ECR Supernanogan Ion Source Commissioning Preparation for the Sarajevo Ion Accelerator (SARAI)

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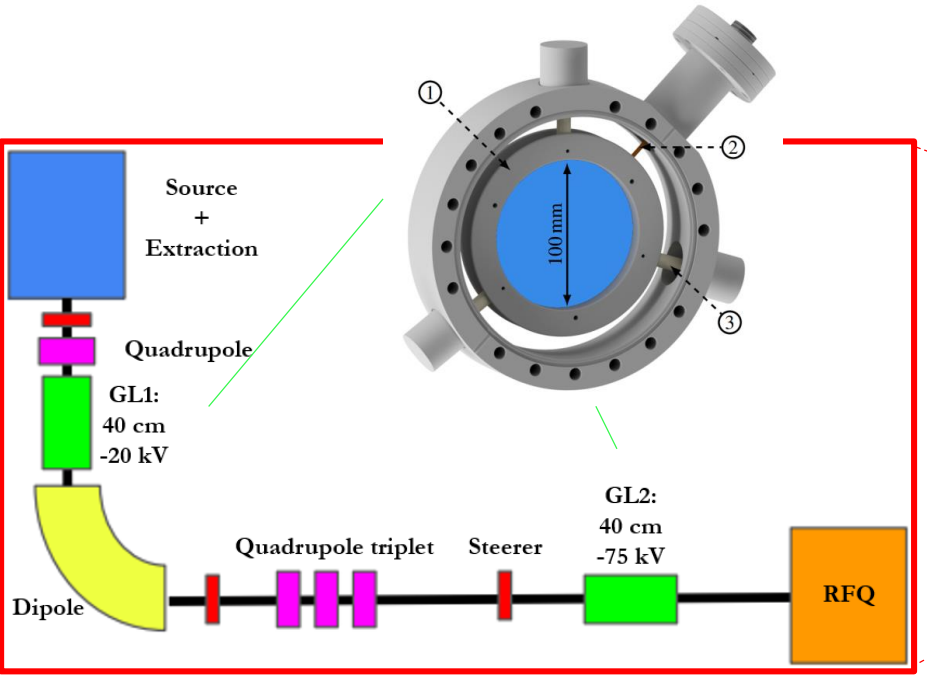
Aristeidis Mamaras, Marten Koopmans, Eleonora Pasino, Alexander Pikin
+ The SARAI Collaboration
CERN / University of Sarajevo (UNSA)

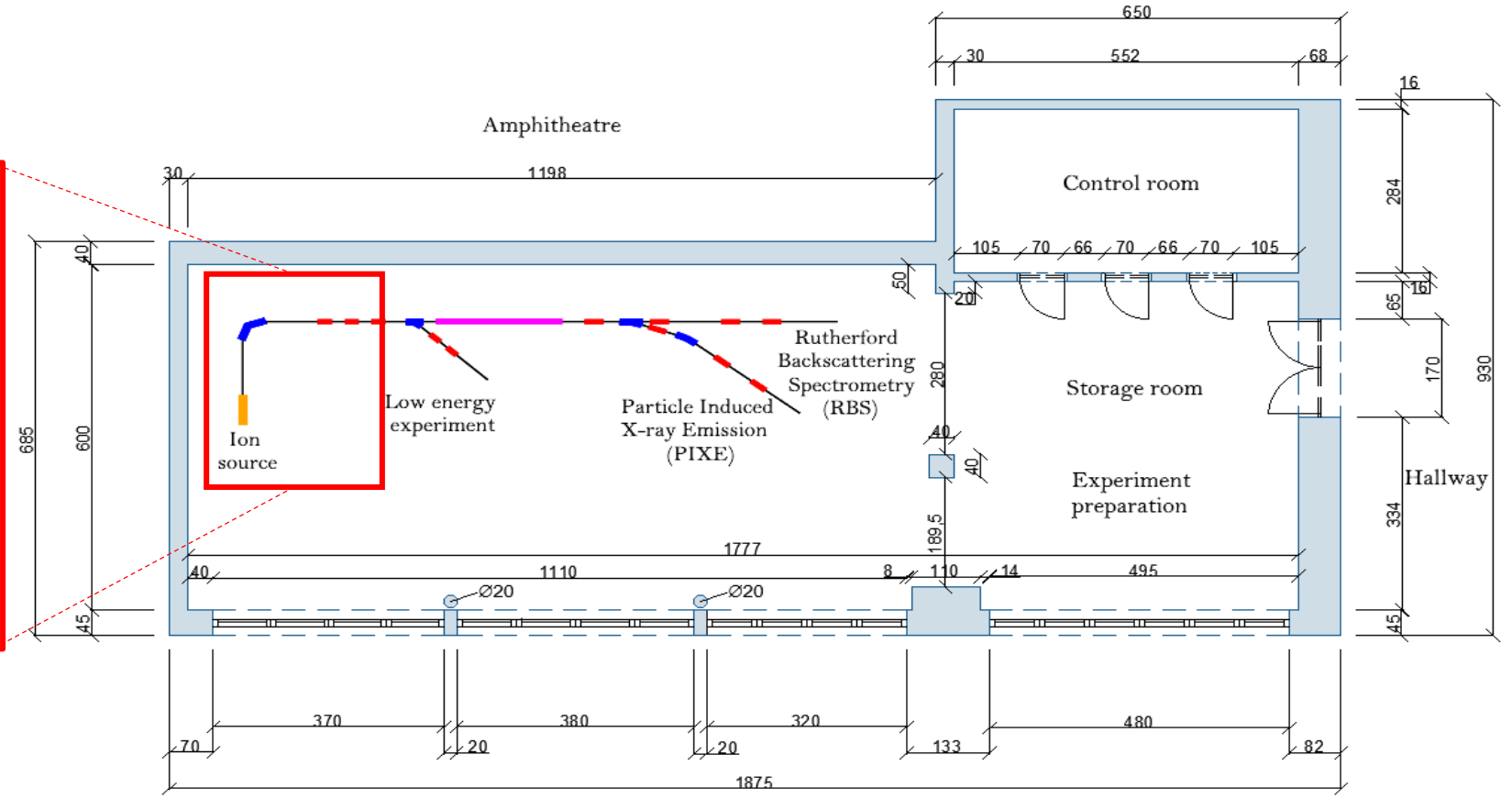
ICIS 2025
09/09/2025

SARAI: Sarajevo Ion Accelerator

The SARAI Collaboration = UNSA-CERN-JSI-GSI-COSYLAB-PANTECHNIK



@ CERN



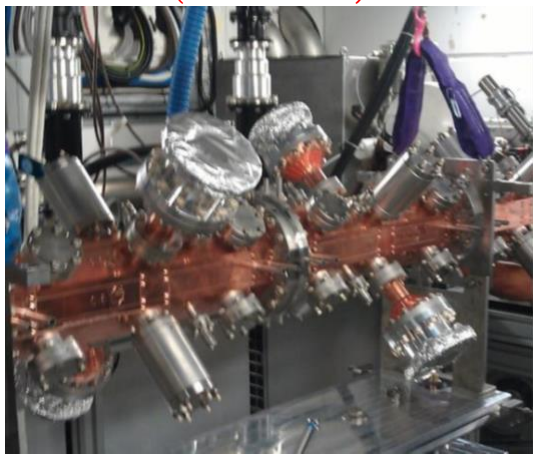
M Koopmans CERN Note 2024:
Beam Simulations of a Gridded Lens for the Low-Energy Beam Transport of the Carbon RFQ

SARAI Lab Plans
@ UNSA

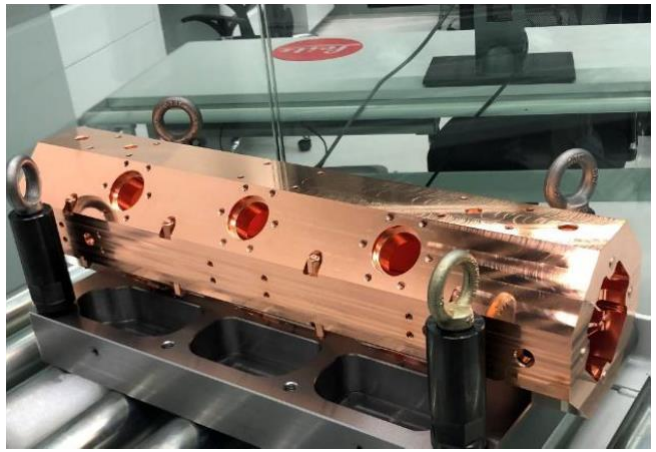
Motive: CERN Family of RFQs for Societal Applications

CERN LINAC2 → LINAC4 Upgrade → new High Frequency RFQ

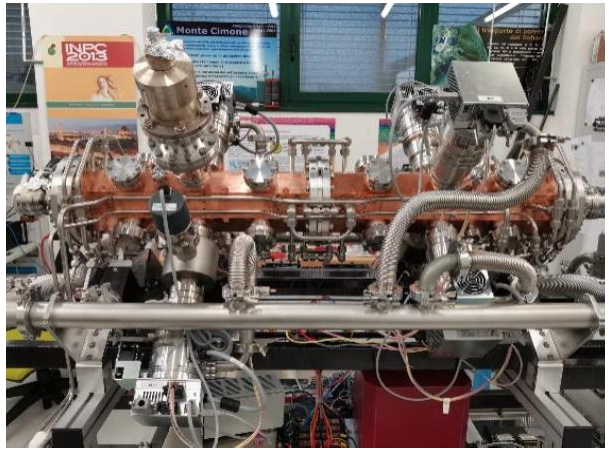
proton RFQ injector
for hadron therapy facility
(at CERN)



C-ion RFQ injector
for hadron therapy facility
(at CERN+CIEMAT)



proton PIXE-RFQ
for surface analysis
(at CERN Science Gateway)



proton PIXE-RFQ
for art diagnostics
(at INFN in Florence)

A Lombardi IPAC25:
Compact Hadron Sources and Linacs for Societal Applications

SARAI: following the CERN LINAC4 RFQ success path

→ RFQ for ion beam applications with ions of q/m=1/2 (alpha, C6+)

