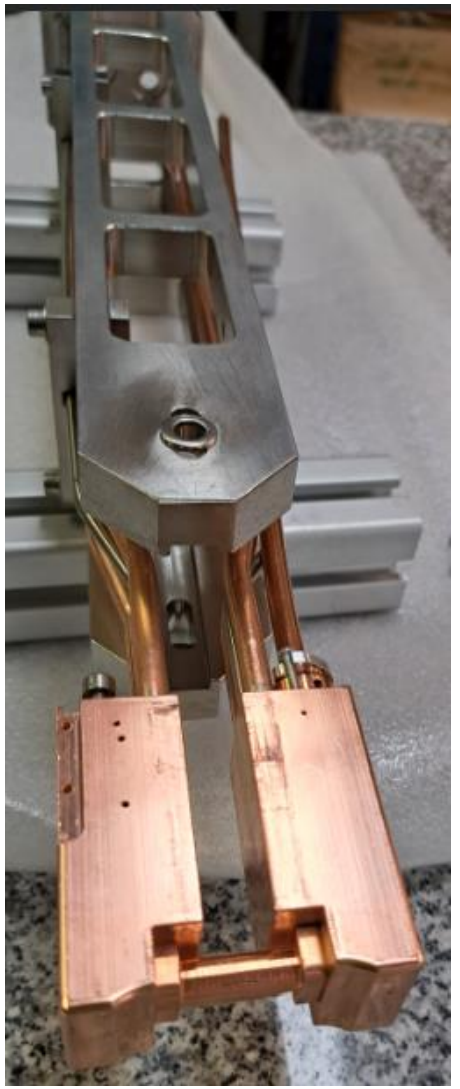
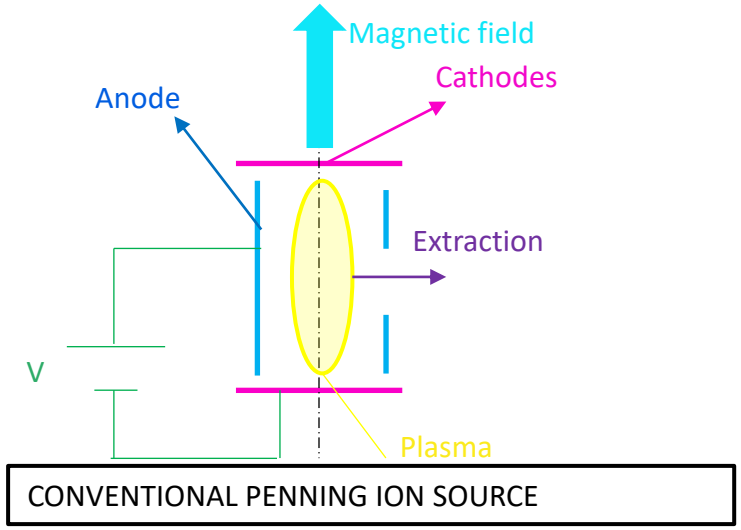
19-04-2023 / I.FAST 2nd Annual Meeting

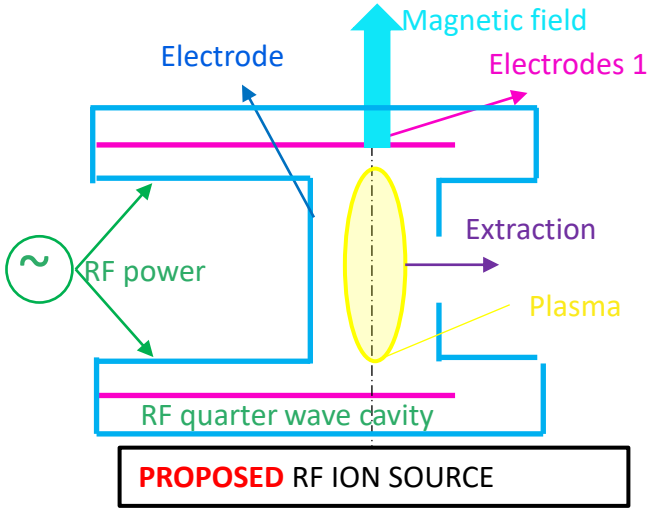
Daniel Gavela (Ciemat) on behalf of RF ion source developing team:

- Tomas Eriksson (GE)
- Pedro Calvo, Antonio Estévez, Luis García-Tabarés, Daniel Gavela, Miguel León, Diego Obradors, Concepción Oliver, J.M. Pérez, Fernando Toral (Ciemat)



IFAST Task 12.3. Internal Ion Source for Cyclotrons. Concept





A new concept of internal ion source based on RF for cyclotrons: Change DC voltage of conventional Penning ion source to a RF voltage

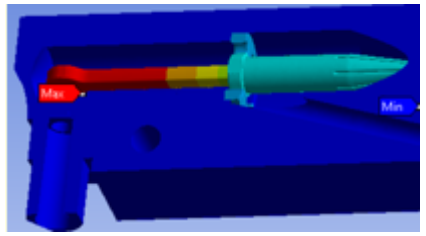
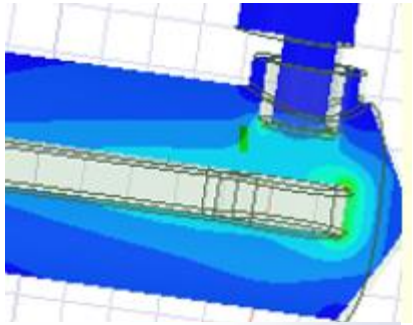
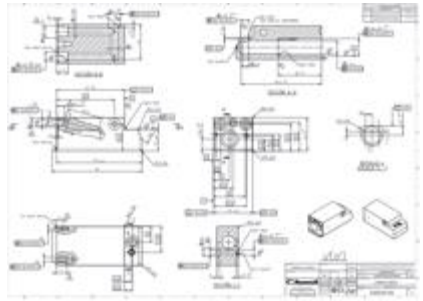
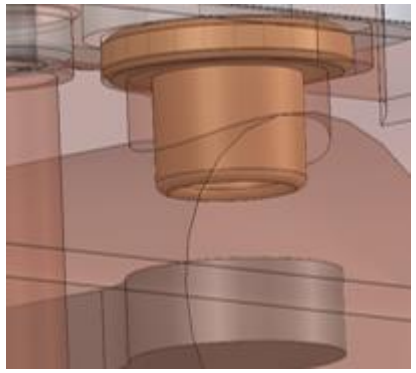
Expected advantages of RF ion source versus Penning:

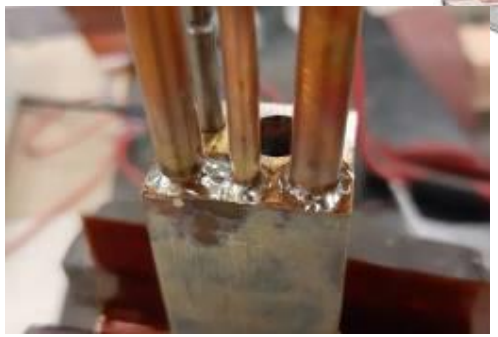
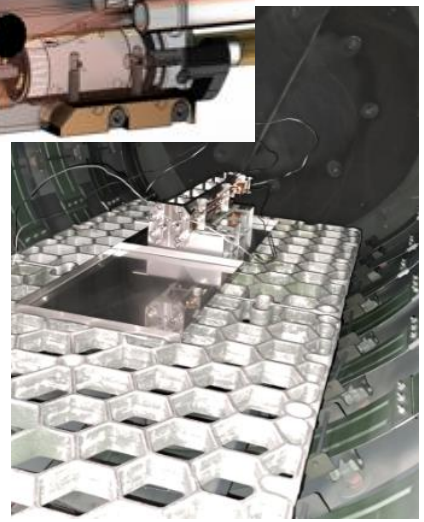
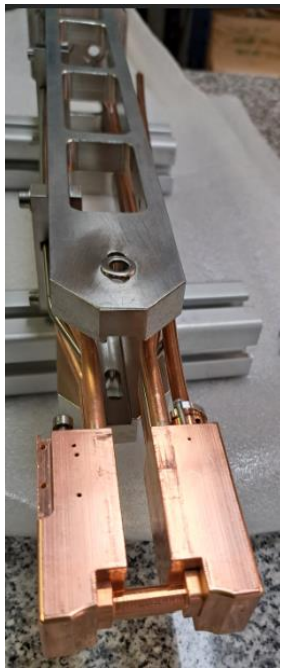
- **Lower cathode wear** (sputtering). Less maintenance time, irradiation and cost. **Cathode** is **heated by RF currents**, no need for ions impact.
- Lower electron energies (~ 10 eV) -> **better efficiency** of producing H^-, leading to reduction of H_2 flow needed and **better vacuum** in the cyclotron.
- **No high voltage**

IFAST Task 12.3. Internal Ion Source for Cyclotrons. Concept

- Innovative concept
- Potential commercial application, mostly oriented to medical cyclotrons
- Simple concept, with relatively easy implementation on existing commercial products
- Partnership industry (General Electric, Cyclomed) – labs (Ciemat)
- I.FAST Task 12.3 objective:
  - Design & manufacture a first demonstrator prototype
  - Perform its experimental characterization (plasma production and beam extracted)

