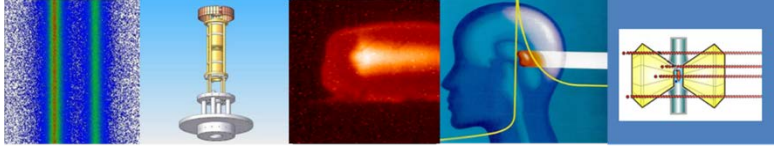
APPA



Report on

Atomic and **P**lasma **P**hysics and **A**pplied Sciences

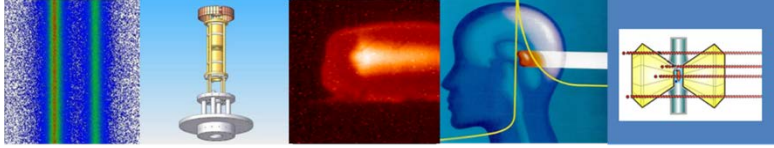
at **FAIR**

Stefan Schippers* for the APPA-Collaborations**

*Justus-Liebig-Universität Gießen (APPA R&D coordinator)

** BIOMAT, FLAIR, HEDgeHOB, SPARC, WDM

KHuK Annual Meeting 2015, 4-5 December 2015, Bad Honnef

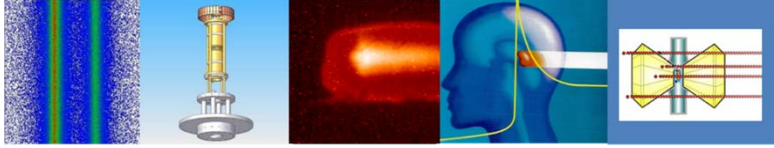


Outline

- Collaborations
- Science
- Facilities
- Funding

APPA Collaborations

APPA



international group of more than **600 scientists from 30 countries**

SPARC — Atomic Physics

Spokesperson: **R. Schuch**, Stockholm University
Coordinator: **A. Bräuning-Demian**, FAIR

BIOMAT — Biophysics & Materials Research

Spokesperson: **M. Durante**, **C. Trautmann**, GSI and TU Darmstadt
Coordinator: **R. Pleskac**, FAIR

HEDgeHOB WDM — Plasma Physics

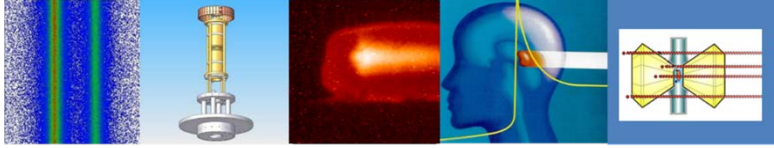
Spokesperson: **D. H. H. Hoffmann**, TU Darmstadt
F. Rosmej, Sorbonne University Paris
Coordinator: **S. Neff**, FAIR

FLAIR — Physics with Low-energy Antiprotons

Spokesperson: **C. Welsch**, University of Liverpool

NIM B 365 (2015) 680

APPA



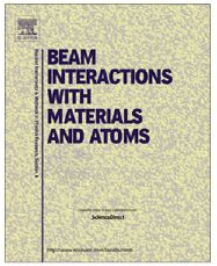
Atomic and Plasma Physics and Applied Sciences

Nuclear Instruments and Methods in Physics Research B 365 (2015) 680–685

Contents lists available at ScienceDirect

Nuclear Instruments and Methods in Physics Research B

journal homepage: www.elsevier.com/locate/nimb



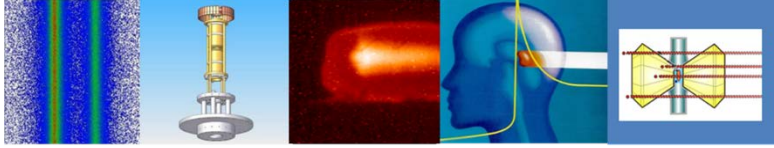
APPA at FAIR: From fundamental to applied research

Th. Stöhlker [a,b,c,*], V. Bagnoud [a,b], K. Blaum [d], A. Blazevic [a], A. Bräuning-Demian [a,e], M. Durante [a], F. Herfurth [a], M. Lestinsky [a], Y. Litvinov [a], S. Neff [a,f], R. Pleskac [a], R. Schuch [g], S. Schippers [h], D. Severin [a], A. Tauschwitz [a], C. Trautmann [a,f], D. Varentsov [a], E. Widmann [i], on behalf of the APPA Collaborations

APPA white paper

APPA Day-1 2021/2022 (prominent examples)

APPA

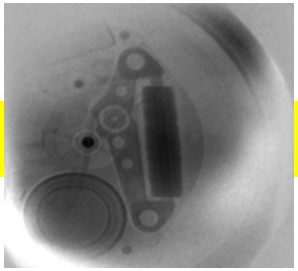


BIOMAT (Biophysics and Materials Research)

- materials under extreme conditions (pressure, heat, irradiation)
- radiation shielding of cosmic radiation

Day-1 experiments (TDRs: 1 in preparation)

- sample irradiation at APPA cave using high pressure cells
- irradiation of biological samples at APPA cave

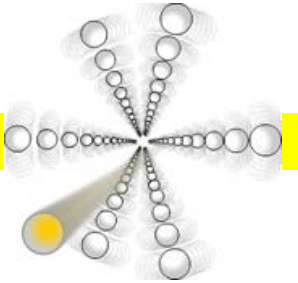


HEDgeHOB/WDM (Plasma Physics)

- phase transitions shocked/compressed matter
- opacity measurements of warm dense matter

Day-1 experiments (TDRs: 5 approved, 1 submitted, 4 in preparation)

- proton microscopy of shocked/compressed materials at APPA cave
- opacity changes from cold- to warm dense matter at APPA cave



SPARC (Atomic Physics)

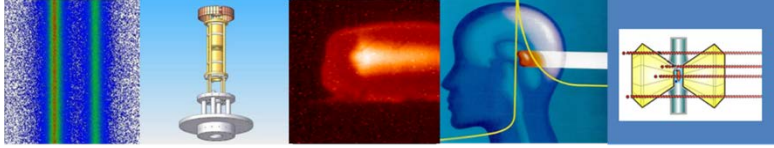
- precision test of QED in the strong field domain ($\alpha Z \approx 1$)
- model independent determination of nuclear parameters

Day-1 experiments (TDRs: 2 approved, 5 submitted, 1 in preparation)

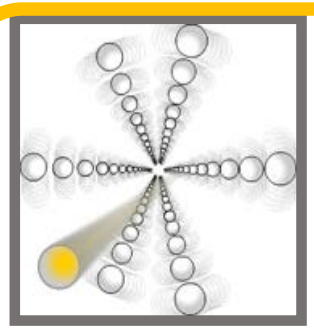
- ion channeling at APPA cave
- laser spectroscopy at HESR (fine-structure) and at CRYRING (hyperfine)

