

Charge Stripper

FAIR Experiments and Accelerators
Darmstadtium – 14. of December 2018
Stefan Zeller

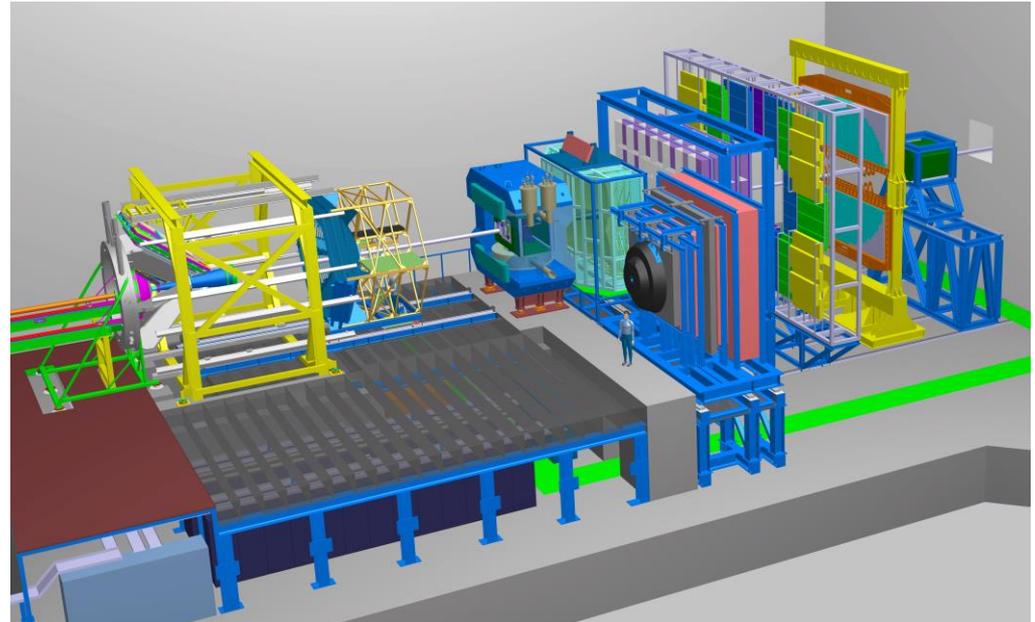
1. Requirements of Experiments
 - CBM
 - SPARC
2. FAIR Parallel Operation Modes
3. Design Approach
 - Linear motion
 - Rotational motion
4. Evaluation of Concept
5. Discussion

CBM

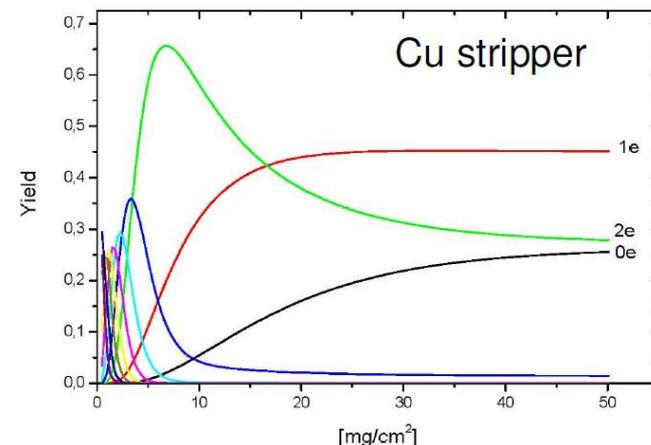
Experiments with bare ions, e.g.
 Au^{79+} , U^{92+}

Highest intensities possible

Highest energies possible



Bare ions are produced by sending the beam through a 100-200 μm metal foil, e.g.
Nb 195 mg/cm^2 :
967 MeV/u $\text{U}^{73+} \rightarrow \text{U}^{92+}$ with 87%



Au,
230 MeV/u
 $Q_{\text{in}} = 59$

SPARC

Experiments with ions of a defined charge state, typically ions with 0 to 4 electrons

