Cave A: experimental area for atomic physics and irradiation experiments

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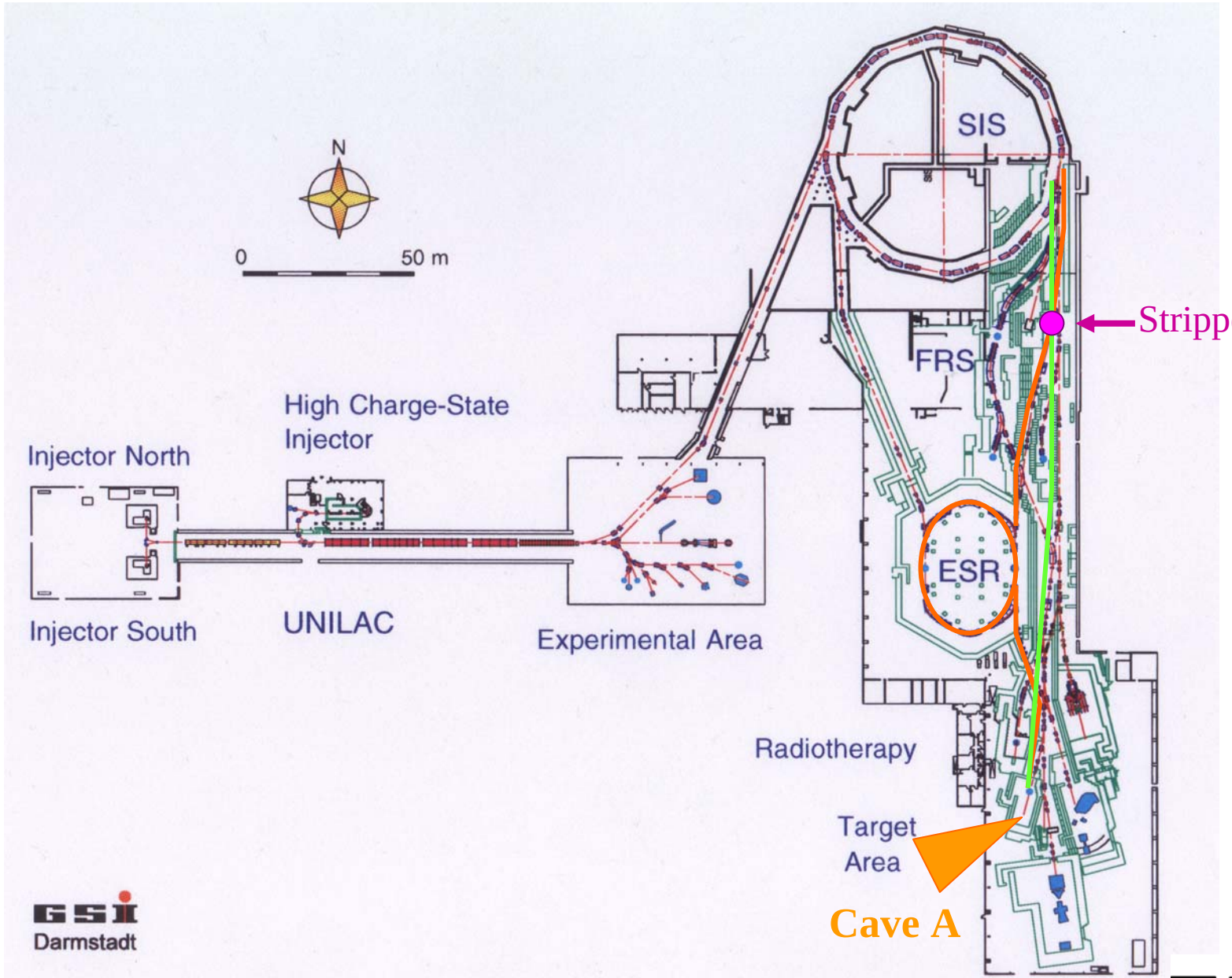
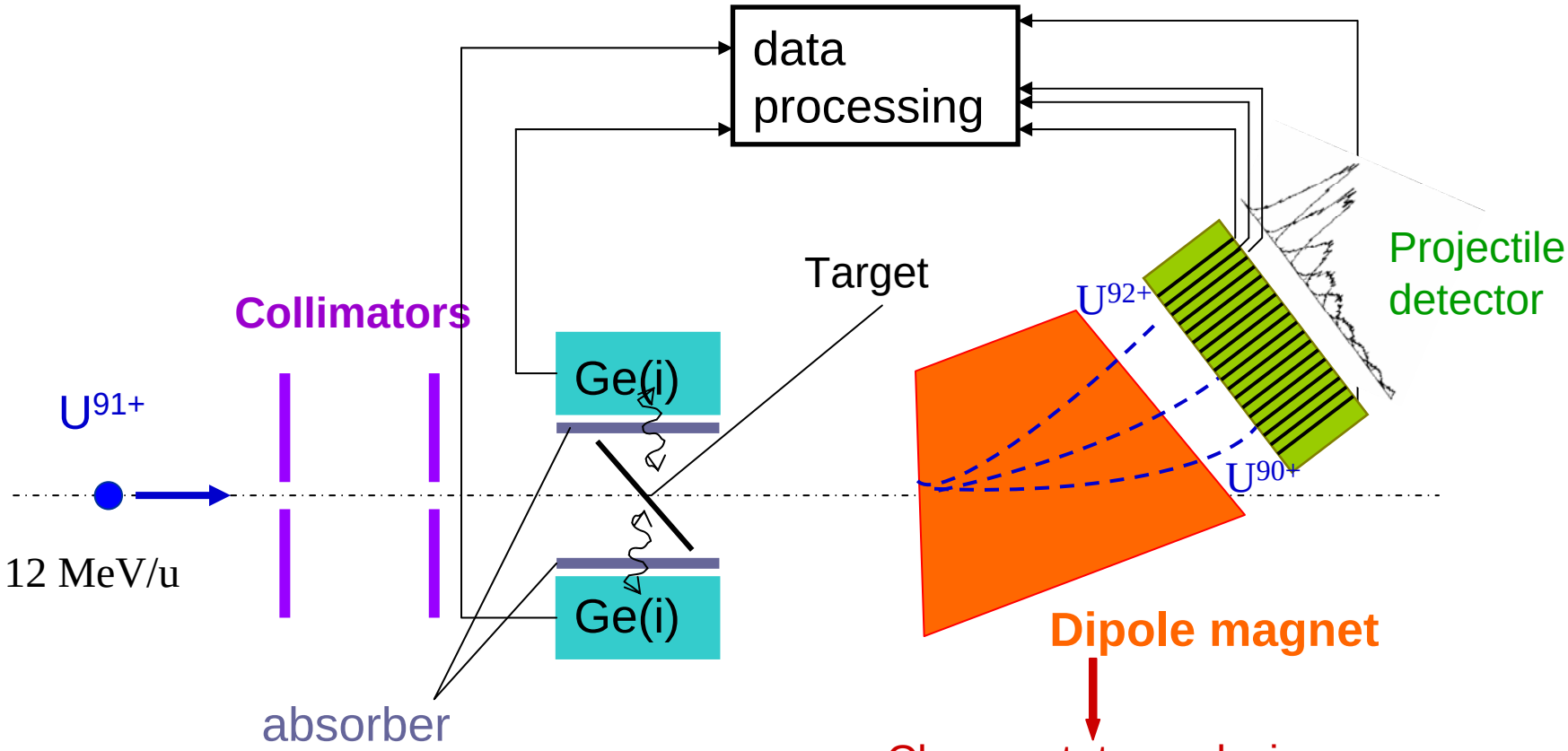

