Horn status review

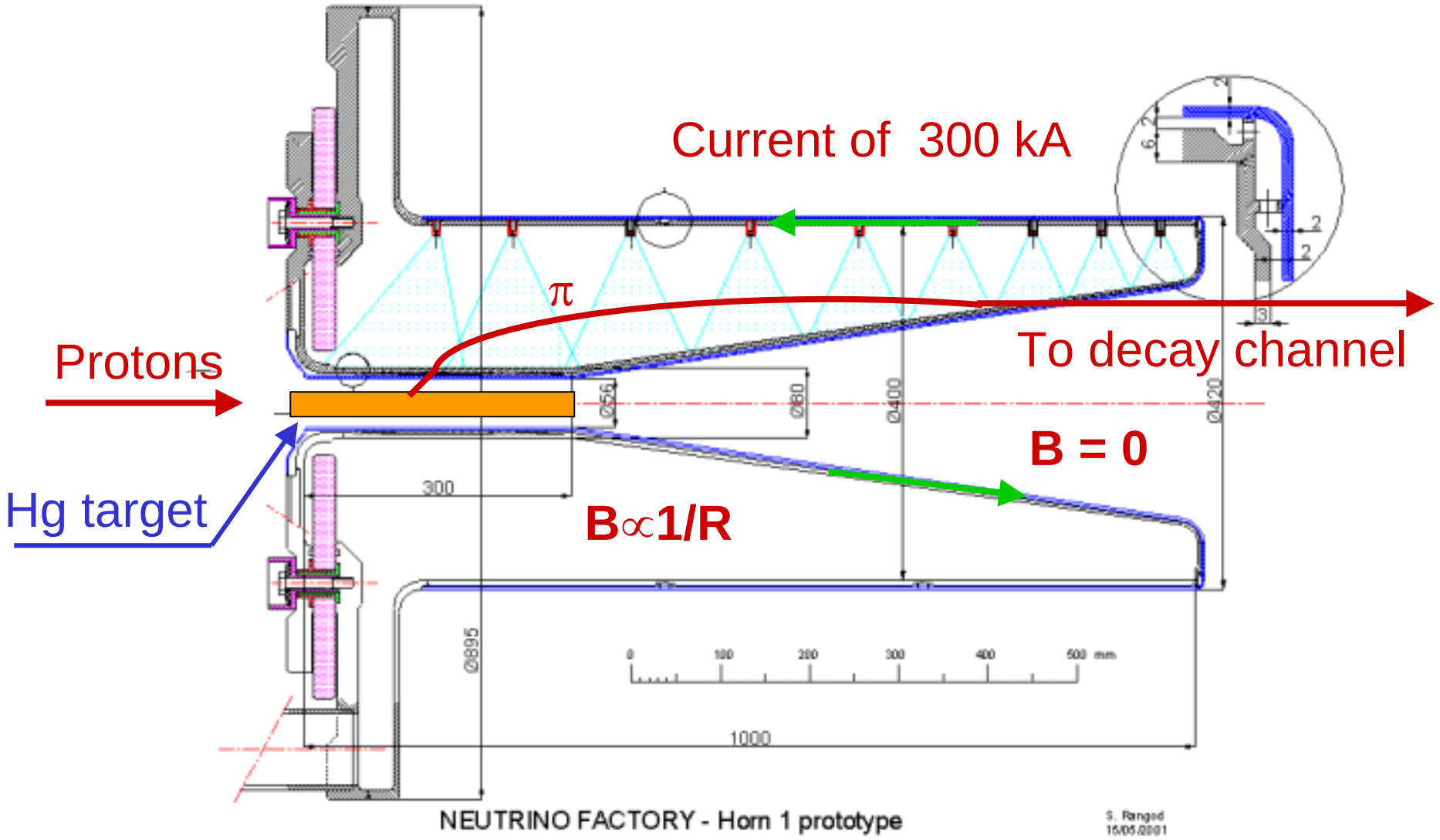
Simone Gilardoni
CERN – PS/PP

For the Horn working group

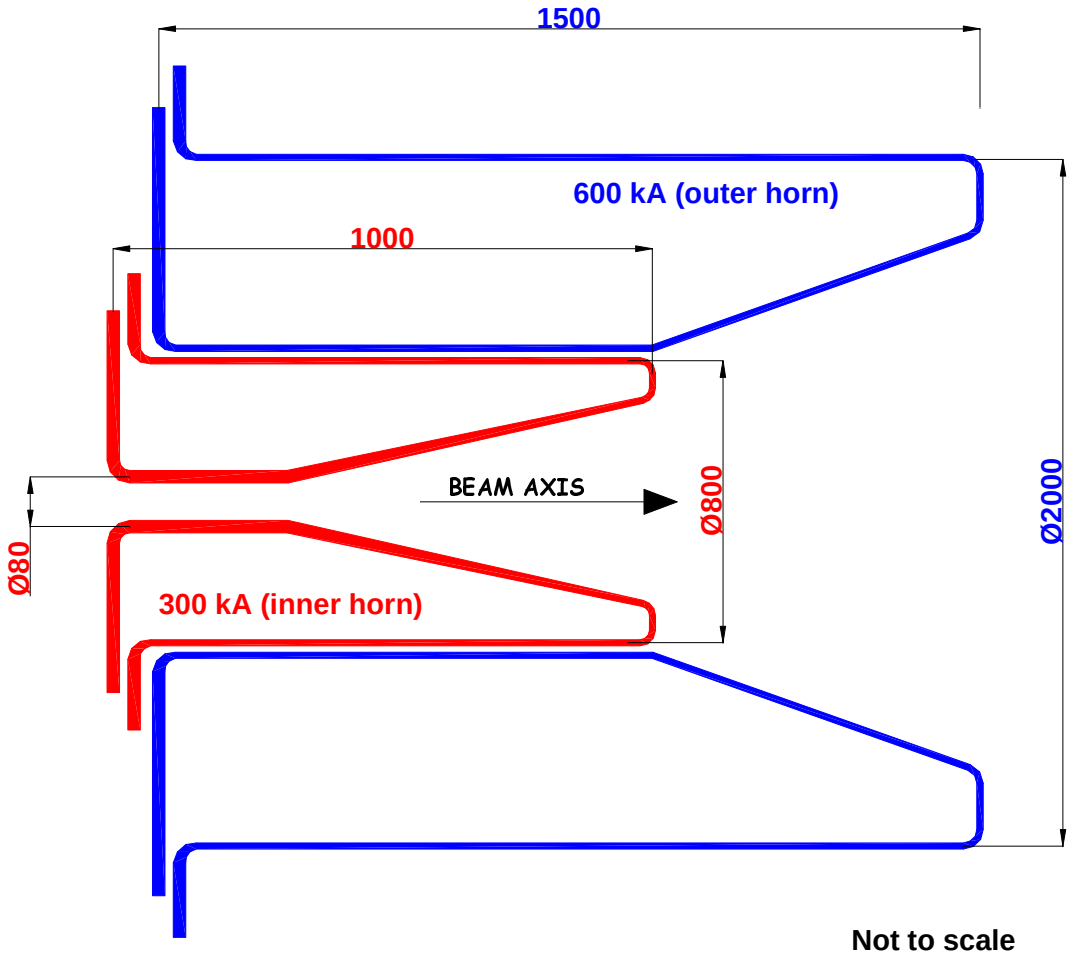
Work in progress

- Horn building and testing
- Horn life-time determination
- Integration between target and horn

Horn focusing system



Double horn concept



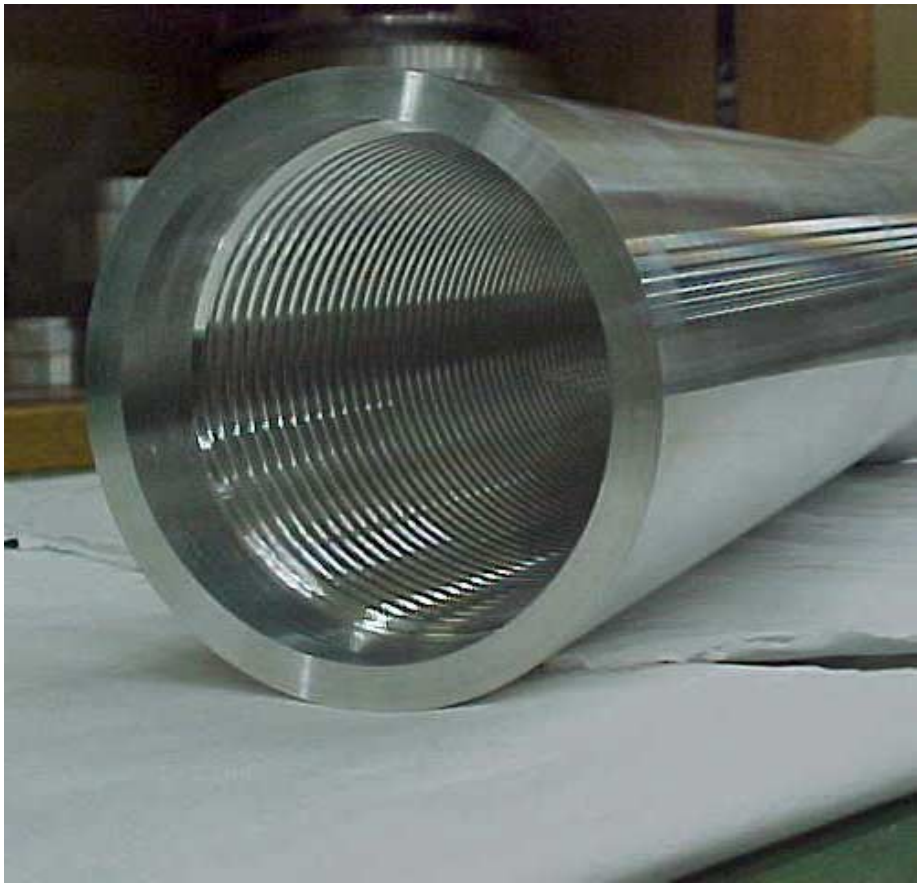
Not to scale

Very good news

Horn conductor

Inner conductor

Horn neck



Discharger Unit

What we planned to do

- First “inner” horn 1:1 prototype
- Power supply for Test One:
  30 kA and 1 Hz, pulse 100 μs long
  - First mechanical and thermal stresses measurements
  - Test of numerical results for vibration
  - Test of cooling system

