

FAIR – Facility for Antiproton and Ion Research: Intro and Status

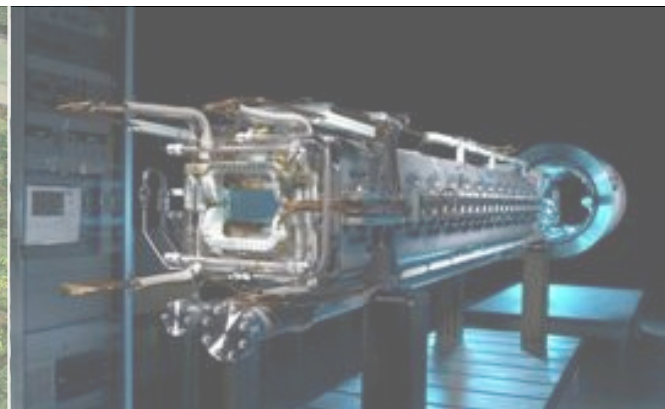
Inti Lehmann

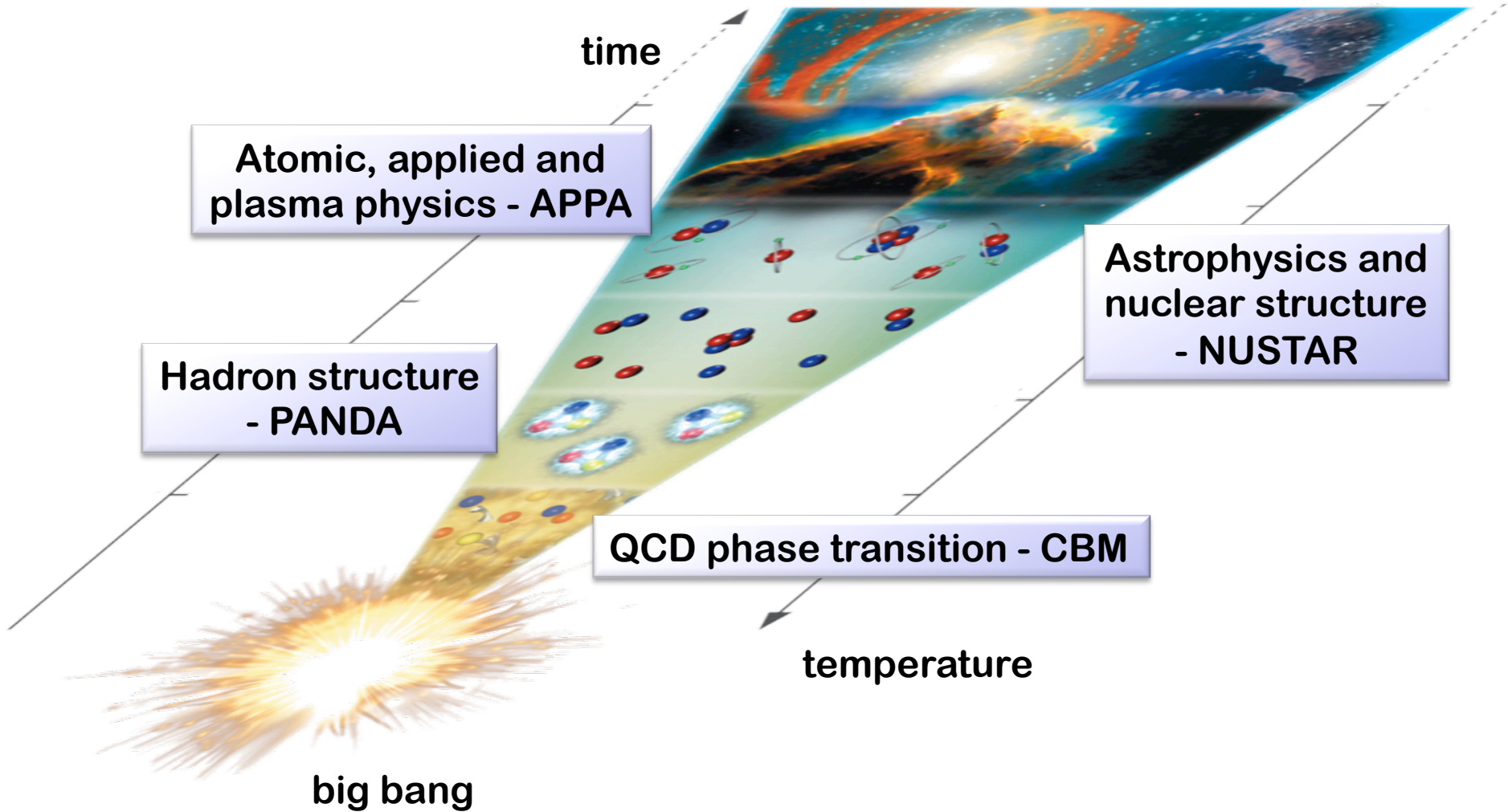
Facility for Antiproton and Ion Research

Darmstadt, Germany

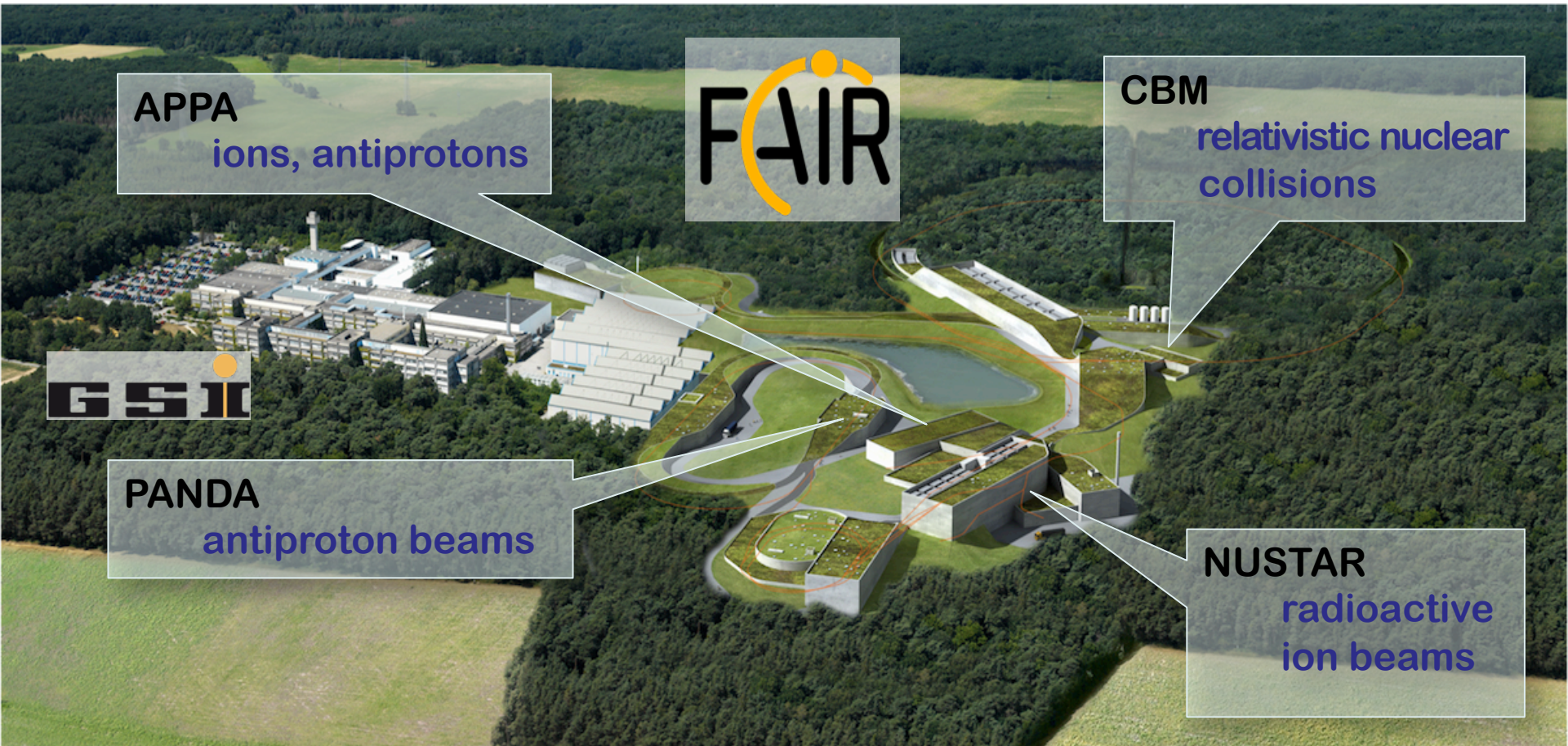


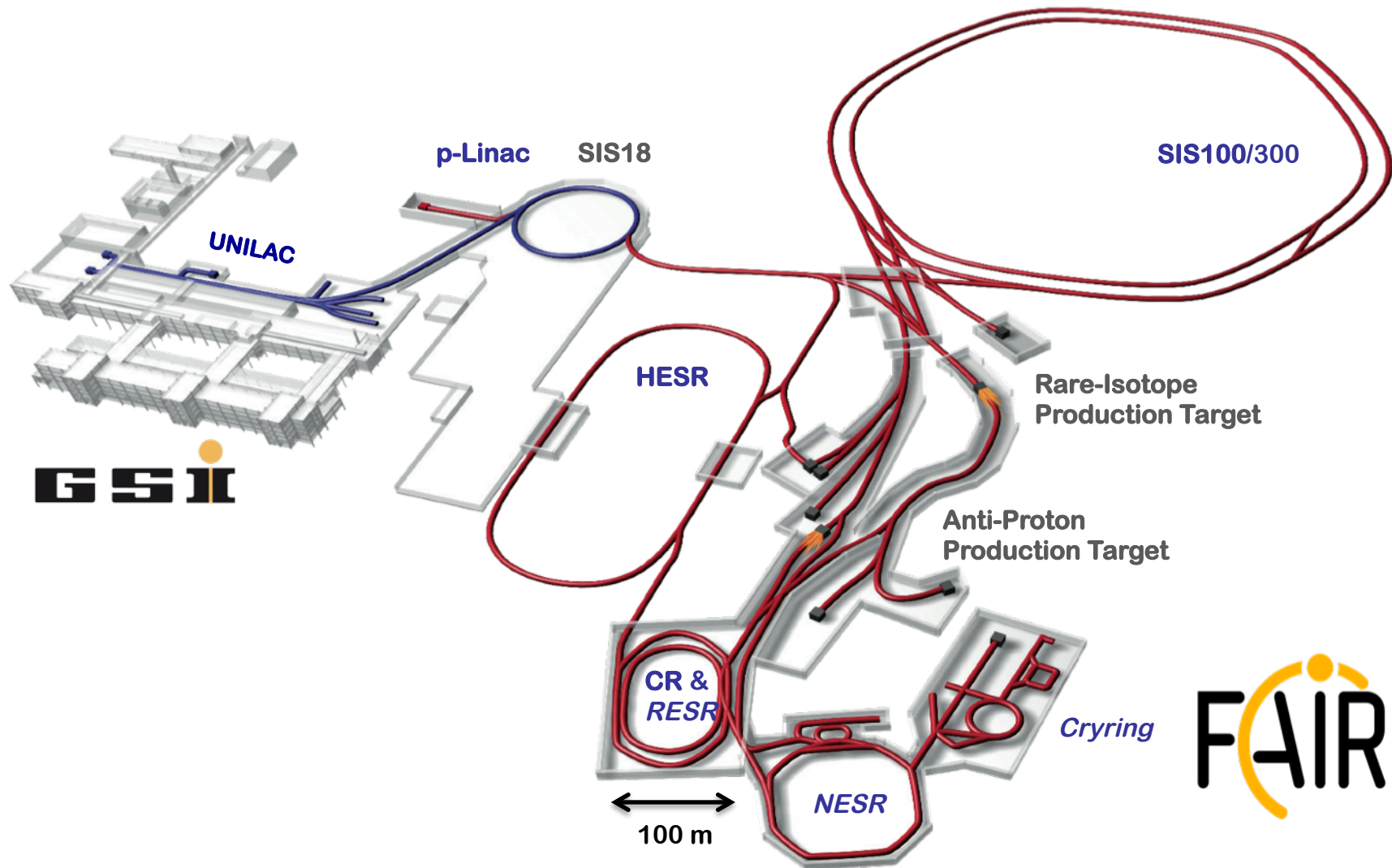
NUSTAR Week 2014, Valencia – 24 Sept 2014





