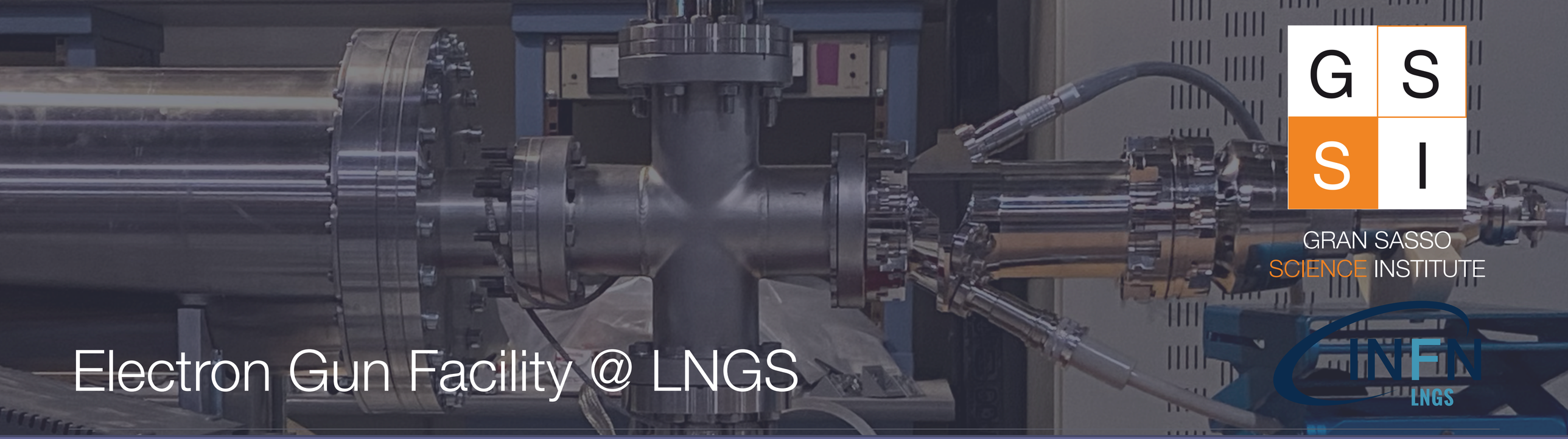


Electron Gun Facility @ LNGS

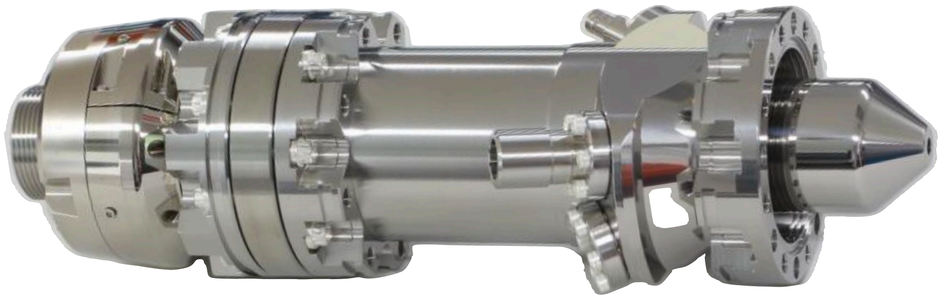
Presentation for PTOLEMY International Meeting - Genova, 20-22 November 2024