Delay due to budget restriction

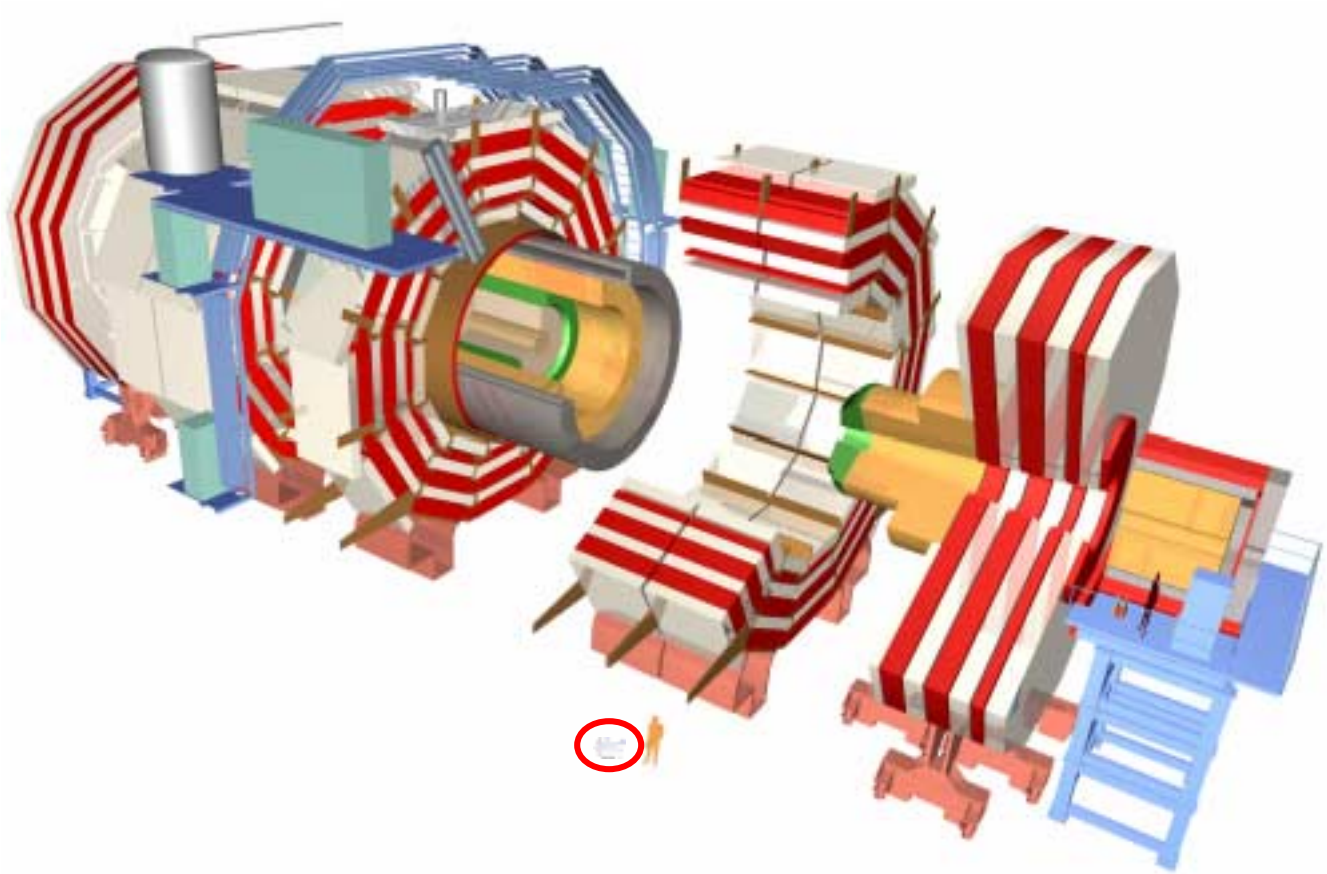
- Test Two: 300 kA and 1 Hz
- Last test: 300 kA and 50 Hz

Unknown schedule

What we are doing

- Finishing the power supply for Test One
  - Cabling going on today
  - Test as soon as possible (summer)
- Stress calculation via a numerical model
- Test two: Looking around for a 200 – 300 kA power supply plus discharger

