Green Cube GSI
FAIR Tier 0

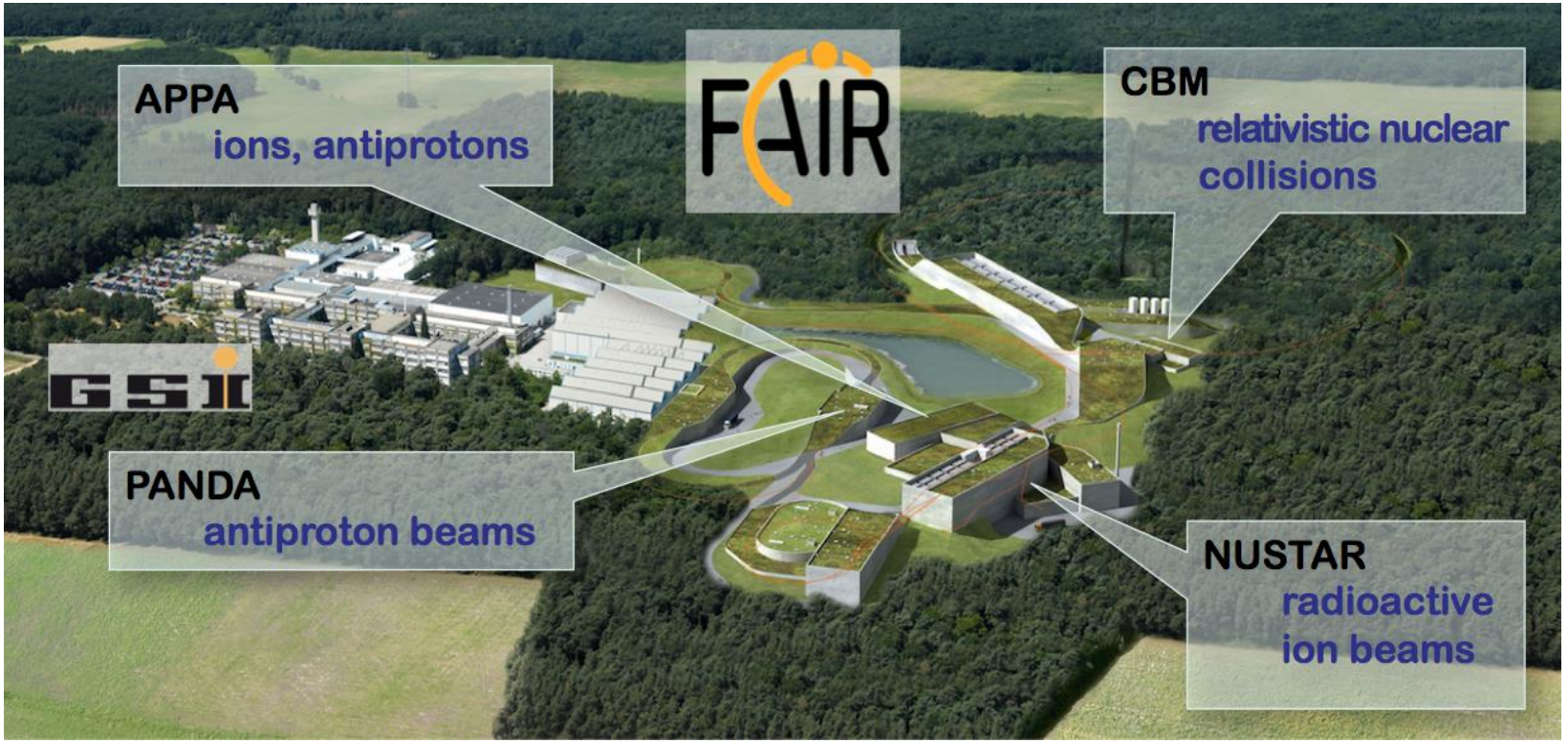
Thorsten Kollegger
FAIR & GSI

30. March 2015
AIME Big Data - Budapest

Green Cube

New data center at GSI, mainly for FAIR Tier0
6 floors, ~25x35 sqm footprint

GSI & FAIR

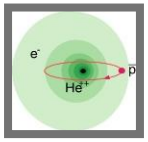


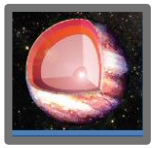
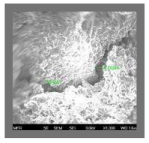
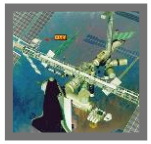
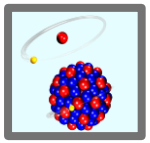
GSI – Helmholtz Center for Heavy Ion Research
FAIR – Facility for Antiproton and Ion Research
Located in Darmstadt, Germany
~1.300 employees and ~3.000 worldwide users

FAIR

Currently under construction
Fully operational in the next decade, ~1B EUR investment
European project of 8 member states + ~50 international partners

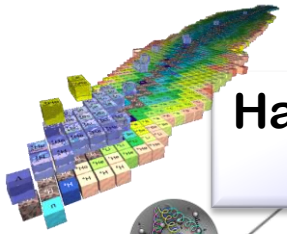
FAIR Science



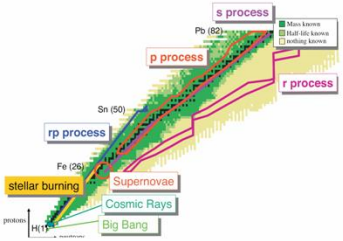
time

Atomic, applied and plasma physics - APPA



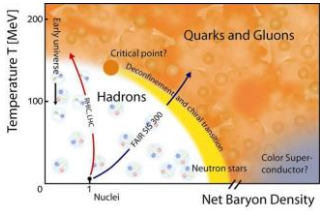
Hadron structure - PANDA

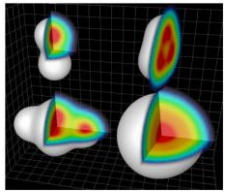
Astrophysics and nuclear structure - NUSTAR