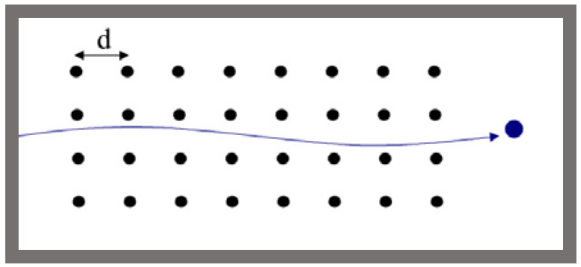
APPA Science at Day-1 one example

APPA

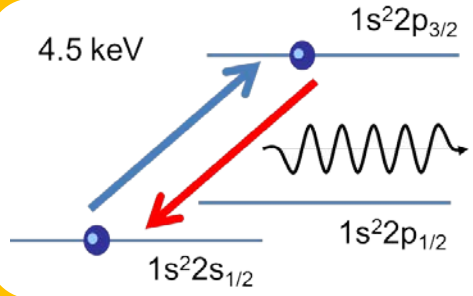


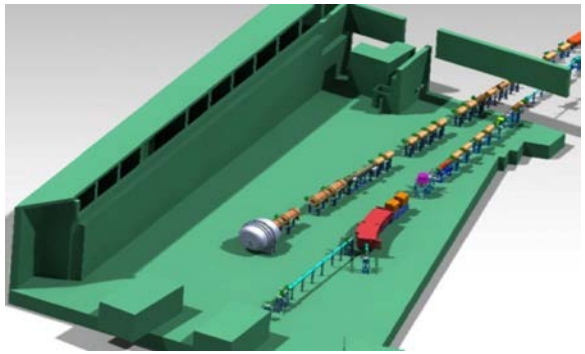
Resonant Coherent Excitation at relativistic energies (test@SIS18/ESR: 2014)



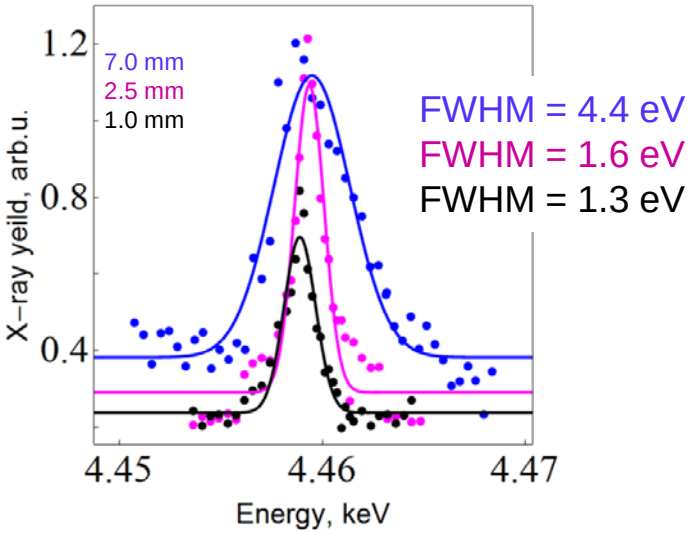


Ion Channeling





$$\Delta E = h\frac{v\gamma}{d}$$



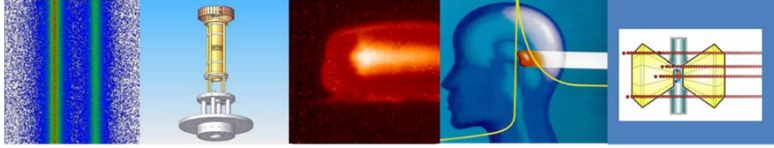
Y. Nakano et al., PRA 87, 060501 (R) (2013)

Only moderate beam intensities are required !

FAIR SIS100: Excitation of 1s-2p in U^{91+} via RCE possible for the first time.

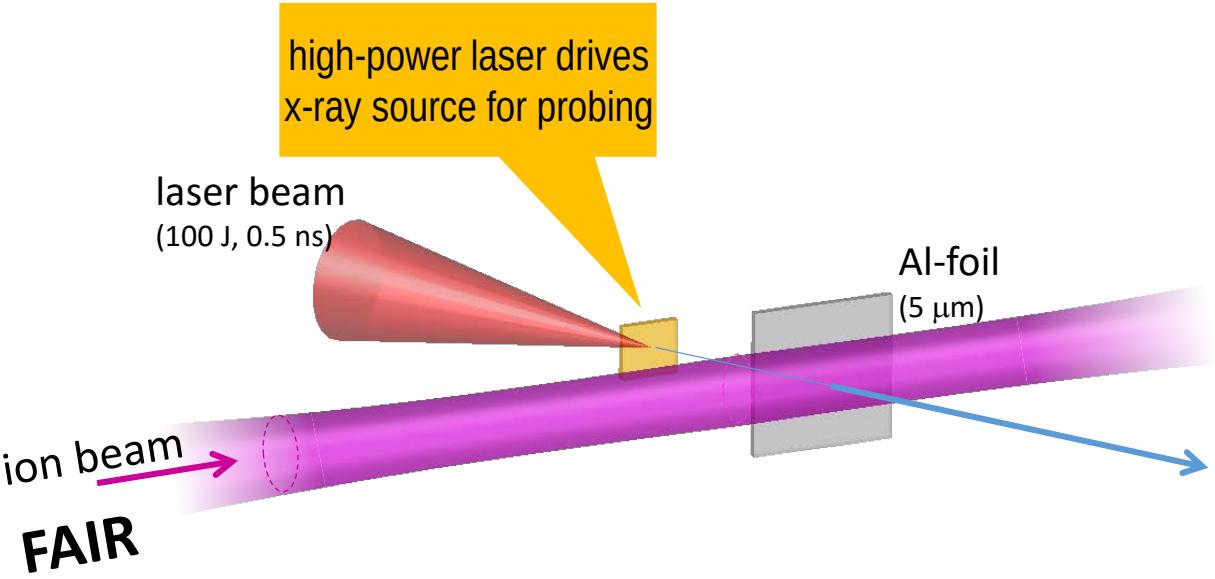
APPA Science at Day-1 another example

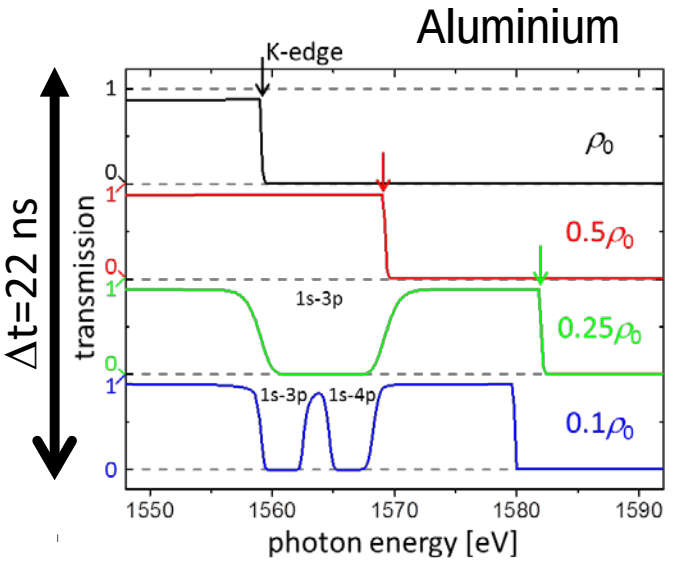
APPA



K-shell absorption spectroscopy in dense plasmas

- **continuum lowering**: fundamental phenomenon in plasma physics
- recent experiments in dense plasmas show significant discrepancies
- in contrast: FEL- and HP-laser produced plasmas: hot, highly non-equilibrium





