



Operation And Experiments At GSI

Yvonne Leifels, Uwe Scheeler

GSI Helmholtz Centre for Heavy Ion Research

Darmstadt

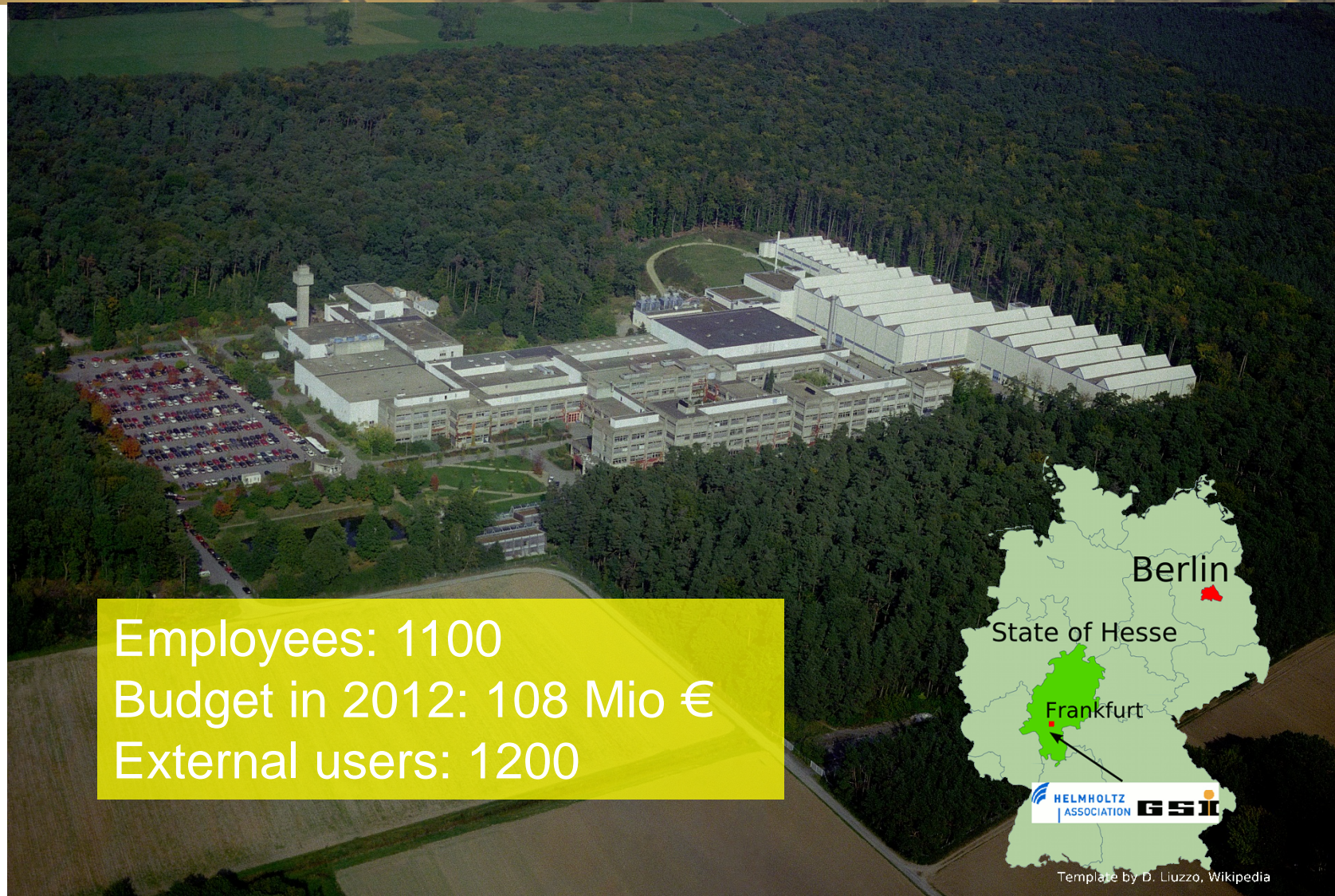
Germany

Operation And Experiments At GSI

Topics:

1. Overview of the laboratory
2. Parts of the accelerator facility
3. Operation possibilities and beam parameters
4. Experimental installations
5. Outlook

Operation And Experiments At GSI



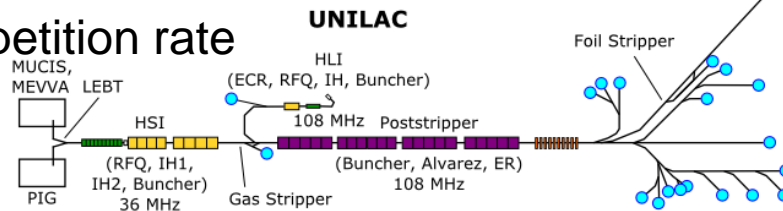
Employees: 1100
Budget in 2012: 108 Mio €
External users: 1200

Accelerator facility

3. GSI accelerators:

UNILAC

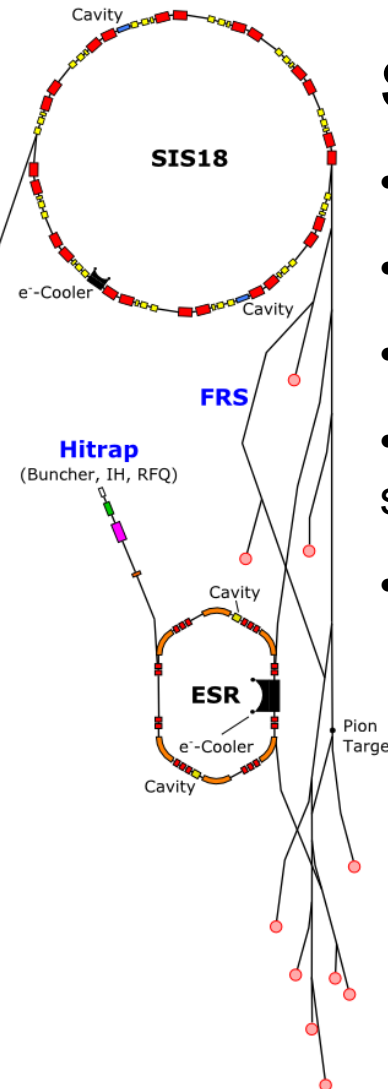
- 3 ion sources
- 4 branches/16 experimental caves
- 50 Hz repetition rate



Time sharing operation:

- different time base for each accelerator
- change the setup from pulse to pulse

0 25 m
A.Bloch-Sp ath, 2011



SIS18

- max. rigidity 18Tm
- slow extraction
- fast extraction
- beam pulse 1µs-10 sec.
- 10 experimental caves

ESR

- beam pulse from a few seconds up to 30 minutes

Beam time schedule

- details of August last year
- contains the sequence of approved beam requests of the experiments
- daily meeting for discussing and organizing details