The FAIR Project





Primary Beams

- $10^{12}/s$; 1.5 GeV/u; $^{238}\text{U}^{28+}$
- $10^{10}/s$ $^{238}\text{U}^{73+}$ up to 35 GeV/u
- $3 \times 10^{13}/s$ 30 GeV protons

Secondary Beams

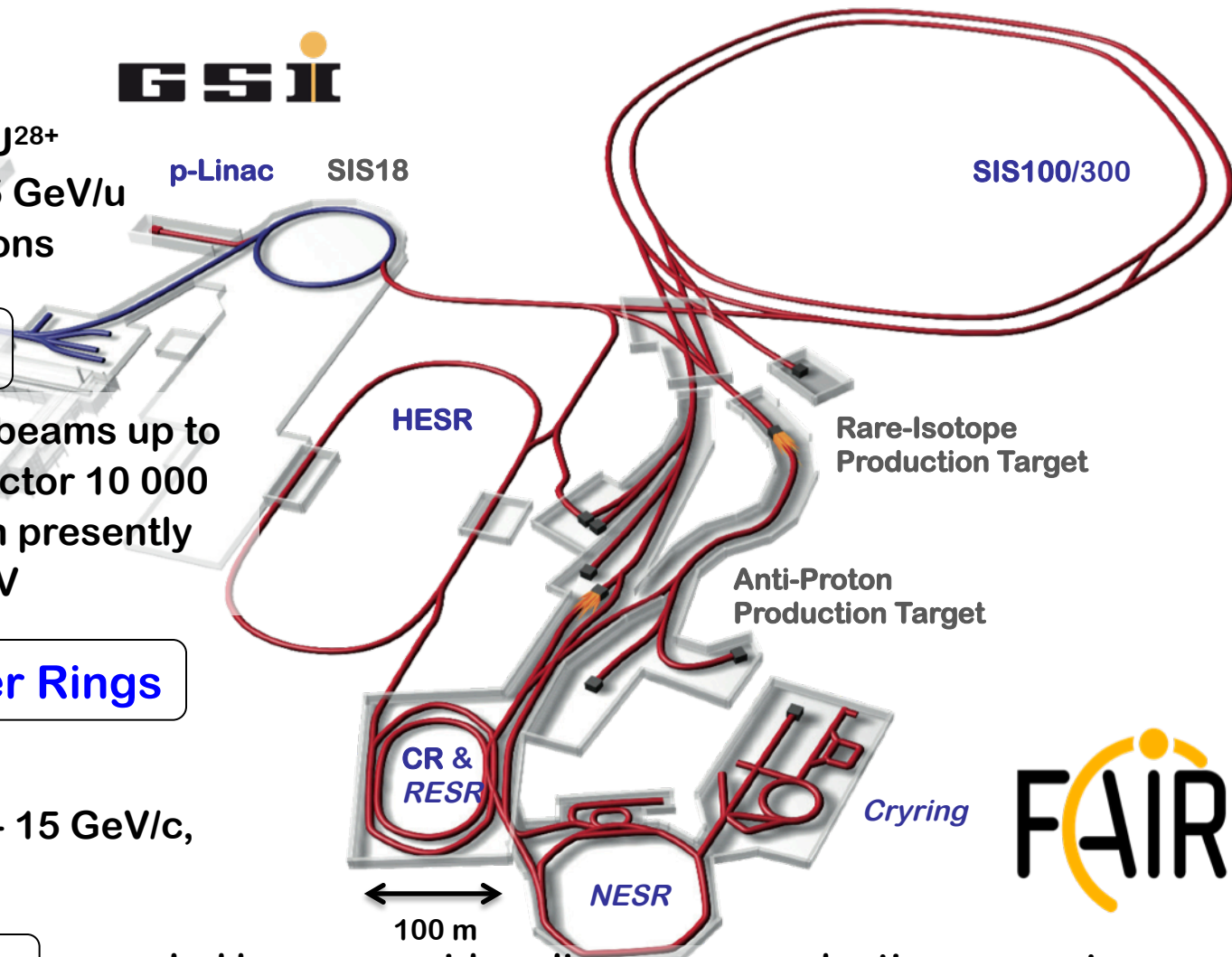
- range of radioactive beams up to 1.5 - 2 GeV/u; up to factor 10 000 higher in intensity than presently
- antiprotons 3 - 30 GeV

Storage and Cooler Rings

- radioactive beams
- 10^{11} antiprotons 1.5 - 15 GeV/c, stored and cooled

Technical Challenges

- cooled beams, rapid cycling superconducting magnets



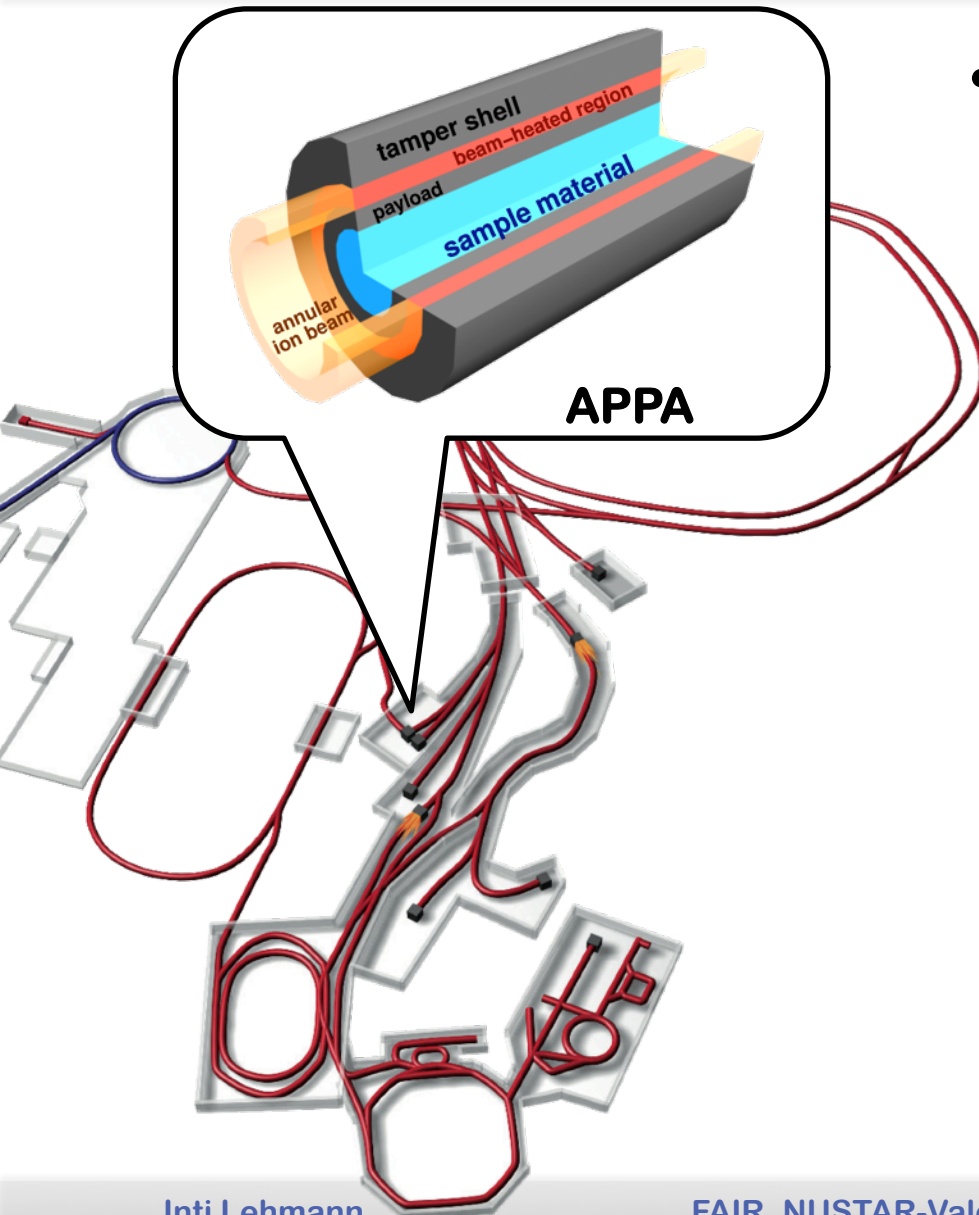
The 4 Scientific Pillars of FAIR

APPA: Atomic, Plasma Physics and Applications

CBM: Compressed Baryonic Matter

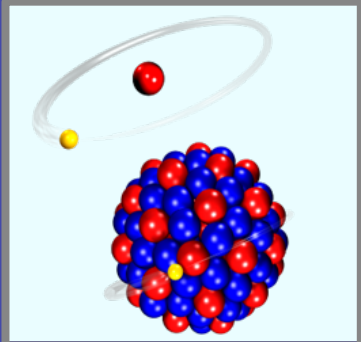
NUSTAR: Nuclear Structure, Astrophysics and Reactions

PANDA: Antiproton Annihilations at Darmstadt



- Atomic, Plasma Physics and Applications
 - About 700 members
 - Wide field of science
 - basic research to material, biological and medical applications

