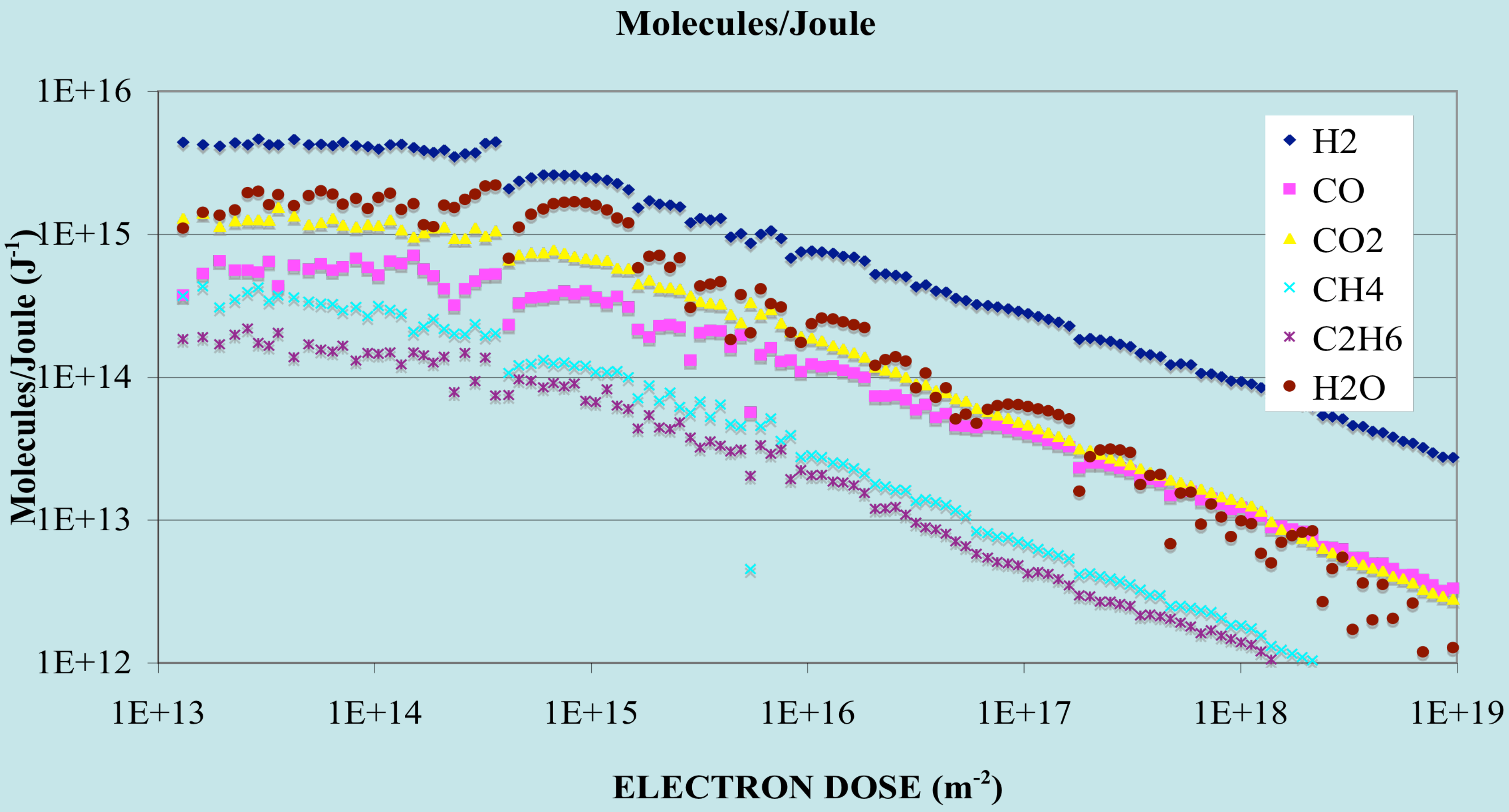
GAS LOAD

- Baked
  - Expensive
  - Mechanical constraints (thermal elongation)
  - Extra space needed for bellows
  - Space in quadrupoles?
  - Lower pressure in shorter time
- Unbaked
  - More demanding in terms of materials/cleanliness (ferrite excluded)
  - Longer time to achieve “good” pressure
  - Reduced thermal elongation=> less constraints on bellows=> more space
  - Cheaper operation
  - Less constraints on Quad aperture