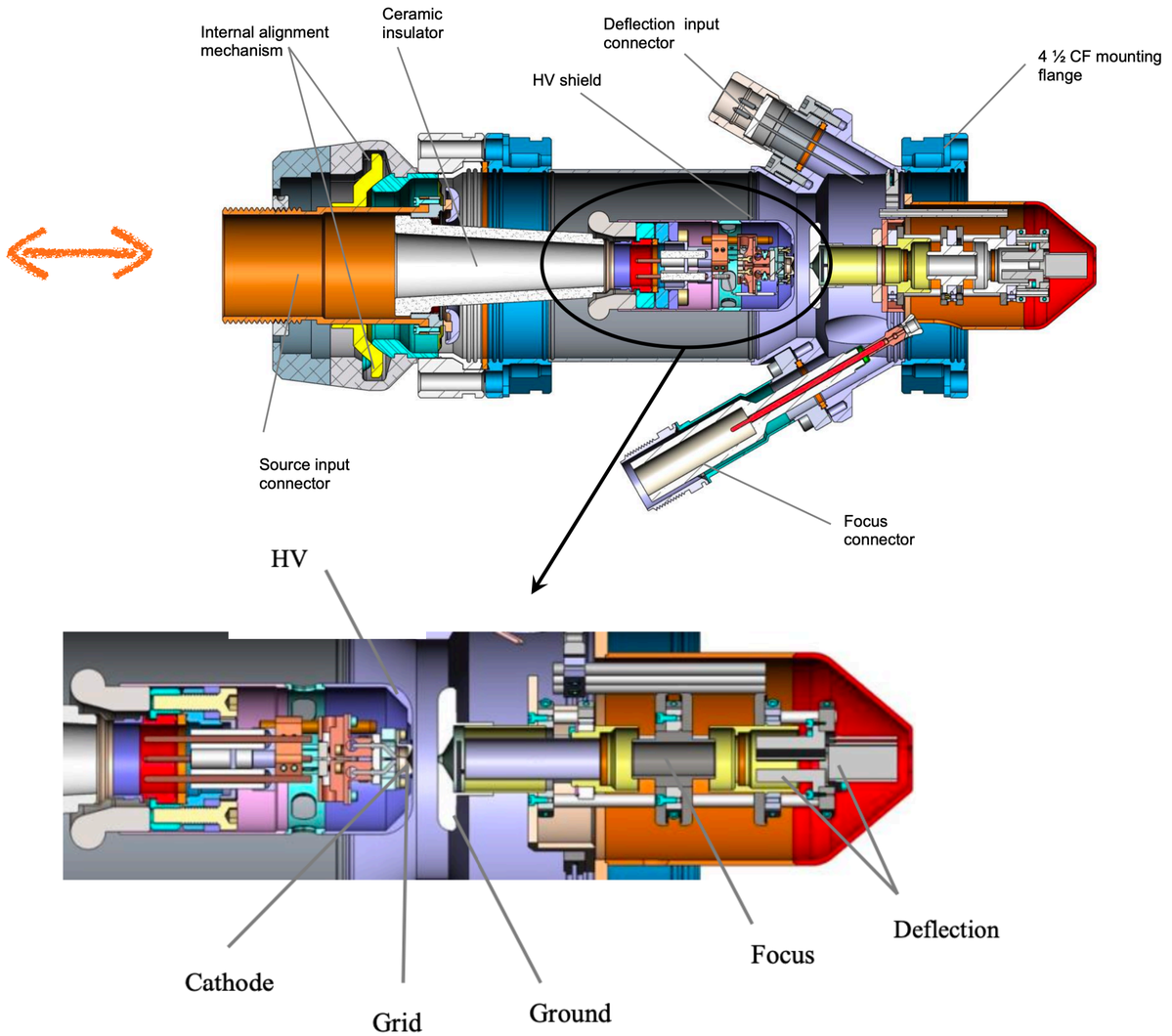
Francesca Maria Pofi - GSSI, INFN LNGS

What's Inside?

