

Green|TCube

The new data center for FAIR & GSI

Jan Trautmann

GSI Darmstadt

HEPiX Spring 2016



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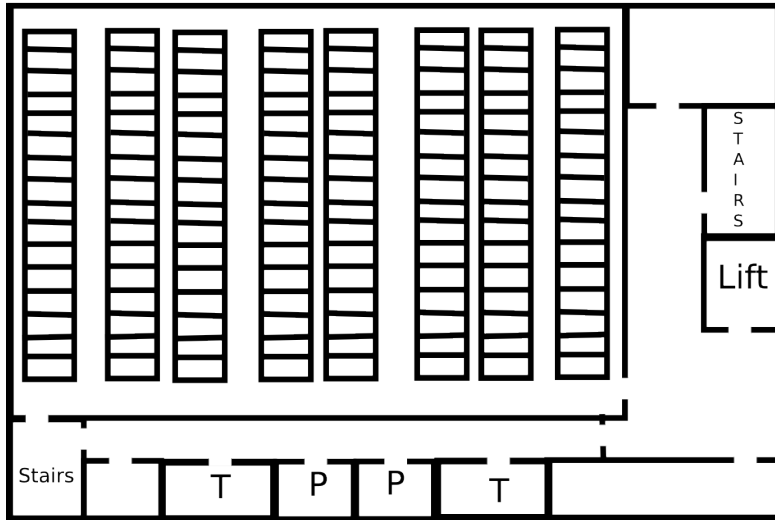
Starting



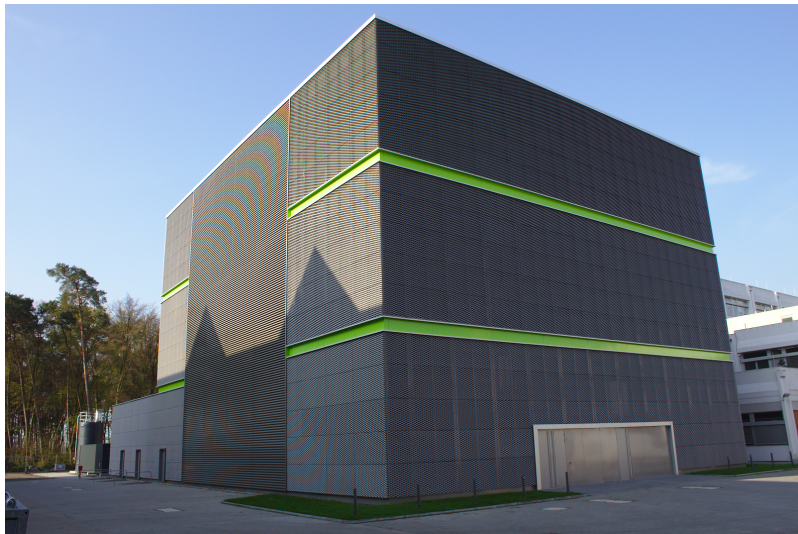
Going on



floor plan



Finally



Finally



Inside



Inside



Building

- 27*30 meters, height 22 meters - nearly a cube :-)
- 6 floors with 128 racks each
- only level 5+6 in use now
- 2225m³ concrete
- 480t steel
- building for cooling infrastructure attached in the south
- Costs including technical infrastructure:
11.5 million euro / 16 million euro for all floors
- Construction started December 2014, opening ceremony was January 2016
- First clusters running March 2016



Energy

- Two independent power supplies
 - 8 rows equipped redundant
 - 4 rows only Power A
 - 4 rows only Power B
- possible to switch to only one supply manually
- In the data center: power cables on top of the racks

Transformers



Jan Trautmann (GSI Darmstadt)



