The GENEPI neutron sources at Grenoble Prospectives for GUINEVERE

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History

- *GENEPI:* GEnérateur de NEutrons Pulsé Intense
  - Deuteron accelerator (240 keV, 1μs pulses, 50 mA peak)
  - Neutron production by D+T or D+D reactions

- *Why such a machine ?*
  - Need of very intense and very sharp edges neutron pulses
  - No commercial solutions

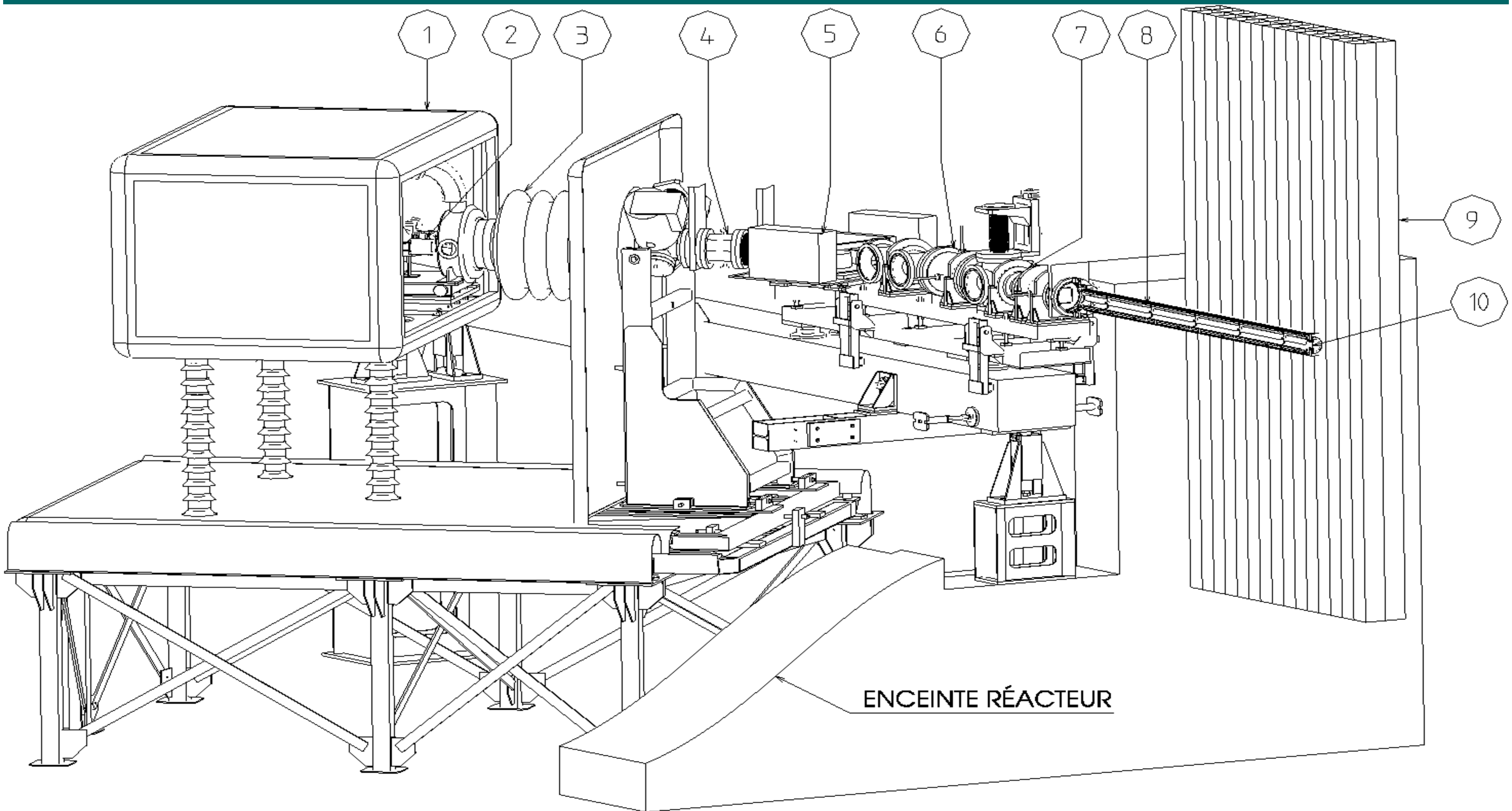
- *Motivations:*
  - Neutron production at the MASURCA reactor (Cadarache) for the MUSE4 programme (GENEPI-1) – First coupling accelerator/reactor
  - Neutron production for cross-sections studies (LPSC, GENEPI-2) on the PEREN facility.