→ Need dedicated low energy beam transport lines →

A Ajanovic IPAC25:
LEBT for SARAI

→ **Need source**

Source: Pantechnik ECR Supernanogan Ion Source

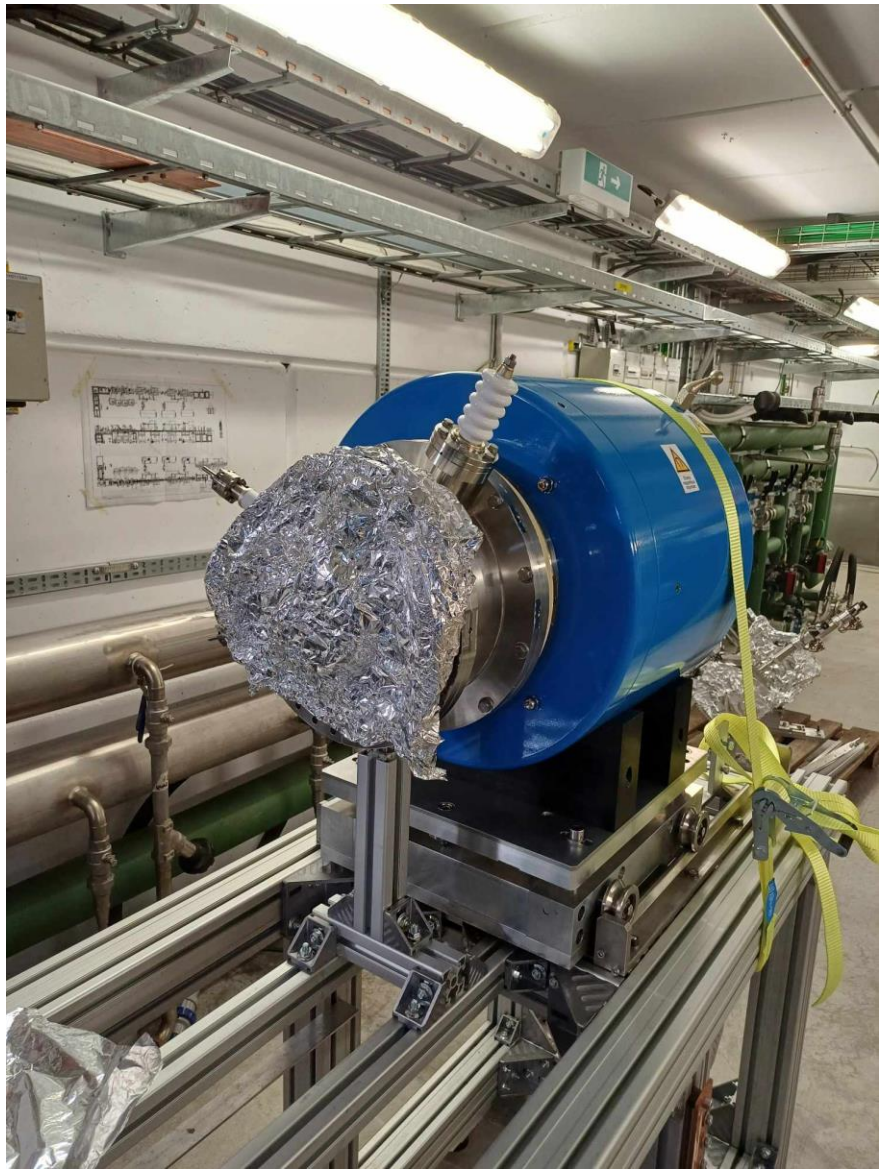
Multiple ion species possible;
start with H, He, C
→ focus on **He2+** in this talk

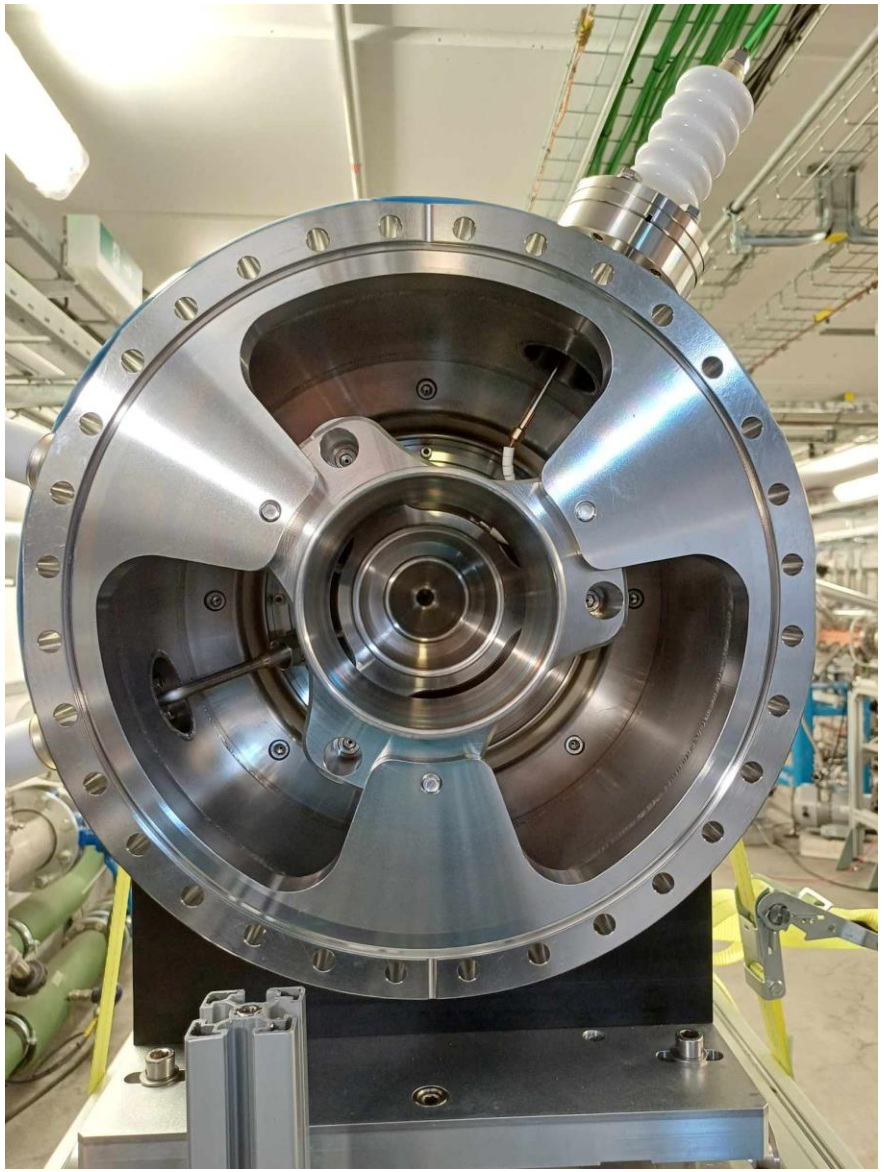
Radial magnetic field **[-1.0, 1.0] T**,
Axial magnetic field **[-1.0, 1.2] T**

13.75 – 14.5 GHz RF system

4-electrode extraction, **30 kV** max

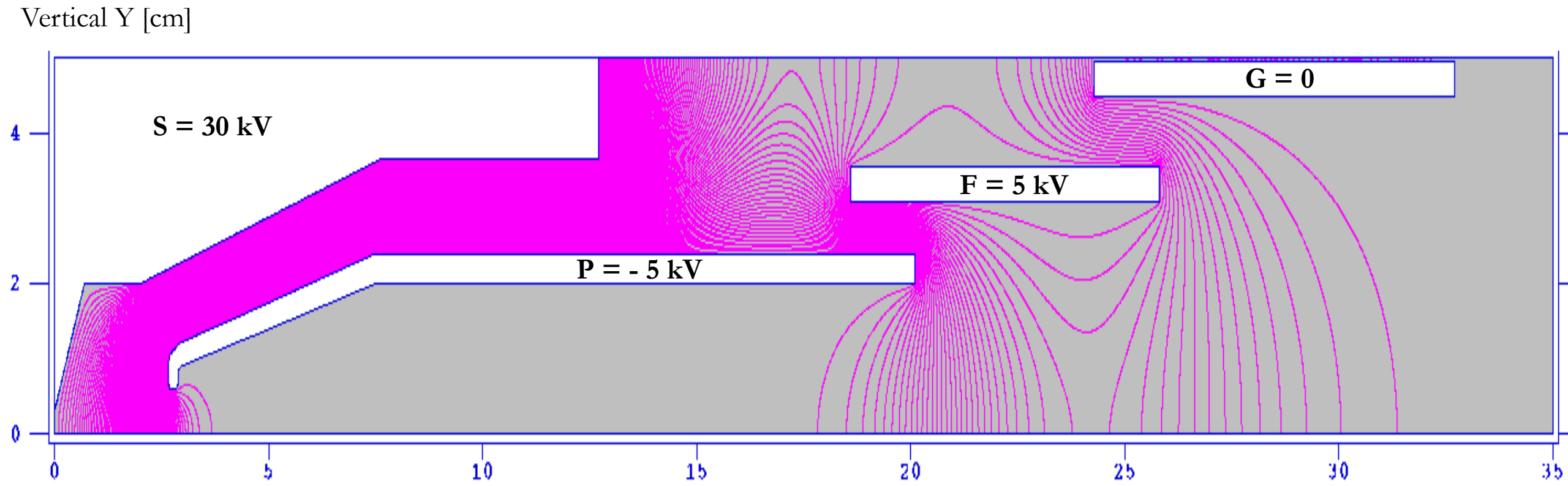
At CERN to commission





Source Beam Dynamics: Extraction Electrodes

S = source (plasma chamber) electrode, P = puller, F = focus (electrostatic lens), G = ground