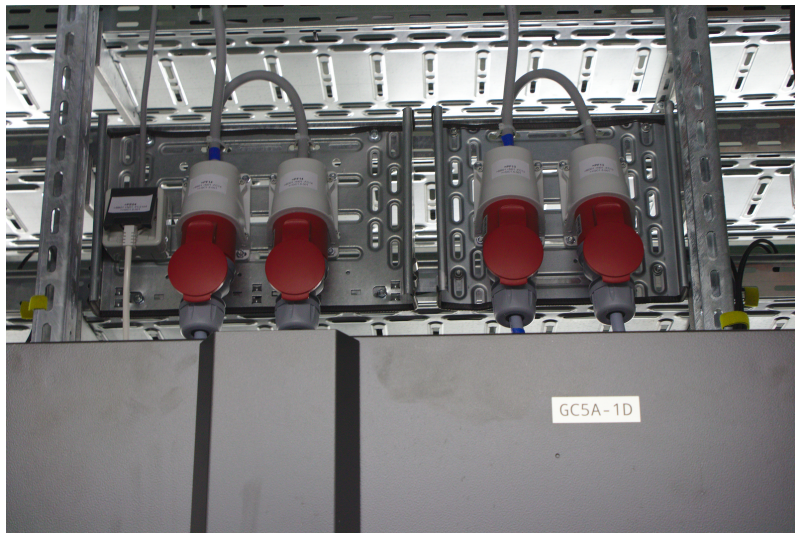
Green|TCube

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Energy



Energy



Cooling

- cooling is placed in separate building (GT1)
- 2 circuits
 - closed circuit: racks \rightleftharpoons heat exchangers in GT1
 - open circuit: heat exchangers in GT1 \rightleftharpoons free fall water towers
- 1300m³/h water moved in closed circuit
- pumps, heat-exchangers, cooling tower: n+1 redundancy
- heat is used for heating the new office&cantine building
- In the data center: tubes located in the corridors

Cooling



Cooling



Cooling



Cooling



Heating new office building



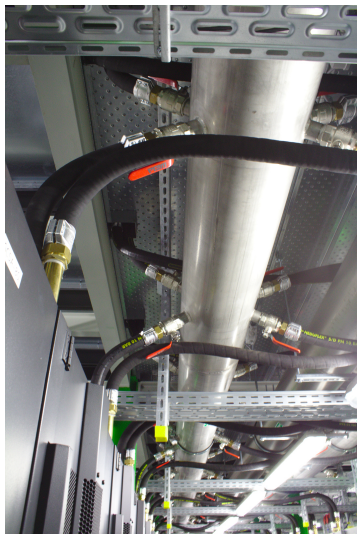
bringing water to the rack



bringing water to the rack



bringing water to the rack



Racks

- Emerson Knürr DCD racks
- Passive rear-door heat-exchanger up to 35kW
- no additional fans - only fans inside the servers
- 220*80*120cm (H*W*D), 47 U
- Bought completely equipped with PDUs, cable reels, ...
- PDU:
 - Sensors for humidity and temperature
 - independent network for PDUs
 - Used for: Monitoring, Alarming, Emergency shut off
 - 2 PDUs in racks with redundant power -> PDU Array
 - SNMP problems -> investigating together with Emerson