KIMBALL PHYSICS
Excellence in Electron and Ion Optics

EMG-4212 / EGPS-3212
ELECTRON SOURCE / POWER SUPPLY

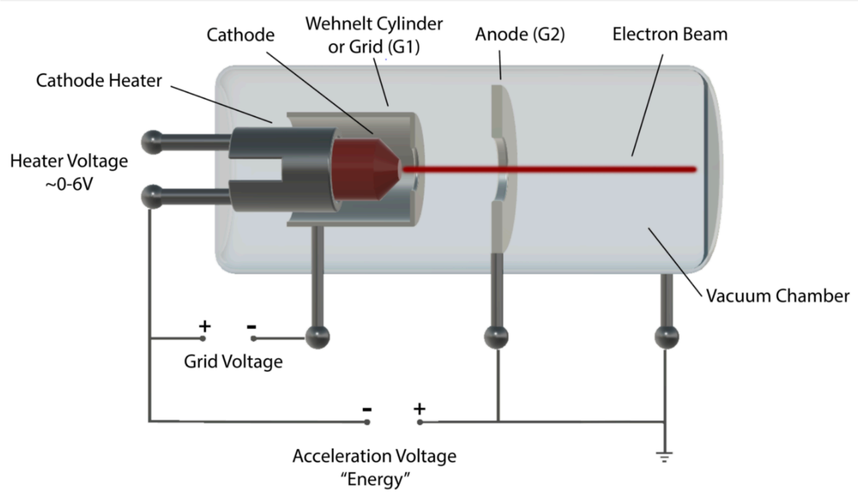


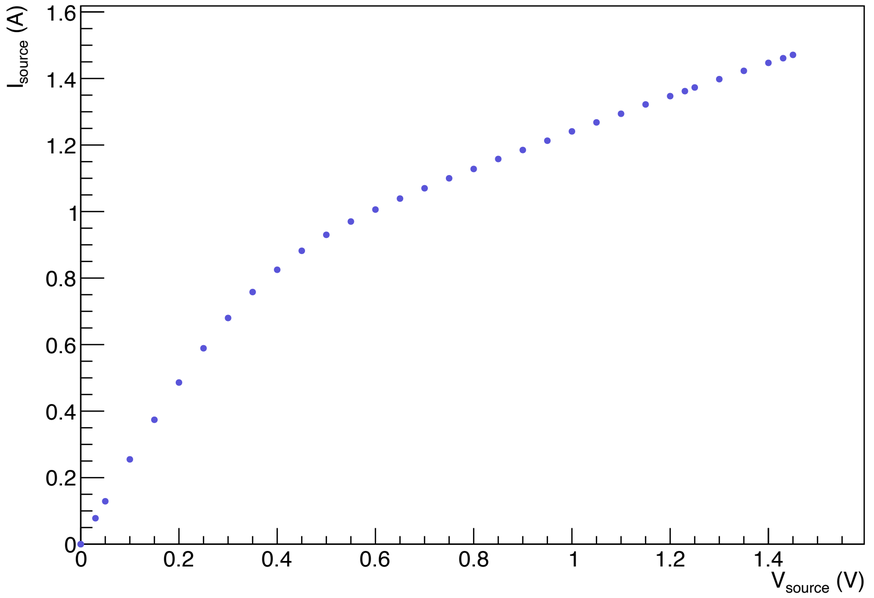


- Grounded Anode
- HV to accelerate electrons (up to -20 kV)
- Wehnelt (grid, up to -500 V)
- Focus system (Einzel lens, up to -20 kV)
- X/Y deflection plates (up to ± 300 V)

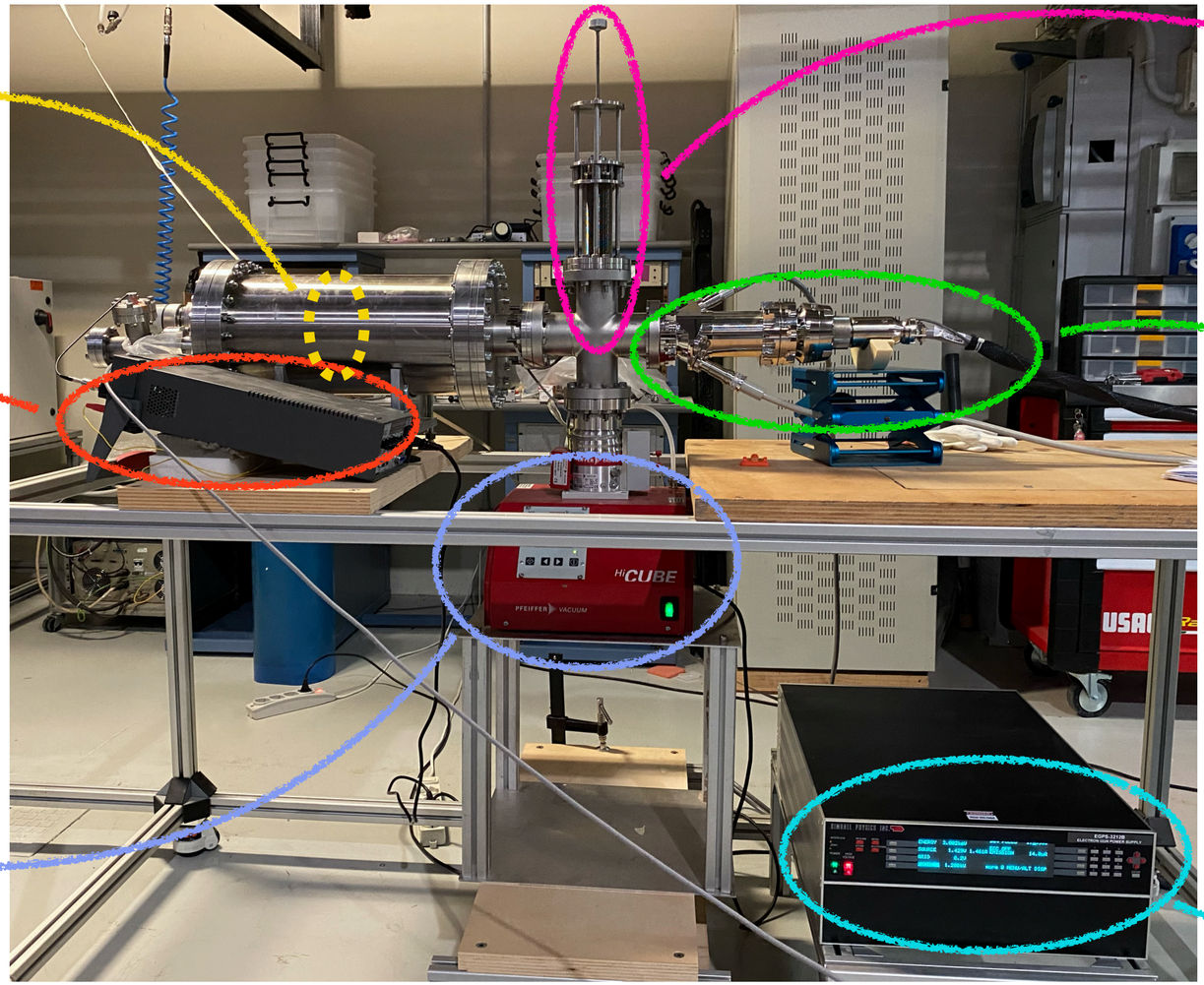
The Source: Details and a First Characterization

