

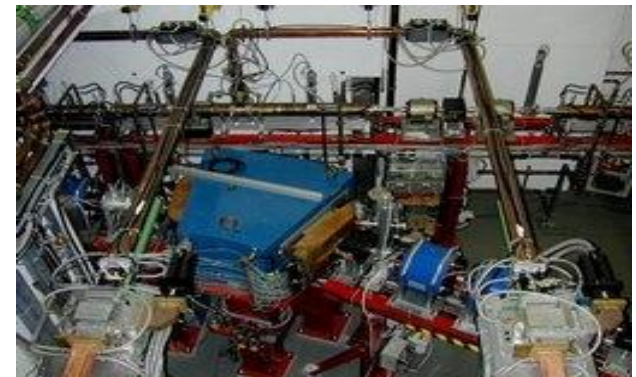
## Structure, Symmetry, and Stability

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Düllmann<sup>b</sup>, M. Schädel<sup>b</sup>, M. Block<sup>b</sup>, F. P.  
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# Helmholtz Instruments to foster Cooperation with Universities

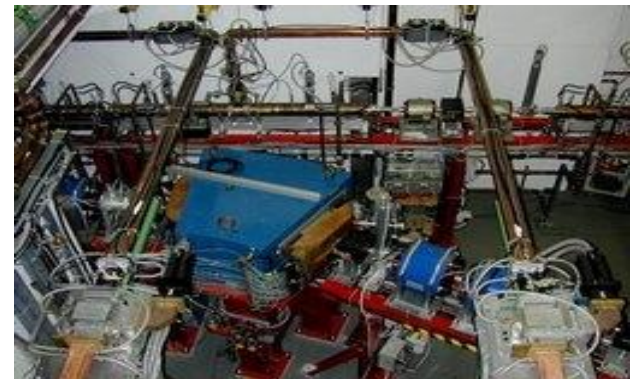
- **Helmholtz Alliances** (Volume: ca. 3 - 5 M€ / year)
  - 'centered around' a Helmholtz Centre;  
e.g. Physics at the Terascale / DESY,  
Extreme Matter Institute / GSI
- ***New:* Helmholtz Institutes**
  - 'located at' universities (Volume: ca. 3 - 5 M€ / year)
- **Helmholtz University Young Investigator Groups**  
(Volume: ca. 250 k€ / year)
- **Helmholtz Graduate Schools, Helmholtz Schools**
- ...

# GSI Helmholtz Centre and FAIR



# Five centers of excellence

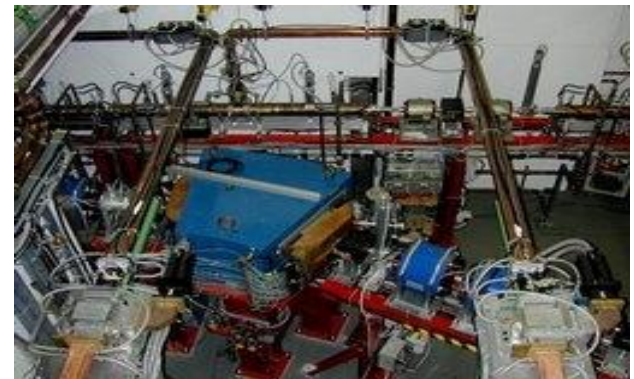
- Social and Cultural Studies
- Immunology and Oncology
- Materials Science
- Earth System Sciences
  