2 / 2012					August 2012										Schedule as of 27-Jun-2012																				
Week 31					Week 32					Week 33					Week 34					Week 35															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
U258, Düllmann/Düllmann, 50Ti(PIG), 5.5-6.5 MeV/u, 1-2 particle-microAmps in X8, 50 Hz / >= 5 ms, X8 TASCA																																			
U277, Heinz/Heinz, 238U28+, 6 MeV/u, 1 mA, 1 Hz, no, Z7										a)										U272, Rosmej, O/Rosmej, O., Ti, 4-7 MeV/u, 100pA, 5Hz 10-15 min/2hours, no, Z6															
UBIO, Friedrich/Scholz, Ti, 11.4 MeV/u, einige					UMAT, Severin/Bender, Ti, 4.8, 5 ms, 5Hz, M3										UBIO, Friedrich/Scholz, U, 11.4 MeV/u, einige TnA, 1 Hz, M-branch					b)															
S411, Dendooven/Purushothaman, 238U, 1000 MeV/u, 10A0 /s, slow extraction					c)					S388, Mukha/Litvinov, 38Ar (MUCIS, enriched), 1000 MeV/u, 3e10/spill, 4 s extraction, EPS					d)					S415, Tabei/Simon, Kelic, 238U MEVVA, 1000 MeV/u, 1E9 /spill, 10 s extr., EPS/MTC					SBIO, Bert/Scholz, 12C EZR, 100-600, 1e3 - 1e8/spill, therapy conditions (Cave M), HTA/HTM						e)				
SMAT, Schuster/Trautmann, 238U, 150-250 MeV/u, 5e8/spill, 1s extraction																																			
E090, Haggmann/haggmann, 238U92+, 50-100 AMeV, einige 10**8 ESR					E089, Buesmann/Winters, C3+, 122 MeV/u, 100 micro Ampere, ESR										E090, Haggmann/haggmann, U92+, 50-100 AMeV, einige 10**8, ESR																				

- a) U252, Roth/Blazevic, 12C EZR, 3,6 MeV/u, 2 µA, Z6
- b) UBIO, Friedrich/Scholz, C, 11.4 MeV/u, 1 Hz, M-branch
- c) SESA, Scholz/Scholz, Ti, 1 GeV/u, 1e8 / spill, slow (5s) extraction, HTA
- d) SESA, Scholz/Scholz, Ti, 1 GeV/u, 1e8 / spill, slow (5s) extraction, HTA
- e) S401, Heuser/Kis, 84Kr Mucis, 1.4 GeV/u, 1e9/spill, long extraction, 10 s, HTB

4 rows UNILAC
 3 rows SIS
 1 row ESR

Burkhard Kolb, Phone +49-6159-71 2667, E-Mail: beamtime@gsi.de

27.06.12 11:09

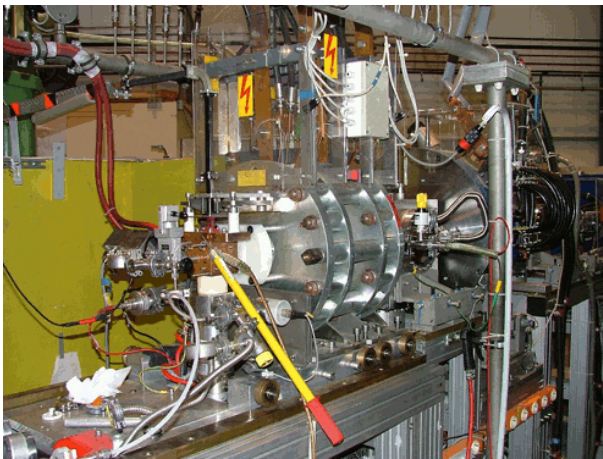
UNILAC beam parameters

iso- tope	ele- ment	ion source	energy [MeV/u]	duty cycle [%]	charge state [exp.]	intensity [eμA]	intensity [pps]
12	C	ECR	5.9	26	2	21	$1.7 \cdot 10^{12}$
50	Ti	PIG	6.1	25	10	50	$7.8 \cdot 10^{12}$
64	Ni	ECR	5.5	27	9	30	$5.6 \cdot 10^{12}$
136	Xe	ECR	11.4	10	17	5	$1.8 \cdot 10^{11}$
197	Au	PIG	4.8	15	24	18	$7.0 \cdot 10^{11}$

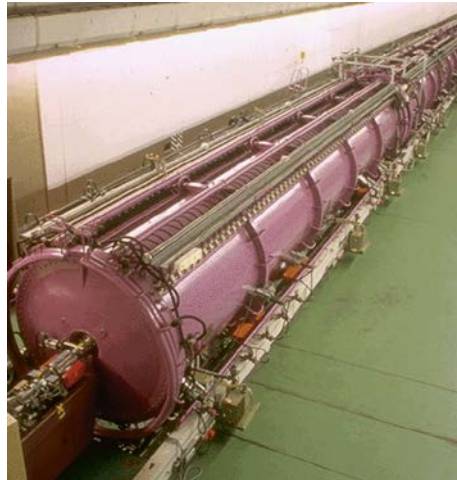
-duty cycle up to about 27% , depending on the rf- power

-energy from 3.6-12 MeV/u

-intensity depends on source and operation conditions



ECR-source



Alvarez-section



single gap resonators

SIS beam parameters

-high pulse current
from UNILAC
requested

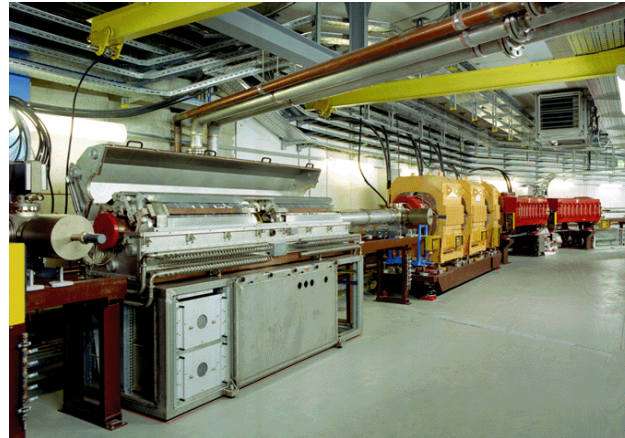
-extraction energy
from 50keV/u to
2GeV/u