- Refractory metal thermionic emitter
  - Tantalum disc, diameter 25 mm
  - Mounted on a hairpin filament wire
  - Circular, planar emission surface
  - Emitting electrons when filament wire heated by voltage source, energy spread 0.5 eV
- Both voltage applied & current in filament displayed on power supply monitor
  - I-V curve to characterize source





How the Full Setup Looks Like



MICRO CHANNEL PLATE

(INSIDE)

FEEDTROUGH

+ (INSIDE)

PHOSPHOROUS SCREEN & FARADAY CUP

PICOAMMETER

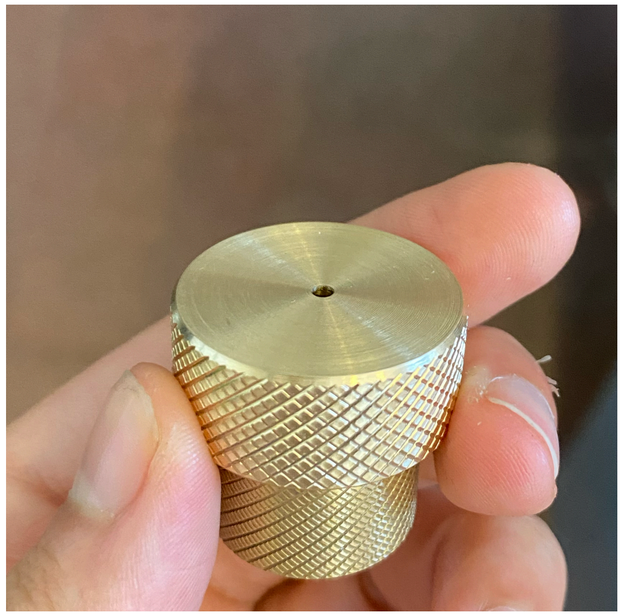
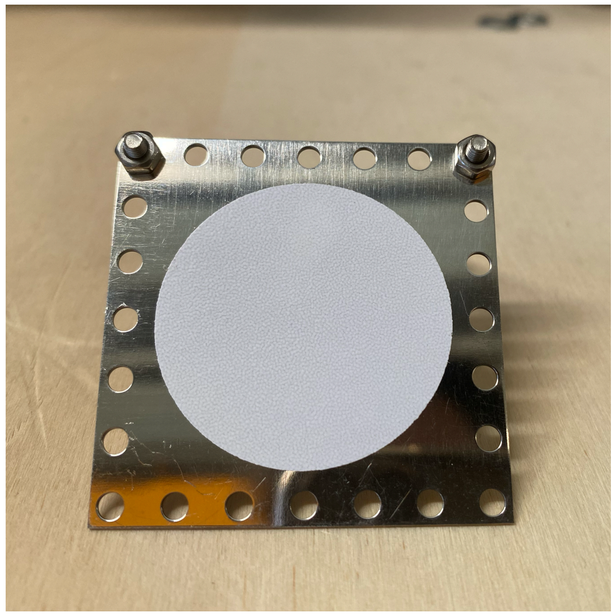
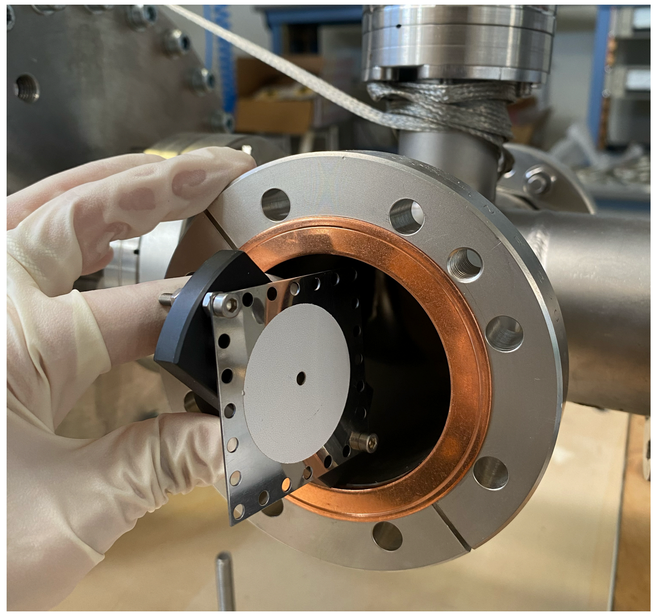
ELECTRON GUN

