News from FAIR

Diana Nicmorus
FAIR Research Division

For excited QCD 2016

FAIR

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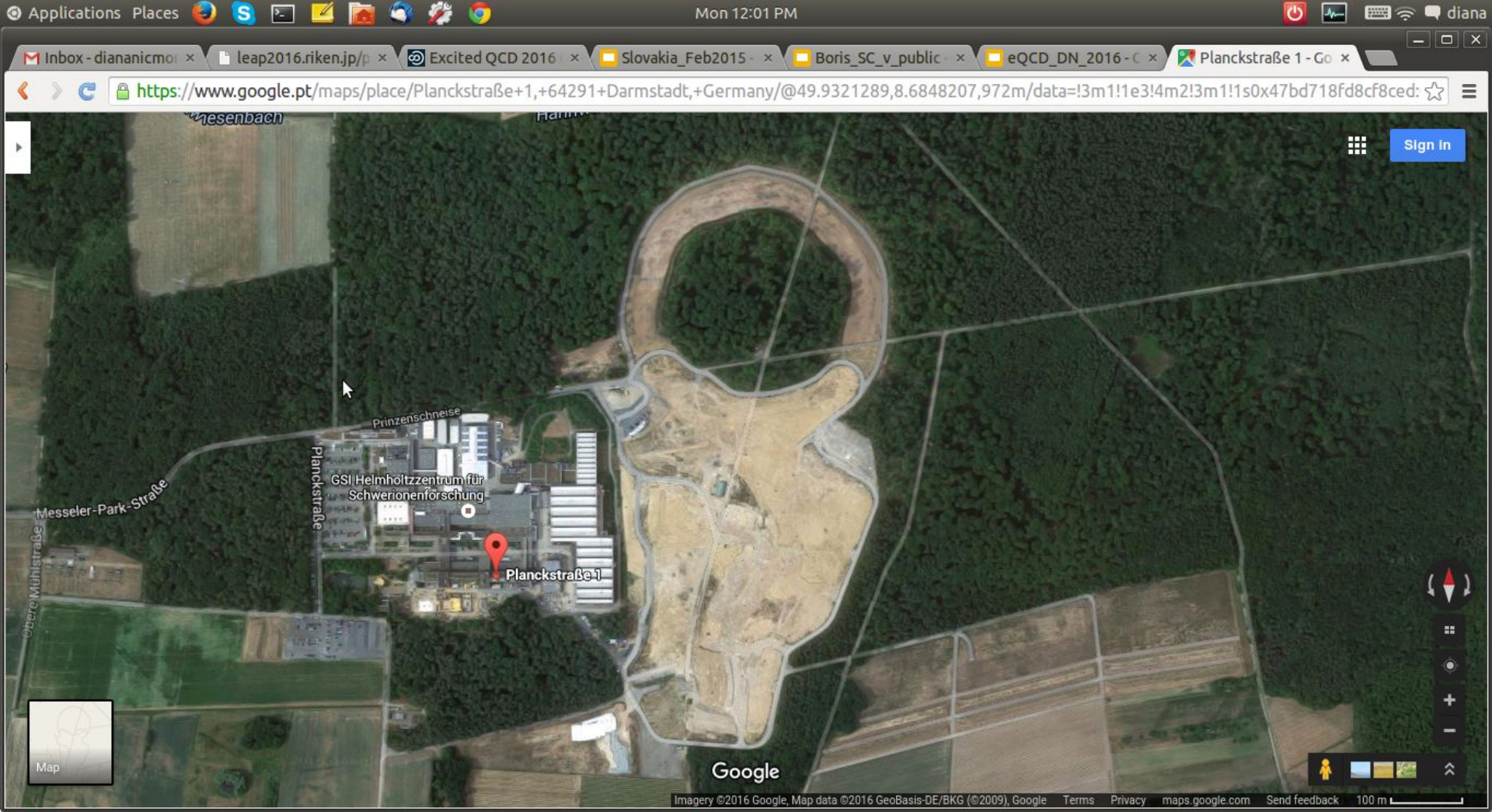
New international research lab under construction
to explore the nature and evolution of matter in the Universe

Darmstadt, Germany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In numbers

- 8 storage rings
- double-synchrotron 1100 m in circumference
- 2 linear accelerators
- 3.5 km beam transfer line
- 17 m underground deep double-ring tunnel
- 200 000 m2 forest cleared for buildings
- 519.000 m3 concrete
- 3000 international scientists @ FAIR
- Costs approx. 1.3 Billion Euro in 2005 prices

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FAIR Science case

Nuclear Structure & Astrophysics
(Rare-isotope beams)