- Nuclear & Particle Physics, Nuclear Chemistry



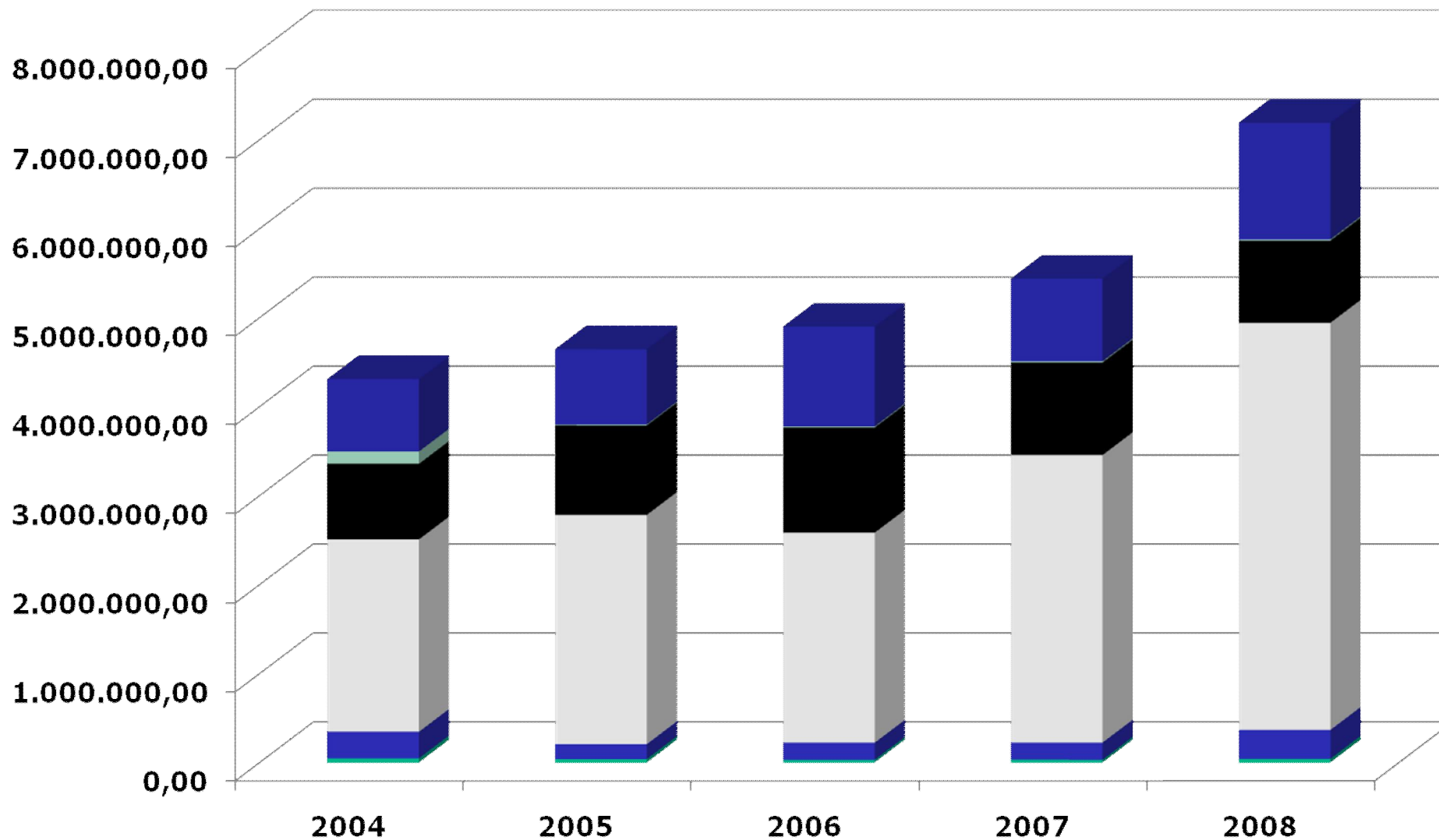
# Five centers of excellence

- Social and Cultural Studies
- Immunology and Oncology
- Materials Science
- Earth System Sciences
  
- Nuclear & Particle Physics, Nuclear Chemistry

*Research Center for Elementary Forces  
and Mathematical Foundations*

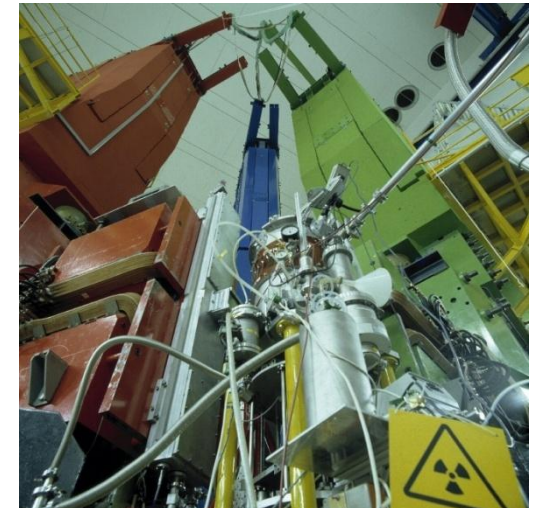


Third-party grants (nucl. & part. phys; nucl. chem.)



## Technical resources

- Mainz Microtron MAMI, Inst. for Nuclear Physics  
Electron accelerator ( $> 1500$  MeV)  
National and international co-operations
- Light Water Research Reactor TRIGA  
One of two research reactors at a German university  
Power:  $100 \text{ kW}_{\text{therm}}$ , Pulsed mode:  $250 \text{ MW}$  for  $0.03 \text{ s}$   
Neutron source for nuclear chemistry
- High-performance PC cluster for Lattice QCD  
New acquisition in 2008 (investment:  $1.3 \text{ M€}$ )  
High-performance computing ( $3,7$  Teraflops)



Strong tradition of collaboration with GSI (since 1960s)

Scientists:

Department of Physics

Department of Nuclear Physics

Department of Nuclear Chemistry



Joint appointments:

Prof. Kratz

Prof. Rudolph

Prof. Maas

Prof. Saito

Prof. Nörtershäuser

nuclear chemistry

*successors to be  
appointed for both*

nuclear  
physics

Joint graduate program: MainS within HGS-HIRE



# Strategic goals of HIM

- Strengthening the close cooperation between GSI and Mainz University
- Supporting FAIR by ideas, competence, and new scientific projects
- Using FAIR for high precision tests of theoretical concepts developed at Mainz University („beyond MAMI“)
- Sharpening the research profile of the Mainz nuclear physics and chemistry groups
- Attracting excellent students, post-graduates and young researchers for scientific involvement at GSI / FAIR



# Structure, Symmetry and Stability of Matter and Antimatter

Precise and quantitative understanding of the effects of the **strong interaction** in atomic, nuclear, hadronic and particle physics.

