ERL Mode of S-DALINAC: Design and Status*

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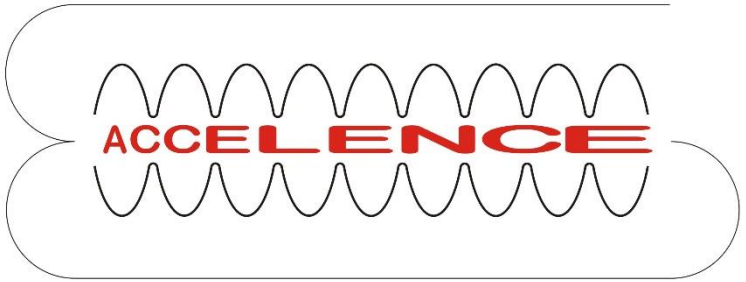
[2] Helmholtz-Institut Mainz



*Work supported by DFG through RTG 2128, INST163/383-1/FUGG and INST163/384-1/FUGG

Content

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- Overview S-DALINAC
- Design of third recirculation / ERL
- Status of commissioning

ACCELENCE

S-DALINAC - Old

Superconducting-**Da**rmstadt-**Lin**ear-**Ac**celerator

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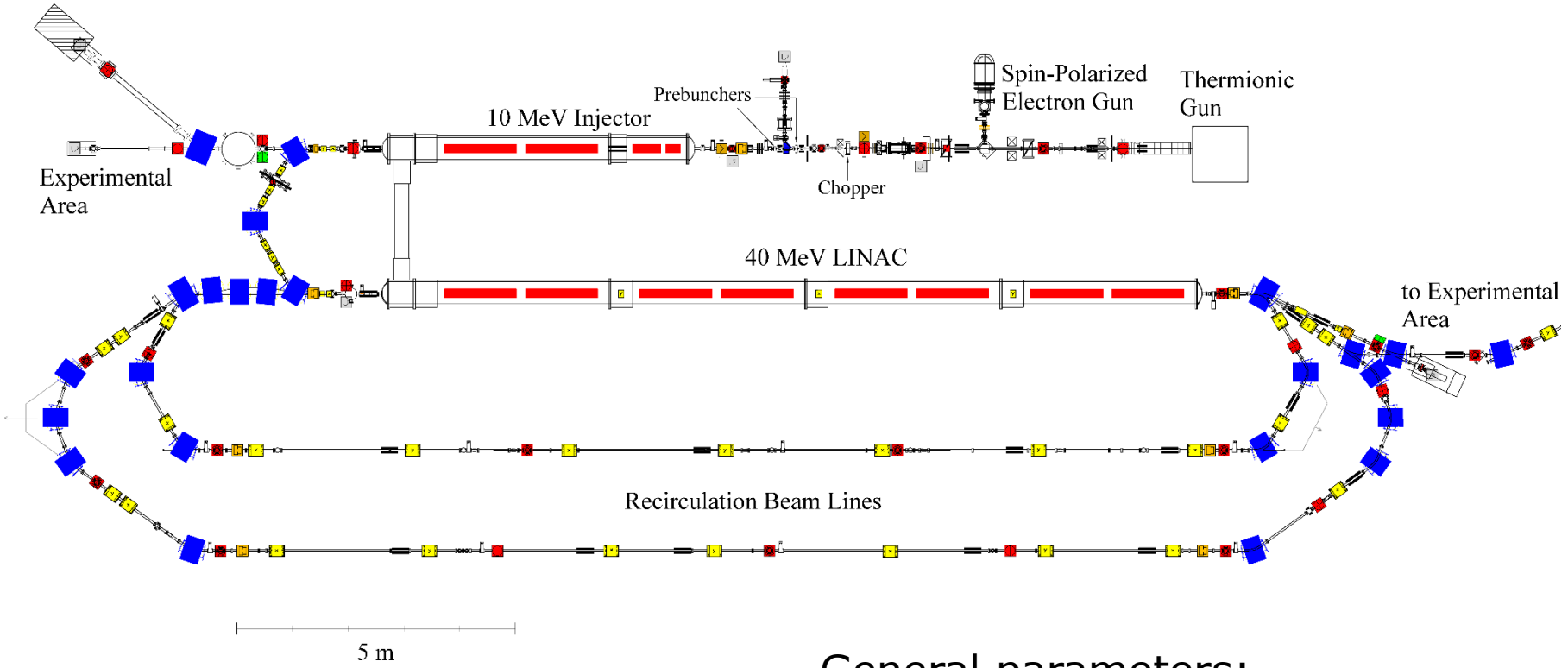

- Built in the 1980s
- First beam in 1987
- 1991 first recirculated beam

General parameters:

Modus: cw-operation

Operating frequency: 3 GHz

S-DALINAC - New

Superconducting-**Da**rmstadt-**Lin**ear-**Ac**celerator

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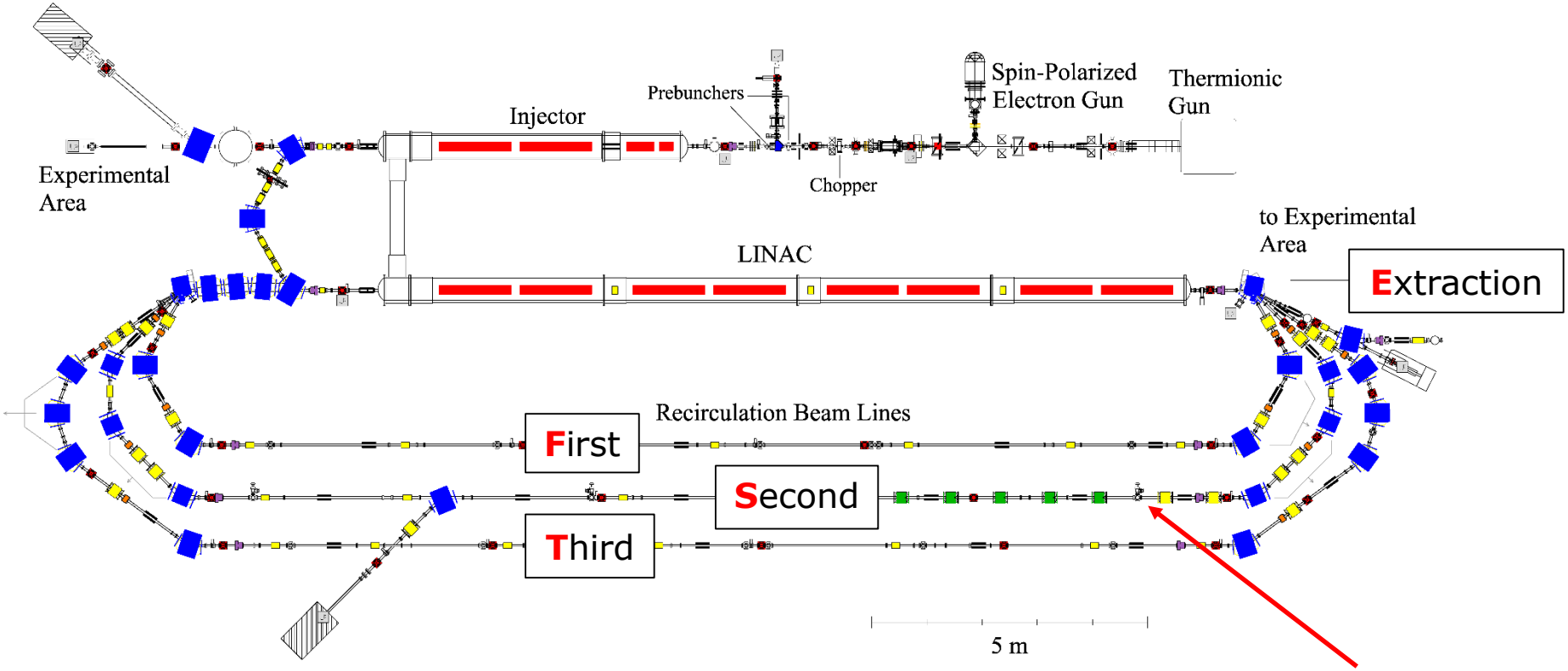


