Facility for Antiproton and Ion Research (FAIR)

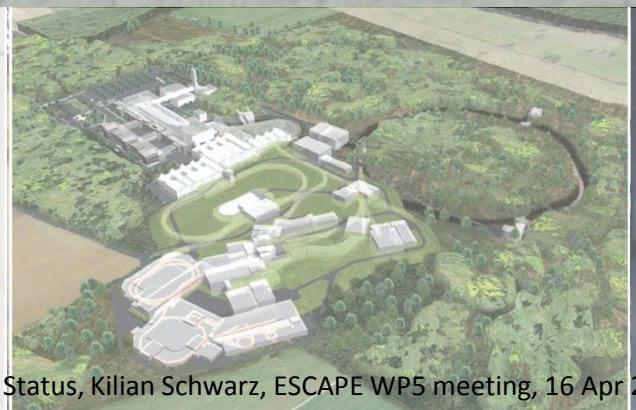
(under construction in Darmstadt, Germany)

# Status of FAIR

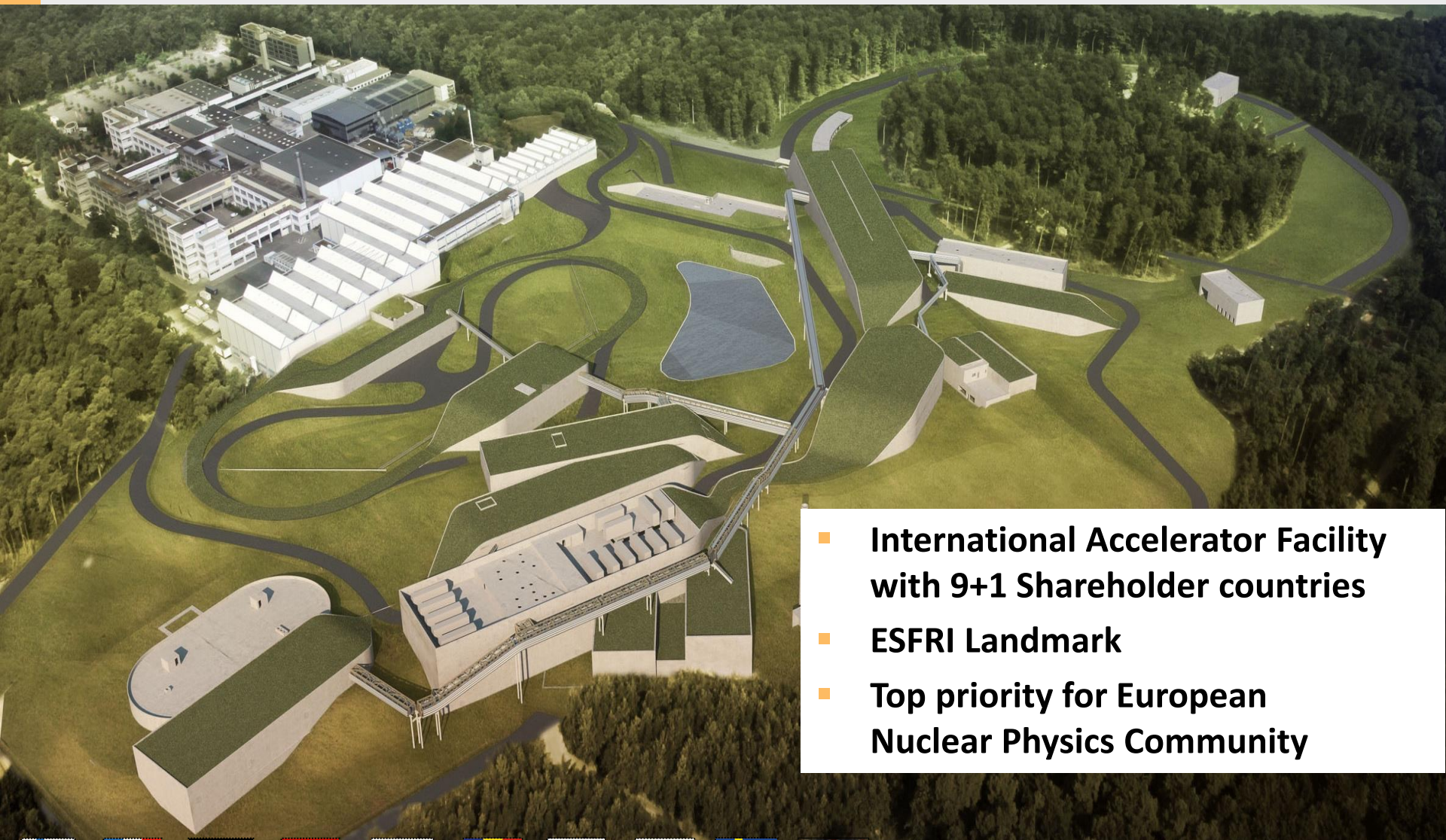
**- challenges in data processing**
**in the context of EOSC and the *FAIR* principles**