- *GENEPI-1:* design from 1996 to 1999 and implantation in Cadarache in 2000 – partially dismanteled in 2005
- *GENEPI-2:* under operation in Grenoble

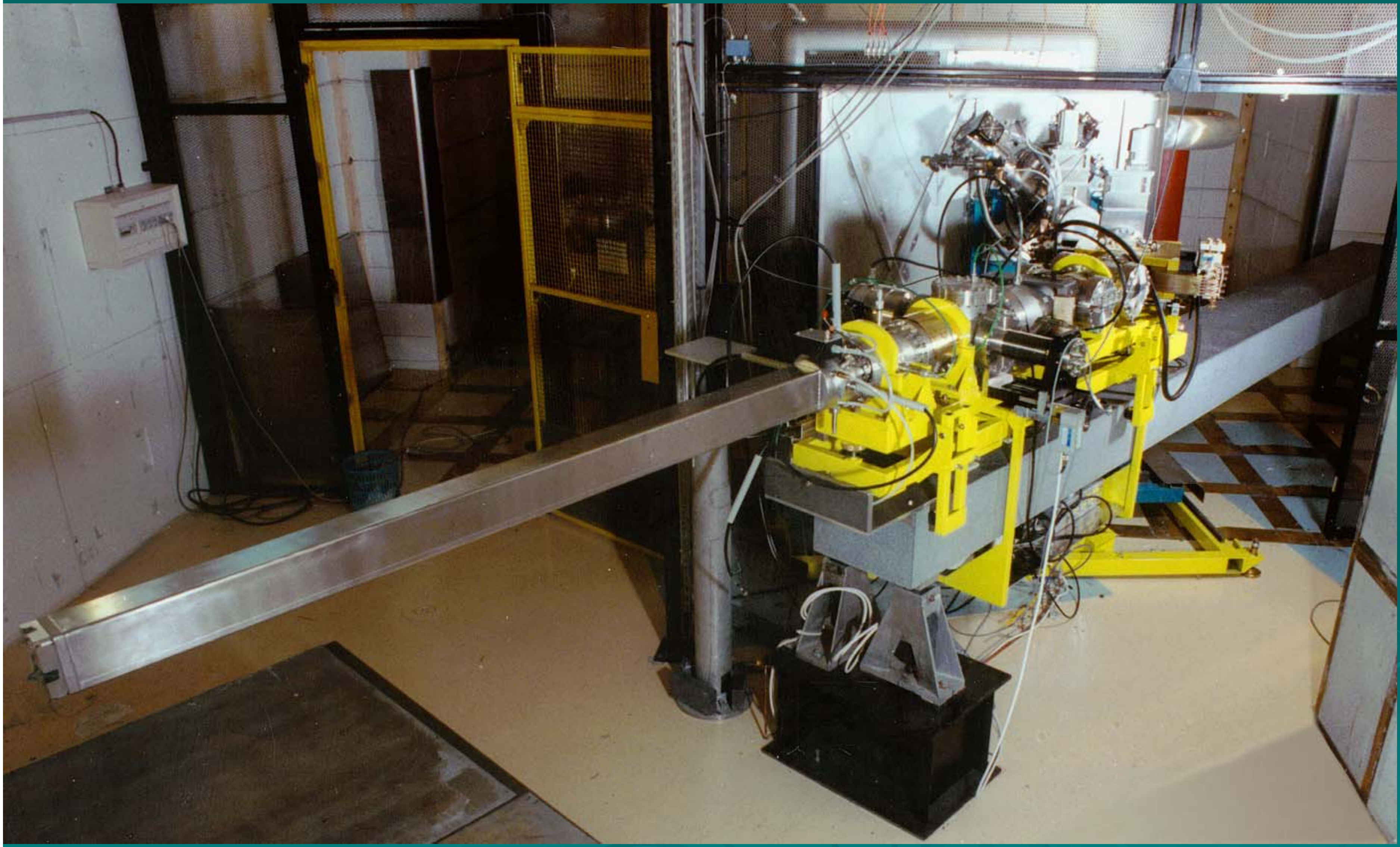
Specifications

- Peak current (deuterons) ~50 mA (@10Hz-5kHz)
- Pulse deuteron length 0.5-0.7 μs (mid height)
- Energy 140-240 keV
- Neutron energy 2.5 / 14 MeV
- Target: Deuterium or Tritium / Titanium
- Spot diameter 20-25 mm
- Neutron production (peak) ~5 10^6 n/pulse
- Reproducibility 1% from pulse to pulse