-beam cooling to
increase pulse
intensity

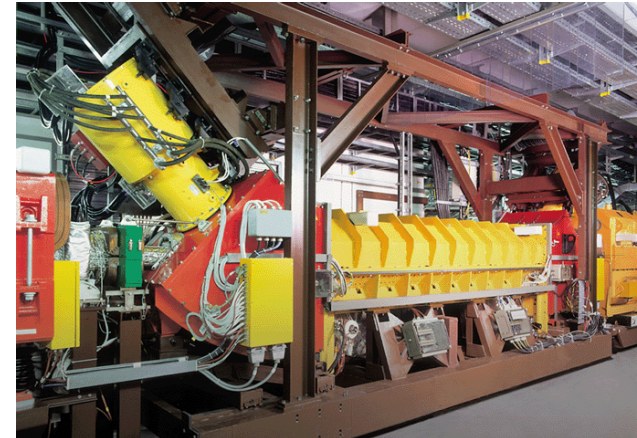
isotope	element	ion source	charge state (SIS)	extraction energy [MeV/u]	intensity [ppp]	max. energy [MeV/u]
2	D	MUCIS	1	1250	$2.3 \cdot 10^{10}$	2000
86	Kr	MUCIS	33	730	$1.5 \cdot 10^{10}$	1400
107	Ag	MEVVA	43	750	$1.3 \cdot 10^9$	1500
208	Bi	MEVVA	68	600	$2.1 \cdot 10^9$	1100
238	U	MEVVA	73	600	$3.0 \cdot 10^9$	1000



one SIS section



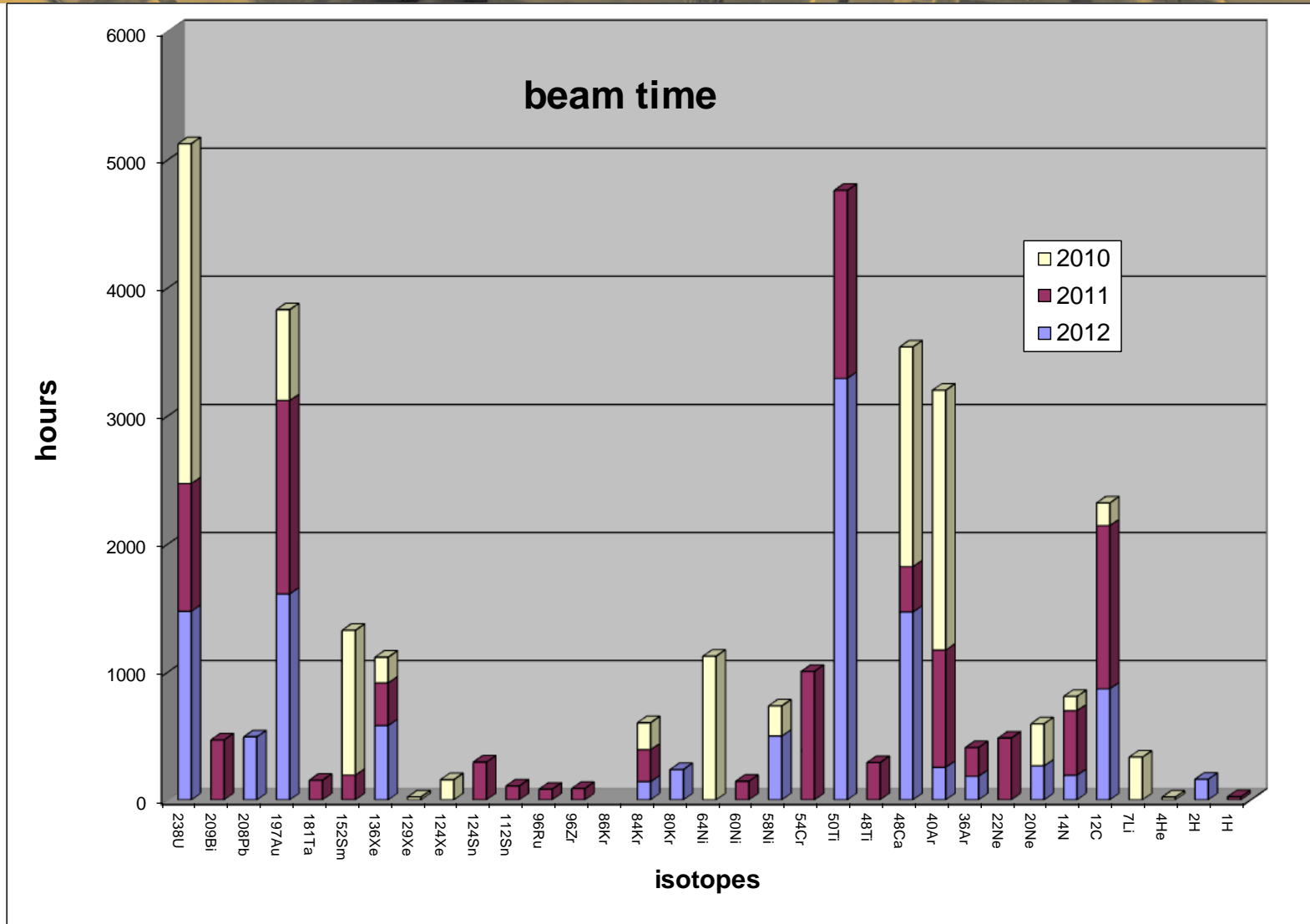
rf-cavity



electron cooler

Accelerated isotopes

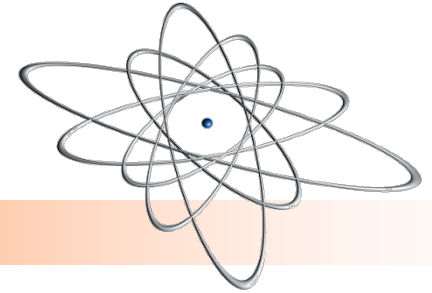
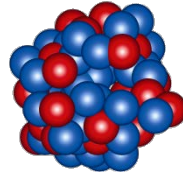
- uranium was often requested by many users
- medium heavy isotopes for superheavy production
- carbon for biological irradiations and the ESA program



Experimental program

Nuclear Physics

- Nuclear reactions up to highest energies
- Superheavy elements
- Hot dense nuclear matter



Atomic Physics

- Atomic Reactions
- Precision spectroscopy of highly charged ions

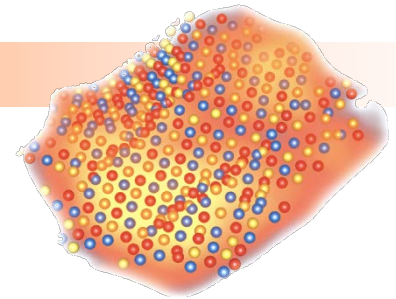
Biophysics and radiation medicine

- Radiobiological effect of ions
- Cancer therapy with ion beams



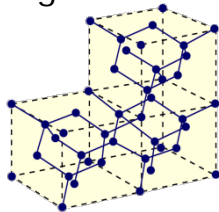
Plasma Physics (5%)