**Kilian Schwarz**
**(with slides from J. Eschke and M. Al-Turany)**
**GSI & FAIR GmbH**

**ESCAPE WP5 meeting, Groningen, 16 April 2019**



# FAIR: Facility for Antiproton and Ion Research – A World-Wide Unique Accelerator Facility



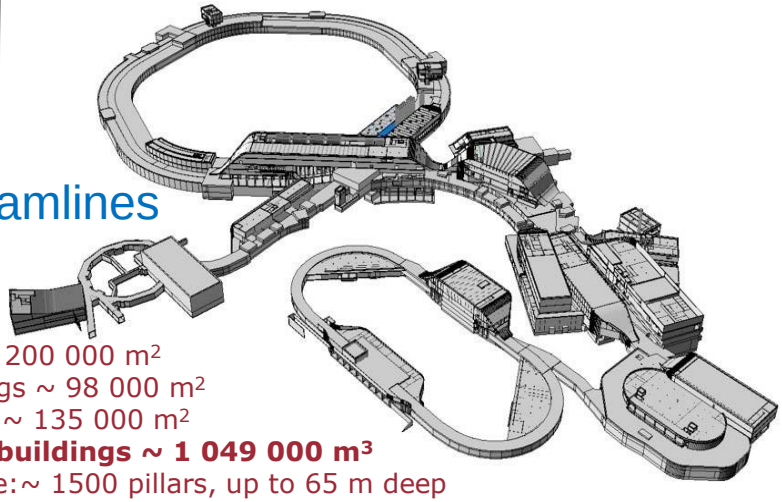
- International Accelerator Facility with 9+1 Shareholder countries
- ESFRI Landmark
- Top priority for European Nuclear Physics Community

Finland France Germany India Poland Romania Russia Slovenia Sweden UK

# Status of FAIR Project: Civil Construction

## Progress since official start on 4th of July 2017

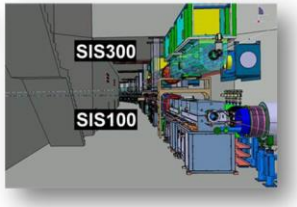
Inside the tunnel of the FAIR ring accelerator SIS100



3.2 km beamlines

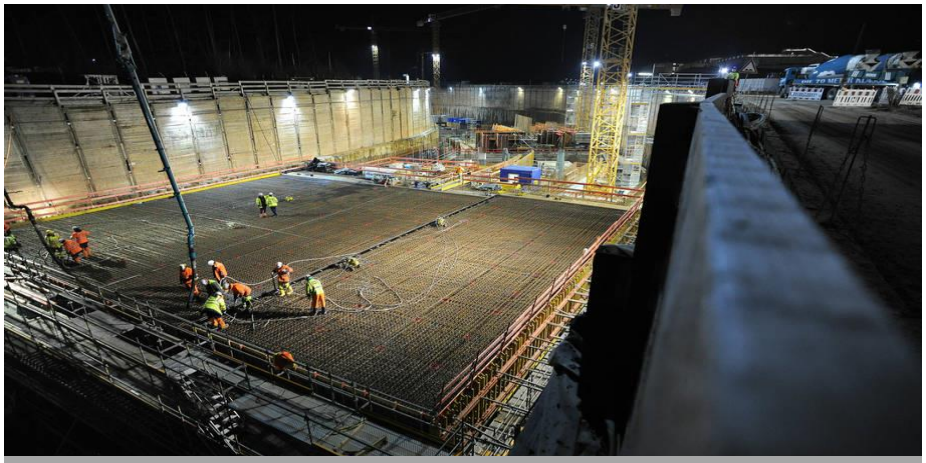
Total area > 200 000 m²
Area buildings ~ 98 000 m²
Usable area ~ 135 000 m²
**Volume of buildings ~ 1 049 000 m³**
Substructure: ~ 1500 pillars, up to 65 m deep

