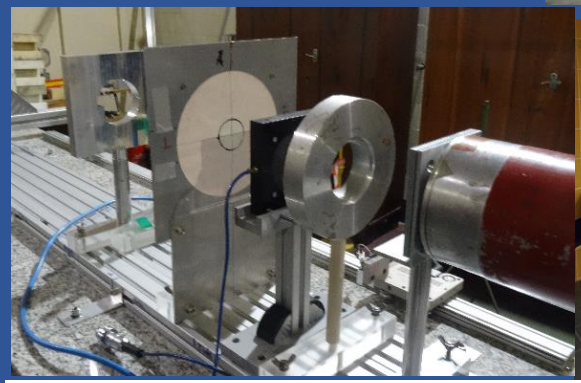
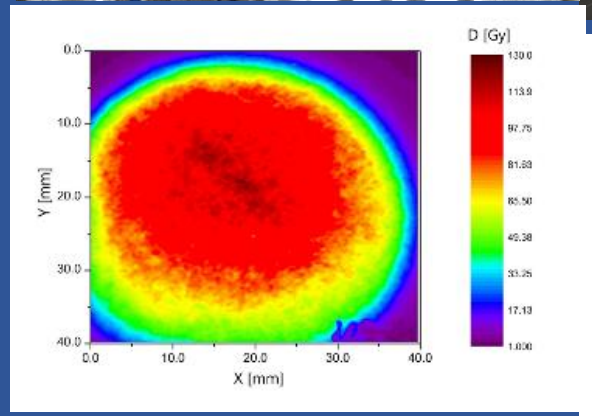
Implications on the necessary developments / upgrades of the different categories of TPs

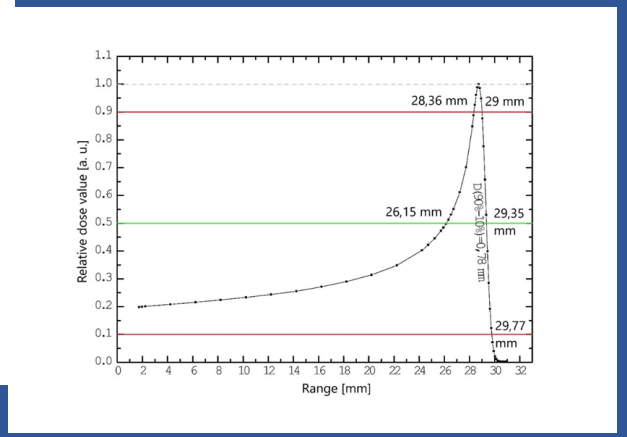
A. **Facilities for beam tests of accelerator components**

- **Requested information:**
  - *Trends;*
  - *AMICI Technology Infrastructures;*
  - *Description of the facilities;*
  - *Activies;*
  - *Necessities.*

- **Laboratoires:**
  1. *IFJ PAN*
  2. *STFC*
  3. *INFN-LNL*
  4. *INFN-LNF*







Dariusz Bocian (IFJ PAN),
Jan Swakoń (IFJ PAN), Dorota Zajdel (IFJ PAN),
Anthony Gleson (STFC), Luca Bellan (INFN-LNL),
Andrea Liedl (INFN-LNF)

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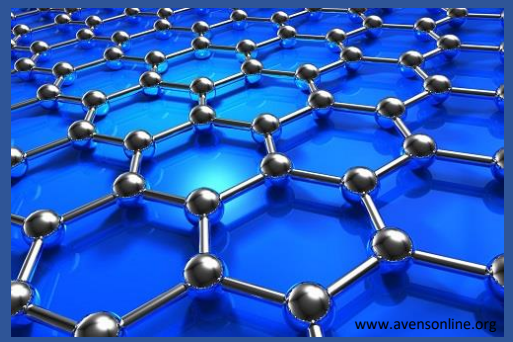
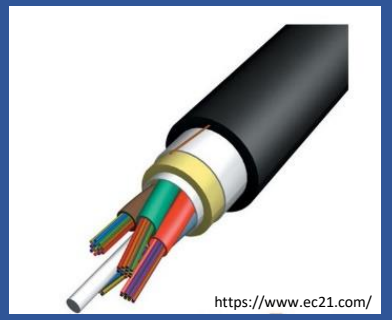
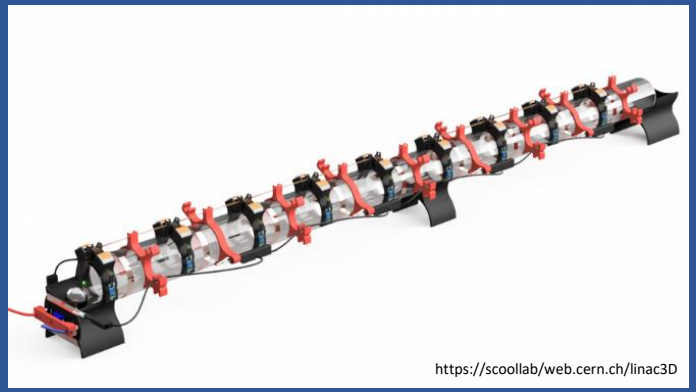
TRENDS :

- The influence of low-energy particles on the properties of polymers and adhesives;
- The influence of radiation on the properties of accelerator elements that were created using 3D printing;
- The influence of radiation on mechanical properties of nanostructured amorphous-ceramicand metal composites;
- Study of the influence of radiation on the resistance of cable dielectric materials/insulation materials;
- Study the effect of radiation on the properties of resins used in accelerator materials.