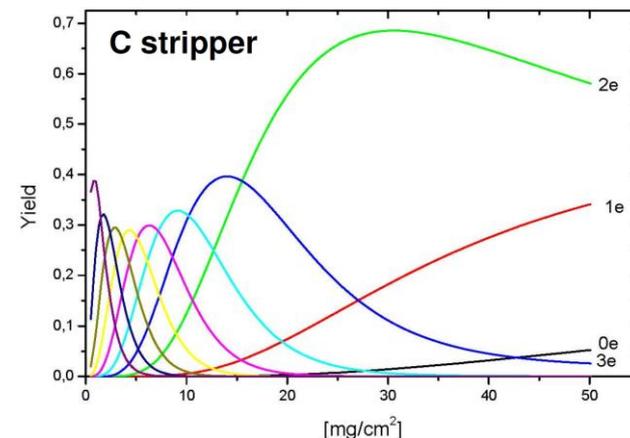
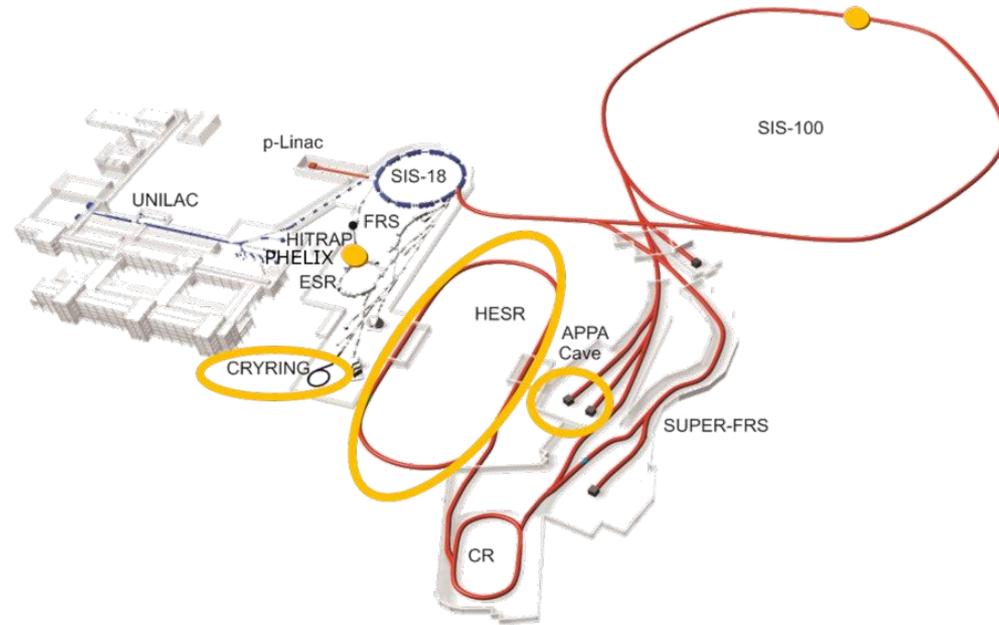
Intensity: $1E^8 - 5E^{11}$ ions/s

Energies: 0,5 – 10 GeV/u

Momentum spread: $\Delta p/p = \sim 1E^{-4}$

Multiple species over the course of one beamtime block.

Charge state tailoring to maximize fraction of desired charge state



Au,
230 MeV/u
 $Q_{in} = 59$

FAIR Parallel Operation Modes



In Parallel Operation Modes, the beam is shared between different experiments in defined reference patterns of pulses.

