Conditions at the Storage Rings

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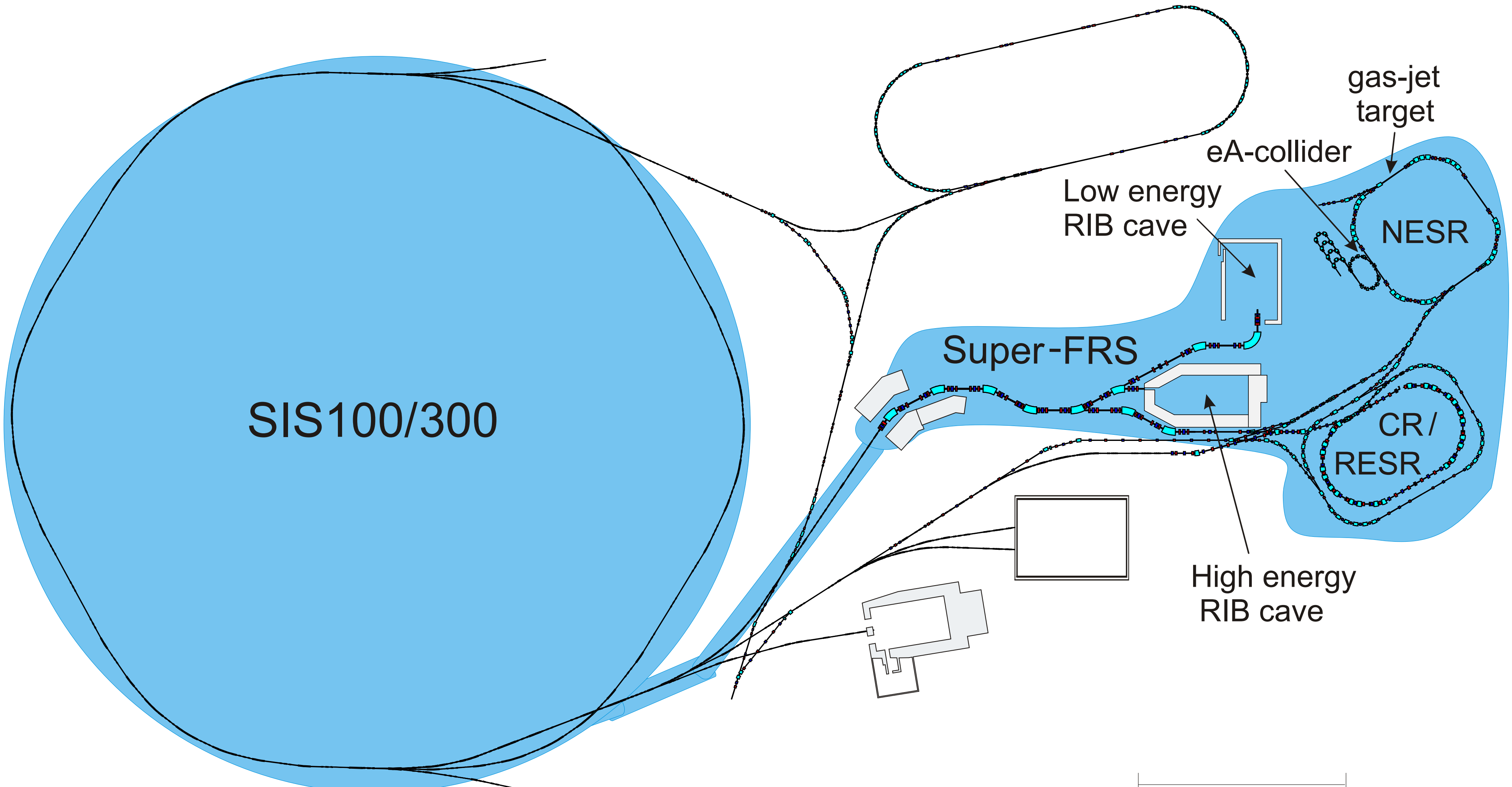
EXL collaboration meeting
Liverpool, 22-23.06.2004