VACUUM PUMP

POWER SUPPLY

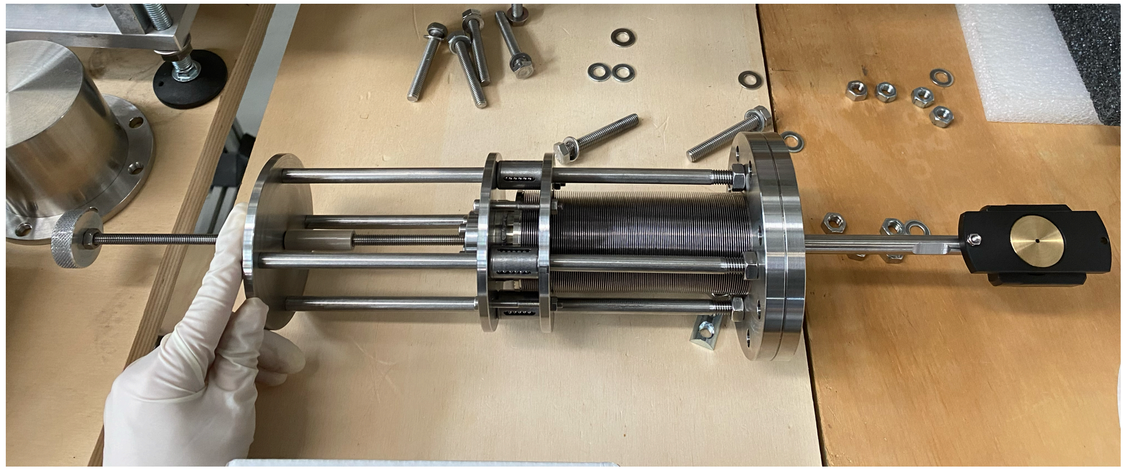
Output Monitoring: Ingredients

- Brass Faraday cup, 1 mm hole diameter
- Phosphorous screen:
  High luminosity blue phosphor (P-22) disk of 4 cm diameter & 75 µm thickness on stainless steel
- Mounted on a 3D printed insulating support with holes matching

A Versatile Setup

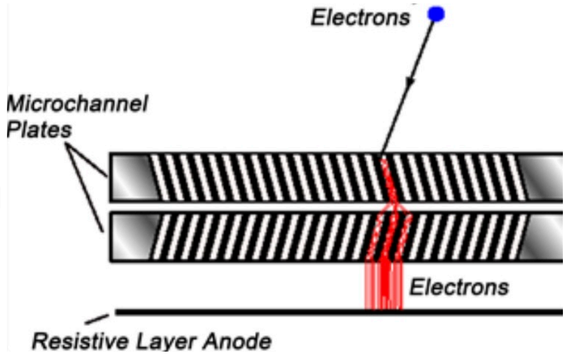
- Phosphorous Screen + Faraday cup mounted on a feedthrough
  - ✓ Custom-made, in collaboration with LNGS Mechanics Workshop
  - ✓ Allows shifts on y-axis with sub-mm precision
  - ✓ Allows to completely remove beam monitoring unit from beam path