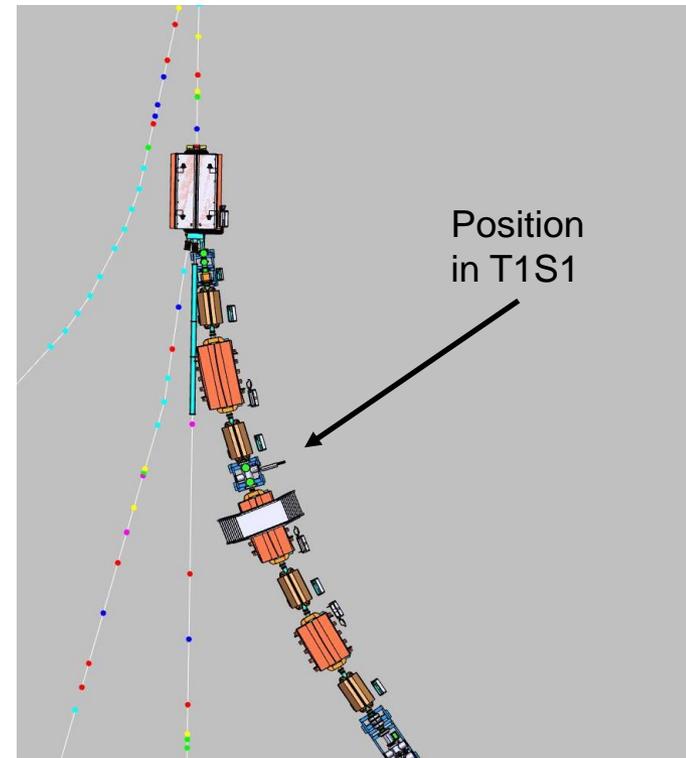
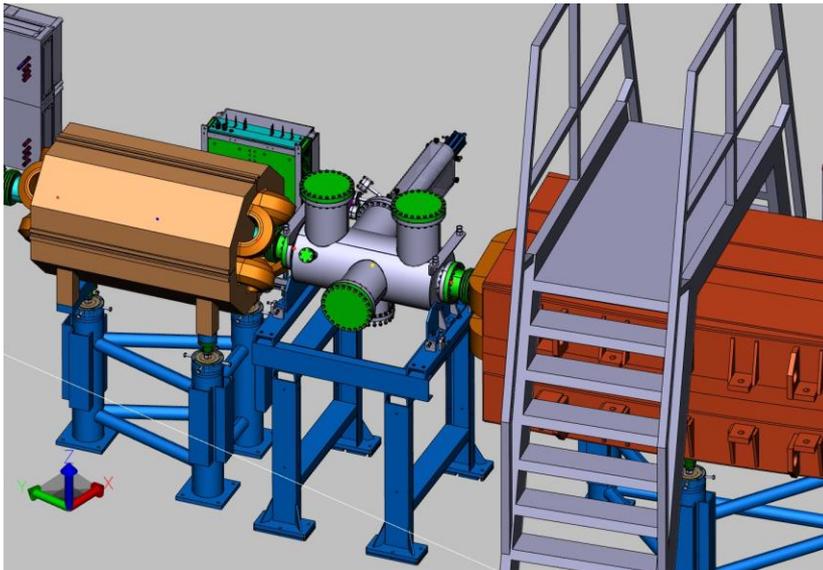
Depending on the experiments consecutive pulses require different charge states.

→ Stripping foils have to be insertable or exchangeable between two pulses

see text for explanation of the color codes.	columns: parasitic user											
	SIS18 - SIS100 - SuperFRS	SIS18 - SIS100 - SuperFRS - CR	SIS18 - SuperFRS	SIS18 - SuperFRS - CR	SIS100 - CBM	Antiprotons: CR - HESR	SIS18 - SIS100 - APPA	SIS18 - SIS100 - APPA (Plasma physics)	SIS18 - APPA	SIS18 - CR - HESR	SIS18 - ESR (- Crying)	SIS18 - HTA or HTM
rows: main user												
SIS18 - SIS100 - SuperFRS	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1
SIS18 - SIS100 - SuperFRS - CR	#6	#6	#6	#6	#6	#6	#6	#6	#6	#6	#6	#6
SIS18 - SuperFRS	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1
SIS18 - SuperFRS - CR	#6	#6	#6	#6	#6	#6	#6	#6	#6	#6	#6	#6
SIS100 - CBM	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1
Antiprotons: CR - HESR	#2	#2	#2	#2	#2	#2	#2	#2	#2	#2	#2	#2
SIS18 - SIS100 - APPA	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1
SIS18 - SIS100 - APPA (Plasma physics)	#5	#5	#5	#5	#5	#5	#5	#5	#5	#5	#5	#5
SIS18 - APPA	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1
SIS18 - CR - HESR	#1	#6	#1	#6	#6	#4	#6	#5	#6	#6	#6	#1
SIS18 - ESR (- Crying)	#1	#6	#1	#6	#6	#4	#6	#5	#6	#6	#6	#1
SIS18 - HTA or HTM	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1	#1
Sharing is not desired												
Sharing is not possible												
change overhead/penalty												
time-sharing												
reference pattern												