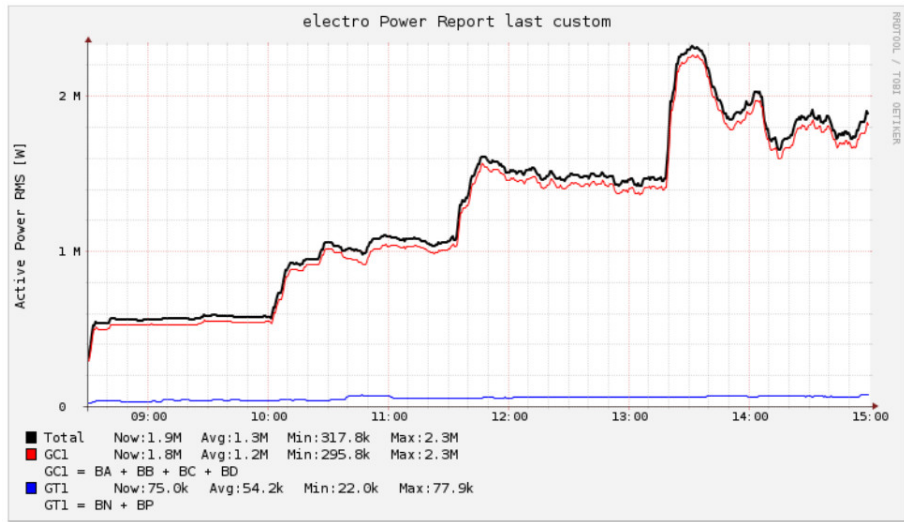
Racks



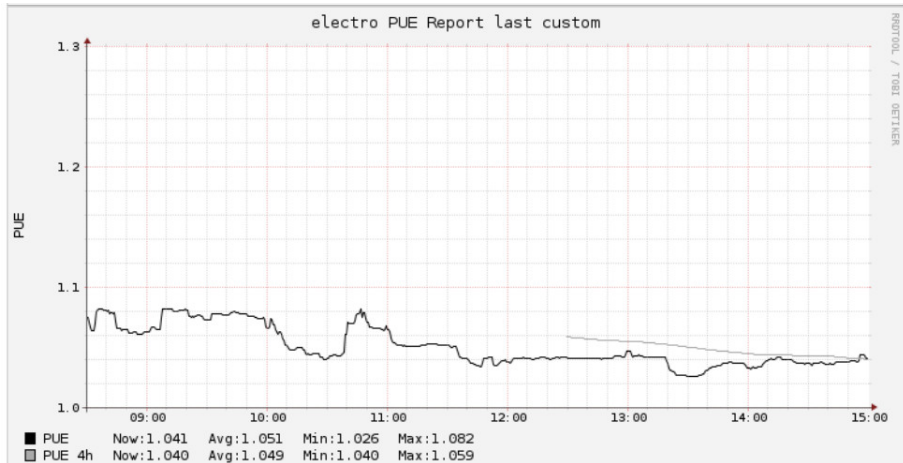
Testing the Cube

- Installed fan heater in each rack
- fan heaters used stable with 10kW -> 2.5MW reached
- PUE measured during test < 1.1
- Fan heaters used for intensive PDU testing, too

bringing water to the rack



bringing water to the rack



Migration

- What was moved?
 - Nyx - 7.1 PB Lustre FS (11 racks)
 - Kronos - 4000 Cores CPU cluster (3 racks)
 - L-CSC - GPU cluster (8 racks)
 - in addition service machines, gateways, ...
- Will add new machines during this year
- AND of course more services will move to the Cube



Steps

- planing everything in detail (long time)
- preparing network before (3 weeks)
- moving itself & in-rack cabeling (1 week)
- checking the systems (2 days)
- bring everything online (1 day)
- moving itself was done by external company
- everything else by GSI employes beside normal work, mostly HPC people
- only 3 of 460 servers damaged/didn't start



Combining FS & Compute

- Advantages
 - perfectly filling up IB switch
 - optimised usage of power capacity



What is monitored?

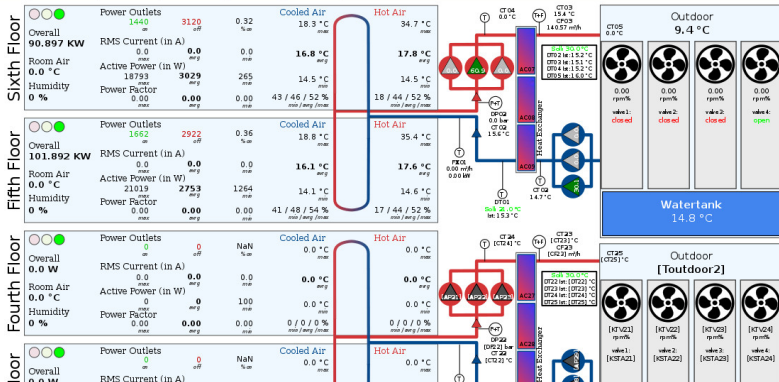
- racks (temperature and humidity)
- infrastructure (cooling and energy)
- data of infrastructure directly collected from different system controls
- At the moment collecting as much as possible
- ToDo: Learn, which parameters are relevant and create reports