AMICI Technology Infrastructures

Facilities for beam tests of accelerator components

FREIA, Uppsala, SWEDEN

KIT, Karlsruhe, GERMANY

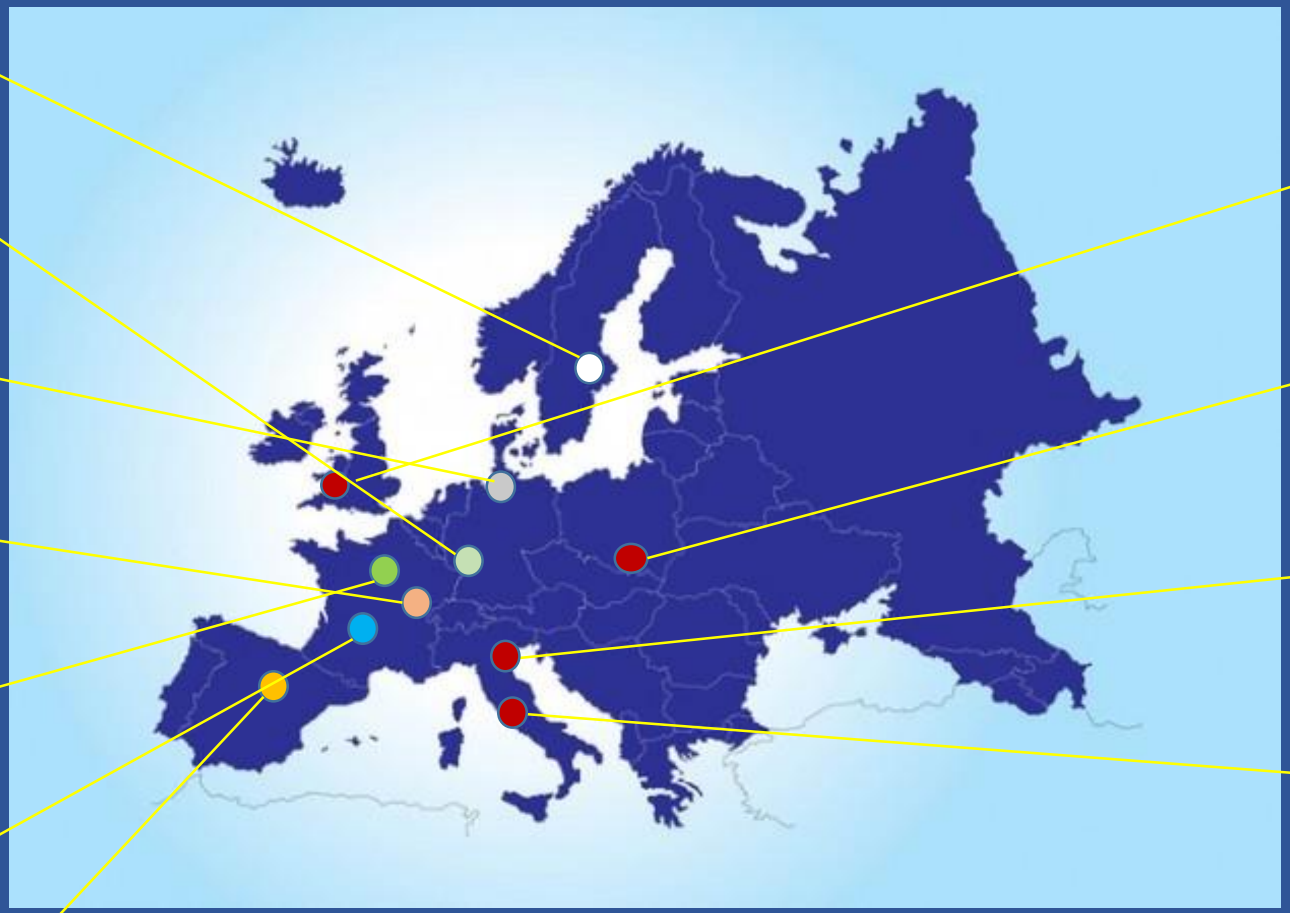
DESY, Hamburg, GERMANY

CERN, Meyrin, SWITZERLAND

CEA, Saclay, FRANCE

CNRS, Orsay, FRANCE

CIEMAT, Madrid, SPAIN



UKRI-STFC, Daresbury, UK
CLARA, Compact Linac

IFJ PAN, Krakow, POLAND
PROTEUS C-235, AIC-144

INFN-LNL Legnaro, ITALY
TANDEM-ALPI-PIAVE,
Van de Graaf: CN, AN2000

INFN-LNF Frascati, ITALY
DAΦNE
BTF, SPARC_LAB

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Mission of AMICI beam test facilities :

