

LEBTRANSPORT AND RFQ-INJECTION

FIPS SCHNEIDER

HICforFAIR Workshop, Riezlern '15

Institut für Angewandte Physik
Goethe-Universität Frankfurt am Main

09.03.2015

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Physics Group

AGENDA

1 WHY LEBTs?

2 OVERVIEW TO DIFFERENT LEBTs

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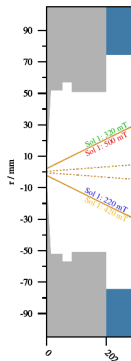
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WHY DO WE NEED THIS STUFF?

Source

divergent

beam given

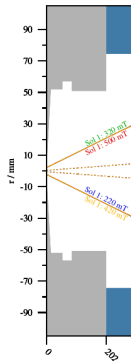


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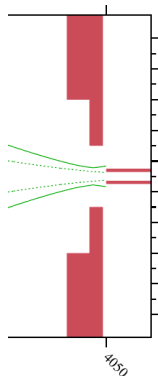
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WHY DO WE NEED THIS STUFF?

Source
divergent
beam given



RFQ needs
convergent
beam

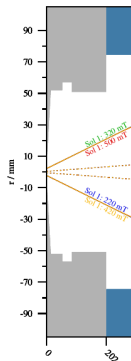


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WHY DO WE NEED THIS STUFF?

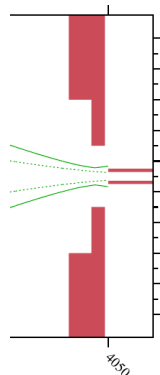
Source
divergent
beam given



Nice idea: focusing in between

→ Without a LEPT, beam current behind RFQ might be very low.

RFQ needs
convergent
beam

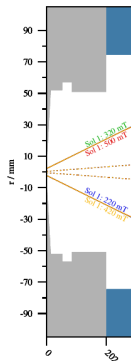


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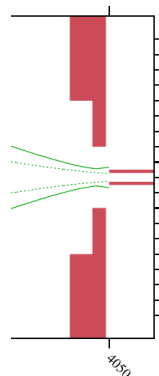
Source
divergent
beam given



PRIMARY TASKS

- catch beam from source
- match RFQ acceptance parameter

RFQ needs
convergent
beam



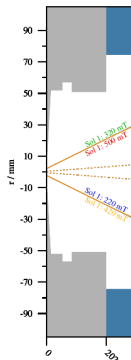
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WHY DO WE NEED THIS STUFF?

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divergent
beam given



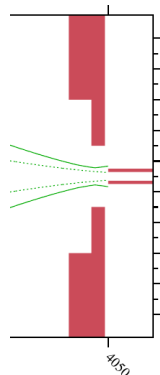
PRIMARY TASKS

- catch beam from source
- match RFQ acceptance parameter

SECONDARY TASKS

- ion separation (charge states, fractions (H^+ , H_2^+ , ...))
- chopping: time structure, adjustment of beam current
- first diagnosis of beam
- emergency beam stop

RFQ needs
convergent
beam



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AGENDA

1 WHY LEBTs?

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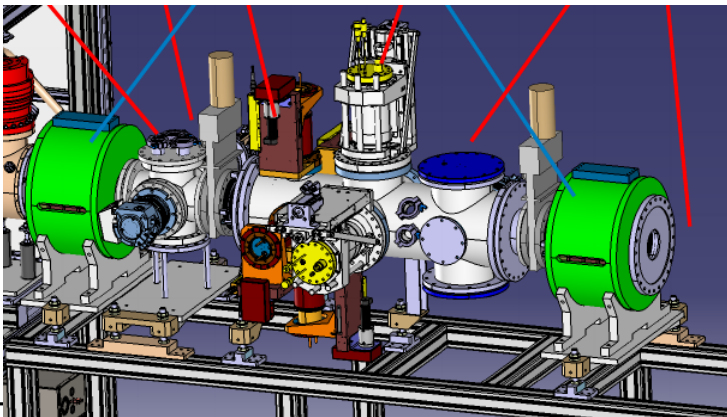
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MYRRHA-LEBT

Primary task

- transport and match into RFQ
- $I_B = 20 \text{ mA}$, $W_B = 30 \text{ keV}$ [Sal14]



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Image by courtesy of SCK-CEN

PRIMARY TASK [SAL14]