SIS100/300 tunnel


# Status of FAIR Project: Civil Construction

Excavation SIS100 tunnel



First tunnel slab is being poured at night

Upgraded SIS18 completed ready for FAIR and FAIR phase 0

Excavation transfer building & CBM cave

## construction timeline:

- civil construction completed in 2023
- installation of accelerators and experiments 2022 - 2024
- start of pilot beams in 2025

# Facility for Antiproton & Ion Research

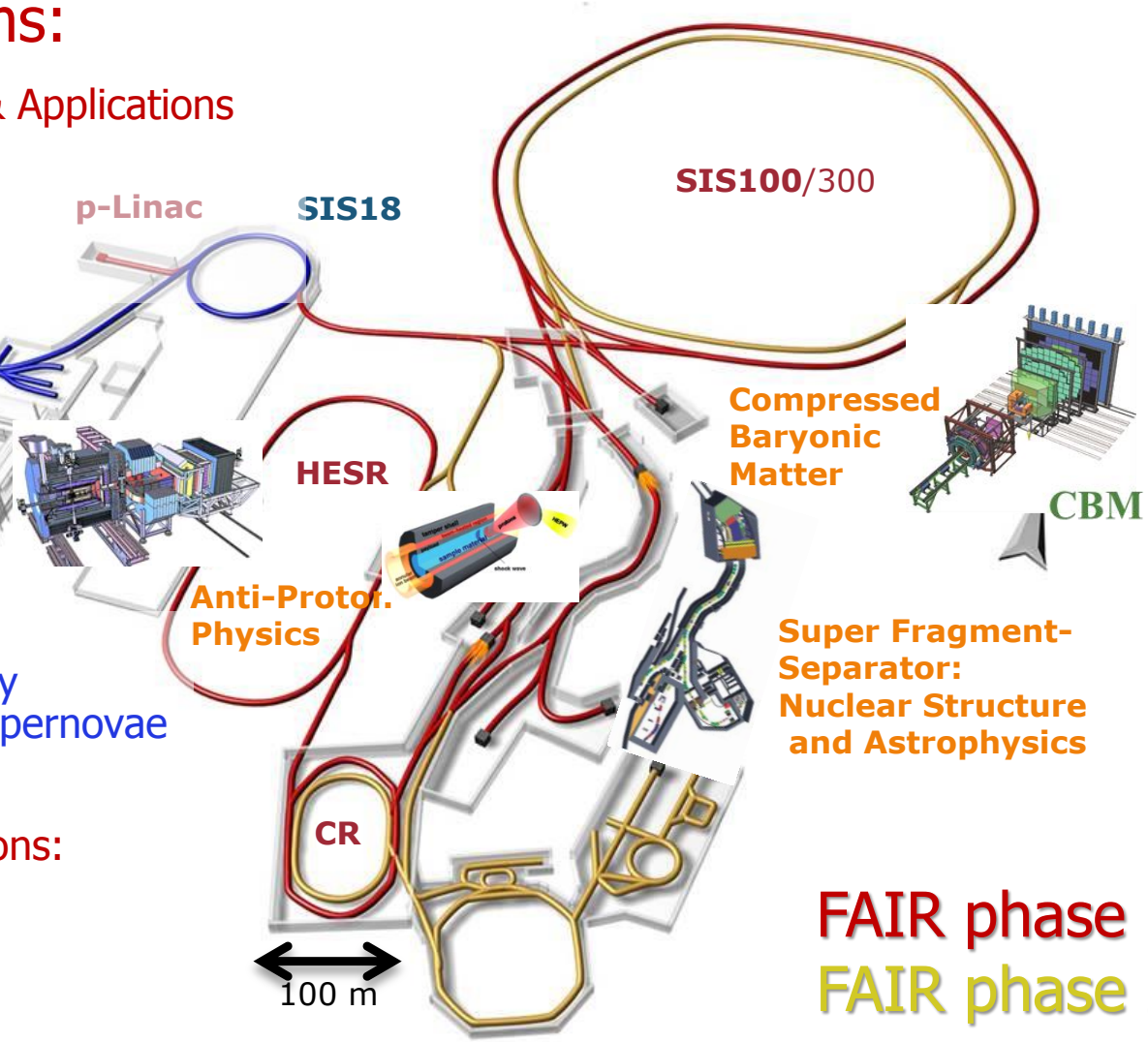
## Experimental programs:

APPA: Atomic & Plasma Physics & Applications
- Highly charged atoms
- Plasma physics
- Radiobiology
- Material science

CBM: Nucleus-nucleus collisions
- Nuclear matter at neutron star core densities
- Phase transitions from hadrons to quarks

NUSTAR: Rare Isotope beams
- Nuclear structure far off stability
- Nucleosynthesis in stars and supernovae

PANDA: Antiproton-proton collisions:
- Charmed hadrons (XYZ)
- Gluonic matter and hybrids
- Hadron structure
- Double Lambda hypernuclei




FAIR phase 1
FAIR phase 2

# FAIR Collaborations

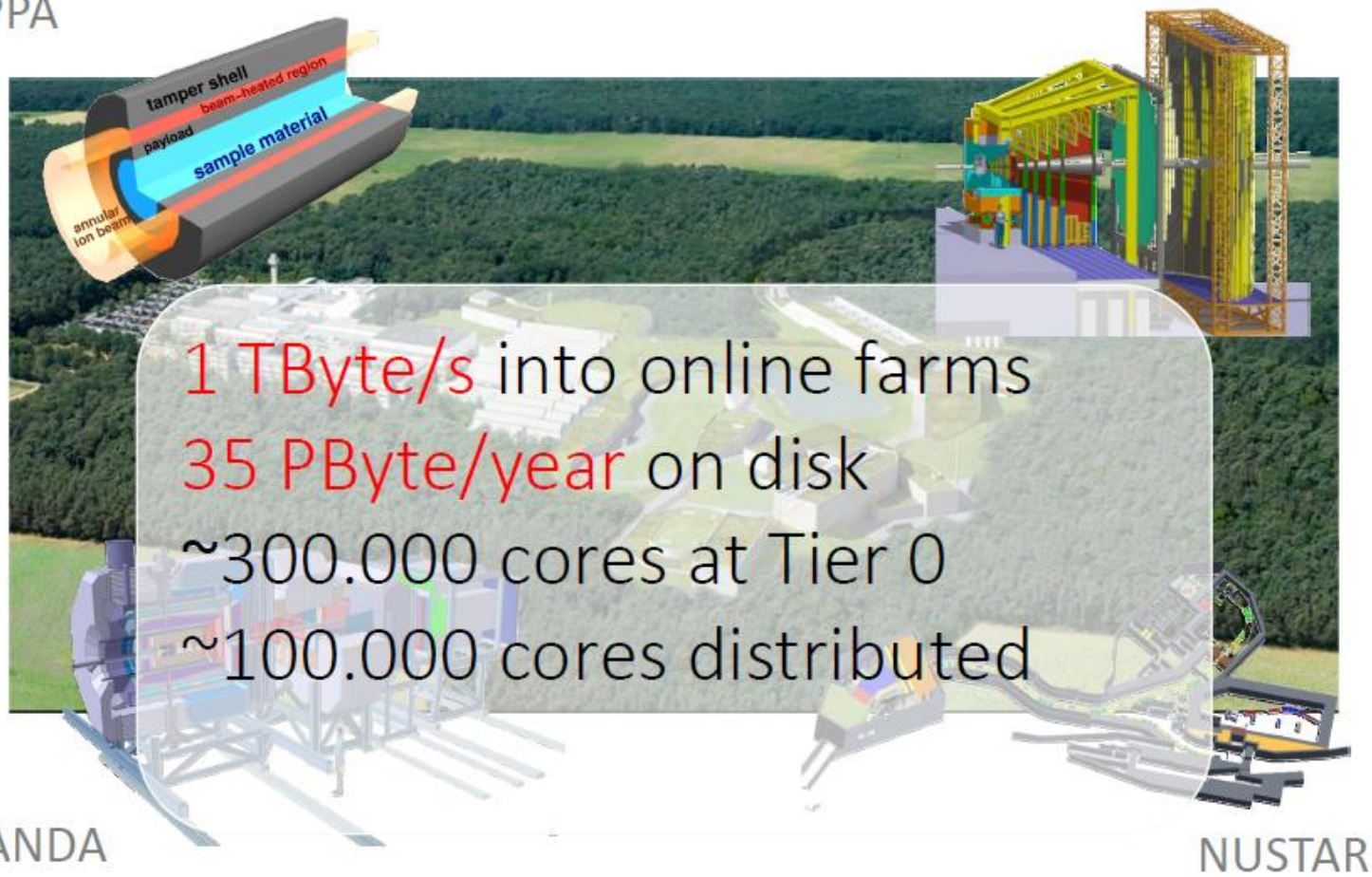
**more than 2500 scientist from ~200 institutions in over 50 countries**