QCD phase transition - CBM

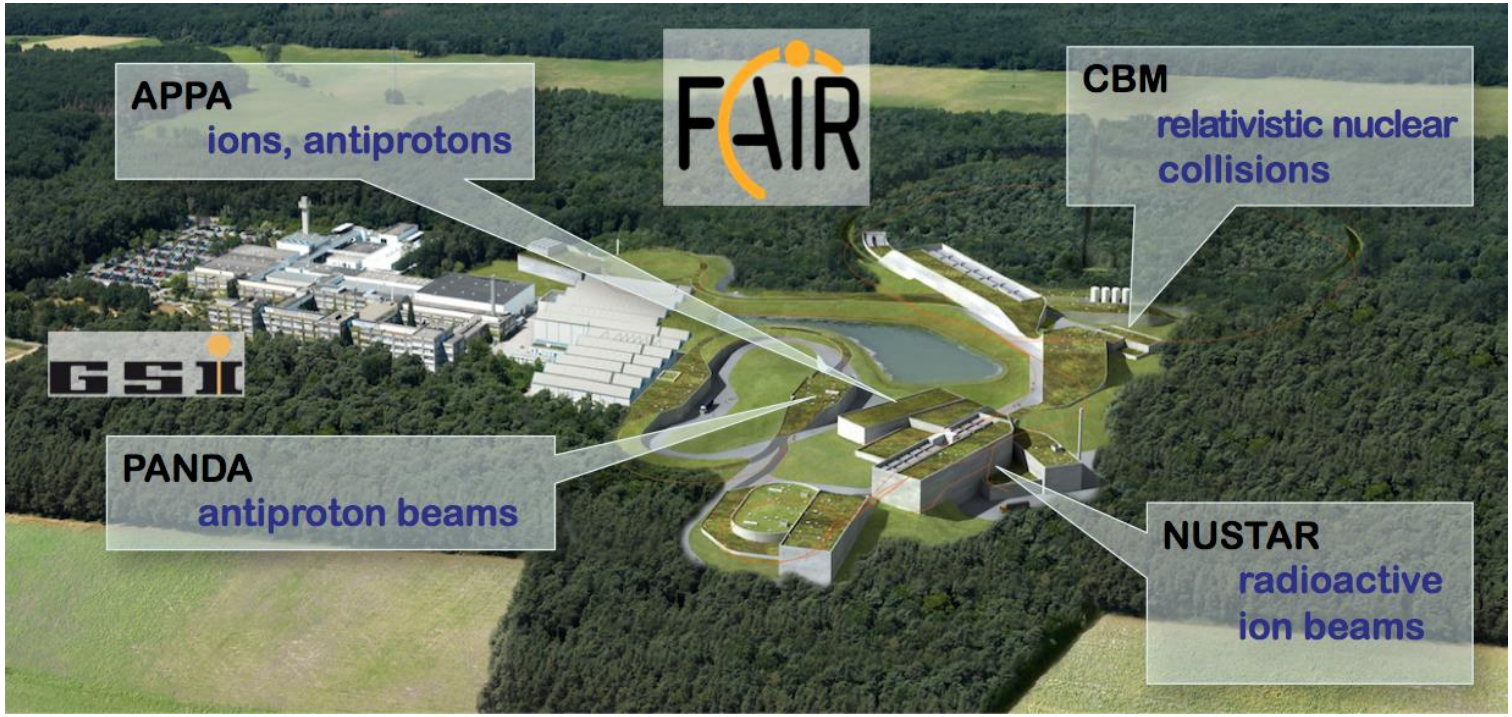
temperature





big bang

FAIR Computing



The FAIR experiments will

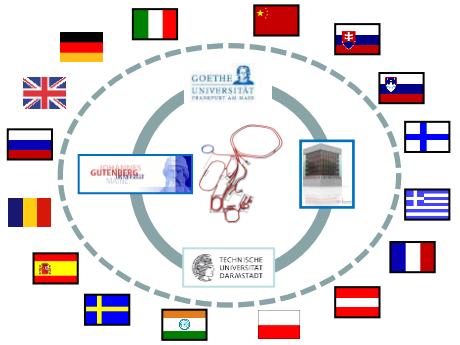
- produce **tens of PetaBytes** of raw data per year, with up to **1 TByte/s** from the experiments to the Tier0, which need to be safely and permanently stored
- analyze these datasets over several years, requiring also extensive simulations and theory calculations

FAIR Computing

FAIR Tier 0 @ full FAIR operation

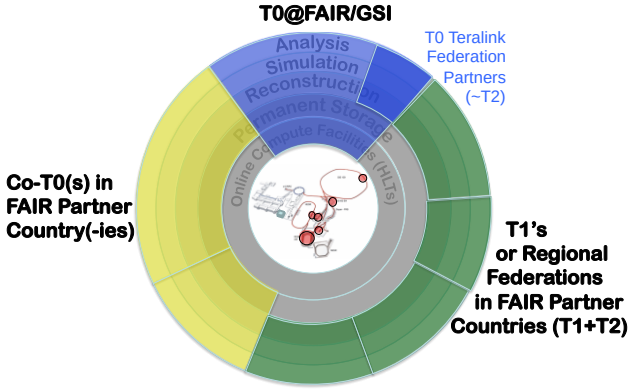
- 300.000 CPU-cores
- 35 PByte/year Online-Storage (HDD)
- 30 Pbyte/year Permanent-Storage (Tape)

Comparable resources in FAIR partner countries



Key Points

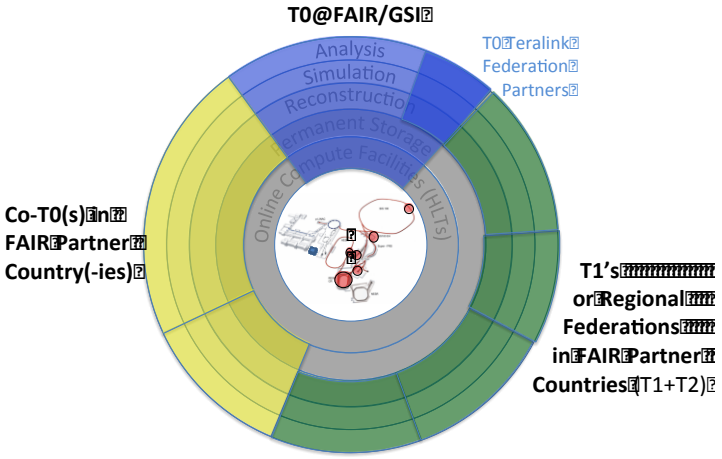
- Few big, highly efficient data centers
- Further partner connected via regional federations



FAIR Tier 0 @ GSI

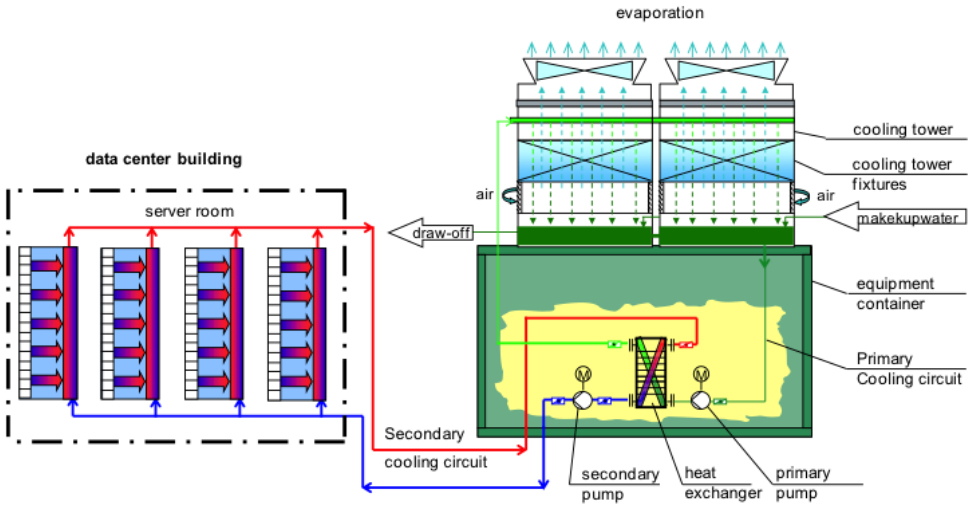
FAIR Tier 0 is the core of the FAIR Computing Model