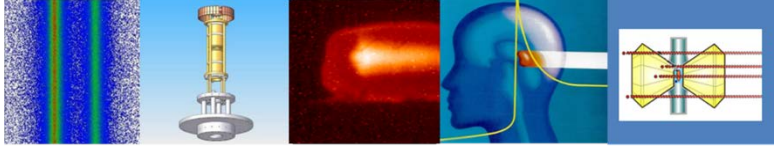
- **rapid heating by intense heavy-ion pulse**
- **hydro-expansion to ρ = 10%...50% ρ_0**

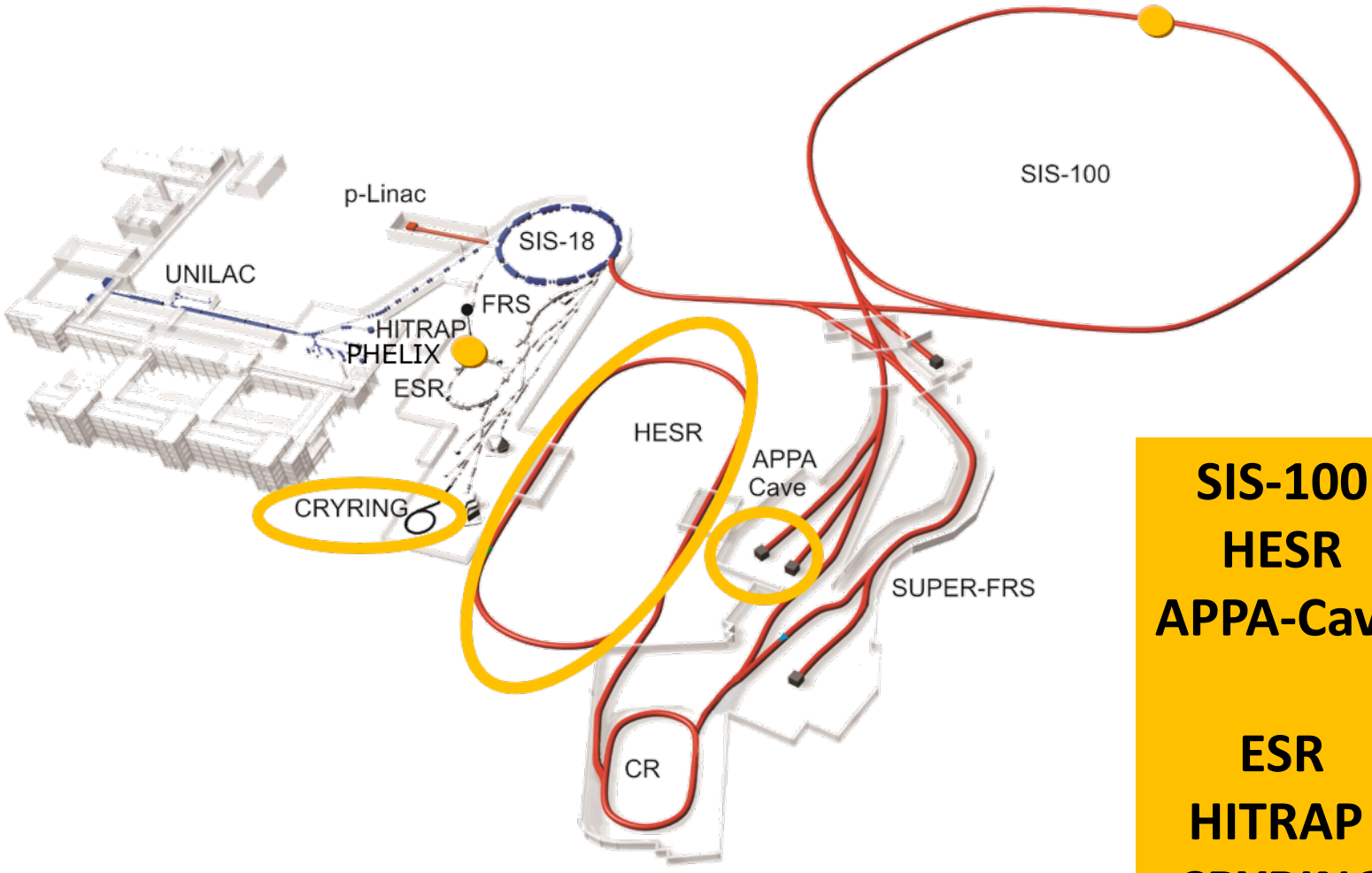
- K-edge shift
- M-shell rebinding

Experiment at FAIR will access transition from dense gas to metal.

