The GENEPI-3C accelerator for the GUINEVERE project

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The GUINEVERE project

Generator of Uninterrupted Intense NEutrons at the lead VEnus Reactor

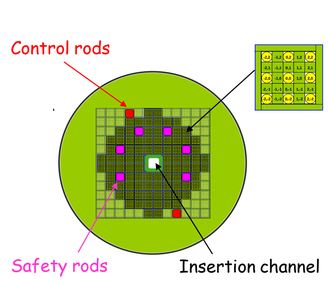
- Part of the Program IP-EUROTRANS (FP6), DM2 ECATS
- Provide an system representing an ADS demonstrator, continuing the MUSE-4 experimental program (FP5)
- Investigate on-line reactivity monitoring, sub-criticality determination & operational procedures in an ADS
- Collaboration CNRS/IN2P3 (France), SCK•CEN (Belgium) & CEA (France)
- Zero(low)- power coupling of
  - a fast lead core reactor, VENUS-F
  - a neutron source, GENEPI-3C

GUINEVERE's keypoints

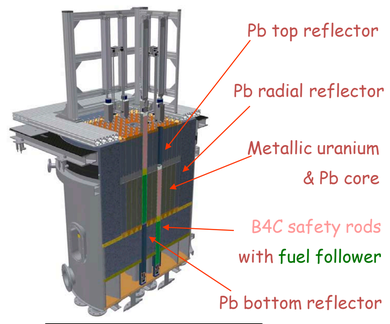
- Improving from MUSE4/GENEPI-1, new specifications
  - Vertical coupling
  - Neutron source operated in both pulsed and continuous modes
- **Reactor (SCK-CEN) : VENUS-F**
  - Modify the water-moderated VENUS into a solid lead core
  - Fuel and lead rodlets provided by CEA-Cadarache
  - Adapt building to accomodate the accelerator above the reactor
- **Construction of a new neutron source (CNRS/IN2P3) : GENEPI-3C**
  - Vertical beamline insertion into the core
  - Pulsed mode
  - Continuous mode with programmable beam interruptions

VENUS-F

- Fast core based on metallic Uranium (30% enrichment) & solid lead
- Sub-critical configurations with central insertion channel

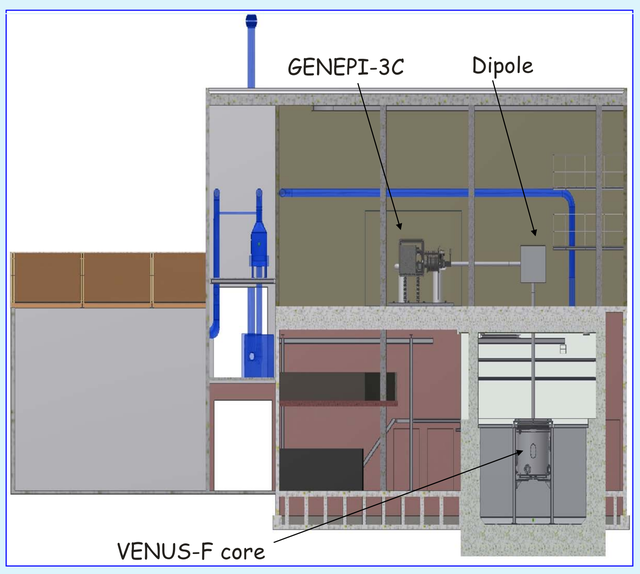


VENUS-F core (top view)