GENEPI-1 at MASURCA: overview

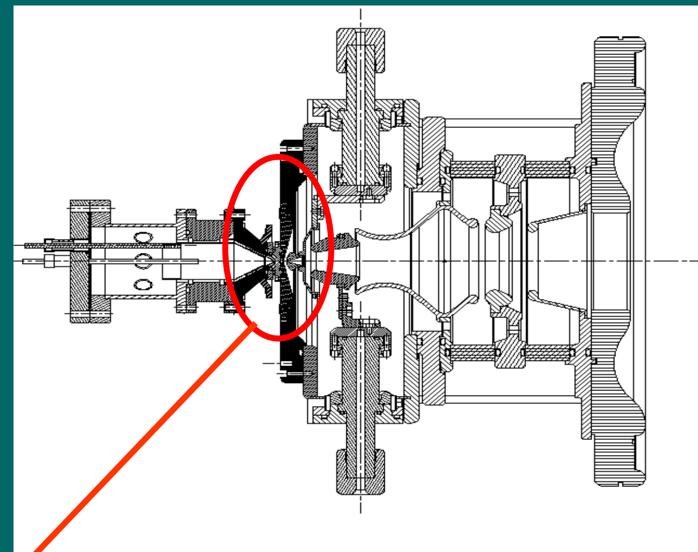


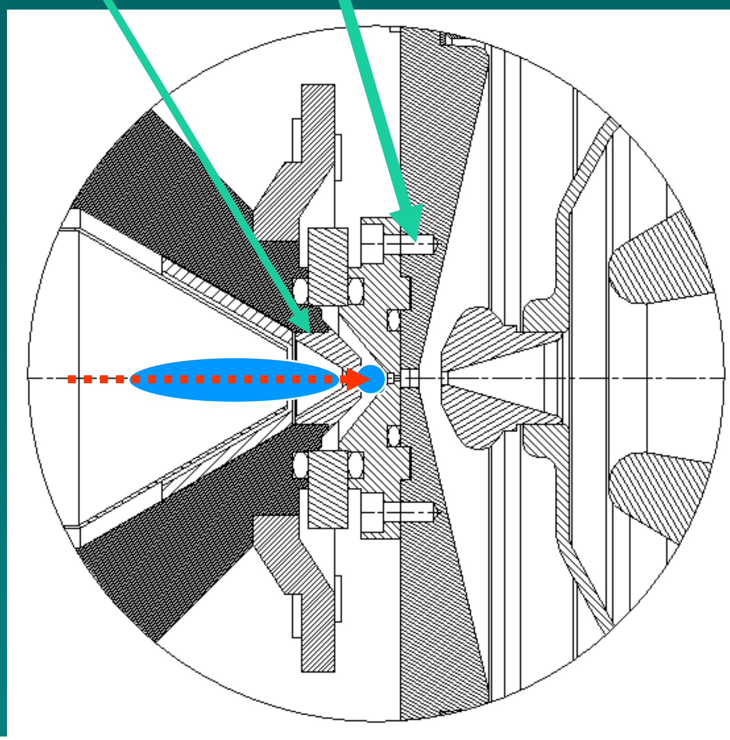
GENEPI-1 at LPSC

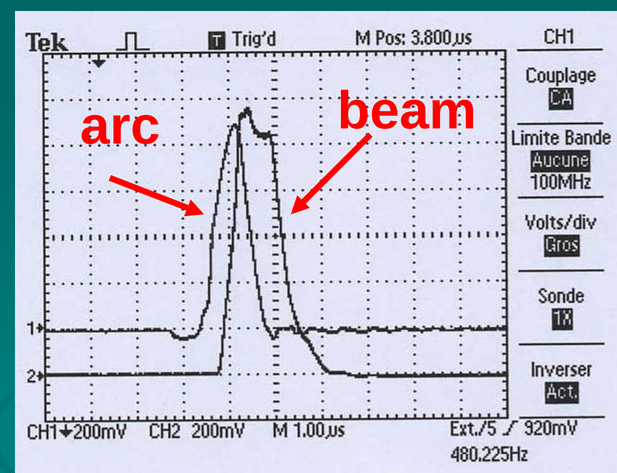


The ion source: specific for short pulses

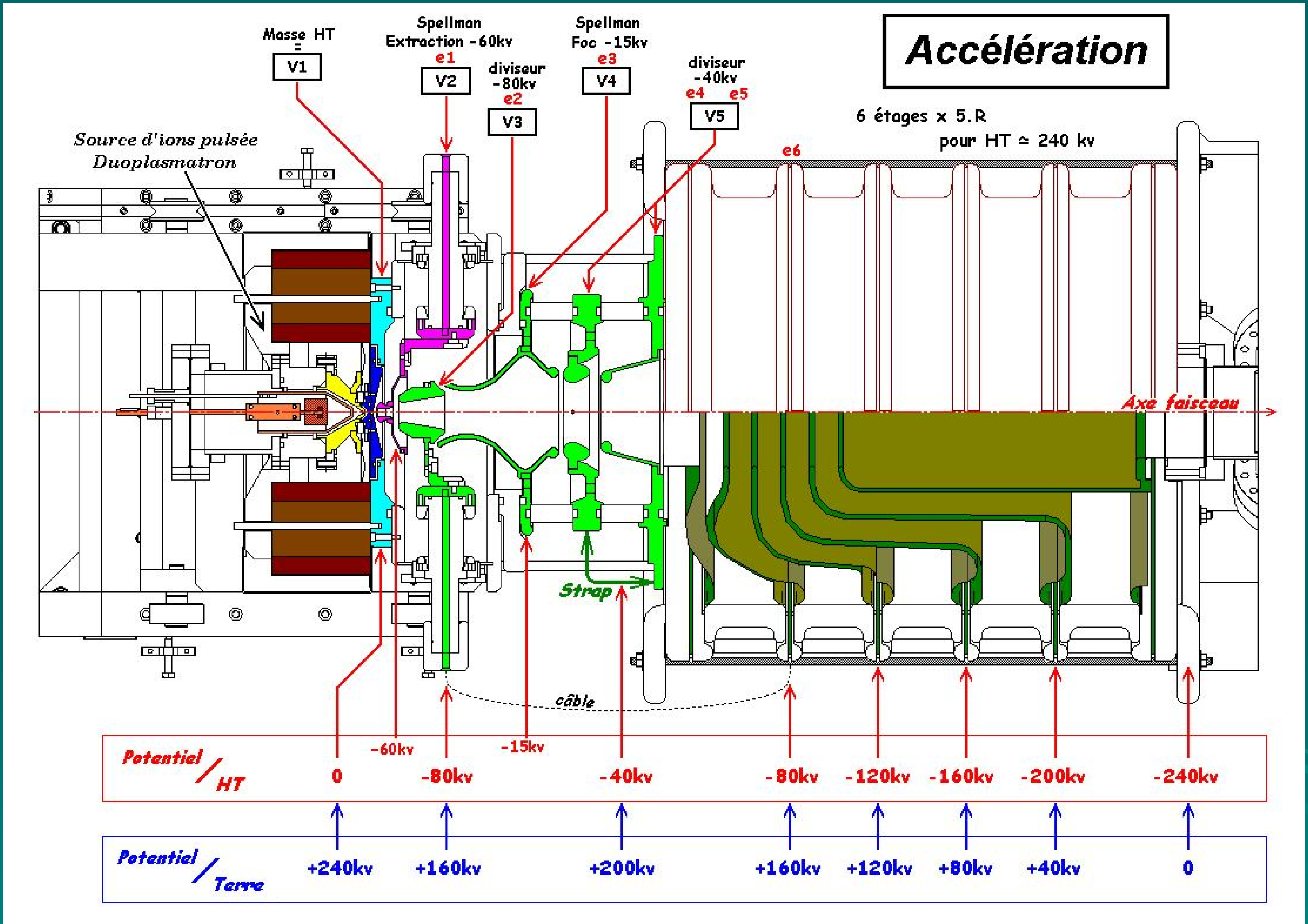
- Duoplasmatron used like a thyratron
  - Triggering of electron discharge
  - LC delay line on anode