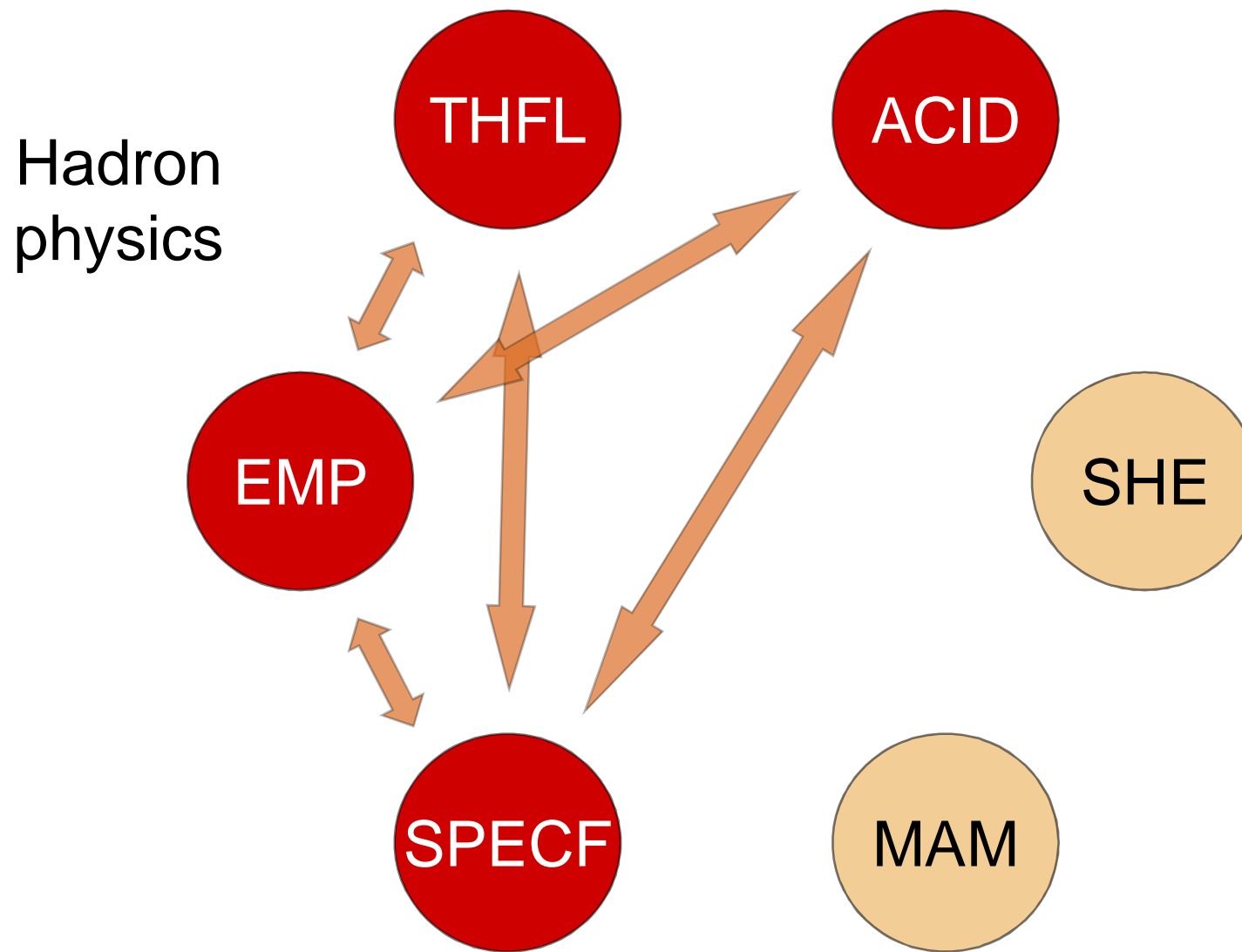
- Spacetime, spin and flavor **structure** of hadrons  
Tomography of the proton
- Limits of the **symmetries** of the standard model  
Exotic hadrons, glueballs, CP-violation, hypernuclei, antimatter gravity
- Limits of **stability** in nuclei  
Physics and chemistry of superheavy elements