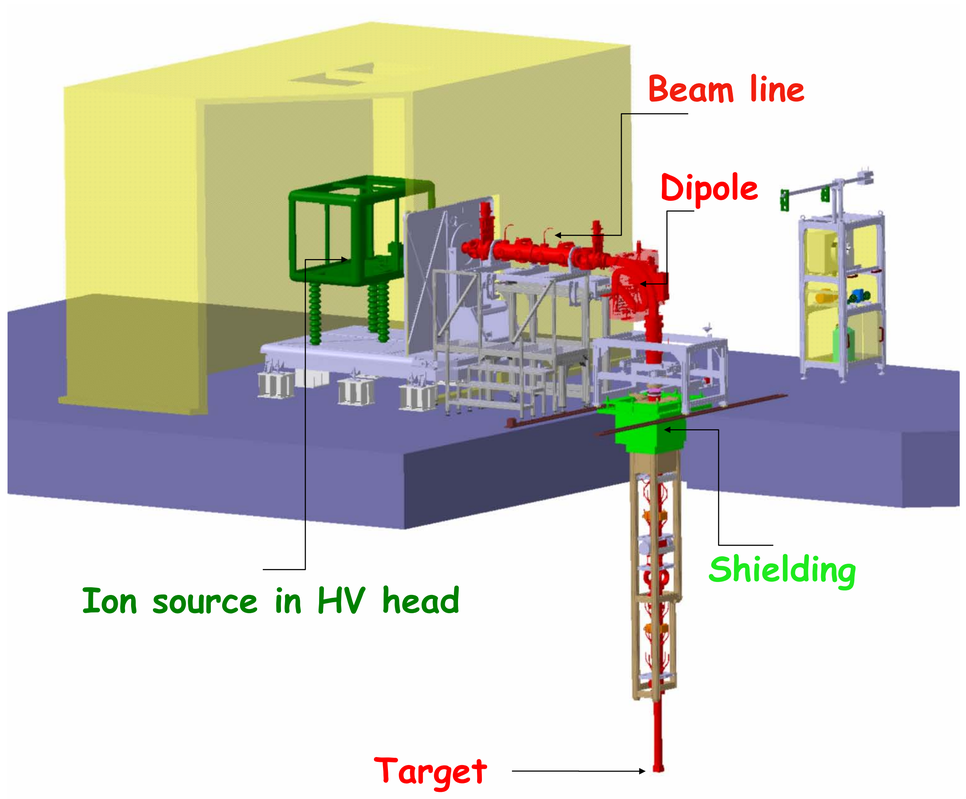
VENUS-F reactor

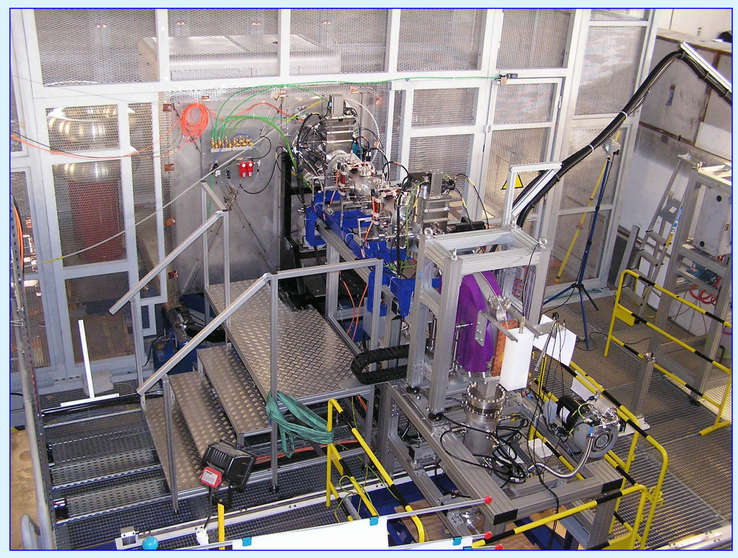
- Construction of additional floor to host the accelerator



GENEPI-3C coupled to VENUS-F

Accelerator design





Partial GENEPI-3C assembly at LPSC

GENEPI-3C beam specifications

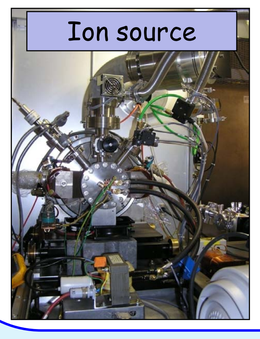
- GEnerator of NEutrons Pulsed & Intense
  - Electrostatic Deuteron accelerator (240 keV)
  - Neutron (14 MeV) production via T(d,n)4He
- Accelerator capable of producing alternatively
  - **Intense pulsed mode**
    - 40 mA peak current
    - FWHM < 1 µs
    - repetition rate : 10-5000 Hz
  - **Continuous mode**
    - DC beam
    - programmable beam trips