- $I_B = 20 \text{ mA}$
- $W_B = 30 \text{ keV}$
- ⇒ perveance:
 $K = 2.50 \cdot 10^{-3}$
- $\varepsilon_{in} = 0.1 \pi \text{ mm mrad}$
- $\varepsilon_{out} < 0.2 \pi \text{ mm mrad}$
- ⇒ allowed Emittance growth: 100%
- goal current: $I_b = 4 \text{ mA}$
- ⇒ max. beam loss: 80%

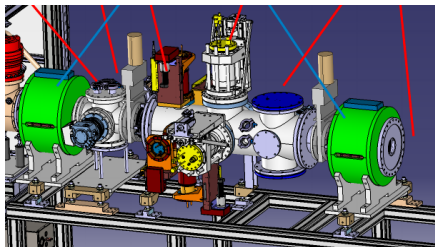


Image by courtesy of SCK·CEN

SECONDARY TASKS [SAL14]

- ion separation by scraping
- electric chopper: time structure (dumping on RFQ collimator)

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PXIE-LEBT

Primary task

- transport and match into RFQ
- $I_B = 15 \text{ mA}$, $W_B = 30 \text{ keV}$

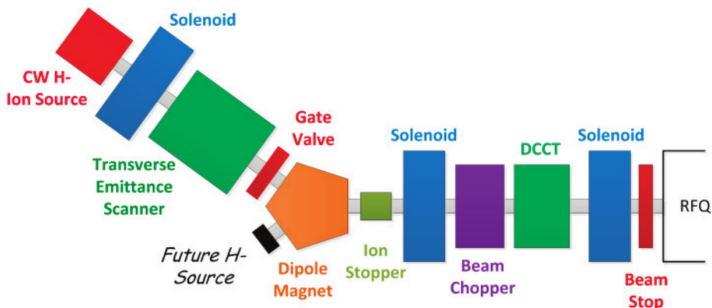


Image by [Sca12]

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PRIMARY TASK [SCA12]

- $I_B = 15 \text{ mA}$
- $W_B = 30 \text{ keV}$
- ⇒ perveance:
 $K = 1.87 \cdot 10^{-3}$
- $\varepsilon_{\text{in}} = 0.2 \pi \text{ mm mrad}$
- $\varepsilon_{\text{out}} < 0.25 \pi \text{ mm mrad}$
- ⇒ allowed Emittance growth: 25%
- goal current: $I_b = 5 \text{ mA}$
- ⇒ max. beam loss: 66%

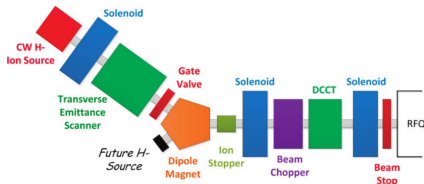


Image by [Sca12]

SECONDARY TASKS [SCA12]

- electric chopper (dumping: absorber in beam line)
- diagnosis
- separate neutrals
- induced decomp. in last part

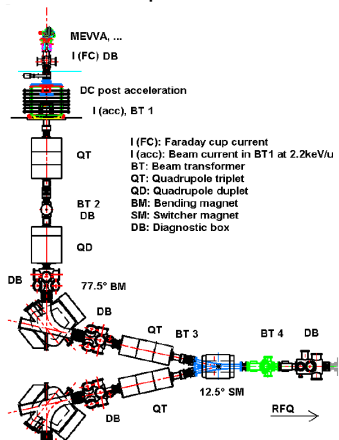
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HSI-LEBT

Primary task

- transport and match from two sources
- transport a lot of different beam species
- currents between several mA up to 210 mA

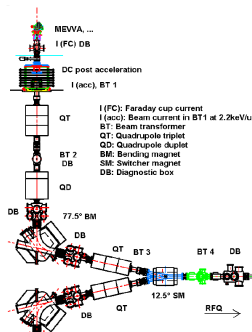


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PRIMARY TASK [HOL12]

- $I_B = 20 - 210 \text{ mA}$
(dep. on Ion species)
 - $W_B = 2.2 \frac{\text{keV}}{u}$
 - $\varepsilon_{\text{in}} \approx 200 - 1000 \pi \text{ mm mrad}$
(unnormalized)
 - $\varepsilon_{\text{out}} < 138 \pi \text{ mm mrad}$
(unnormalized)
- ⇒ allowed Emittance growth:
-31...-87%
- goal current: $I_b = 30 \text{ mA}$ (FAIR)
- ⇒ max. beam loss: $\approx 85\%$



