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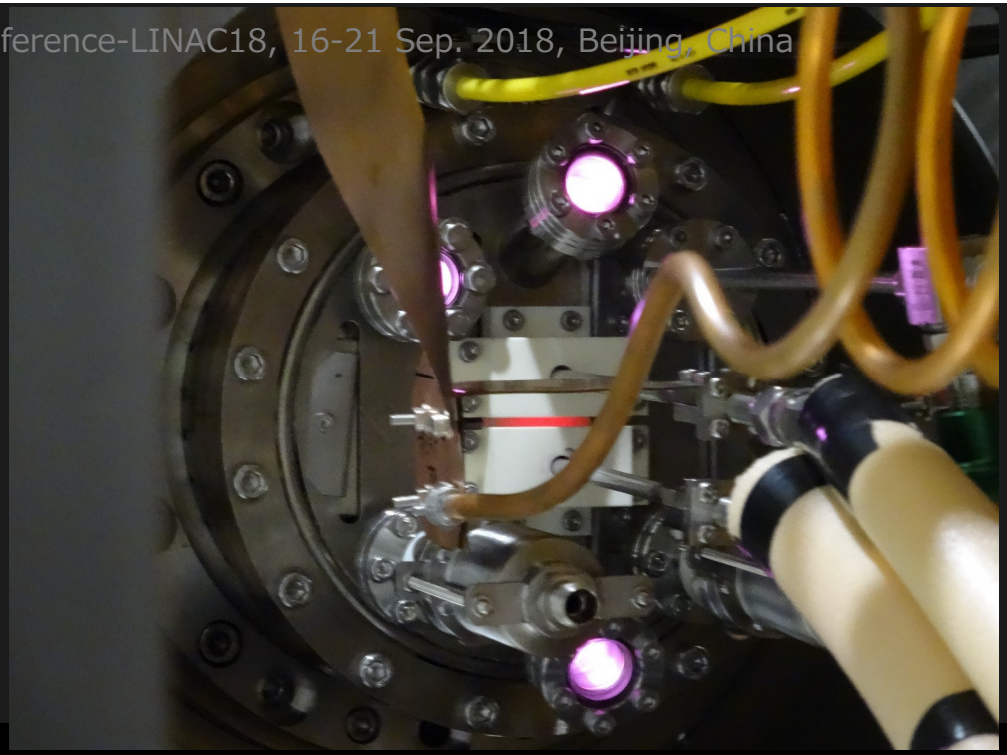
TUOP-10
TUPO-079