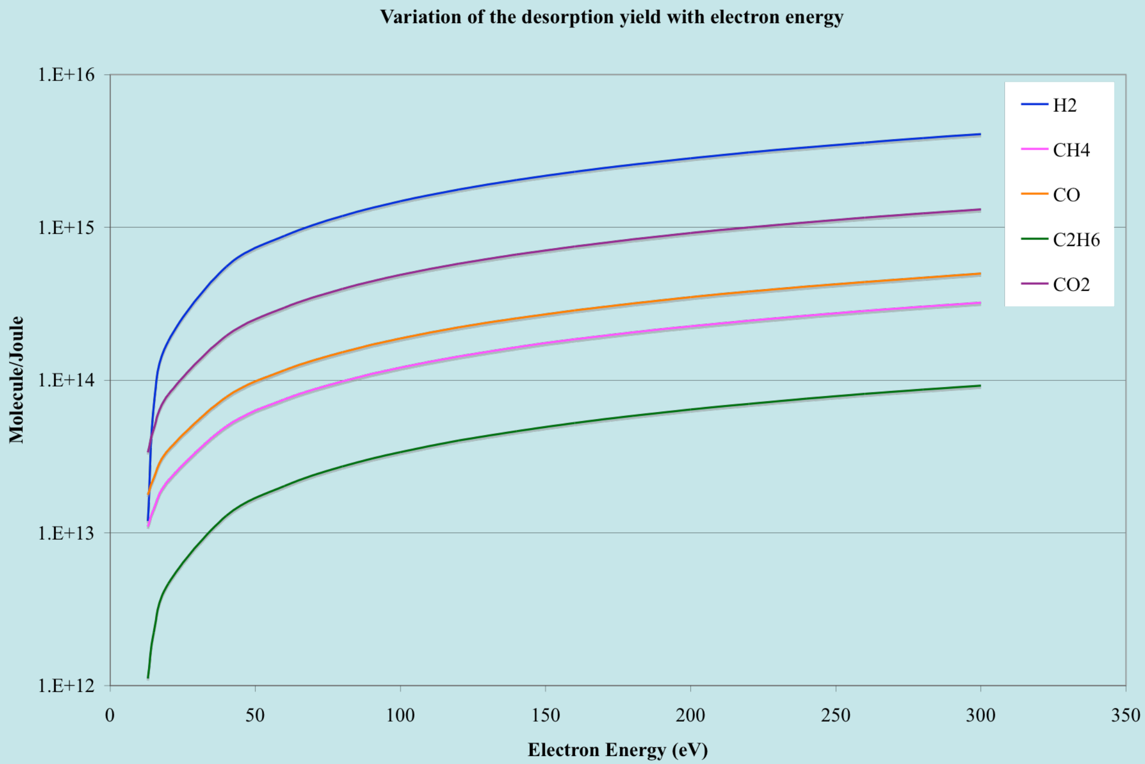
Gas Load

- Dynamic: e^- induced desorption?
  - 10J/breakdown (Walter)