FAIR MSV
APPA Facilities

APPA



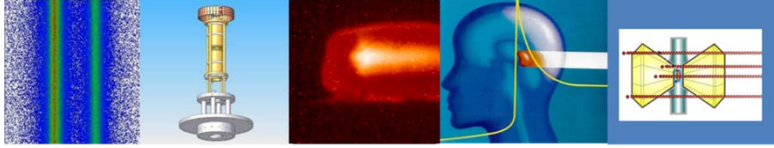


SIS-100
HESR
APPA-Cave

ESR
HITRAP
CRYRING

FAIR MSV
APPA Cave

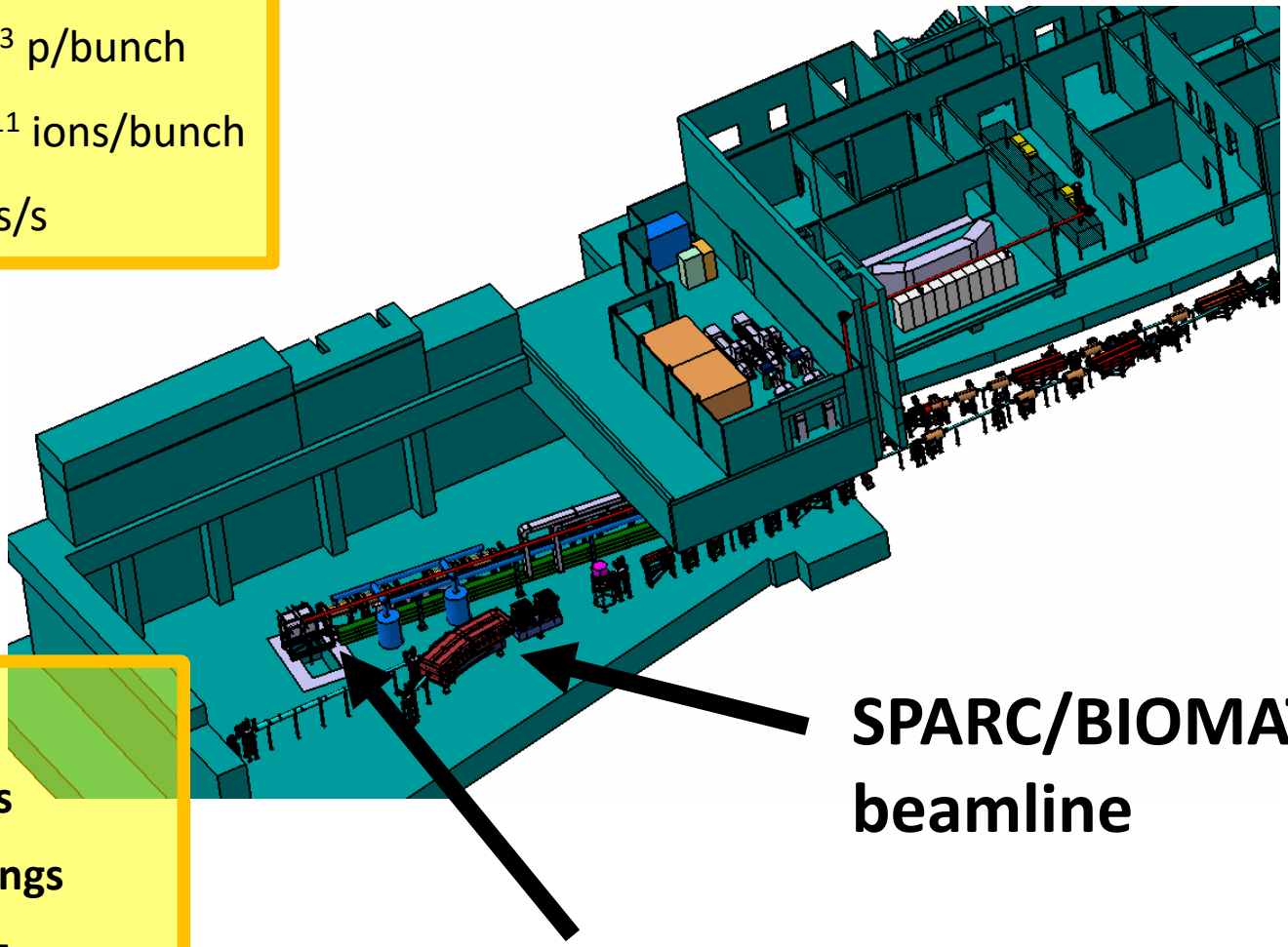
APPA



protons (10 GeV): 2 x 10^{13} p/bunch

U^{28+} (2 GeV/u): 5 × 10^{11} ions/bunch

U^{92+} (10 GeV/u): 10^{8} ions/s



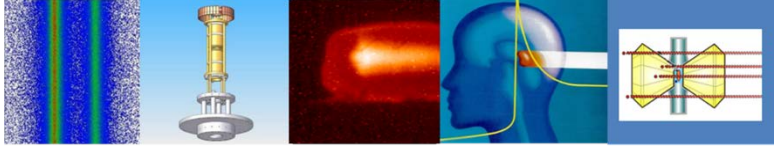
- **user facility**
- **several target stations**
- **flexible detector settings**
- **flexible beam shaping**
- **external drivers**

SPARC/BIOMAT beamline

HEDgeHOB/WDM beamline

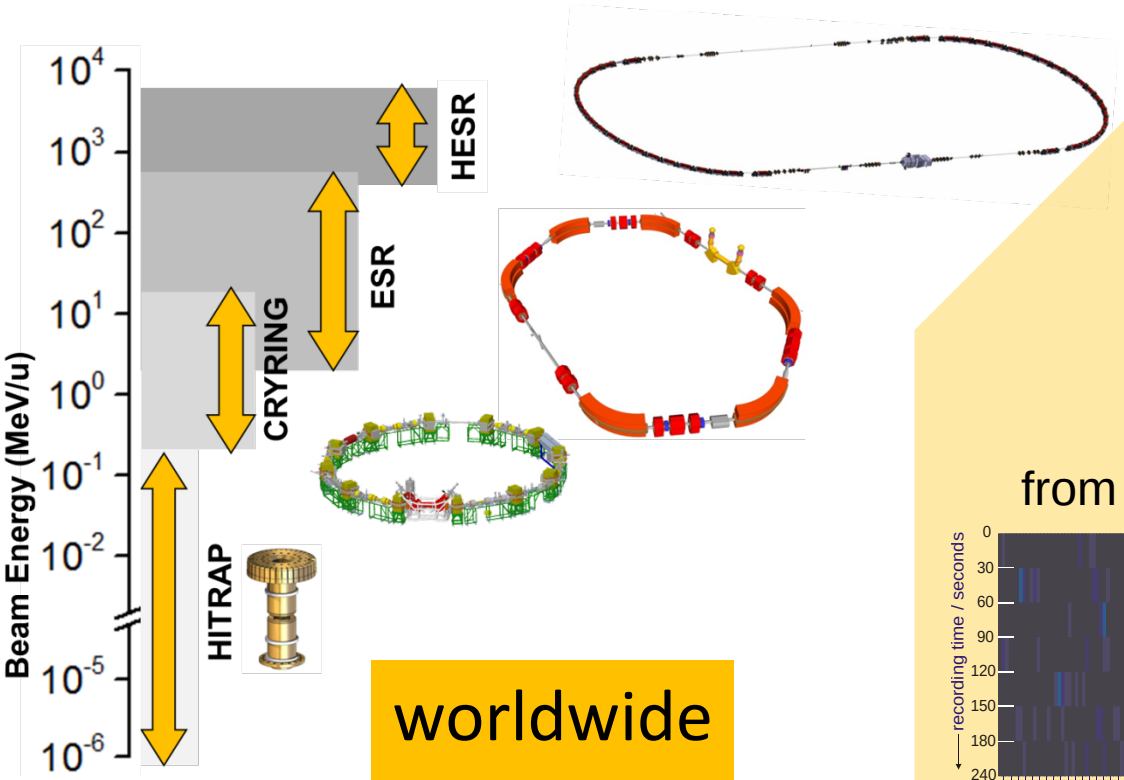
FAIR MSV

APPA



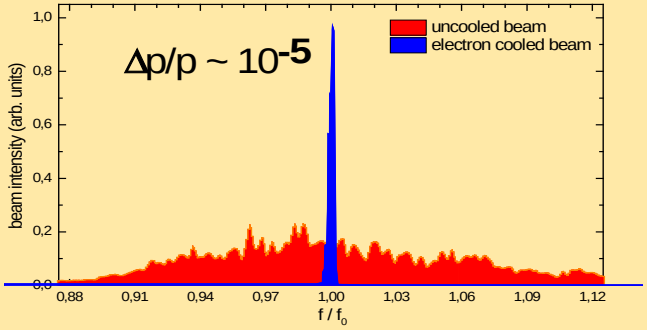
Trapping and Storage Facilities

highly charged ions (e.g. U^{92+}) and exotic nuclei
from rest to relativistic energies (up to 6 GeV/u)