## Scientific Goals of HIM:

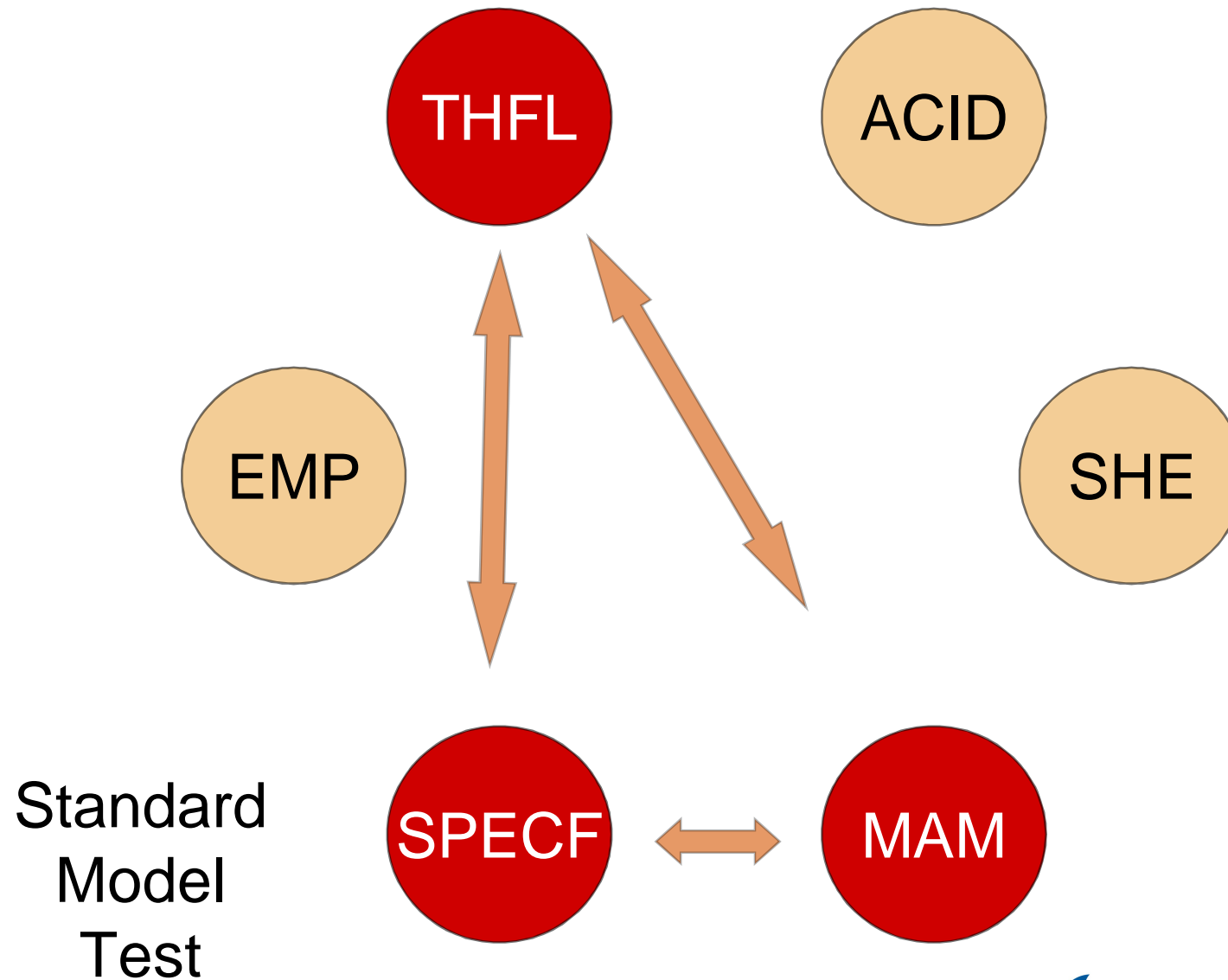
- Planning and realizing **joint projects relevant for GSI and in particular for FAIR** in the areas:
  - Hadron Structure and Spectroscopy
  - Symmetry of Matter and Antimatter
  - Stability and Properties of Super-heavy Elements
  - Integrated Systems of Accelerators and Detectors
  - Hadron and Nuclear Theory