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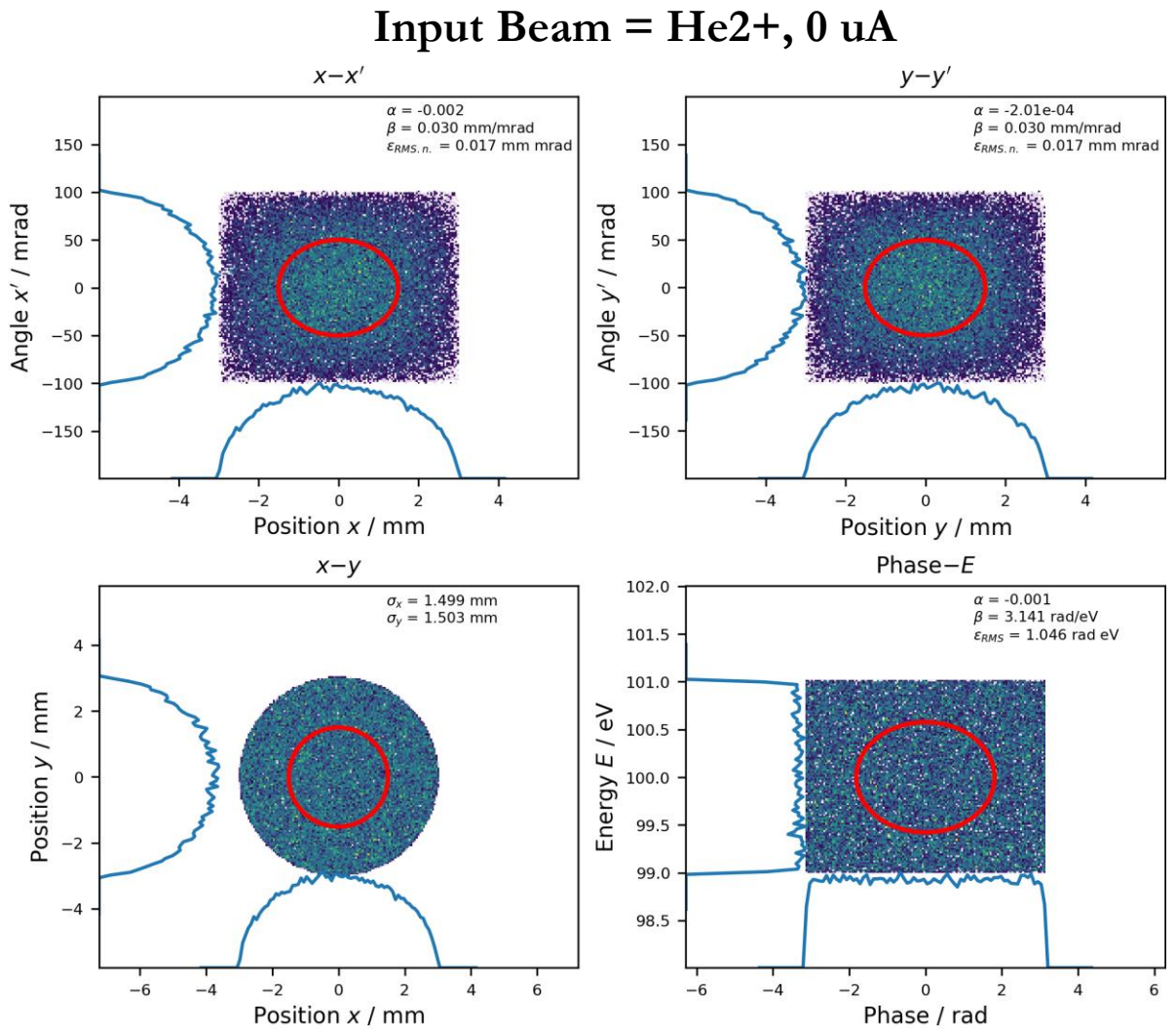
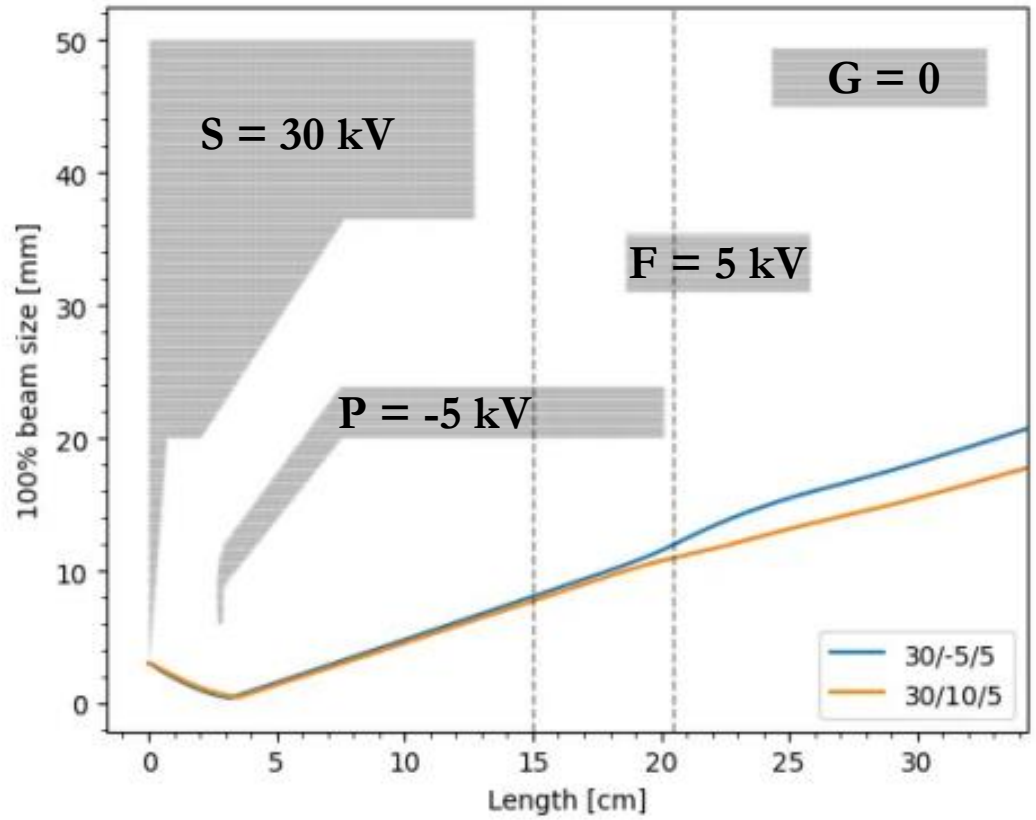
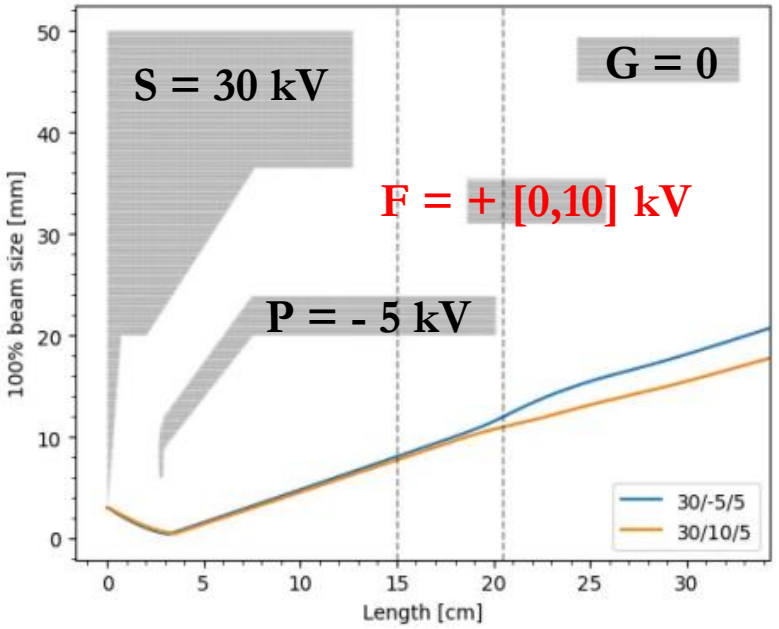
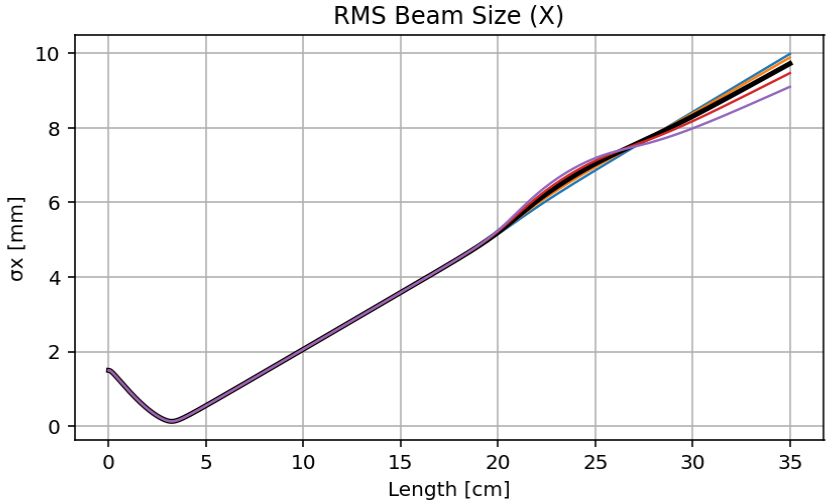
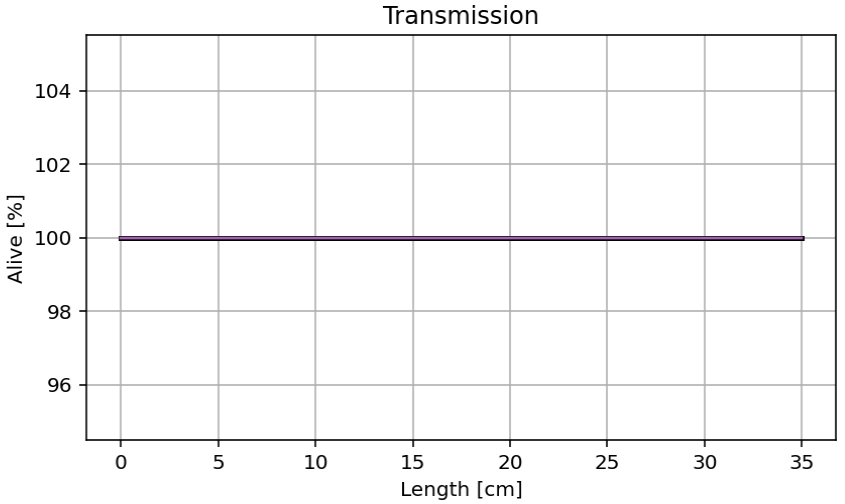