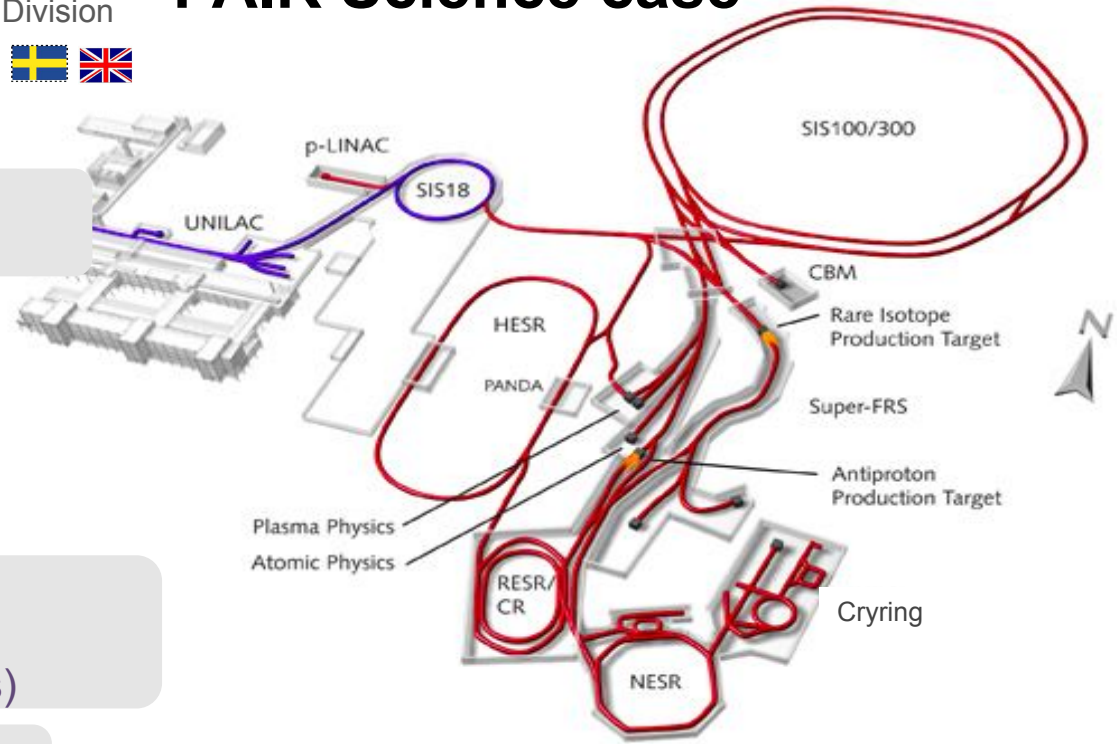
Hadron Physics
(Stored and cooled
14 GeV/c anti-protons)

QCD-Phase Diagram
(HI beams 2 to 45 GeV/u)

Fundamental Symmetries
& Ultra-High EM Fields
(Antiprotons & highly stripped ions)

Dense Bulk Plasmas

Materials Science & Radiation Biology
(Ion & antiproton beams)



- Highest beam intensities
- Unprecedented beam quality
- High beam energies
- Highest beam power

Accelerator Physics

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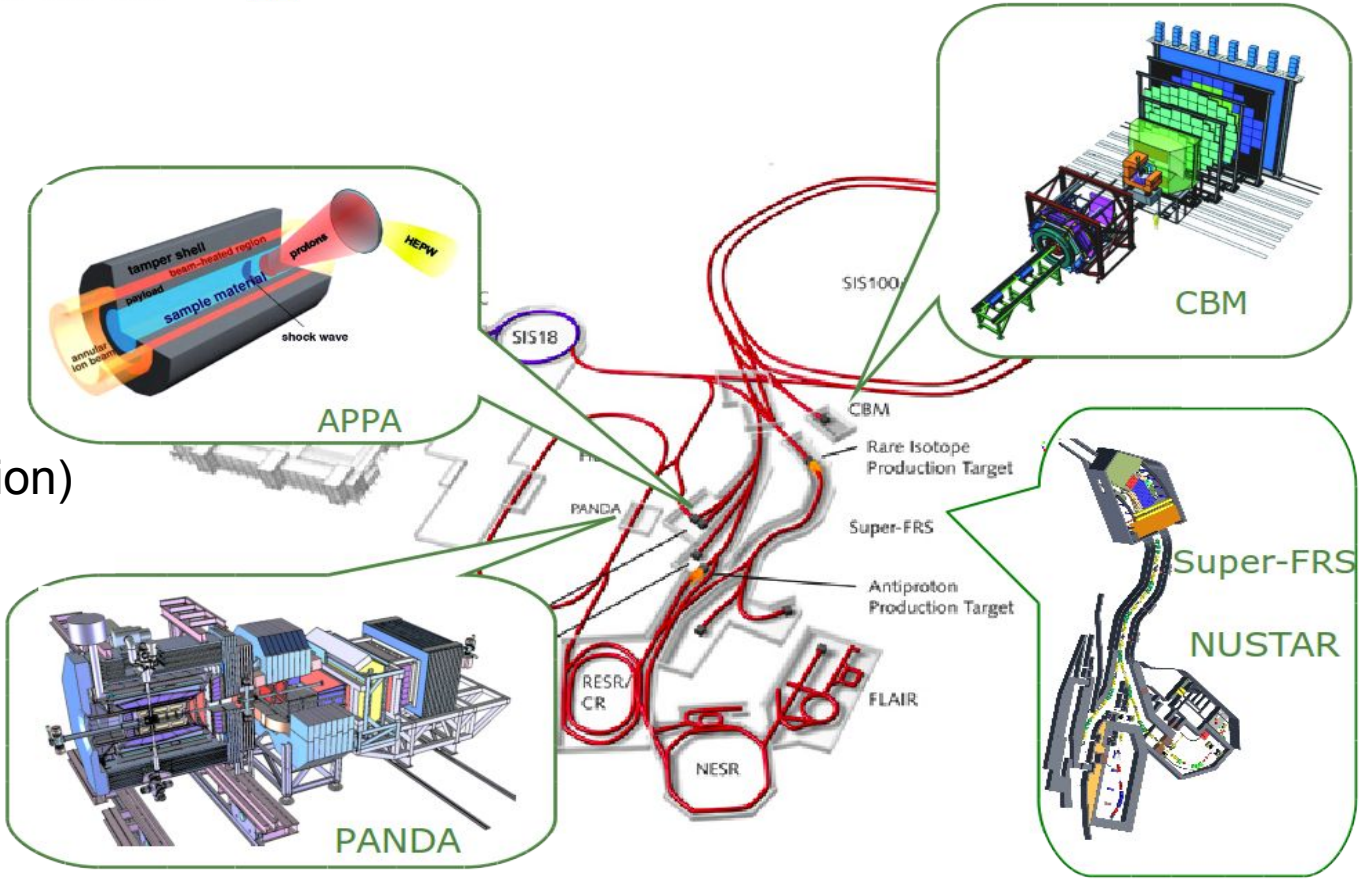
APPA: **A**tomic, **P**lasma **P**hysics and **A**pplications
CBM: **C**ompressed **B**aryonic **M**atter
NUSTAR: **Nu**clear **S**tructure, **A**strophysics and **R**eactions
PANDA: Anti-**P**roton **An**nihilations at **Da**rmstadt