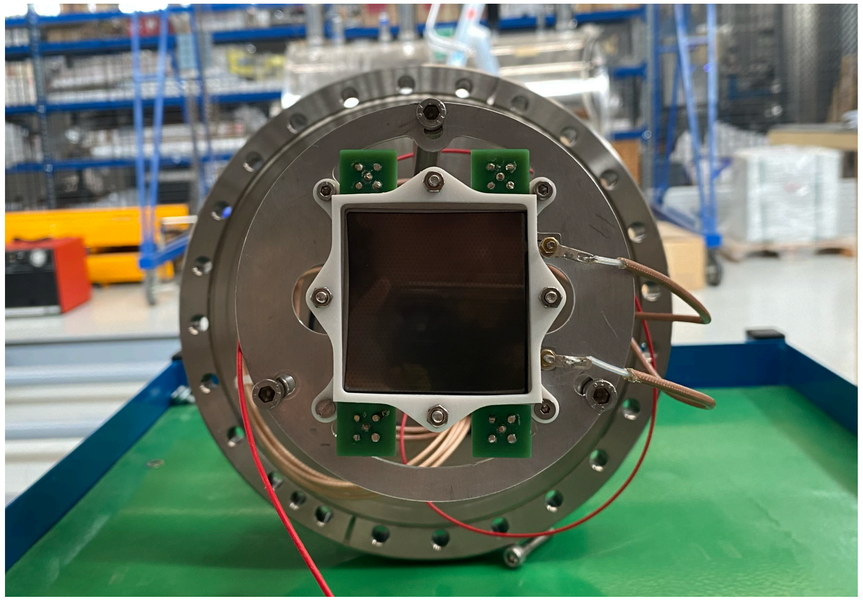


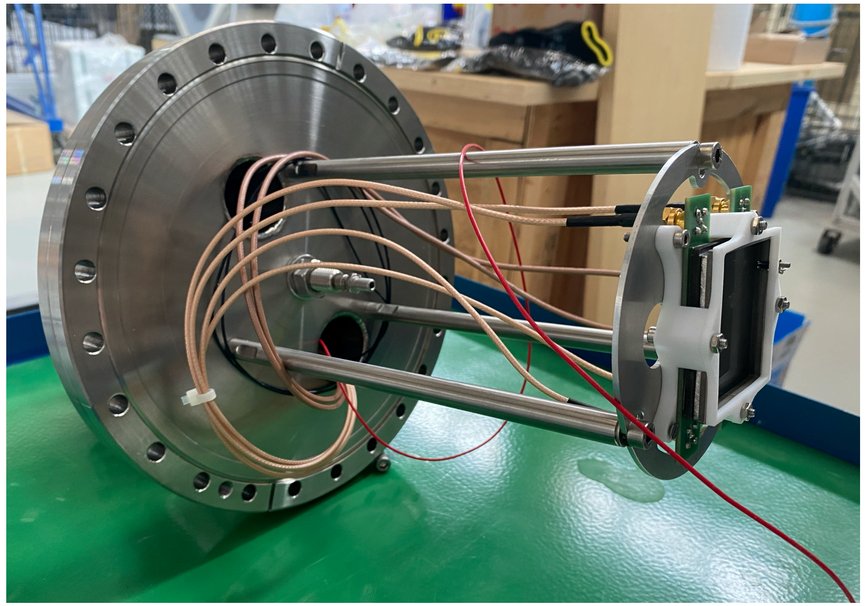
Electron Detection with Micro Channel Plate