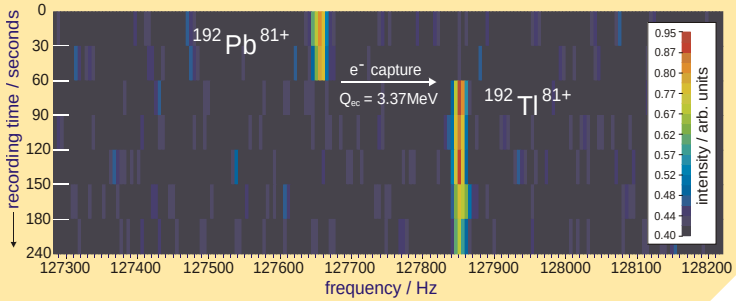


worldwide
unique

cooling: The key for precision

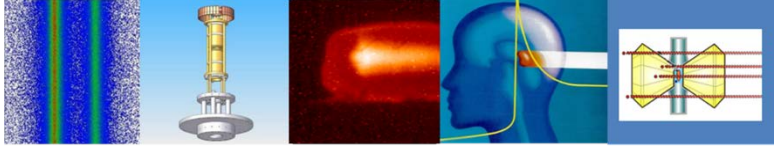


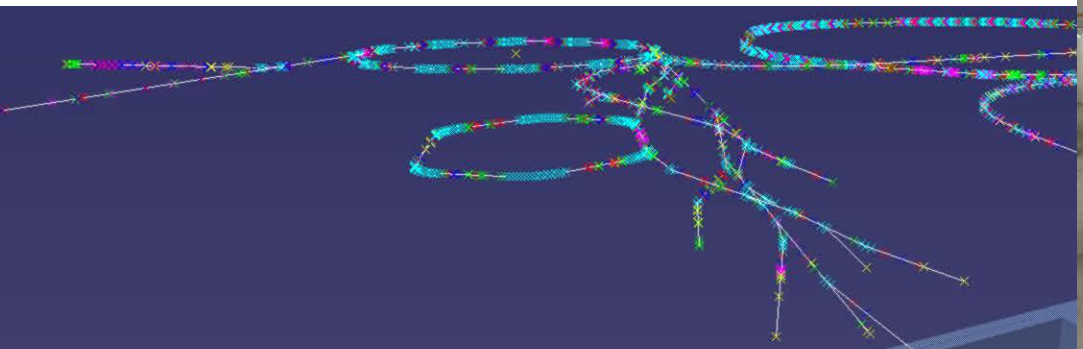
from single ions to highest intensities



FAIR MSV
CRYRING status

APPA

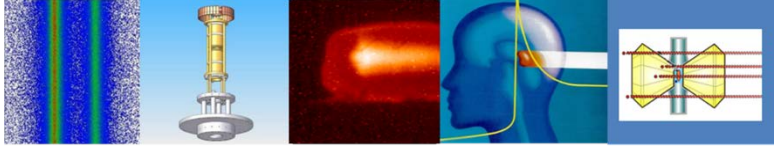




Commissioning will start in 2016!!!

- separate injector available
- tests of FAIR accelerator control system
- tests of experimental equipment
- first experiments
- beam extraction for MAT experiments

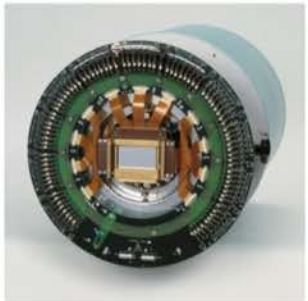
Instrumentation APPA

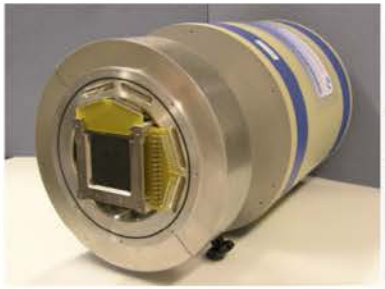


granular, versatile, state-of-the-art

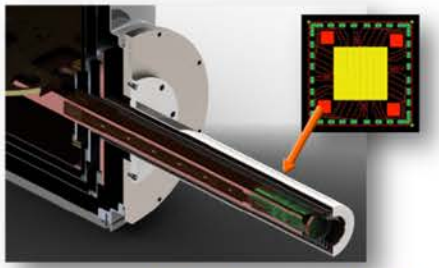
detection systems for photons, electrons, positrons, and ions

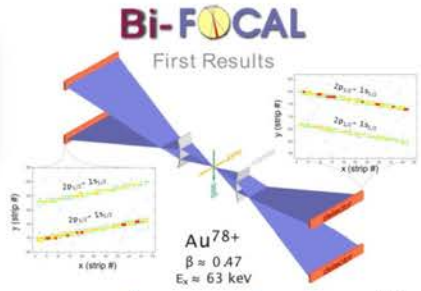
Targets





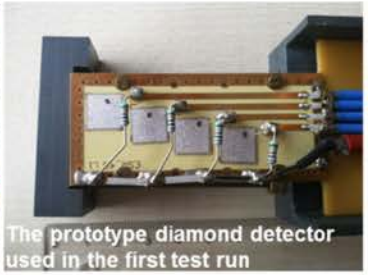
Position-sensitive solid-state detectors