SECONDARY TASKS

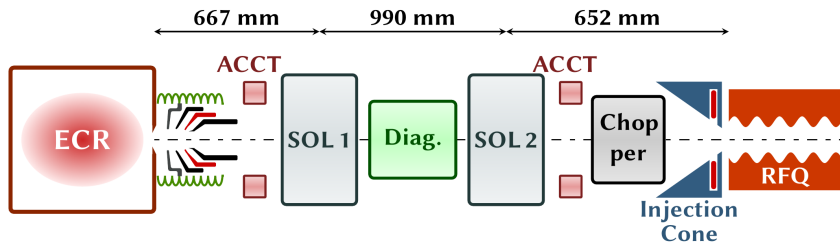
- charge state separation
- switch sources
- diagnosis

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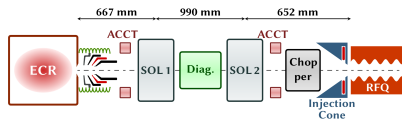
Primary task

- transport and match into RFQ
- $I_B = 100 \text{ mA}$, $W_B = 95 \text{ keV}$



PRIMARY TASK

- $I_B = 100 \text{ mA}$
- $W_B = 95 \text{ keV}$
- ⇒ perveance:
 $K = 2.22 \cdot 10^{-3}$
- $\varepsilon_{in} < 0.18 \pi \text{ mm mrad}$
[Cha14]
- $\varepsilon_{out} < 0.3 \pi \text{ mm mrad}$
- ⇒ allowed Emittance
growth: 66 %
- goal current: $I_b = 70 \text{ mA}$
- ⇒ max. beam loss: 30%

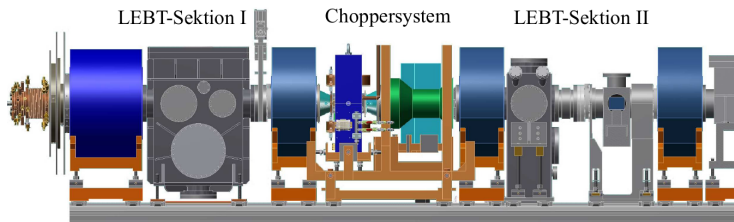


SECONDARY TASKS

- electric chopper
(dumping: RFQ entrance)
- ion separation with wien-filter
- diagnosis

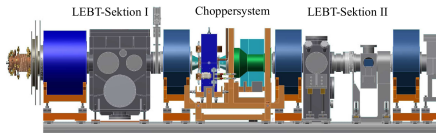
Primary task

- transport and match into chopper system
- transport and match into RFQ
- $I_B = 50 \text{ mA}$, $W_B = 120 \text{ keV}$



PRIMARY TASK

- $I_B = 50 \text{ mA}$
- $W_B = 120 \text{ keV}$
- ⇒ perveance:
 $K = 0.87 \cdot 10^{-3}$
- $\varepsilon_{\text{in}} = 0.03 \pi \text{ mm mrad}$
- $\varepsilon_{\text{out}} < 0.3 \pi \text{ mm mrad}$
- ⇒ allowed Emittance
growth: $10\times$
- goal current: $I_b = 50 \text{ mA}$



SECONDARY TASKS

- $E \times B$ chopper
(dumping: separate dump)
- ion separation
- diagnosis

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WEITER FÜR:



Image source: [Teu99]

Thank you for your attention.

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- CHA14 N. Chauvin et al.**, *Status of the FAIR Proton Source and LEBT*, Proceedings of LINAC2014, Geneva, Switzerland, THPP015
- HOL12 R. Hollinger**, *High Current Ion Sources for the FAIR Accelerator Facility*, Proceedings of RUPAC12
- SAL14 R. Salemme**, *The MYRRHA LEBT test stand*, Talk at EuCARD-2/MAX Accelerators for Accelerator Driven Systems Workshop
- SCA12 Scarpine et al.**, *Fermilab PXIE Beam Diagnostics Development and Testing at the HINS Beam Facility*, Proceedings of IPAC2012, New Orleans, Louisiana, USA, MOPPR072
- TEU99 Klaus Teuber**, *Die Siedler von Catan*, Erweiterung zum Kartenspiel