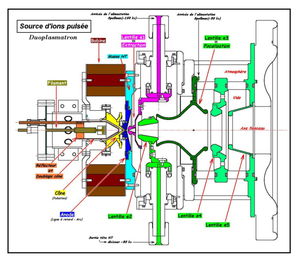
Mean current	160 µA to 1 mA
Beam trip rate	0.1 to 100 Hz
Beam trip duration	~ 20 µs to 10 ms
Transition edge	~ 1 µs
Beam spot size	Φ ~ 20-40 mm
Maximum n rate	~5□1010 n/s
Pulse stability	~1%

- Deuteron ion source driving the beam structure

Ion source

- Ion source to generate D+ beam
  - Duoplasmatron source
    - Well adapted for pulsed mode
- Beam extracted & focused by a series of 5 electrodes (up to 60 kV)

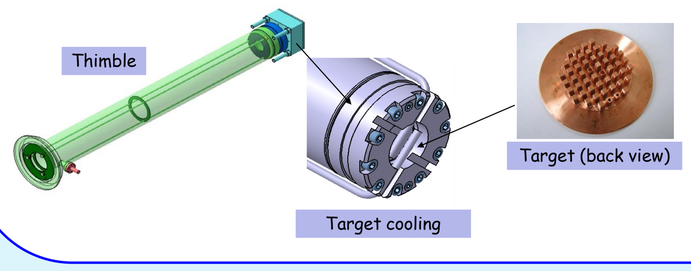




- R&D on test bench to reach DC mode requirements
  - ✓ 1 mA D+
  - ✓ beam interruptions
  - ✓ transitions ON/OFF ~ µs
  - *adjustable trip rate : under study*

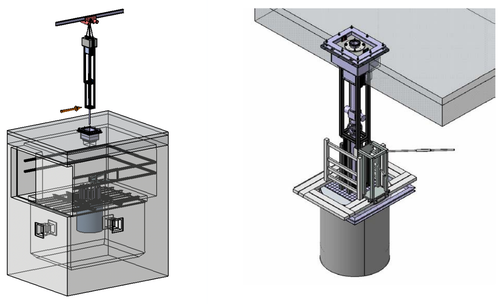
Target

- Thin layer of TiT (12 Ci) deposited over a copper disk
- Current and temperature to be measured at back of target
- Temperature to be kept below 100 ° Celsius (T desorption)
- Cooling by air only (250 W beam power) in a non-cooled core (~45°)
- Mounted on beamline termination (thimble)
- Silicon detector at thimble front-end to monitor α recoil particles



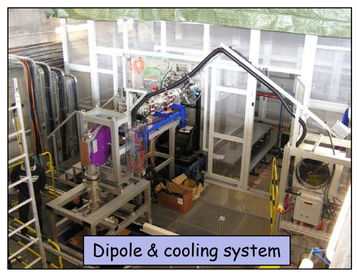
Beam line insertion

- Target within the thimble to be inserted at core center
- Machine sections mobile for periodic target changes & core maintenance
  - Dipole magnet to grant access to the vertical line
  - Vertical beamline to be lifted up
- Vertical line & shielding embedded in support structure, guided at upper and lower level.



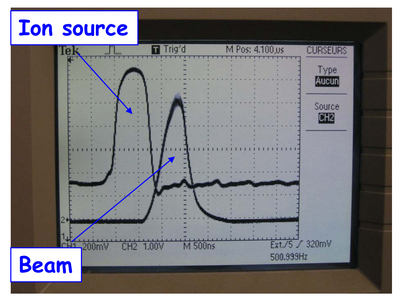
Dipole magnet

- Deflect the beam towards core & perform magnetic separation
- Magnet features : C design, 0.5 m radius, 0.2 T, 30° faces
- Water cooled with stringent precautions against leaks
  - Coil & cooling system waterproof
    - Water & electrical connections in waterproof casing
    - Multiple leak detection
- Ion collector connected to the chamber (D2+, D3+ out of source)
- Proton recoil telescope facing the target



Milestones

- R&D remains on source : DC mode & current driving for coupling
- Machine assembly & commissioning at LPSC underway
  - ✓ Half of the machine tested & validated (March 2009)



First beam at LPSC (220 keV, 500 Hz)

- Assembly & commissioning (LPSC) : until summer 2009
- Machine assembly & tests (SCK-CEN) : September-October 2009
- Load VENUS & start physics program : November-December 2009

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