- Experiment Online Farms connected via ~4000 fibres to Experiments
- Experiment Storage Systems
- Experiment Processing Farm
- Integration of HPC Centers of surrounding partners (Teralink)
- Distribution of experimental data to FAIR Partners; several 100 Gb/s links



FAIR Data Center

A common data center
for FAIR (Green Cube)



Key Facts

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

An Alarming Truth

World wide air-traffic causes around 2 % of the global CO_2 emission –

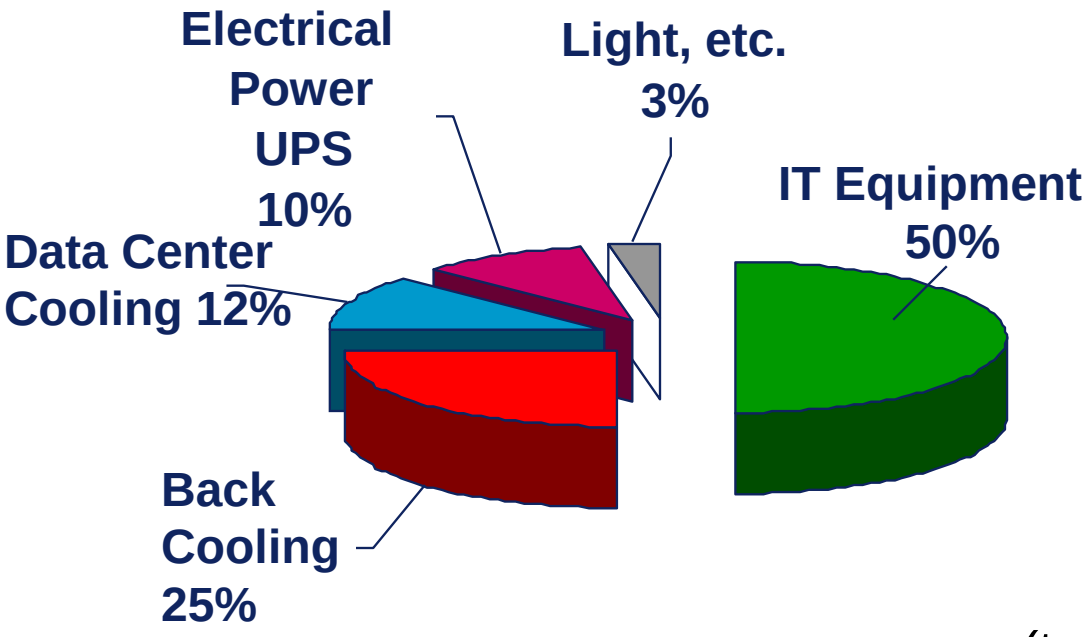
just as much as commercial IT! (ca. 30 GW)

[Gartner]

FIAS Frankfurt Institute for Advanced Studies

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Data Center State of the Art



the green grid™

$$\textbf{PUE} = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

Power **U**sage **E**ffectiveness

PUE = 2

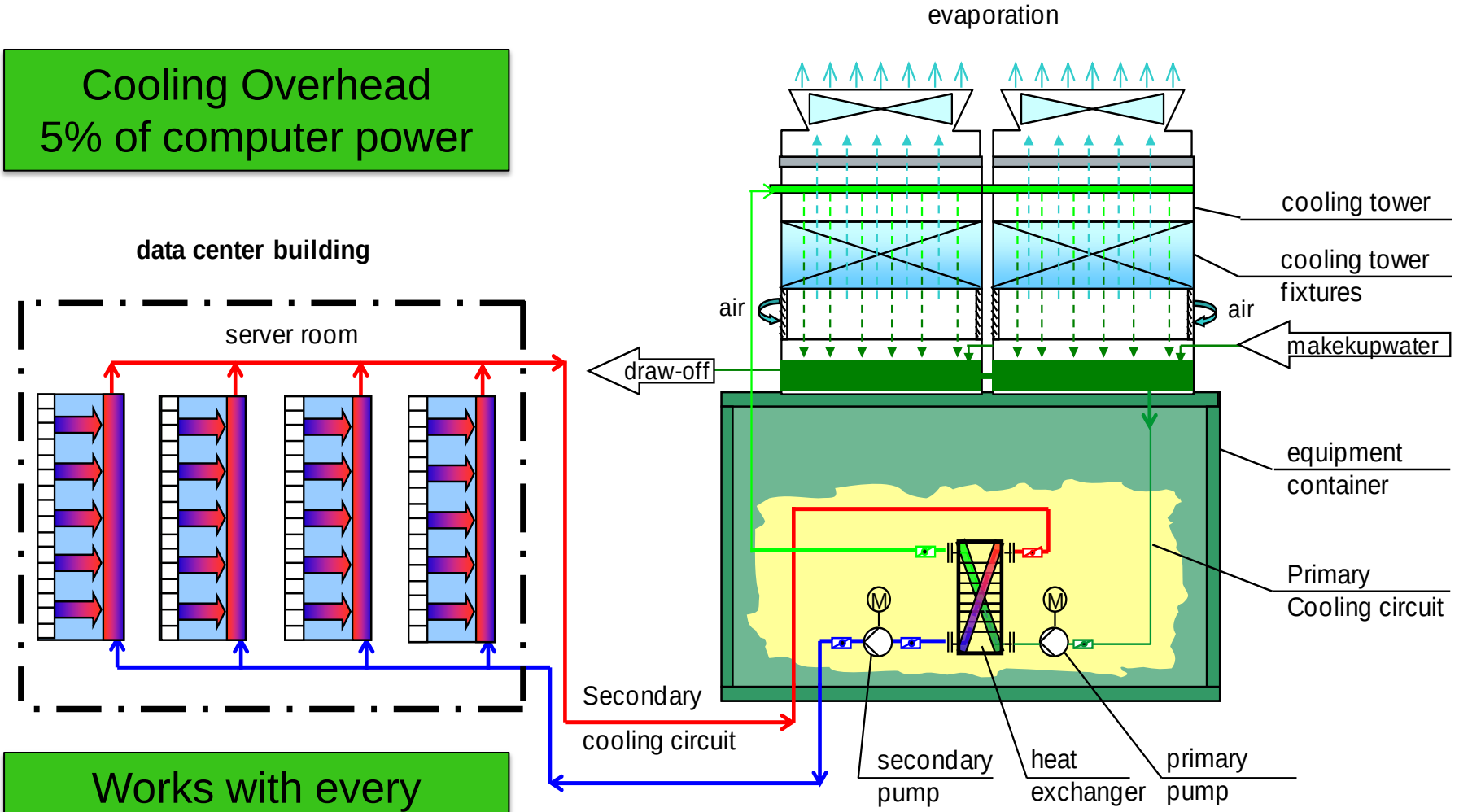
(typical PUE = 1,6 to 3,5)

