

# GSI Helmholtzzentrum für Schwerionenforschung

Heavy Ions-  
Synchrotron

Storage Ring

Linear Accelerator



## GSI – Some Facts and Figures:

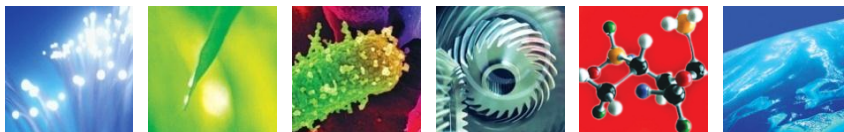
- Founded: 1969
- √ Shareholders: Bundesrepublik Deutschland, Land Hessen
- √ Mission: Heavy Ion Research and Construction and Operation of Accelerators
- √ Budget (2011): ca. 113 million €
- √ Employees: approx. 1050
- √ Scientific users: 1250; (approx. 1000 external)

# GSI – Member of the Helmholtz Association (HGF)

## - Helmholtz: Some Facts and Figures

- 17 Research Centres
- 245 Institutes
- 31.000 Employees
- 9.500 Scientists & Engineers
- 4.700 Doctoral Students
- Budget ca. 3.3 Billion Euro (including Third Party Funding)

*Largest Research Organization in Germany*



# Research Areas in the Helmholtz-Association

## - Program Oriented Research & Funding



Energy



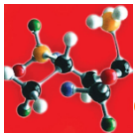
Earth and Environment



**Health**



Key Technologies



**Structure of Matter**



Transport and Space

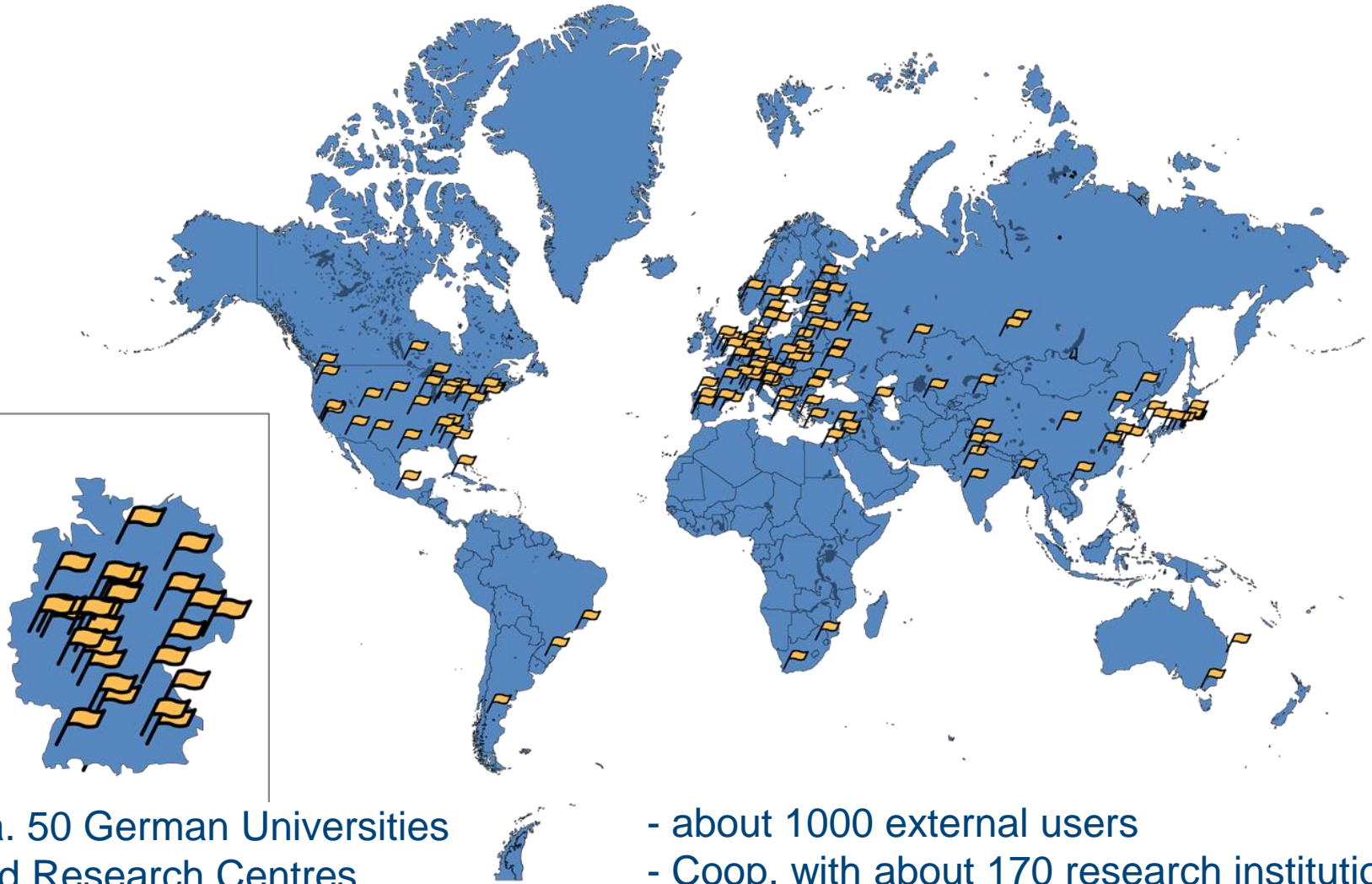


# GSI: Brief History ... and Outlook into the Future



- **Founded in 1969:**  
as large research infrastructure (Großforschungseinrichtung) to 'serve' the surrounding universities
- **Today:**  
German 'National' Laboratory for Nuclear and Heavy-Ion Physics;  
User Facility for European/  
International Users
- **Future:**  
***FAIR - International Facility for Antiproton and Ion Research***

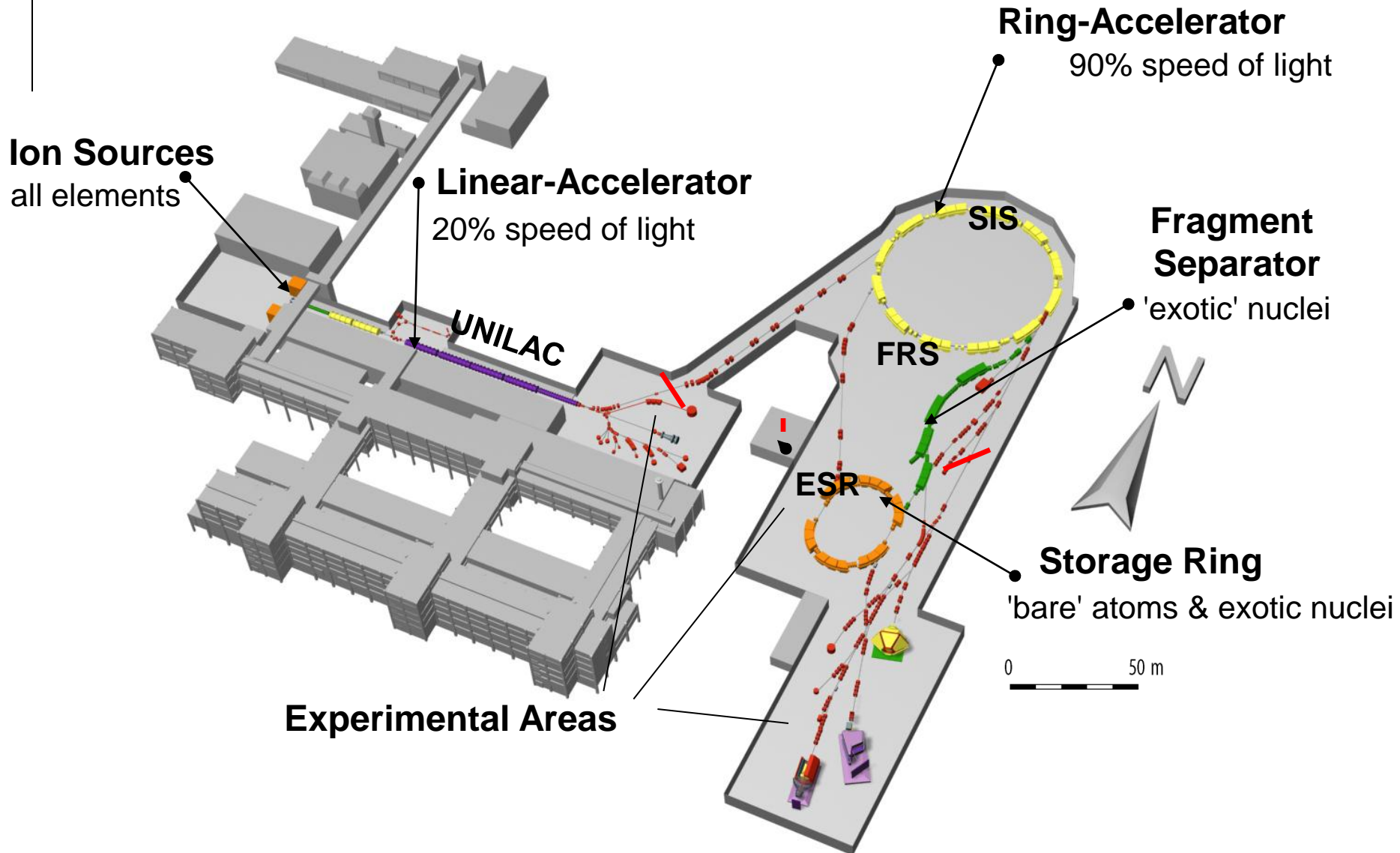
# National and International Cooperation