Conception of FAIR experiments (Convention)

- 4 scientific pillars



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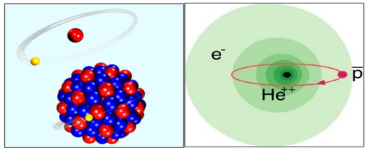
Atomic & Plasma Physics & Applications

600 scientists

Atomic physics: Test fundamental theories: highest intensities for relativistic beams of stable and unstable heavy nuclei, combined with strongest available electromagnetic fields

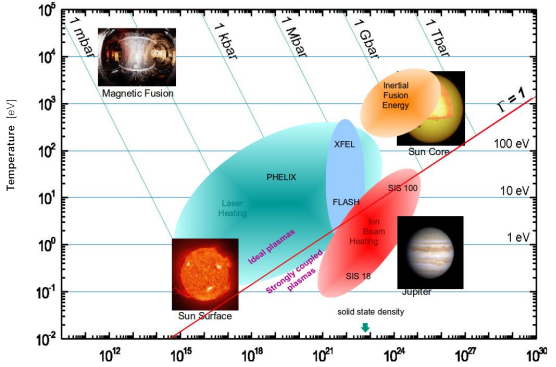
---> allow atomic spectroscopy across virtually the full range of atomic matter.

Test matter-antimatter asym: low-energy antiprotons ---> precision spectroscopy of antiH



Plasma physics: very intense and highly focused heavy-ion beams

Physics of very dense plasmas – study of interaction of intense ion and laser radiation with heated and compressed matter (e.g. stars, giant planets...)



Material research and Biophysics: cancer therapy; space radiation effects (damage to space instrumentation, shielding optimization)...

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Compressed Baryonic Matter

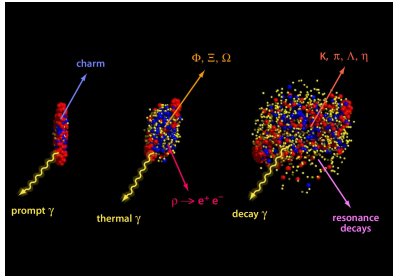
400 scientists

Nuclear matter under extreme conditions

- nu-nu collisions - highly compressed nuclear matter
- baryonic matter at highest densities - neutron stars, core of supernova explosions
- QCD critical end-point (breakthrough!), phase transitions