■ ■ ■

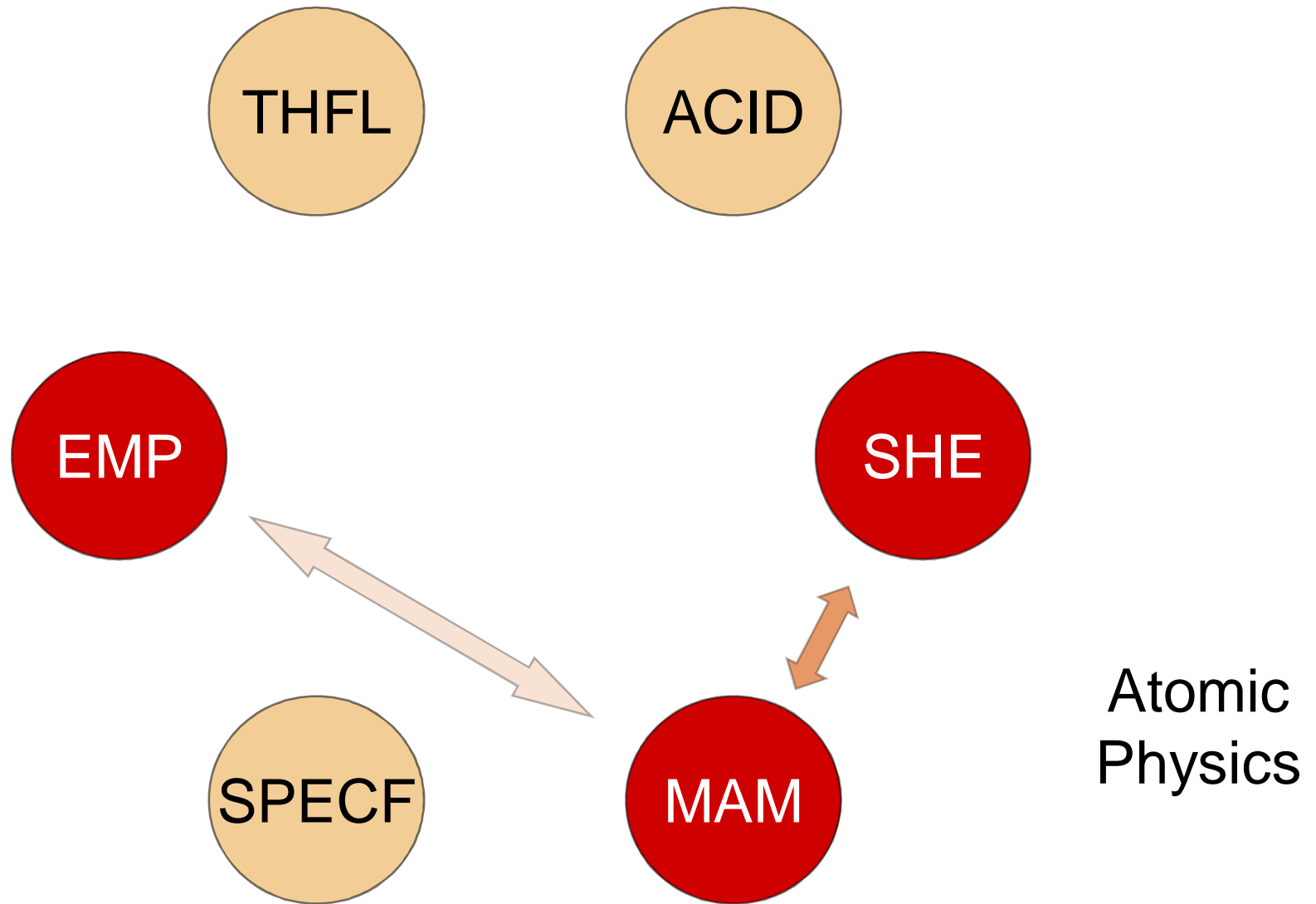
# Scientific Relations of HIM



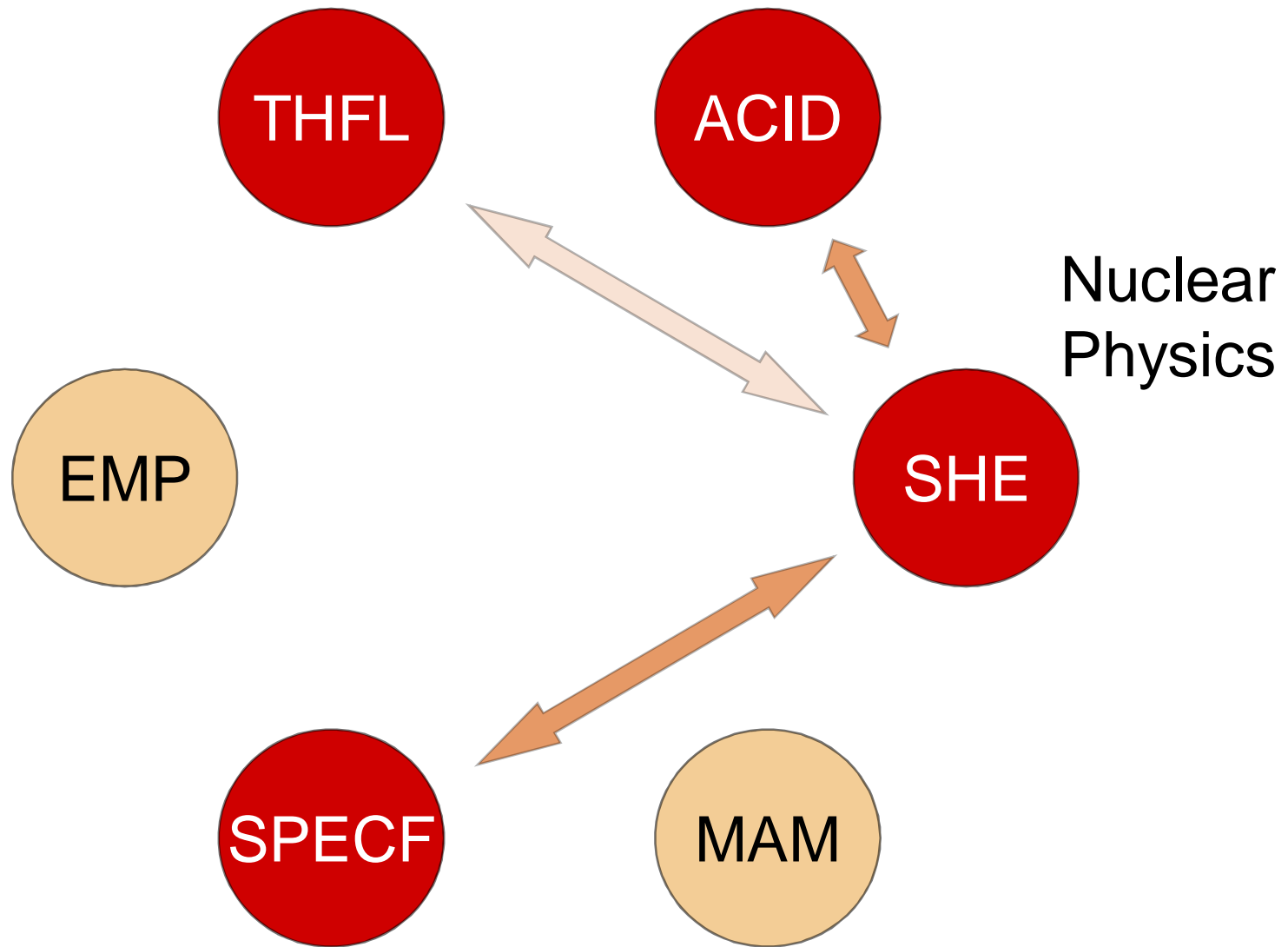
# Scientific Relations of HIM



# Scientific Relations of HIM



# Scientific Relations of HIM



# HIM and the GSI/FAIR Program

**FAIR**

EMP  
SPECF

PANDA

ENC

MAM