Ca. 50 German Universities  
and Research Centres

- about 1000 external users
- Coop. with about 170 research institutions  
from over 35 countries

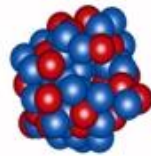
# GSI Accelerator and Experimental Facilities



# Overview of GSI main-research topics

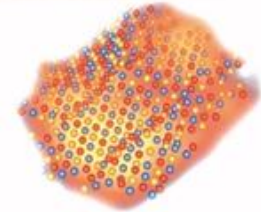
## Nuclear physics

- Nuclear reactions
- Superheavy elements
- Hot condensed nuclear matter



## Plasmaphysics

- Hot dense plasmas
- Ion-plasma interaction



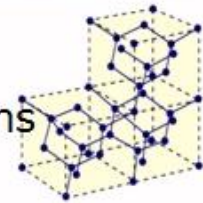
## Biophysics und medical applications

- Radiobiologic effects of ions
- Tumorthrapy with ionbeams



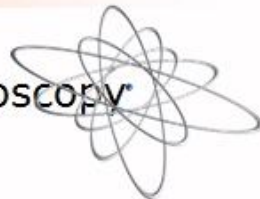
## Material-research

- Ion-solid matter interactions
- structure-investigations with ionbeams



## Atomic physics

- Atomic reactions
- High resolution spectroscopy of charged ions



## Accelerator technology and -physics

- linear and circular accelerators
- high current accelerator-physics



# Example I: Search for super-heavy elements ...

- At GSI: Discovery of six new chemical elements with atomic numbers 107–112

**Presently:** Hunting for Element 120!

I											VIII																										
H 1											He 2																										
II												III	IV	V	VI	VII	He																				
Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10																				
Na 11		Mg 12												Al 13		Si 14		P 15		S 16		Cl 17		Ar 18													
K 19		Ca 20		Sc 21		Ti 22		V 23		Cr 24		Mn 25		Fe 26		Co 27		Ni 28		Cu 29		Zn 30		Ga 31		Ge 32		As 33		Se 34		Br 35		Kr 36			
Rb 37		Sr 38		Y 39		Zr 40		Nb 41		Mo 42		Tc 43		Ru 44		Rh 45		Pd 46		Ag 47		Cd 48		In 49		Sn 50		Sb 51		Te 52		I 53		Xe 54			
Cs 55		Ba 56		La 57		58-71		Hf 72		Ta 73		W 74		Re 75		Os 76		Ir 77		Pt 78		Au 79		Hg 80		Tl 81		Pb 82		Bi 83		Po 84		At 85		Rn 86	
Fr 87		Ra 88		Ac 89		90-103		Rf 104		Db 105		Sg 106		Bh 107		Hs 108		Mt 109		Ds 110		Rg 111		112 112		113 113		114 114		115 115		116 116		117 117		118 118	
119 ?		120 ?																																			