# Computing at FAIR

APPA

CBM




1 TByte/s into online farms

35 PByte/year on disk

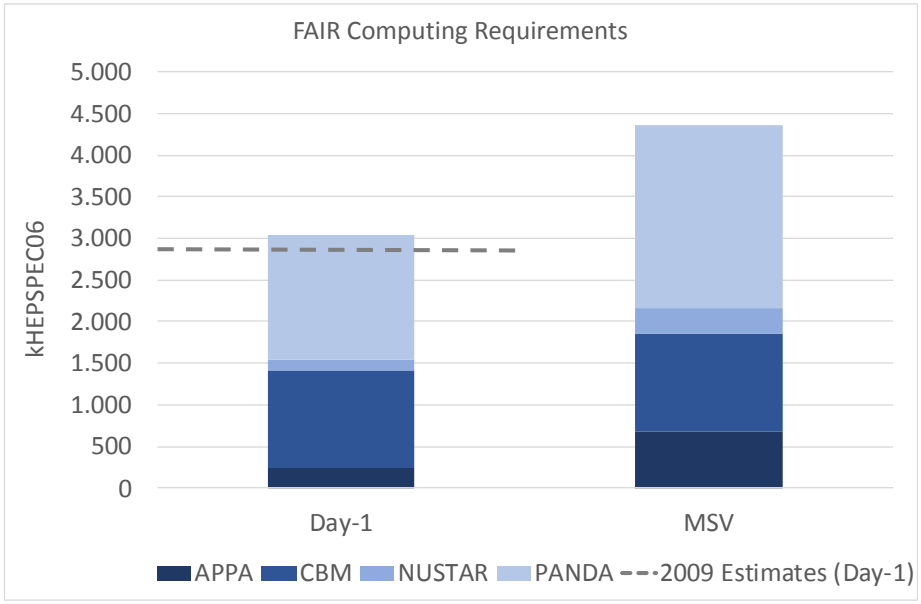
~300.000 cores at Tier 0

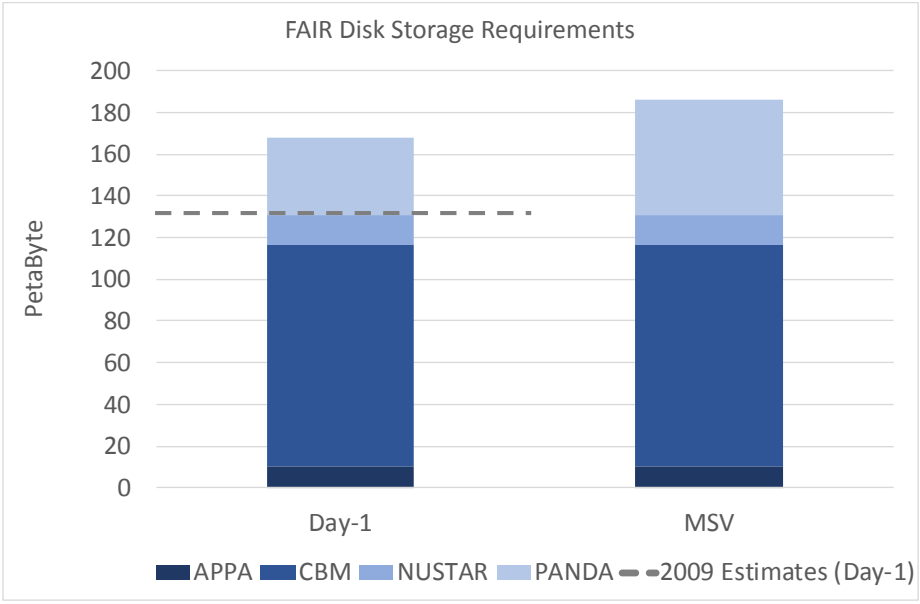
~100.000 cores distributed

PANDA

NUSTAR

# Computing – step 1: Experiment requirements determined




Assumptions for resource requirements:
Day-1 and MSV detector setups, nominal accelerator performance, multi-year integrated values (data lifetime)