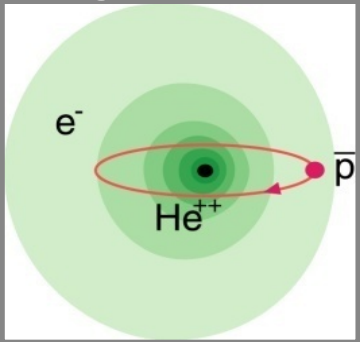
Atomic Physics



SPARC

strong field research

... probing of fundamental laws of physics

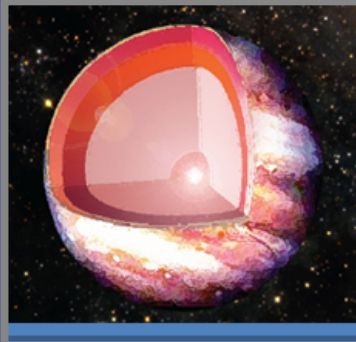


FLAIR

anti-matter

... matter / anti-matter asymmetry

Plasma

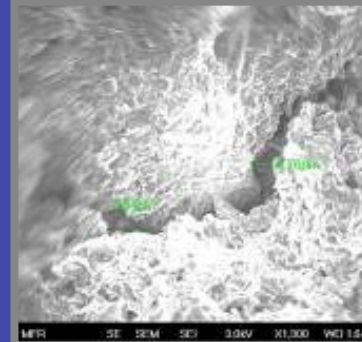


HEDgeHOB/WDM

planetary interiors

... states of matter common in astrophysical objects

Materials



MAT/BIOMAT

extreme conditions

... radiation hardness and modification of materials

Bio



BIO/BIOMAT

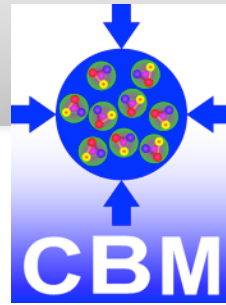
aerospace engineering

... radiation shielding of cosmic radiation

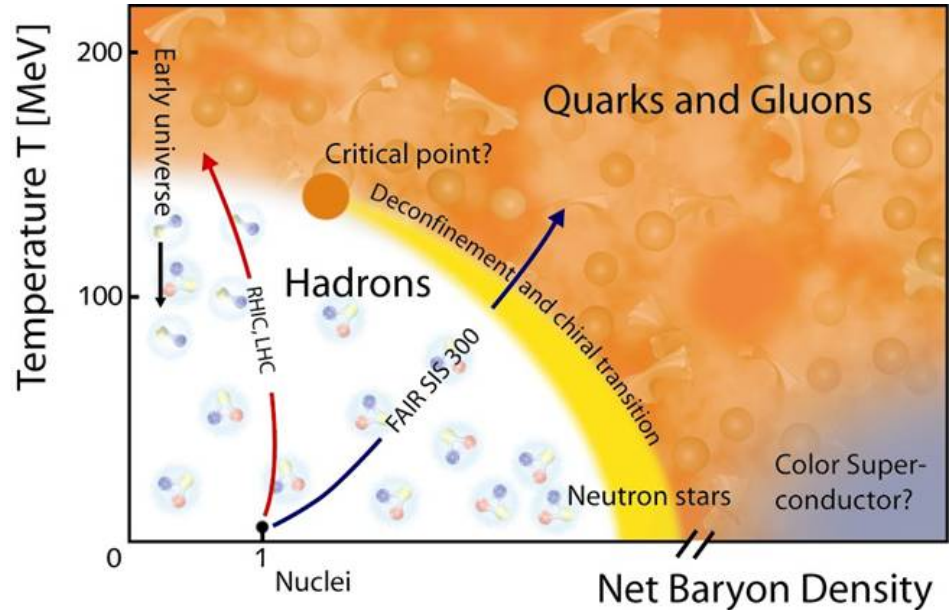
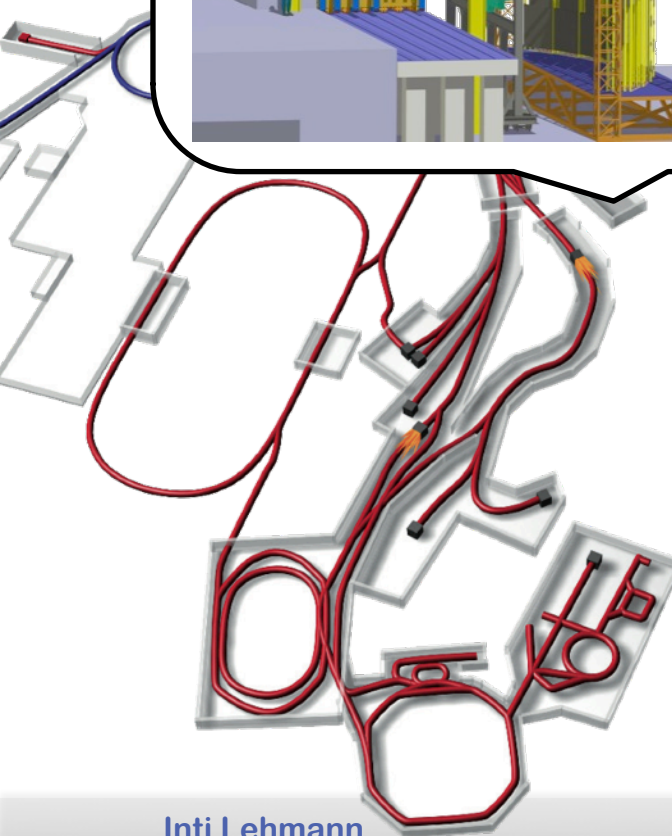
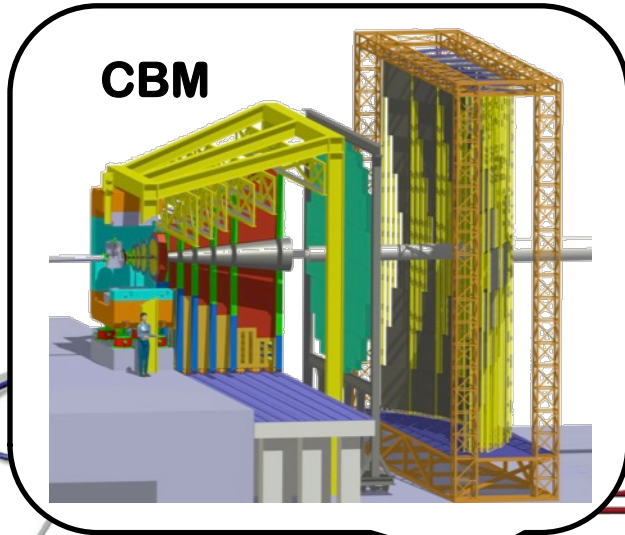
- **Highest Charge States**
- **Relativistic Energies**
- **High Intensities**
- **High Charge at Low Velocity**
- **Low-Energy Anti-Protons**

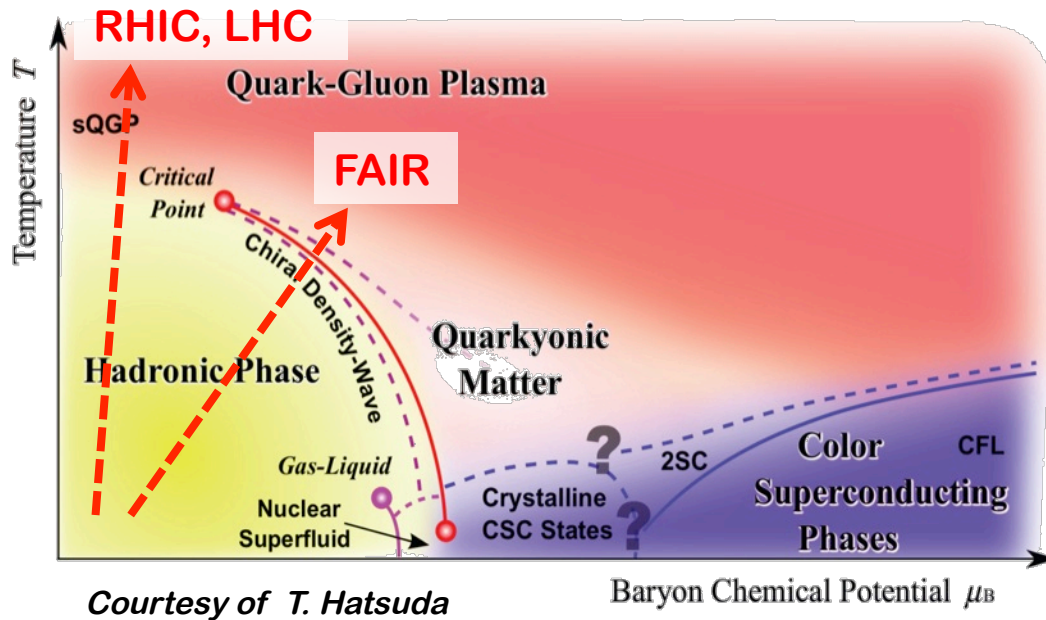
- **Extreme Static Fields**
- **Extreme Dynamical Fields and Ultrashort Pulses**
- **Very High Energy Densities and Pressures**
- **Large Energy Deposition**
- **Antimatter Research**

CBM

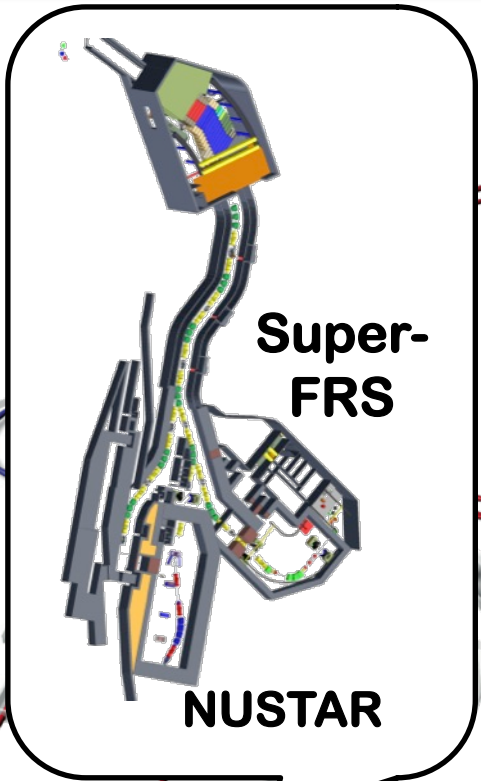


- **Compressed Baryonic Matter**
 - **About 400 members**

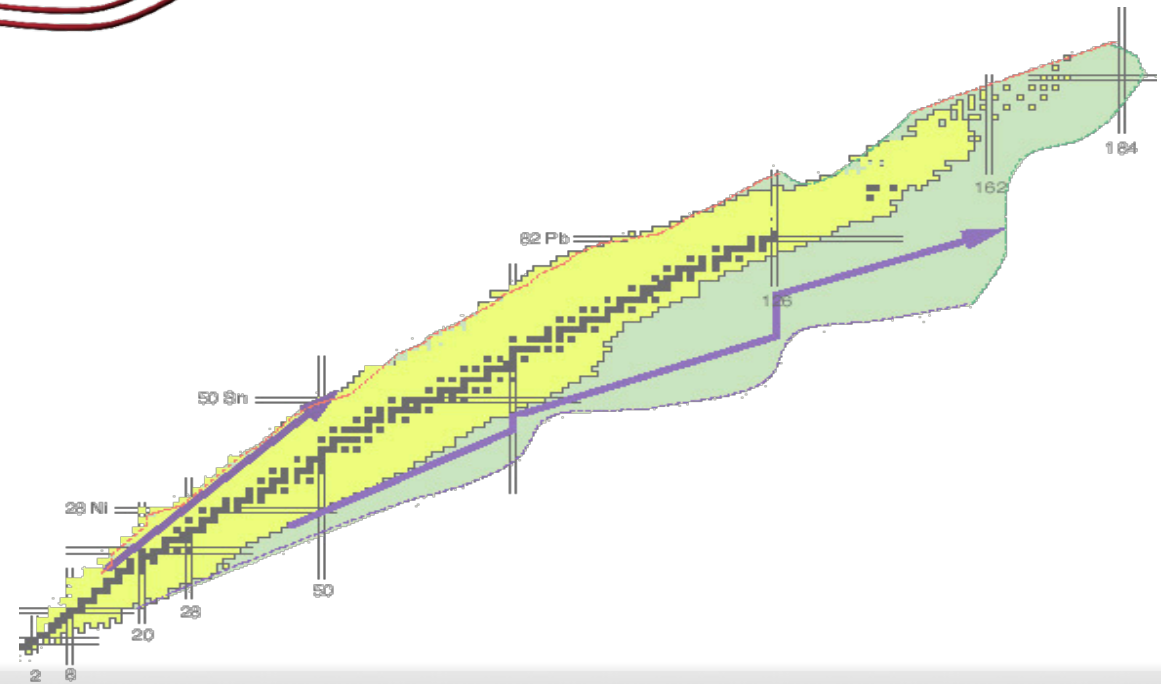




- The equation-of-state at high baryonic density
- New phases of strongly-interacting matter
- Deconfinement phase transition at high baryonic density
- QCD critical endpoint
- Onset of chiral symmetry restoration at high baryonic density
- Strange matter