CMS Magnets Power supply



- Total current for CMS magnets: 19 kA DC
- Ramping in 5h
- Horn average DC current: 14.5 kA

Horns available from the shelf

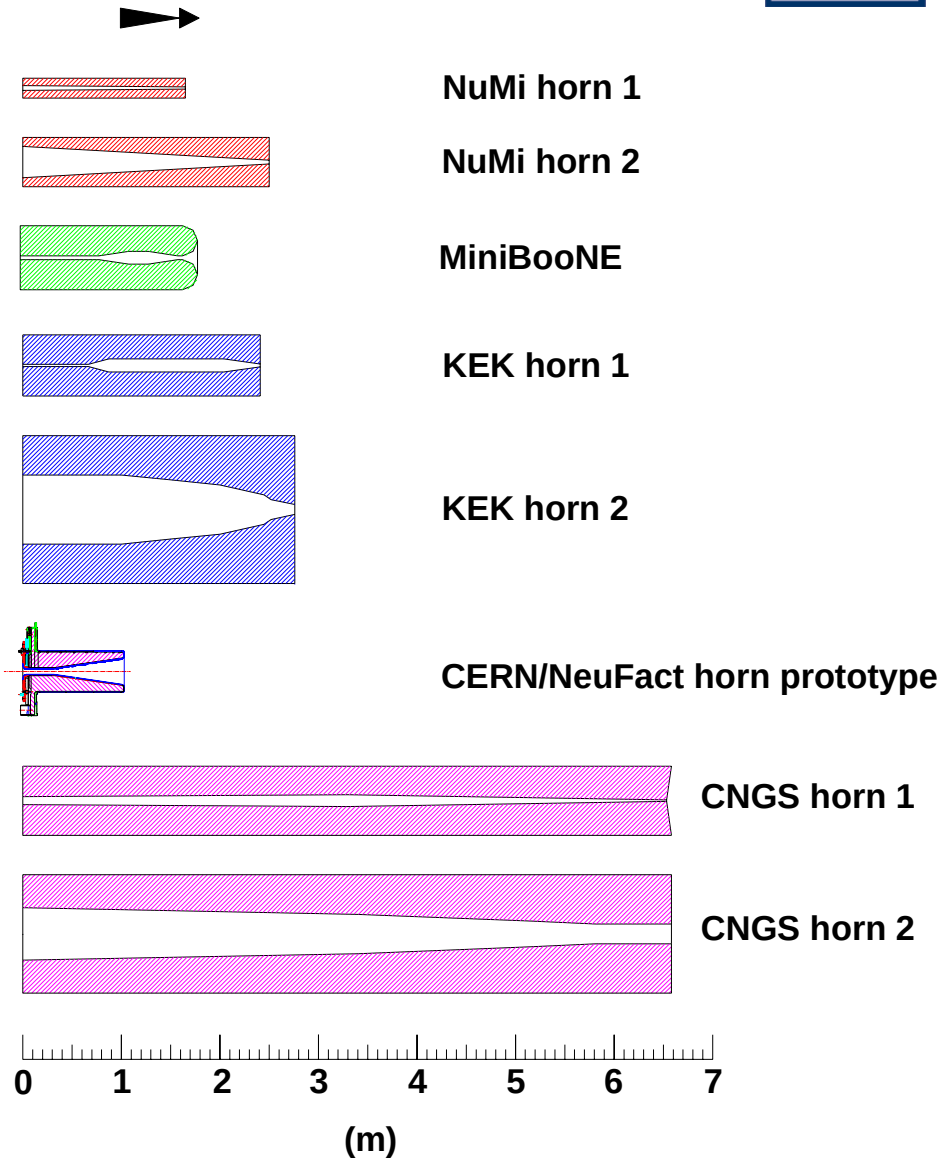
Numi: 200 kA, 0.5 Hz, 6M pulses
1 year

MinibooNe: 170 kA, 5 Hz, 11M pulses
1 year