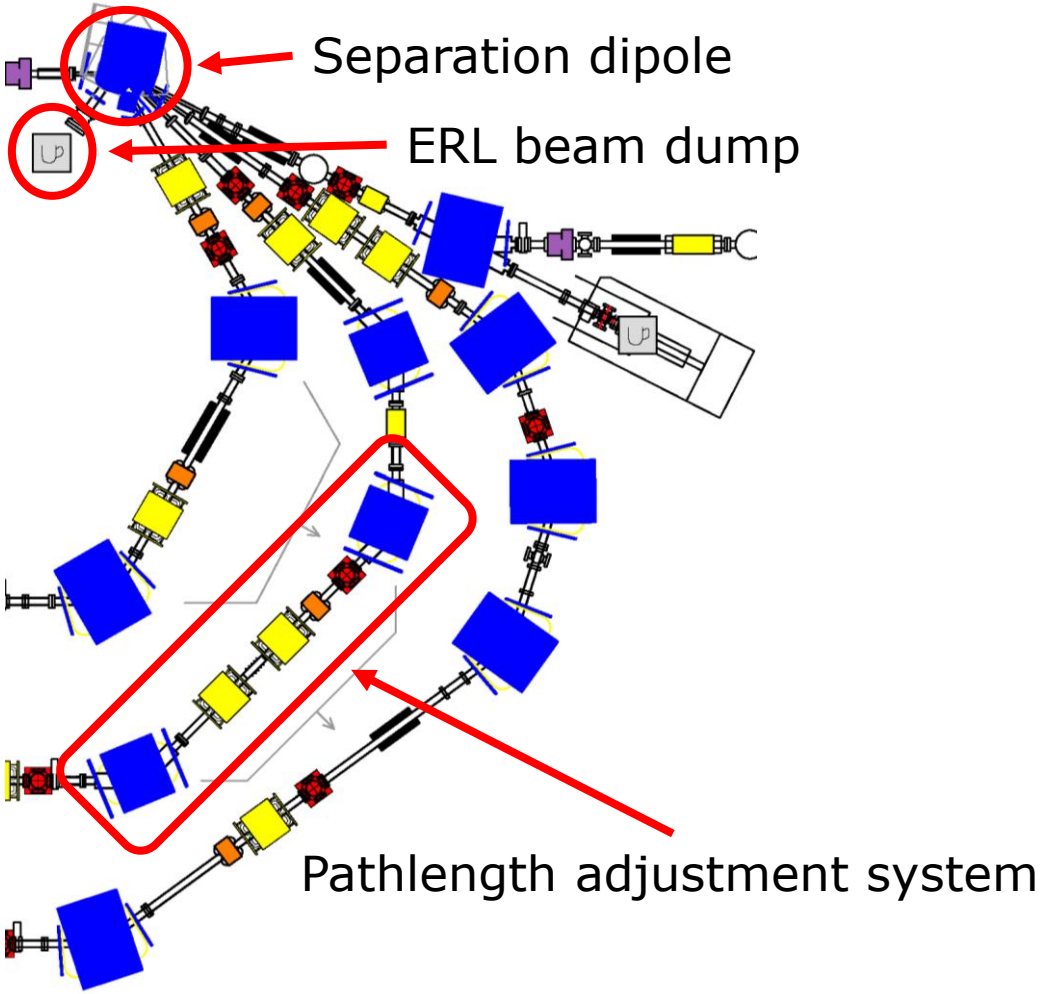
Thrice recirculating operation

Energy gain injector: 7.6 MeV

Energy gain LINAC: 30.4 MeV

Beam current: approx. 20 µA

S-DALINAC as ERL



S-DALINAC as ERL

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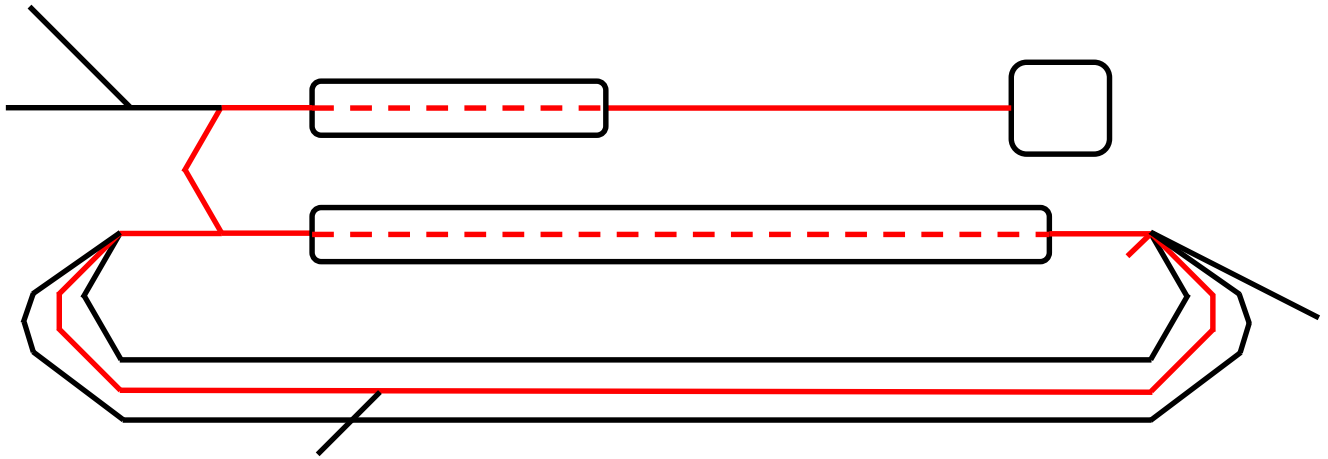
once



S-DALINAC as ERL

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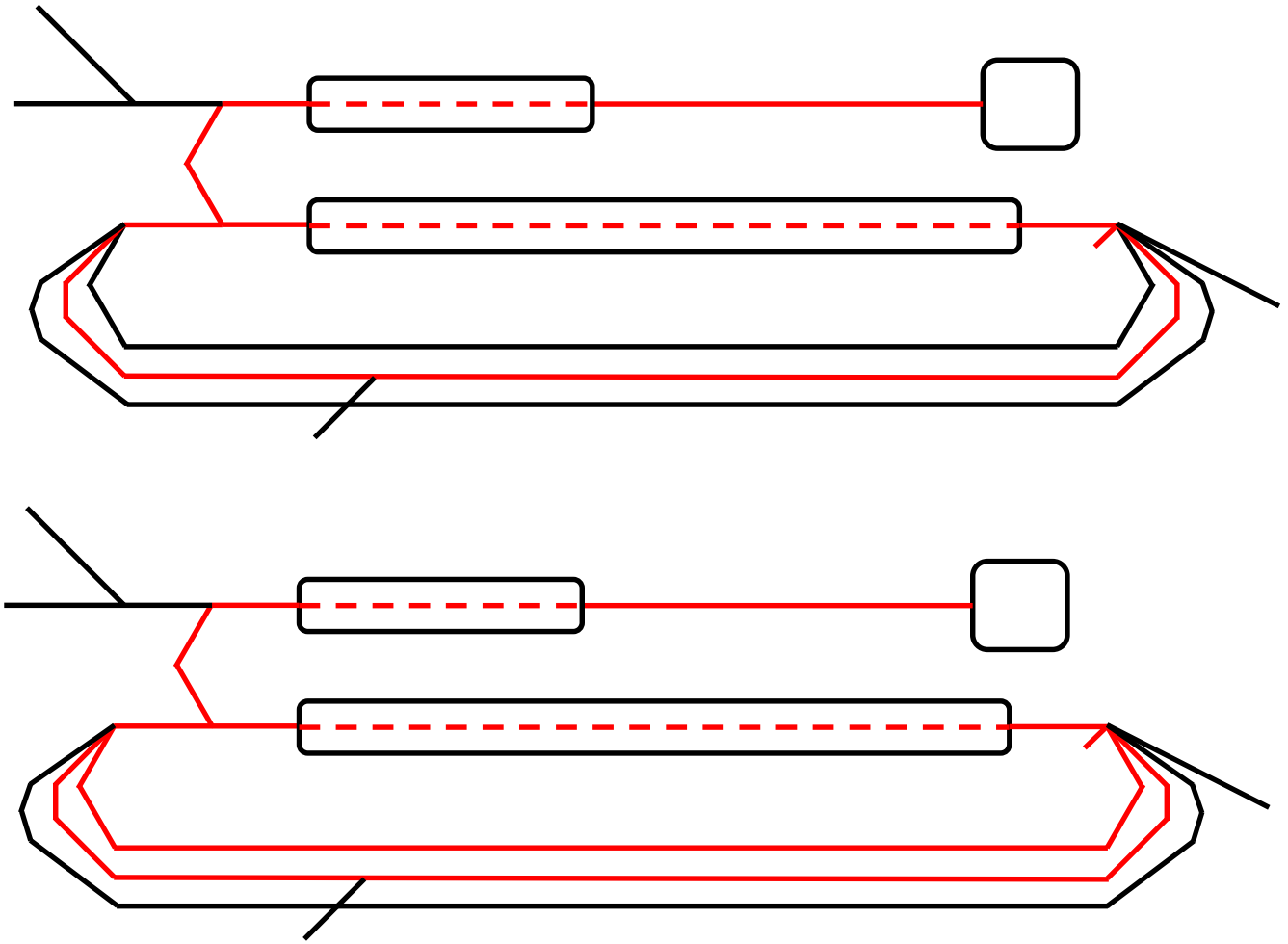
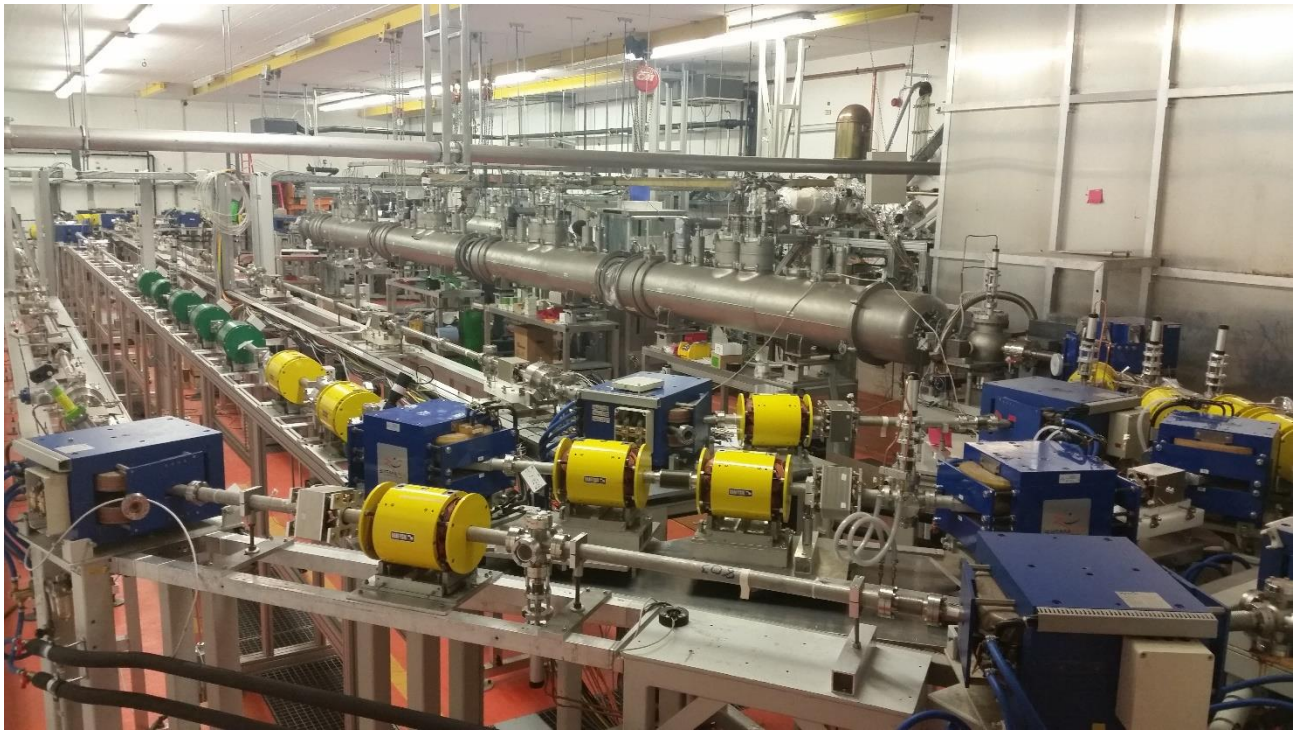
once