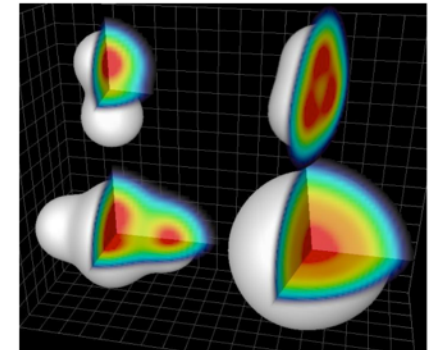


- Nuclear Structure, Astrophysics and Reactions
 - About 800 members



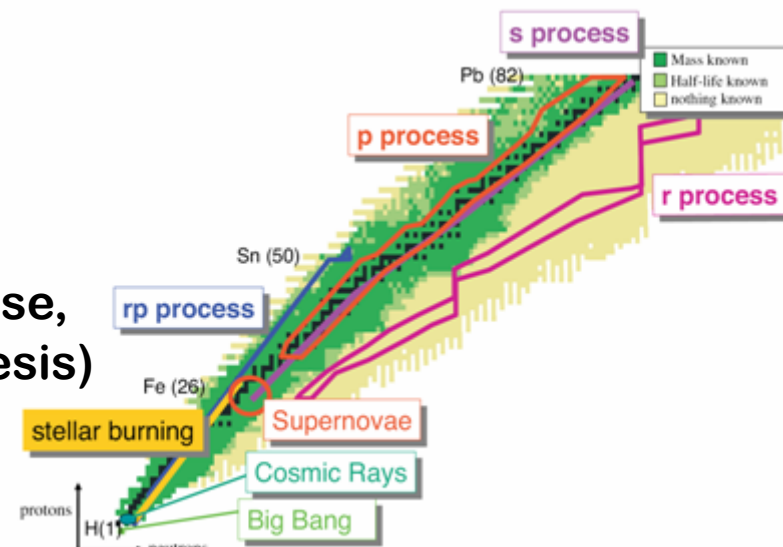
Nuclear structure

- Underlying QCD structure → complex nucleon-nucleon force
- Study of exotic short lived nuclei far off stability (proton/ neutron skins or halos, new magic numbers...)
→ Pave way for theoretical framework with predictive power for nuclei beyond experimental reach

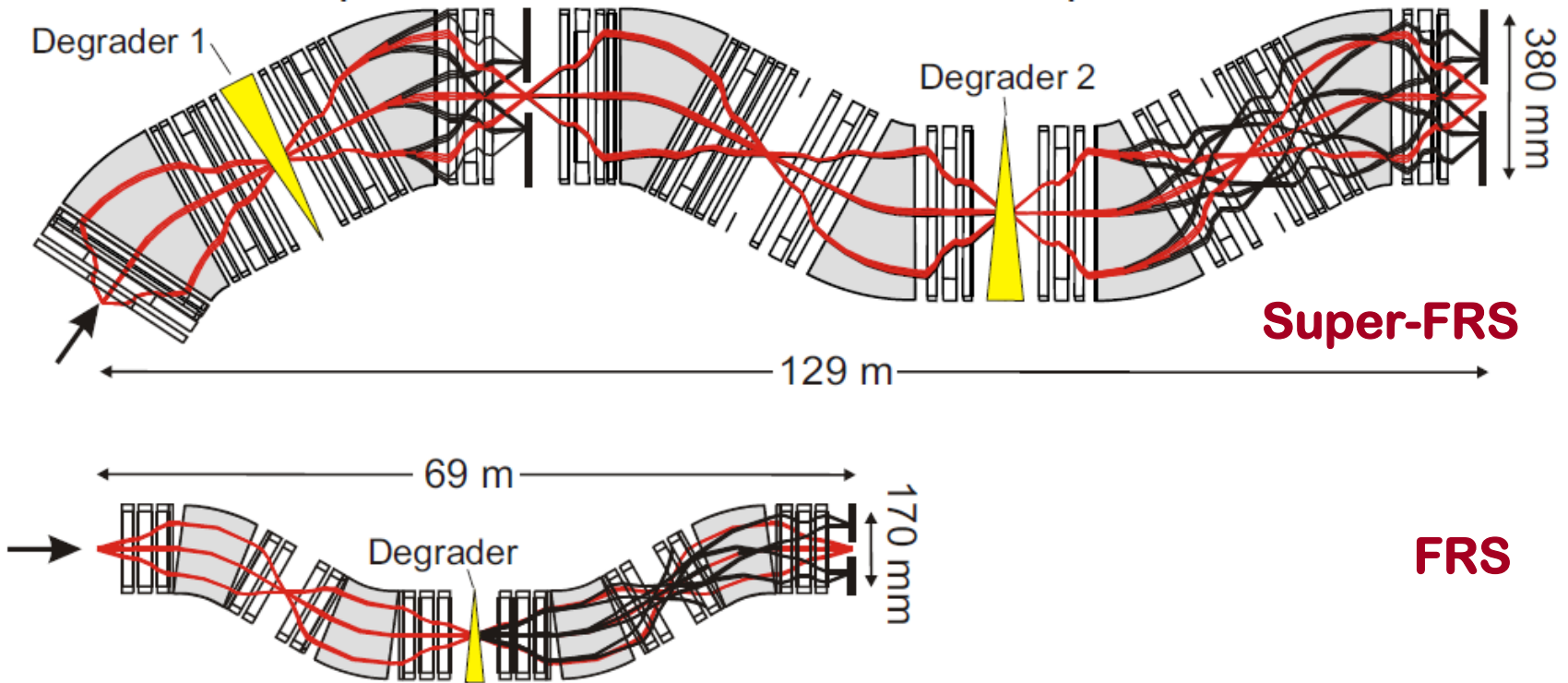


Astrophysics

- Origin of the heavy elements?
- Physics of stellar explosions (core-collapse, thermonuclear supernovae, nucleosynthesis)
- Compact objects and the explosions on their surfaces (x-ray bursts)

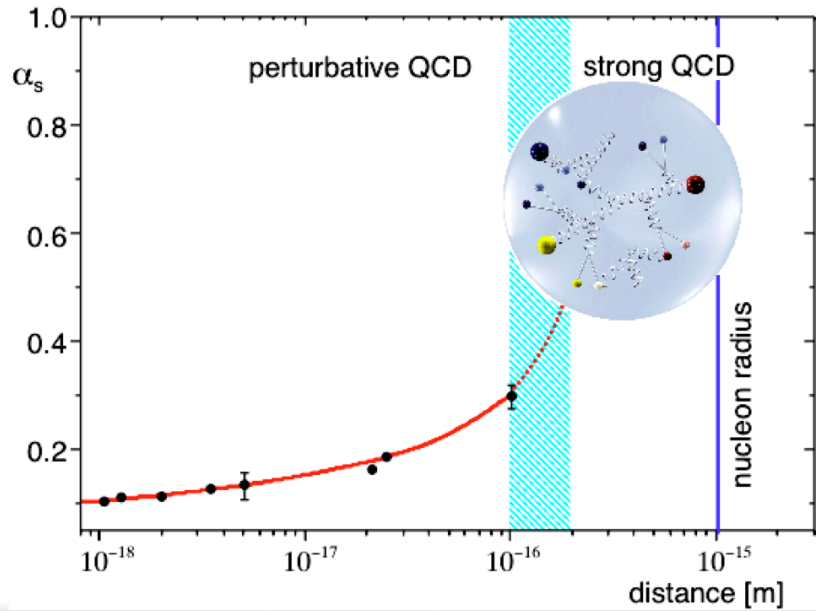
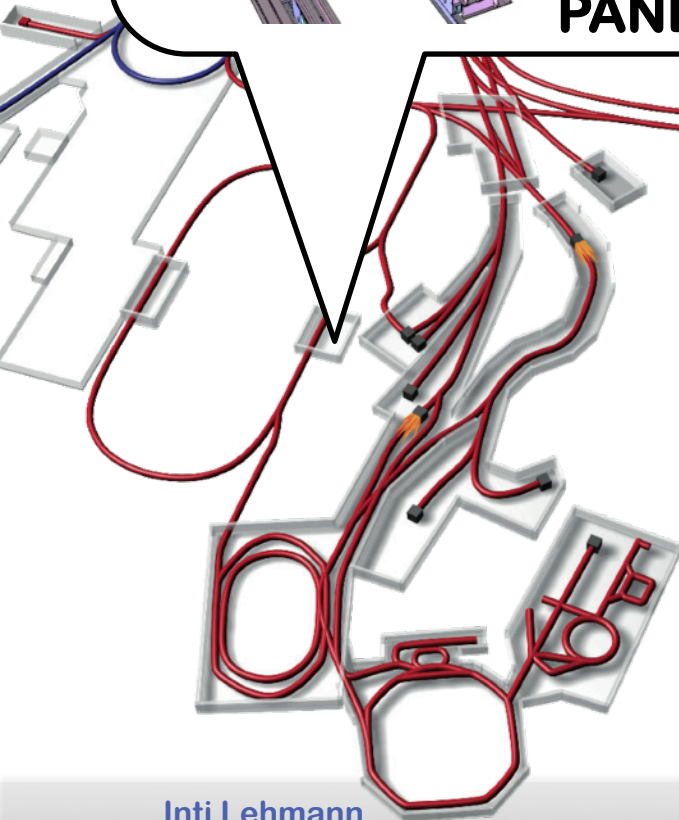
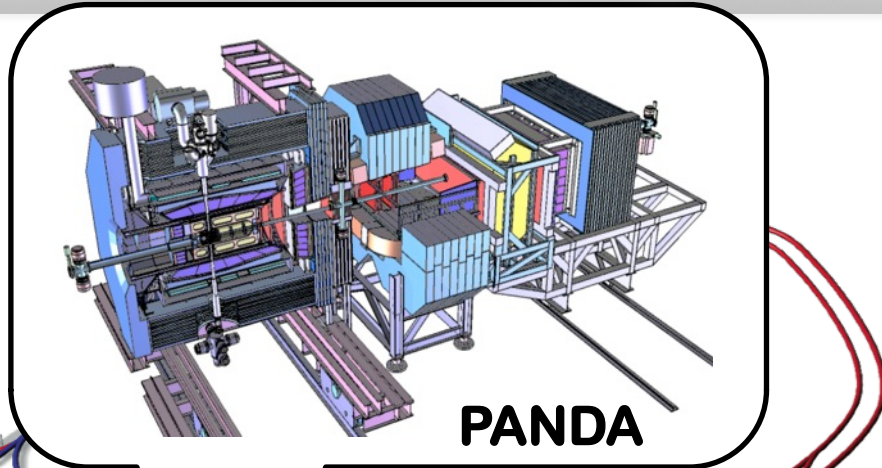


GSI FRS → FAIR Super-FRS



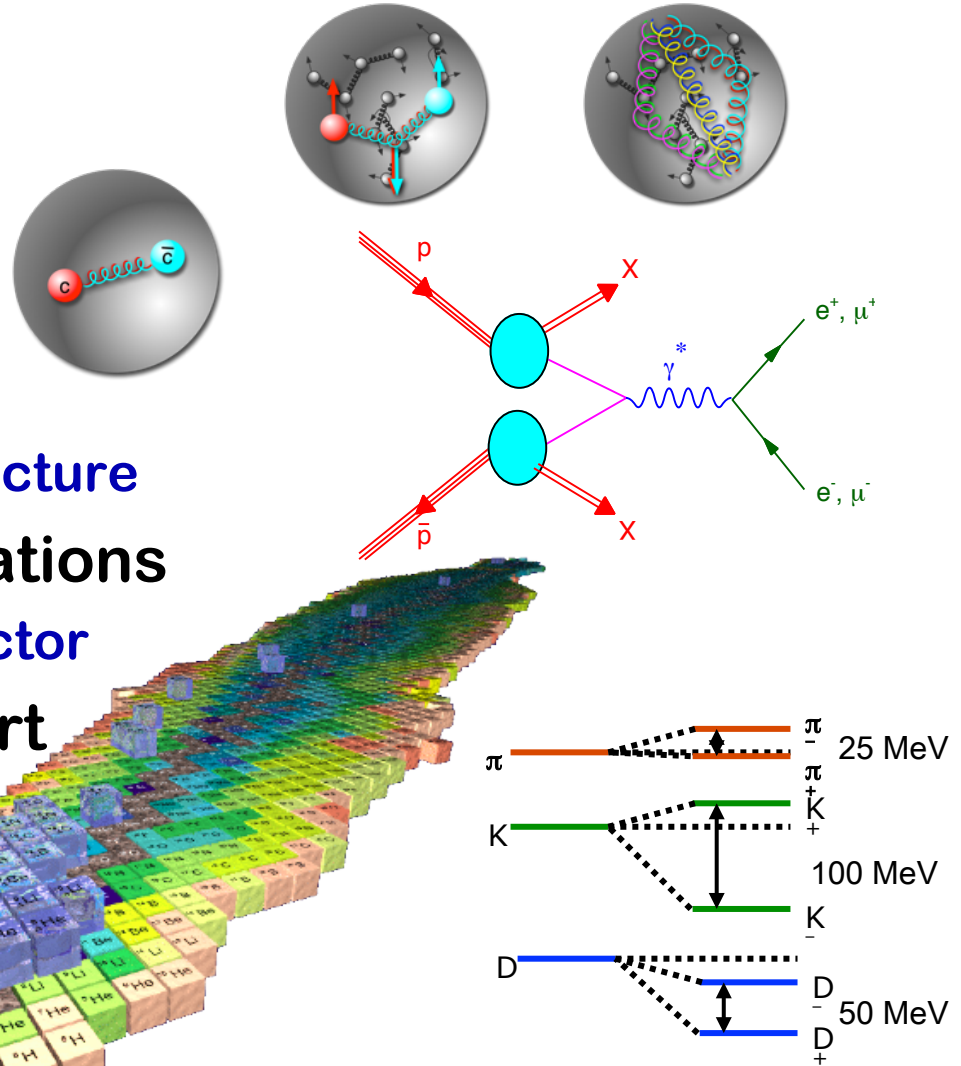
	$B\rho_{\max}$	$\Delta p/p$	$\Delta\Phi_x, \Delta\Phi_y$	resolving power	gain factor	
					^{19}C	^{132}Sn
FRS	18 Tm	1.0 %	$\pm 13, \pm 13$ mrad	1500	1	1
Super-FRS	20 Tm	2.5 %	$\pm 40, \pm 20$ mrad	1500	5	10
				including primary rate	1000	7500