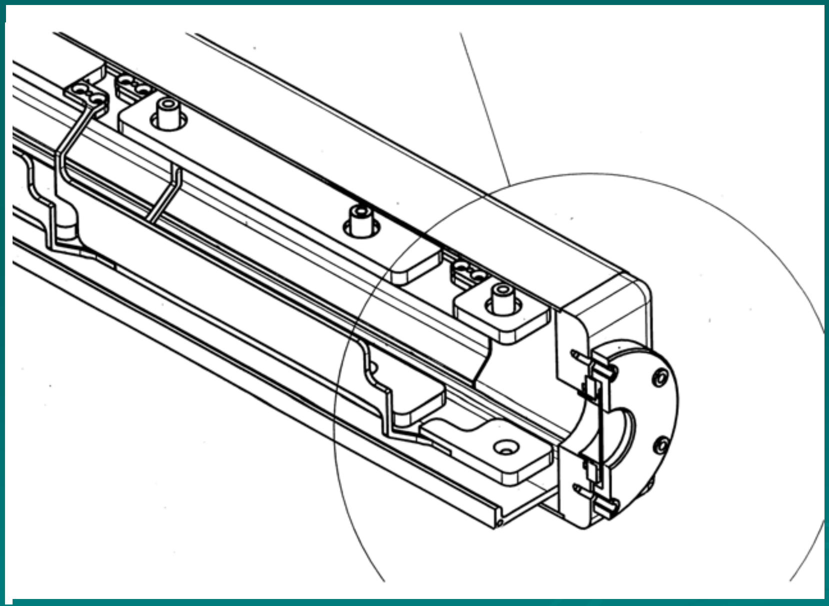


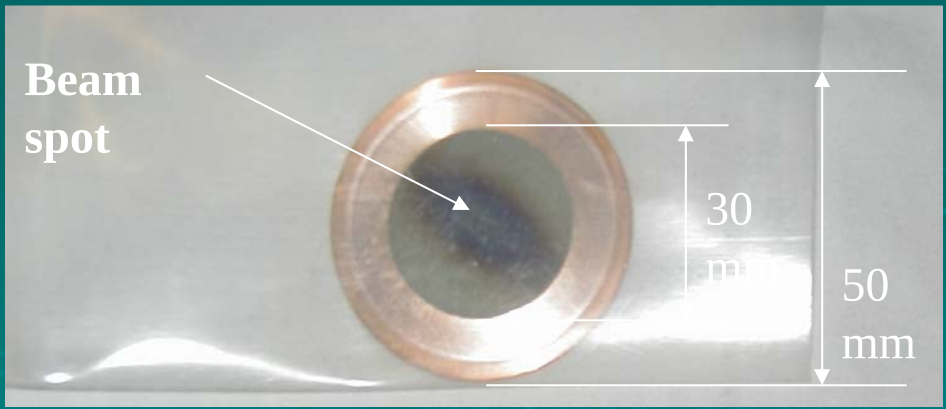
Source+focusing+acceleration with space charge