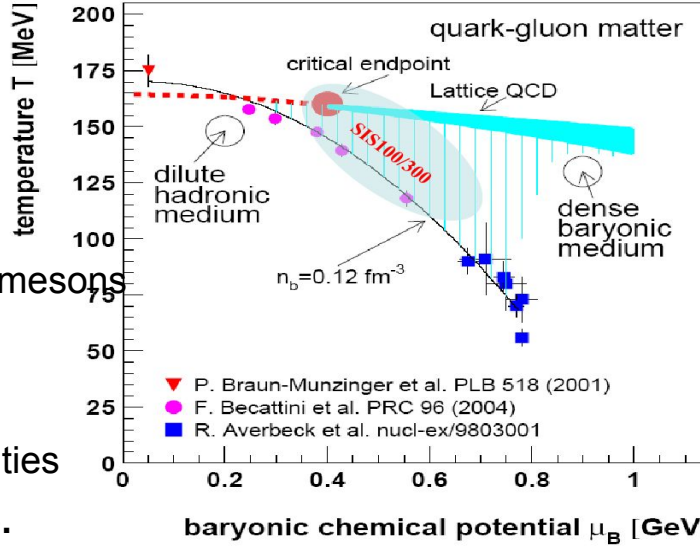
(1st order deconfinement & chiral, chiral restoration at high densities)

- in-medium modifications of hadrons in dense matter
- exotic states of matter (condensates of strange particles)



Measure simultaneously observables that are sensitive to high density effects and phase transitions:

- short-lived light vector meson (e.g. rho), multi-strange hyperons, c-mesons



Complement investigations at RHIC and LHC

- strongly interacting matter at extremely high T and low net baryon densities

Such parameters require unprecedented detector performance.

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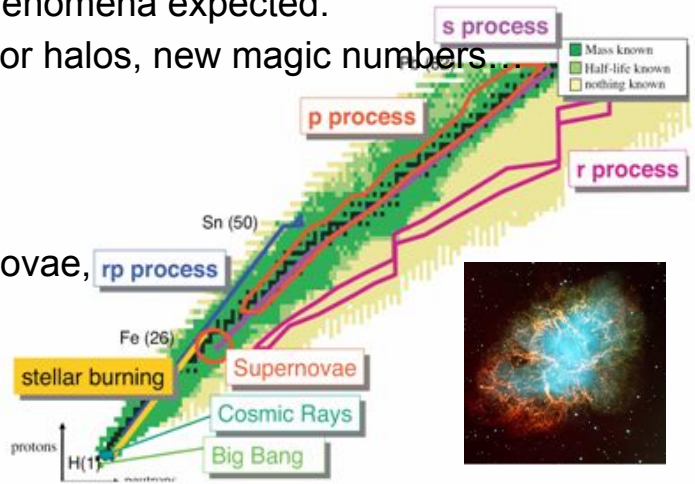
HISPEC/DESPEC,ELISE, EXL, ILIMA, LASPACE, MATS, R3B,
Super-FRS (high-performance separator - beam intensity improvement 10^2 to 10^5)

Nuclear Structure, Astrophysics and Reactions

800 scientists

Provide intense secondary beams of unstable isotopes across the entire nuclide chart.
Beam intensities >> those available at existing facilities by several orders of magnitude.
Beams of rare isotopes separated and identified by the Superconducting Fragment Recoil Separator (Super-FRS).

- **Nuclear structure**
  - study of exotic short lived nuclei far off stability – new structural phenomena expected: different proton & neutron density distributions with proton/neutron skins or halos, new magic numbers…
- **Astrophysics** - nuclear reactions and nuclear structure effects directly reflected in evolutionary stages of the universe.
  - origin of the heavy elements?
  - physics of stellar explosions - core-collapse, thermonuclear supernovae, nucleosynthesis in stars and supernovae.
  - unstable nuclei far away from stability are involved, determine astrophysical processes.



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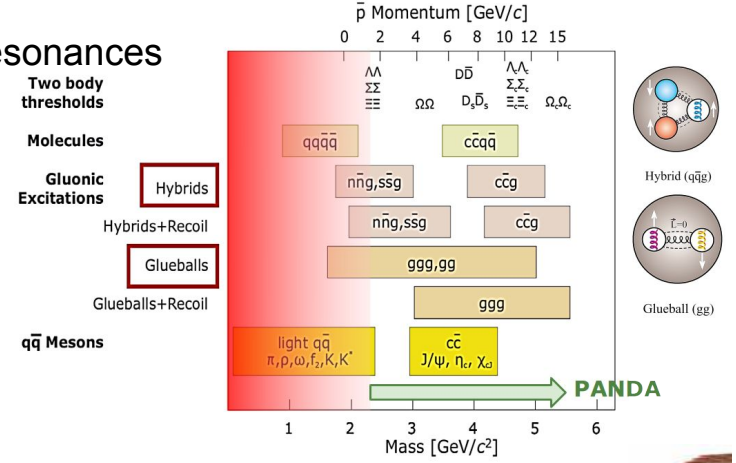
antiProton ANihilation at DArmstadt