twice



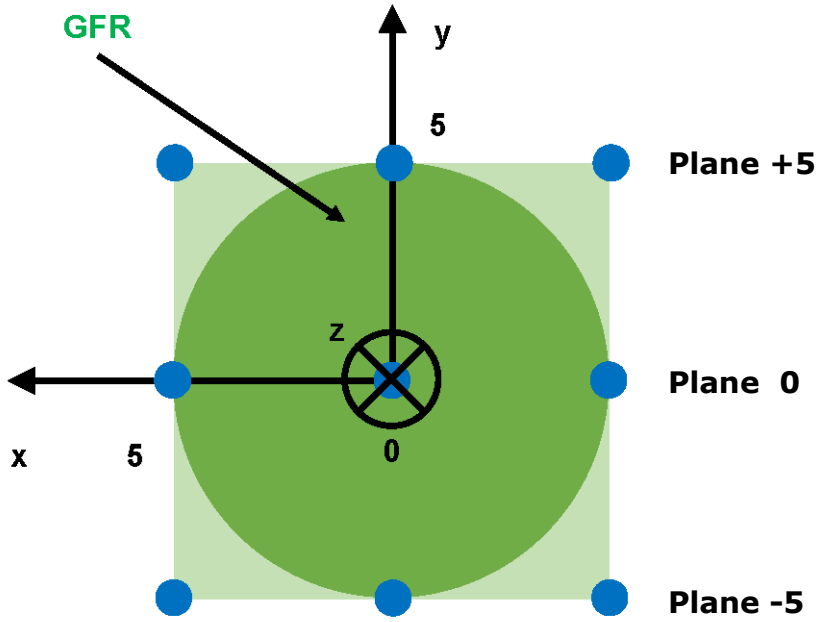
Design of Third Recirculation / ERL



Main Requirements Separation Dipole

Field quality in "good field region" (GFR)

- Deflecting properties
- Homogeneity of field (transversal, longitudinal) $\leq 1 \cdot 10^{-3}$
- Multipole components $\leq 1 \cdot 10^{-3}$



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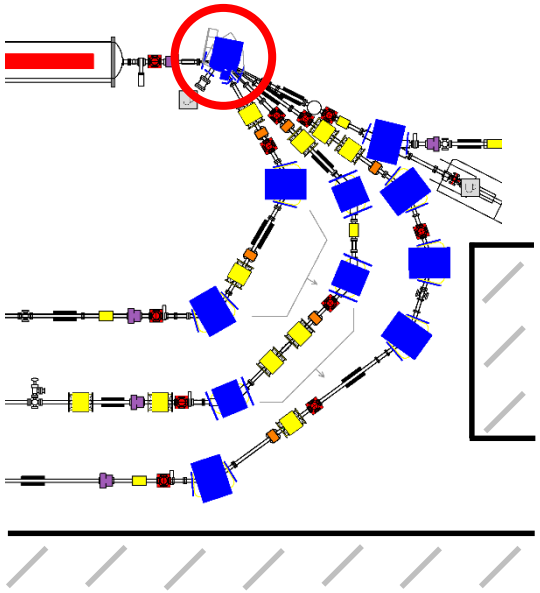
Additionally

- Spacial limitation



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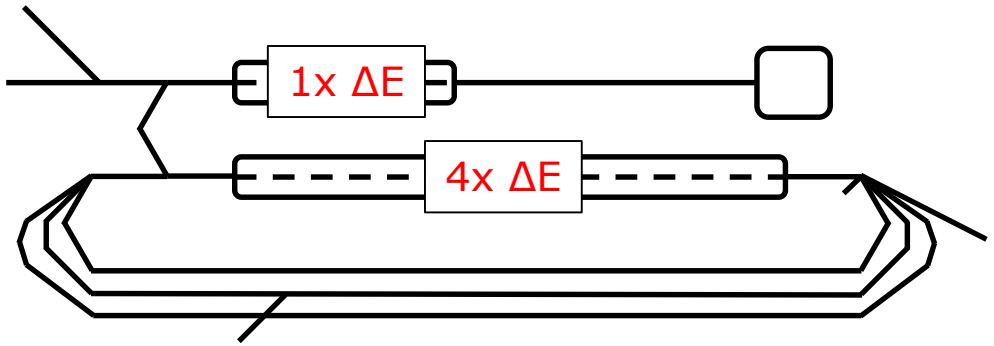
- Energy ratio fixed



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Additionally

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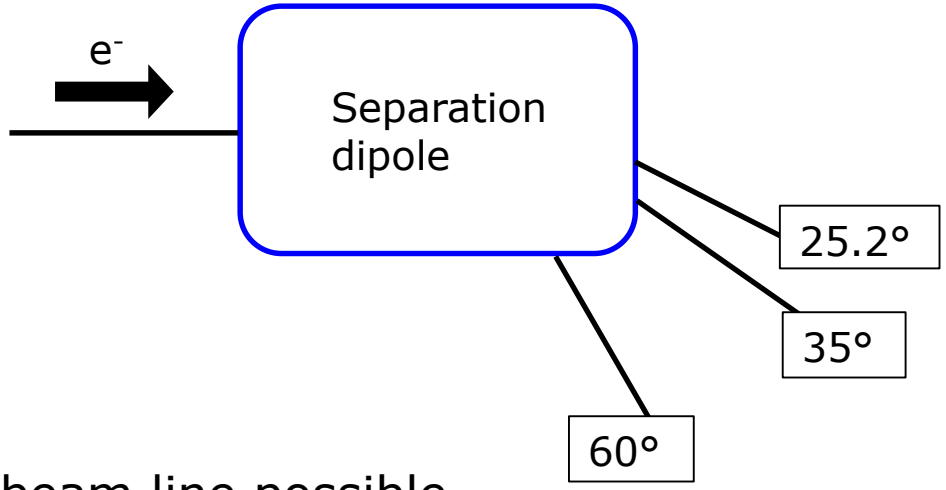
- Energy ratio fixed
- Existing beam lines



→ Fixation of one recirculation beam line possible

Main Requirements Separation Dipole

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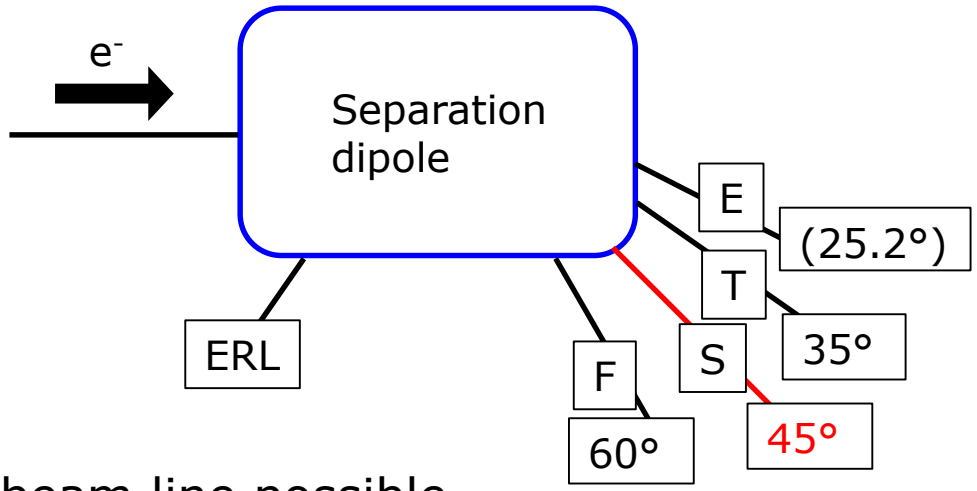
- Homogeneity of field (transversal, longitudinal) $\leq 1 \cdot 10^{-3}$
- Multipole components $\leq 1 \cdot 10^{-3}$

