Material choice

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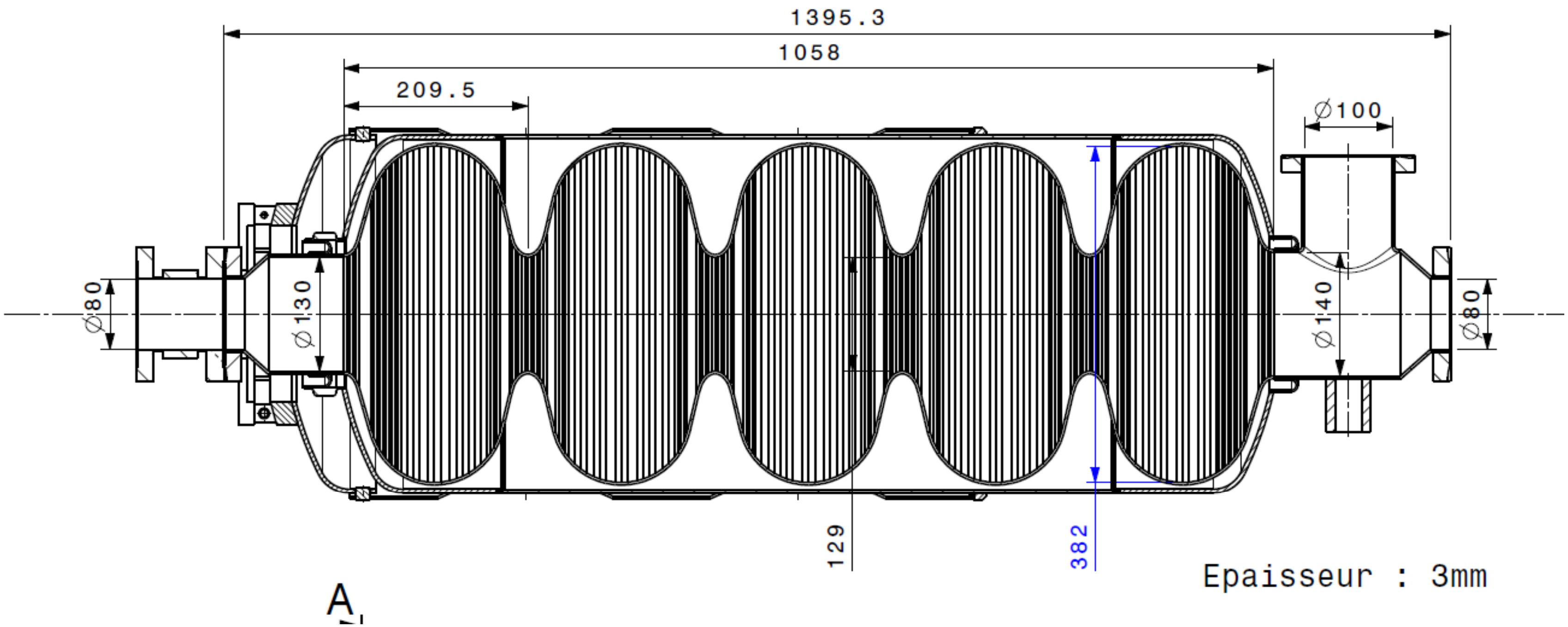
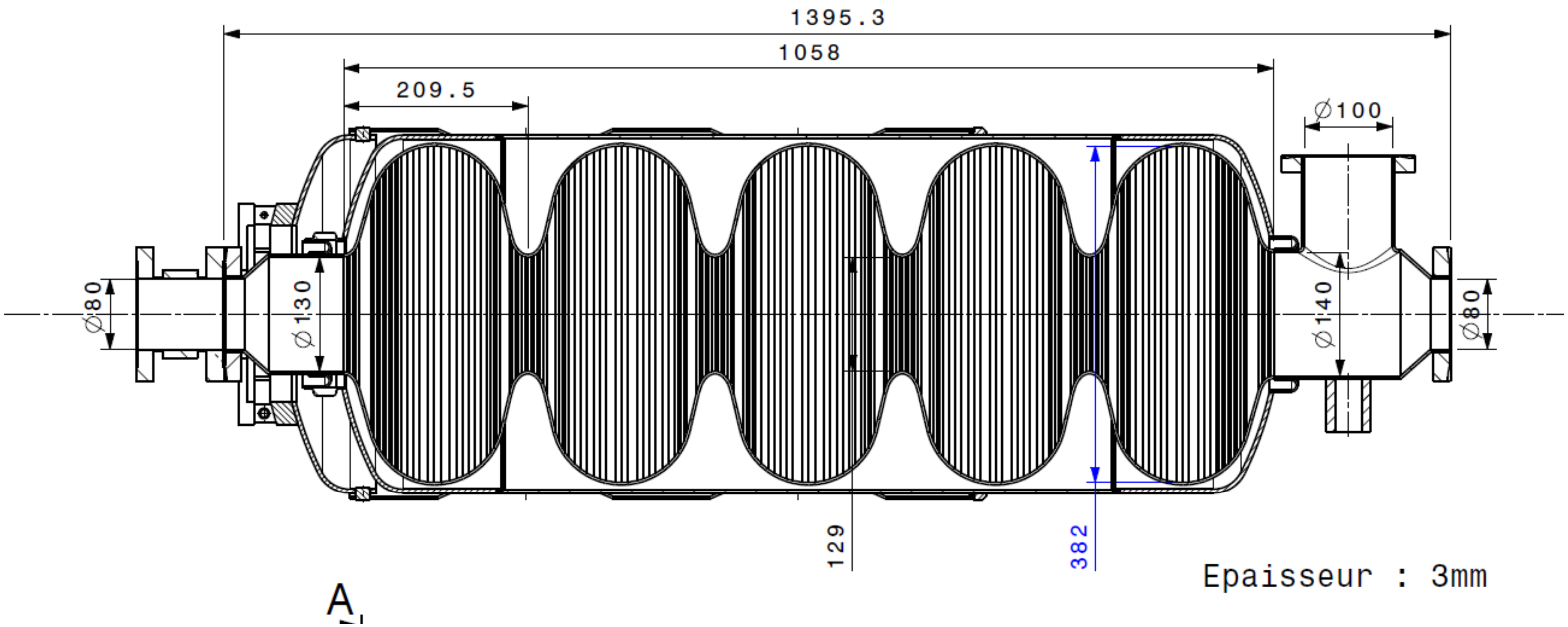
Material choices