K2K: 250 kA, 0.5 Hz, 11M pulses
1 year

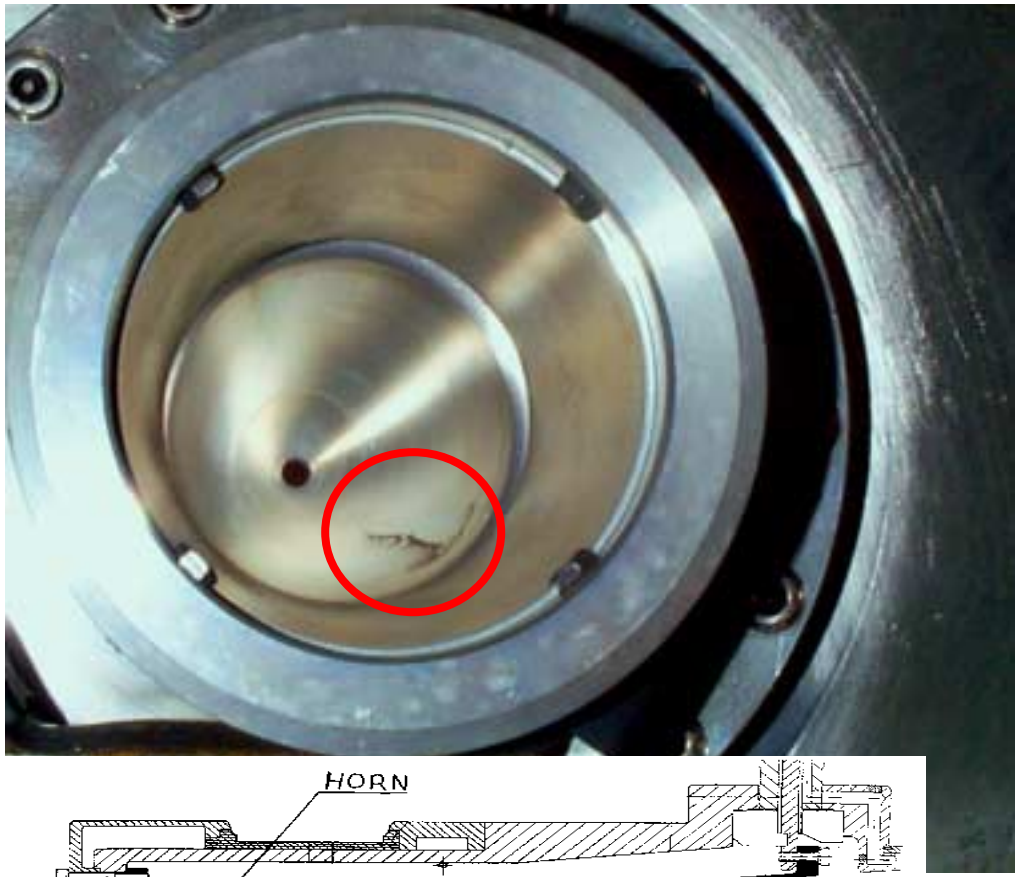
Nufact: 300 kA, 50 Hz, 200 M pulses
6 weeks

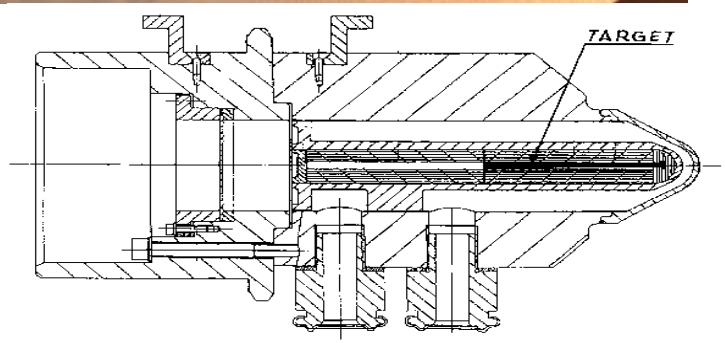
CNGS: 150 kA, 2 pulse/6s, 42 M pulses
4 years

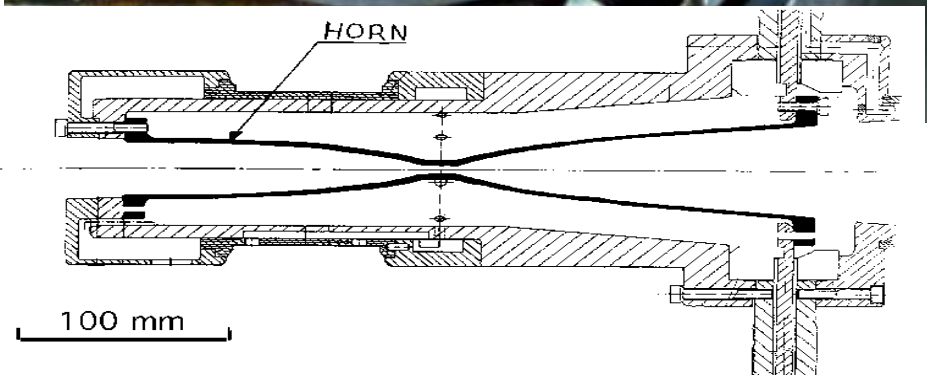


Horn failures ...When? Why?