- Hot dense plasma
- Ion-plasma-interaction



Materials Research

- Ion-Solid-Interactions
- Structuring of materials with ion beams

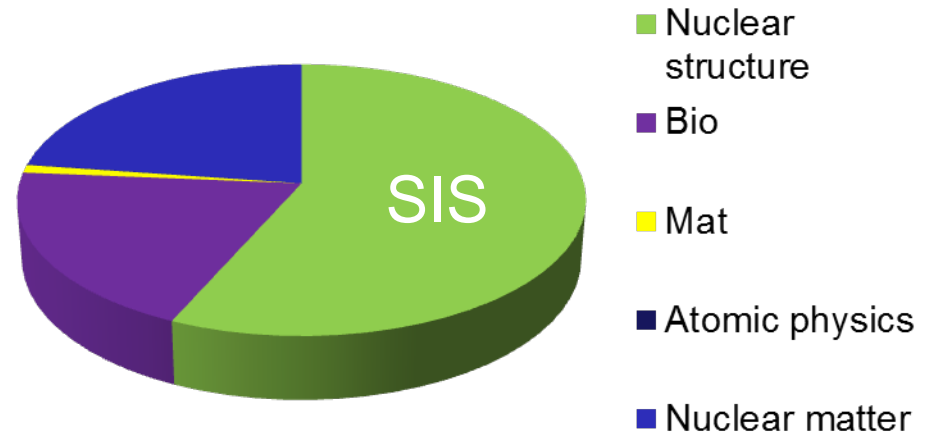
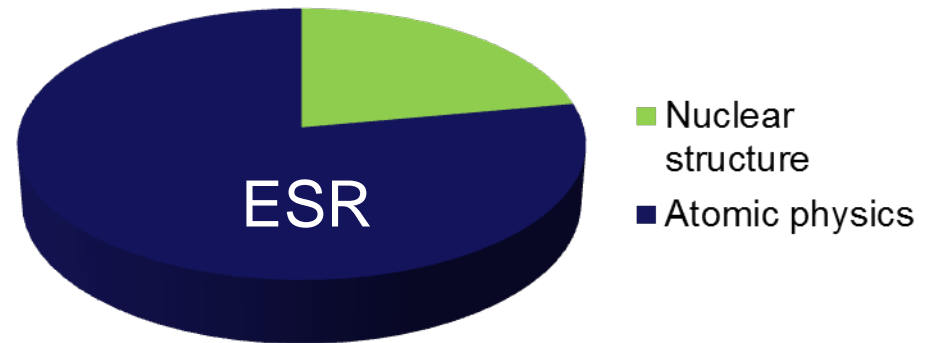
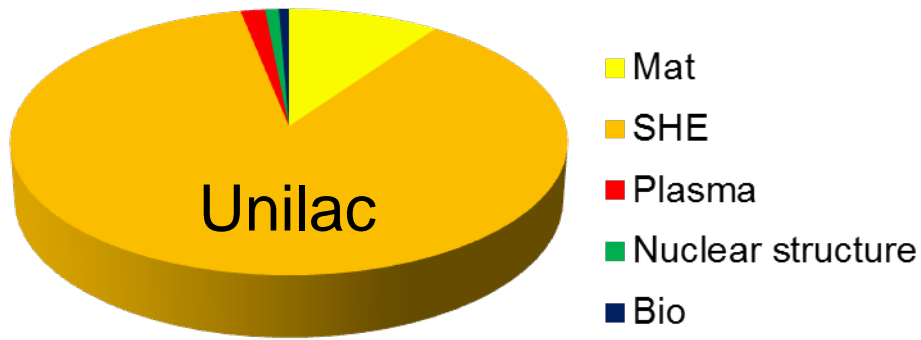


Accelerator Technology

- Linear accelerator
- Synchrotrons and storage rings



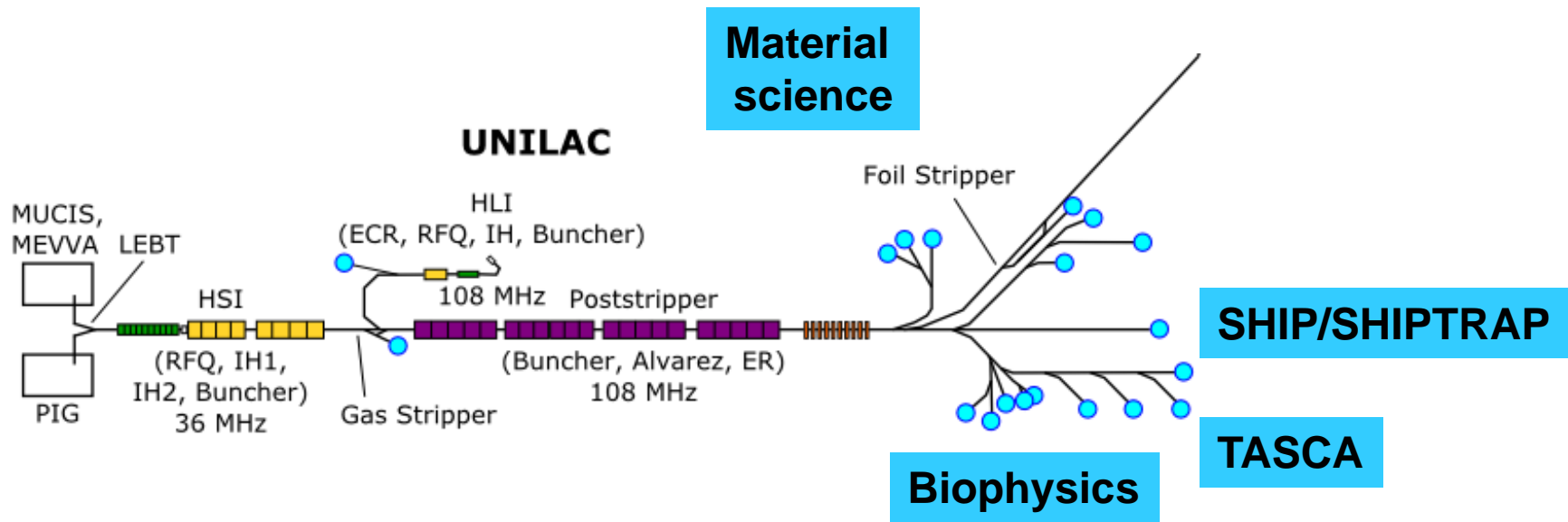
Beam time distribution



Total beam time 2012 (hours)