Numerical and Experimental Study of H^- beam Dynamics in J-PARC LEBT

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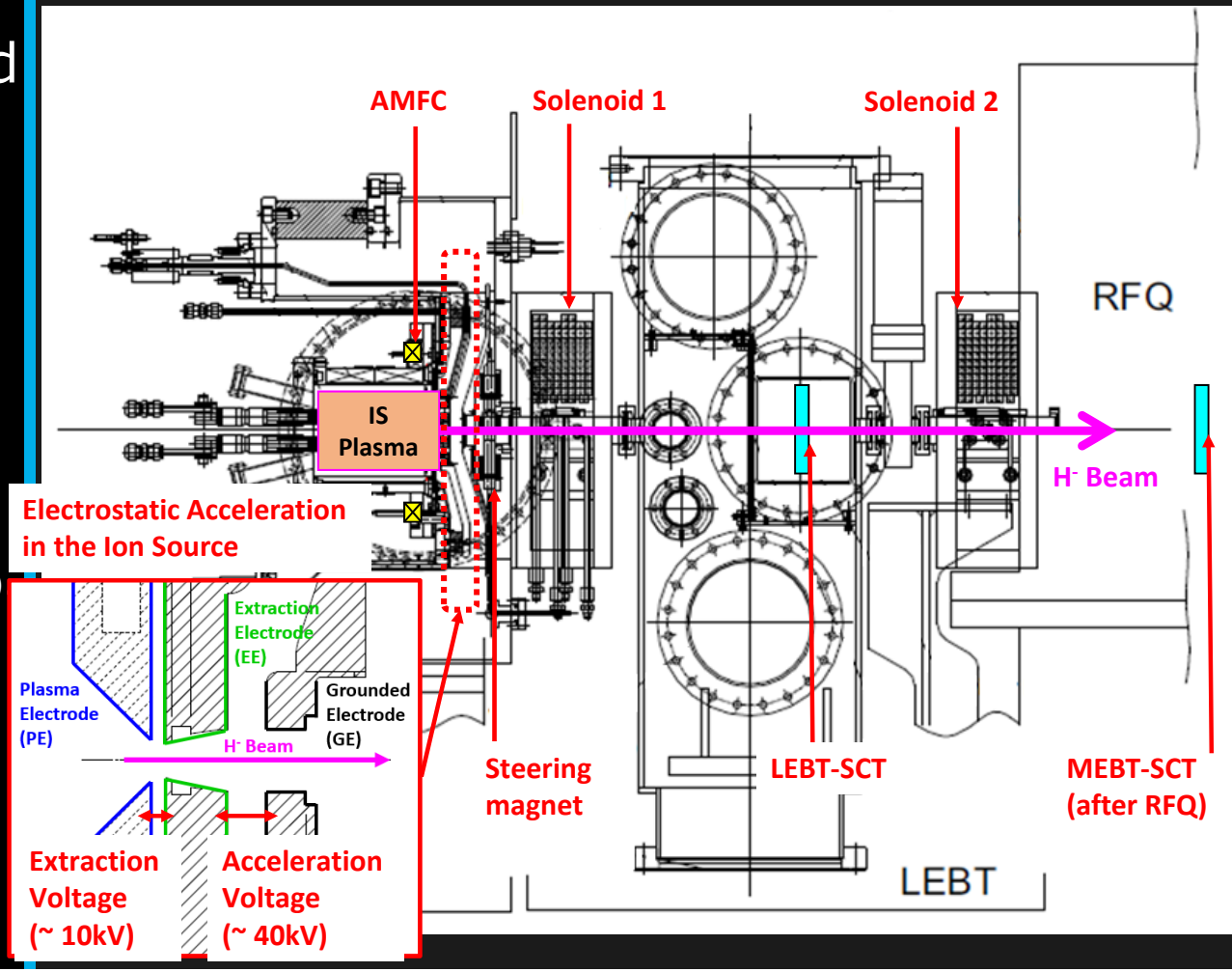
Commissioning of the J-PARC Linac Front-End (Ion Source & LEBT)

Tuning parameters

- AMFC (Axial Magnetic Field Correction) coil current
  → Originally for IS plasma stability. The field also change ion extraction plane at the IS exit.
- Extraction voltage & Acceleration voltage
  → static acceleration to around 50 keV (RFQ longitudinal matching)
  → Initial phase space in LEBT.
- Hori./Vert. Steering mag. (STM)
  → beam axis steering in LEBT
- LEBT SOL 1 & 2 current
  → emittance reduction and Twiss parameter matching at the RFQ entrance



J-PARC Linac Commissioning

Purpose of the Ion Source (IS) and LEBT commissioning

- Extraction and acceleration of H^- beam to around 50 keV （RFQ longitudinal matching）.
- Steering of the beam axis
- Twiss matching at the RFQ
- Emittance reduction at the RFQ

→ Optimize RFQ transmission rate of the H- beam with high reproducibility in each RUN for the user operation.

Commissioning parameters	LI 30mA (2015 User operation)	LI 40 mA (2017 User operation)	LI 60 mA (2018 Acc. study)
AMFC coil (V)	0.0	2.0	4.0
Ext. voltage (kV)	9.9	9.8	10.3
Acc. Voltage (kV)	42.0	42.5	42.5
Total IS Voltage (kV)	51.9	52.3	52.8
Hori. STM (A)	-1.0	-5.0	-2.0
Vert. STM (A)	-5.5	-4.0	-5.0
LEBT SOL1 (A)	495	500	540
LEBT SOL2 (A)	600	620	680