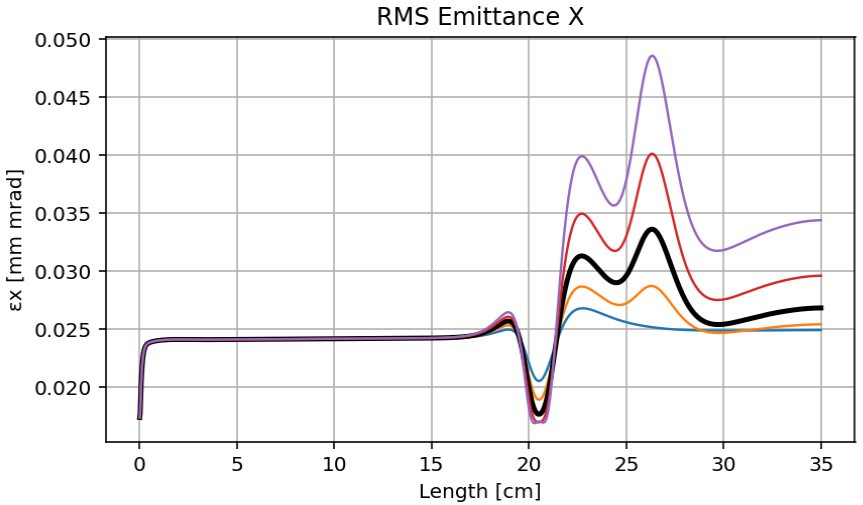


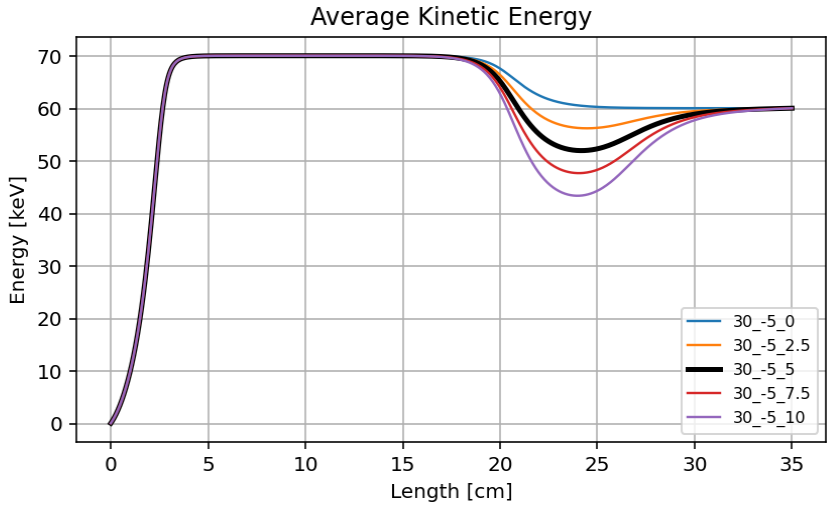
Source Beam Dynamics: Extraction Electrodes











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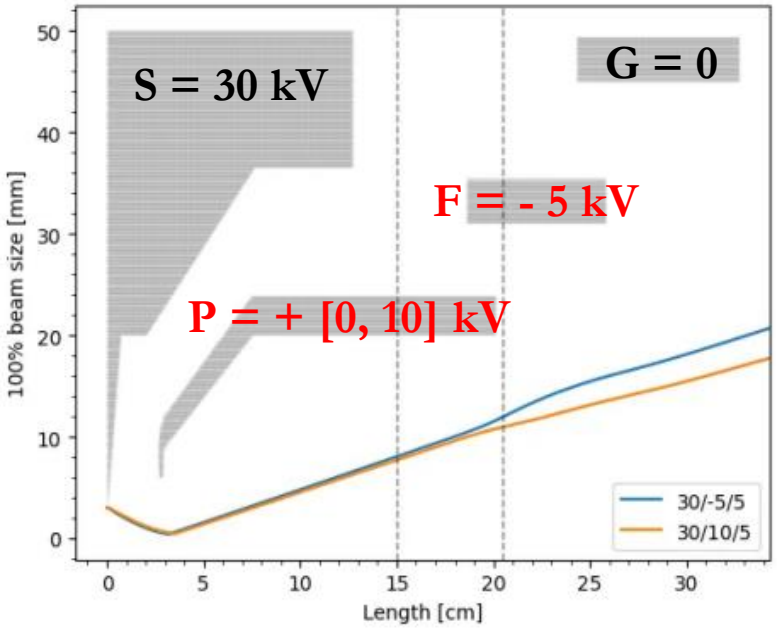
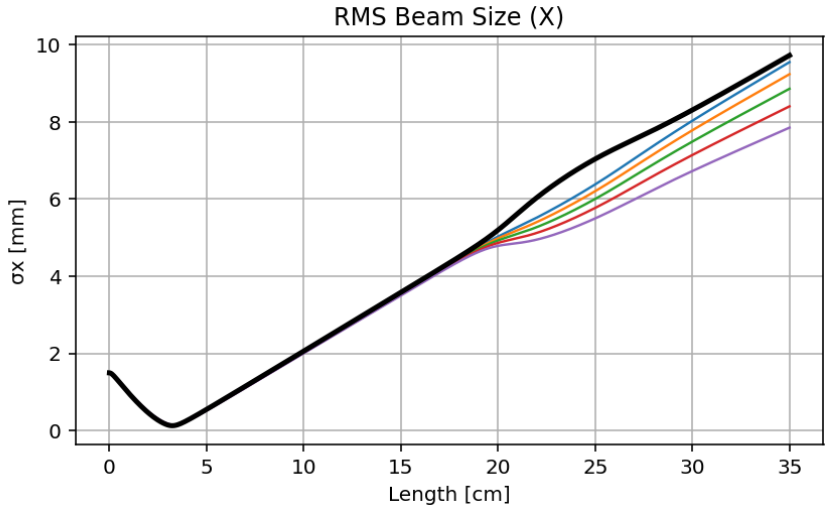
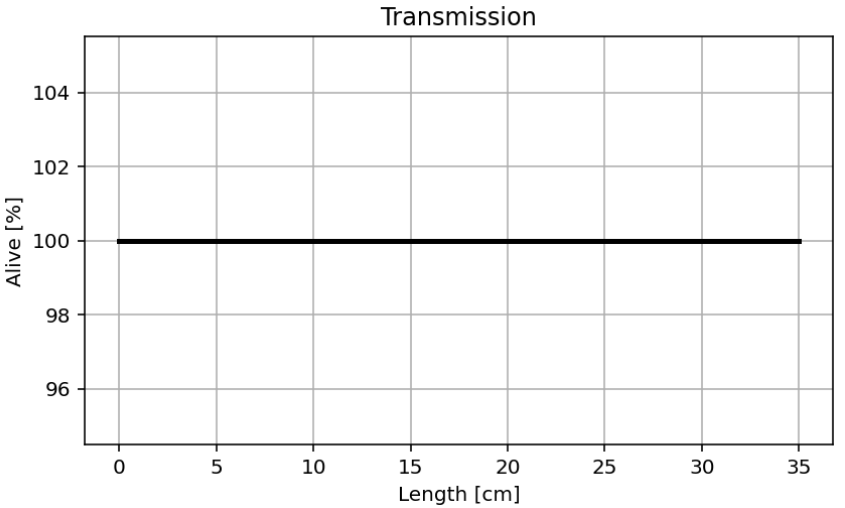
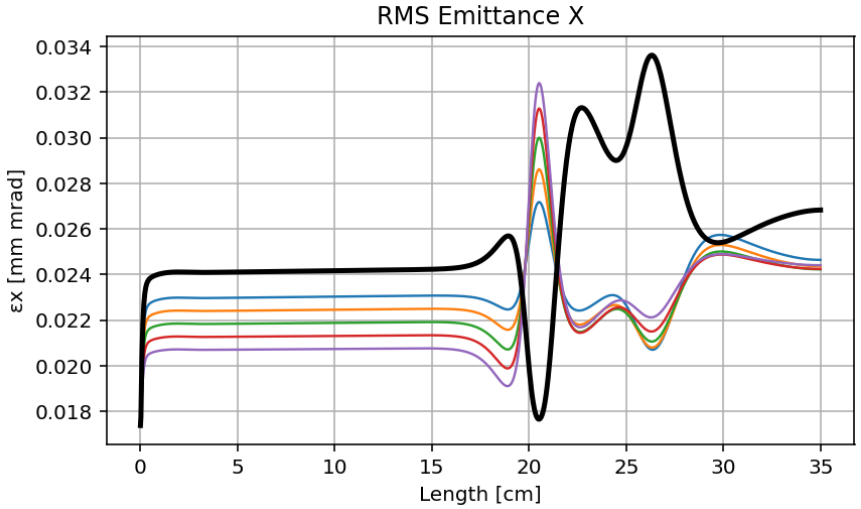
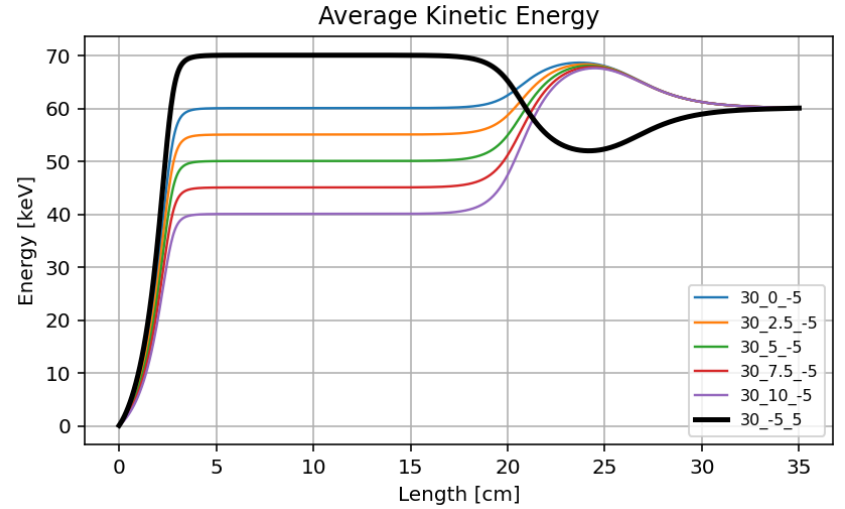