Live-Monitoring

☐ auto-refreshing ☒ auto-refresh

GSI Greencube Monitoring - beta v0.1



Live-Monitoring

auto-refreshing

☒ auto-refresh

GSI Greencube

POU Name: G06A-19

ganglia: pdu-g06a-19-info: pdu-g06a-19

Ganglia: ganglia, link

POU1 MAC: 00:02:99:16:08:18

POU2 MAC: 00:02:99:16:07:44

Last Update: 19.04.2016 14:35:33

Outlets ON: 48

Outlets OFF: 0

RMS Current (A): 0.0

Active Power (W): 8795.0

Power Factor: 0.33

Backdoor Sensors: Outside Inside

Top (°C): 19.3 34.8

Middle (°C): 17.8 33.7

Bottom (°C): 18.3 35.9

Humidity (%): 52 20

Status: Normal

Status: Norm

Status: Norm

Status: Norm

Overview

First Floor

Second Floor

Third Floor

Fourth Floor

Fifth Floor

Sixth Floor

G06A-1F

48 w 0 w

19.3 °C 17.4 °C

50 % 55 %

Status: Norm

G06A-1E

48 w 0 w

18.8 °C 18.2 °C

52 % 55 %

Status: Norm

G06A-1D

48 w 0 w

18.6 °C 18.3 °C

53 % 54 %

Status: Norm

G06A-1C

48 w 0 w

16.6 °C 35.2 °C

57 % 25 %

Status: Norm

G06A-1B

48 w 0 w

3992 w 4261 w

17.0 °C 32.5 °C

56 % 24 %

Status: Norm

G06A-1A

48 w 0 w

4250 w 8795 w

17.3 °C 35.3 °C

57 % 21 %

Status: Norm

G06A-19

48 w 0 w

18.3 °C 35.9 °C

52 % 20 %

Status: Norm

G06A-15

48 w 0 w

8389 w 8660 w

18.9 °C 36.1 °C

52 % 21 %

Status: Norm

G06A-14

48 w 0 w

0.0 °C 0.0 °C

NaN % NaN %

Status: Off

G06A-13

48 w 0 w

18.0 °C 38.1 °C

53 % 21 %

Status: Norm

G06A-12

48 w 0 w

9976 w 9024 w

18.8 °C 37.3 °C

52 % 21 %

Status: Norm

G06A-11

48 w 0 w

9024 w 9027 w

18.9 °C 35.7 °C

52 % 20 %

Status: Norm

G06A-10

48 w 0 w

19.2 °C 38.3 °C

18.9 °C 35.7 °C

52 % 21 %

Status: Norm

G06A-2F

48 w 0 w

18.9 °C 19.4 °C

53 % 49 %

Status: Norm

G06A-2E

48 w 0 w

17.7 °C 19.8 °C

54 % 51 %

Status: Norm

G06A-2D

48 w 0 w

17.7 °C 19.6 °C

54 % 51 %

Status: Norm

G06A-2C

48 w 0 w

17.8 °C 18.1 °C

53 % 55 %

Status: Norm

G06A-2B

48 w 0 w

18.3 °C 18.4 °C

51 % 56 %

Status: Norm

G06A-2A

48 w 0 w

18.8 °C 17.4 °C

50 % 56 %

Status: Norm

G06A-29

48 w 0 w

18.9 °C 16.8 °C

49 % 57 %

Status: Norm

G06A-25

48 w 0 w

19.1 °C 16.9 °C

49 % 57 %

Status: Norm

G06A-24

48 w 0 w

19.3 °C 16.6 °C

49 % 57 %

Status: Norm

G06A-23

48 w 0 w

18.9 °C 16.9 °C

50 % 57 %

Status: Norm

G06A-22

48 w 0 w

18.8 °C 16.6 °C

50 % 57 %

Status: Norm

G06A-21

48 w 0 w

18.8 °C 17.2 °C

49 % 57 %

Status: Norm

G06A-20

48 w 0 w

18.9 °C 16.8 °C

50 % 56 %

Status: Norm

G06A-3F

48 w 0 w

19.0 °C 18.5 °C

50 % 51 %

Status: Norm

G06A-3E

48 w 0 w

18.8 °C 18.4 °C

50 % 51 %

Status: Norm

G06A-3D

48 w 0 w

18.9 °C 18.4 °C