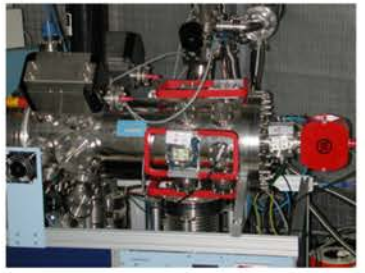


High-resolution spectrometers

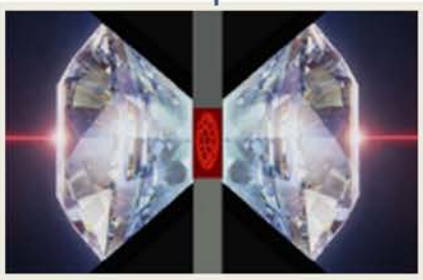
Traps



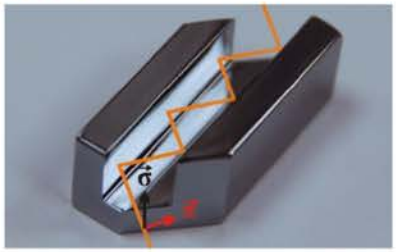
Particle detectors



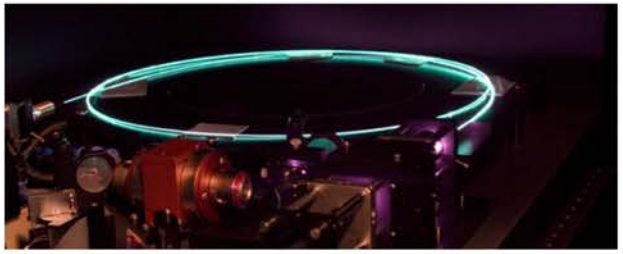
Particle spectrometers



High-pressure cell

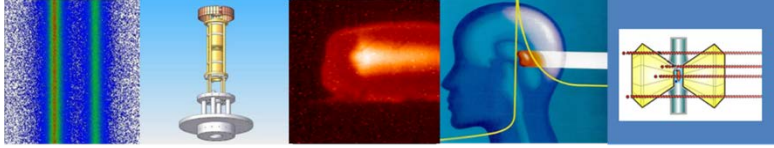


X-ray optics, channel-cut crystals

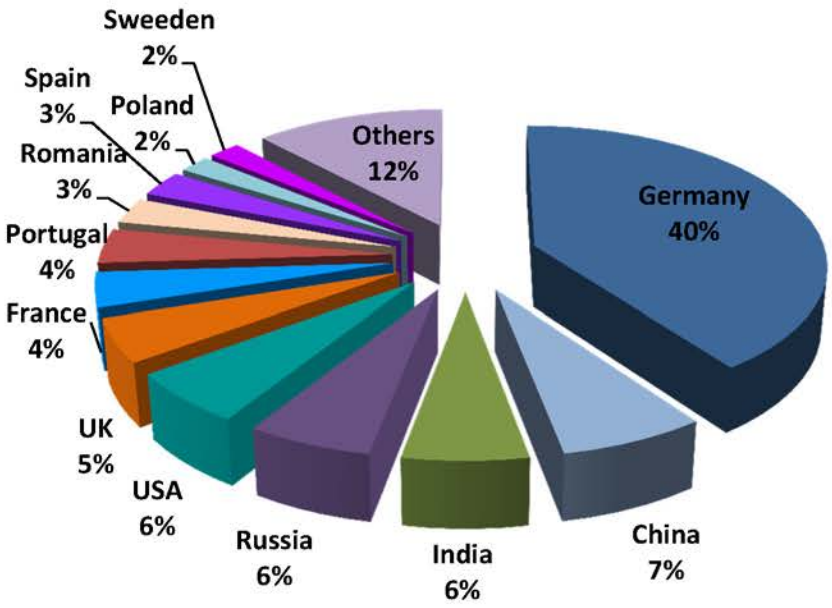


Laser systems

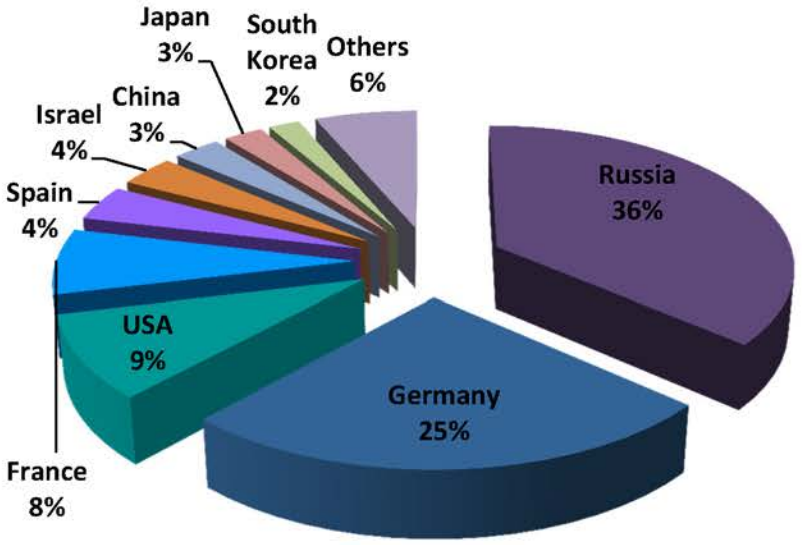
APPA International



SPARC: 338 members



HEDgeHOB / WDM: 240 members

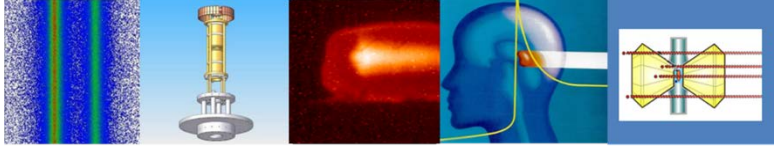


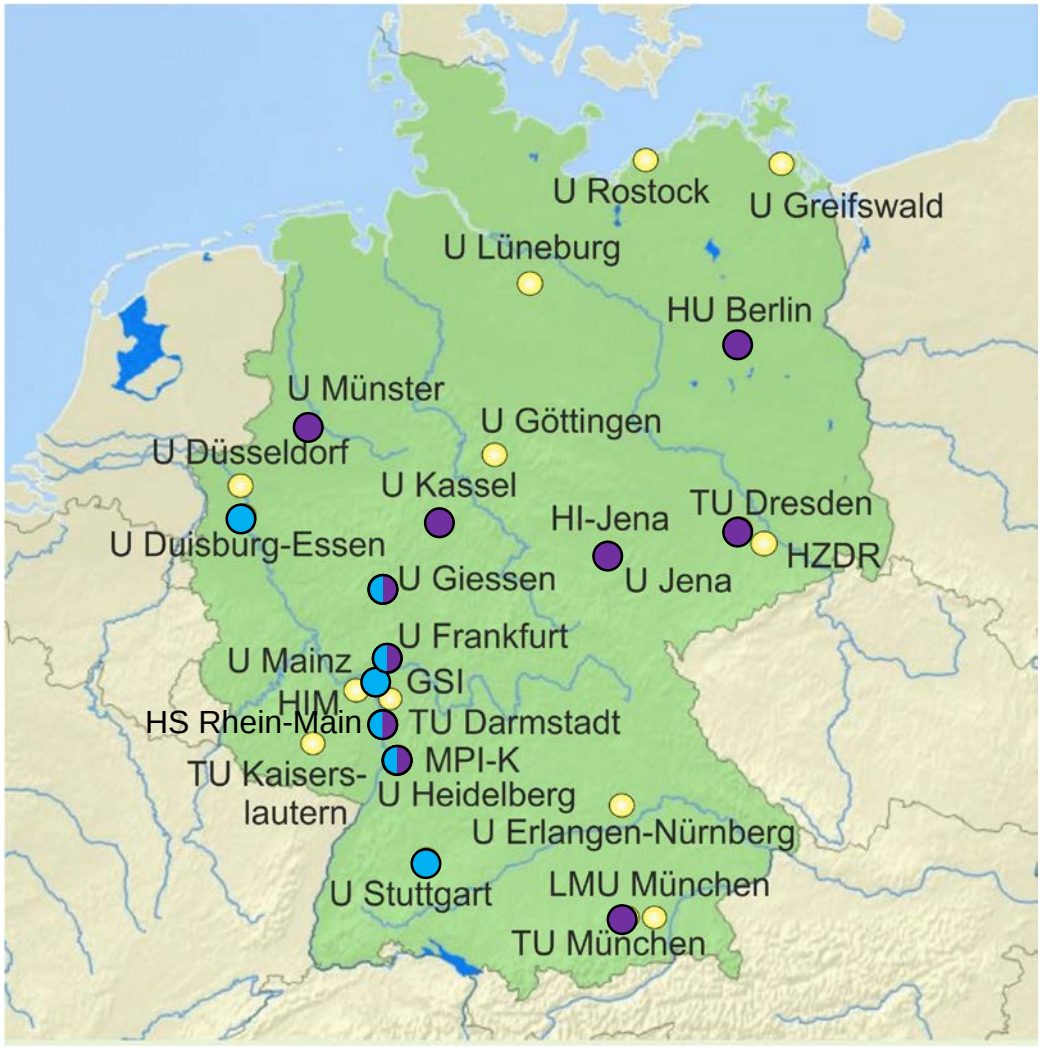
BIOMAT: 180 members

(as of June 2015)