The target

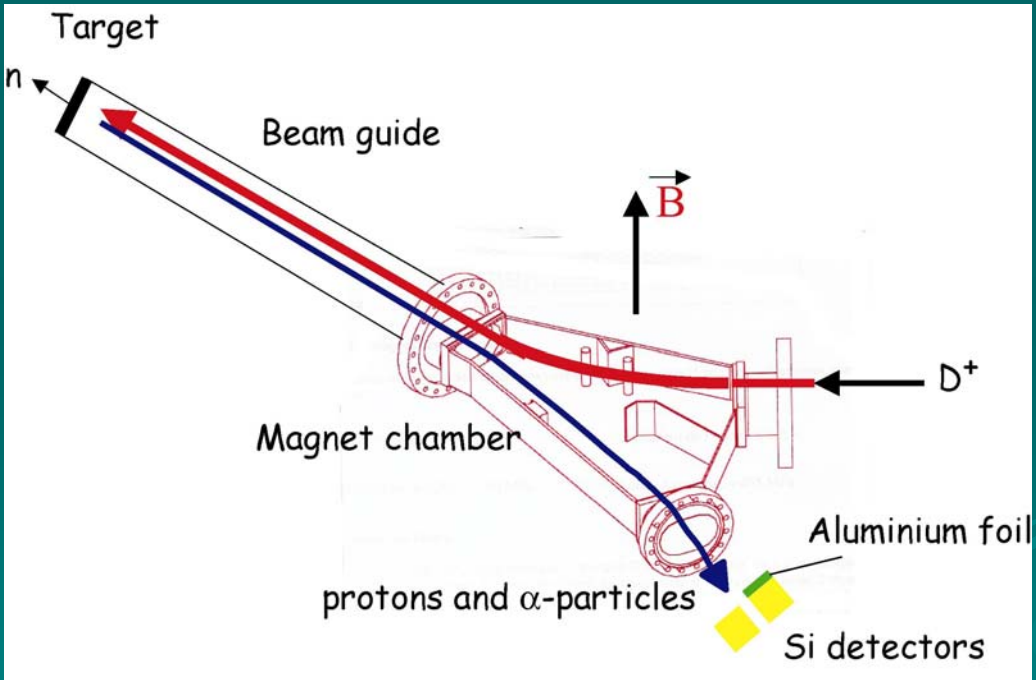
- 49 mm copper disc
- thin layer of Titanium deposited over 30 mm (diameter).
- For Cadarache, about 1.2 mg of T or D is deposited (12 Ci).
- In Grenoble, the load is limited to 0.9 Ci.
- air cooled and kept below 100 degrees Celsius





Neutron production control

- Amperemeter on target
- Two silicon detectors for neutrons
  - Detection of α particles and protons
  - Detection of protons only



GENEPI/MASURCA: a driven system

- Modulation from 100 Hz to 4 kHz of the repetition rate
  - →a factor 13 can be achieved in the intensity range
- Modulation is done in two ways:
  - →Very sharp edge falling times (a few microseconds) A plateau period, a low intensity.
  - →A progressive rise time from (a few tens of seconds), longer than the reactor time constant.

⇨ the MUSE experiment demonstrated the real possibility of control the reactor power by the accelerator.

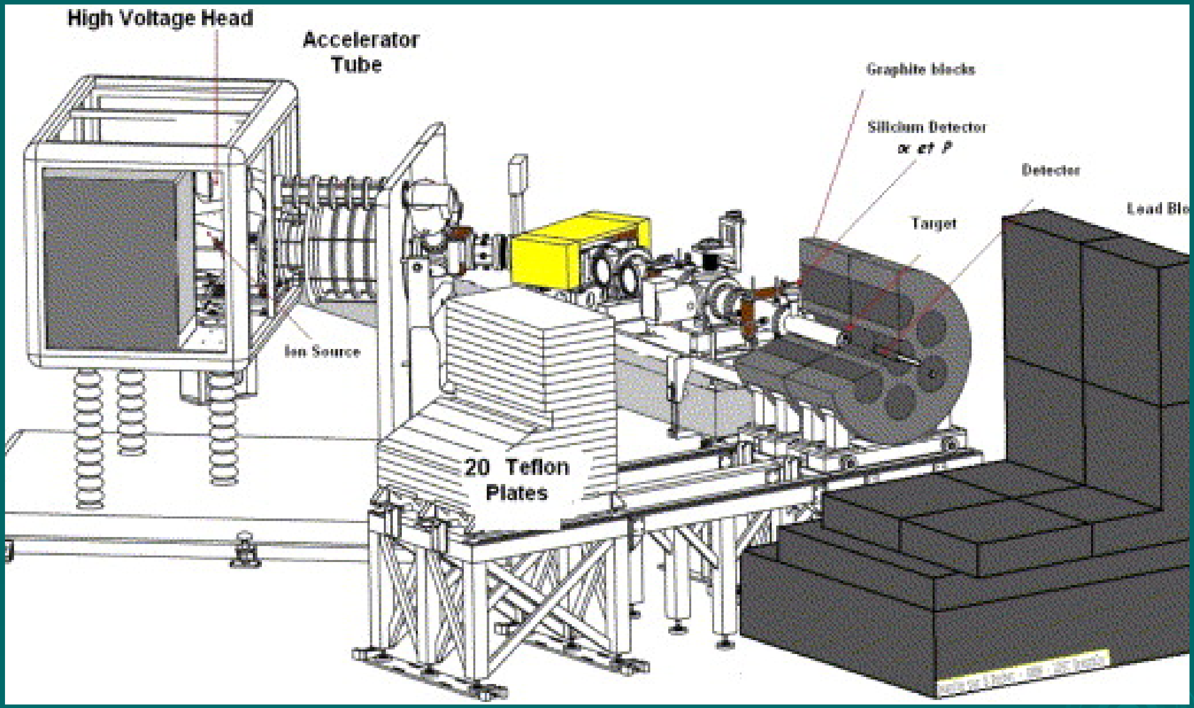
Operation aspects

- Operation by non-specialists
- Filament has been changed only once in 4 years (5000 h life time).
-
- Hardware located in the GENEPI room has suffered from n and γ emission
- Pumping system has given entire satisfaction with only one failure of a secondary turbo-molecular pump in July 2004.
- Control command software has given entire satisfaction permitting quick remote failure diagnostics by the LPSC team .
- Tritium has been released by the beam effect.
  - → Special detectors, gloves box and air flowed diving-suits used for target manipulation have been of a real need.
  - → Pump outlets have to go in a specific tank
- Only 2 TiD and 2 TiD targets have been used during the programme.