Additionally

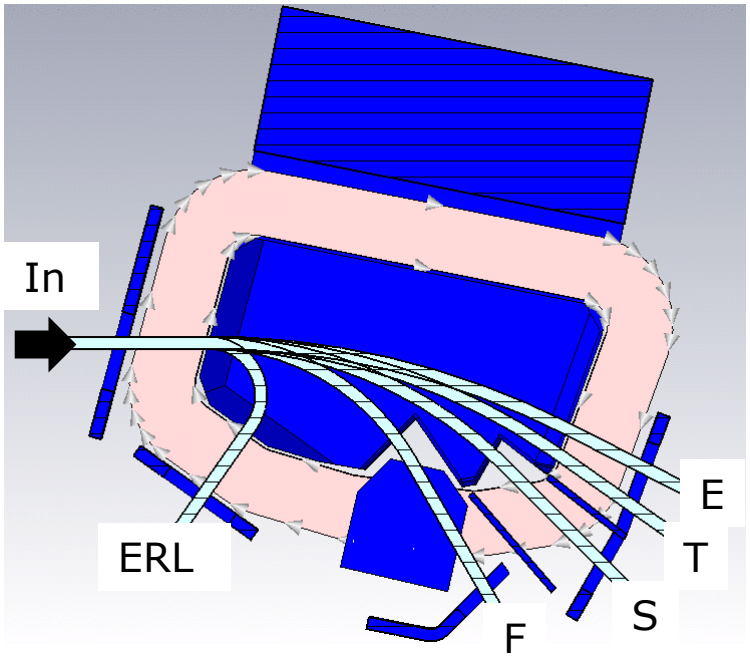
- Spacial limitation
- Energy ratio fixed
- Existing beam lines
- ERL exit

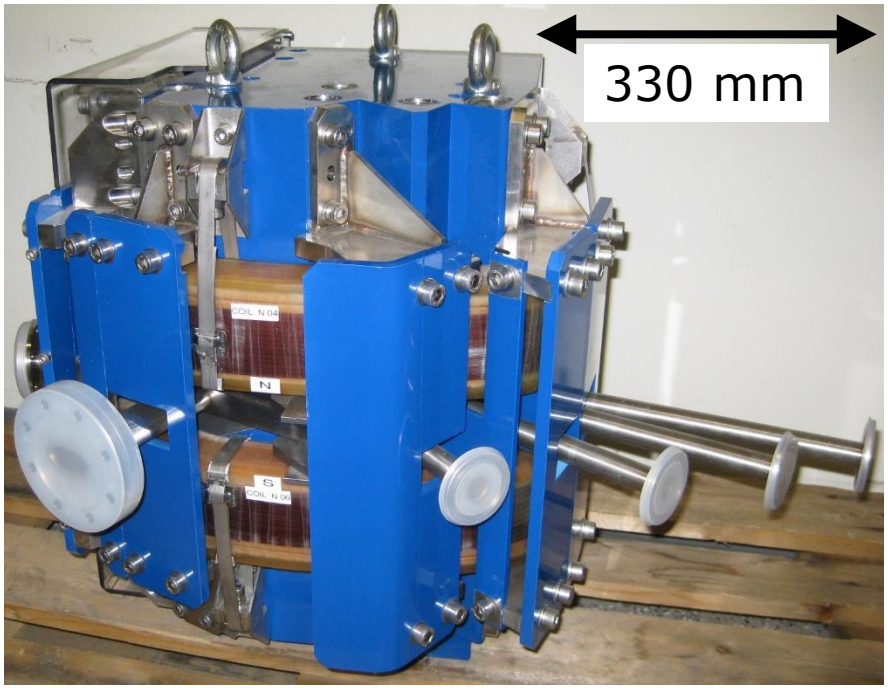


→ Fixation of one recirculation beam line possible

→ Beam dynamics simulations F, S, T, E

Final Design





B_{Design}: 0.65 T at 130 MeV

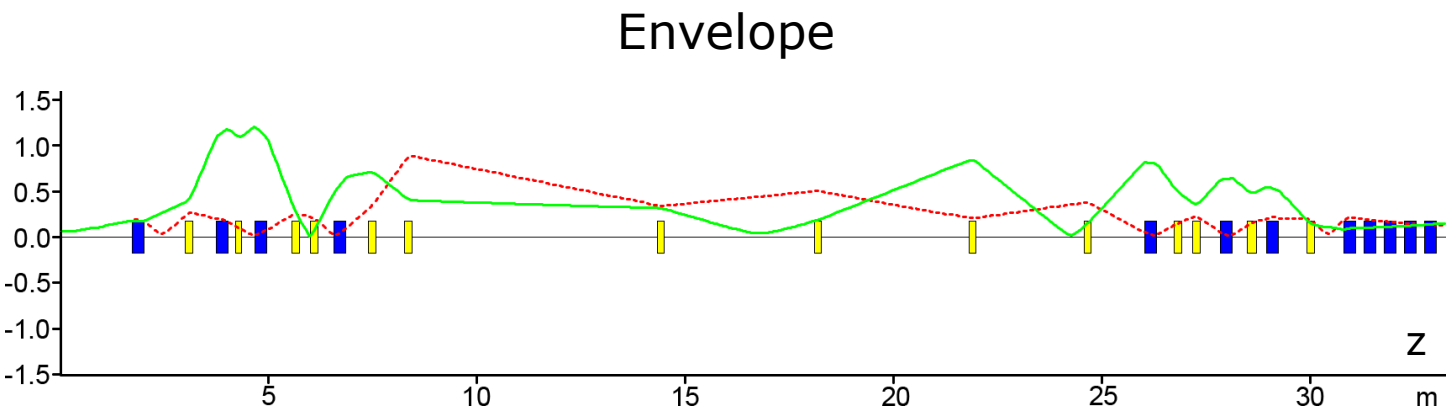
Mirror plates as key elements

Pole gap: 30 mm

C yoke

Beam Dynamics

Recirculation S



Beam Dynamics

Recirculation S

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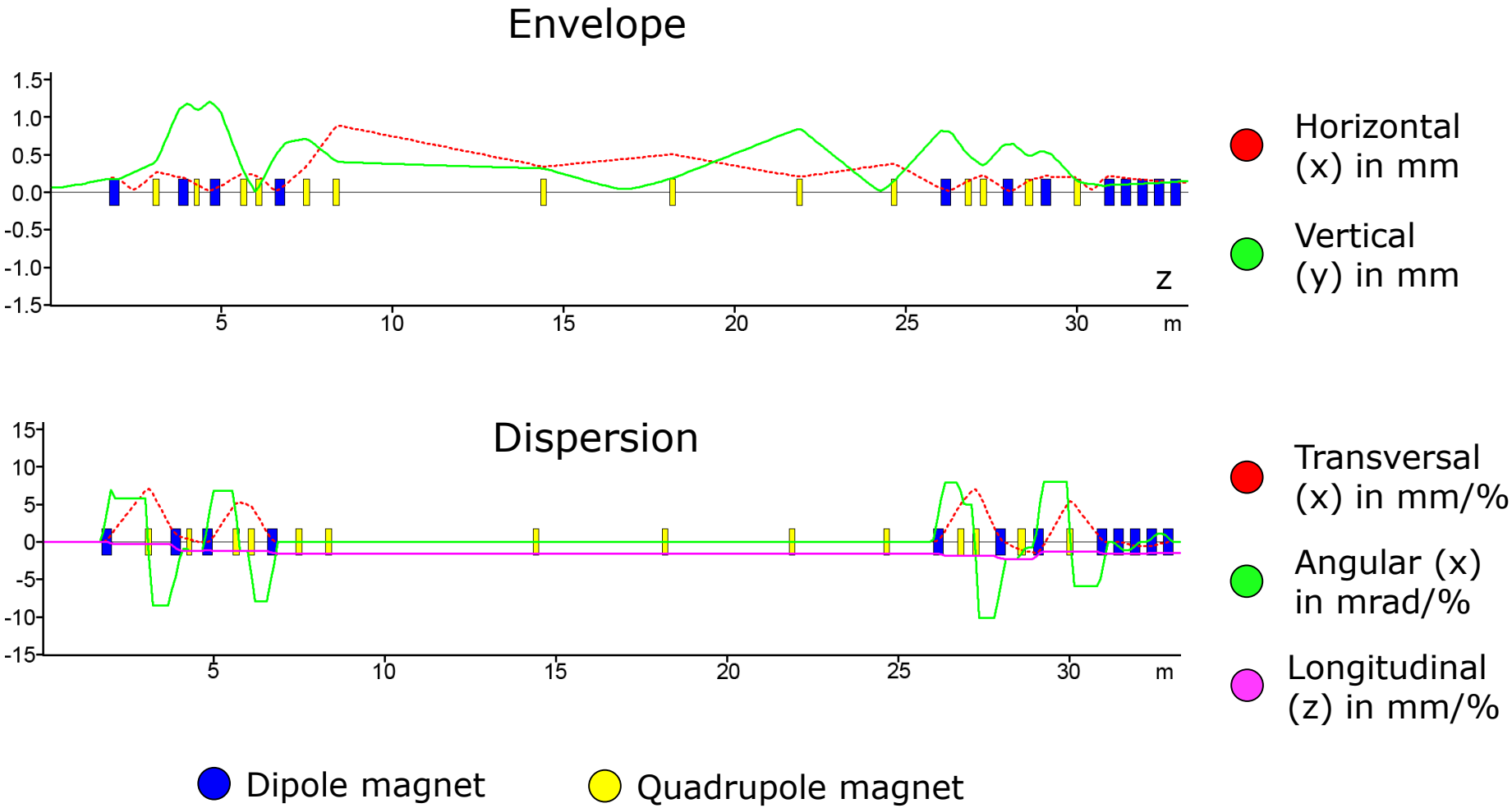
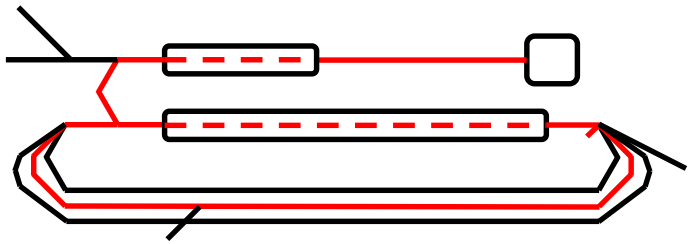
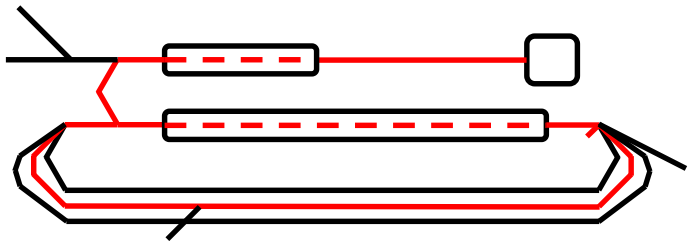


