Control system for a 200 TW laser

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CFEL SCIENCE

LAOLA. is a collaboration of UHH DESY

LUX Junior Research group

Junior Research group at CFEL and Hamburg University

commission & operate 200 TW ANGUS laser system

build and operate the LUX beamline for laser-plasma driven undulator radiation

lux.cfel.de

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Andi Walker

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Paul

Manuel

Chris

Niels

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Spencer *

Irene (Prof. Grüner group, UHH))**

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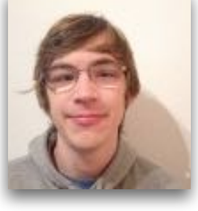


Sören

Henning

Philipp

* eli beamlines
also group Georg Korn

** UH
group Prof. Grüner

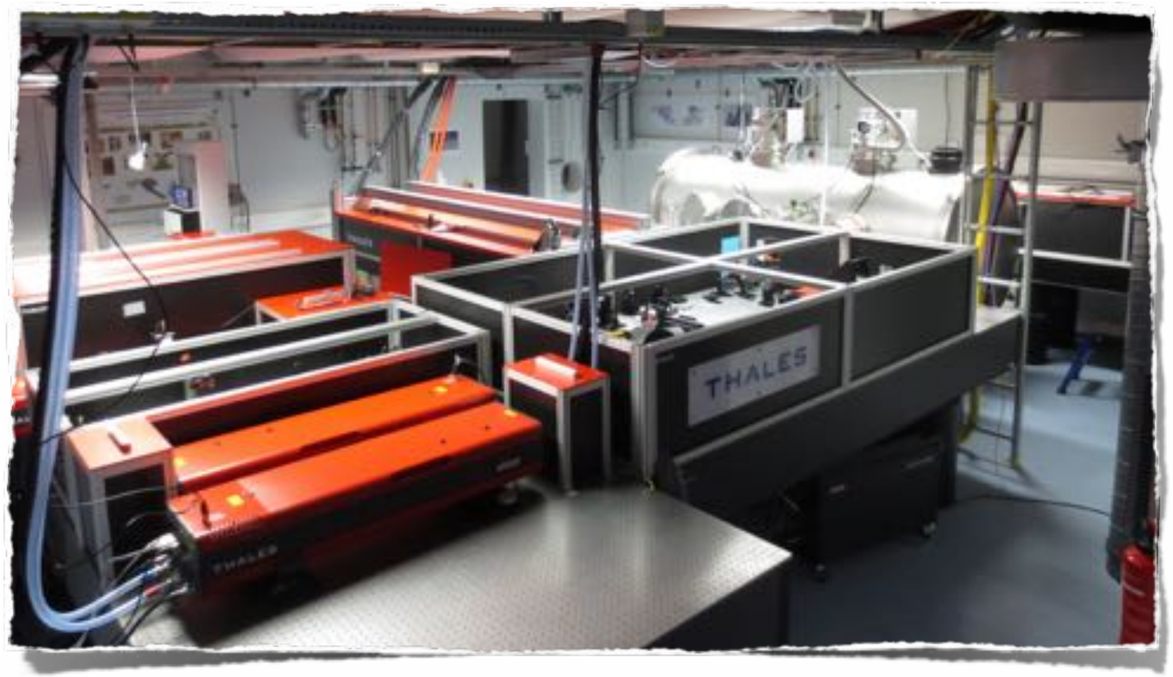
UH CFEL SCIENCE

Our goal

ANGUS parameters
- 200 TW
- 5 J, 25 fs, 5 Hz rep. rate

performance
- < 3 µrad rms pointing
- < 1 % rms energy stability
- strehl better 0.9