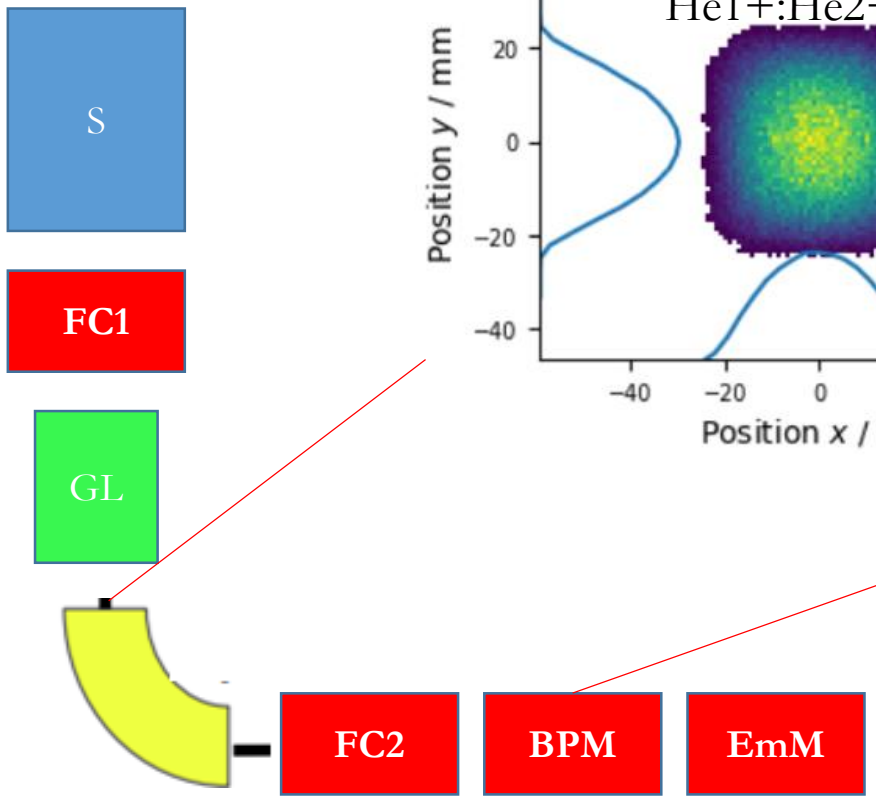


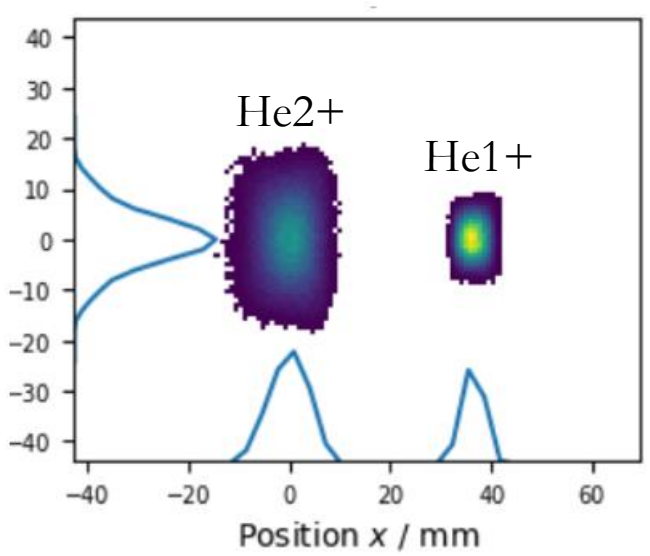




Source Beam Dynamics: Diagnostics

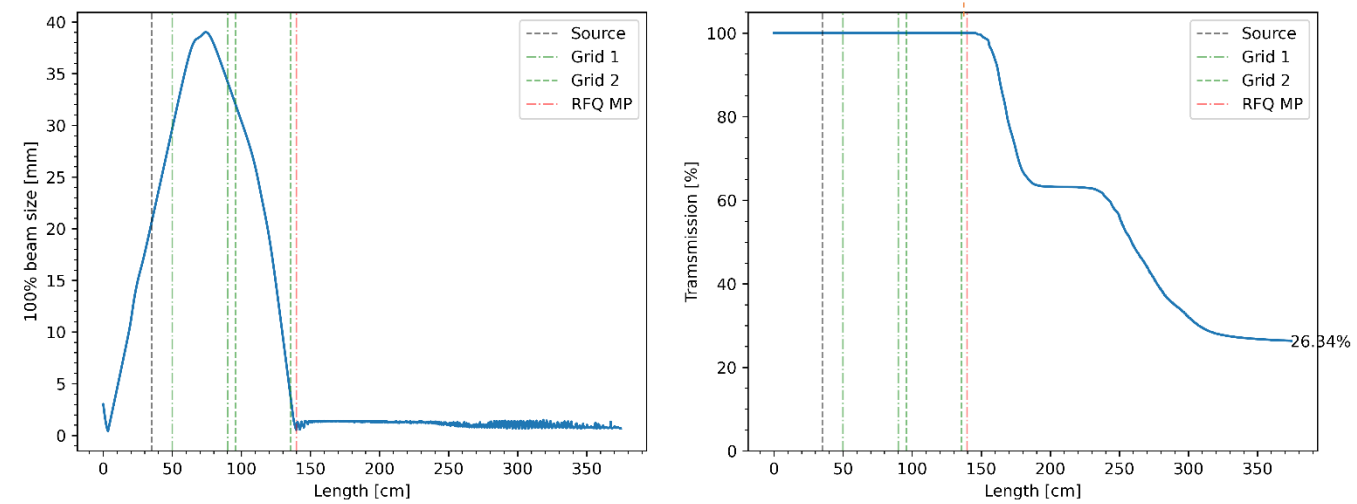
1: Measure currents at the Faraday Cups (FC1 and FC2) – check for losses;
2: Use Diagnostic boxes (2 slits + FC) to measure beam profiles before and after dipole;
3: Tune the RF power, gas parameters and extraction potentials to achieve a desired ratio of He1+:He2+.

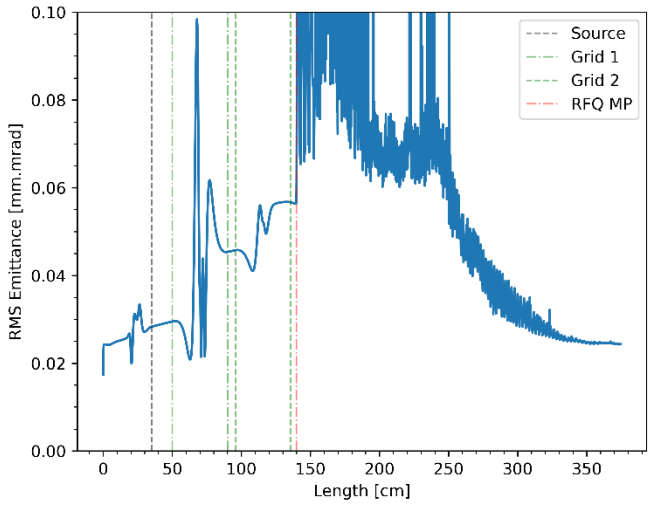


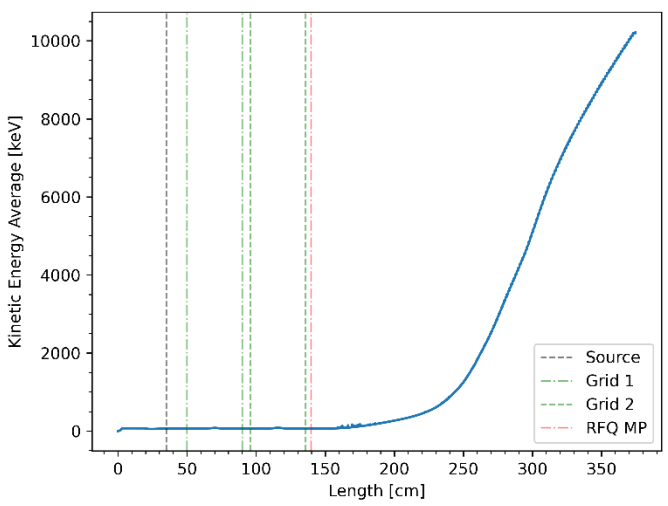


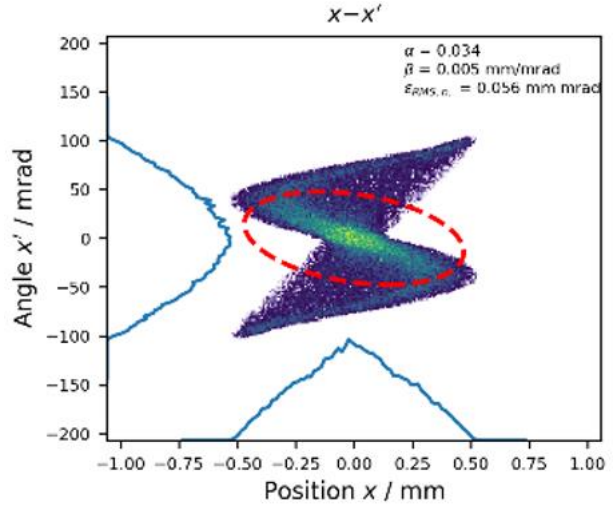
Source Beam Dynamics: compact 2 GL - LEBT

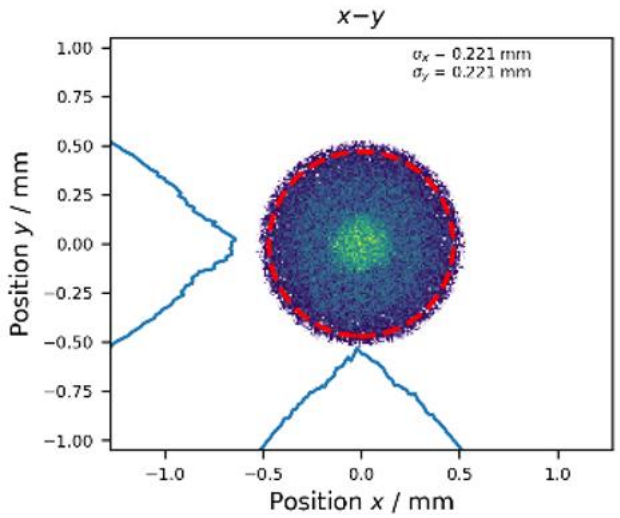
EXP Validation: Aristeidis Mamaras Thursday Poster