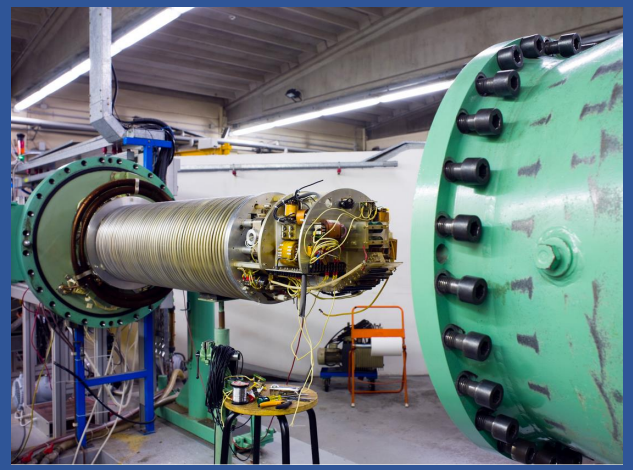
- provide the experimental testbeds for accelerator related development of accelerator technology
- support industry as well as train future scientists and engineers

The main use of these facilities:

- *irradiation of components with high* current particles, namely electronics and materials

FACILITIES (IFJ PAN, STFC, INFN-LNL, INFN-LNF):

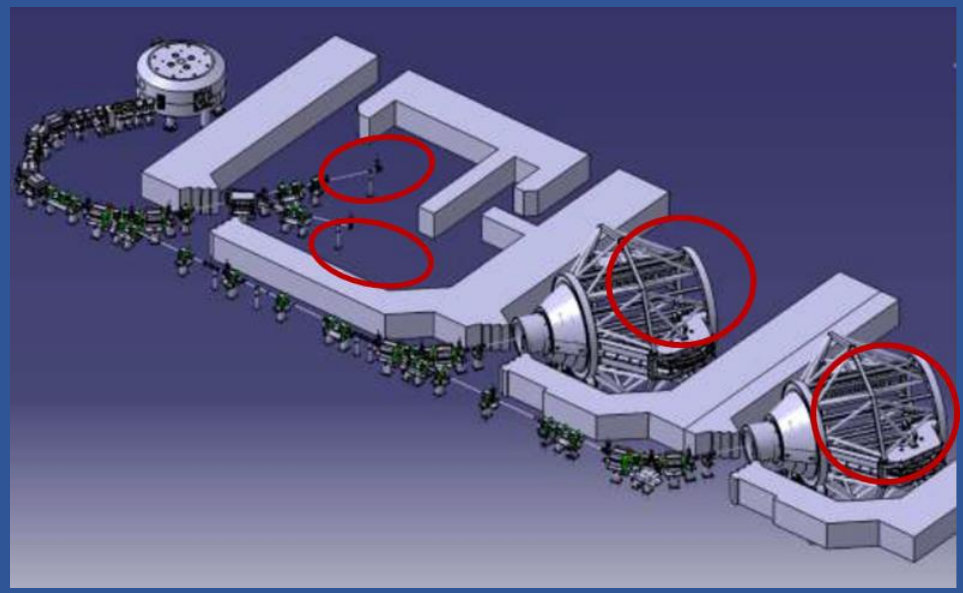
- Proteus C-235, isochronous cyclotron with a compact conventional magnet,
  proton beam with energy from 70 MeV to 230 MeV, beam current: 0.5 nA - 500 nA
- The AIC-144 isochronous cyclotron,
  proton beam with energy 10 MeV to 60 MeV, beam current: 0.5 nA – 80 nA (100 nA)
- CLARA (Compact linear accelerator for research), Compact Linac
  CLARA: electron beam generates up to 50 MeV, 250 pC electron bunches at 10 Hz.
  Compact Linac: electron beam up to 5MeV, peak beam current 240 mA.
- Accelerator complex TANDEM - ALPI – PIAVE,
  heavy ions for applied and nuclear physics, energy from 20 MeV/u to 5 MeV/u, beam current: 2 nA - 200 nA.
- DAΦNE: BTF, SPARC_LAB
  BTF: pulsed electron and positron bunches, 30-780 MeV, up to $3 \cdot 10^{10}$ particles/pulse, up to 49 pulses/second.
  SPARC_LAB: electron beam, 5-140 MeV, 10 pC – 1 nC charge



PROTEUS C-235, isochronous cyclotron with a compact conventional magnet

BEAM PARAMETERS:

- Energy 230 MeV;
- RF 106 MHz;
- Quasi continuous beam;
- Beam current max 500 nA (for 230 MeV)