- Antiproton Annihilations at Darmstadt
 - About 500 members



PANDA Physics Case

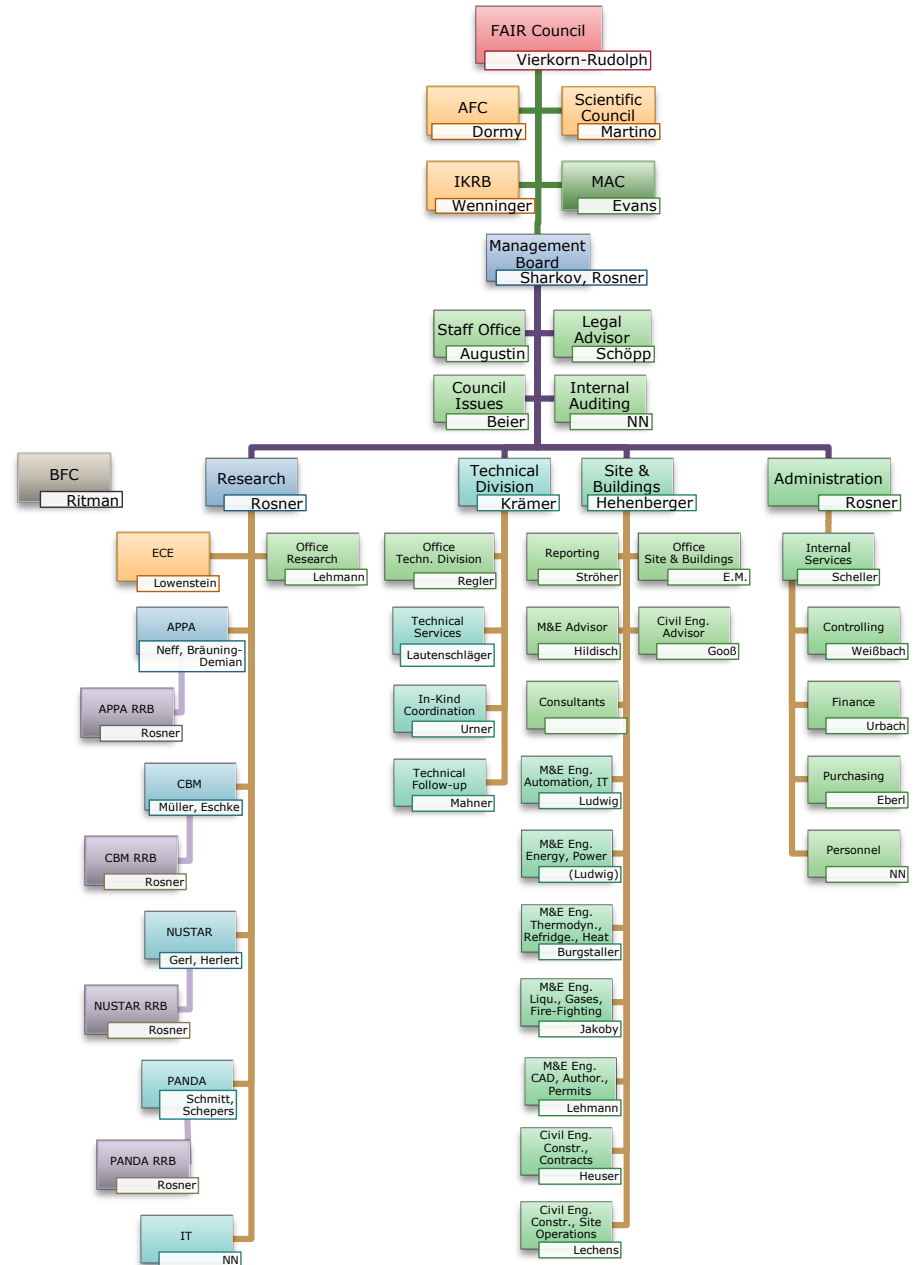
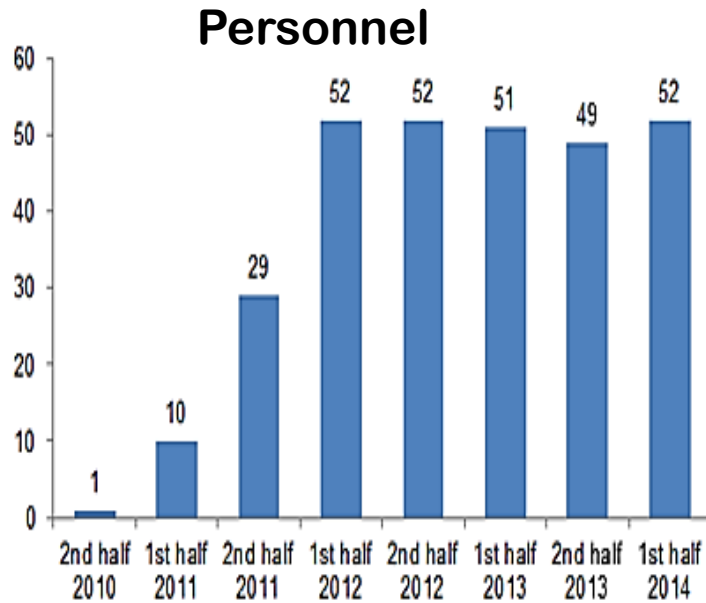
- **Gluonic excitations**
 - Hybrids, glueballs
- **Charmonium states**
 - Precision spectroscopy
- **Time-like**
 - Form factors, nucleon structure
- **In medium mass modifications**
 - Extension to the charm sector
- **Extension of nuclear chart**
 - Double hypernuclei
- **And much more...**