Beam Dynamics ERL



- Twice recirculating ERL under investigation

Beam Dynamics ERL



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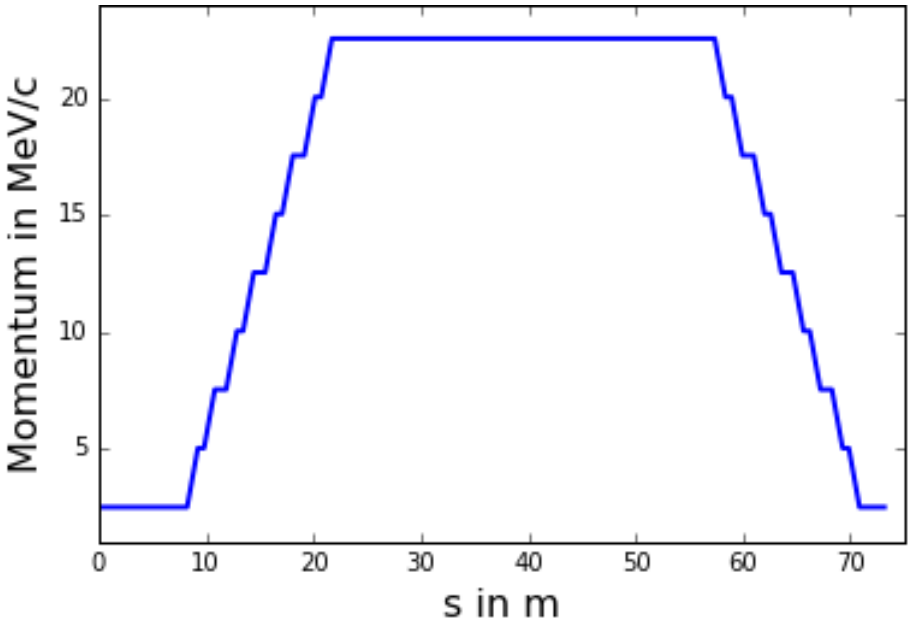
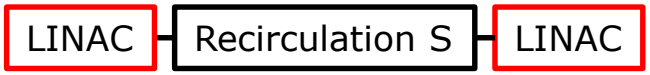
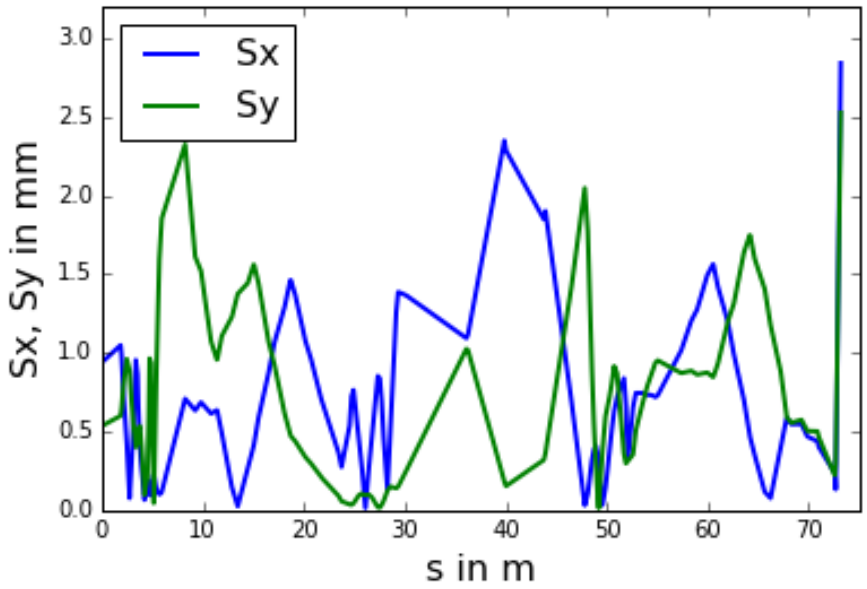
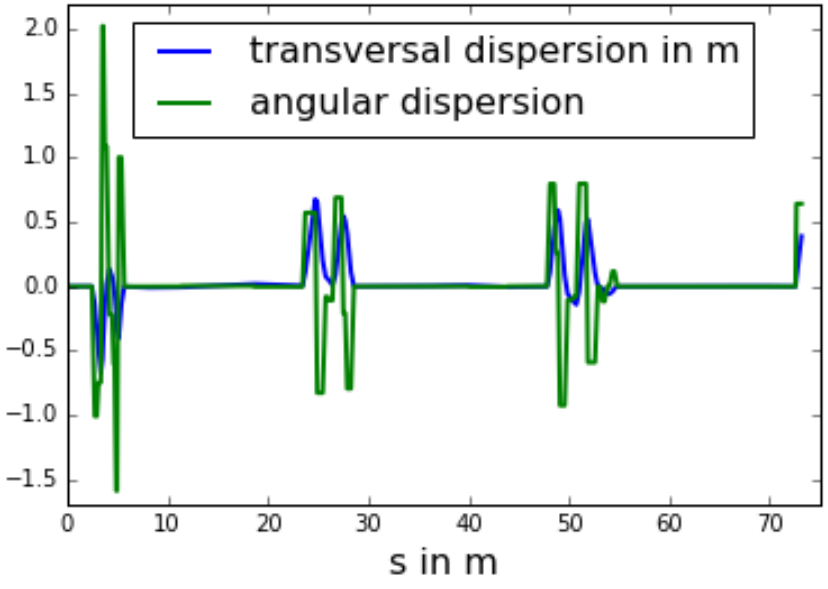


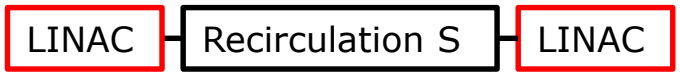


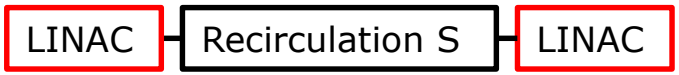
Simulation by J. Pforr

Beam Dynamics ERL









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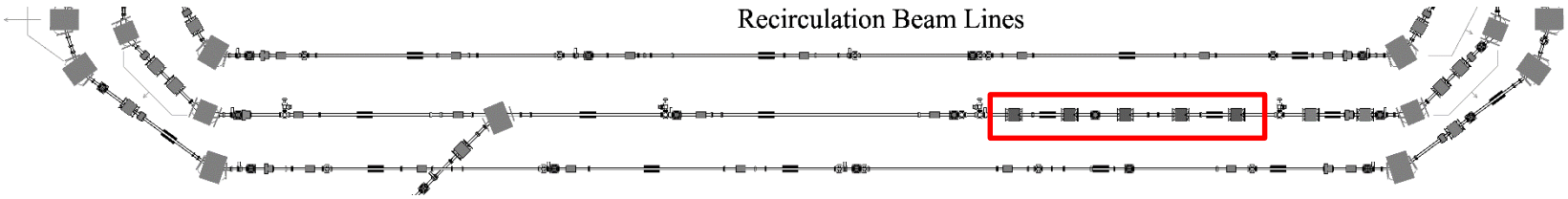
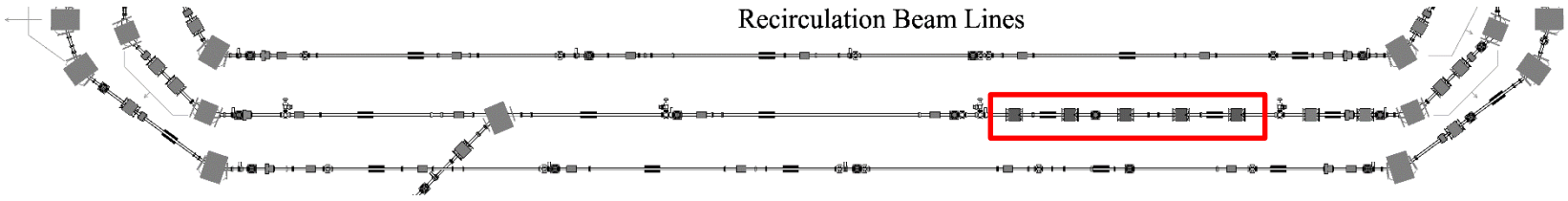
Beam Dynamics ERL