N
0
50 m
SIS
Stripper
FRS
High Charge-State
Injector
Injector North
ESR
Injector South
UNILAC
Experimental Area
Radiotherapy
Target
Area
Cave A
GSI
Darmstadt

Experimental configuration



Precision spectroscopy

Live time measurements

Beam parameters

SIS beams:

- all stable atoms

- high charge states, inclusive bare ions

- energy: up to 1 GeV/u (Bρ = 13 Tm)

- beam intensities: depending on specie, ion energy, charge state

- slow extraction: 8-10 s ‘flat top’ pulses

- electron cooling

ESR beams:

- all stable atoms

- charge states: H-like and lower

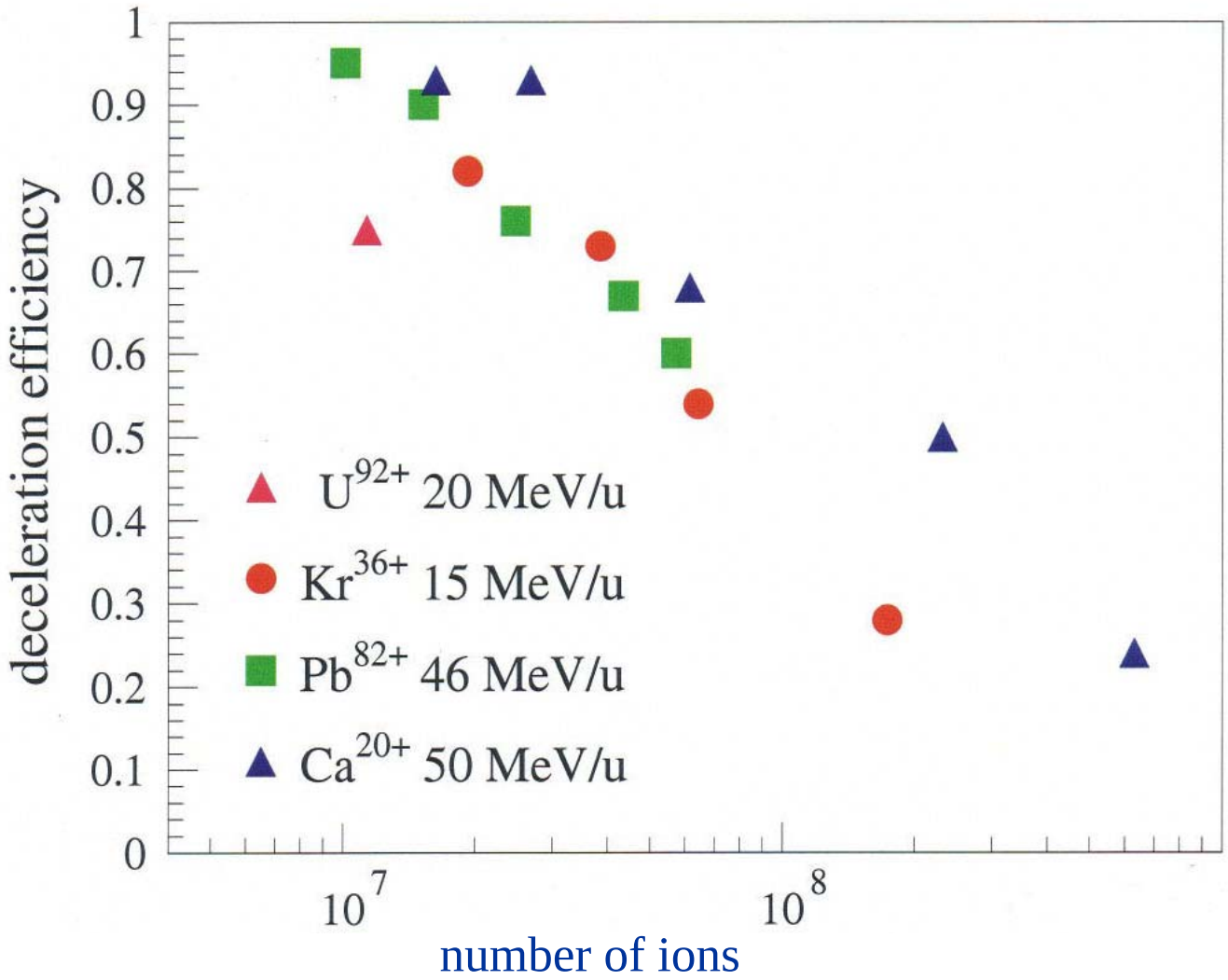
- energy: 12 - 560 MeV/u (Bρ = 10 Tm)