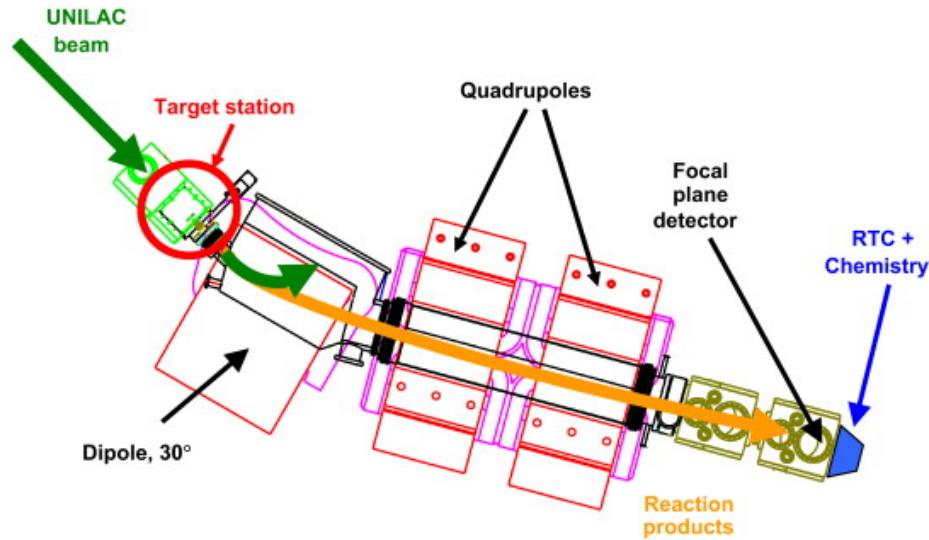
Unilac	4180
ESR	1810
SIS	2570

Experimental sides - Unilac



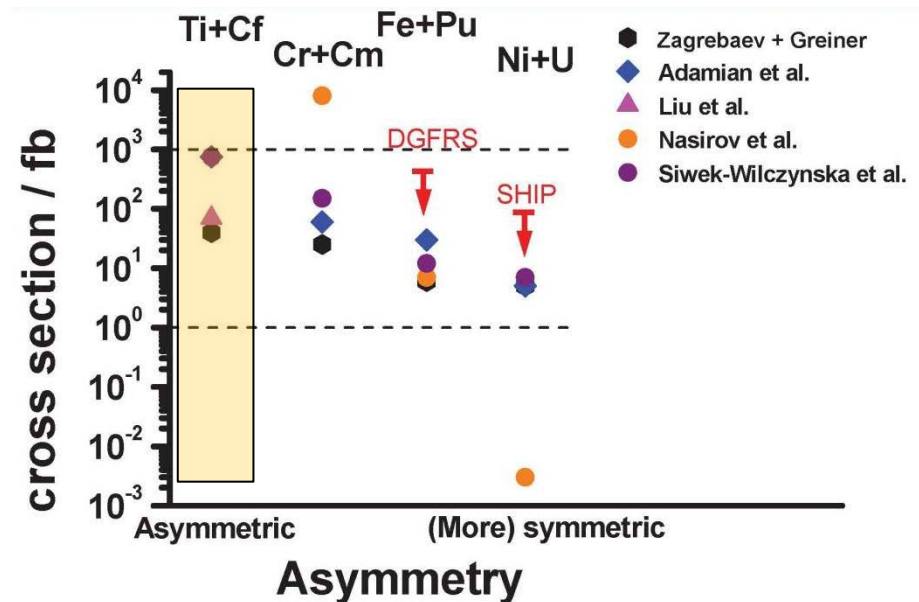
TASCA

TrAnsactinide Separator and Chemistry Apparatus

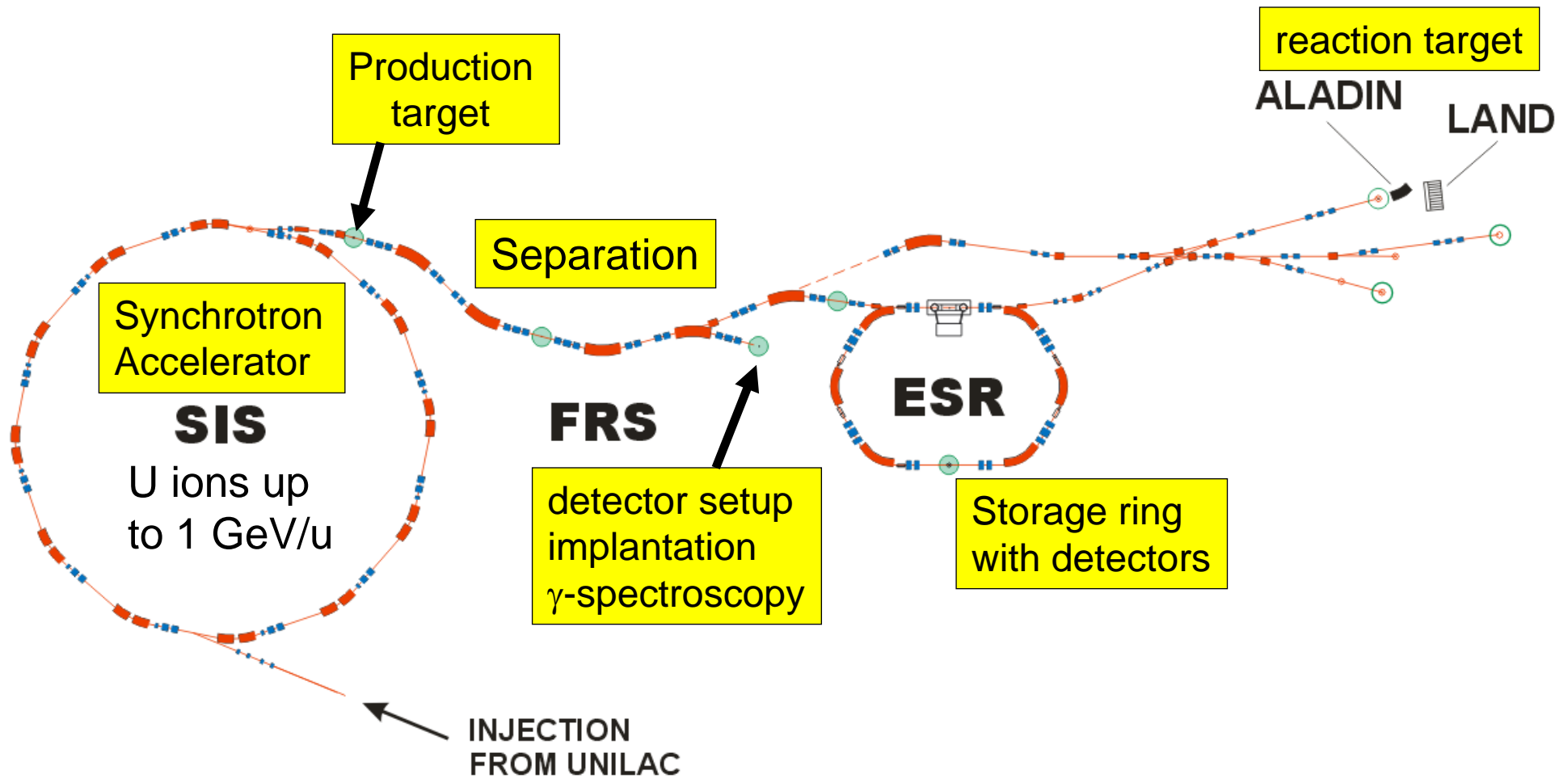


- Synthesis of SHE
- Preseparated SHE for chemical studies

Gas filled separator for transactinides ($Z > 104$)
J. Even et al., Nucl. Instrum. Meth. A638, 157-164 (2011)