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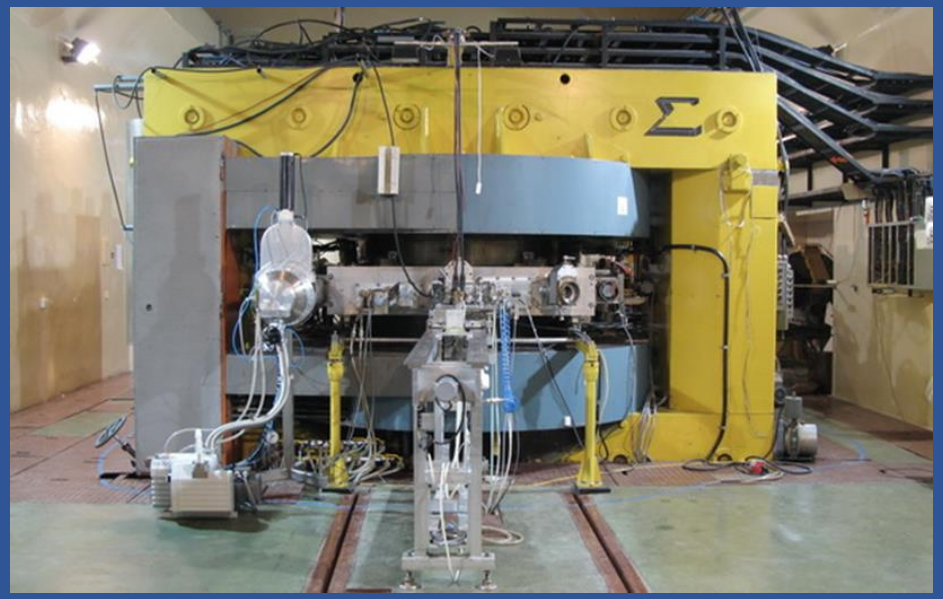
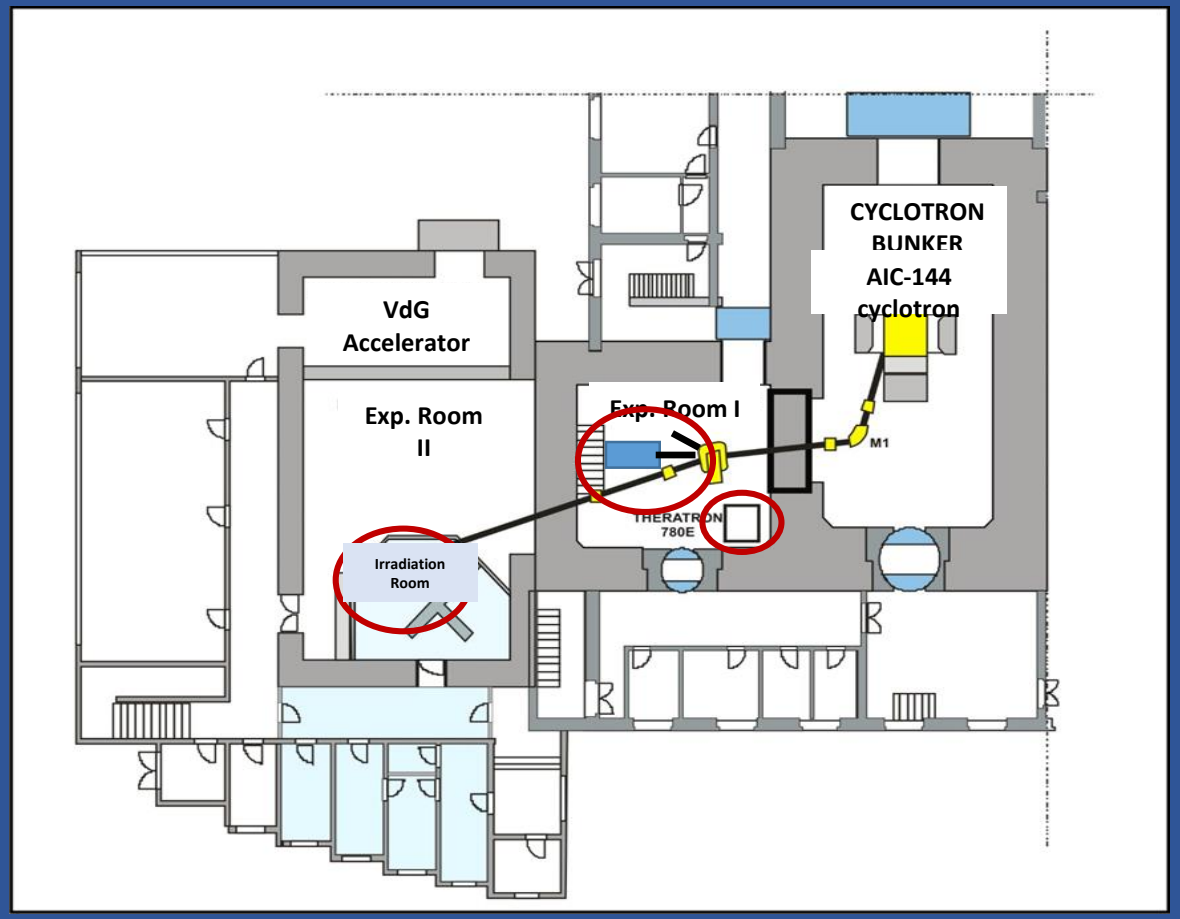
AIC-144 cyclotron facility