49 % 51 %

Status: Norm

G06A-3C

48 w 0 w

19.0 °C 18.5 °C

50 % 51 %

Status: Norm

G06A-3B

48 w 0 w

18.9 °C 18.4 °C

48 % 51 %

Status: Norm

G06A-3A

48 w 0 w

18.9 °C 18.5 °C

50 % 51 %

Status: Norm

G06A-39

48 w 0 w

18.6 °C 18.5 °C

50 % 50 %

Status: Norm

G06A-38

48 w 0 w

19.3 °C 19.6 °C

49 % 49 %

Status: Norm

G06A-37

48 w 0 w

18.8 °C 19.0 °C

50 % 49 %

Status: Norm

G06A-36

48 w 0 w

18.7 °C 18.8 °C

50 % 49 %

Status: Norm

G06A-35

48 w 0 w

18.5 °C 19.0 °C

50 % 49 %

Status: Norm

G06A-34

48 w 0 w

19.5 °C 18.5 °C

51 % 49 %

Status: Norm

G06A-33

48 w 0 w

18.6 °C 19.0 °C

50 % 49 %

Status: Norm

G06A-32

48 w 0 w

18.8 °C 18.8 °C

50 % 50 %

Status: Norm

G06A-31

48 w 0 w

18.8 °C 18.8 °C

50 % 50 %

Status: Norm

G06A-30

48 w 0 w

18.9 °C 18.8 °C

50 % 49 %

Status: Norm

G06A-4F

48 w 0 w

19.0 °C 19.0 °C

51 % 51 %

Status: Norm

G06A-4E

48 w 0 w

18.8 °C 18.7 °C

50 % 51 %

Status: Norm

G06A-4D

48 w 0 w

19.0 °C 18.4 °C

49 % 50 %

Status: Norm

G06A-4C

48 w 0 w

18.9 °C 18.8 °C

50 % 50 %

Status: Norm

G06A-4B

48 w 0 w

18.6 °C 18.6 °C

48 % 50 %

Status: Norm

G06A-4A

48 w 0 w

18.8 °C 18.4 °C

50 % 51 %

Status: Norm

G06A-49

48 w 0 w

18.5 °C 18.5 °C

49 % 51 %

Status: Norm

G06A-48

48 w 0 w

18.5 °C 18.5 °C

49 % 51 %

Status: Norm

G06A-47

48 w 0 w

18.9 °C 18.4 °C

49 % 52 %

Status: Norm

G06A-46

48 w 0 w

18.7 °C 18.4 °C

50 % 51 %

Status: Norm

G06A-45

48 w 0 w

18.8 °C 18.2 °C

50 % 51 %

Status: Norm

G06A-44

48 w 0 w

18.6 °C 18.0 °C

50 % 51 %

Status: Norm

G06A-43

48 w 0 w

18.7 °C 18.6 °C

50 % 51 %

Status: Norm

G06A-42

48 w 0 w

18.5 °C 17.9 °C

51 % 52 %

Status: Norm

G06A-41

48 w 9 w

19.0 °C 18.3 °C

50 % 52 %

Status: Norm

G06A-40

48 w 0 w

19.0 °C 18.5 °C

50 % 50 %

Status: Norm

G06A-5F

48 w 2 w

19.4 °C 19.3 °C

51 % 50 %

Status: Norm

G06A-5E

48 w 0 w

18.8 °C 18.4 °C

49 % 51 %

Status: Norm

G06A-5D

48 w 0 w

19.0 °C 18.0 °C

49 % 50 %

Status: Norm

G06A-5C

48 w 0 w

18.9 °C 18.5 °C

49 % 50 %

Status: Norm

G06A-5B

48 w 20 w

18.9 °C 18.7 °C

49 % 50 %

Status: Norm

G06A-5A

48 w 0 w

18.8 °C 18.9 °C

50 % 50 %

Status: Norm

G06A-59

48 w 0 w

18.6 °C 18.8 °C

49 % 50 %

Status: Norm

G06A-58

48 w 0 w

18.9 °C 19.4 °C

49 % 50 %

Status: Norm

G06A-57

48 w 0 w

19.0 °C 19.1 °C

49 % 50 %

Status: Norm

G06A-56

48 w 0 w

19.0 °C 19.0 °C

49 % 50 %

Status: Norm

G06A-55

48 w 9 w

18.9 °C 19.1 °C

50 % 49 %

Status: Norm

G06A-54

48 w 0 w

19.0 °C 19.1 °C

50 % 51 %

Status: Norm