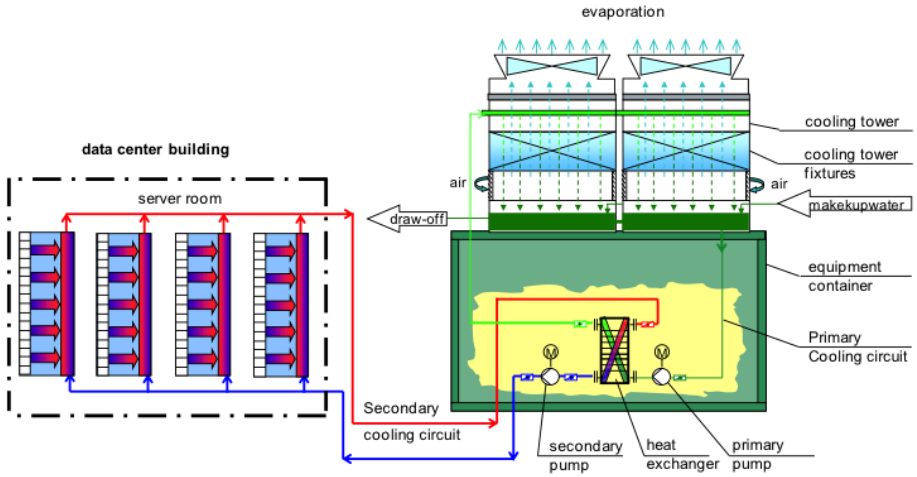
# FAIR Data Center

## A common data center for FAIR (Green IT Cube)


CBM FLES
+ 60'000 CPU cores
  - To perform online a full event reconstruction on the 1 TB/s input data stream
+ ? GPUs
  - To speed up the reconstruction

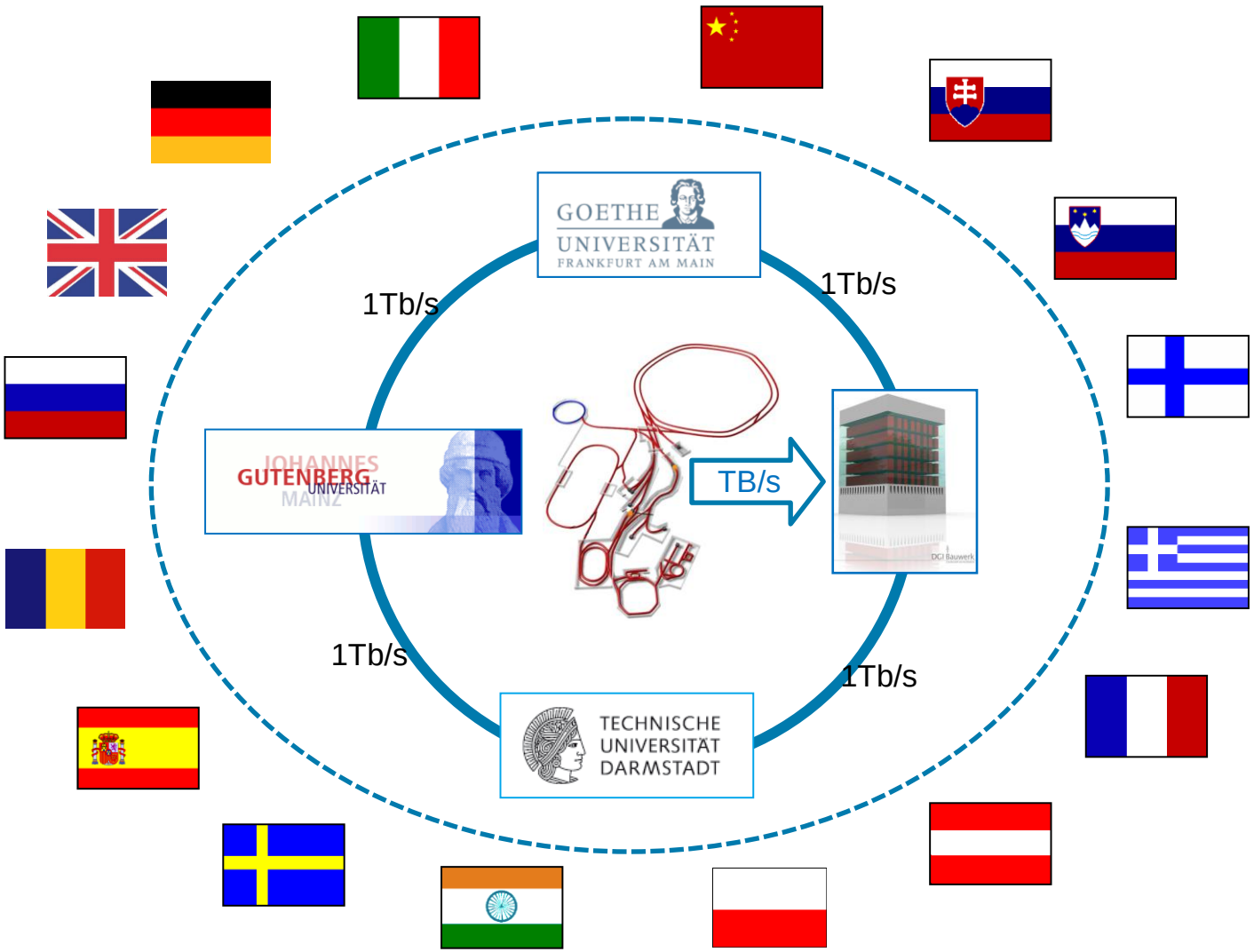
Panda online
+ 66'000 CPU cores
  - To perform online a full event reconstruction on the 300 GB/s input data stream
+ ? GPUs
  - To speed up the reconstruction