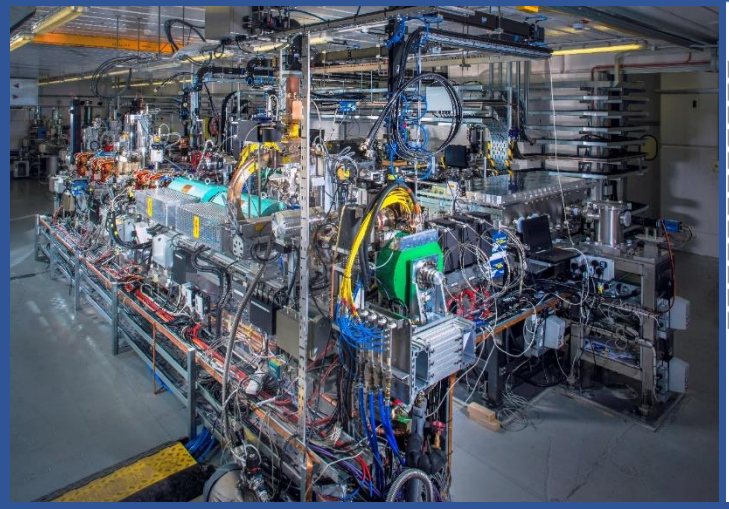


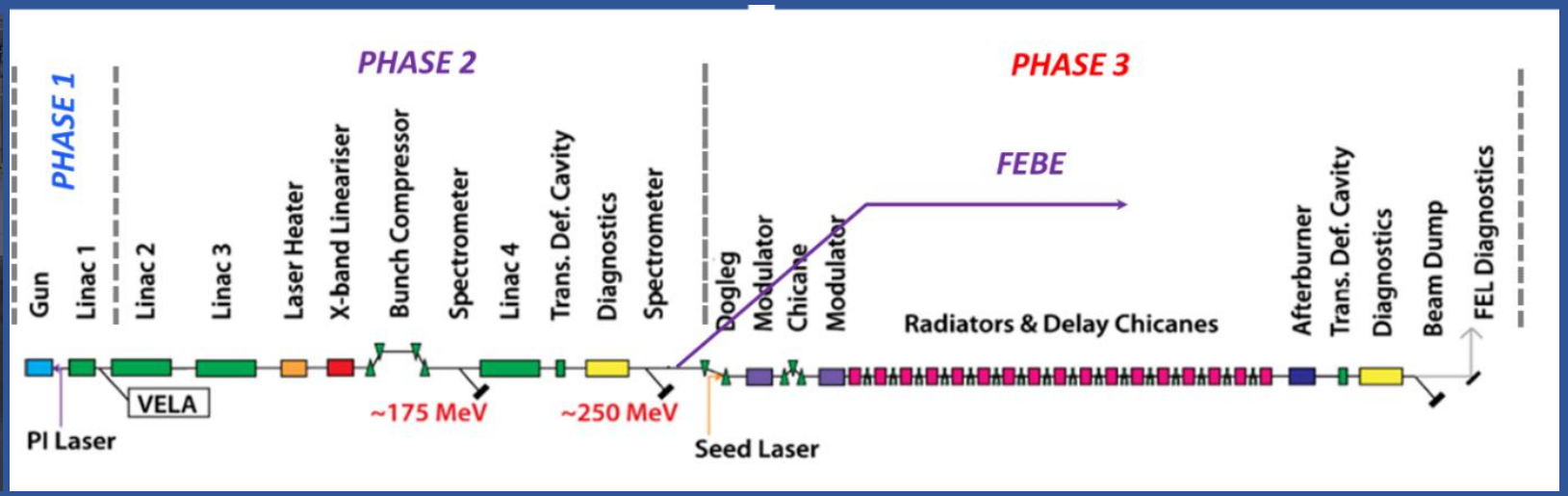


BEAM PARAMETERS:

- Energy 60 MeV;
- RF 26.26 MHz;
- Beam macro structure 50 Hz;
- macro pulse length 0.5 ms;
- beam current 80 nA *(100nA)*