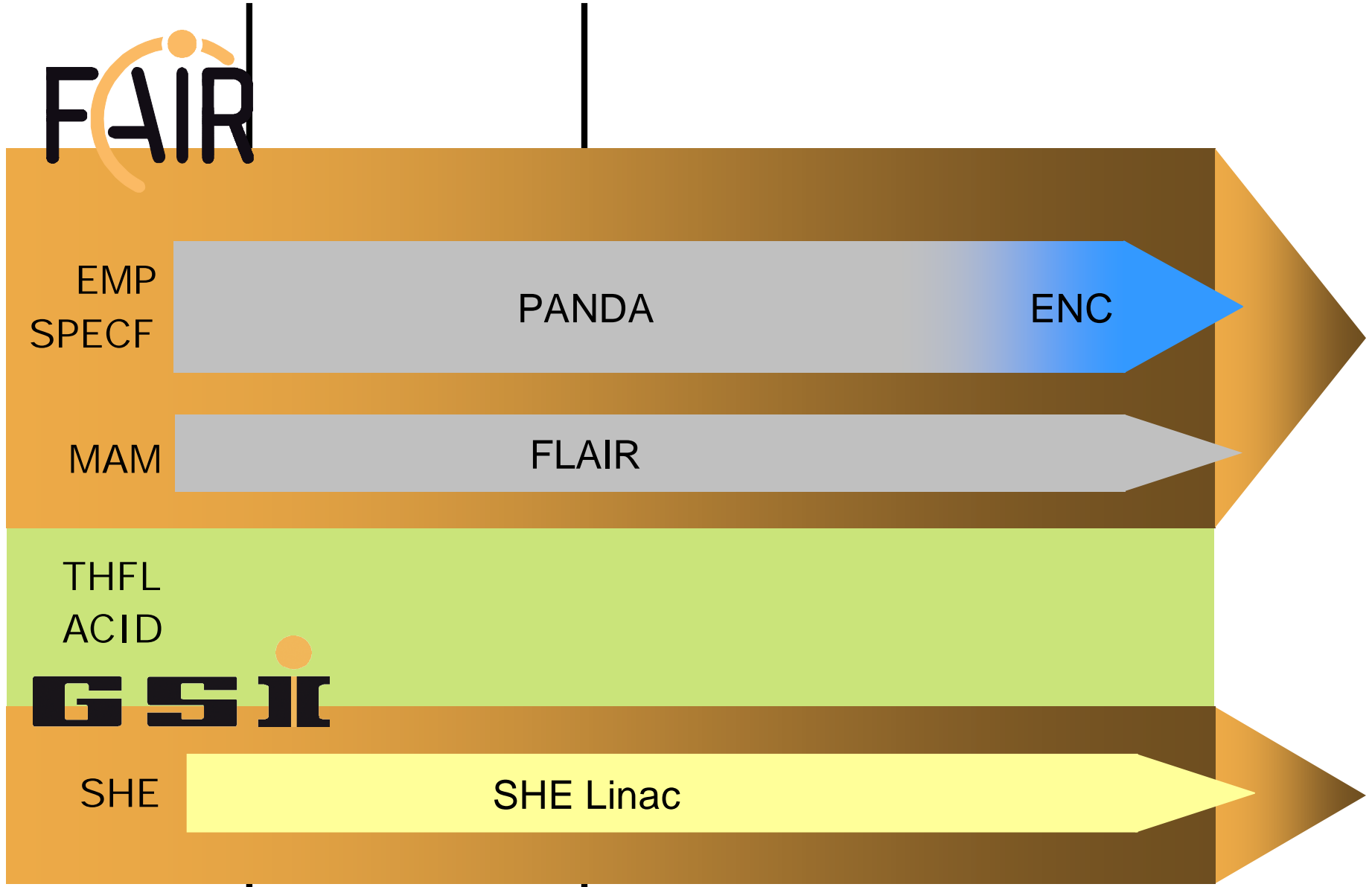
FLAIR

THFL  
ACID

**GSI**

SHE

SHE Linac





# Organisational Structure of HIM

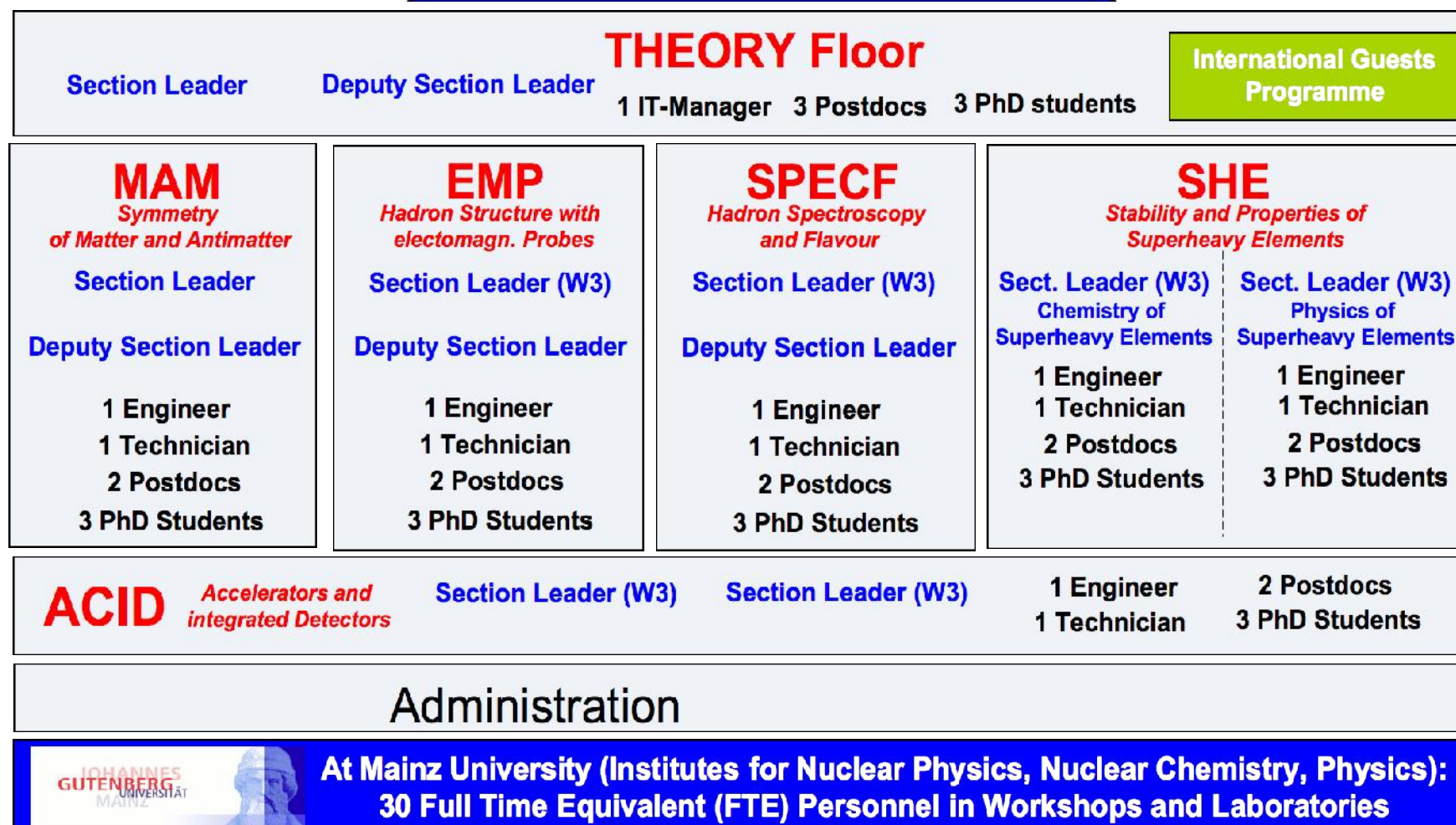


JOHANNES  
GUTENBERG  
UNIVERSITÄT  
MAINZ



## Helmholtz Institute Mainz (HIM)

3 Junior Research Groups  
3 Junior Professors  
1 Postdoc each  
2 PhD Students each



# Beam-on-target Time for SHE Experiments (days per year)



**recent  
years**

~160 d (25% DC)

**40 d**

≥300 d (100% DC)

**300 d**

30 - 300 d (100% DC)

**30-300 d**

**2011+**

≤180 d\* (50% DC)

**90 d**

≥2 x 300 d (100% DC)

**600 d**

≥300 d (100% DC)