AD horn (see Microcosm)
300 kA, 0.5 Hz, 1M pulses





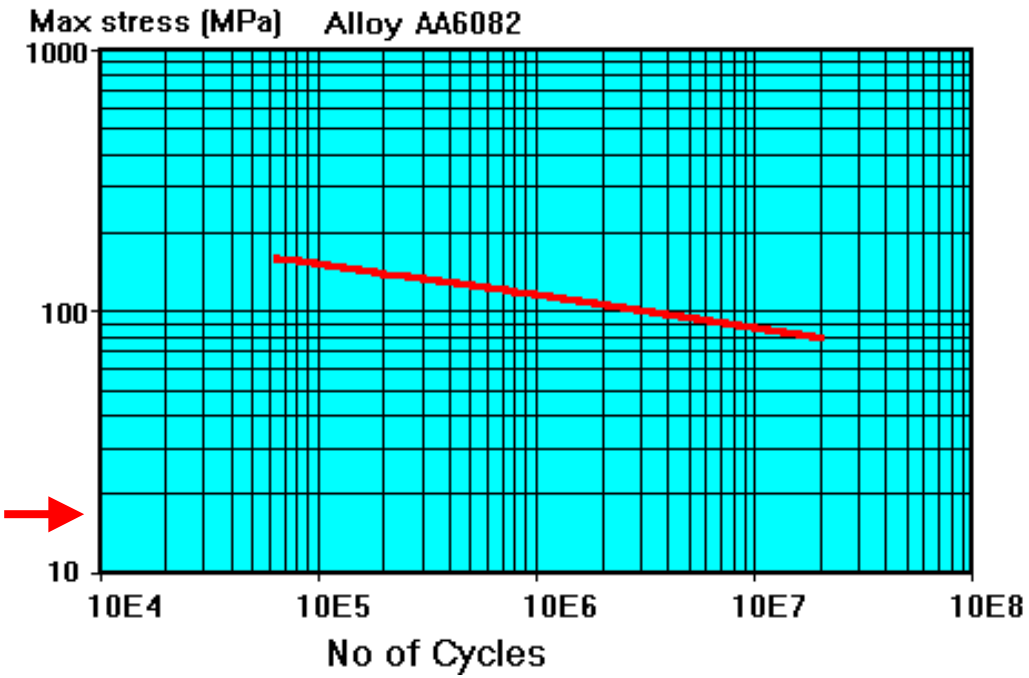


Reasons for horn failure

- Fatigue limit
  - stress due to electro-magnetic forces
  - Max pressure: ≈14 MPa (140 kg/cm^2)
  - Operation always in material elastic regime
- Thermal stresses
  - joule losses: 39 kW
  - particle energy deposition (still to be evaluated)
- Neutron irradiation
  - Swelling
  - Mechanical properties variation

Material choices

- **AA 6082-T6 / (AlMgSi1) is an acceptable compromise between the 4 main characteristics:**
  - Mechanical properties
  - Welding abilities
  - Electrical properties
  - Resistance to corrosion