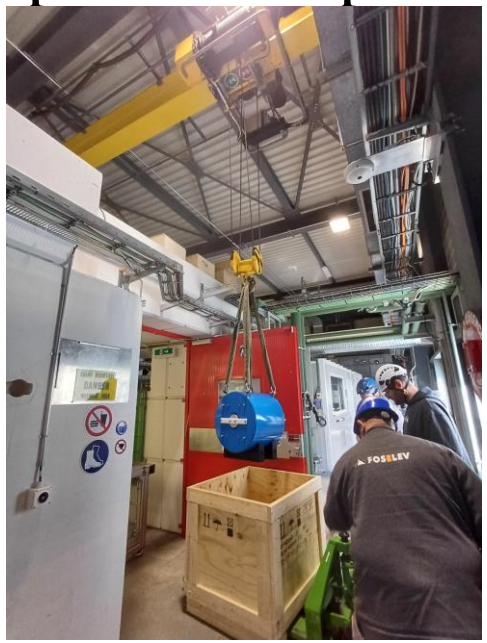






Source Commissioning Prep: Transport + Installation at CERN



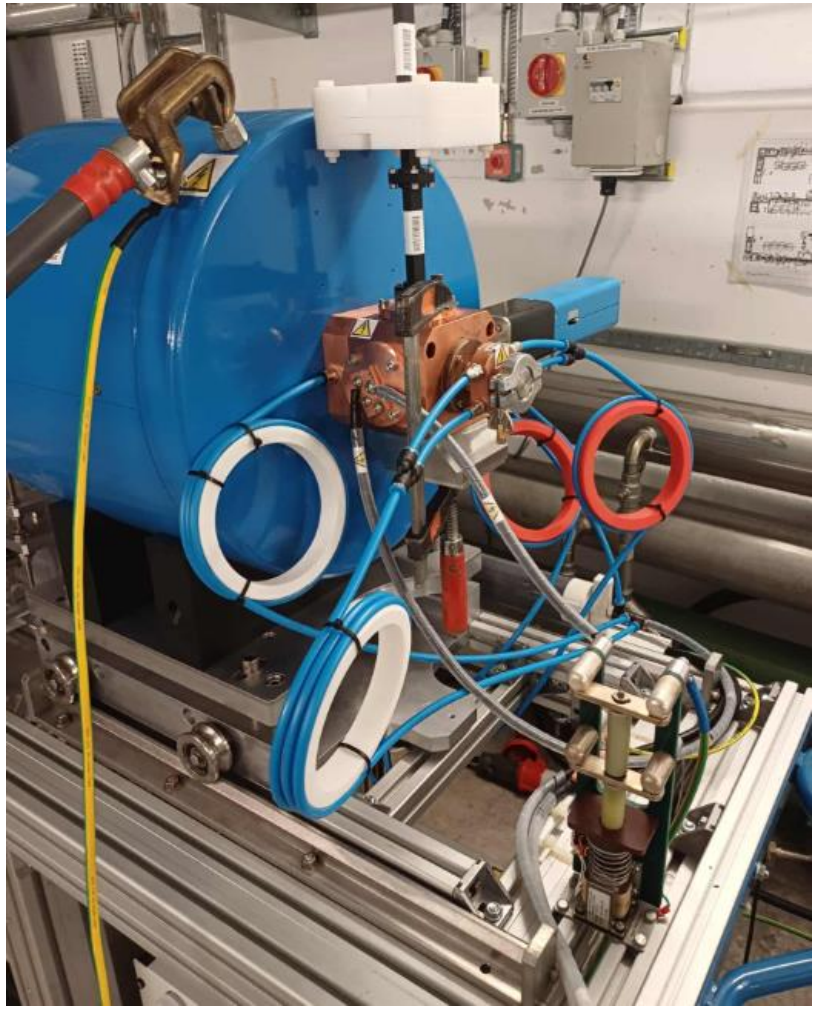




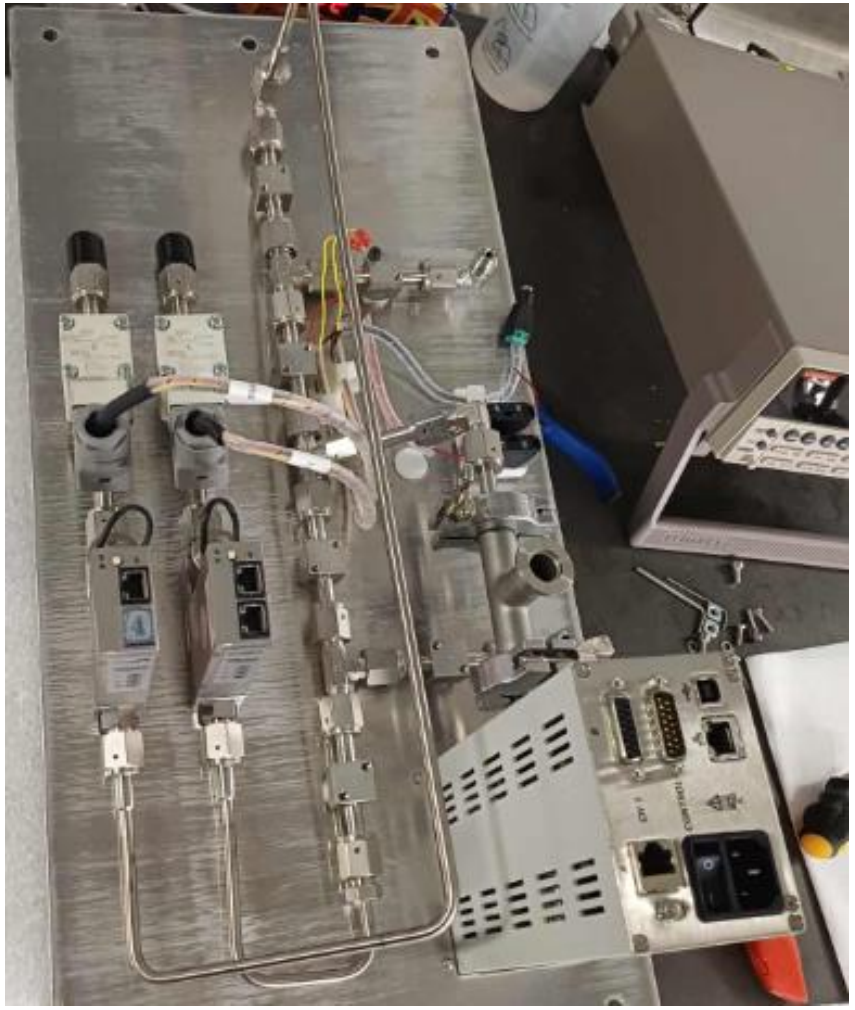


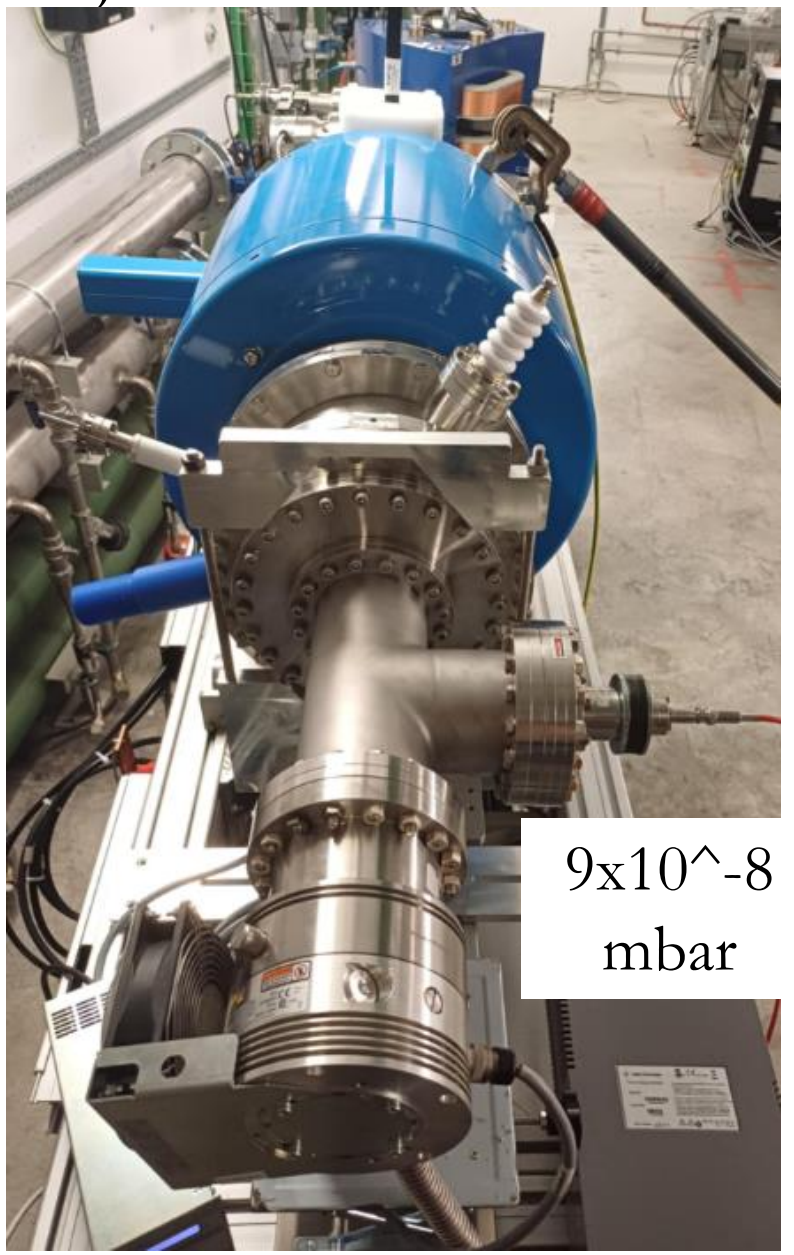
Source Commissioning Prep: Cooling + Gas Injection + Vacuum