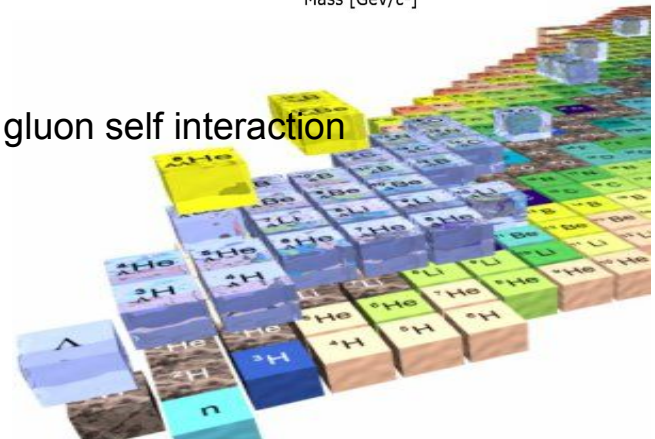
450 scientists

- **Hadron spectroscopy** - mass, width & quantum numbers of resonances
  - charm hadrons: charmonia, D-mesons ...
  - understand new XYZ states, Ds(2317) …
  - exotic QCD States: glueballs, hybrids, multi-quarks
  - spectroscopy with antiprotons:
    - Production of states of all quantum numbers
    - Resonance scanning with high resolution
  - baryon spectroscopy: excited ss, sss, c baryons



- **Nucleon Structure**
  - Testing non-perturbative QCD: quark confinement, mass generation, gluon self interaction
  - timelike nucleon FF

- **Nuclear matter**
  - Hypernuclei - production of double-hypernuclei
  - Hadrons in nuclear medium



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FAIR Convention

Signed October 4th, 2010. Ratified March 1st, 2014.

UK associate member since 2013

New partners

Turkey

- MoU of 16 universities, delegate appointed to RRB by the Turkish ministry
- Activities to extend scientific cooperation to CBM and PANDA

Hungary and the Czech Republic

- consultation at the Ministry of Education, Youth and Sports in Prague on 14 September 2015
- MoU with the Nuclear Physics Institute of the Czech Academy of Science (ready to be signed)
- negotiations on 1 Dec 2015 in Budapest with National Research, Development and Innovation Council of Hungary

Italy

- INFN tries to restart investment in PANDA after Council decision in September 2015.

Talks with ESA, Spain, Austria, Brazil, Norway, South Korea, China, South Africa.

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2 July 2012: Grant of 526 Mil. Euro from BMBF for FAIR Civil Construction delivered!

Radiation protection licences
submitted to the Hessian Environmental Minister

Submission of **771** folders building application to Darmstadt's civil construction authorities in Aug. 2011

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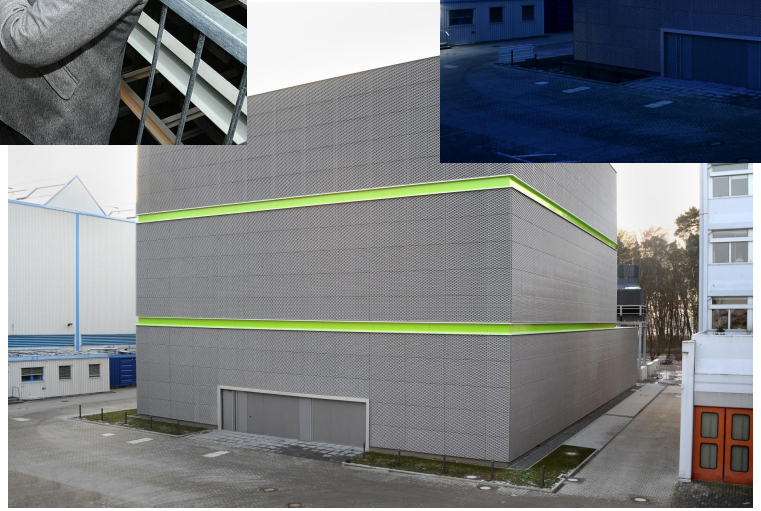
IT-Green Cube FAIR



Feb 2016

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The arrival of the GLAD-magnet at FAIR

2015

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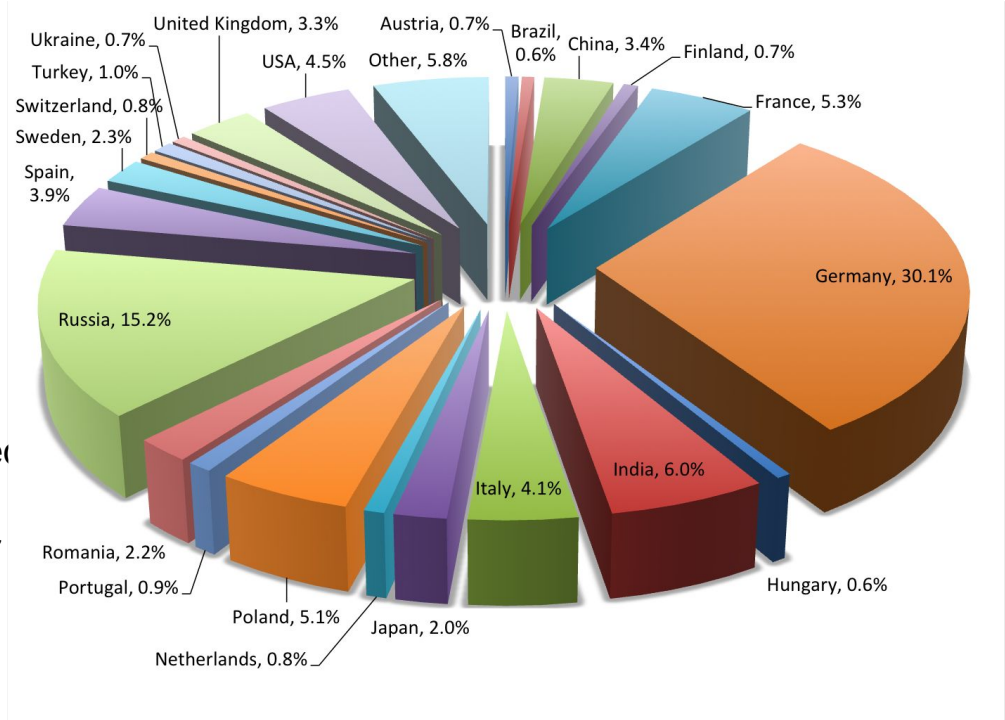
Status of FAIR experiments