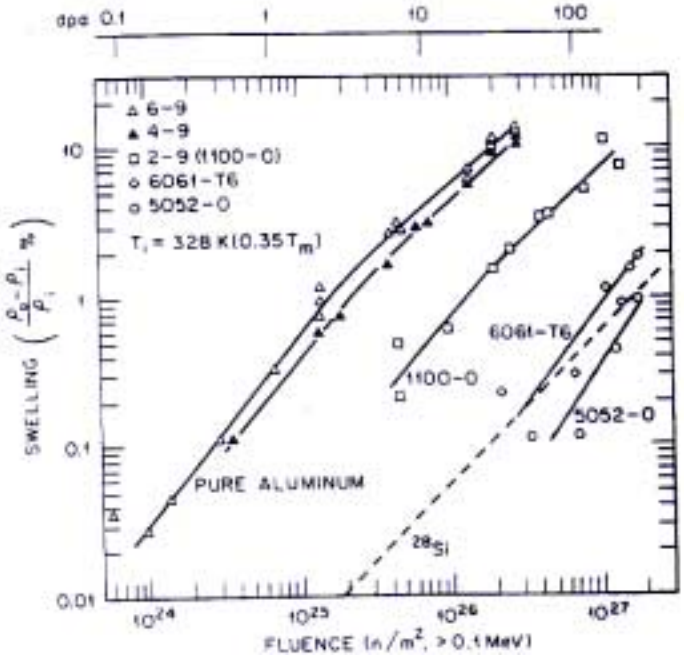
Max. allowed stress →

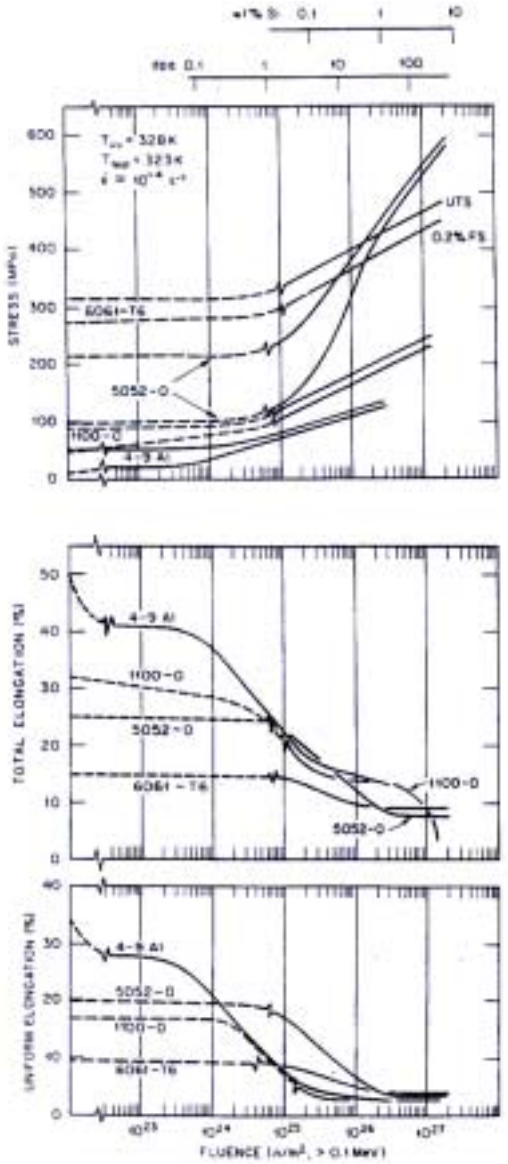
Not compatible with Mercury

Ductility variation and swelling

Neutron flux from Hg
typical of a
Neutron Spallation Source
(ESS, SNS)