- Steering company
- International Convention
- Partners

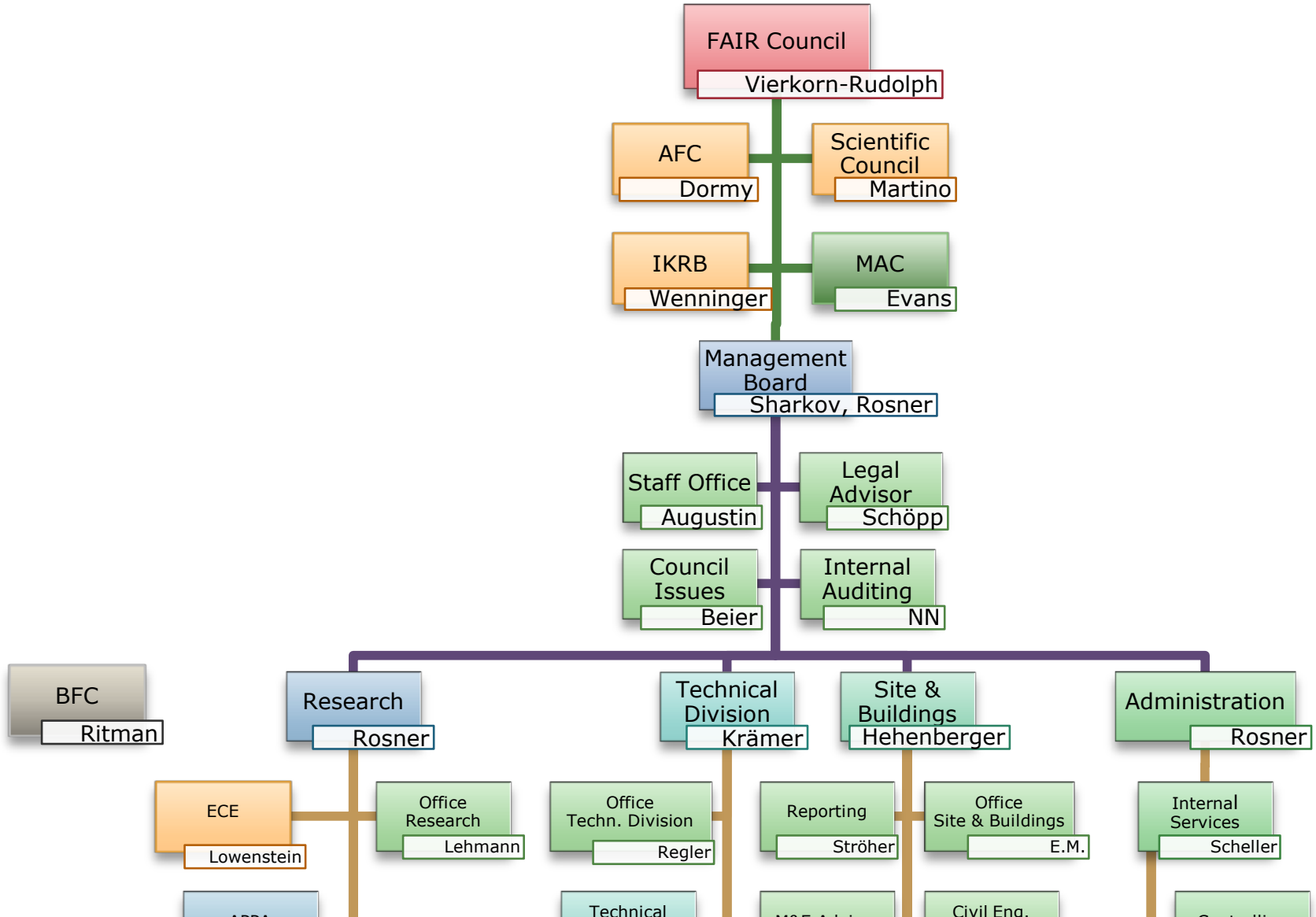


FAIR GmbH



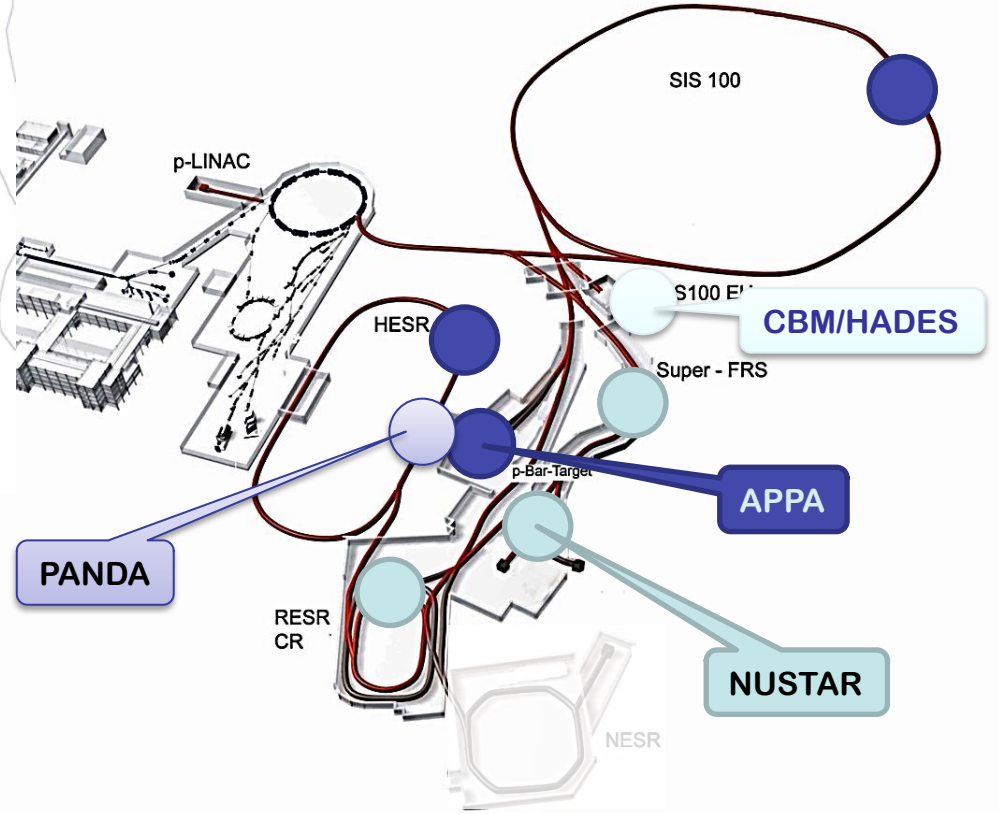
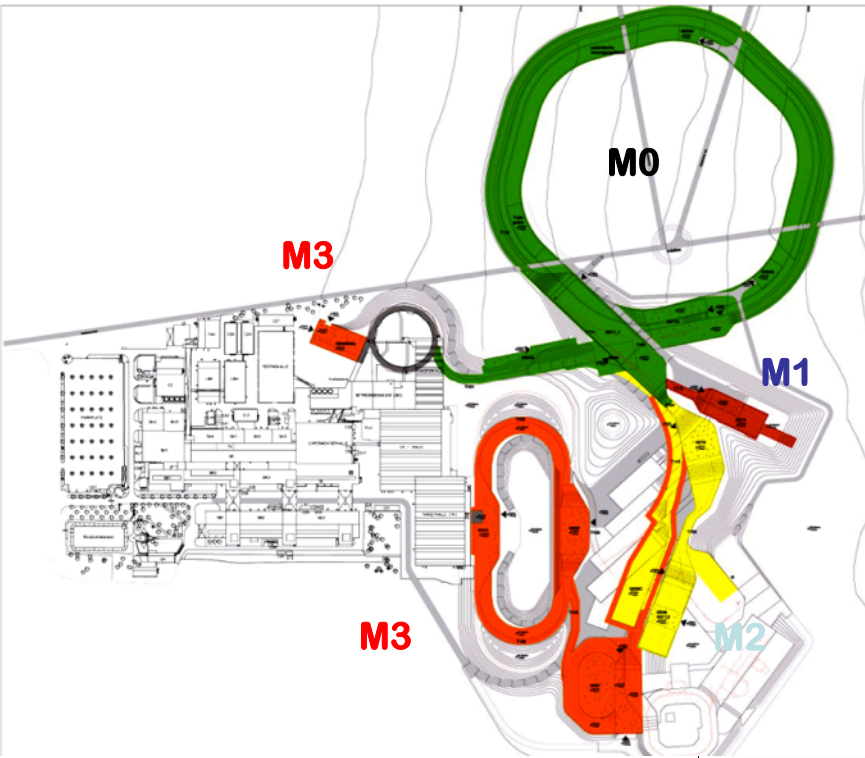
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Modularised Start Version (MSV)

Cost about 1.6 billion by 2018
(1 billion 2005 Euros)



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

Contracting Party	Contribution (in 2005 M€)
Finland	5.00
France	27.00
Germany	705.00
India	36.00
Poland	23.74
Romania	11.87
Russia	178.05
Slovenia	12.00
Sweden	10.00
Total	1.008,66

- All numbers in 2005 € escalation until 2018 ca. +50%
i.e. about € 1.6 billion
- Most contributions in-kind
- Discussions with Spain and Italy on-going
- Interested parties
 - ESA, Saudi Arabia, Netherlands, China, Turkey, Brazil, Ukraine, S Korea, Japan, USA

Funding

- **German Grants**
 - **50+146 M€ GSI**
 - **+Verbundforschung**
 - **65 M€ HESR**
 - **53 M€ FAIR GmbH**



Funding

- 526 M€ for construction
 - largest BMBF grant ever



UK: Associate Member

- 3 May 2013

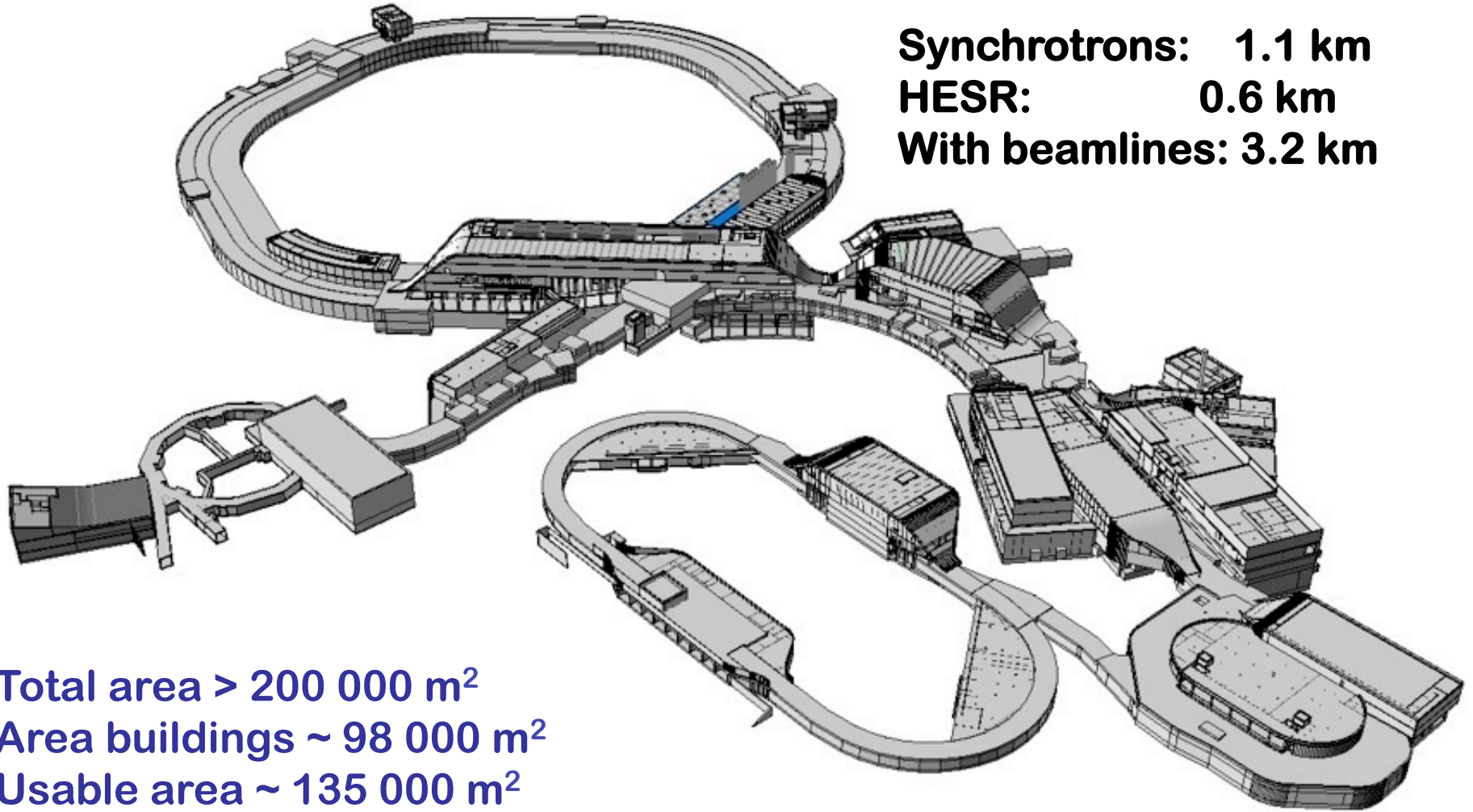


- Poland
 - Jagellonian University ratified 14/3/2013
- France
 - National Assembly ratified
 - President's decree
- Convention entered into force formally
 - 1 March 2014



22nd May 2014:

last (11th) partial construction approval regarding radiation protection



Synchrotrons: 1.1 km
HESR: 0.6 km
With beamlines: 3.2 km

Total area > 200 000 m²

Area buildings ~ 98 000 m²

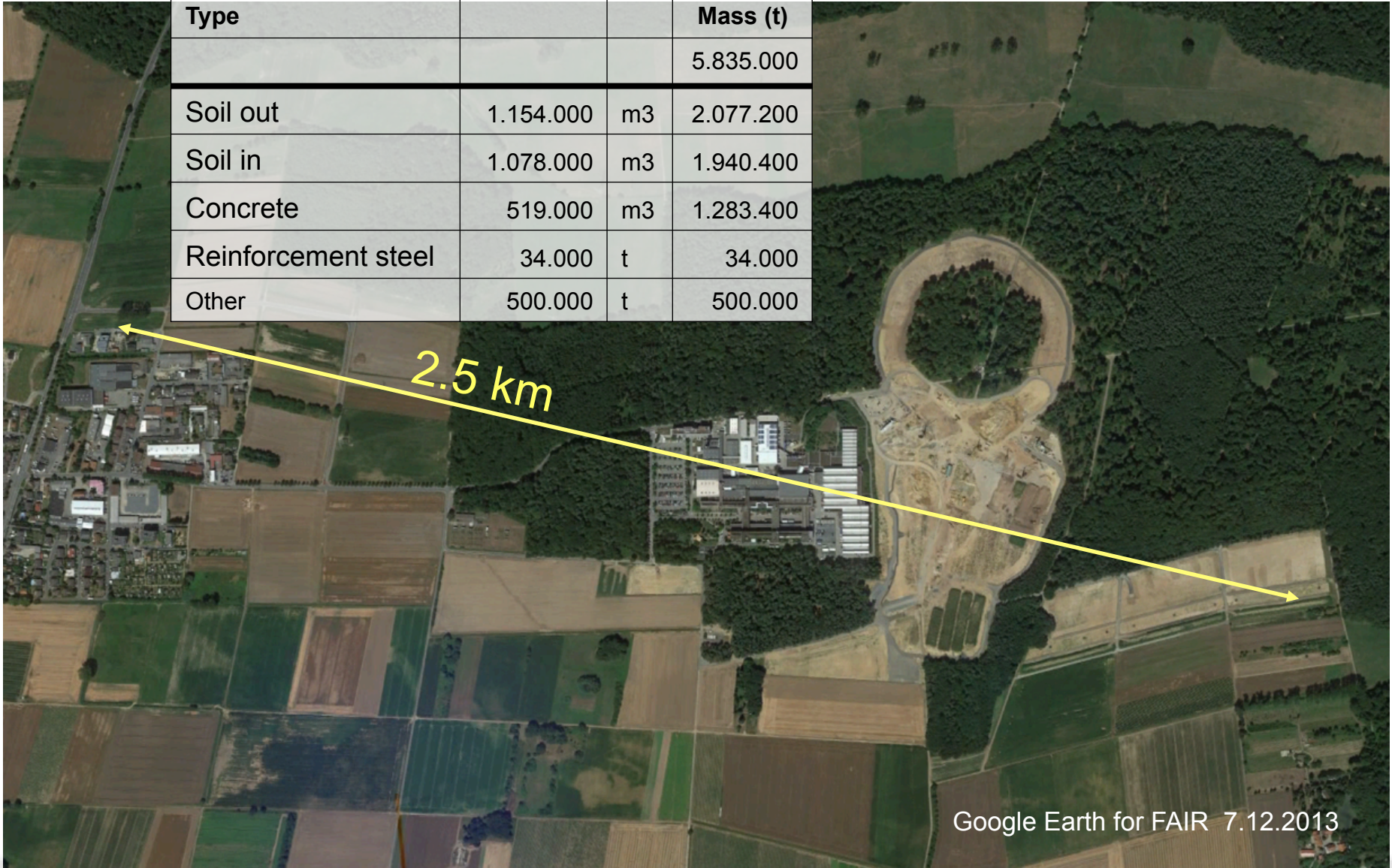
Usable area ~ 135 000 m²

Volume of buildings ~ 1 049 000 m³

Substructure: ~ 1500 pillars, up to 65 m deep

Civil Construction: Satellite's View

Type			Mass (t)
			5.835.000
Soil out	1.154.000	m3	2.077.200
Soil in	1.078.000	m3	1.940.400
Concrete	519.000	m3	1.283.400
Reinforcement steel	34.000	t	34.000
Other	500.000	t	500.000