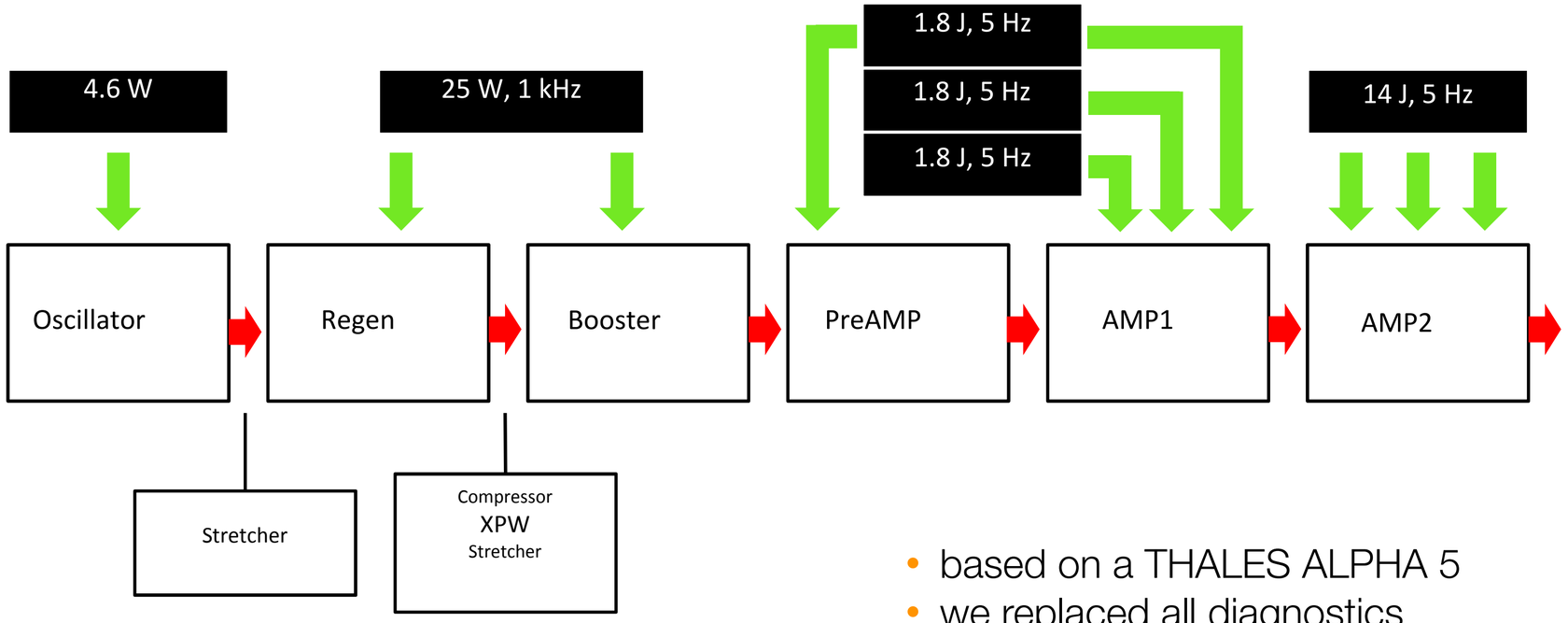
… so let's talk about
- availability
- stability
- reproducability