Bohrium

Hassium

Meitnerium

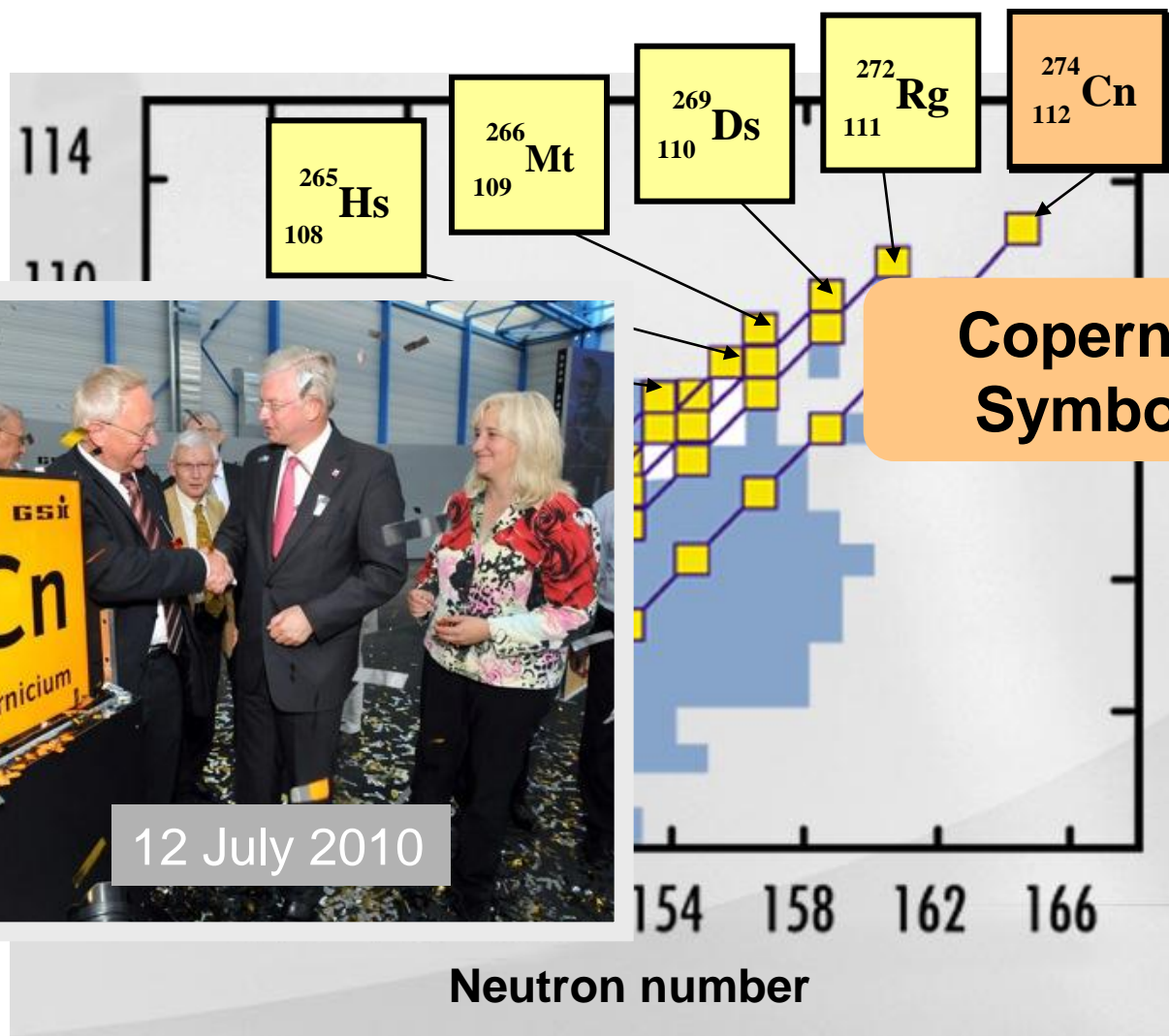
Darmstadtium

Roentgenium

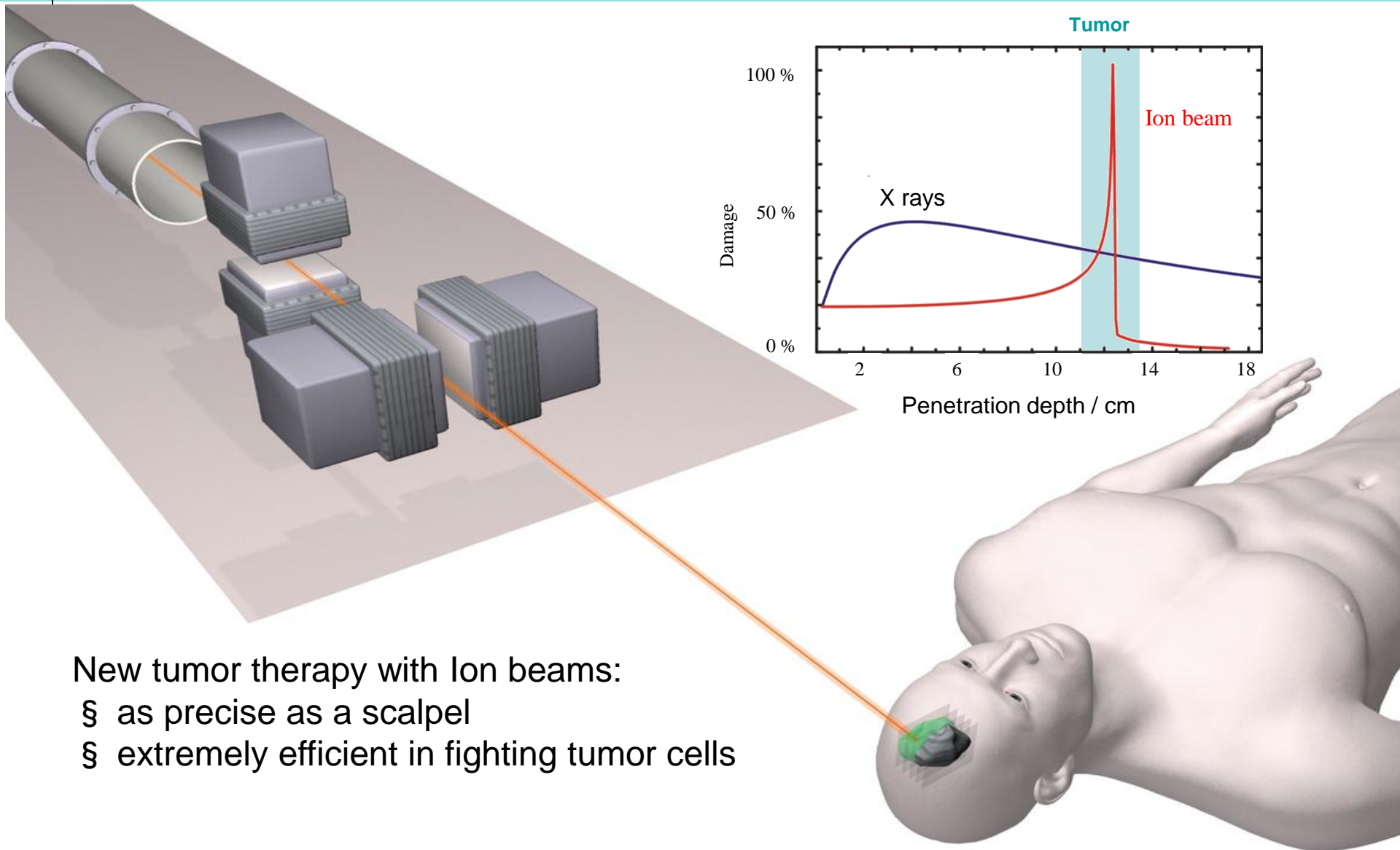
Copernicium



# Naming of Element 112: Copernicium



# Example II: Cancer Therapy with Ion beams...



New tumor therapy with Ion beams:

§ as precise as a scalpel

§ extremely efficient in fighting tumor cells

# From Clinical Studies at GSI... ... to Standard Medical Application

## Pilot phase at GSI



- from 1997 to 2008
- more than 450 patients
- **tumor control rate 80 % - 90 %**
- **almost no side-effects**
- accepted by health insurers

## Heidelberg Ion Therapy HIT



- **start of patient treatments: Nov. 2009**
- **first clinical ion beam unit in Europe**
- three treatment stations
- Goal: 1000 patients per year
- standard medical treatment

- Cooperation and License Contract with Siemens Medical Solutions
- Additional ion beam therapy clinical facilities under construction:  
Marburg-Gießen, Kiel, Shanghai ...