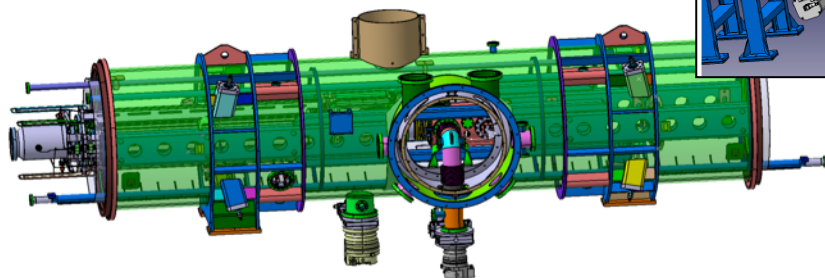
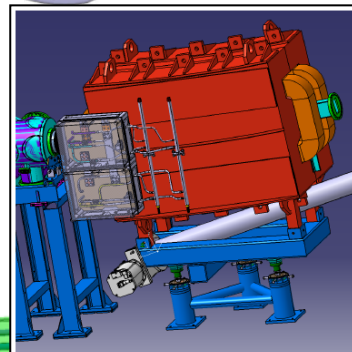
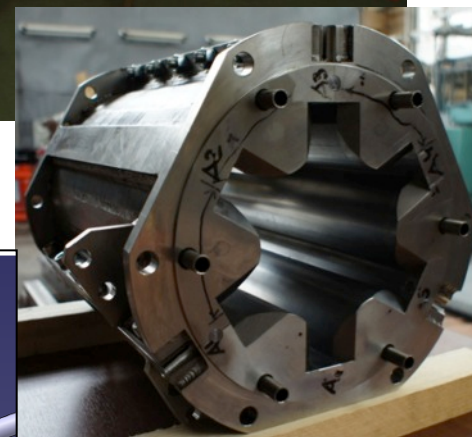
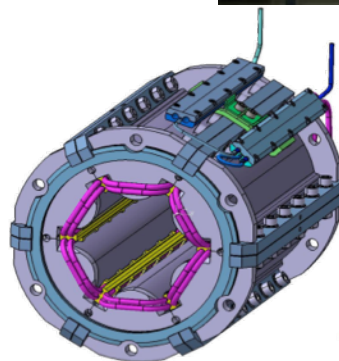
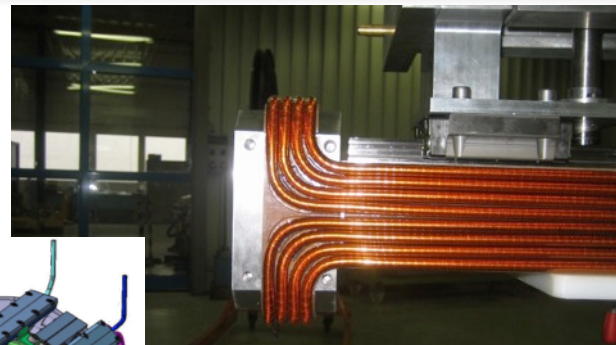


Google Earth for FAIR 7.12.2013

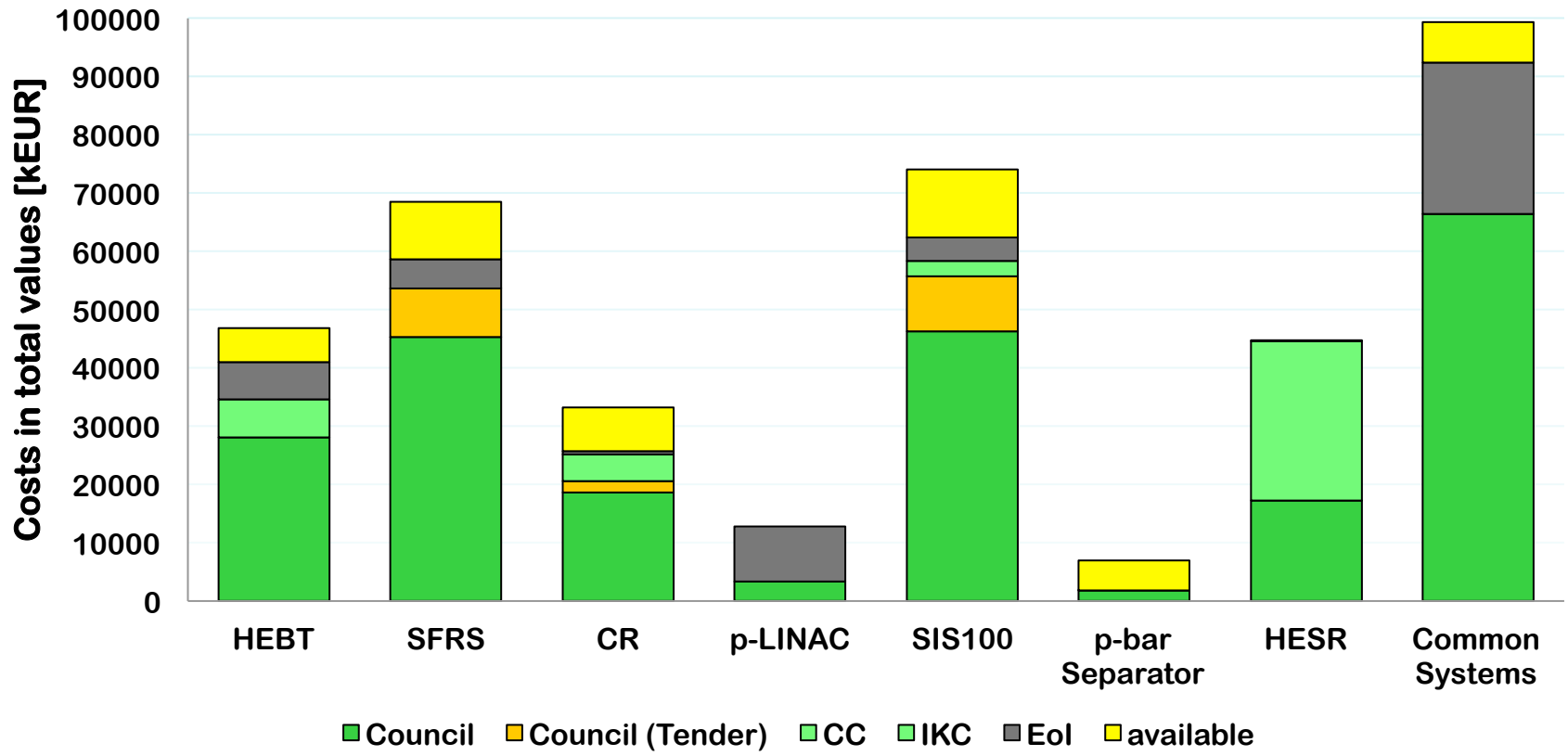


Accelerator's Status

- Progressing well
- SIS 100 dipoles
 - First series del.+tested
- SIS 100 sextupoles
 - Dubna prototype
- HEBT magnets
 - Efremov, St Petersburg
- SIS 100 quadrupoles
 - JINR, Dubna

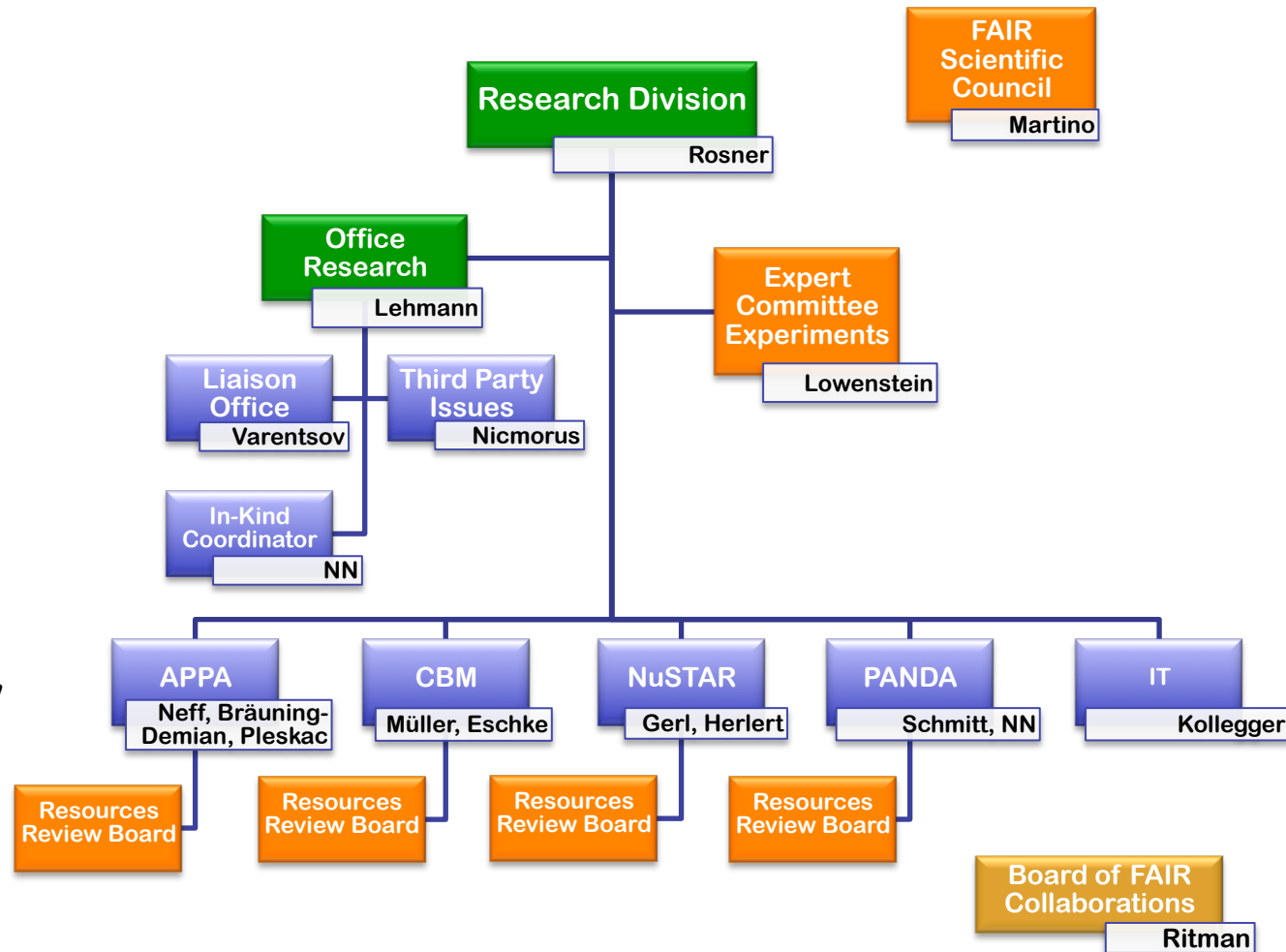


Accelerator In-Kind Contributions



Available ▣ : 47 Mio €, EOI ▣ : 51.5 Mio
 Total assigned: 287,5 Mio € of which Contracts: ▣ 41.1 Mio