G06A-53

48 w 0 w

19.0 °C 18.5 °C

50 % 51 %

Status: Norm

G06A-52

48 w 0 w

18.9 °C 18.6 °C

49 % 51 %

Status: Norm

G06A-51

48 w 0 w

18.9 °C 19.1 °C

49 % 51 %

Status: Norm

G06A-50

48 w 0 w

19.1 °C 18.6 °C

50 % 51 %

Status: Norm

G06A-6F

48 w 0 w

19.0 °C 19.0 °C

51 % 51 %

Status: Norm

G06A-6E

48 w 0 w

18.8 °C 18.4 °C

49 % 51 %

Status: Norm

G06A-6D

48 w 0 w

19.0 °C 18.0 °C

49 % 50 %

Status: Norm

G06A-6C

48 w 0 w

18.9 °C 18.5 °C

49 % 50 %

Status: Norm

G06A-6B

48 w 0 w

18.9 °C 18.7 °C

49 % 50 %

Status: Norm

G06A-6A

48 w 0 w

18.8 °C 18.9 °C

50 % 51 %

Status: Norm

G06A-69

48 w 0 w

18.6 °C 18.8 °C

49 % 50 %

Status: Norm

G06A-68

48 w 0 w

18.9 °C 19.4 °C

49 % 50 %

Status: Norm

G06A-67

48 w 0 w

19.0 °C 19.1 °C

49 % 50 %

Status: Norm

G06A-66

48 w 0 w

19.0 °C 19.0 °C

49 % 50 %

Status: Norm

G06A-65

48 w 0 w

18.9 °C 19.1 °C

50 % 51 %

Status: Norm

G06A-64

48 w 0 w

19.0 °C 19.1 °C

50 % 51 %

Status: Norm

G06A-63

48 w 0 w

19.0 °C 18.5 °C

50 % 51 %

Status: Norm

G06A-62

48 w 0 w

18.9 °C 18.6 °C

49 % 51 %

Status: Norm

G06A-61

48 w 0 w

18.9 °C 19.1 °C

49 % 51 %

Status: Norm

G06A-60

48 w 0 w

19.1 °C 18.6 °C

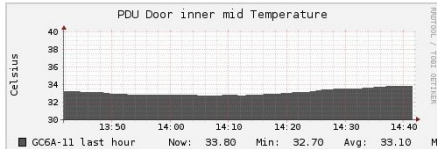
50 % 51 %

Status: Norm

Ganglia - racks

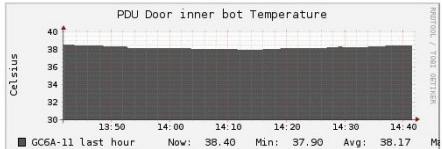
temperature_T2 - PDU Door inner mid Temperature

[+](#)
[CSV](#)
[JSON](#)
[Inspect](#)
[Trend](#)
[Hide/Show Events](#)
[Timeshift](#)



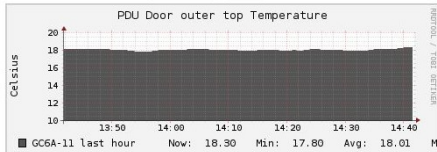
temperature_T4 - PDU Door inner bot Temperature

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[Timeshift](#)



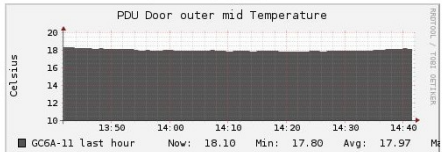
temperature_T5 - PDU Door outer top Temperature

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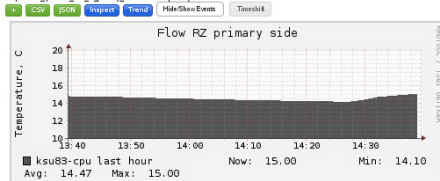
temperature_T6 - PDU Door outer mid Temperature

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[Trend](#)
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[Timeshift](#)

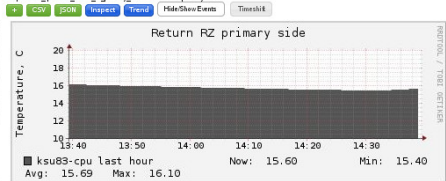


Ganglia - cooling

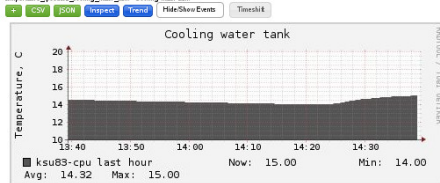
temperature_ip01cd02_flow_rz_primary_side - Flow RZ primary side



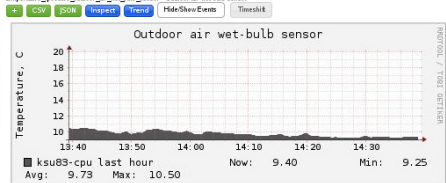
temperature_ip01cd02_return_rz_primary_side - Return RZ primary side



temperature_ip01cd01_cooling_water_tank - Cooling water tank



temperature_ip01cd05_outdoor_air_wet_bulb_sensor - Outdoor air wet bulb sensor



The End

- Thanks to
 - many many people at GSI for supporting this project
 - external partners

Questions?