CLARA, Compact linear accelerator for research and applications



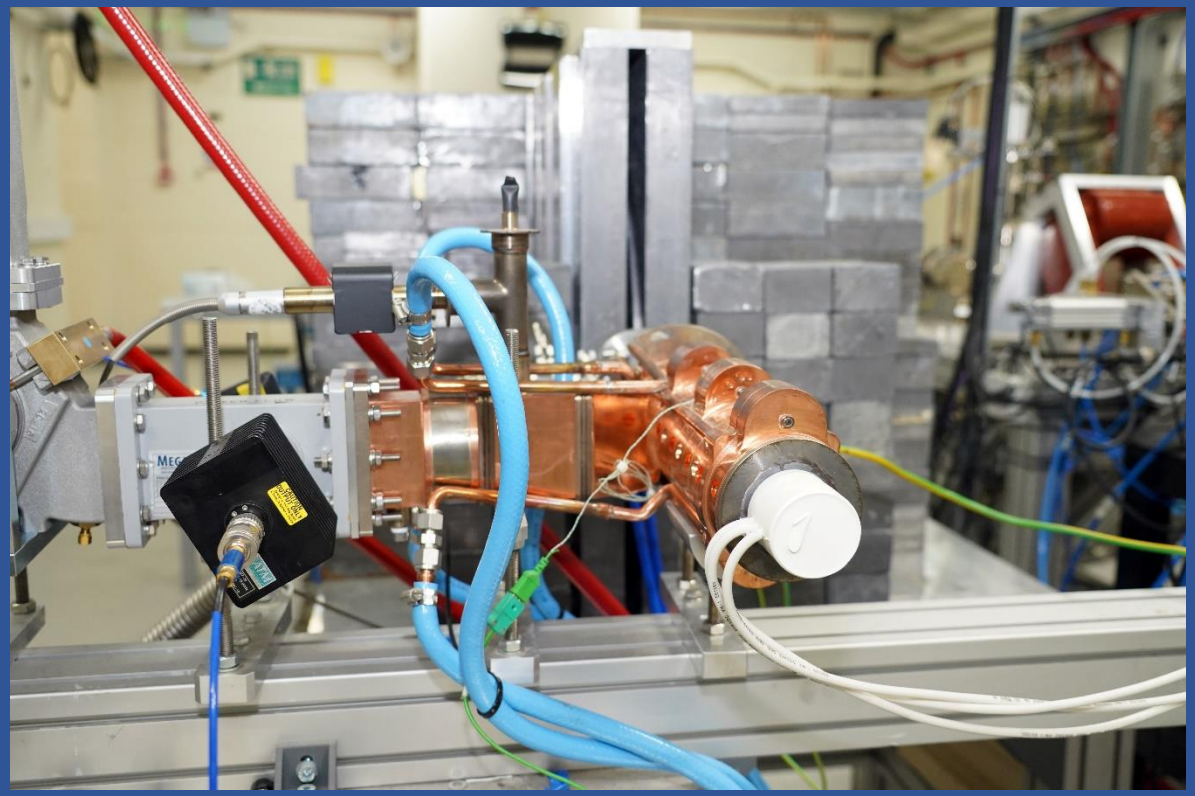


ELECTRON BEAM PARAMETERS:

- Energy: up to 50 MeV;
- Beam macro structure: 250 pC electron bunches at 10 Hz

Compact Linac

Low-energy linear accelerator



BEAM PARAMETERS:

- Energy: up to 5 MeV;
- Pulse widths down to 500ns;
- Repetition rate up to 400 Hz;
- Peak beam current 240mA
- Cooled target available to generate X-rays

TANDEM - ALPI – PIAVE

The accelerator complex composed by a superconductive independent cavity heavy ion linac and Tandem type accelerator.

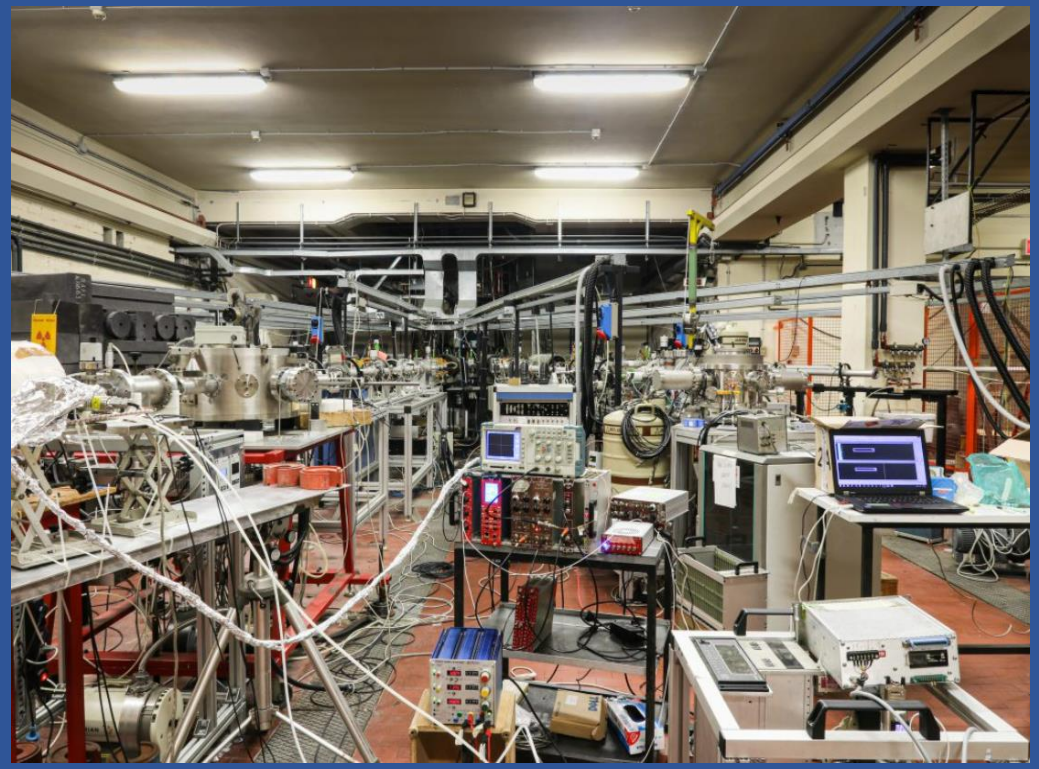
Heavy ions for applied and nuclear physics,