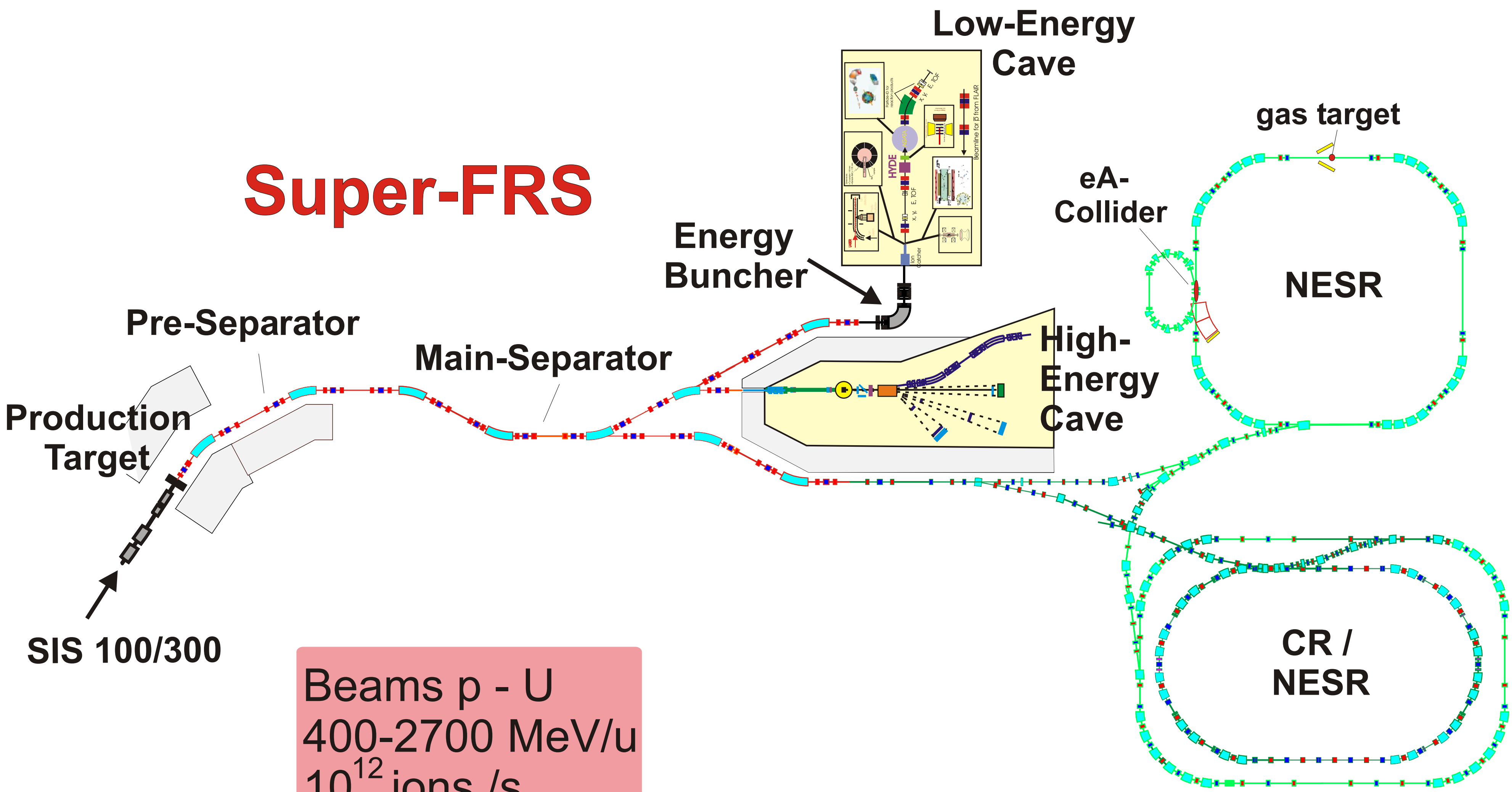
- Beams from Super-FRS
- Operation of storage rings
- Luminosities
- Work packages Super-FRS