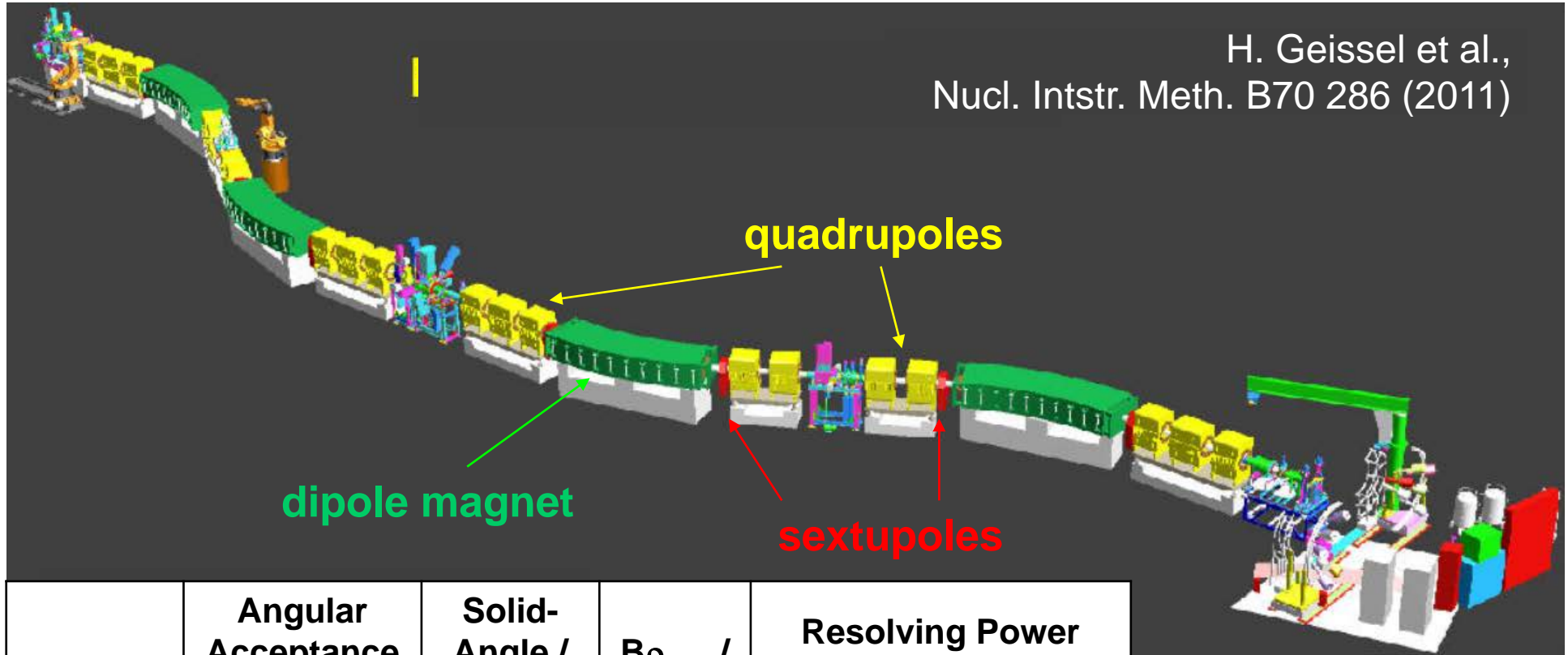
Experimental sides - SIS



FRS

Fragmentseparator

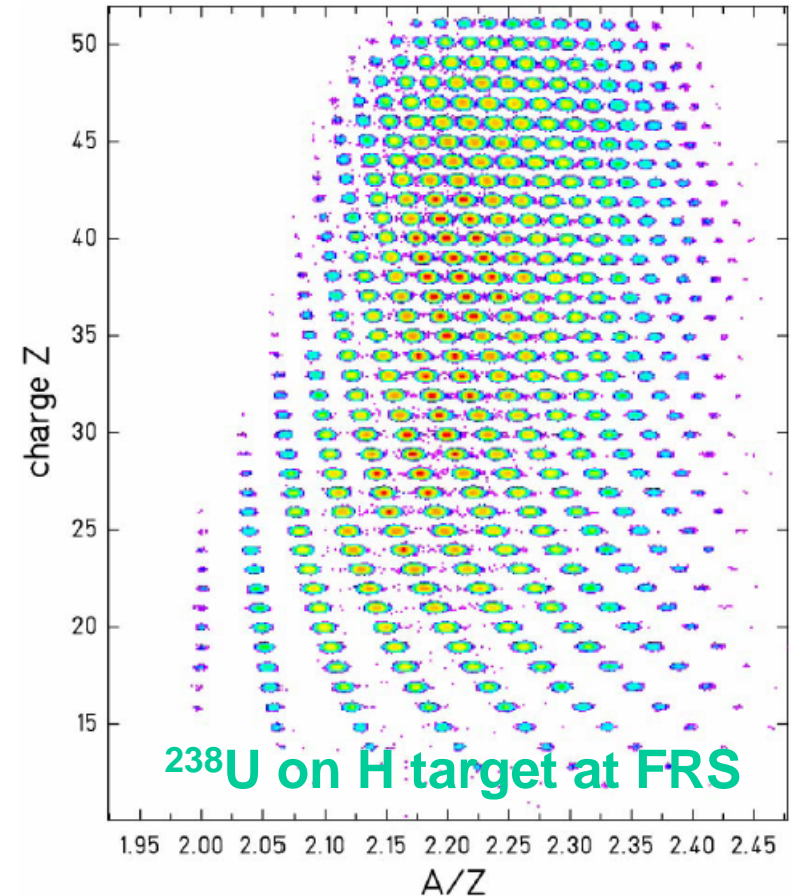
H. Geissel et al.,
Nucl. Instr. Meth. B70 286 (2011)



$\Delta p/p$ / %	Angular Acceptance (φ_x, φ_y) /mread	Solid-Angle / msr	$B\rho_{\max}$ / Tm	Resolving Power $D/\Delta X$ $2x0 = 1\text{mm}$
2	30, 30	0.9	18	3131 ($2x_0=2,7\text{mm}$)