- beam intensities: depending on ion specie, charge state, energy (10^7 ion/spill U^{91+} at 20 MeV/u)

- slow extraction (charge exchange): tens to hundred of seconds, decreasing beam intensity; **no bare ion !!!!**

- decelerated, electron cooled beams: excellent emittance

ESR beam intensities: 2006



Cave infrastructure

Magnetic spectrometer:

- 14.5 ^{o} Dipol & 2 Quadrupoles

- Bρ= 10 Tm $\Longleftrightarrow$ 560 MeV/u

- Dispersion at the focal point (2,5 m behind the magnet: 8.35 mm/%

separation for U 91+, 92+ ~ 9 mm with a calculated beam width of 3 mm

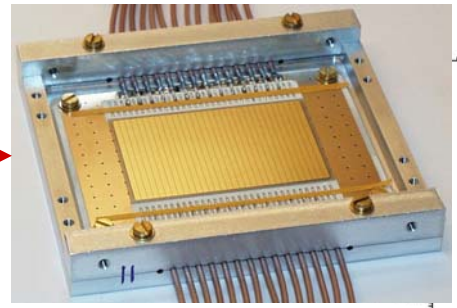
Focal plane detector

Detector capabilities:

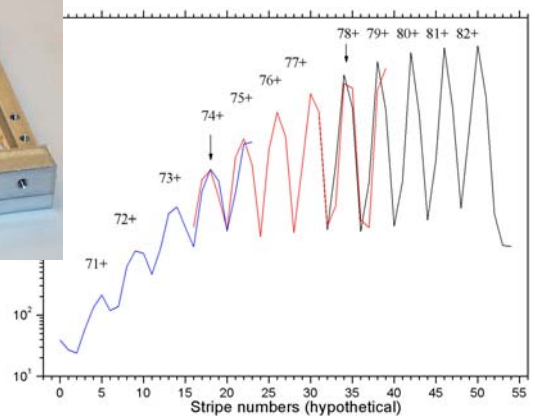
1. position resolution: $\Delta x/x < 0.5$ mm on both directions
2. time resolution: $\Delta t/t < 1$ ns
3. count rate: 10^3 $s^{-1}mm^{-2}$ to few 10^4 $s^{-1}mm^{-2}$ / 10^7 s^{-1} integral
4. active area: at least 60 mm x 40 mm
5. radiation resistant
6. UHV-compatible
7. no window

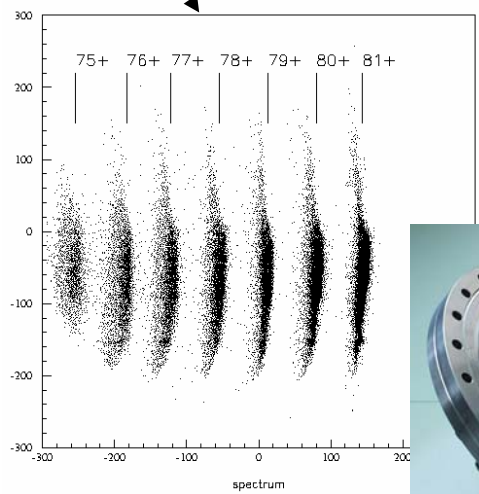
Other options: MWPC, 2D position sensitive !?!?