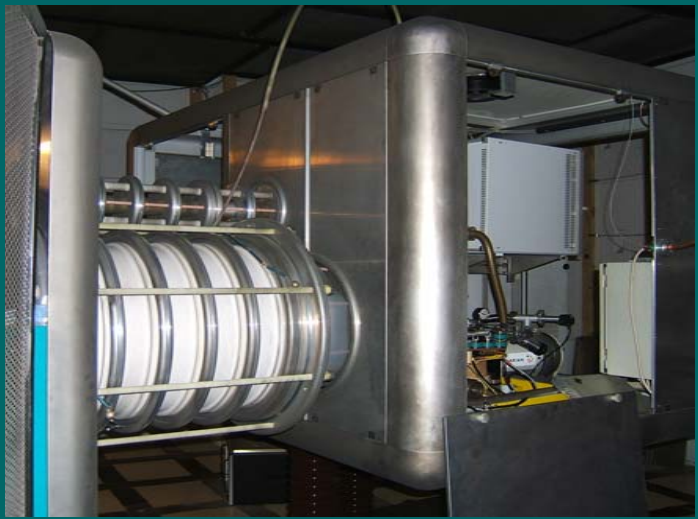
GENEPI-2 and PEREN facility at LPSC

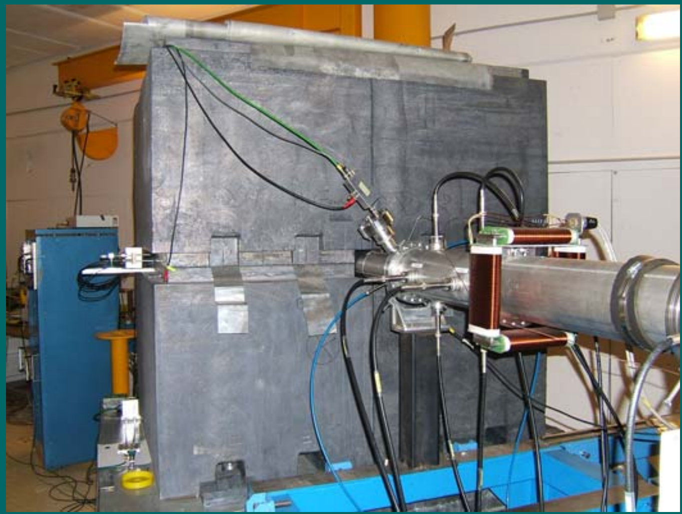
- Capture cross section measurements
- Lead slowing down spectrometer
  - Long thimble
- Other slow down material
  - Short thimble
  - Graphite
  - Téflon (CF4)
  - Graphite + ^{7}LiF