- Collaborations are finalising the design and constructing the components of the FAIR experiments

- The FAIR Research Division supports them concerning:
  - Technical aspects: Expert Committee Experiments, Technical Coordinators employed by FAIR
  - Resources aspects: Resources Review Boards, Resources Coordinators employe FAIR
  - Computing and simulation: IT Coordinator employed by FAIR
- About 1800 senior scientists (ca. 3000 in total) are members of the FAIR Collaborations



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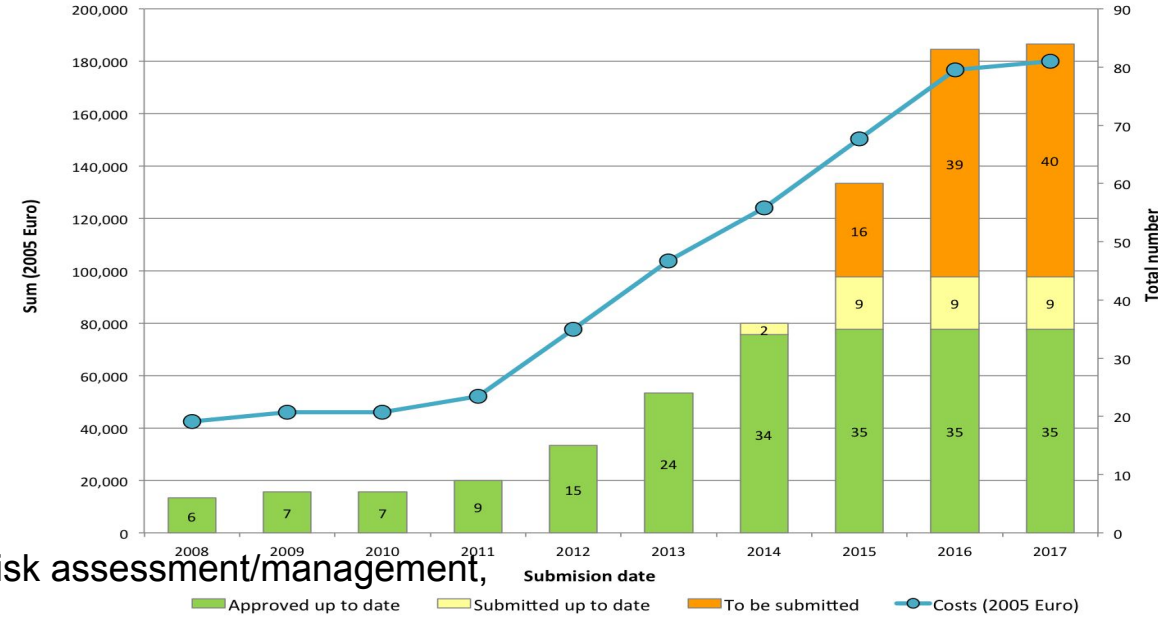
Technical Status Experiments

ECE - Expert Committee Experiments (est. 2012, Jan 2016, 7th meeting)

- 16 internationally acknowledged indep
- meetings 2-3 times/year



On going

In-Kind and Collaboration Contracts, New risk assessment/management, General Conditions for Experiments…