- Exchange of transversal phase space to increase BBU limit
- Five skew quadrupole magnets

Beam Dynamics ERL



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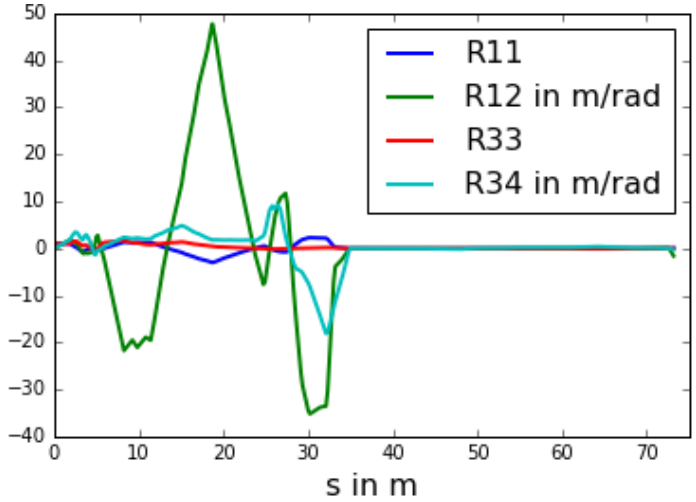
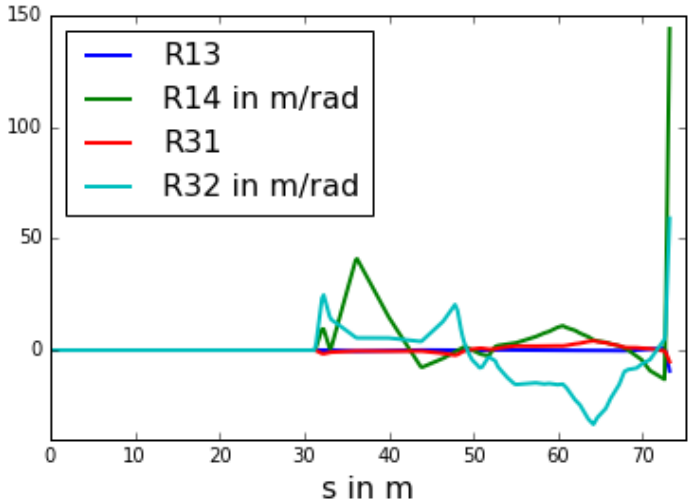
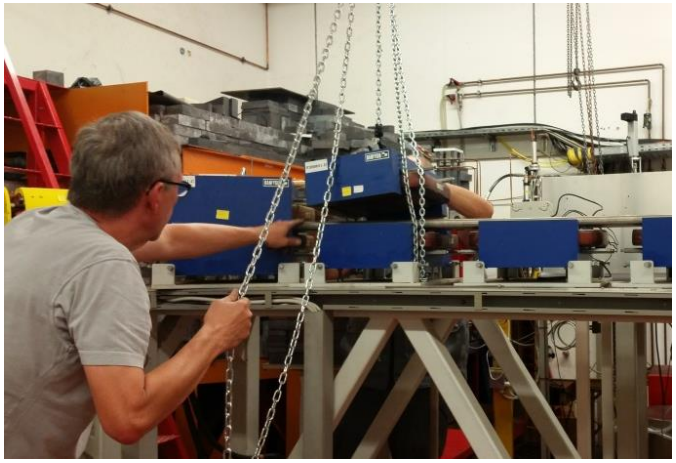


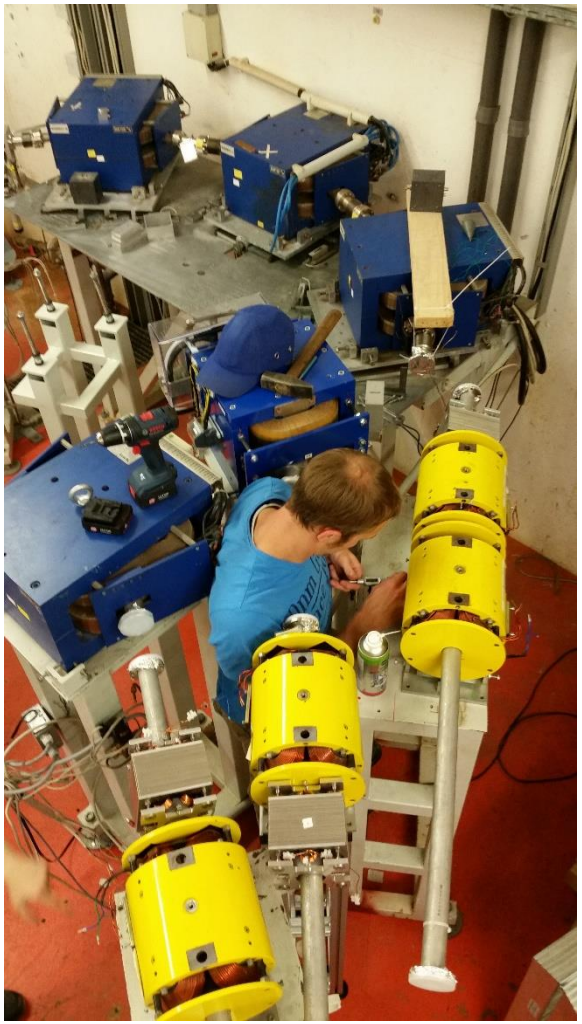
LINAC | Recirculation S | LINAC



LINAC | Recirculation S | LINAC

Installation





Precision Achieved

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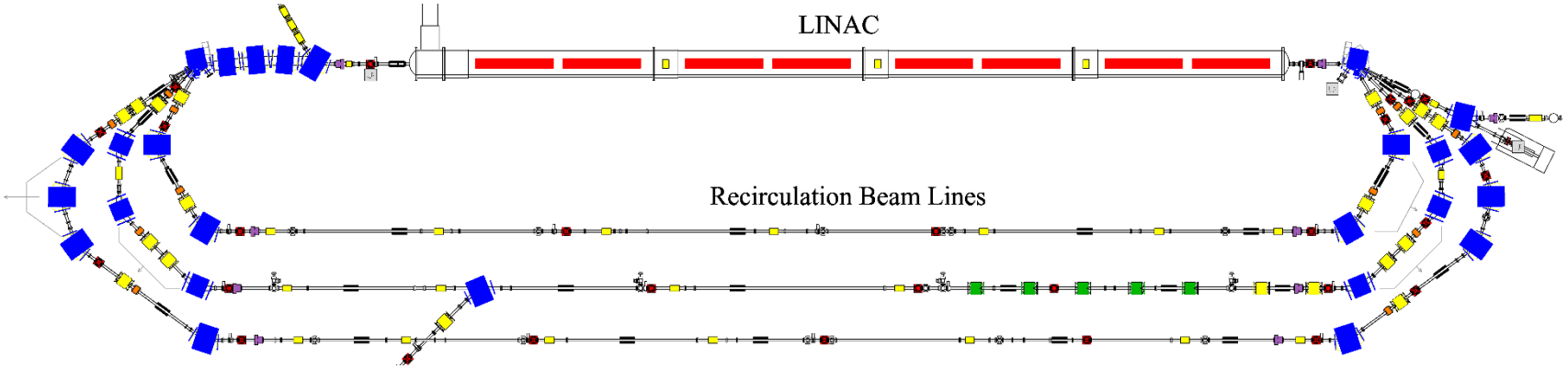
Position in mm (1D-Residues)			
Type	Horizontal (x)	Vertical (y)	Beam Axis (z)
Dipole	0.27 ± 0.12	0.20 ± 0.14	0.17 ± 0.13
Quadrupole Typ 1	0.27 ± 0.11	0.19 ± 0.12	0.23 ± 0.18
Quadrupole Typ 2	0.32 ± 0.16	0.21 ± 0.17	0.28 ± 0.23
Sextupole	0.33 ± 0.18	0.29 ± 0.22	0.15 ± 0.11

Precision of measurement-method, no target position used and thus no residues to it

Type	Tilt in ° around x and z
Dipole	0.020 ± 0.019
Quadrupole Typ 1 und 2	0.057 ± 0.051
Sextupole	0.104 ± 0.084