Availability - 7 Week Performance Test

… get some data

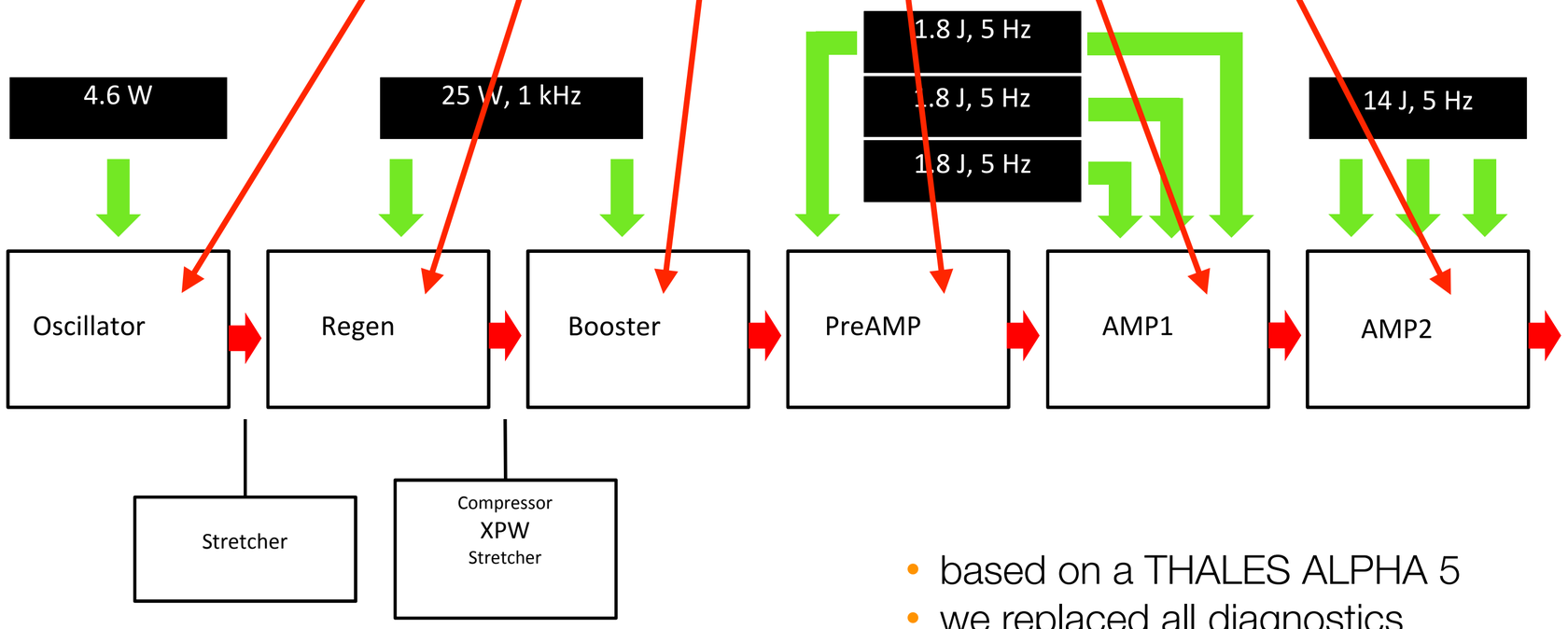
ANGUS



- based on a THALES ALPHA 5
- we replaced all diagnostics
- added many more diagnostics
- added active stabilization
- integrated to system into the accelerator controls system @ DESY

ANGUS

divide into subsystems… („boxes“)



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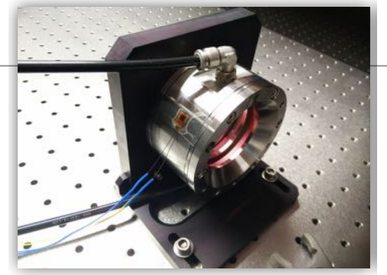
for each box…

temperatur at relevant points (crystals)