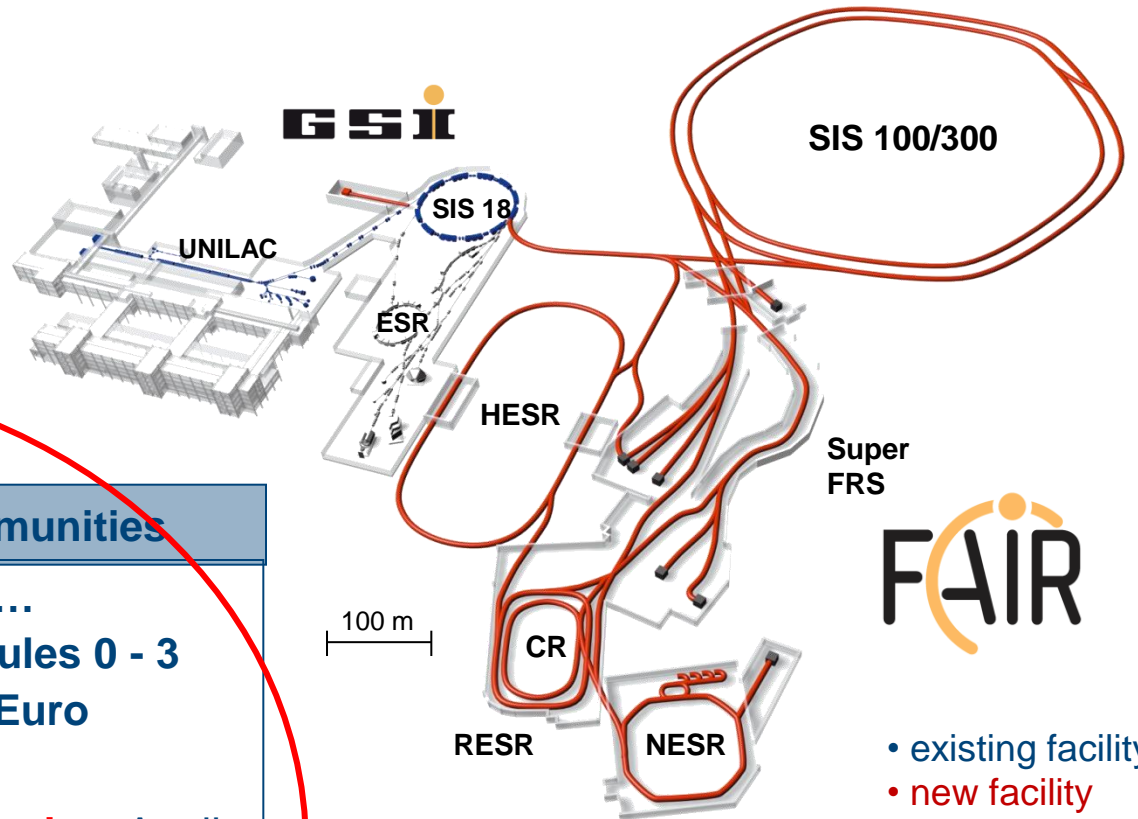
# The present Main Project: FAIR

## Added value

- § Beam intensity by a factor of 100 - 10000
- § Beam energy by a factor of 20
- § Anti-matter beams
- § Unique beam quality
- § Parallel operation

## Construction, cost, scientific communities

- § Construction in modules 0 – 5, ...
- § Modularized Start Version: Modules 0 - 3
- Construction cost: 1.027 Billion Euro
- § Scientific Pillars:
  - **APPA**: Atomic Physics, **Plasma Physics**, Applic.
  - **CBM**: Compressed Baryonic Matter
  - **NuSTAR**: Nucl Structure & Astrophysics
  - **PANDA**: Hadron Structure & Dynamics
- In total: **2500 – 3000 Users**



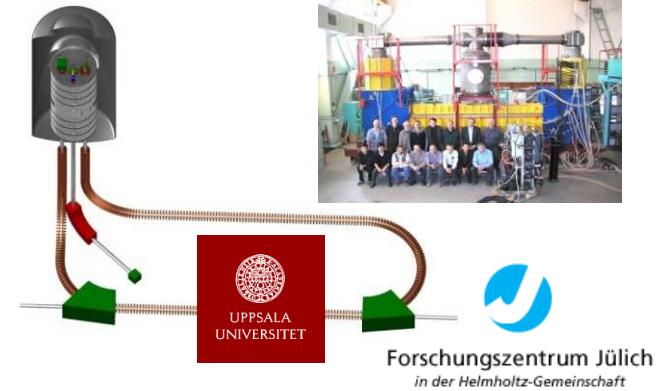
## Funding (Construction)