IFAST Task 12.3. Internal Ion Source for Cyclotrons. Progress

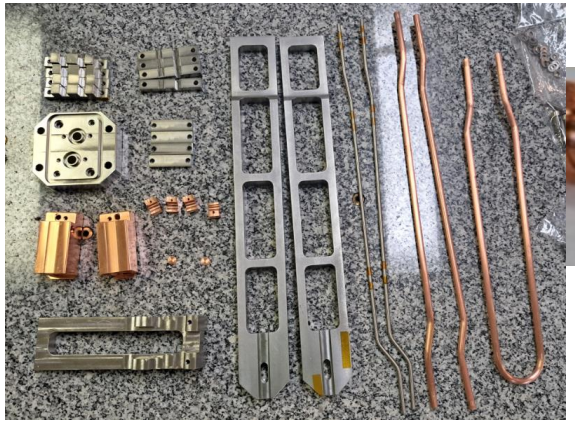





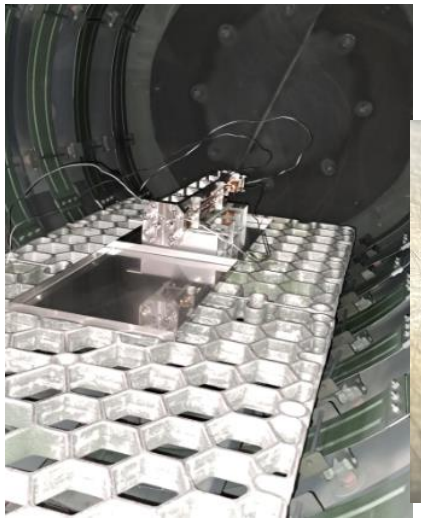




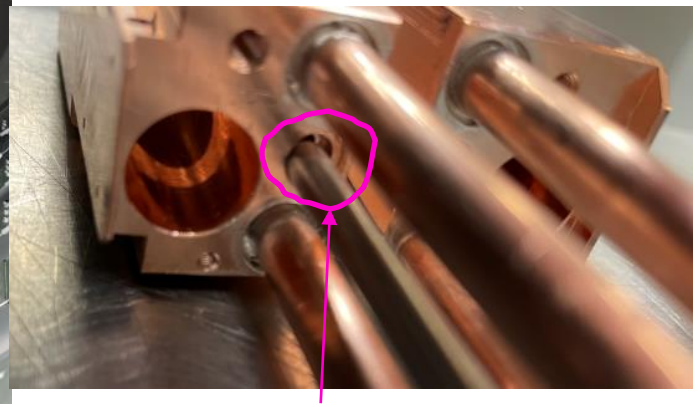
Task progress from may'2021 to apr'2023

- Definition of specifications for the ion source prototype
- Calculations and simulations to arrive at a conceptual design
- Development of a detailed mechanical design
- Welding tests
- Fabrication of all ion source components and toolings
- Bending of the cooling and hydrogen tubes for the ion source
- Brazing of the ion source
- Low power RF tests