Layout of FAIR Beamlines

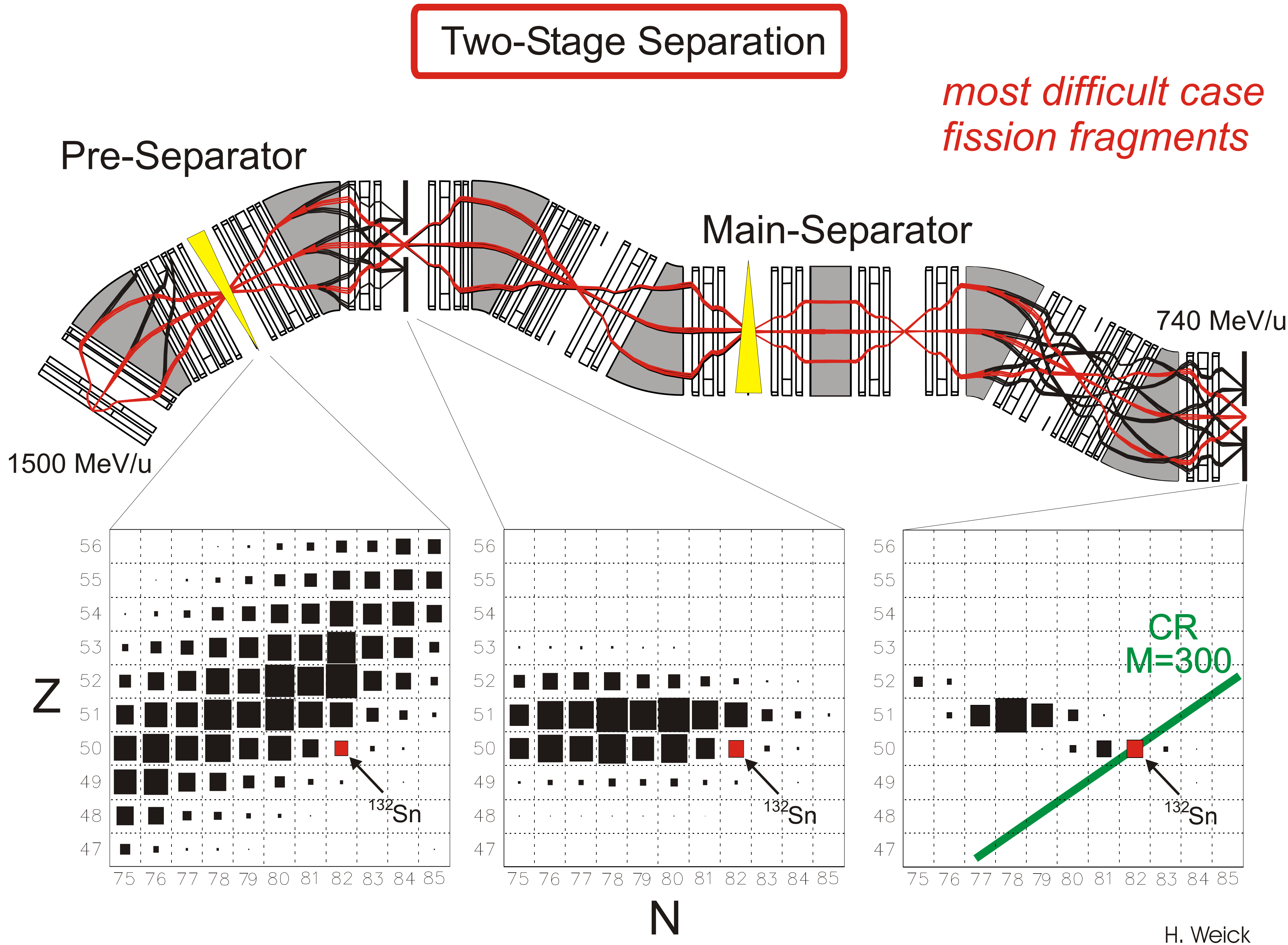


topology 21.06.2004

Layout of the NUSTAR Facility



Beams p - U
400-2700 MeV/u
10^{12} ions /s

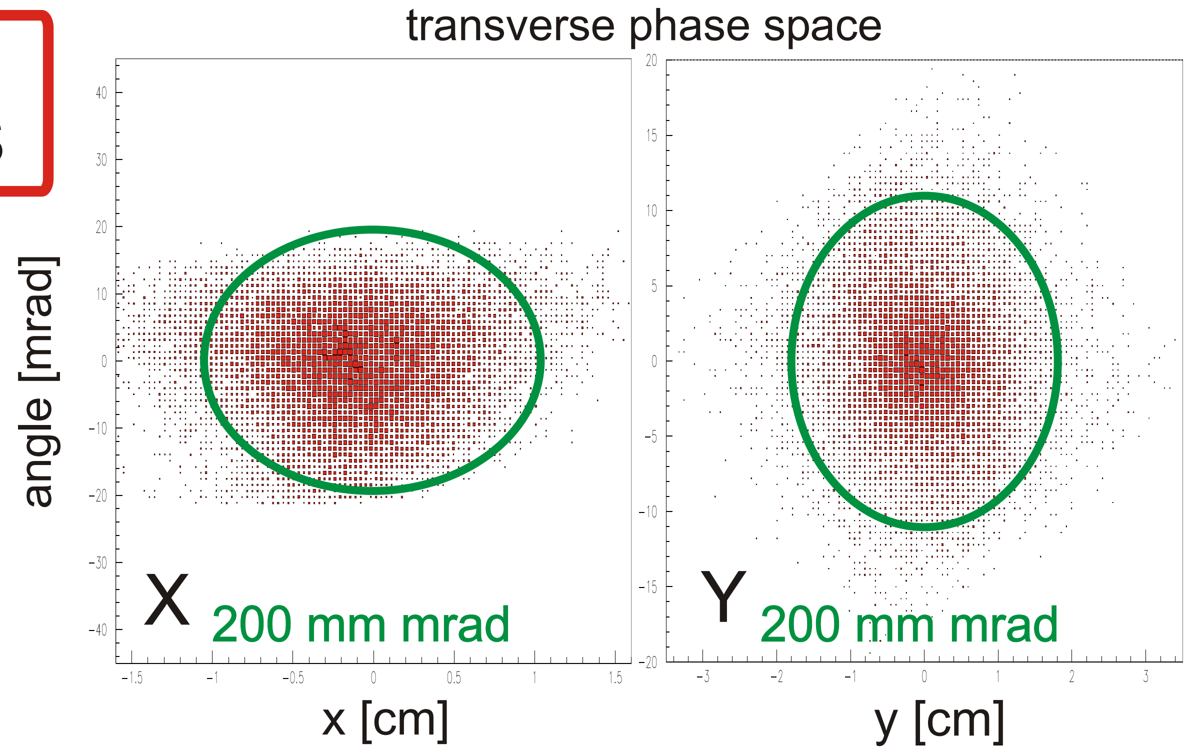

Two-Stage Separation
most difficult case
fission fragments
Pre-Separator
Main-Separator
740 MeV/u
1500 MeV/u
Z
56
55
54
53
52
51
50
49
48
47