Note: 12C/kWh → 1W = 1,05€/a

Source: EYP Mission Critical Facilities Inc., New York

Innovative Cooling System Architecture

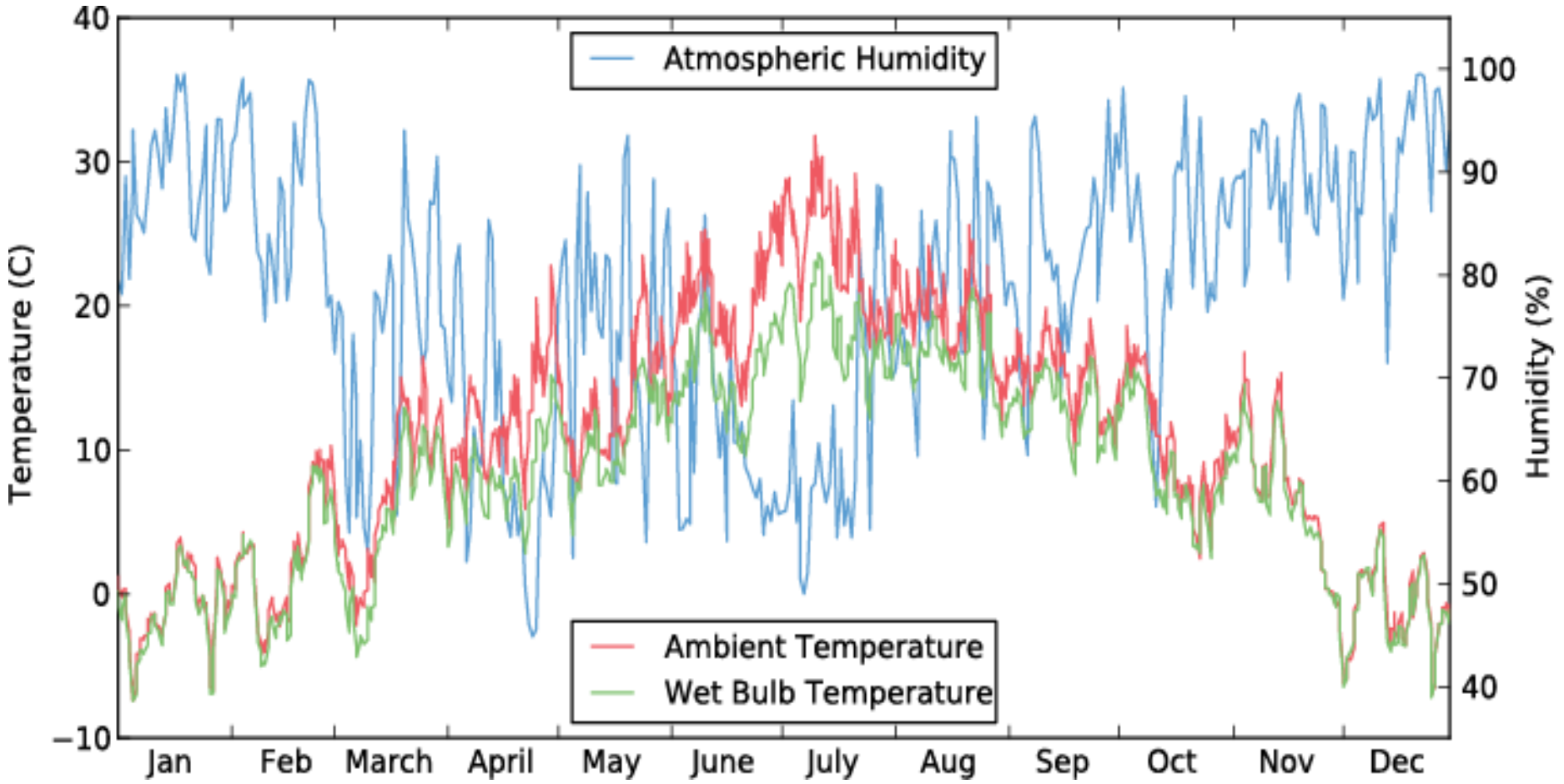
Cooling Overhead
5% of computer power

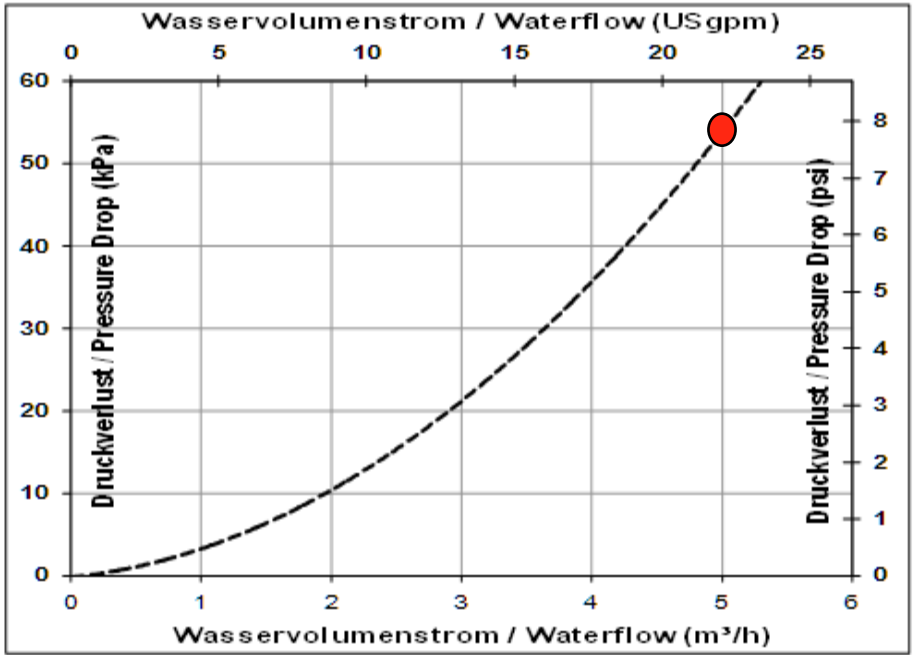


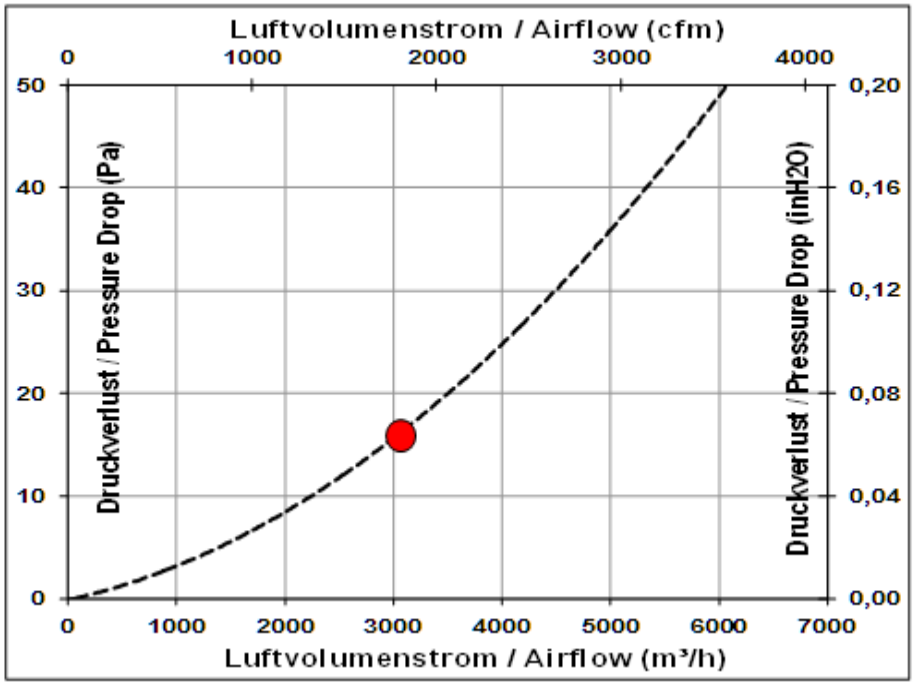
Works with every
commercial computer

Volker Lindenstruth (www.compeng.de) 30. März 2015— Copyright ©, Goethe Uni, alle Rechte vorbehalten

Wet bulb temperature 2010



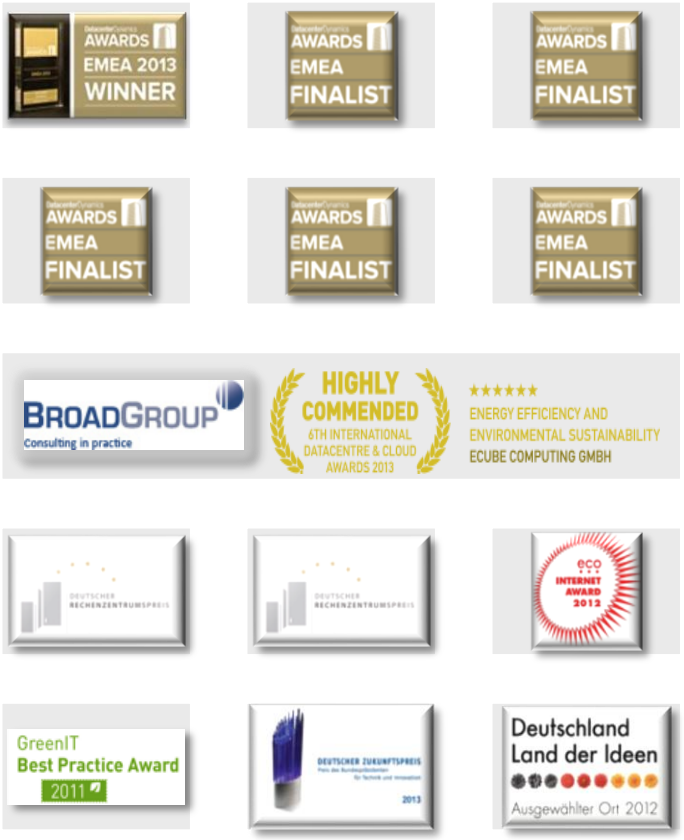




knürr
environments for electronics

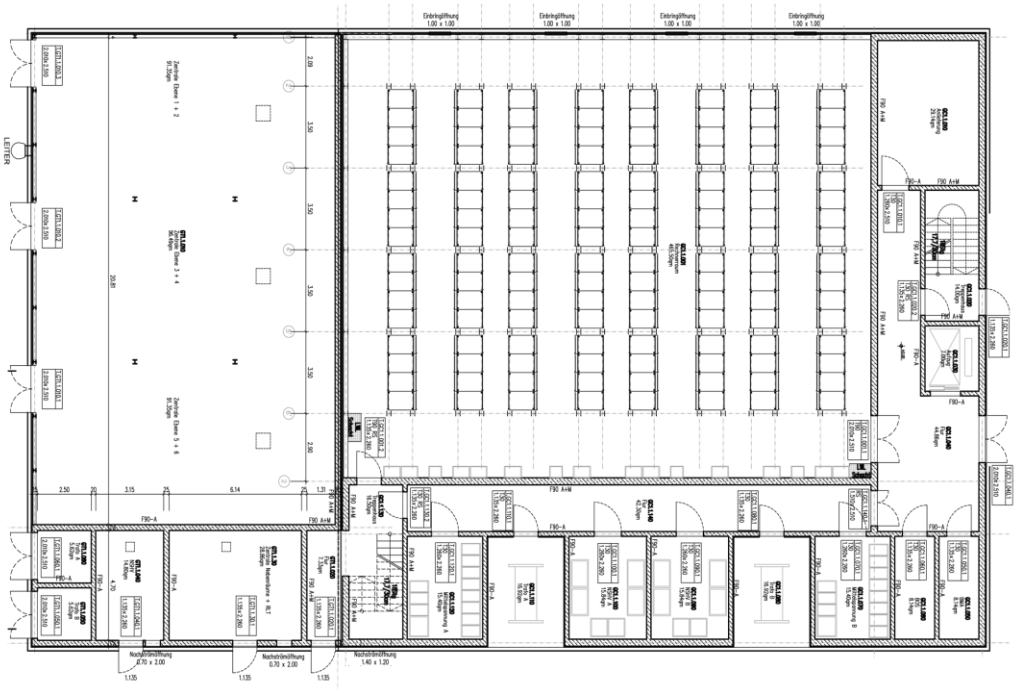
Heiko Ebermann

Prizes



- **Green-IT Award Bundesregierung „Visionäre Gesamtkonzepte“**
- **Deutscher Rechenzentrumpreis 2012 – energy efficiency**
- **Deutscher Rechenzentrumspreis 2013 – Visionary Datacenter Architecture**
- **Nominated for Deutscher Rechenzentrumspreis 2014 – energy efficency**
- **DataCenterDynamics EMEA Award 2013 – Data Center Blueprint**
- **BroadGroup EMEA Awards Special Commendation – Energy Efficiency**
- **„Land der Ideen“2012 for LOEWE-CSC**
- ***Green Cube* Project of the Month, BMBF**
- **5 Nominations with 4 ranks at Data Center Dynamics EMEA Awards – 2011, 2012, 2013**
- **2nd rank at Deutsche Internet Awards 2012**