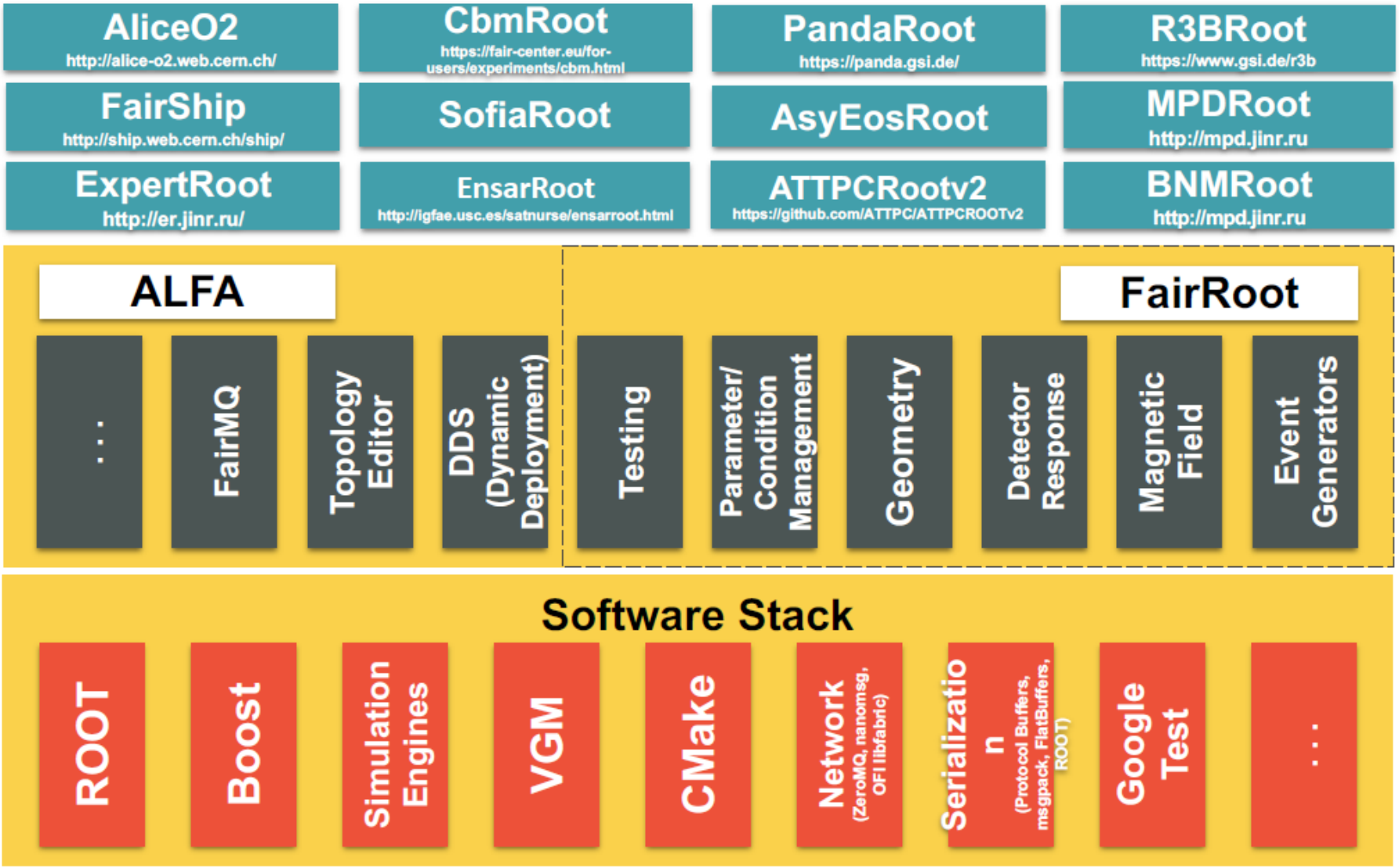
Dynamically allocated resources
for exclusive usage and limited time