APPA R&D
German University Groups

APPA





BMBF-Verbundforschung

Bundesministerium
für Bildung
und Forschung

SPARC, HEDgeHOB, WDM

31 applications, 22 funded by

"Physik der kleinsten Teilchen"

coordinated by S. Schippers (Gießen)

BIOMAT

8 applications under review at

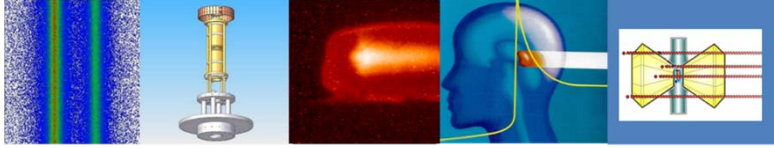
"Kondensierte Materie"

coordinated by

M. Schleberger (Duisburg/Essen)

APPA R&D funded projects (6.8 M€)

APPA



- **lasers & x-rays: spectroscopy, diagnostics**
- **targets & traps**
- **particle detection and identification**
- **theory: time-dependent phenomena, simulations**

05P15KHFAA: **HU Berlin**, *Lö*
In

05P15PMFAA: **U Münster**, *E*
Sp
La

05P15RDFA1: **TU Darmstad**
M

05P15RDFAA: **TU Darmstad**
Laserspektroskopie an der GSI

05P15RFFA1: **U Frankfurt**, *Entwicklung von Diagnostik und Simulationen für plasmaphysikalische Experimente bei FAIR*

05P15RFFAA: **U Frankfurt**, *Umladedetektoren am CRYRING/LSR: Detektor-Manipulatoren und UHV-taugliche Si-Detektoren*

05P15RGFAA: **U Gießen**, *Aufbau und Tests von Experimentiereinrichtungen zur Elektronenstoß- und Röntgenspektroskopie*

05P15RKFAA: **U Kassel**, *Hochauflösendes Seya-Namioka-Fluoreszenzspektrometer für den Spektralbereich zwischen 35 nm und 700 nm für Experimente an Speicherringen für hochgeladene Ionen*

05P15SJFA1: **U Jena**, *Spektroskopie von Plasmen bei FAIR*

05P15SJFAA: **U Jena**, *Licht-Materie Wechselwirkung mit hochgeladenen Ionen*

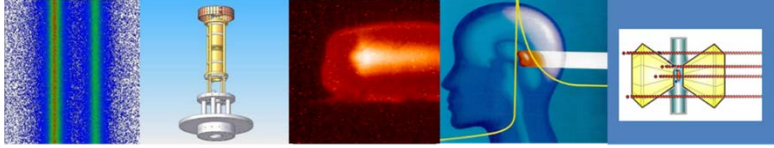
05P15VHFAA: **U Heidelberg**, *Mikrokalorimeter-Arrays und Quantengas-Target für Experimente an der GSI/FAIR*

05P15WOFA1: **TU München**, *Optische Strahldiagnose für intensive Ionenstrahlen*

05P16ODFA1: **TU Dresden**, *Kühlung von Strahlen hochgeladener Ionen bei hochrelativistischen Energien mit Hilfe eines gepulsten Lasersystems*

BIOMAT projects under review

APPA



(BMBF-Verbundforschung “Kondensierte Materie”)

Verbund Ionenstrahl-induzierte Materialmodifikationen (IIM@FAIR)

Coordinator: Prof. Marika Schleberger (UDE)

CRYRING – UNILAC – SIS – APPA Cave

Projects:

P1 Marika Schleberger (Universität Duisburg-Essen), *Syn[illegible]*

P2 Andreas Wucher (Universität Duisburg-Essen), *Masse[illegible]*
mit hochenergetischen schweren Ionen

P3 Michael Dürr (Justus-Liebig-Universität Gießen), *Che[illegible]*
mittels Photo-Elektronenspektroskopie

P4 Wolfgang Bolse (Universität Stuttgart), *Materie-Ejekt[illegible]*

P5 Björn Winkler (Johann-Wolfgang-Goethe Universität [illegible]
Bestrahlung mit relativistischen Schwerionen[illegible]
resonante Ultraschall- Spektroskopie und Inte[illegible]

P6 Wolfgang Ensinger (Technische Universität Darmstad[illegible]
Röntgen-(X-ray)-Emission zur Analyse der Aus[illegible]
Beschleuniger- und Nano-Materialien (HI-EXE[illegible]

P7 Ulrich Glasmacher (Ruprecht-Karl-Universität Heidelb[illegible]
spektroskopischen Analyse von schwerioneni[illegible]
unter extremen Drücken und Temperaturen w[illegible]

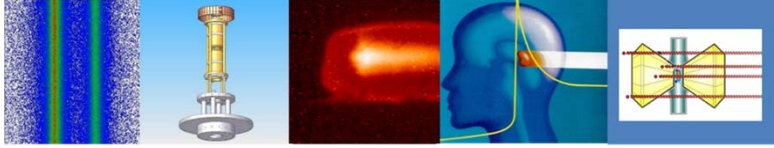
P8 Friedemann Völklein (Hochschule Rhein-Main), *Ionenstrahlinduzierte Ionenstrahl-induzierte Desorptionseffekte*

intense high-energy ion beams

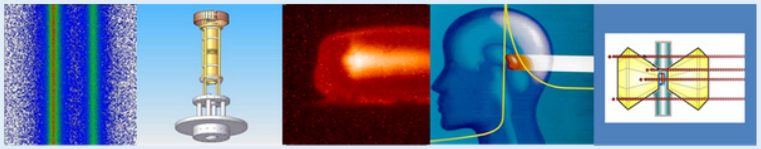
- **irradiation of materials**
- **bulk and surface effects**
- **track formation**
- **spectroscopy**
- **time-dependent phenomena**

http://appa-rd.fair-center.eu/

APPA



APPA R&D web pages



Forschungsverbund APPA R&D

Startseite

- Startseite
- Universitätsgruppen
- Geförderte Projekte
- Dokumente
- Termine
- Links

gefördert im Rahmen der BMBF-Verbundforschung durch das Bundesministerium für Bildung und Forschung

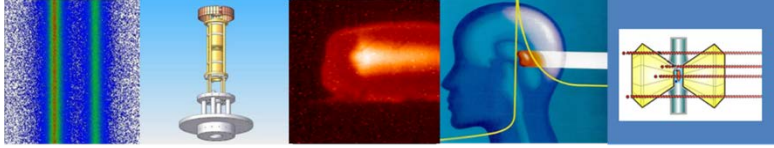
Der vom BMBF im Rahmen der Verbundforschung geförderte Forschungsverbund APPA R&D umfasst die deutschen Universitätsgruppen, die sich im Rahmen des internationalen APPA-Verbunds für die Forschung an der zukünftigen internationalen Beschleunigeranlage FAIR engagieren. Die FAIR-Anlage wird derzeit auf dem Gelände des GSI Helmholtzzentrums für Schwerionenforschung in Darmstadt errichtet. APPA („Atomic, Plasma Physics and Applications") ist eine der vier Forschungssäulen von FAIR. Die unter dem gemeinsamen Dach von APPA agierenden internationalen Forschungskollaborationen BIOMAT, FLAIR, HEDgeHOB, SPARC und WDM, konzentrieren sich auf die Erforschung der Bausteine und Phänomene der Materie unter extremen Bedingungen (hohe Felder, Dichten, Drücke und Temperaturen).