- Experiment + IT Coordinators
 - in place
- Expert Committee Experiments
 - 5th meeting
24-25 Nov 2014
- Scientific Council
 - 4th meeting
22-23 Oct 2014
- Resources Review Boards
 - 4th meeting
27-28 Jan 2015



Status Experiments

- Technical Design Reports

Collaboration	Approved	Submitted	Still outstanding	Announced 2014	Total expected
APPA	4	4	16	7	24
CBM	3	4	4	3	11
NUSTAR	12	2	27	11	41
PANDA	6	0	13	5	19
Total	25	10	60	26	95

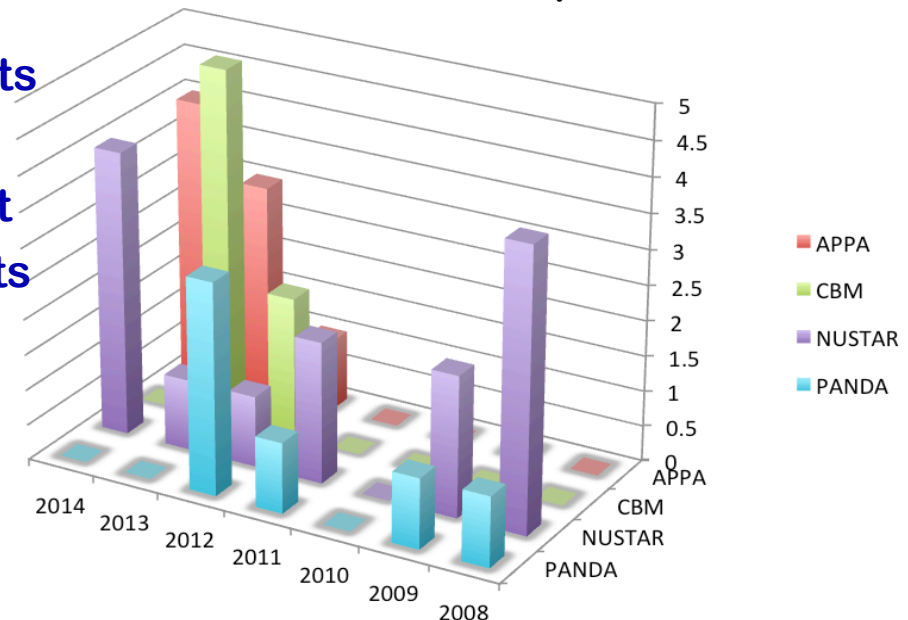
- Work in progress

- In-Kind and Collaboration Contracts
- Synchronised timelines
- New risk assessment/management
- General Conditions for Experiments
- Cost Book

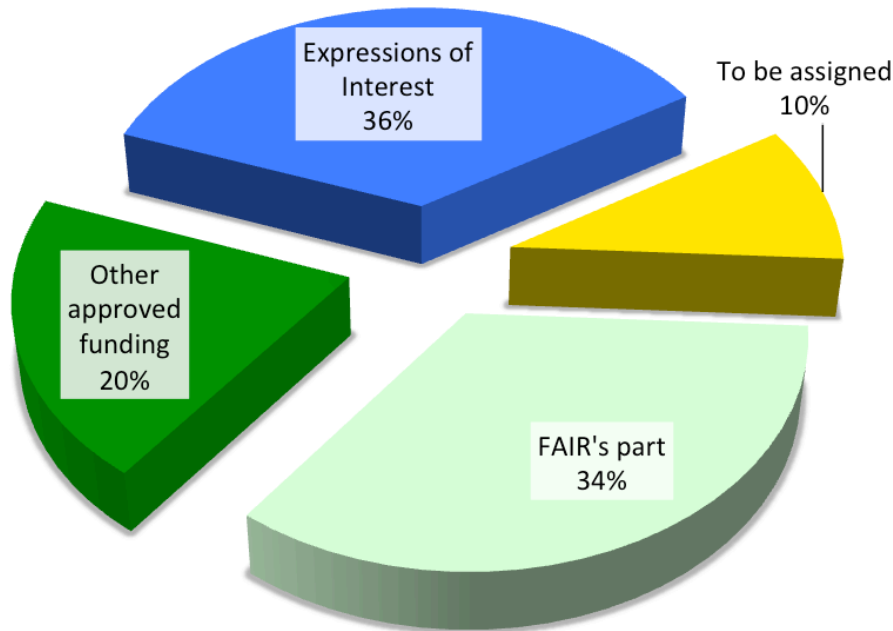
- Construction MoUs

- To be agreed upon in RRBs

TDR submission profile



Funding Experiments as of 3rd RRBs

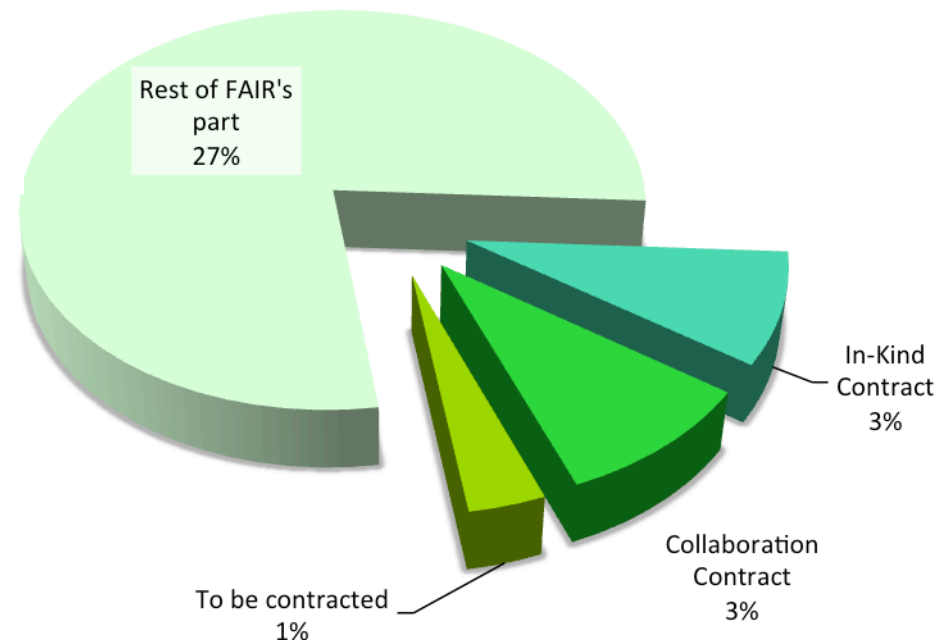


Breakdown (2005 prices)

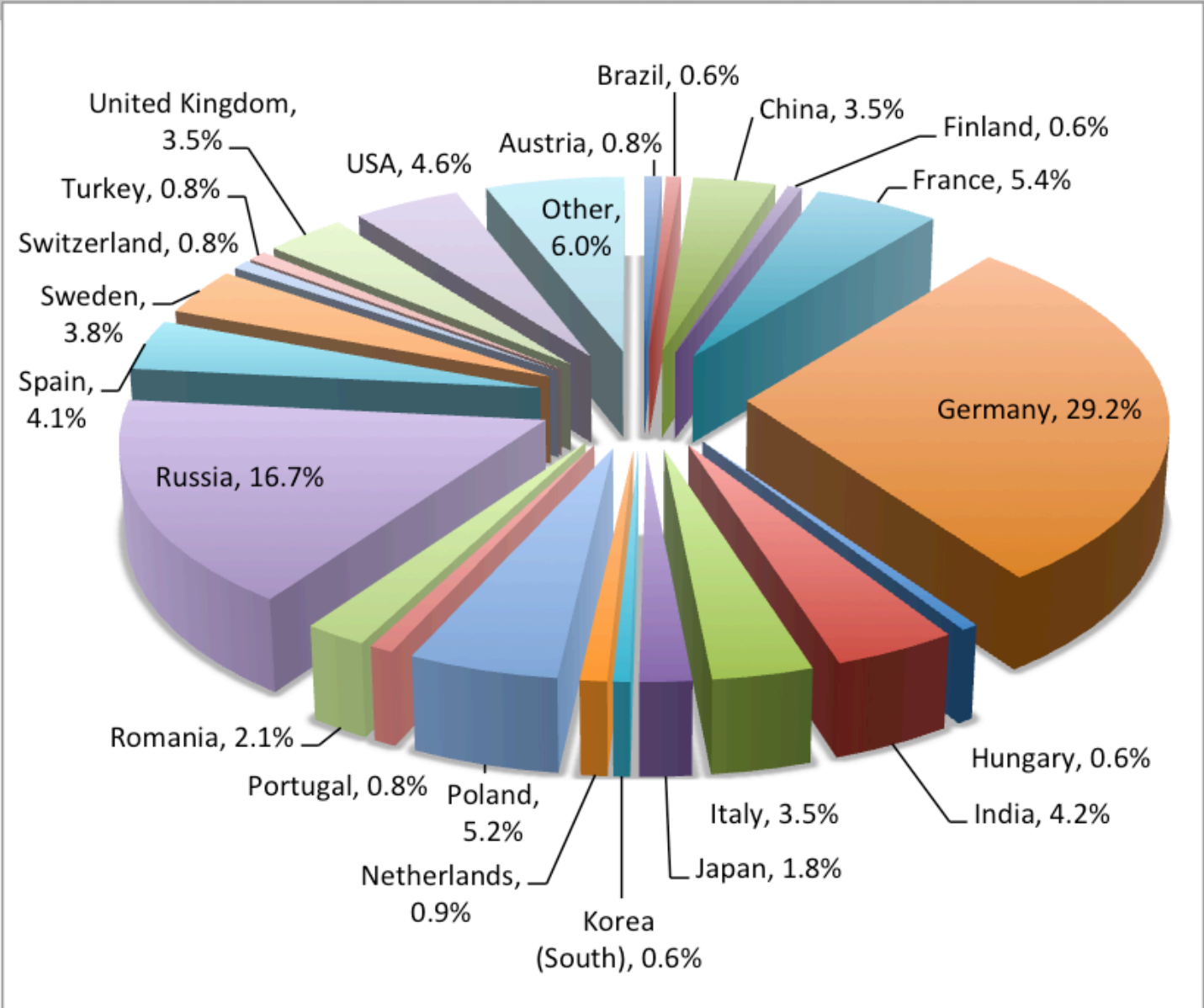
- **FAIR's part: 68.9 M€**
 - In-Kind Contract: 6.0 M€
 - Collaboration Contract: 6.6 M€
 - To be contracted: 2.4 M€
- **Other approved funding: 40.5 M€**
- **Expressions of Interest: 70.9 M€**
- **To be assigned: 19.5 M€**

- **Cost estimate June 2014, Collaborations' input to 3rd meetings of RRBs**
 - 252 M€ = 200 M€ in 2005 prices
- **Cost Book (issued in 2006)**
 - 188 M€ in 2005 prices

FAIR's Part in Detail



Collaboration Members by Country



Understand more

about:

life,

the universe...

...and everything!

Atomic, applied and
plasma physics - APPA

Nuclear structure
- ANDRA

Astrophysics and
nuclear structure
- NUSTAR

QCD phase transition - CBM

temperature

big bang