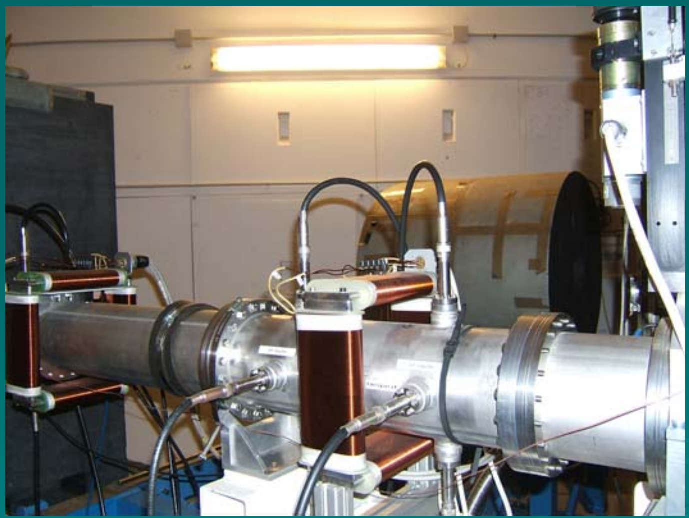
- Copy of GENEPI-1

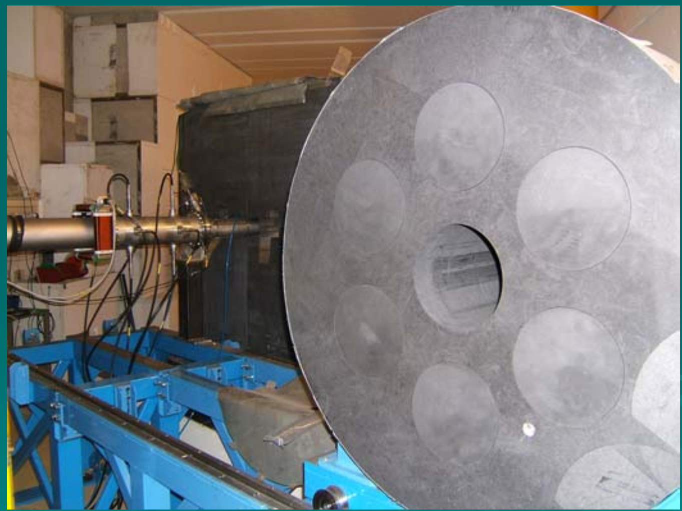


GENEPI-2 at LPSC









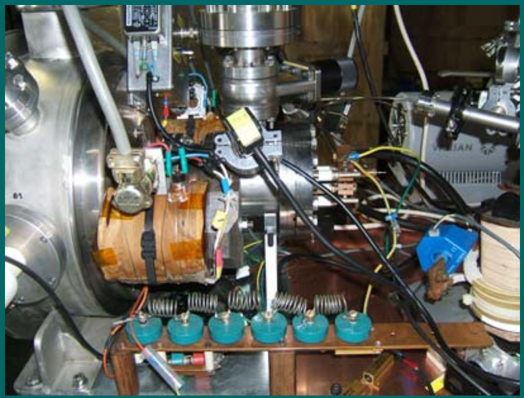
GENEPI-3C, VENUS and GUINEVERE

- A new need for GENEPI: pulsed beam AND continuous beam (200μA-1mA) with possible interruptions (~1ms)

→ A new topology
→ New design and new study
→ Two very different space charge regimes for beam transport

Present studies: the source in continuous mode

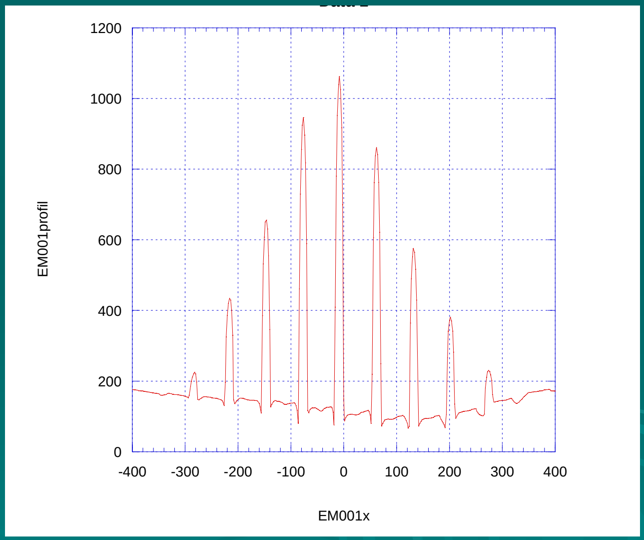
- New bench test
  - 1.2 mA DC achieved
  - Emittance measurements done