Chiller, Cartridge
Cooling HV Pipes



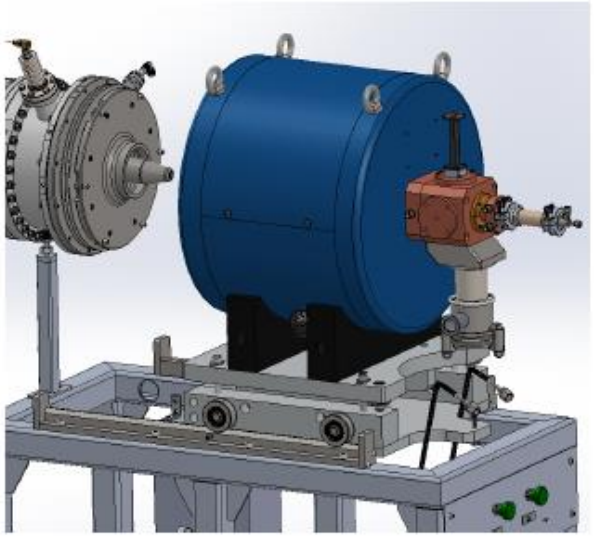
2 injection pipes
2 flowmeters



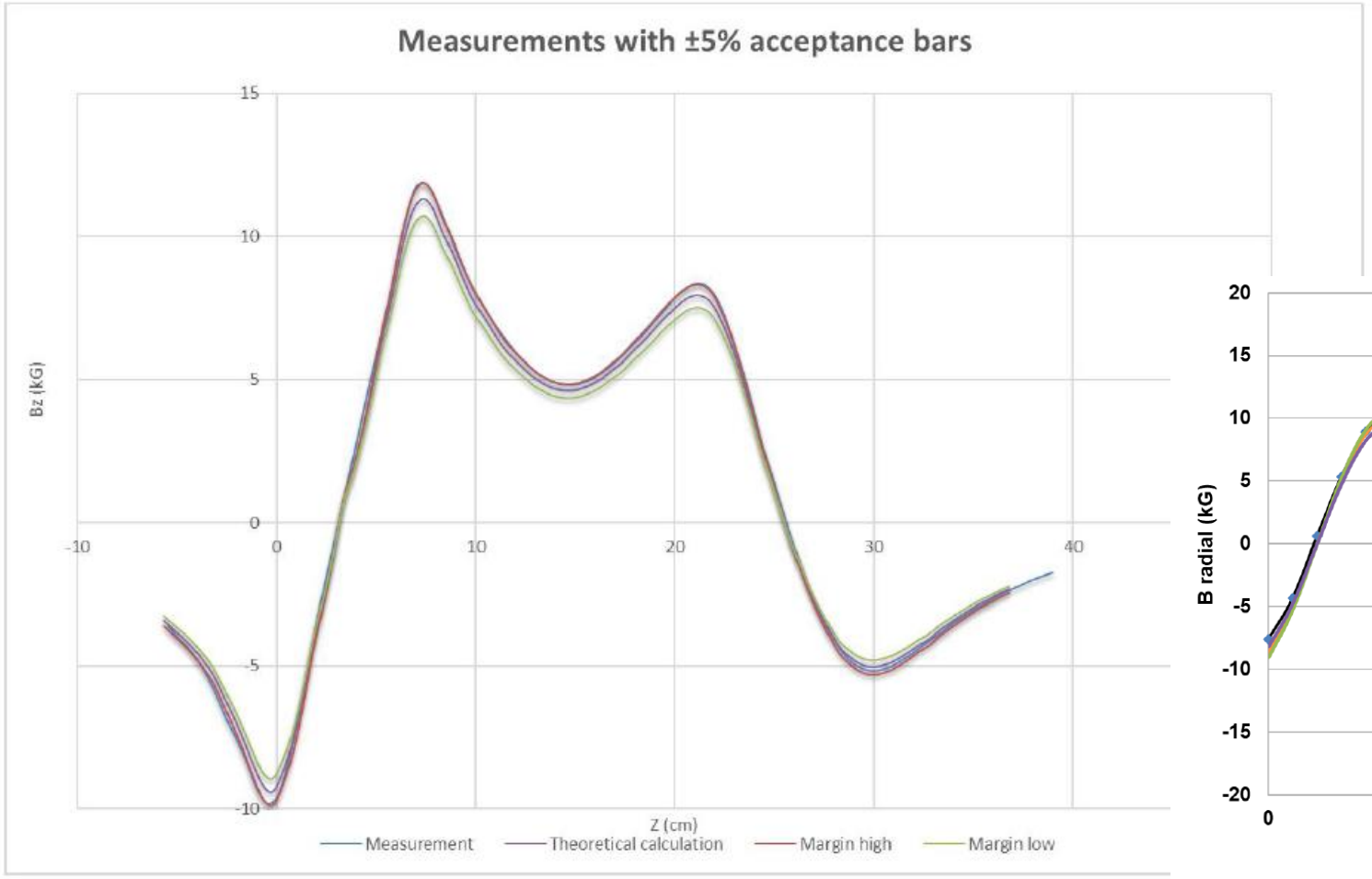


9x10^-8
mbar

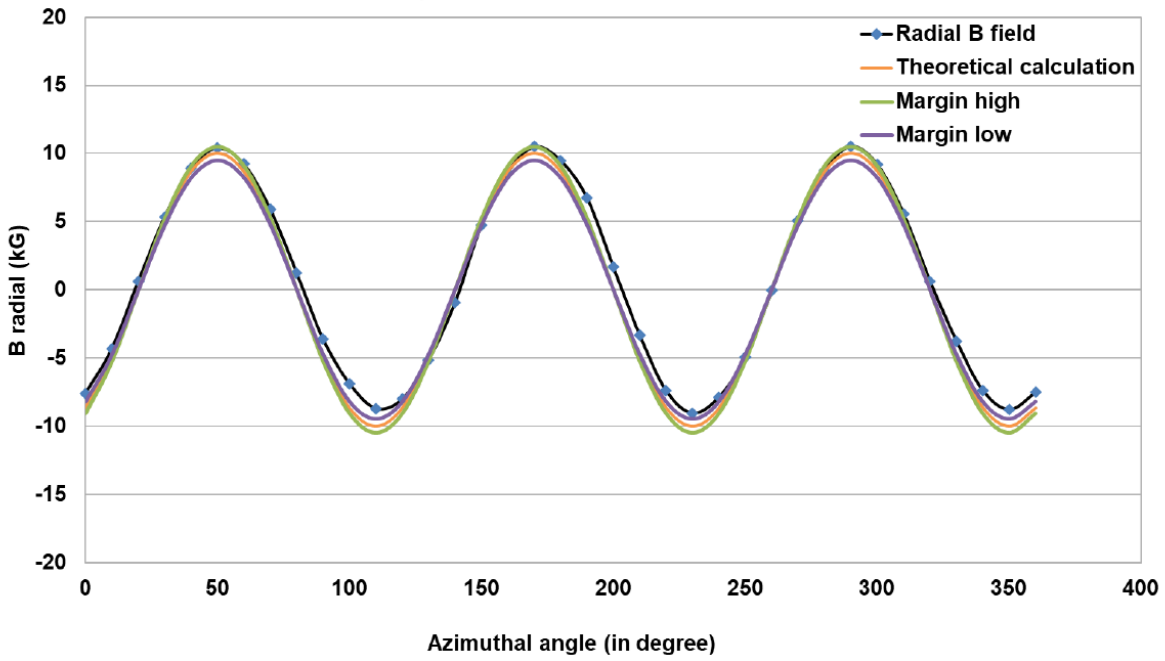
Source Commissioning Prep: The Magnet



Axial B with +- 5% error



Radial B at z = 14.8 cm



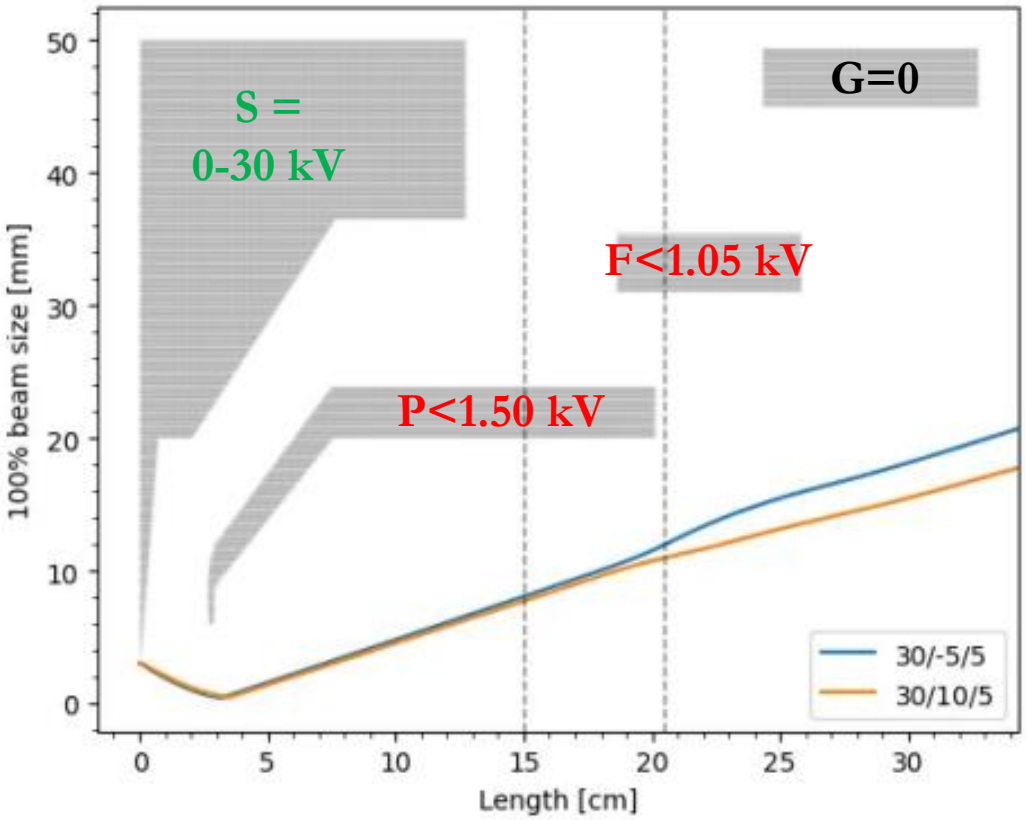
Source Commissioning Prep: Extraction High Voltage Holding

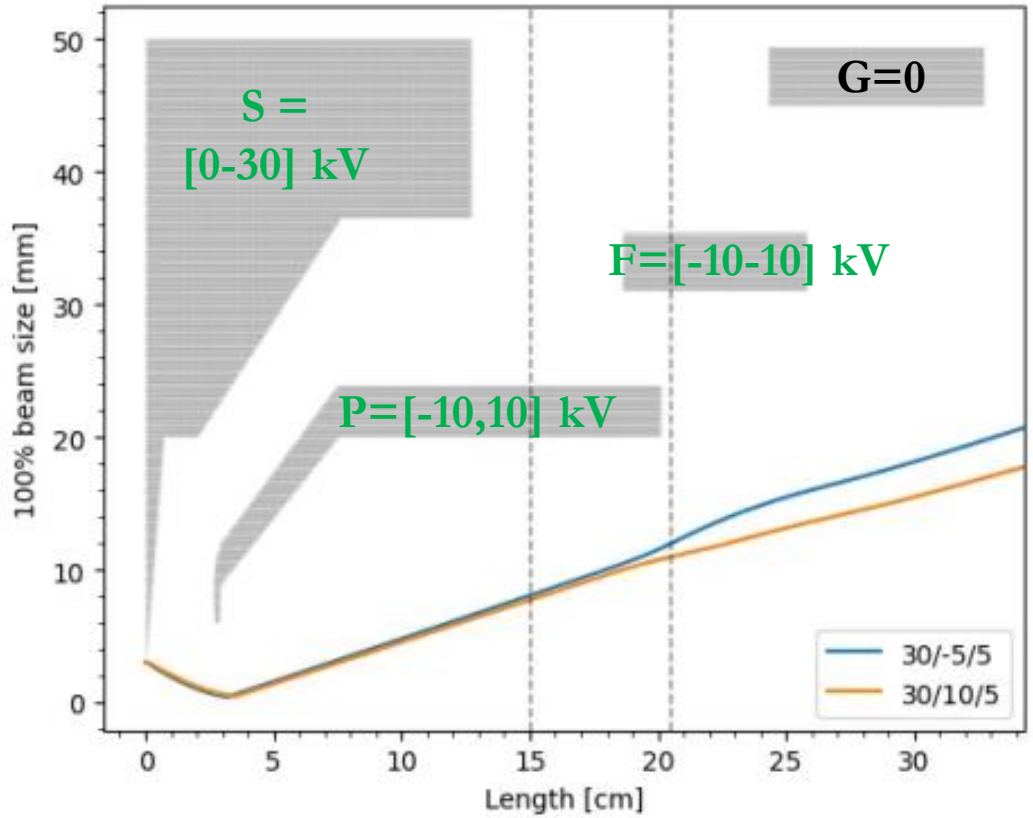
high residual I (100 uA)