Different Peaks of RFQ transmission rate in SOL 1&2 scan

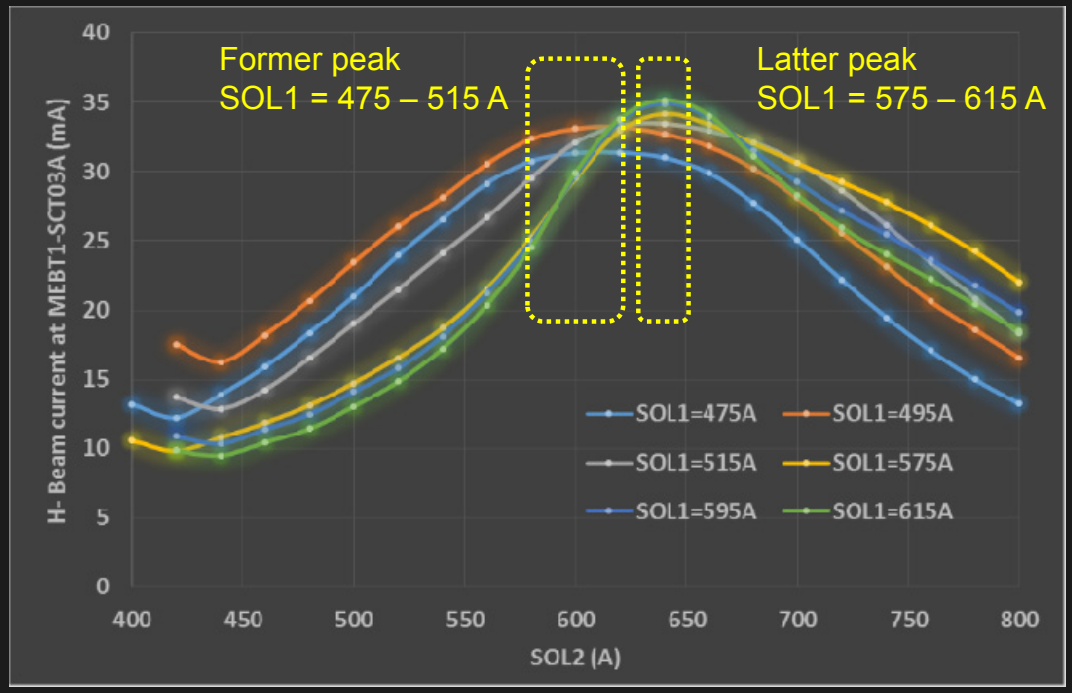
In the LEBT SOL 1 & 2 scan, high RFQ transmission rate (H- beam current measured at MEBT-SCT just after RFQ exit) has shown different peaks.

Former peak

Observed for relatively **lower** SOL 1 & 2 current pairs;
→ SOL 1 = 475 – 515 A
→ SOL 2 = 580 – 620 A (wide)

Latter peak

Observed for relatively **higher** SOL 1 & 2 current pairs;
→ SOL1 = 575 – 615 A
→ SOL2 = 640 – 660 A (narrow)



Dependence of H^- beam current measured at MEBT-SCT to the SOL 1 & 2 current

→ Why are the different peaks obtained?

Numerical Analysis

A three-dimensional (3D) Particle-In-Cell (PIC) Monte-Carlo modeling;

Basic Equations

$$m_{\mathrm{H}-}\frac{d\boldsymbol{v}_{\mathbf{H}-}}{dt} = q(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B})$$

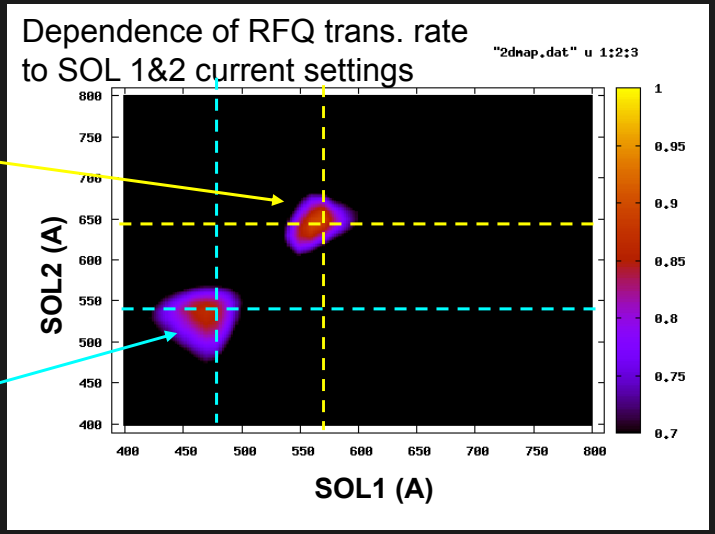
$$\frac{\partial^2 \phi}{\partial r^2} = -\frac{\rho(r)}{\varepsilon_0}$$

Main effects taken into account in the modeling

1. 3D Magnetic Field Configuration
2. 3D Spatial Configuration of the LEBT
3. Space Charge Effect

Latter peak
SOL1 = 570 A
SOL2 = 640 A
RFQ trans. rate = 90.2 %

Former peak
SOL1 = 480 A
SOL2 = 540 A
RFQ trans. rate = 86.8 %



- Detailed analysis from the calculation gives a reason of the two different peaks.
- From the understandings of the H- beam dynamics, we now have high reproducibility of the LEBT tuning.

For detail, please find

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谢谢!

Thank you for your attention!