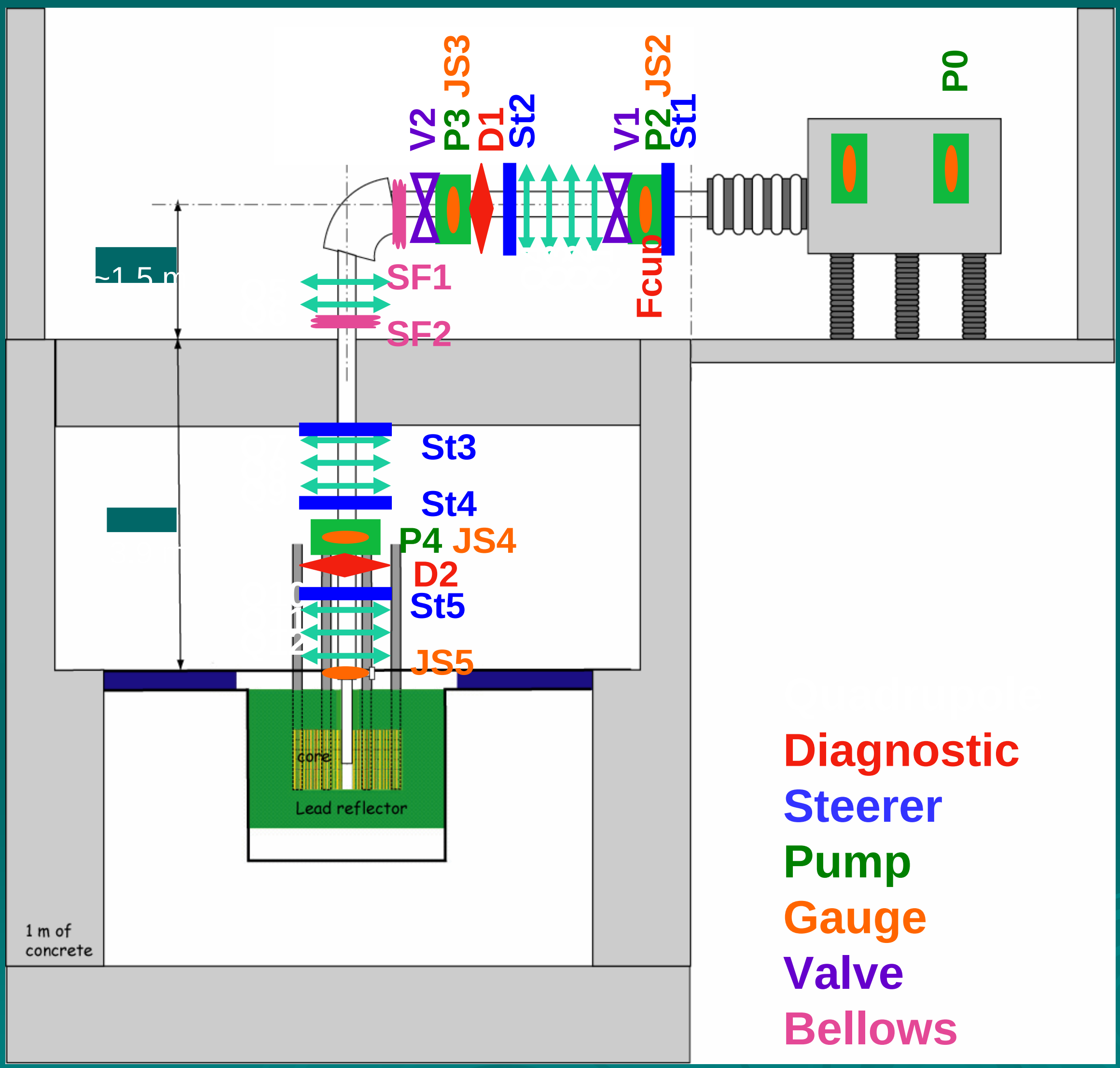
- Heating issues to solve

- Second step: beam analysis (molecular versus atomic ions)

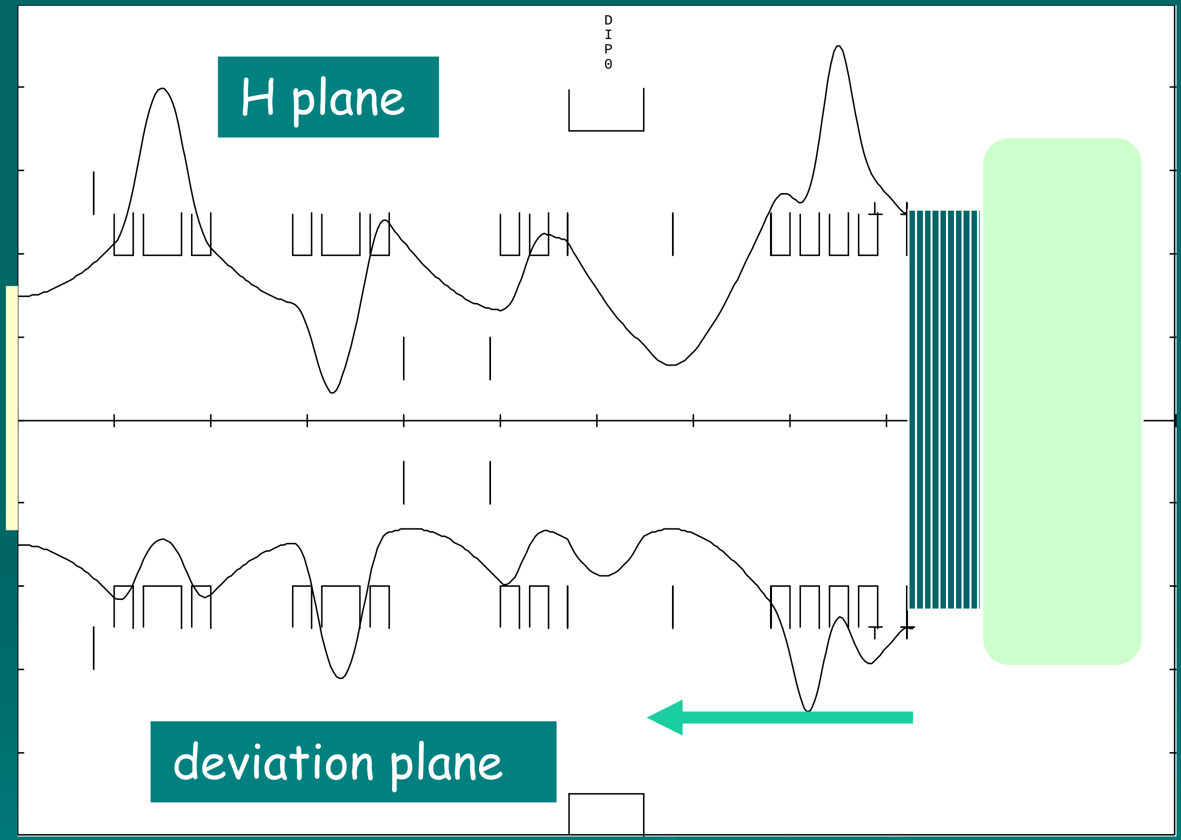
- Concl: ONE source



GENEPI-3C structure (preliminary)



Beam enveloppes in the accelerator at 50 mA



- Electrostatic focusing
- 90 degree magnetic dipole
- No focusing in thimble

- 2ϕRMS=26mm
- I=50 mA
- Horizontal scale: 1m/division
- Vertical scale:
- 10mm/division

Some issues for GENEPI-3C

- The 90 degree dipole (must accomodate a neutron telescope + cooling –safety-)
  $\rightarrow$ IPN Orsay
- Vertical removing of the beam line for core loading and target change
  $\rightarrow$ LPC Caen
- Thimble and cooling + horizontal line support
  $\rightarrow$ IPHC strasbourg
- Beam diagnostics (250 W)

Conclusion

- GENEPI-1 and 2 are a success
- Give us confidence in design, planning, cost estimate and operation by non-accelerator specialists
- Design and test of GENEPI-3C is under way
- ~1M€, ~25 person.year
- Test and first commissioning will be in Grenoble
- Arrival of GENEPI at SCK on May 2nd 2009
- Many thanks to our colleagues from CNRS/IN2P3, CEA and SCK-CEN !
- Thanks to 5th Framework Programme of the European Commission (MUSE contract) and the 6th FP EUROTRANS contract).