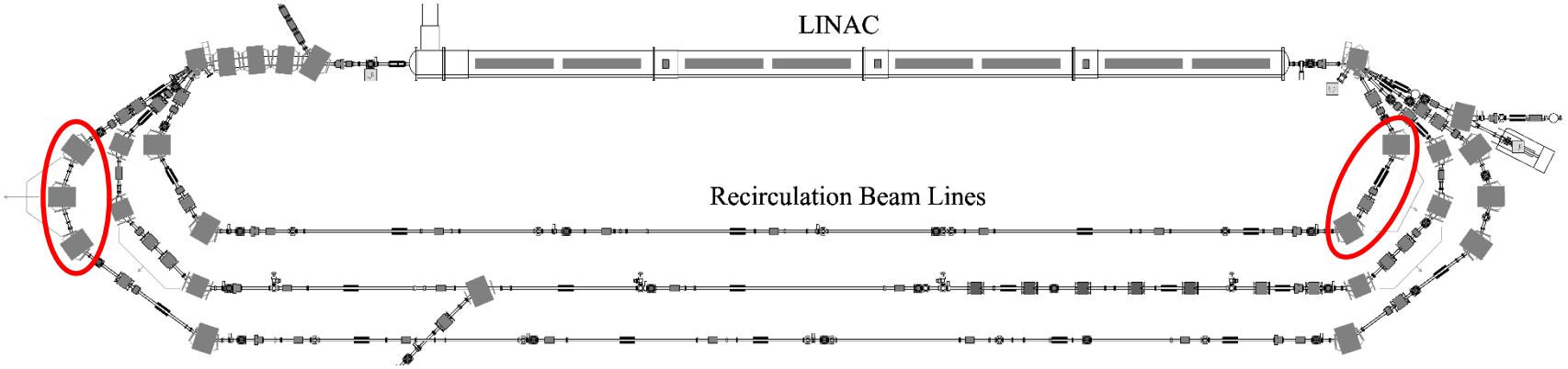
ACCELENCE

Pathlength Adjustment System



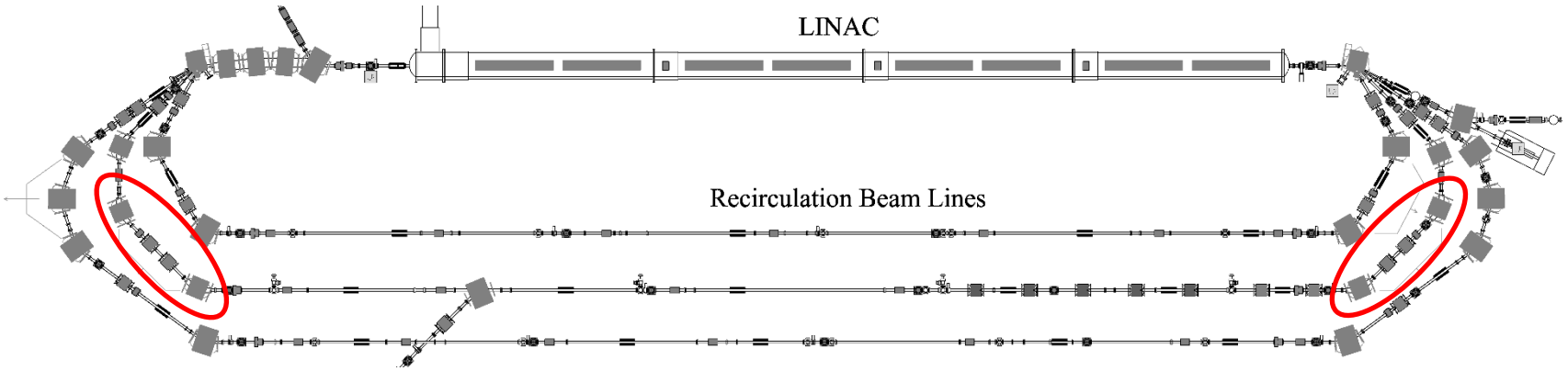
- Adjusting the phase of the beam re-entering the main LINAC

Pathlength Adjustment System



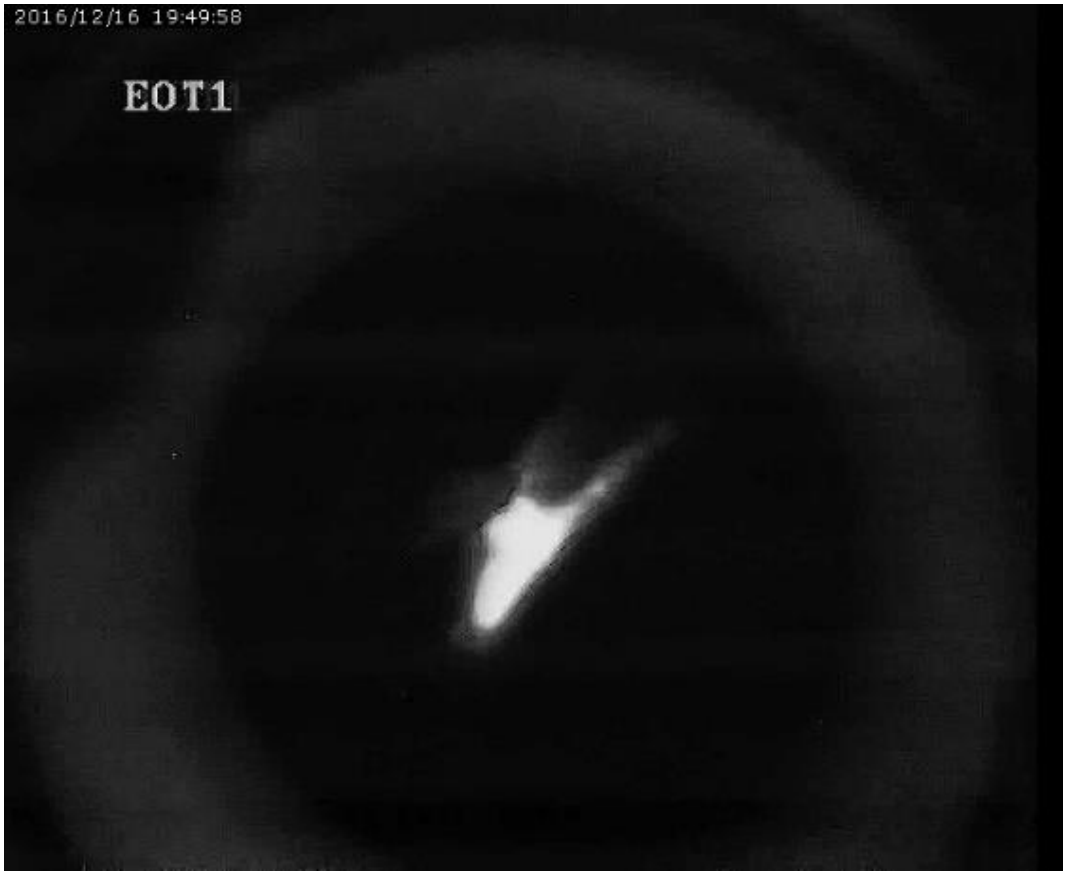
- Adjusting the phase of the beam re-entering the main LINAC
- Existing systems in old recirculation beam lines
  - Stroke F measured: 33.76 mm
  - Stroke T measured: 30.62 mm

Pathlength Adjustment System



- Adjusting the phase of the beam re-entering the main LINAC
- Existing systems in old recirculation beam lines
  - Stroke F measured: 33.76 mm
  - Stroke T measured: 30.62 mm
- New systems are capable of full RF wavelength adjustment
  - Stroke measured: (50.21 + 50.57) mm = 100.78 mm

Status of Commissioning



Long and Stony Road to Go

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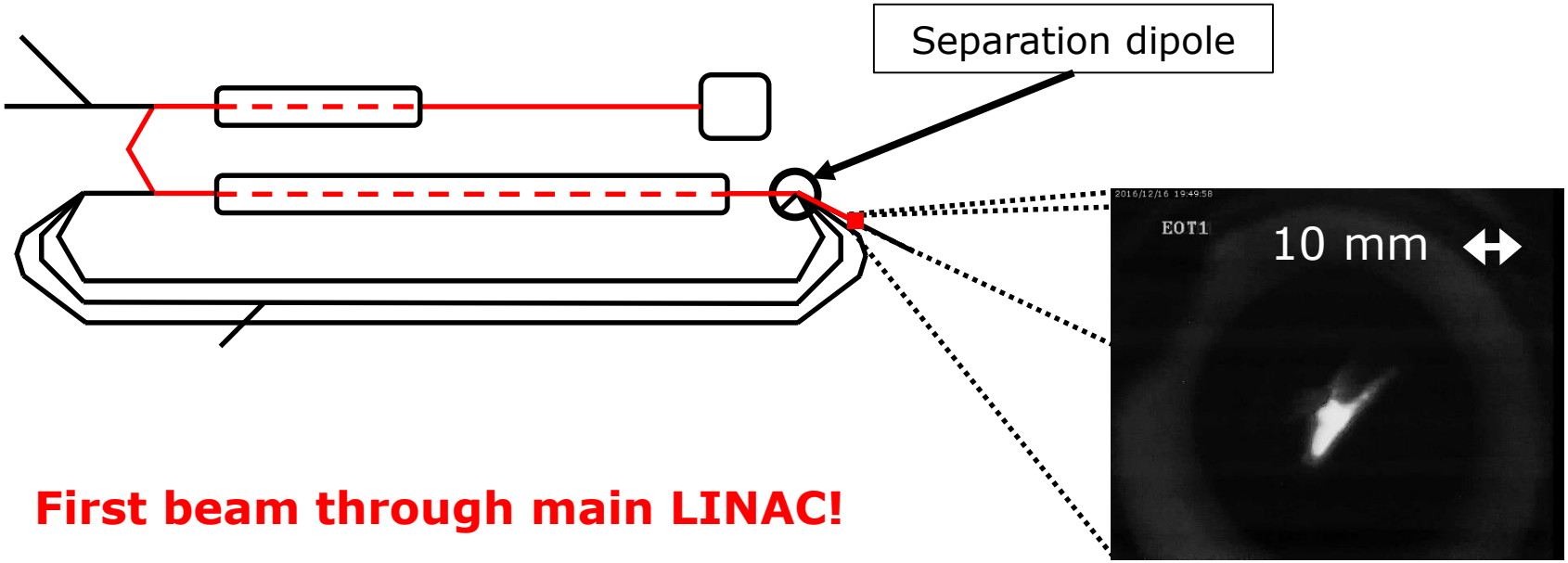
Success 1



First beam through main LINAC!