Construction MoUs - To be agreed upon in RRB

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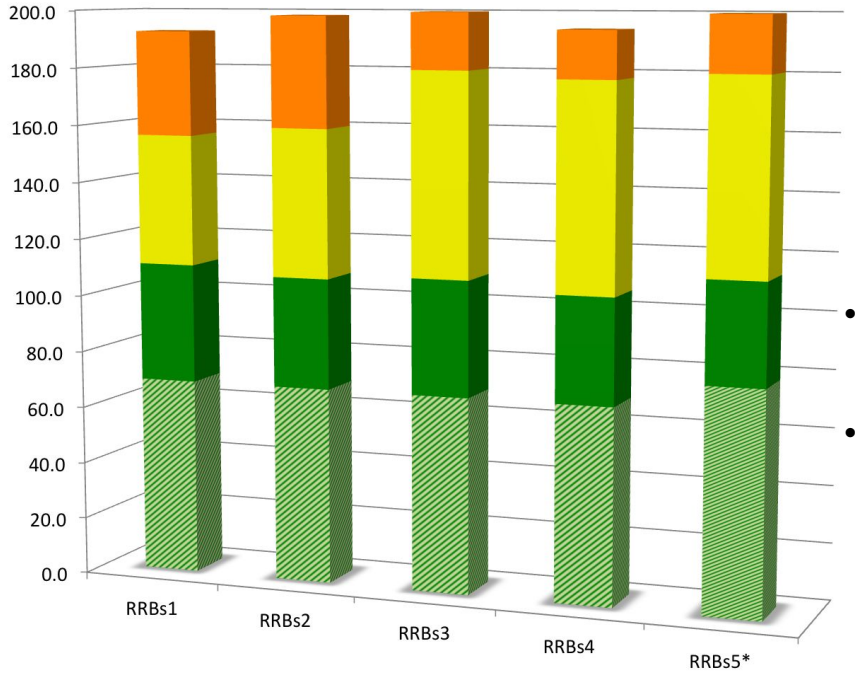
Financial Status Experiments

RRB - Resource Review Boards (est. 2013, Feb 2016, 5th meeting)

- country ministry representatives
- meetings 2 times/year



- Collaborations' input to 5th RRB (full MSV setups)
  - **200 M€** (2005 prices) = 249 M€ (2016 prices)
- Breakdown (2005 prices)
  - 78 M€ in FAIR budget
  - Other approved funding: 35 M€
  - Expressions of Interest: 67 M€
  - To be assigned: 19 M€

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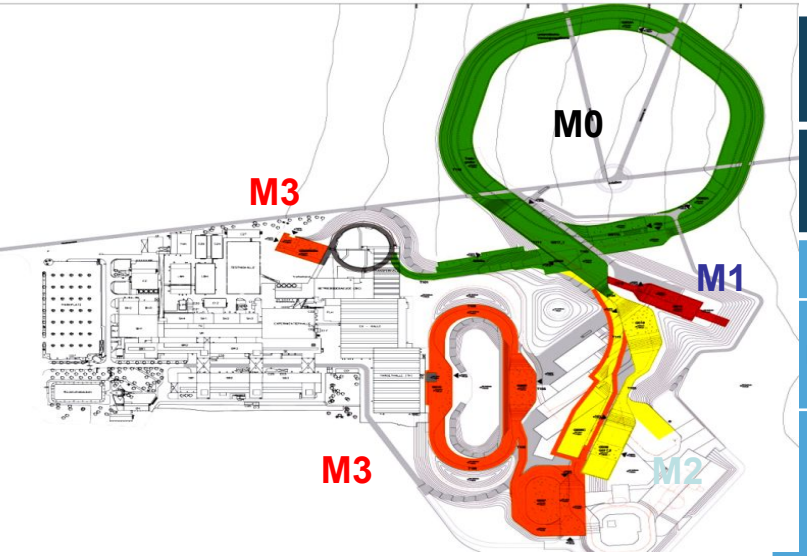


Modules
M0: SIS100
M1: APPA
M1: CBM/HADES
M2: NUSTAR
M3: PANDA, NUSTAR, APPA

Baseline Technical Report 2005

Start Version Phase A 2007
(SIS100)

Phase B
(SIS300)

Modularised Start Version 2009

Module **0**	Module **1**	Module **2**	Module **3**	Module **4**	Module **5**
SIS100	**Exp. halls** *CBM & APPA*	**Super-FRS** *NUSTAR*	**Antiproton Facility** *PANDA & NUSTAR*	**LEB, NESR, FLAIR** *NUSTAR & APPA*	**RESR** *PANDA, NUSTAR & APPA*

What happened in/since 2015

- Cost increase, delay of construction start
- Council discussions and evaluation of strategies
- Re-assessment of experiments:
  - scientific merit, discovery potential, competitiveness, timeline…
  - crucial decisions of international partners (Sept.2015) regarding Scope, Cost-cap, Time-line, Joint Scientific Council FAIR/GSI

(continuous monitoring and scrutiny of scientific strategy, 12 scientists, 9-10 June 2016 1st meeting, evaluate strategy towards phase-1 experiments)

- **Scientific programme not changed**
- **Experiments focus on Day-1 programme**