Stable system: for both nominal (–P, +F) & inverted (+P, -F) scenario

low residual I (3 uA)

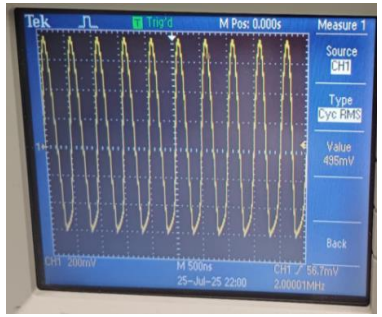
Lots of internal sparks



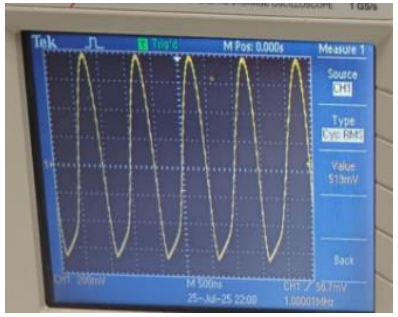


Source Commissioning Prep: The RF

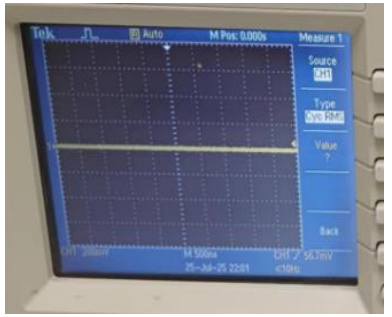
RF GENERATOR: Frequency synthesizer (100 kHz – 22 GHz)



2 MHz

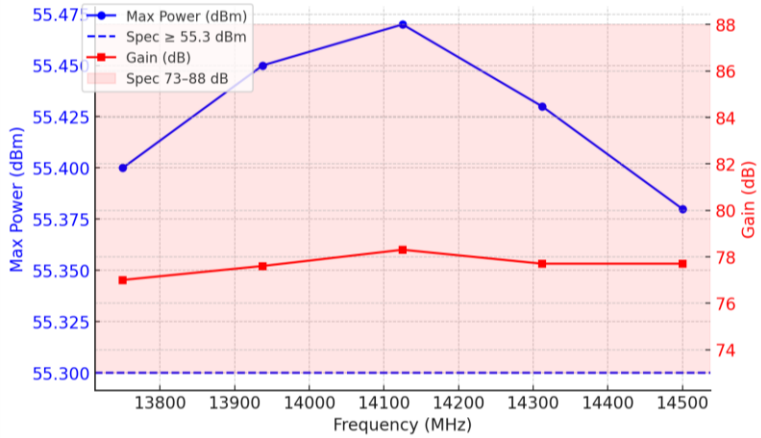


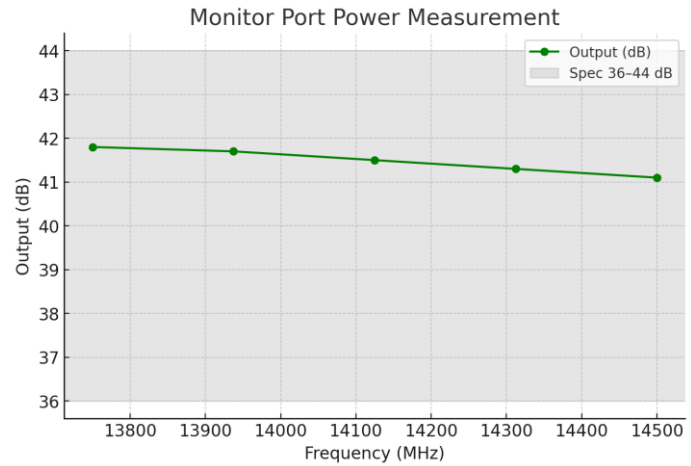
1 MHz



No RF

RF AMPLIFIER: Compact medium power amplifier (55 dB, 13.75-14.50 GHz)





Conclusions

Sarajevo Ion Accelerator (SARAI) in development with Pantechnik Supernanogan ECR Ion Source;

Beam Dynamics of the source ready for nominal and other extraction parameters;

Improved source extraction performance by inverting the nominal puller and focus electrode polarity;

The full system ready for commissioning with H and He ions;

To follow initially: diagnostic lines, LEBTs, RFQ.

Thank you

The ICIS Organizers,
Committees

Collaborators:
A Lombardi,
M Vretenar,
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E. Hasovic,
F di Lorenzo,
O Khrul,
S Isakovic,
A Mamaras,
M Koopmans,
E Pasino,
A Pikin,
P Foka,
J B Lallement,
U Bobek,
T Meglic,
T Tratnik
…

Contact:
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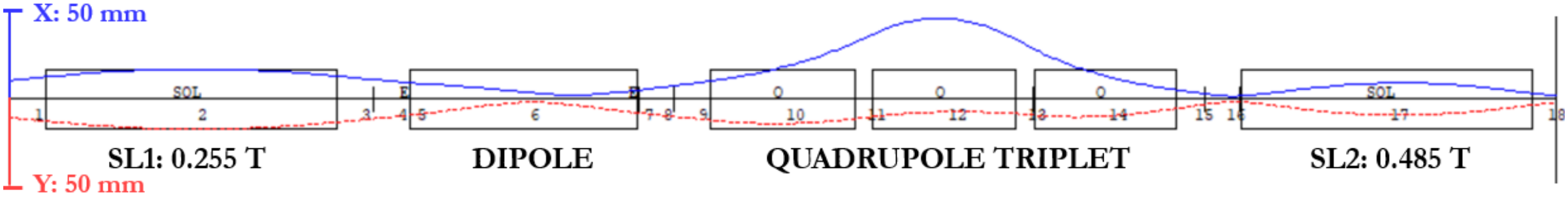
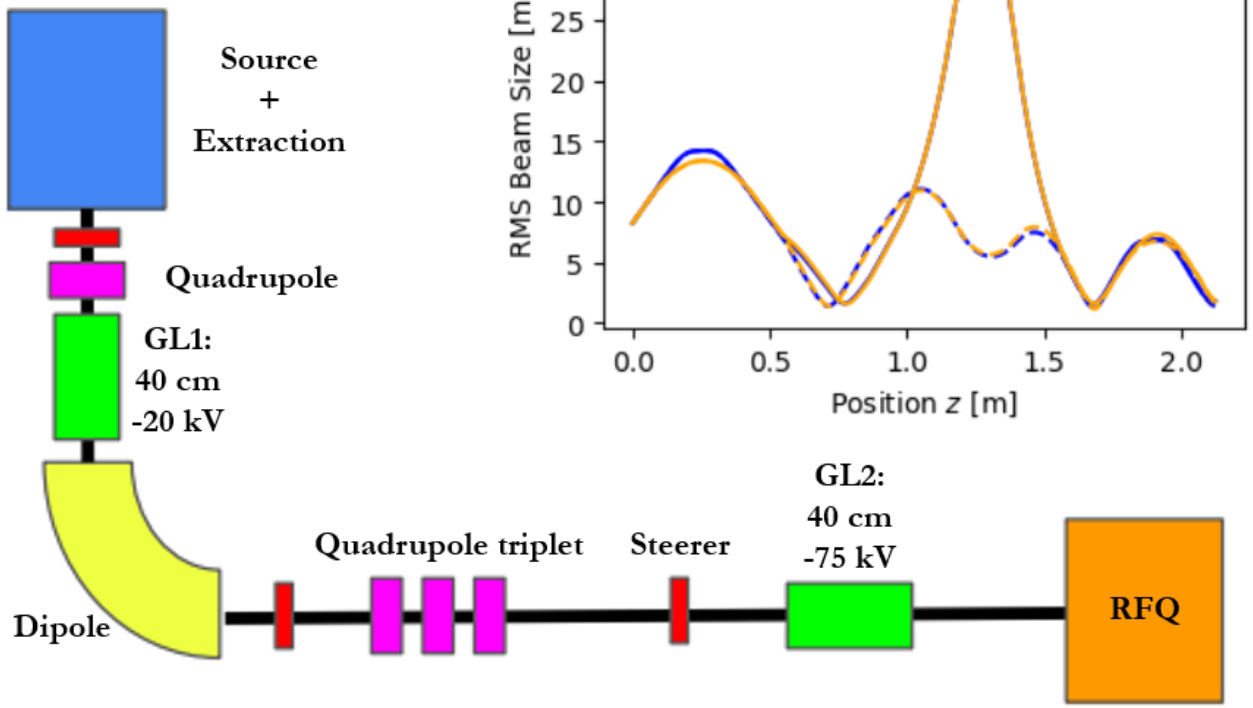
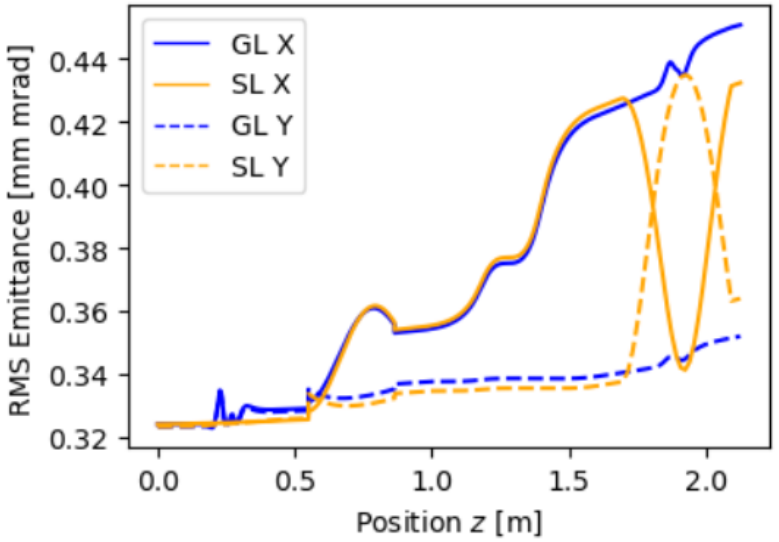
Support
3 Physicists Foundation
IAEA
EU Horizon
CERN Knowledge Transfer

Backup: Source Beam Dynamics: LEBT 1







AA IPAC25 PAPER

Source Commissioning Prep: The 7 Subsystems

RF

MAGNET

GAS INJECTION

HV EXTRACTION

DC BIAS

VACUUM

COOLING