(16.12.16 18:45 Uhr)

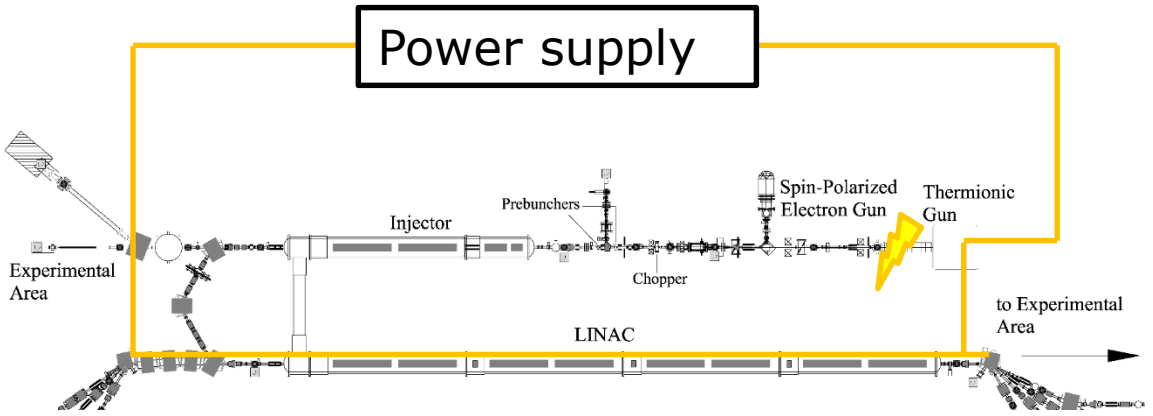
BeO-Target

Long and Stony Road to Go

Success 1

completed

Challenge 1



$B_{cable} \approx 3\mu T$

- Powering of separation dipole → deflection of beam at gun
- Unexpected Helium compressor maintenance
- ~ 9 weeks

Long and Stony Road to Go

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Success 1

Challenge 1 — completed

Challenge 2 — completed

- Leak in LN_2 shielding of cryostat
- ~ 4 weeks

ACCELENCE

Long and Stony Road to Go

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Success 1

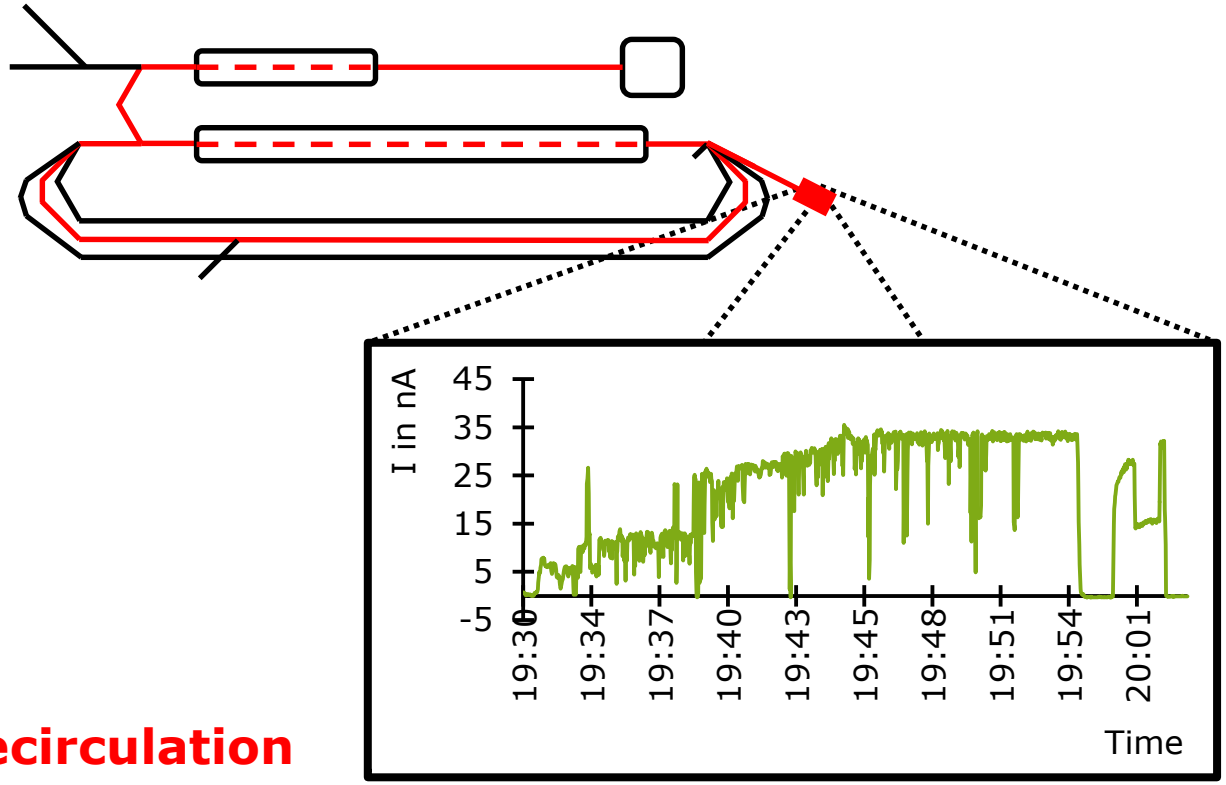
completed

Challenge 1

completed

Challenge 2

Success 2



First beam in new recirculation beam line and twice through main LINAC! (May 2017)

Transmission of ~35 %

Long and Stony Road to Go

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Success 1

Challenge 1 — completed

Challenge 2 — completed

Success 2

Challenge 3 — ongoing

- 2/3 quadrupole magnets in main LINAC broken
- First main LINAC cavity not operable

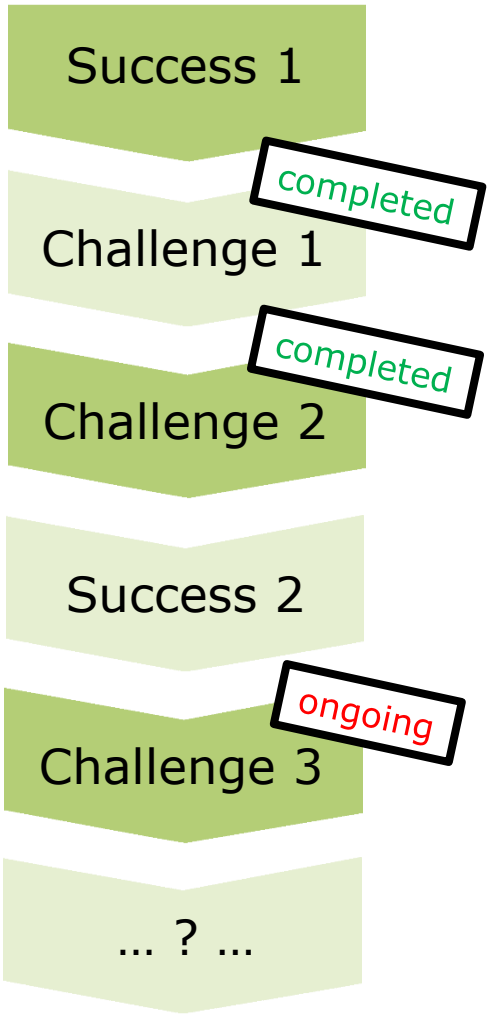
→ Shut down for maintenance

- Additionally: Installation of new steering magnets between main LINAC modules

- ~ 6 weeks (estimation)

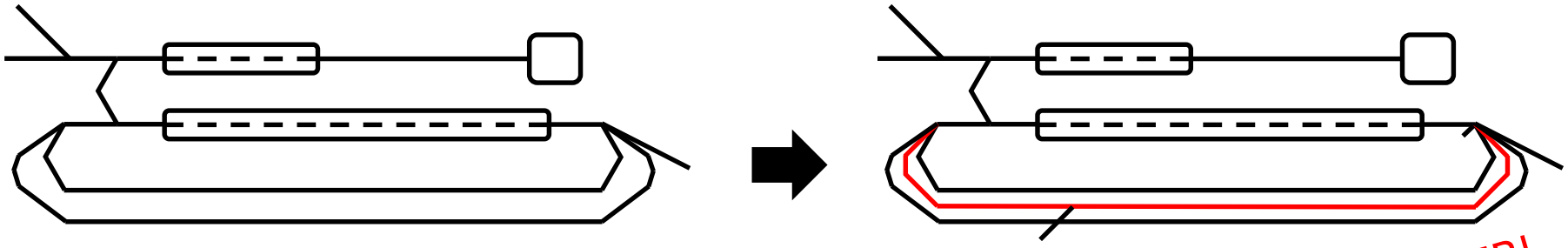
ACCELENCE

Long and Stony Road to Go



Commissioning continues
beginning of July 2017

Take Home Massage



Modification of S-DALINAC

- Magnet design separation dipole was challenging
- Beam dynamics for lattice and different modes calculated
- Installation of beam line finished
- Alignment of lattice conducted
- Functionality of pathlength adjustment systems proven
- Challenges and successes during commissioning experienced

Thanks a lot for your attention!

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Thanks to...

… the whole accelerator group and both workshops!

… Florian Hug (KPH Mainz) for his great support!

… Ulrich Römer (TEMF) for helping with the design of the separation dipole!

… Cornelia Eschelbach and Michael Lösler (FH FFM) for their help with the alignment!

… Philipp Winkemann (FH FFM) for his work with the laserscanner!