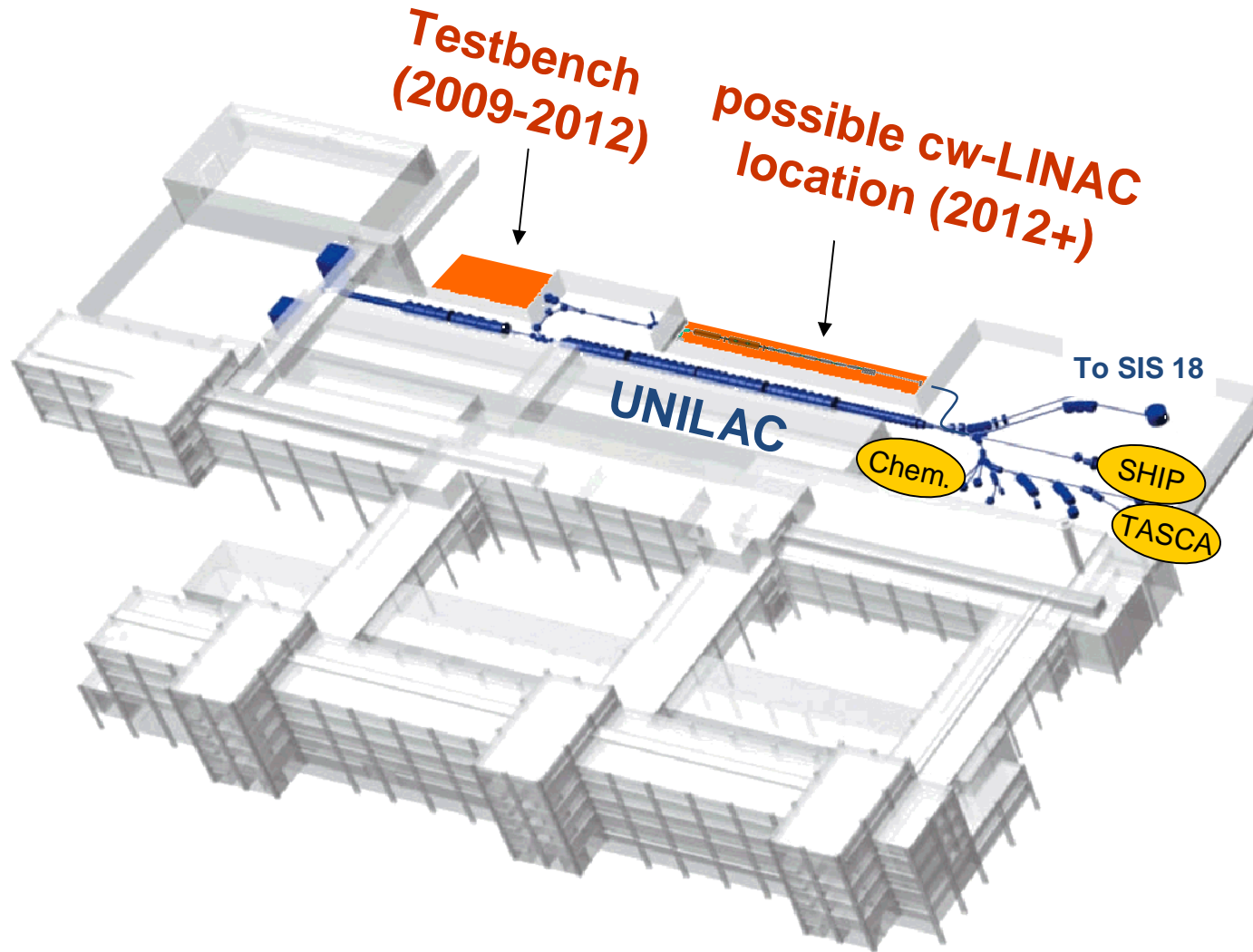
**300 d**

\*desired

**UNILAC not suited for simultaneous**

/ FAIR (A>180, 4 Hz, 100 μs pulses)  
 \ long duty-cycle SHE operation (A<80)

# Toward a Dedicated SHE LINAC



## ACID Section in HIM:

Paving the way for a  
dedicated cw-SHE-  
ECR/LINAC:

Energy: 3.5-7.5 MeV/u

Uncertainty: <3 keV/u

Duty cycle: 100%

Construct  
cavity as a  
prototype to  
demonstrate  
feasibility

first



See talk by A. Jankowiak!

# SHE in HIM: Added Value

International

Collaborations

## SHE @ Helmholtz Institute Mainz (HIM)

THFL @ HIM: Exchange via guest program

Traps  
Lasers

MAM @ HIM

Nucl.  
Chemistry  
TASCA



SHIP  
SHIPTRAP



SHE Chemistry  
Actinide Targets



TRIGA  
TRIGA-TRAP  
TRIGA-LASER



Strong  
force

SPECF @ HIM

ACID @ HIM: SHE-LINAC prototype

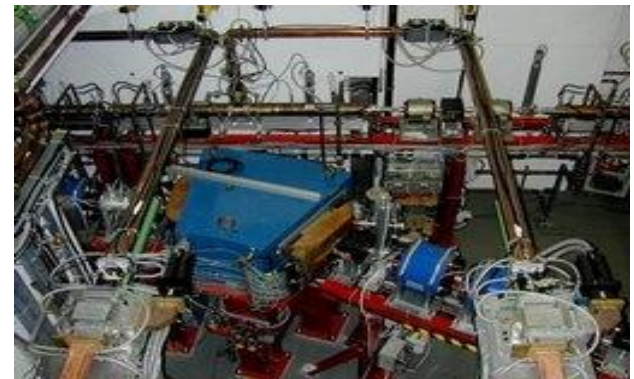
Success depends critically on

local expert groups at 

- firm links between GSI and University – including PhD students / postdocs
- embedded in **multi-disciplinary** campus environment
- **common scientific strategy** using nuclear physics, atomic physics, nuclear chemistry
- **unique** variety of experimental **tools**

# SHE in HIM: Added Value

- Syntheses and decay of SHE (towards  $^{306}122^{184}$ )
- Nuclear structure studies @ SHIP, TASISpec
- Single-ion mass measurements @ TRIGATRAP => SHIPTRAP
- Coupling of TASCA with SHIPTRAP
- Collinear laser spectroscopy @ TRIGA – laser
- Chemical characterization of SHE
- New compound classes



# Contributions to the Helmholtz Institute

State of Rhineland-Palatinate

State contribution to HIM budget (10%)

New building (3.000 sqm)

Johannes Gutenberg-University Mainz

Competence in accelerator physics

Technical infrastructure (e.g. machine shops)

Scientists

Technicians

Central facilities (e.g. computing)

} ~ 4.95 Mio € p.a.

# HIM Operational Budget (90/10%, Steady State): 5.55 M€