6 floors, 4.645 sqm
room for 768 19" racks (2,2m)
4 MW cooling (baseline)
Max cooling power 12 MW
Fully redundant (N+1)
PUE <1.07

# FAIR Computing: T0/T1 MAN (Metropolitan Area Network) & Grid/Cloud




AliceO2
http://alice-o2.web.cern.ch/
CbmRoot
https://fair-center.eu/for-users/experiments/cbm.html
PandaRoot
https://panda.gsi.de/
R3BRoot
https://www.gsi.de/r3b
FairShip
http://ship.web.cern.ch/ship/
SofiaRoot
AsyEosRoot
MPDRoot
http://mpd.jinr.ru
ExpertRoot
http://er.jinr.ru/
EnsarRoot
http://igfae.usc.es/satnurse/ensarroot.html
ATTPCRootv2
https://github.com/ATTPC/ATTPCROOTv2
BNMRoot
http://mpd.jinr.ru
ALFA
FairRoot
. . .
FairMQ
Topology Editor
DDS (Dynamic Deployment)
Testing
Parameter/ Condition Management
Geometry
Detector Response
Magnetic Field
Event Generators
Software Stack
ROOT
Boost
Simulation Engines
VGM
CMake
Network (ZeroMQ, nanomsg, OFI libfabric)
Serialization (Protocol Buffers, msgpack, FlatBuffers, ROOT)
Google Test
. . .

# FAIR status/requirements computing:

- data management
  - 2 large experiments with similar requirements as LHC and several smaller non HEP like experiments targeting many different areas of research
  - a common data management infrastructure has to be created which fulfills requirements of all experiments.
- software development
  - FairRoot is already being used by all FAIR experiments and additionally by some non FAIR experiments.
  - software needs to support continuous data read out and complex online processing for event selection at high data rates.
  - online and offline processing needs to become faster and more efficient, also by using new architectures and algorithms.

# FAIR status/requirements computing:

- data/software access in the context of EOSC
  - In order to be able to publish at least parts of the data FAIR is in the process of developing corresponding MoUs.
  - The FAIR analysis software (FairRoot) should be made accessible via the software and service repository developed in the context of ESCAPE.
- FAIR paradigm
  - the FAIR paradigm is planned to be introduced (at least to a large extend) for a consistent data management system which is being developed based to a large extend on common systems and available technologies. Also a meta data system under consideration of the DOI/data cite requirements is under development.

# FAIR status/requirements computing/ESCAPE WP5/questionaire:

- 1 TB/s into online farm, 10 GB/s on disk
- no hardware trigger on events, detector hits with time stamps
- simulated event size (CBM): 250 kB
- meta data are planned to be made VO compliant
- access rights to data: proprietary period after which public
- at least parts of the data will be geographically distributed
- data will have replicas
- offline data processing will to some extent be geographically distributed
- currently data are stored and processed mainly at GSI
- software visualisation tools should be integrated into science platform
- building blocks for standard processing pipeline are available

# FAIR interest in ESCAPE

- ESCAPE takes place right before the official start of FAIR.
- within ESCAPE essential IT ingredients are being developed,  especially infrastructures for distributed data management and computing, which are needed by FAIR.
- FAIR hopes to profit from taking part in ESCAPE by getting important support and ideas for setting up their own infrastructure for distributed computing.