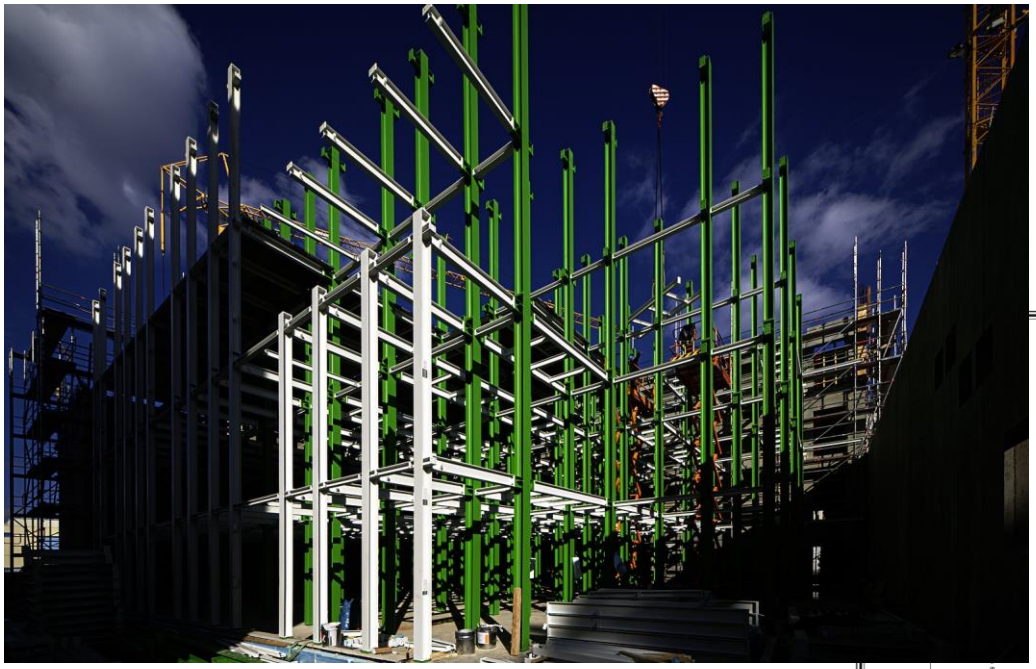
The FAIR Data Center (Green Cube)

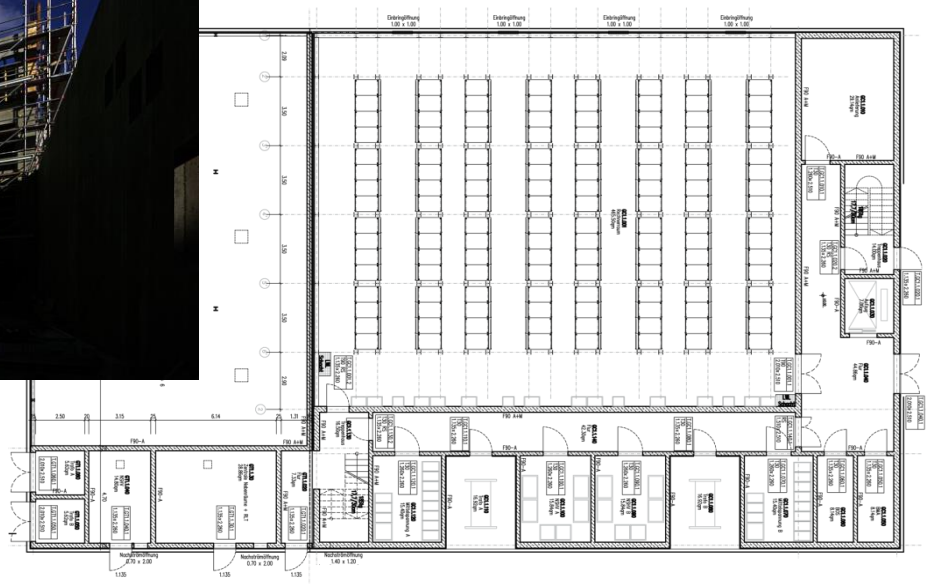


- Space for 768 19” racks (2,2m)
- 4 MW cooling (baseline)
- Max cooling power 12 MW
- Fully redundant (N+1)

- Can be used for any commercial IT
- No battery backup required
- PUE <1.07
- Baseline building cost 12 M€

Green Cube





Construction started in Dec 2014
On schedule for start of operation in Q4/2015

Green Cube

Green Cube Prototype

Two floor prototype in “Testinghalle” @ GSI

Home of current GSI Computing Systems

GSI Scientific Computing Systems

Compute clusters

Prometheus ~10.000 cores

Kronus ~4.000 cores + HT

L-CSC ~3.000 cores
+ 4 GPUs/node (AMD S9150/S10000)

Storage systems

Hera ~7 PByte netto (Lustre)

Nyx ~5 PByte netto (Lustre)

x2 by end of year

Used for FAIR&GSI Experiments, ALICE Tier2 & National Analysis Facility, Theory

GSI Scientific Computing Systems

Compute clusters

Prometheus ~10.000 cores

Kronus ~4.000 cores + HT

L-CSC ~3.000 cores

+ 4 GPUs/node (AMD S9150/S10000)

Storage systems

Hera ~7 PByte netto (Lustre)