Gas Load

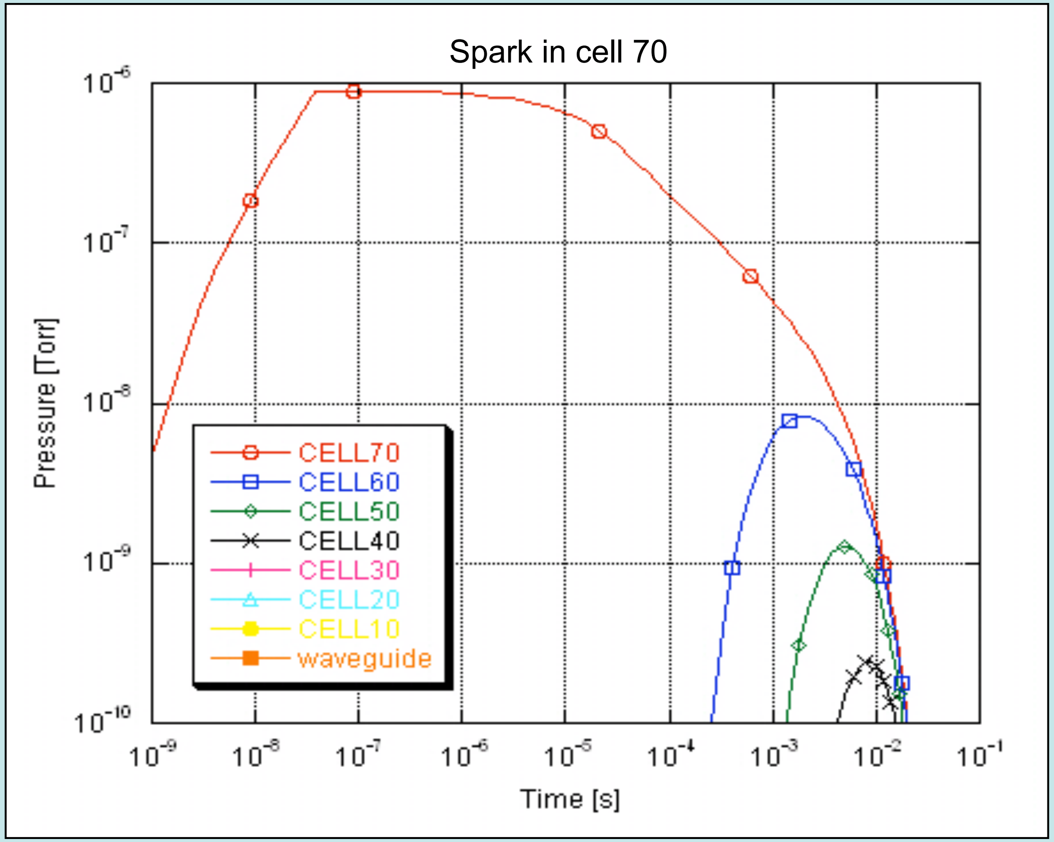
- Dynamic: e^- induced desorption? 10J/breakdown (Walter). Electron Energy: 100 keV: stopping force reduced by~10 (compared to 300 eV)
- => Breakdown liberate ~ 10^{15} mol/breakdown (4×10^{-6} Pa.m^3)



Gas Load

- Dynamic: irrelevant for vacuum design
  - Cell Pressure entirely determined by structure design

Simulation for HDS
(30GHz)



For 11GHz structures
conductance per cell is ~30x higher
Per structure ~4x higher

	30GHz S[l/s]	11GHz S/l/s]	increase
H2/cell	0.02	0.56	28.9
CO/cell	0.01	0.15	27.5
H2/struct	10.934	45.15877	4.1
CO/struct	3.035658	11.90549	3.9

Gas Load

- Dynamic: irrelevant for vacuum design

  (If no influence of bake out)

  - Gas load during breakdown : pretreatments
  - Pumping speed independent of pumps (conductance)
  - Breakdowns transients pumped by container volume: VdP/dt

PUMPS

- MAIN PUMPS:
  - Pumping during breakdown:
    - holes in the structure
  - P recovery between breakdowns:
    - Volume of the vacuum tank
  - Mean pressure
    - External pumps
- Example:
  Breakdown $dP/dt=10^{-6}$Pa/ms, $P=10^{-6}$ Pa
  - Q pump: $P=10^{-6}$ Pa, 1000l/s=>$Q=10^{-3}$Pa.l/s
  - Q vol (200l) =>Q= 2 10^{-1} Pa.l/s

PUMPS

- Preevacuation: Mobile TM stations (access??)
- Holding pumps: Ion+ Capture pumps
  - Ion: 50 l/s =>
    - Pump ignition ~ 1day
    - start up of structure operation (1 week)
  - Su pumps for hard conditioning/ operation (~1000 l/s)
    - Cheap reliable
    - Efficient after ~ 2 weeks
    - Tests needed (speed/capacity for water?)
  - Alternate: Cryogenic pumps/TM pumps
    - Expensive (very)
    - Reliability ? (expensive maintenance)

Sectorisation

- Each quadrupole is a barrier (0.4 l/s conductance)
- Length of sector determined by:
  - Money (1 valve~ 20kCHF)
  - Space lost (~ 10 cm minimum)
  - Operation: in case of failure or modification all the length vented=> reconditioning. Failure rate?
  - Guess :
    - 1% total length (20km=>200m)
    - lost space (≥100 mm)
    - 100 sectors=> 10m
  - 200m long sectors: 1% of the accelerator opened (i.e. reconditionned) per failure