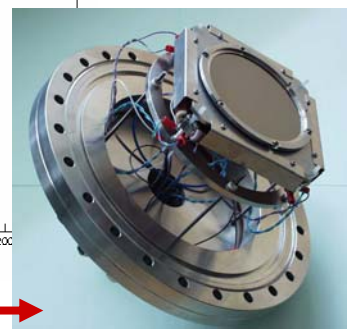
Strip diamond detector



Pb charge state spectra



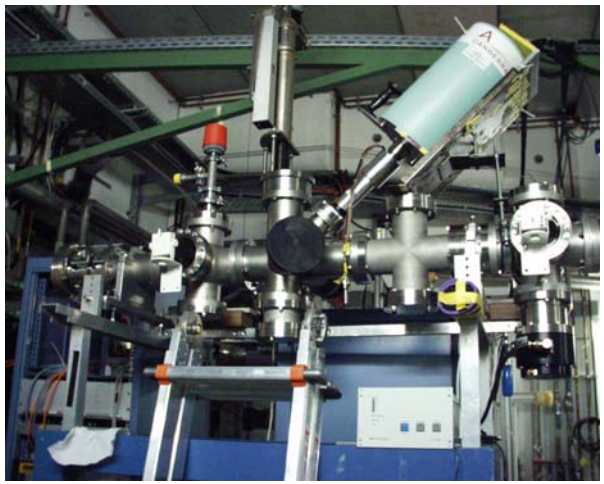




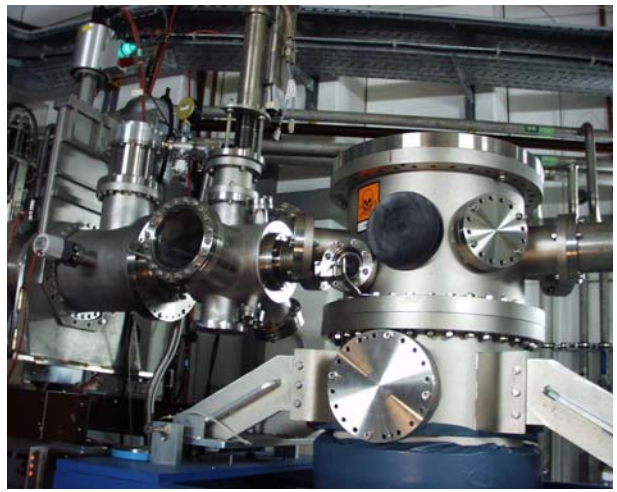
MCP detector, 2D position sensitive

Cave A target area

Target chambers for:

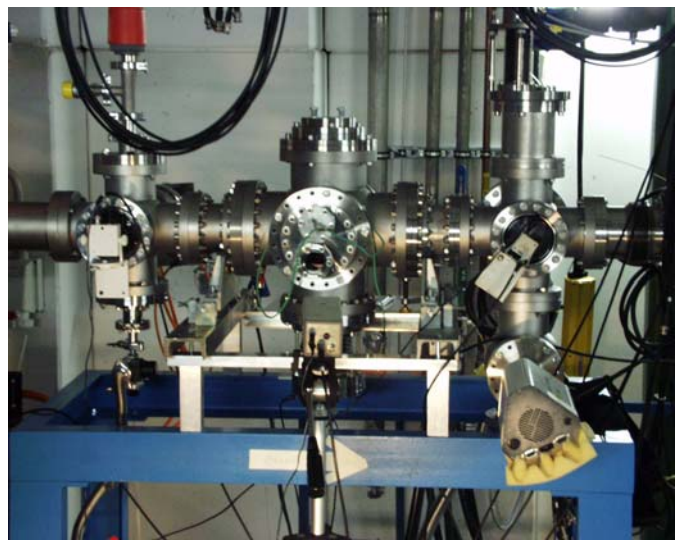


Channeling



Atomic spectroscopy

Life time measurements

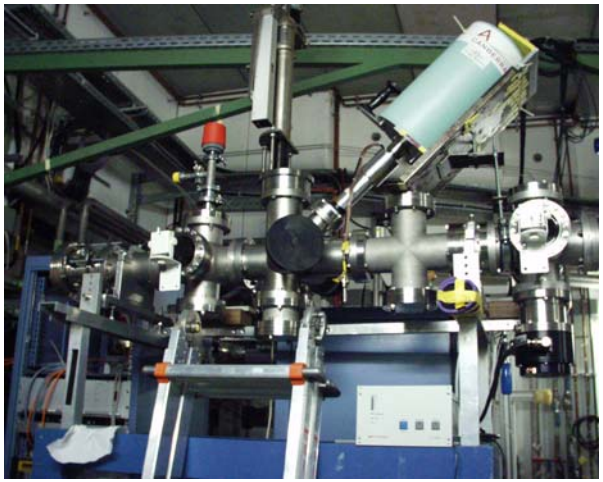


C60 target and target fragment spectrometer

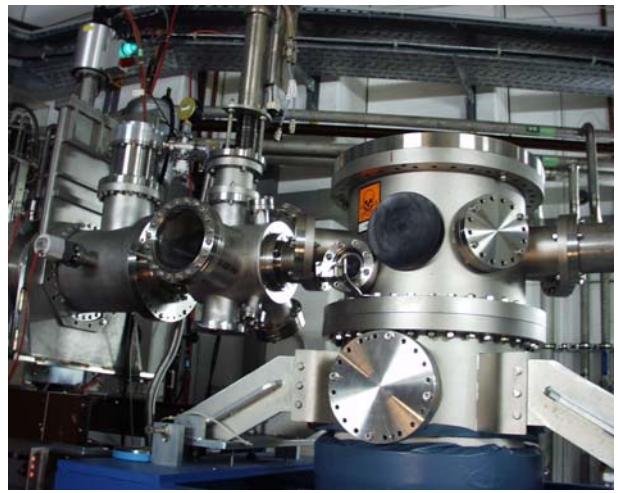
X-ray detectors: Ge(i)

Cave A target area

Target chambers for:



Channeling



Atomic spectroscopy

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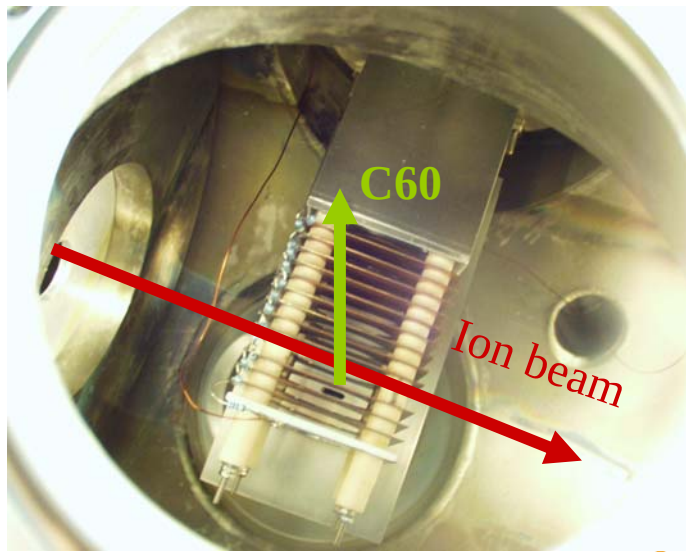
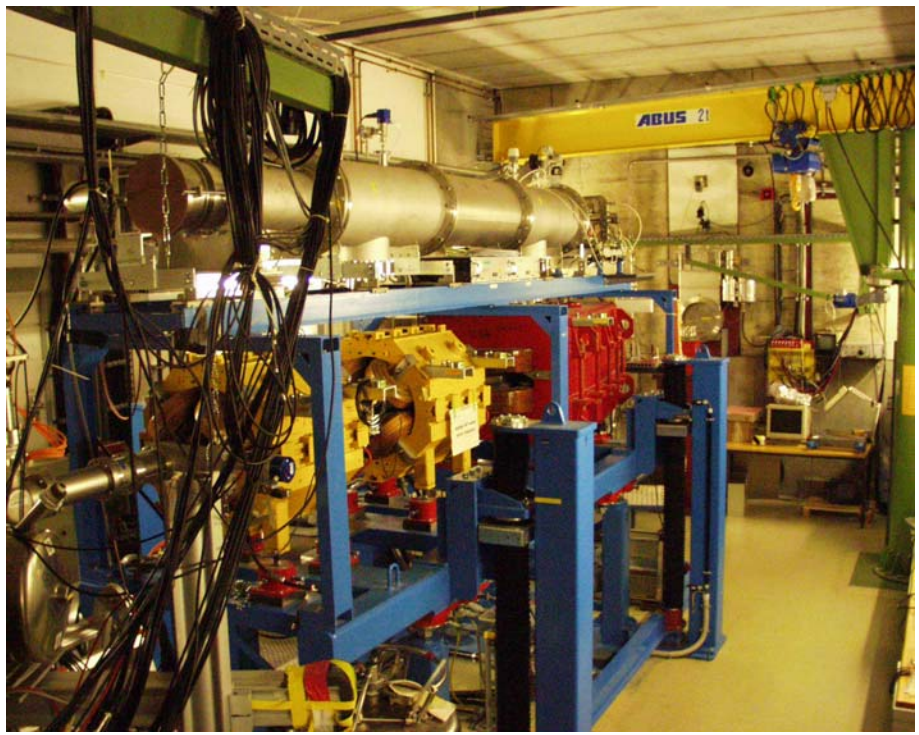