- Discuss material choices for
  - Helium tank
  - Flanges, joints, bellow

Helium tank material



- Choice between:
  - Titanium alloy: DESY technology (which alloy is used at DESY ?)
  - Stainless steel

Helium tank material

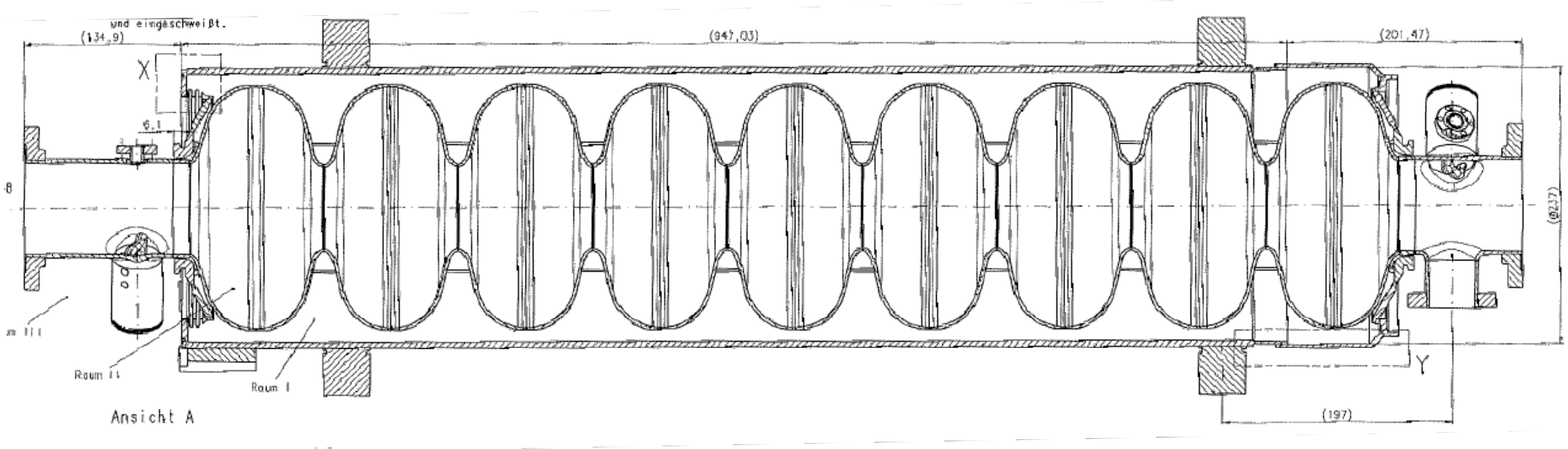
- Material choice involves differences in:
  - Manufacturability
  - Feasibility of connection to cavity
  - Heat treatment / sequence
  - Interface to cryogenic piping
  - Tuner design
  - Material compliance with pressure vessel regulations
  - Overall price