Fragment separator

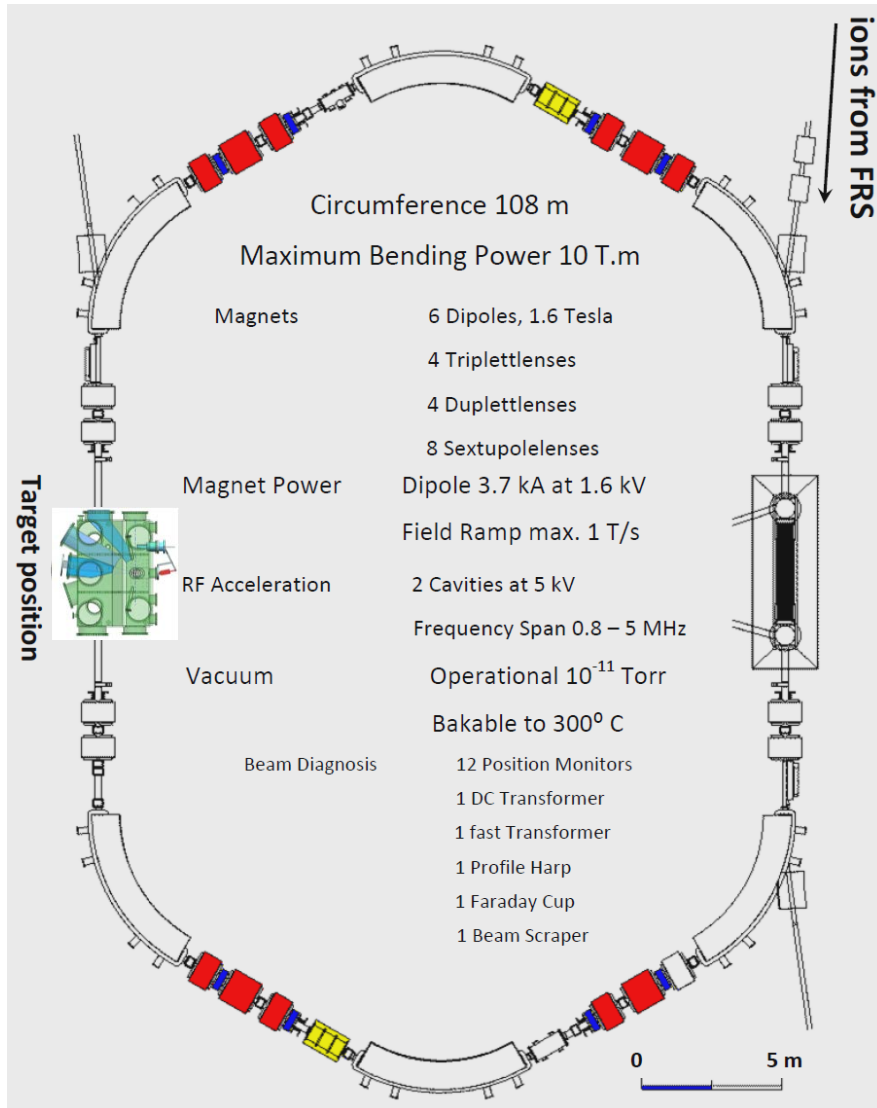
Separator	$\Delta p/p$	Angular Acceptance (ϕ_x, ϕ_y)	Solid-Angle	$B\rho_{\max}$	Resolving Power $D/\Delta X$
	%	mrad	msr	Tm	($2x_0=1\text{ mm}$)
FRS	2	30, 30	0.9	18	3131 ($2x_0=2,7\text{mm}$)
Big-RIPS	6	80, 100	8.0	9	1 st stage 1290 2 nd stage 3300 ($2x_0=1\text{mm}$)
A1900	5		8.0	6	2900
RIPS	6	80, 80	5.0	5.8	1500
Super-FRS	5	40, 20	3.2	20	3076



**+ RIBLL 1+2, LISE-3, ALPHA, COMBAS, ACCULINA,
EN, Triμp, CRIB, ...**

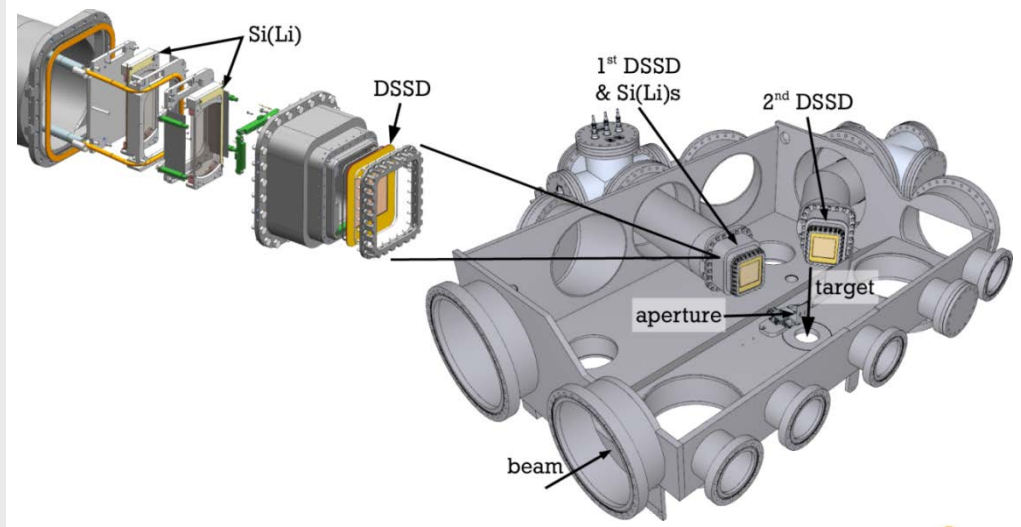
ESR/EXL

Exotic Nuclei studied in Light ion induced reactions



- $^{58}\text{Ni}(p,p)$ and $^{58}\text{Ni}(\alpha,\alpha')$: feasibility studies and proof of principles
⇒ UHV capability of detector setup, background conditions at ESR target
- $^{56}\text{Ni}(p,p)$: doubly magic nucleus ^{56}Ni : of high interest for structure and astrophysics
- EXL@NESR at FAIR

P. Egelhof et al.



Outlook

FAIR facility:

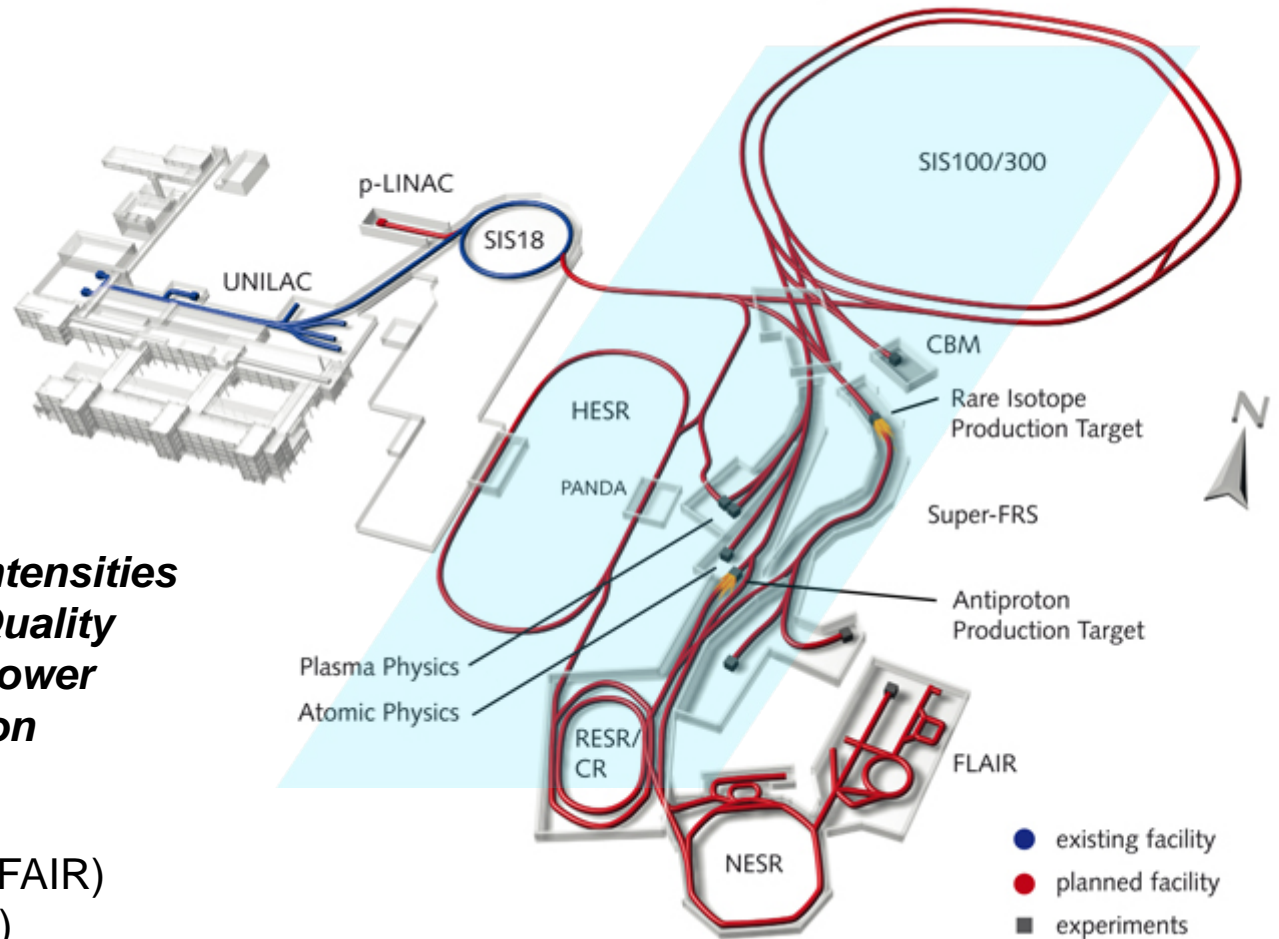
center for antiproton and ion research:

- p-linac
- 100Tm synchrotron
- Super FRS
- Anti proton target
- Collector ring
- High energy storage ring

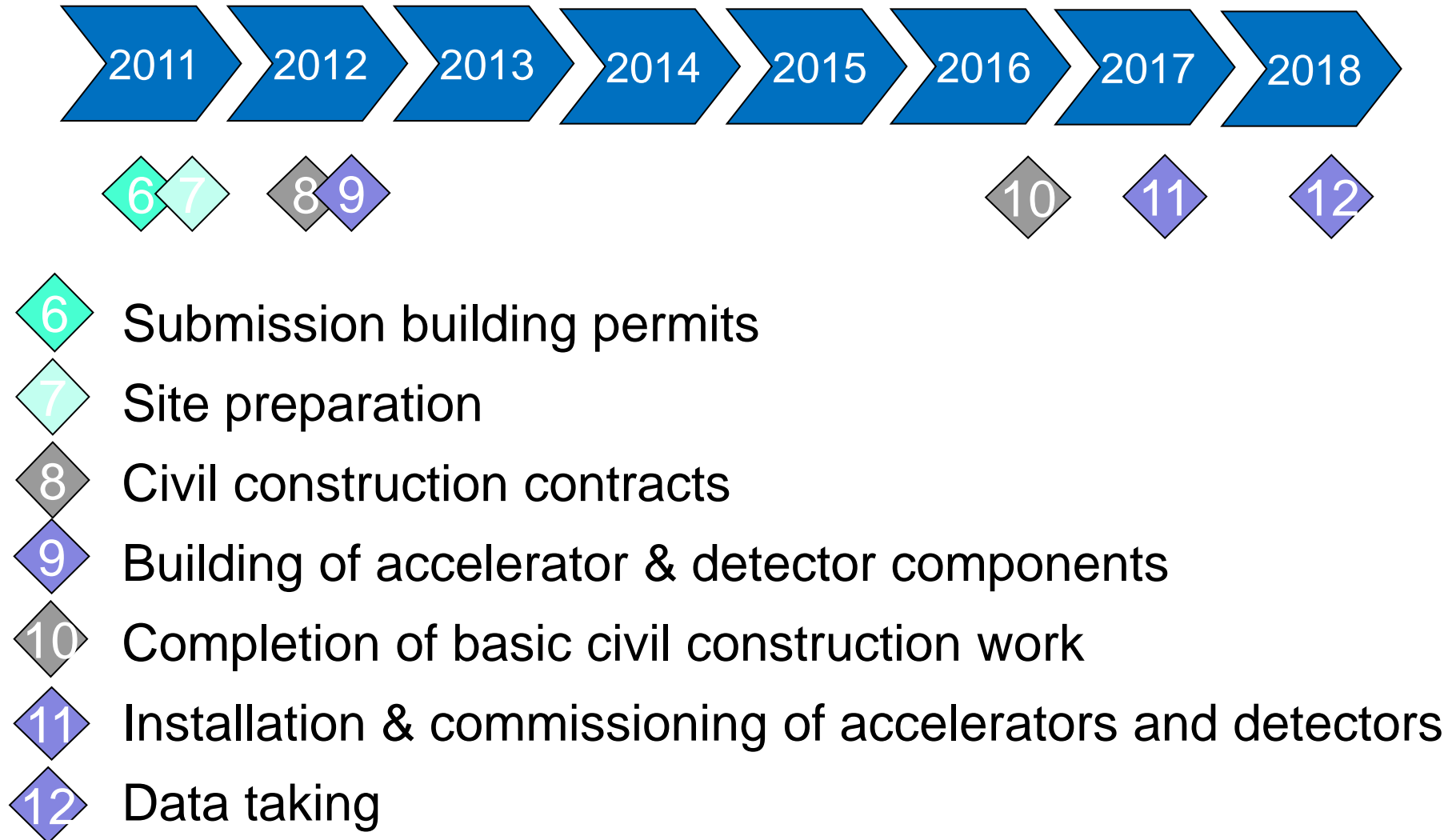
Highest Beam Intensities
Brilliant Beam Quality
Highest Beam Power
Parallel Operation

GSI upgrade:

- link existing facility (connection to FAIR)
- high energy linac (FAIR intensities)
- cw demonstrator/linac (R&D, UNILAC Hall)



Timeline start version



Operation And Experiments At GSI

Thank you for your attention
and a bright future for ALTO!

Further information:

email: y.leifels@gsi.de

u.scheeler@gsi.de

web: www.gsi.de

www.fair-center.de