75 76 77 78 79 80 81 82 83 84 85
^{132}Sn
CR
M=300
N
H. Weick

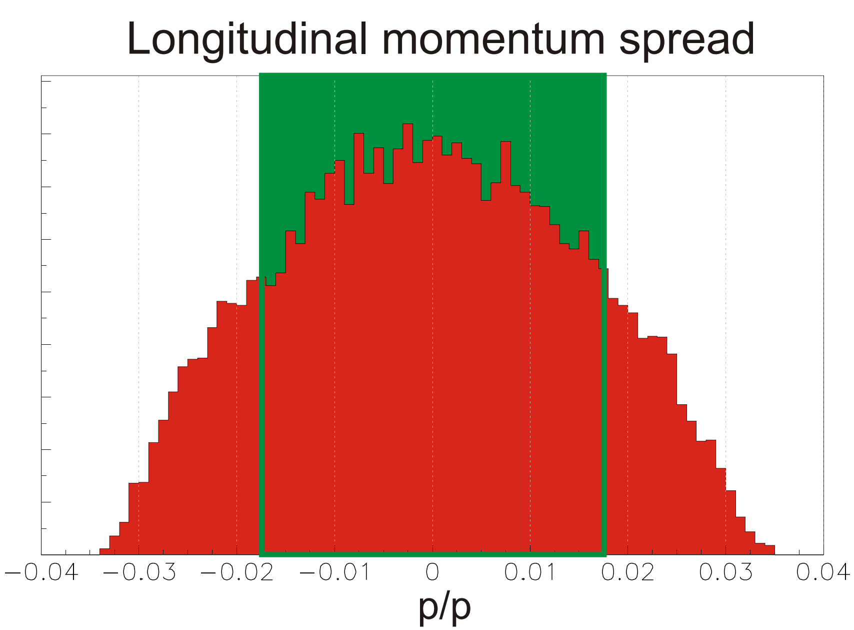
Beam Parameters at the Exit of Super-FRS

1500 MeV/u

^{238}U -> 740 MeV/u ^{132}Sn

two Nb degraders





Emittance much larger at exit

- Angular straggling in degrader
- Redistribution from longitudinal emittance to transversal

CR acceptance:

$_{x,y}$ = 200 mm mrad

p/p=1.75%

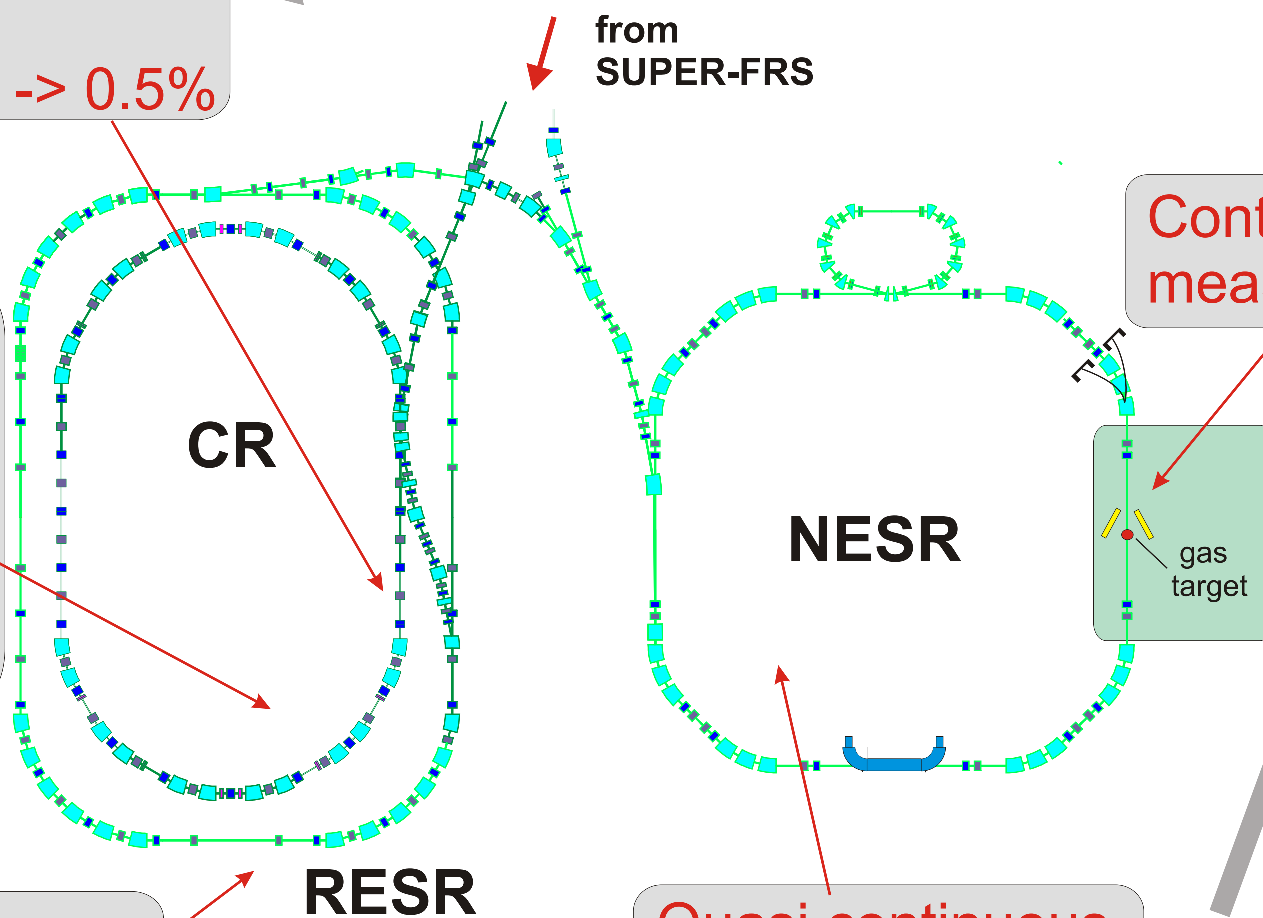
Operation of Storage Rings

Injection at
740 MeV/u

<u>bunch rotation</u>
short bunch
p/p= 1.75% -> 0.5%

<u>stochastic cooling</u>
in 100 ms
reduction by 1/e
---> in 0.5s
1.3 mm mrad
p/p=10E-4

<u>slowing down</u>
740 - 100 MeV/u
to 100 MeV/u in 1.3s



Quasi continuous
accumulation and
electron cooling

Continuous
measurement

Calculation of Luminosity

Target

- Abrasion ablation code for cross sections (K.H. Schmidt)