Vacuum monitoring

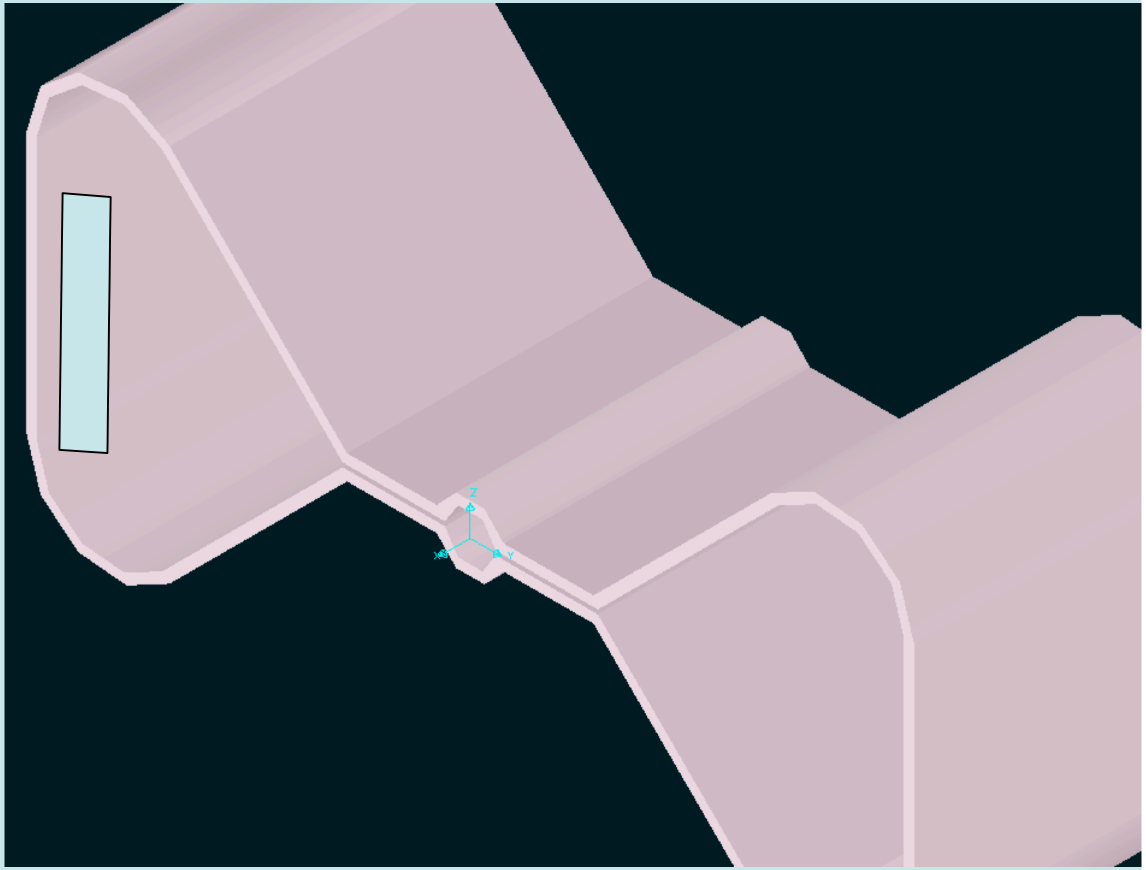
- One valve (manual) on vacuum envelope per girder
- Ion pump used for vacuum measurement (reliable above 10^{-6} Pa)=> provides VAC interlocks
- When problems: magic box connected to the valve: (gauge, RGA…)
- Leak check made per girder (lengthy)
  - Possibly by-pass between two tanks

Miscellaneous

- Construction element: 1 girder (~2m)
- In case of problem transported as a block to the lab
- Avoid any unnecessary constraints :
  - Cheap (hopefully) welded vacuum tank
    - Geometry ±some mm
    - Tank cover with bellows <u>**at**</u> the beam pipe (no load on the fragile beam tube)
    - Welded beam tube junction (no flange but space for automatic welding machine)
- Possibility to bake each girder before installation?

Possible quad chamber design

- Produced in 2 halves
- Machined (accurate parts)
- Longitudinal weld between 2 profiles
- NEG strips in the appendixes (Pumping and heating elements)
- To be adapted to actual quad design
- Integrated pump~ 10l/s/m
- To be checked for feasibility, cost and performance



CONCLUSIONS

- Most important question: design pressure?
- =>Choice between baked/unbaked system
- Achievable pressure in cells determined only by geometric constraints
- Connexion between module/BPM/quadrupoles must be studied: space, technique…