- § 65 % Federal Republic
- § 10 % State of Hessen
- § 25 % International Partners

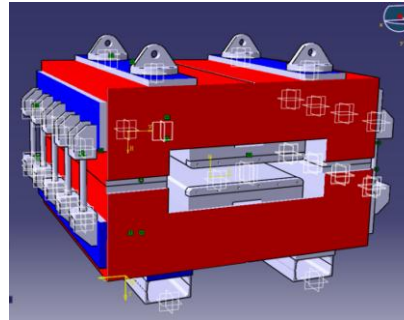
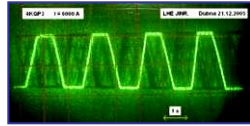
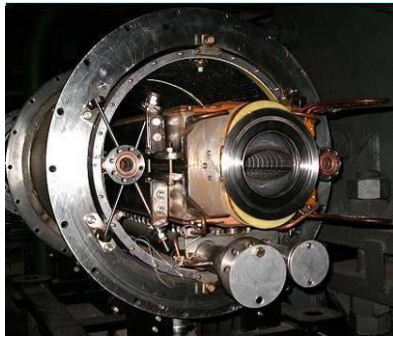
# FAIR key components



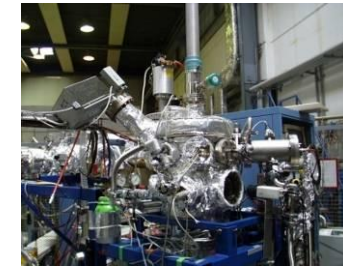
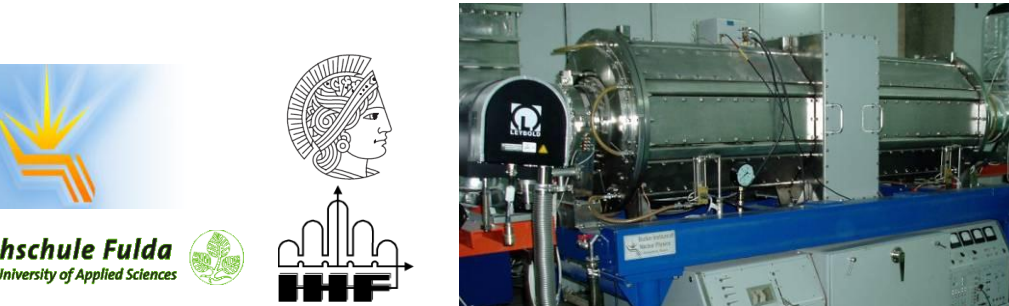
Precision beams:  
Electron & Stochastic Cooling



Compact & cost effective accelerators:  
Fast cycling superconducting magnets:  $dB/dt \sim 4T/s$