Current status of the experiments

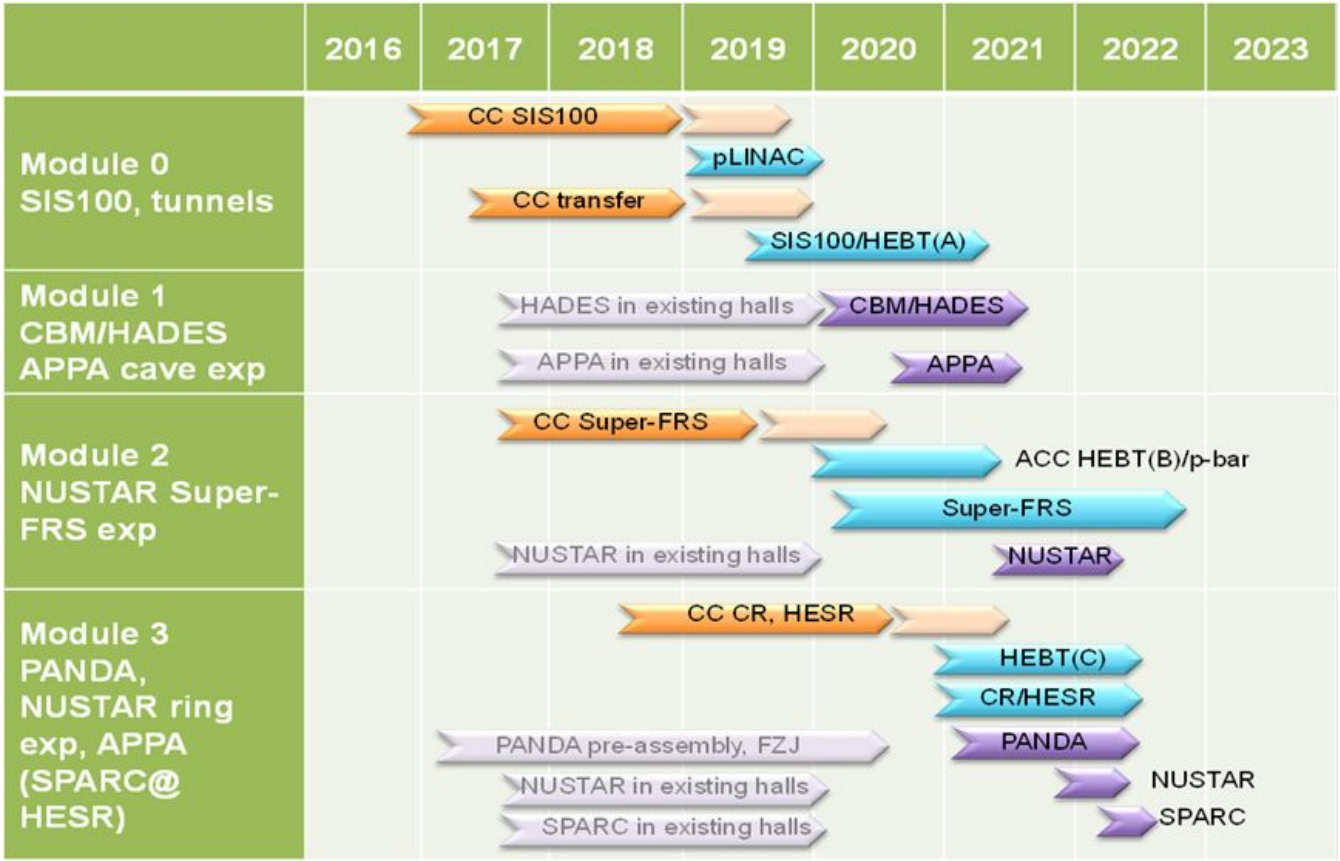
- All four FAIR Collaborations have re-assessed their experimental programme and instrumentation in view of
  - Progress in science,
    the changed timeline
    and availability of funding

- The programme for day-one experiments starting in 2022 has been developed
  - Prioritising for max. scientific merit and concentrating on the initially required equipment

Costs of the MSV for the FAIR-Shareholders

Total costs (M€)	2005 prices	Escalated prices*
Experiments	78,0	83,6
Accelerators	385,0	412,5
Acc. coordination personnel Personnel	110,9	113,1
FAIR GmbH Running costs	38,0	43,1
Civil Construction original estimate	15,4	19,8
	495,0	676,3
Subtotal	1.122,3	1.348,4
less site costs	1.027,3	1.220,9
Civil Construction cost increase	227,9	**320,1**
LEB building	6,5	9,6
Total incl. site costs	1.356,8	1.678,1

High level schedule of the MSV



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Designated Scientific Managing Director of FAIR and GSI

Paolo Giubellino currently ALICE Spokesperson will start 1 January 2017

Jörg Blaurock,
joint Technical Managing Director
(since 2/2016)

Ursula Weyrich,
joint Administrative Managing Director
(since 11/2014)

FAIR-GSI merger in administration

Conclusions

- Despite of the delay, technical design of FAIR acc. and FAIR exp. is progressing well.
- FAIR will allow for unique measurements in many fields and remain competitive for decades.
- Rich scientific program and discovery potential already at MSV with beams from SIS100.
- More scientists expected to join in the coming years.
- Versatile detector configurations for optimal performance are under construction.
- Phase-1 physics. Intermediate Phase 0 research program of high relevance and quality, which also keeps the scientific communities alive.

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Thank you.

FAIRNESS 2016, 4th workshop

Creating and educating the next generation