Cave A research activities

Year	Exp. Nr.	Short title	Spoksperson
1991/92		X-Ray Spectroscopy Recoil Ion Spectroscopy	D. Liesen (GSI) J. Ullrich, R. Moshammer (GSI)
1993	S040	Electron emission in Heavy Ion Collisions	K. Stiebing (IKF, Frankfurt)
1994	S225	Life time measurements in He-Like Au^{77+}	R. Mahrrus (Berkeley)
1995	E027	Deceleration of HCI by crystal channeling	D. Dauvergne (IPN Lyon)
1996			
1997	E026	2E1-Decay in He-like Au	P. Mokler (GSI)
1998		Cave upgrading; Spectrometer installation	D. Liesen (GSI)
1999	 E042	Comissioning Multielectron capture from thin foils	H. Bräuning (GSI)
2000	S225	Life time measurements in He-like Au	R. Mahrrus (Berkeley)
2001	E027 S225 E042 + E043	Channeling Life time measurements in He-like Au Multielectron capture from thin foils	 R. Mahrrus (USA) H. Bräuning (GSI)
2002			
2003	E052 S084+E026 E043	Deceleration of HCI by crystal channeling Punita Multielectron transfer in highly charged ions from cluster targets	D. Dauvergne (IPN,Lyon) A. Bräuning-Demian (GSI)
2004	S134	Qusimolecule formation in collisions of few electron heavy ions with heavy targets	P.Mokler, A, Bräuning-Demian (GSI)
2005	E052 S282	Deceleration of HCI by crystal channeling 2E1-decay in heavy He-like systems	D. Dauvergne (IPN, Lyon) R. Dunford (Argonne)
2006			
2007....	E026 E076	2E1-decay in heavy He-like systems Radiative double electron capture in collisions of bare HCI with light targets	P.Mokler, A. Bräuning-Demian (GSI) A. Warczak (Jagellonian Univ. Krakow)

But, nobody is perfect……..

1. Different beam requirements for irradiation experiments and atomic physics:
   - Geometry: beam scanner + large beam pipe diameter
   - Vacuum
2. Beam line ESR-Cave A: difficult to transport the beam; missing diagnosis for low energy beams and not enough optical elements for ESR beams
3. Projectile detector: limited in count rate or in position resolution



Outlook

➢ Cave A is an experimental place with many good capabilities for research with high quality HCI beams at low / medium energies