- from ^{12}C to ^{208}Pb

BEAM PARAMETERS:

- Energy: from 20 MeV/u to 5MeV/u ;
- Beam intensity 2 nA - 200 nA.

CN Van de Graaf light ions accelerator



Heavy ions for applied and nuclear physics,

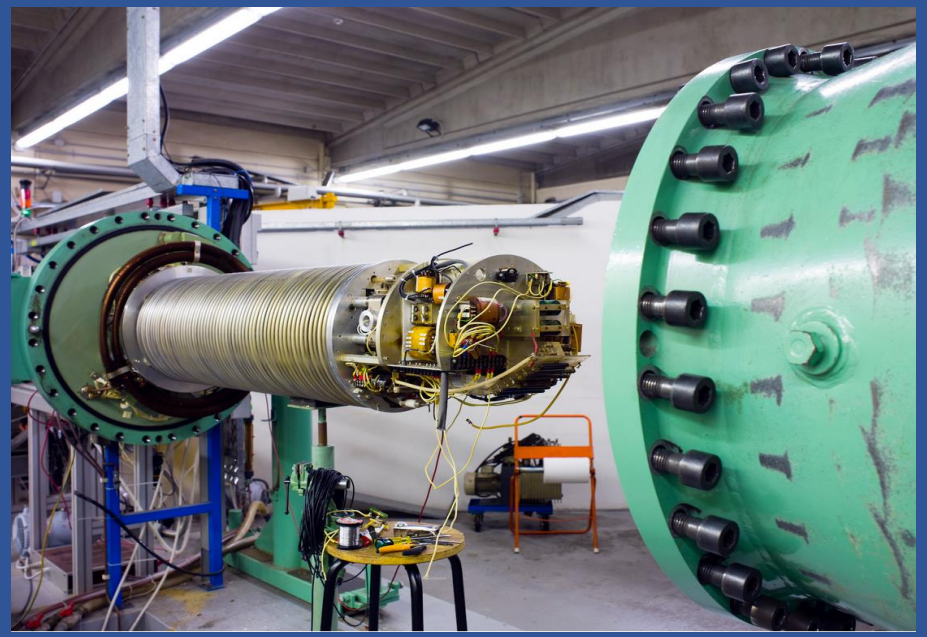
- Ion species: H^+, $^2H^+$, $^3H^+$, $^4H^+$, $^4H^{2+}$

BEAM PARAMETERS:

- Duty Cycle: CW, pulsed;
- Terminal tension: from 0.8 MV to 5.5 MV;
- Currents (electrical): protons up to 4 uA, the other species between 1 uA to 10 nA;

Available line equipped with a thermal neutron moderator generates, neutron flux of 5×10^5 n/(s·cm^2);

AN2000 Van de Graaf light ions accelerator



Micro beam with light ions: H^+, $^3H^+$, $^4H^+$;

BEAM PARAMETERS:

- Ion species: H^+, $^3H^+$, $^4H^+$;
- Duty Cycle: CW;
- Terminal tension: from 0.2 MV to 2.0 MV;
- Currents (electrical): protons and $^4H^+$ up to 1 uA;

DAΦNE: BTF, SPARC_LAB

The Beam-Test Facility (BTF):
Pulsed electron and positron bunches;

BEAM PARAMETERS:
- Energy: 30-780 MeV
- up to $3 \cdot 10^{10}$ particles/pulse
- up to 49 pulses/second.

SPARC_LAB:
Electron beam;

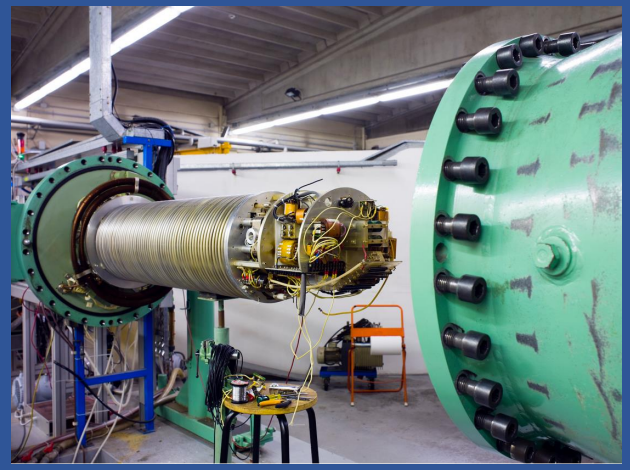
BEAM PARAMETERS:
- Energy: 5-140 MeV,
- 10 pC – 1 nC chargé
- 20 fs ps (rms)