Super-FRS

- Optimize target thickness for best production rate
- Choose E_in, degraders for separation and E_out=740 MeV/u
- Monte-Carlo simulation of transmission into CR, secondary reactions in target and degraders

LISE++ code

MOCADI code

www-linux.gsi.de/~weick

CR

NESR

- cooling time (~ 1 s), lifetimes in NESR

$$\frac{1}{\ } = \frac{1}{\ _{RR}} + \frac{1}{\ _{REC}} + \frac{1}{\ _{nucl.}}$$

RR: electron capture in cooler

REC: electron capture gas target

nucl.: nucl. lifetime as seen from lab frame

- stacking factor for accumulated intensity, intensity limit for good beam quality

$$F = \ / T_{Inj.}$$

F: stacking Factor

(empty numerator): lifetime

$T_{Inj.}$: time between injections

- Luminosity

$$L = N * f * d$$

N: number of stored ions

f: revolution frequency ~10^6 /s

d: target thickness

Luminosities

Table 2 Expected luminosities in the NESR storage ring adopting an internal target density of 10^{14} hydrogen atoms/cm^2 and for a beam energy of 740 MeV per nucleon.

Nucleus	Rate after production target [1/s]	Lifetime including losses in NESR [s]	Luminosity [cm^{-2} s^{-1}]
^{11}Be	2×10^9	36	$> 10^{28}$
^{46}Ar	6×10^8	20	$> 10^{28}$
^{52}Ca	4×10^5	12	2×10^{26}
^{55}Ni	8×10^7	0.5	5×10^{26}
^{56}Ni	1×10^9	3800	$> 10^{28}$
^{72}Ni	9×10^6	4.1	1×10^{27}
^{104}Sn	1×10^6	51	2×10^{27}
^{132}Sn	1×10^8	93	$> 10^{28}$
^{134}Sn	8×10^5	2.7	3×10^{25}
^{187}Pb	1×10^7	34	2×10^{28}

at 100 MeV/u factor 2-3 less.

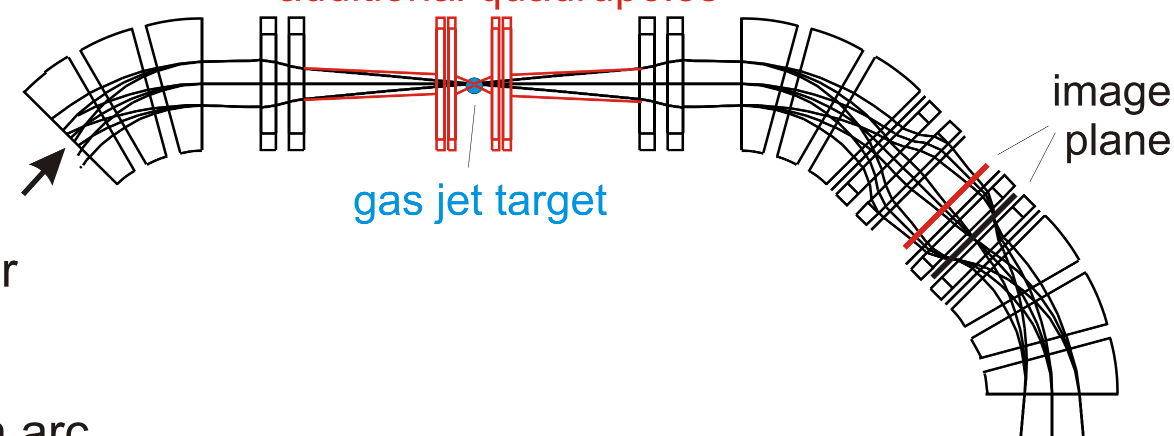
Spot Size at Target

No further cooling after CR
= 1.3 mm mrad
x= ± 3.7 mm, y= ± 5.4 mm

With electron cooler
~ 0.1 mm mrad
(depends on intensity)
x~ ± 1 mm, y~ ± 1.5 mm

... and there is some emittance growth during stacking

<u>Possibility -</u>
<u>Low Beta Section at Gas Target</u>



- ✚ Improves transmission of heavy ion spectrometer
- ✚ Small spot size -> better angular resolution for light recoil
- ✚ Shifts position of image plane in arc
- ▬ Quadrupole aperture blocks large angles in forward spectrometer

Design Tasks: Super-FRS to Rings

Especially for storage ring experiments

Target/ Beam Dump

Target for fast extraction:
- Carbon wheel will break or melt!
- Windowless liquid metal target