IFAST Task 12.3. Internal Ion Source for Cyclotrons. Fabrication





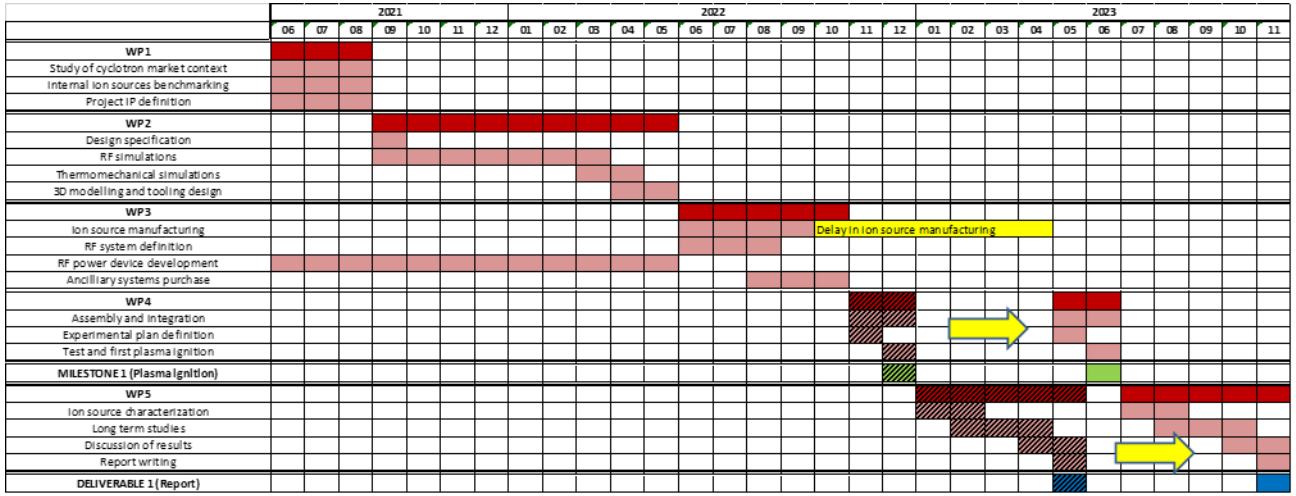


Tube fell down in brazing

FABRICATION FINISHED

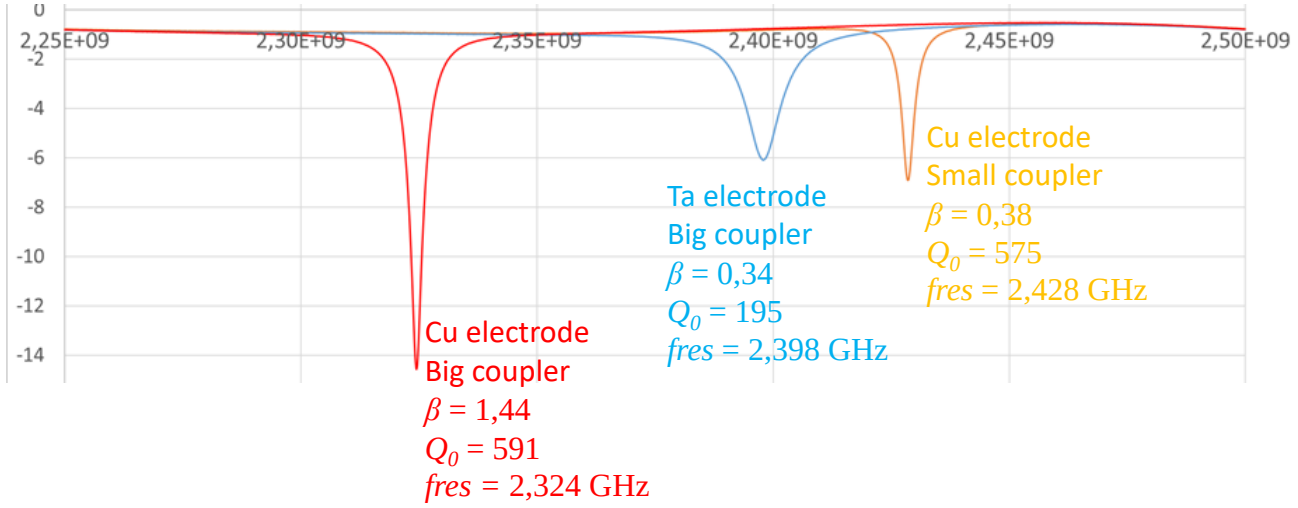
About 6 months later than expected. We asked for an extension of the milestone and deliverable. Reasons for the delay:

- Long deliverable terms of materials and manufacturing companies
- Change in brazing procedure: from manual brazing with torch to vacuum brazing -> redesign of toolings
- One tube not brazed –> change shape of tube and repeat brazing



IFAST Task 12.3. Internal Ion Source for Cyclotrons. Low power RF tests

- One port measurement, fixed frequency (no tuning)
- Quality factors close to expected (not negligible losses are at the RF connections, outside the cavity). Good enough to achieve reasonable overall loss.
- Good couplig (close to critical) difficult to achieve, but good enough