Helium tank material

- Manufacturability:
  - Titanium alloy
    - Proven technology at DESY
    - Requires:
      - Specialized technicians
      - Special equipment
      - Know-how?
  - Stainless steel:
    - Conventional procedures and equipment

Helium tank material

- Feasibility of connection to cavity:
  - Titanium alloy
    - Via titanium-niobium alloy flange
    - EB welding between Nb and Ti52 Nb48 flange
    - EB welding between Ti52 Nb48 flange and titanium tank



Helium tank material

- Feasibility of connection to cavity:
  - Stainless steel:
    - Brazing
      - SS brazing on small Nb part
      - EB welding of SS/Nb assembly on cavity Nb
      - Feasibility to be proved ?
    - Explosion bonding
      - R&D required ?

Helium tank material

- Heat treatment / sequence :
  - Titanium alloy
    - Comparable to DESY sequence ?
  - Stainless steel
    - Annealing with respect to brazing ?
    - Protection during chemical treatments
    - …

Helium tank material

- Interface to cryogenic piping
  - Titanium alloy
    - Bi-metallic transitions
      - R&D required to prove reliability with HeII operation ?
    - Flanges
      - Leak-tightness reliability with HeII operation?
  - Stainless steel
    - Welding (conventional)
    - Flanges
      - Leak-tightness reliability with HeII operation?

- ! Experience from LHC: all interconnects to be done after installation, inside the tunnel should include only conventional operations

Helium tank material

- Tuner design:
  - Titanium alloy
    - Existing CEA tuner design adaptable to
    - Thermal contraction equivalent to Nb thermal contraction =>

    Tuner stroke smaller than for SS helium tank

  - Stainless steel
    - Thermal contraction ~ twice the Nb thermal contraction
    - Tuner design to adapt / redevelop for much more important stroke
    - Equivalent stroke as for Ti material if cavity assembly design to compensate differential thermal contraction (risk of high thermal stresses ?)

Helium tank material

- Material compliance with pressure vessel regulations :
  - Ti alloy
  - Stainless steel

Helium tank material

- Overall price:
  - For equivalent stiffness we have

    Price He tank Ti / Price Helium tank SS = Price 1 kg Ti / Price 1 kg SS

    Since we have $E_{Ti} / \rho_{Ti} = E_{Ti} / \rho_{Ti}$

    (Calculated for Ti 6Al 4V ELI and 316LN)

    Thus Price He tank Ti / Price Helium tank SS ≈ 4 (100 CHF / 25 CHF)

  - Material price: for 260 cavities, the price for the material would be:
    - 316LN: ≈ 300’000 CHF
    - Ti 6Al 4V ELI: ≈ 1’200’000 CHF
    - Additional material cost if additional Titanium needed (pipes, bellows etc)

Helium tank material

- Overall price:
  - On top of material price add:
    - Special procedures, material and specialized technicians for Ti alloy
    - Tuner re-design for Stainless Steel to cope with larger stroke

Flanges, joints, bellow

- Same analysis should be made as for He tank material

- Material choice involves differences in:
  - Manufacturability
  - Feasibility of connection to cavity
  - Heat treatment / sequence
  - Interface to cryogenic piping
  - Tuner design
  - Overall price