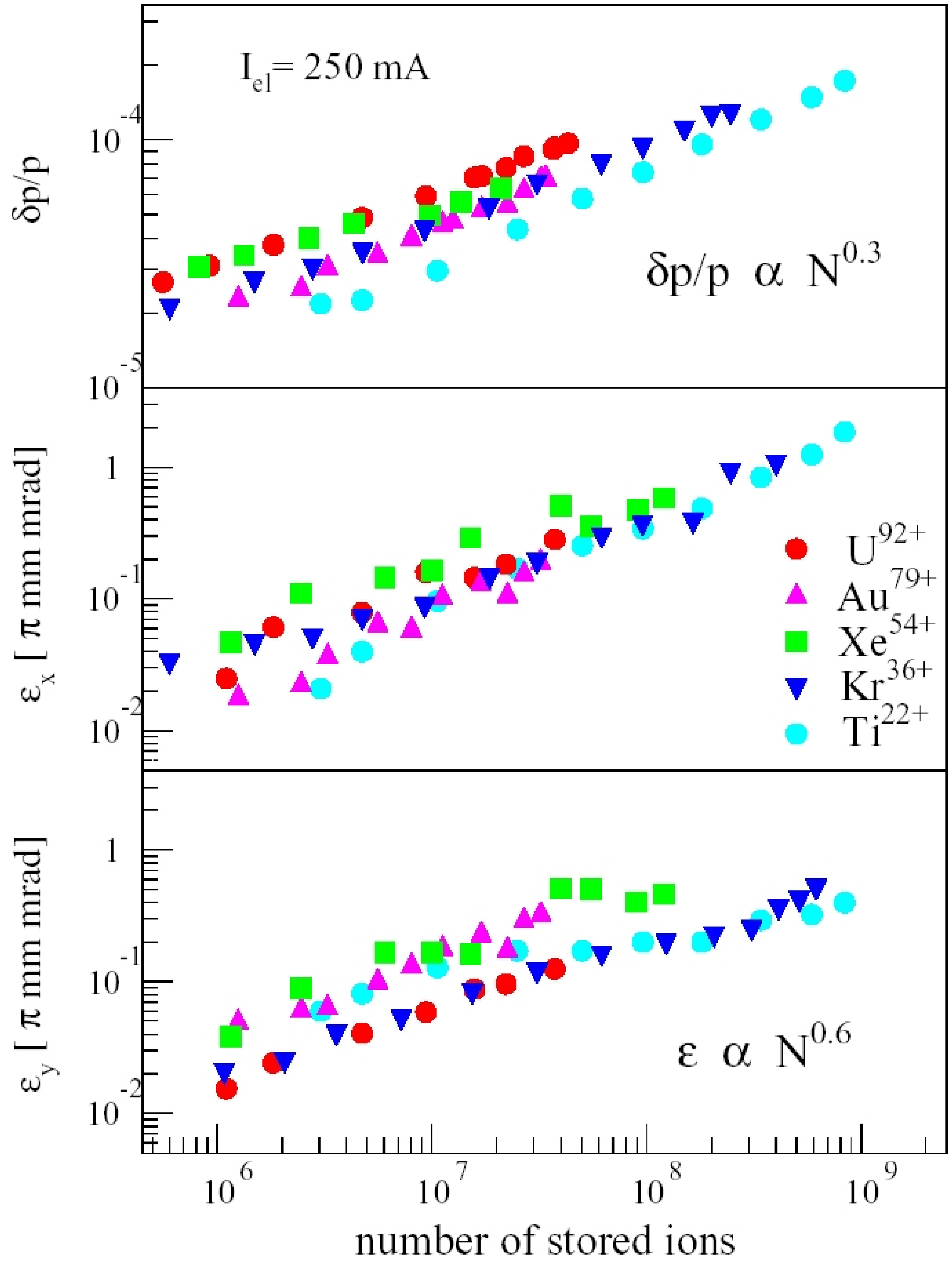
Beam dump for fast primary beam:
- Again all solids will melt!
- Liquid metal container ?

Ring Branch

Beam diagnostics for fast extracted beams:
- profile monitors to see fragment distribution
- beam transformators.

Coupling of Super-FRS to rings:
- construct a working scheme for experiments

Electron Cooling of Intense Beams



M. Steck, PRL

Acceptance of Heavy Ion Spectrometer

start at target with small spot size
transmission to image plane