Approx 10^{26} n/m^2



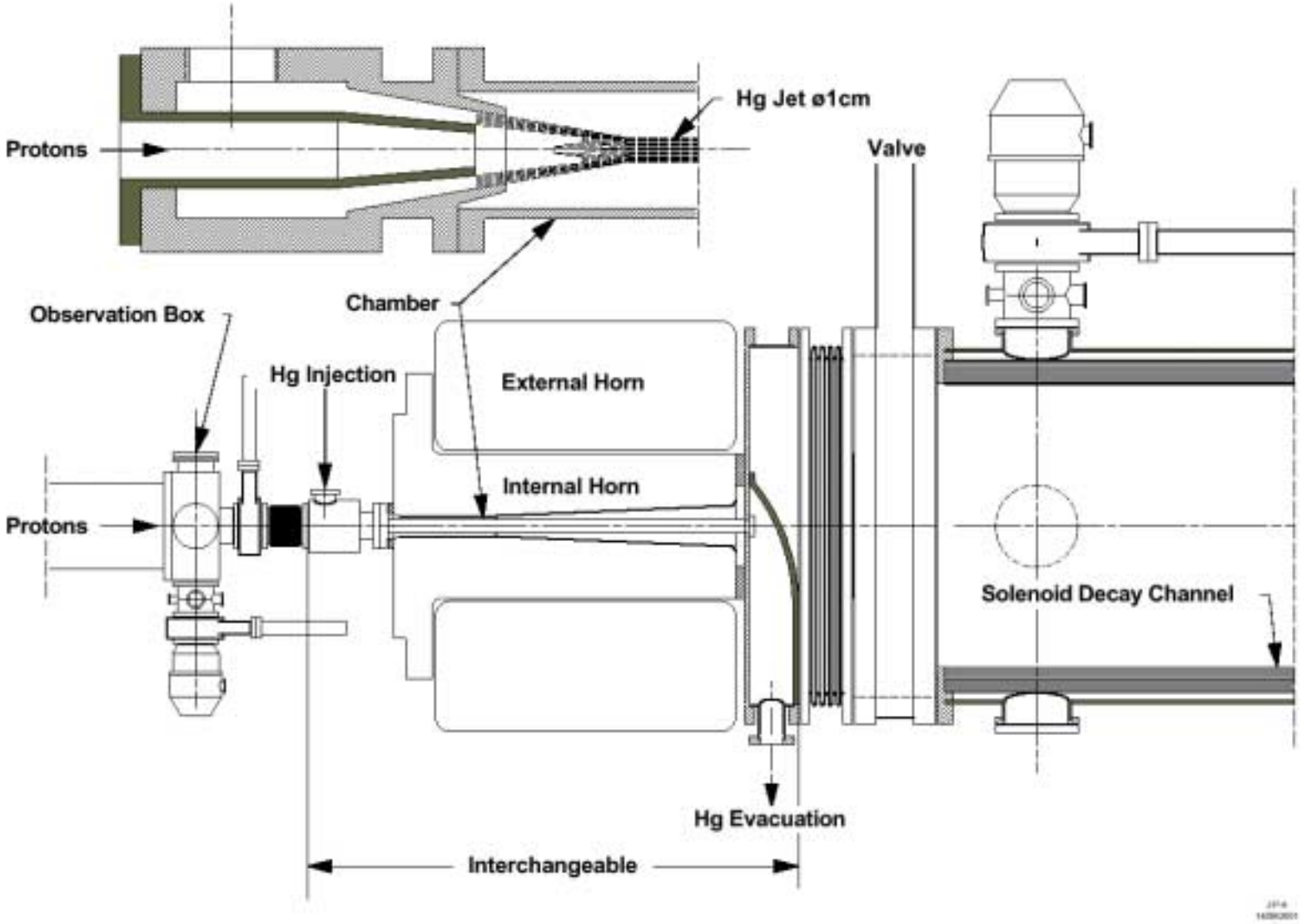


Material development

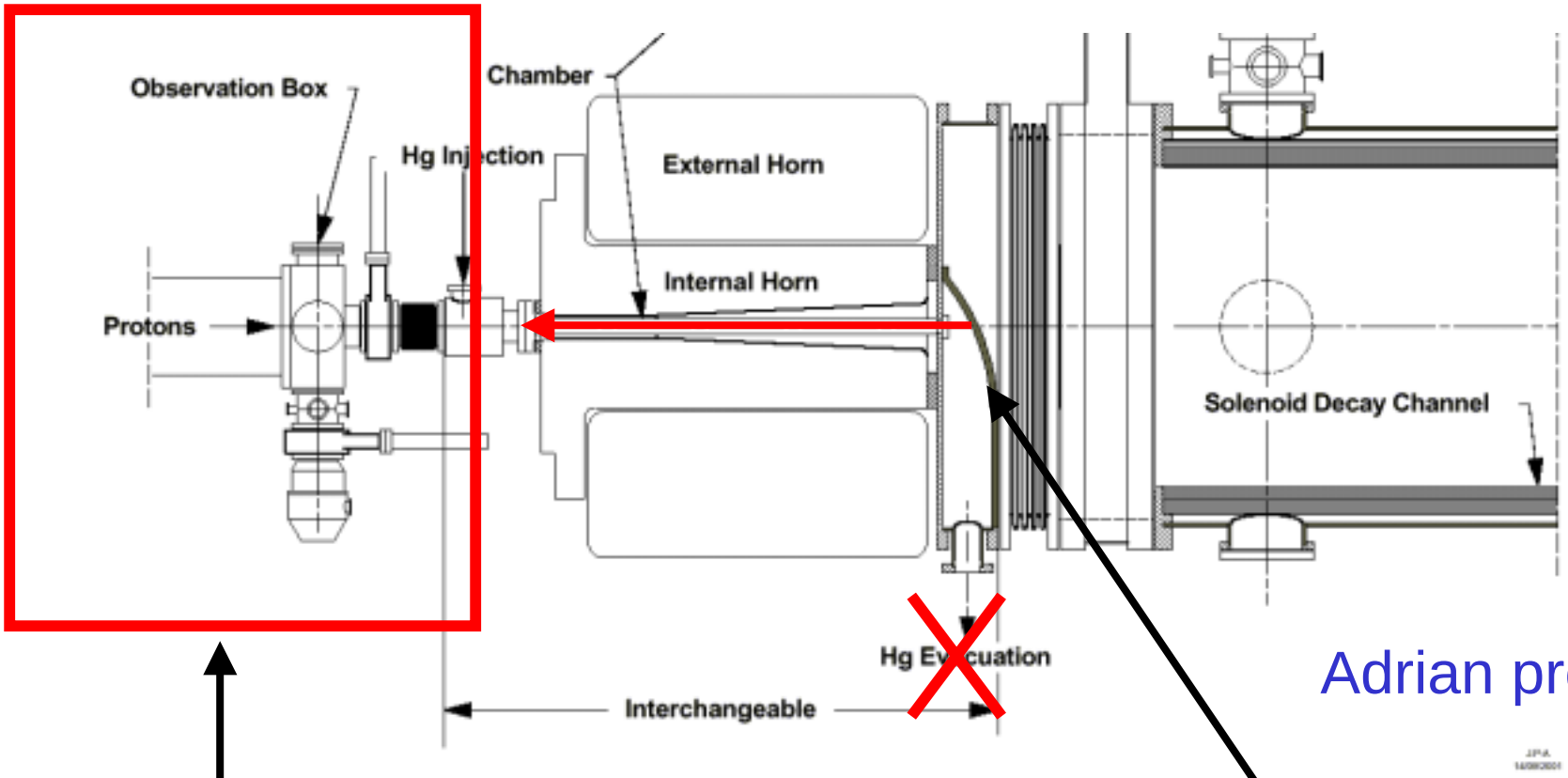
- Mechanical tests of Aluminum-Alloys before and after irradiation
  - Variation of the mechanical parameters
  - CERN is not equipped for such measurements
    - Isolde as irradiation facility but somewhere else for tests

- Test for define material as a wall between Aluminum and Hg
  - Highly “active” environment:
    - Mercury splashing around (See Jacques talk)
    - Minimum thickness but high mechanical resistance (Ti-Alloys? Stainless Steel? See ESS, SNS target)

Target and Horn integration



Target and Horn integration



Adrian proposal

Chamber for Mercury Evacuation

New Nozzle position

Life-Time of Nozzle?

Conclusions

- Inner horn finished and ready for test
- Horn mechanical test:
  - 30 kA, 1 Hz, 100 μs during the summer
  - Power supply nearly ready for tests
- Material study at first stage
- New nice idea how to put horn and mercury together