- 4x4 cm Micro Channel Plate (MCP) - 4 2x2 cm pads
- Mounted perpendicular to beam @ ~ 20 cm distance from electron emission
  - earth's magnetic field deflection
  - electrons absorption

to take into account

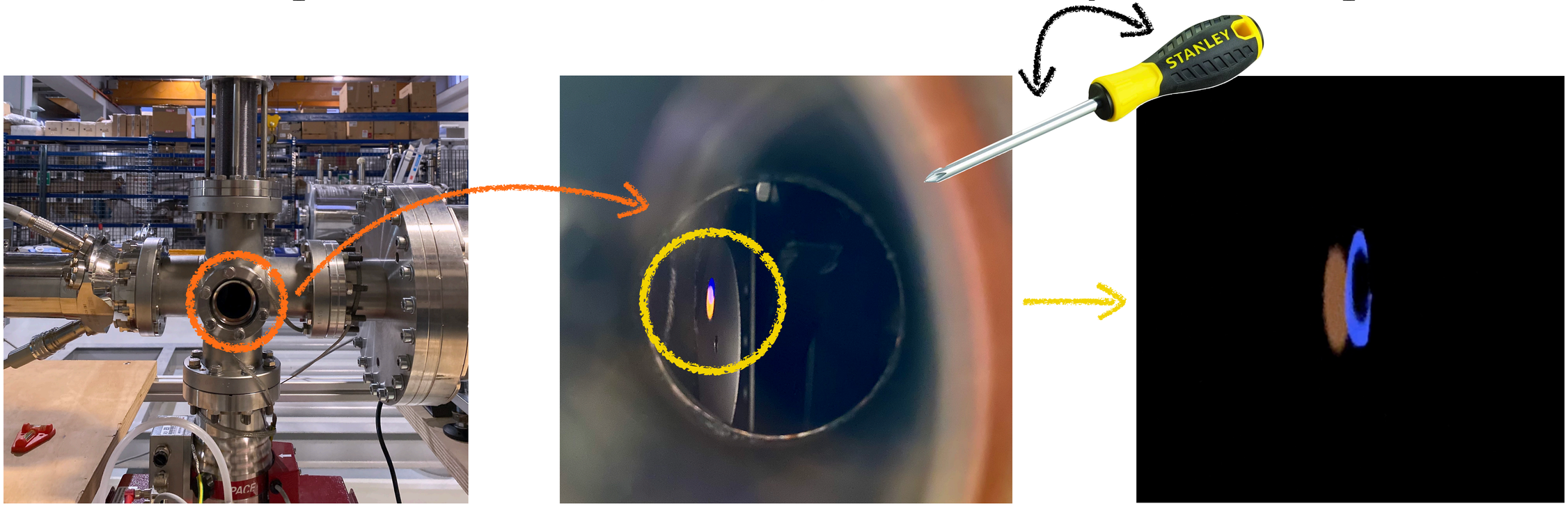






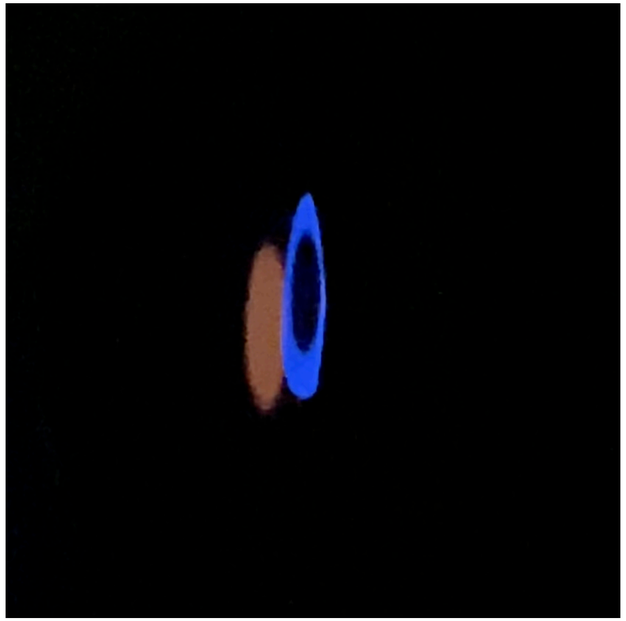
Playing with Electrons

- First beam ignition in new setup on November 13, pressure of $4.96 \cdot 10^{-7}$ mbar
- Monitoring unit @ ∼10° wrt beam perpendicular plane to look screen lighting through glass opening
  - Both cathode glow disk & electron beam visible, 2nd deflected by crewdriver magnetic field