Gegenstand des Forschungsverbunds APPA R&D sind thematisch abgestimmte Forschungsprojekte im Bereich beschleunigergestützter Experimente mit schweren Ionen an der zukünftigen FAIR-Anlage. Zentrale Punkte dabei sind:

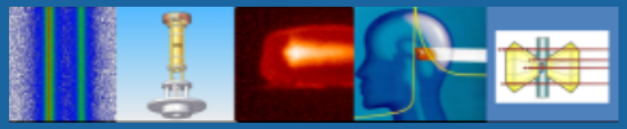
- Fortentwicklung der Großgeräteinfrastruktur, vor allem Forschung und Entwicklung zur Steigerung der wissenschaftlichen Leistungsfähigkeit vorhandener Anlagen sowie zukünftiger Beschleuniger- und Detektorsysteme einschließlich der entsprechenden Basistechnologien und
- Aufbau der APPA-Experimente in den Modulen 0-3 der Modularisierten Startversion von FAIR.

https://indico.gsi.de/event/appard

APPA



APPA R&D meeting 14./15.01.2016



APPA - R & D

14-15 January 2016
GSI
Europe/Berlin timezone

- Overview
- Timetable
- Registration
  - Modify my registration
- List of registrants
- Travel & Accomodation

Kontakt

Stefan.Schippers@physi...
+49 641 99 15203

Kick-off Meeting für APPA-Verbundforschung 2015 - 2018

Starts 14 Jan 2016 14:00
Ends 15 Jan 2016 15:30
Europe/Berlin

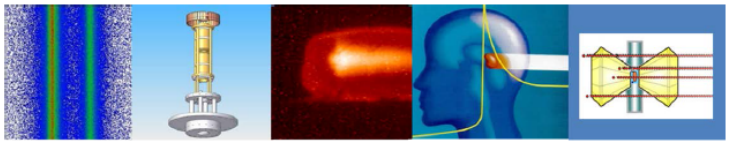
GSI
SB3.3.170a
Planckstraße 1
64291 Darmstadt-Wixhausen

Schippers, Stefan
Stöhlker, Thomas
Trautmann, Christina

Webseiten des APPA-R&D-Verbunds

Program of the APPA R&D meeting 14./15.01.2016

APPA



Forschungsverbund APPA R&D

APPA R&D Annual Meeting 2016

Time: 14.-15.01.2016

Place: GSI, Darmstadt, Seminar Room Theory (SB3.3.170a)

Program

Tuesday, 14.01.2016

14:00 Welcome (Stefan Schippers, Thomas Stöhlker, Christina Trautmann)

Session Chair: **Reinhold Schuch** (U Stockholm)

14:10 **Boris Sharkov** (FAIR): *Status of FAIR*

14:40 **NN** (PT-DESY): *tba.*

15:10 **Yuri Litvinov** (GSI): *Status of ESR, SIS100, and HESR*

15:30 **Michael Lestinsky** (GSI): *Status of CRYRING*

15:40 **Wolfgang Quint** (GSI): *Status of HITRAP*

16:10 **Abel Blazevic** (GSI): *Status of the HEDgeHOB Facilities*

16:30 **Daniel Severin** (GSI): *Status of the BIOMAT Facilities*

16:50 Coffee Break

Session Chair: **Vincent Bagnoud** (GSI)

17:20 **Stephan Fritzsche/Andrej Surzhykov** (U Jena / SPARC): *tba.*

17:40 **Saskia Kraft-Bermuth** (U Gießen / SPARC): *SiM-X: Silicon Microcalorimeters for High-Precision X-ray Spectroscopy*

18:00 **Björn Winkler** (Uni Frankfurt / BIOMAT): *Ultrasound and Raman Spectroscopic Studies of Irradiation-induced Processes*

18:20 **Florian Meinerzhagen** (Uni Duisburg-Essen / BIOMAT): *Oberflächenmodifikationen durch intensive elektronische Anregung*

18:40 **Christian Spielmann** (U Jena / HEDgeHOB): *tba.*

19:00 **Michael Bussmann** (TU Dresden / SPARC): *Laser Cooling of Relativistic Ion Beams at FAIR. From ESR to SIS100 and HESR*

Friday, 15.01.2016

Session Chair: **Christina Trautmann** (GSI & TU Darmstadt)

09:00 **Jochen Walz** (U Mainz / FLAIR): *tba.*

09:20 **NN** (GSI / BIOMAT): *tba.*

09:40 **Markus Bender** (GSI / BIOMAT): *Ion-induced Desorption and Sputtering Processes*

10:00 **Andreas Fleischmann** (U Heidelberg / SPARC): *tba.*

10:20 **René Reifahrt** (U Frankfurt / SPARC): *tba.*

10:40 Coffee Break

Session Chair: **Stephan Neff** (FAIR)

11:00 **Matthias Weidemüller** (U Heidelberg / SPARC): *Status of the Heidelberg Quantum Gas Target*

11:20 **Jan Rothhardt** (U Jena / SPARC): *High-Power XUV Laser Sources for Laser Spectroscopy of Highly-charged Ions*

11:40 **Markus Roth** (TU Darmstadt / HEDgeHOB): *tba.*

12:00 **Joachim Jacoby** (U Frankfurt / HEDgeHOB): *tba.*

12:20 **Malte Kaluza** (U Jena / HEDgeHOB): *tba.*

12:40 Lunch Break

Session Chair: **Angela Bräuning-Demian** (GSI & FAIR)

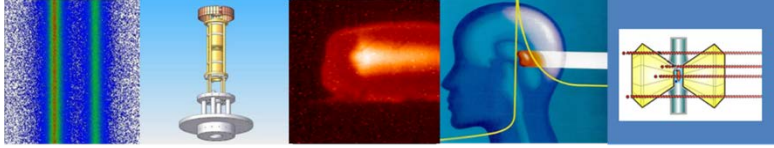
13:40 **Arno Ehresmann/André Knie** (U Kassel / SPARC): *tba.*

14:00 **Robert Loetzsch** (U Jena / SPARC): *X-ray spectroscopy at hard X-ray wavelength*

14:20 **Thomas Stöhlker** (GSI & HI-Jena): *Beam Times at GSI/FAIR 2016 – 2020*

14:40 **Stefan Schippers** (U Gießen): *APPA R&D Business*

15:00 End of the meeting



The End

Thank you for your attention!