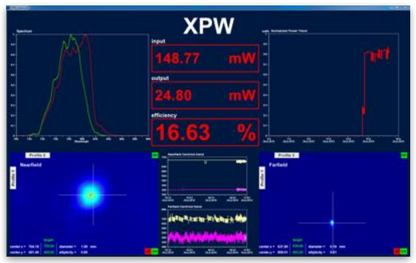
spectrum w/ reference

online energy (power) measurement w/ trend chart

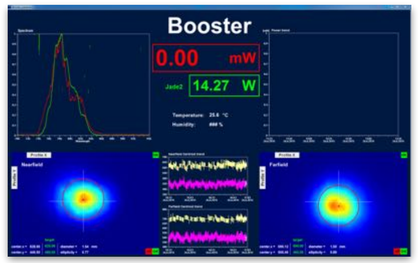
near- and farfield at the output

get centroids of NF/FF and display trend chart on laser position and direction

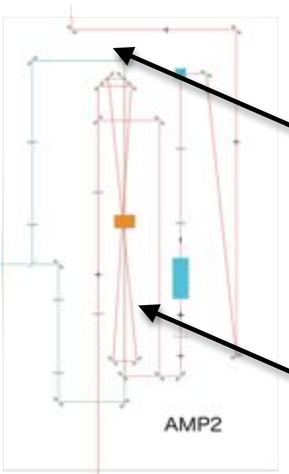
… the whole system …

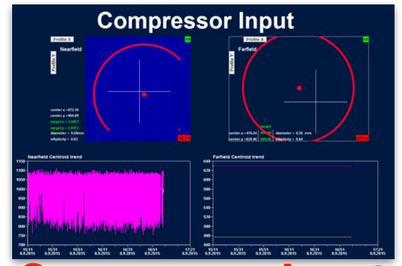


XPW

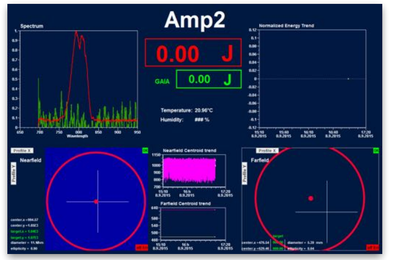


Booster

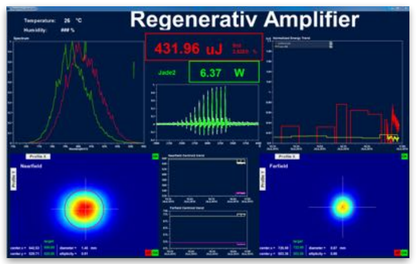




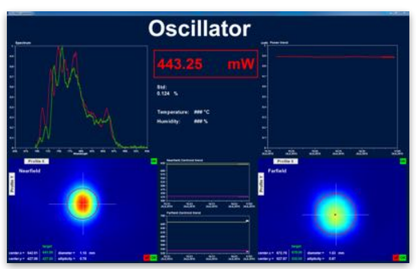