Mid term priorities

➢ Use ESR beams at lower energies: 4 MeV/u < E < 12 MeV/u

➢ Test the resonant slow extraction: bare ion beams

➢ Radiative Double Electron Capture

➢ HCI interactions with nanostructures

➢ Rezonant Coherent Excitation

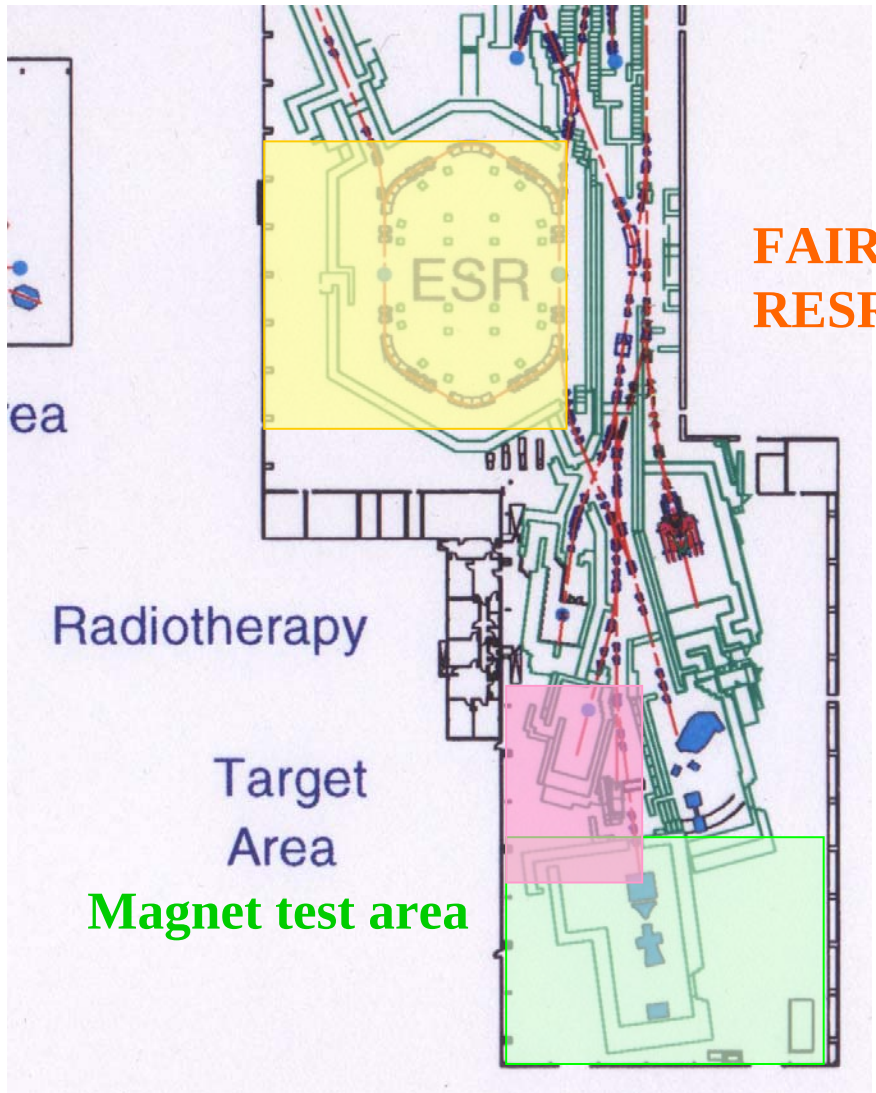
➢ Parametric X-ray emission

Outlook

Future perspectives: **FAIR**

The research activities in cave A will resume to give place to activities related to the construction of the new accelerator

The earliest time could be **2010**



Good ideas are welcome but … should come soon!!!!

Collaboration

Giessen University

Frankfurt University

Kassel University

Jagellonian University, Krakow, Poland
Institute of Nuclear Physics, Krakow, Poland

IPN Lyon, France

University Paris VI-VII

CIRIL, Caen, France

LBL, Berkeley, USA

Argonne, USA

NIPNE, Bucharest Romania

Moscow, Russia

RIEKEN, Tokio

Dresden University

Tomsk Polytechnic University, Russia