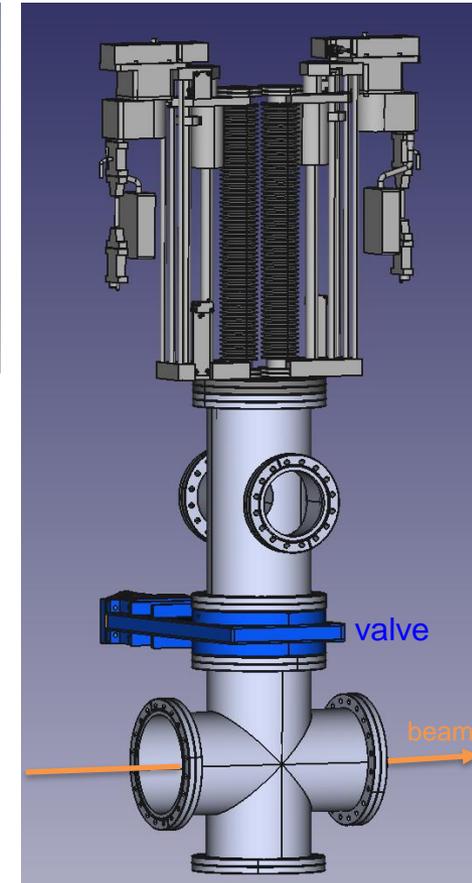
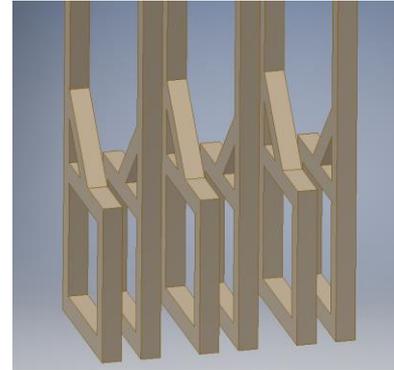
Boundary Conditions:

- Stripper shall be placed directly after SIS18, in beamline T1S1.
- 5+ different stripping foils should be available at any time. The more, the better.
- Time to move the foils in/out of the beam: ~250 ms
- Size of the beam: 55x52 mm
- Area required for adjusting the beam: 70x70 mm
- Possibility to replace foils during shutdown.
- Vacuum conditions: $1 \cdot 10^{-8}$ mbar



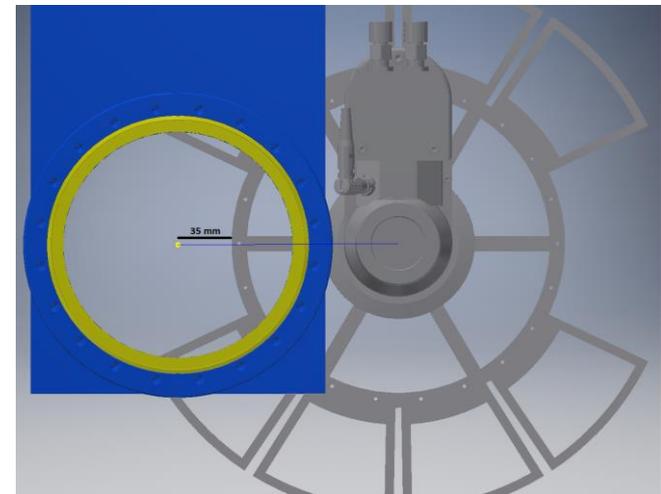
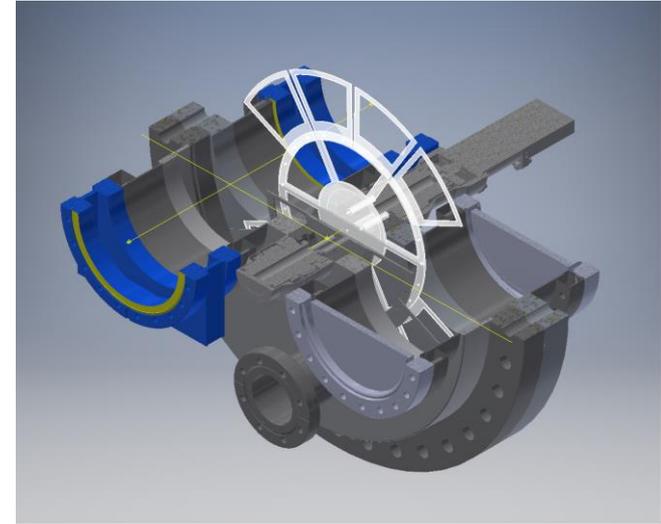
Linear Motion:

- Stripping foils are placed in single frames. One Motor per foil.
- Three defined positions:
 - In beam path
 - out of the beam at the closest possible distance of 35 mm (movement of 70 mm required)
 - service position behind valve
- Same exchange time for any pair of foils.
- Lifetime of edge welded bellow reached within years.
- 4-6 foils (limited space in T1S1)



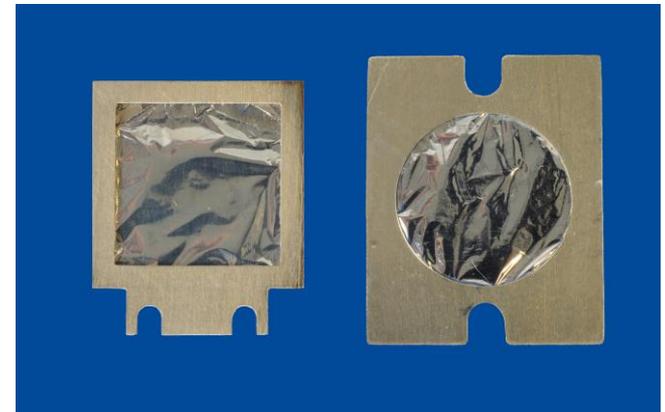
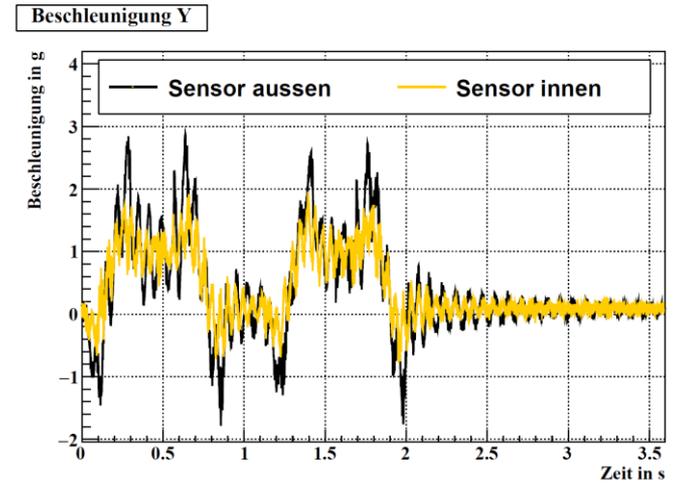
Rotational Motion:

- Stripping foils are placed in targetwheel
- Change to adjacent foil by rotation of 33° .
- Different swap times for any pair of foils. Sequence of foils should consider beamtime requirements.
- Continuous rotation possible, but currently not planned (difficult timing with possibly non-stable beam pattern)
- Magnetically coupled. No bellow which might wear out.
- 16 foils in current design draft.
- Larger volume to be vented in case of maintenance (but presumably fewer interventions required).



Toughness of foils:

- Acceleration required to move the foils 70 mm in 250 ms: ± 1 g for optimized ramp
- But: besides the pure acceleration, vibrations are transferred during the motion, which can exceed 3 g. Stress on foils is currently evaluated.
- Presumably weakest foil is determined by Atomic Physics group (e.g. Carbon, 20 μm) and will be tested in air and, if required, in vacuum.





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