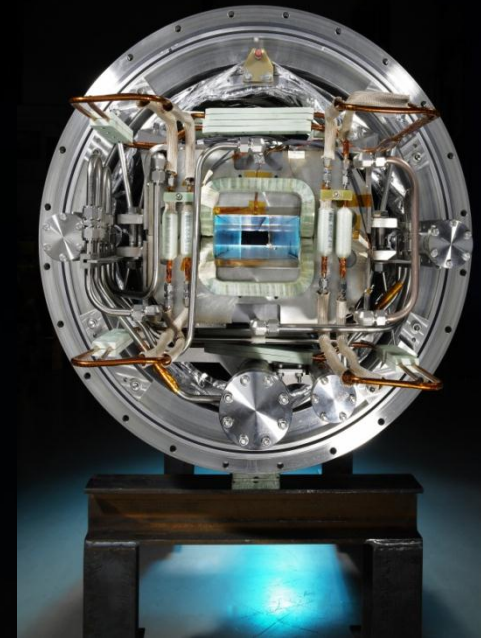
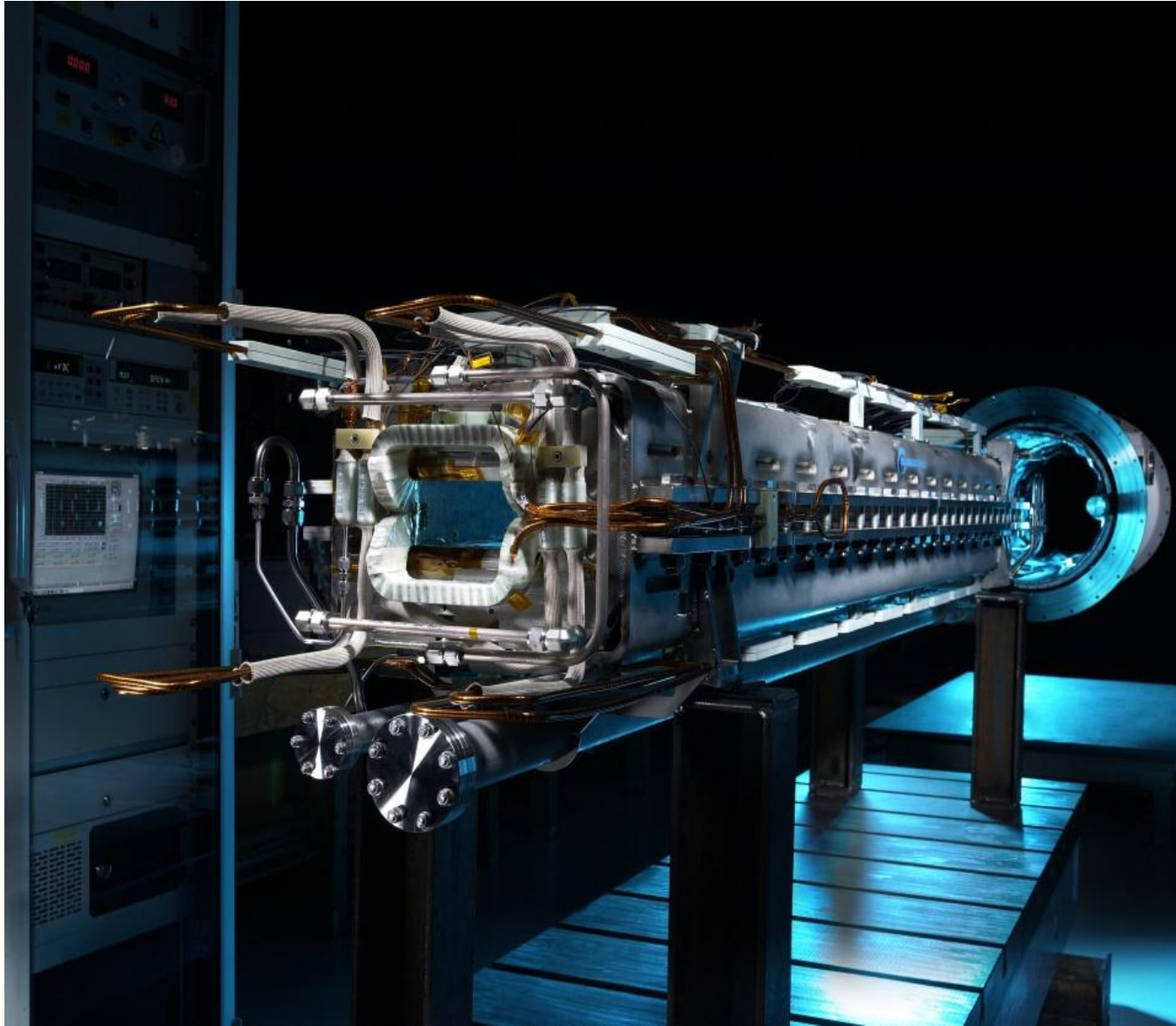
Fast acceleration:  
High gradient variable frequency Ferrit & MA loaded cavities



XHV at high beam intensities:  
Extreme High Vacuum  $\sim 10^{-12}$  mbar



# SIS100 magnet prototype



# Signing Ceremony of FAIR international Convention



*04.10.2010 Castle Biebrich, Wiesbaden*

*Signing Countries:*

*Finland, France, Germany, India, Poland, Romania, Russia, Slovenia and Sweden*

# FAIR in 2020



Thank You!



Austria



China



Finland



France



Germany



Greece



India



Italy



Poland



Romania



Russia



Slovakia



Slovenia



Spain



Sweden



Great Britain





GSI Helmholtzzentrum für Schwerionenforschung