IFAST Task 12.3. Internal Ion Source for Cyclotrons. Experimental phase

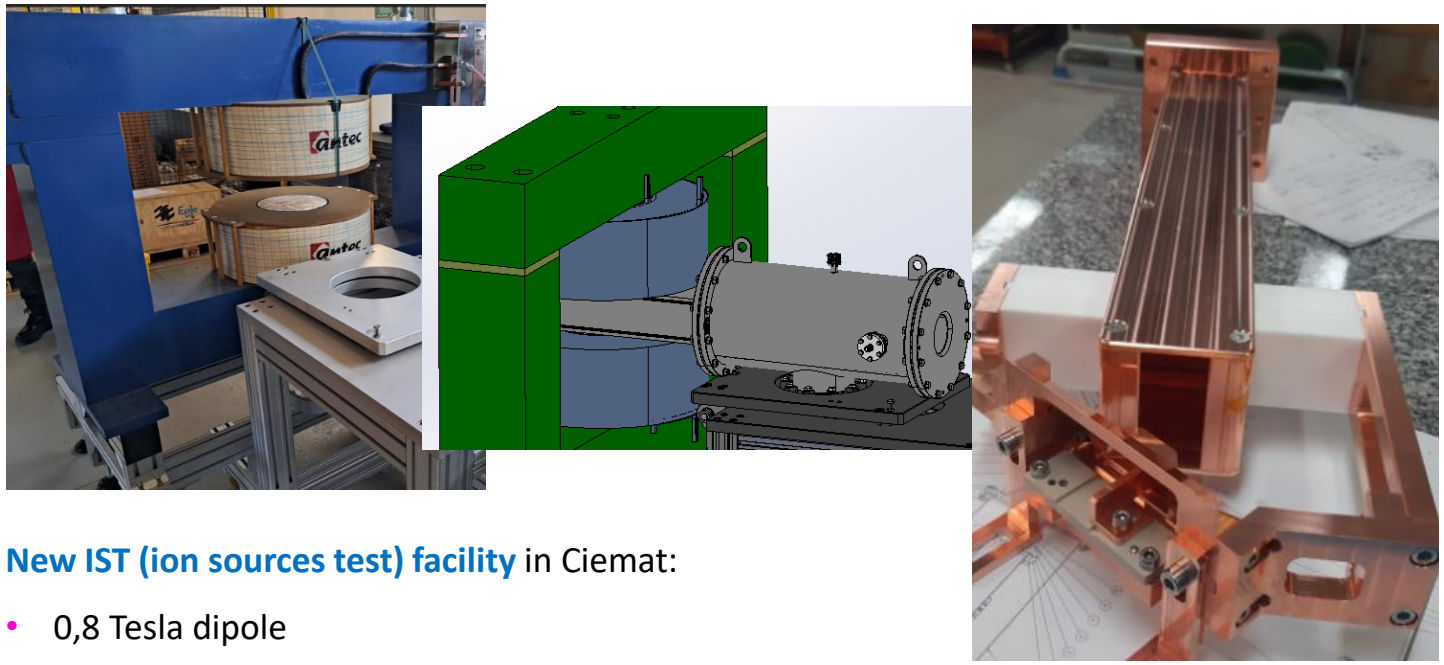
To be performed in second half of 2023

1st phase: plasma ignition and characterization using light spectroscopy

- Using an instrumented chimney

2nd phase: measuring and characterization of the beam extracted

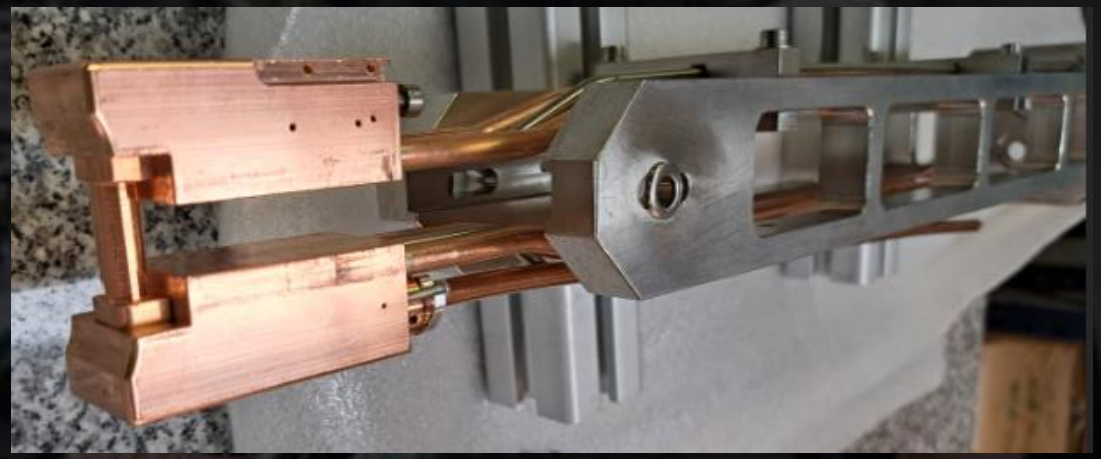
- Using the normal (with extracting slit) chimney



New IST (ion sources test) facility in Ciemat:

- 0,8 Tesla dipole
- RF vacuum cavity for extraction (60 MHz, 10 kV)
- LLRF system for ion source and extraction
- Auxiliary systems (cooling, hydrogen, …)
- Diagnostics systems:
  - Visible range spectrometer and fiber optic line for plasma study
  - Beam prove with micro-amperimeter for beam current measurement

iFAST



Thanks

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.