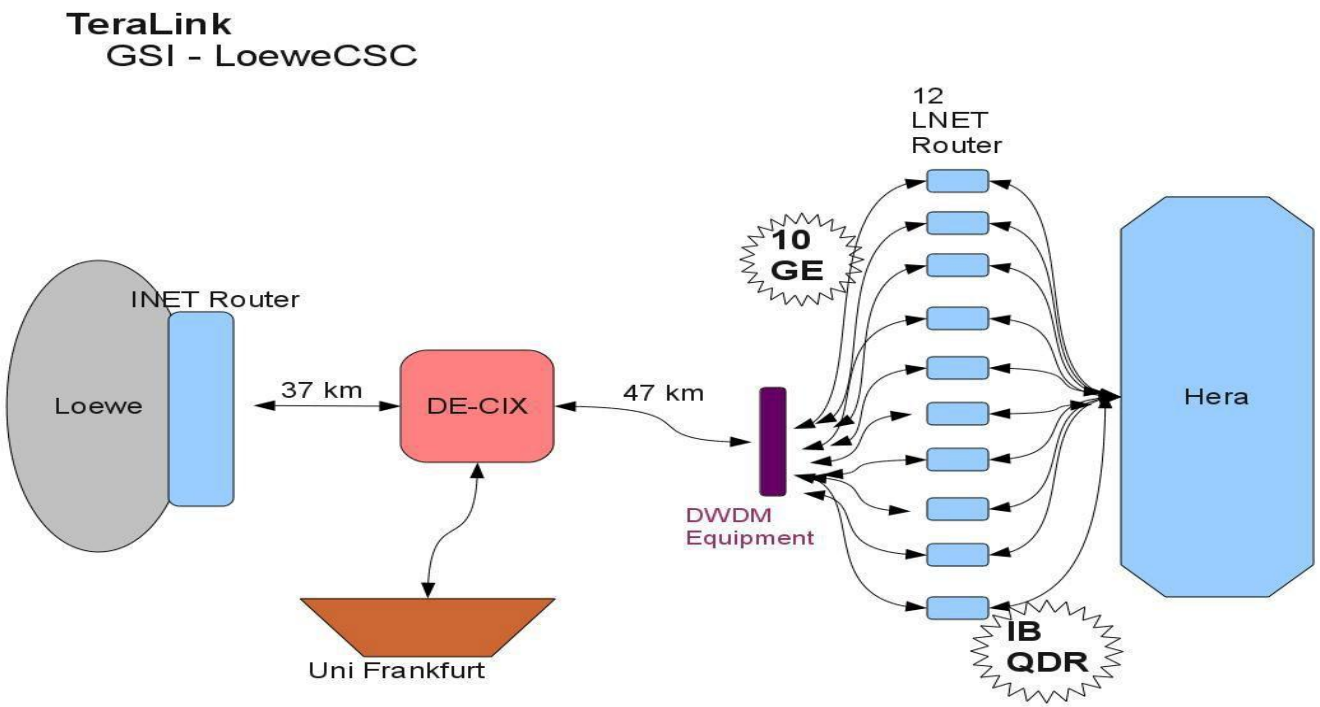
Nyx ~5 PByte netto (Lustre)

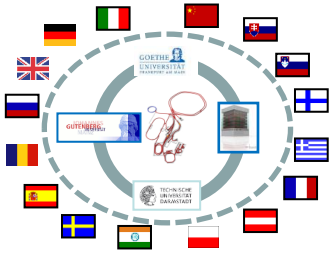
#1 in
Green 500 list
(Nov 2014)
5,27 GFLOPS/W

x2 by end of year

Used for FAIR&GSI Experiments, ALICE Tier2 & National Analysis Facility, Theory

TeraLink



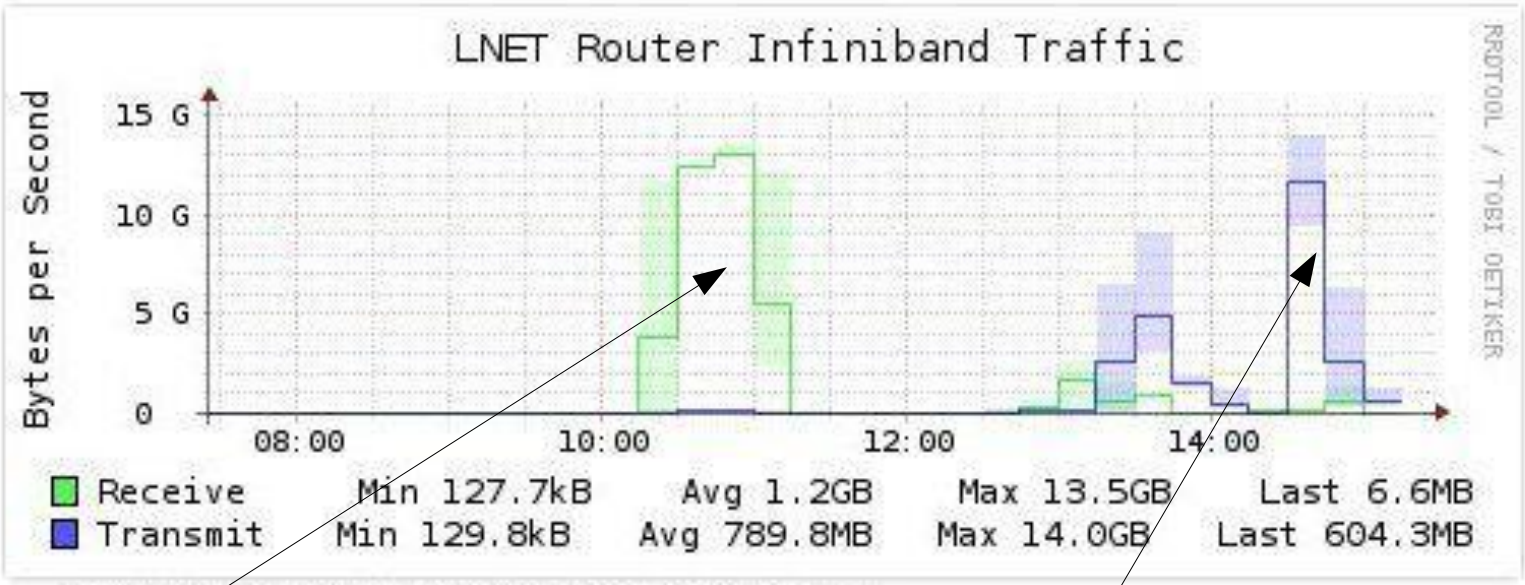


Tight integration of LOEWE-CSC Computing Center in Frankfurt (~30km away; 84km in fibres)

- Router cluster (LNET) for the TeraLink
  12 x 10 Gbit Ethernet => lustre IB loadbalancing

TeraLink

lustre clients at Gauss Supercomputer Frankfurt
Hera lustre cluster at GSI



Reading: 13.5 GB/s

Writing: 14GB/s

Offloading of jobs to Frankfurt, opportunistic resource usage
Additional storage system for selected users in Frankfurt