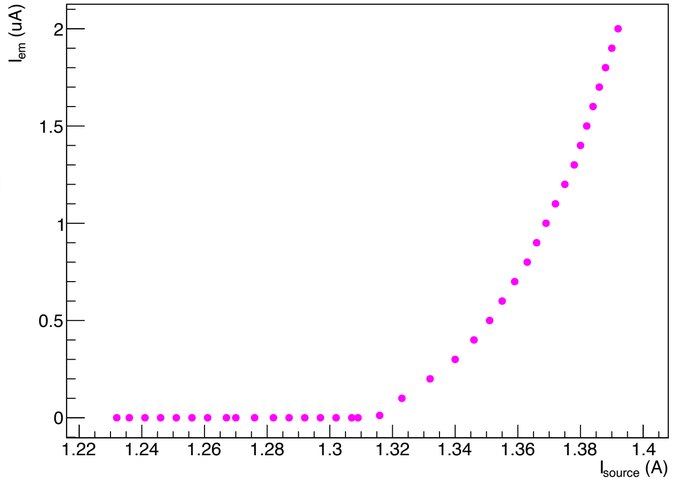
Trying to Catch the Faraday Cup

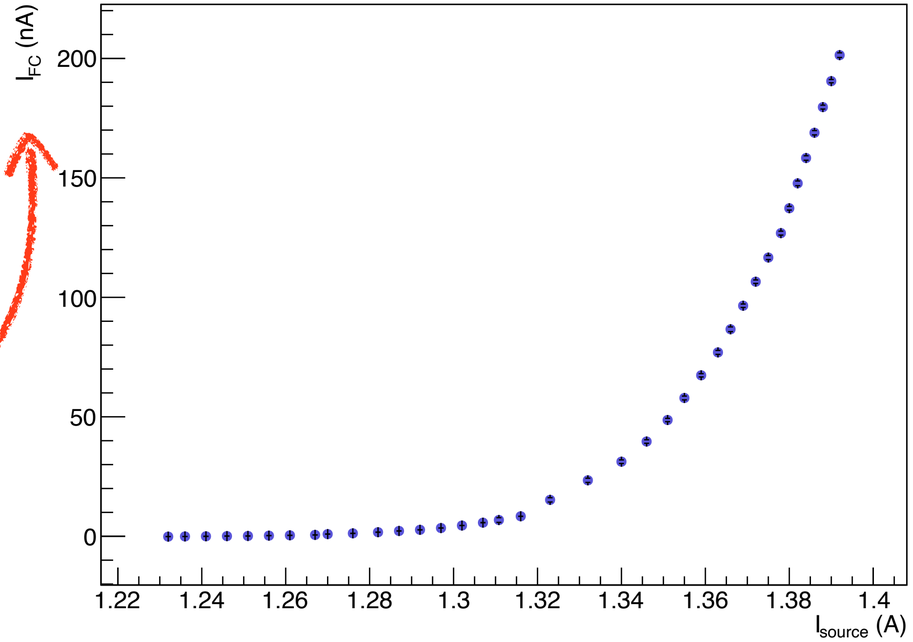
- Focus & X/Y Deflection voltages by electron gun power supply
  1. Optimized to center the hole in phosphor screen (2 mm diameter)
  2. Optimized to maximize current red by faraday cup



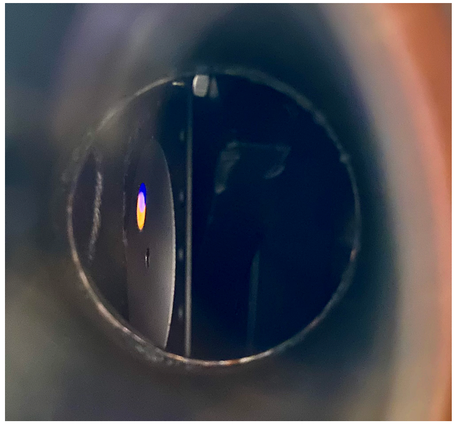
Preliminary Beam Characterization

- ∼ 1 day of electron emission needed for current stabilization
- Faraday cup current using Keithley 2450 SourceMeter (0.01% accuracy)
  - For 1 keV elecrons: mission start ∼ 1.23 A of source current
  - Just 1/10 of emitted current from source (mechanical misalignment, not perfect hole centering, losses)
  - Same behaviour
  - Measured down to 65 pA with percent precision





Grid as a Beam Intensity Filter



- First beam ignition of LNGS electron gun → it works!
- Setup almost ready to characterize beam, few optimization needed
  - Faraday cup orthogonal to beam, positive voltage applied
- Next steps
  - Build a Helmholtz coils cage to compensate earth magnetic field
  - Try to use grid as a Beam Intensity Filter → need to reduce amount of electrons for future usage as electron trap calibration source
  - Detect electrons with MCP (as double check)