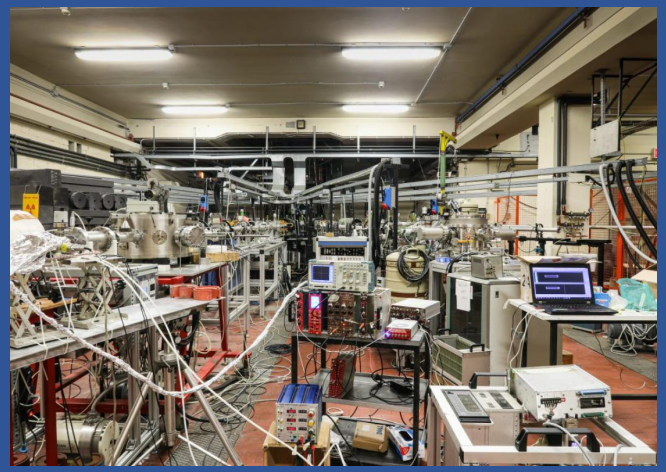
ACTIVITIES (IFJ PAN, STFC, INFN-LNL, INFN-LNF):

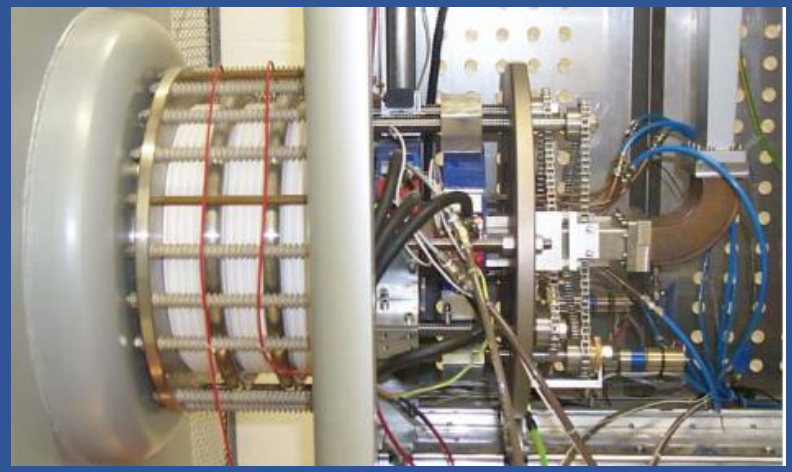
- **Proteus C-235 / AIC-144**
  - → research in the field of applications in dosimetry and developing new methods in proton radiotherapy;
  - → tests of the radiation hardness of electronics and construction of material components for the space sector and for designing and constructing the new research facilities;
  - → activation analyses of charged particles and isotope production for radiochemical research;
- **CLARA and Compact Linac**
  - → develop new accelerator based technologies, treatments, and frontier research;
  - → pave the way to develop next generation FEL light sources to advance the frontiers of knowledge;
  - → studies of Plasma afterglow diagnostics, THz driven acceleration and the testing of hybrid pixel detectors;
- **TANDEM - ALPI – PIAVE**
  - → nuclear physics experiments;
  - → material testing via heavy ion irradiation (such as Xe ions at 1 GeV for aerospace material tests);
  - → neutron irradiation experiments (Van Der Graaf the accelerator CN - high dose bunker);
- **AN2000 and CN Van de Graaf accelerators**
  - → line is equipped with a thermal neutron moderator;
  - → line for generate several neutron spectra using Be/Li targets;
  - → line equiped with heavy irradiation bunker for high dose irradiations;
  - → light ion microbeam available;
- **DAΦNE: BTF, SPARC_LAB**
  - → nuclear physics experiments
  - → testing of particle detectors and tests for advanced diagnostics

NECESSITIES (IFJ PAN, STFC, INFN-LNL, INFN-LNF):

- Proteus C-235 / AIC-144
  - → upgrade and development of beam guide lines and proton beam control systems;
  - → modernization of the scattering and beamforming system to provide a larger diameter and homogeneous radiation field on the high-intensity irradiation line;
  - → development of automatic sample moving and positioning system.
- Compact linear accelerator for research CLARA,
  - → elevates the beam to 250 MeV, 250 pC at 100 Hz;
  - → development of the Full Energy Beam Exploitation (FEBE) area to provide a dedicated user experimental area where the 250 MeV electron beam can be combined with a high-power laser beam (up to 100 TW).
- Accelerator complex TANDEM - ALPI – PIAVE,
  - → eight new target stations avaliable for user;
  - → TRIPS – the low energy high intensity proton source for production high intensity CW protons beam
- DAΦNE: BTF, SPARC_LAB
  - → new line in the BTF







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