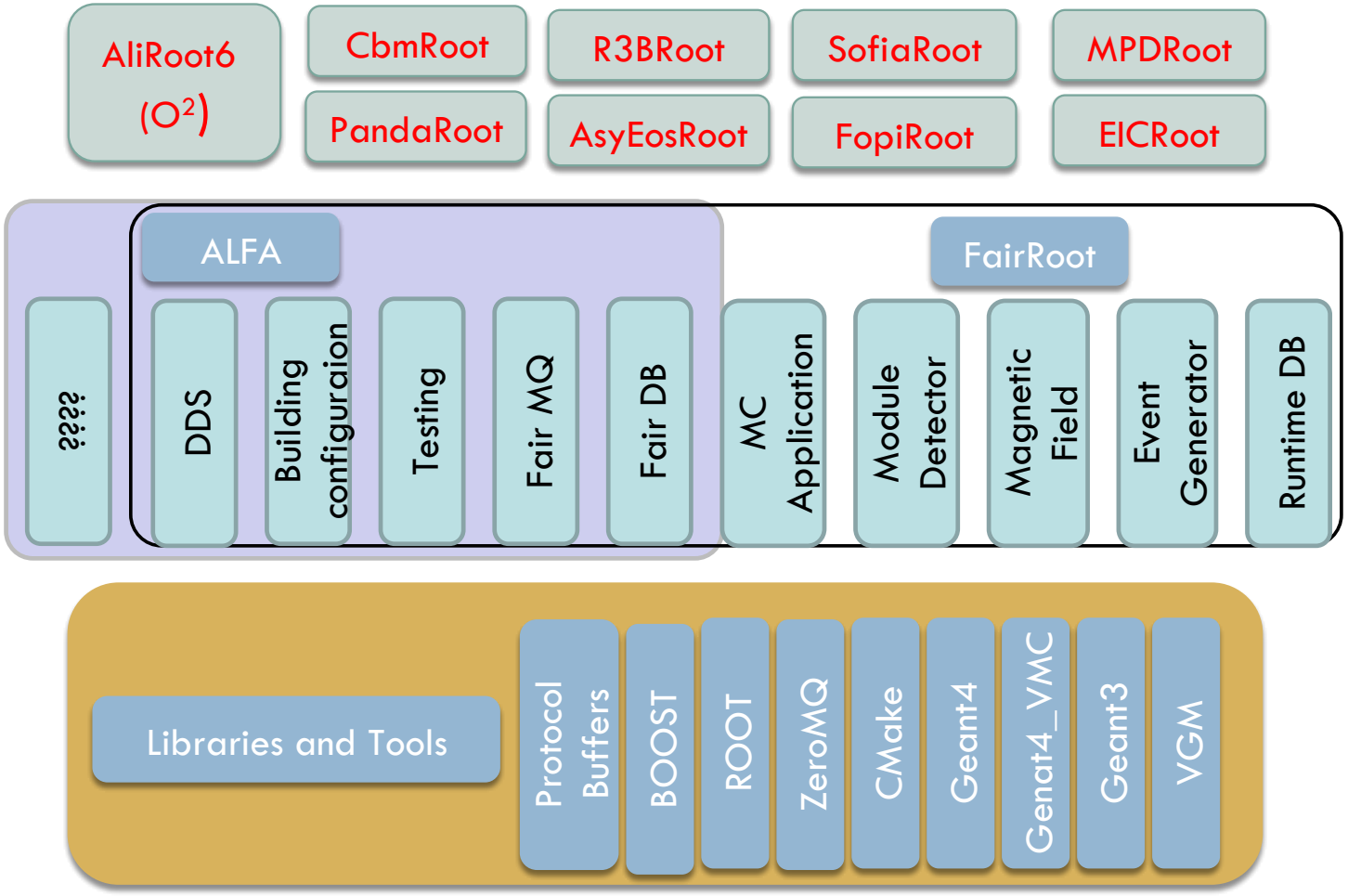
Software Stack

FairRoot

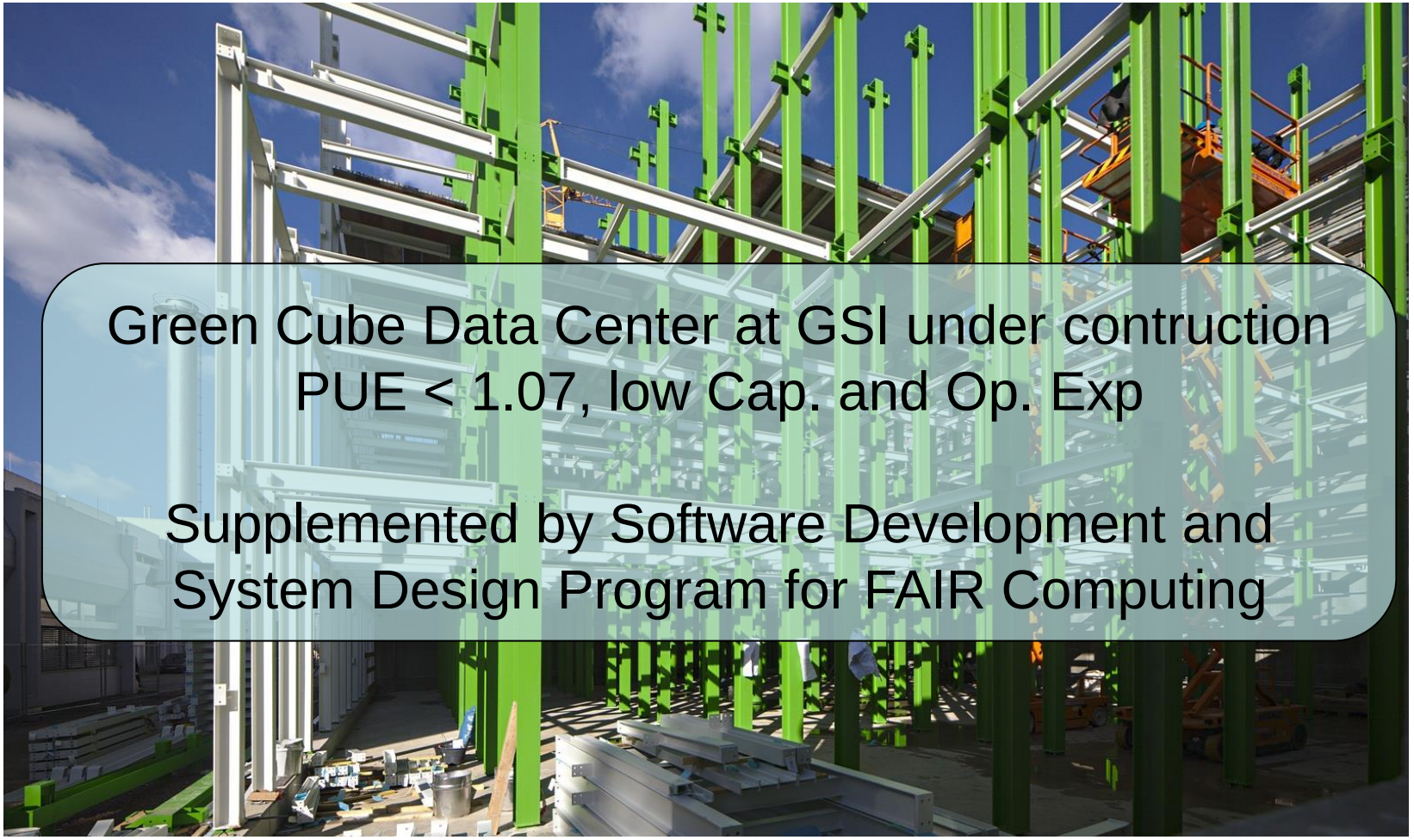
Common Software Framework for Simulation,
Reconstruction and Analysis for the FAIR Experiments

https://github.com/FairRootGroup/FairRoot

FairRoot and ALFA



Summary


Green Cube Data Center at GSI under contruction
PUE < 1.07, low Cap. and Op. Exp
Supplemented by Software Development and
System Design Program for FAIR Computing