Compressor Input



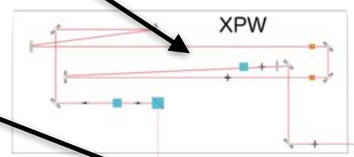
Amp2

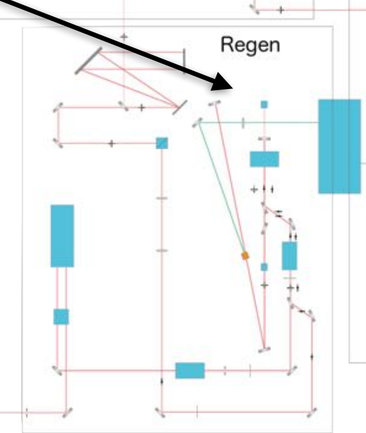


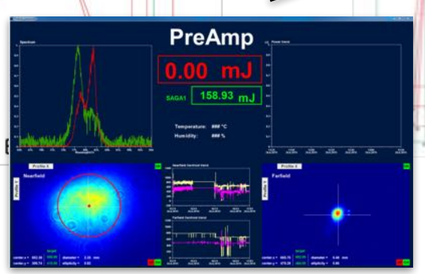
Regen



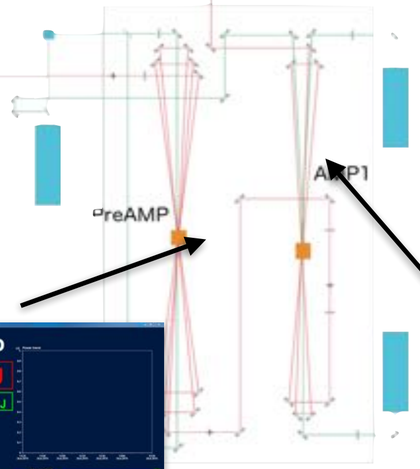
Oscillator

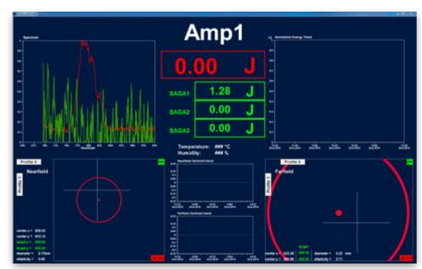






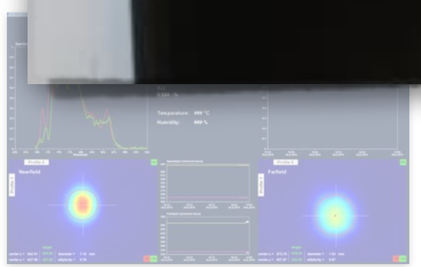
PreAmp



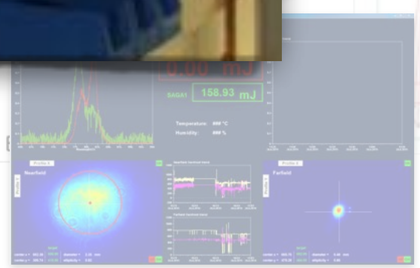


Amp1

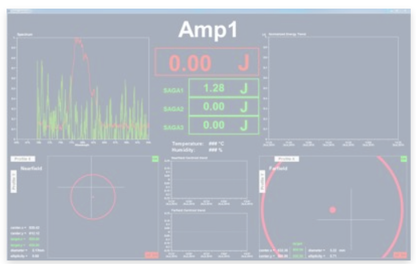
… and in real life.



Oscillator

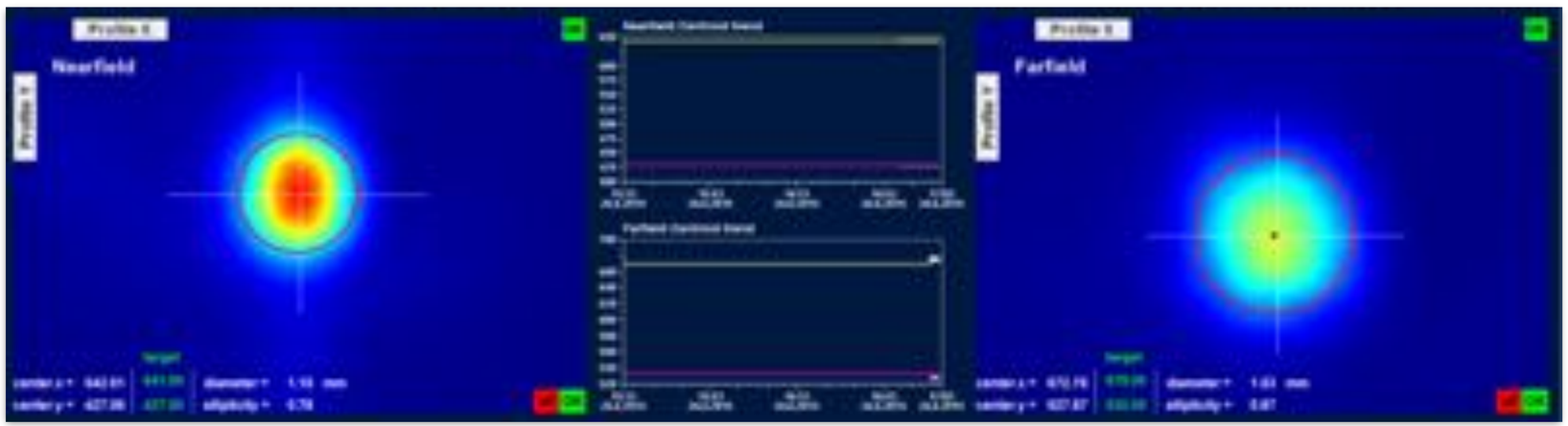


PreAmp

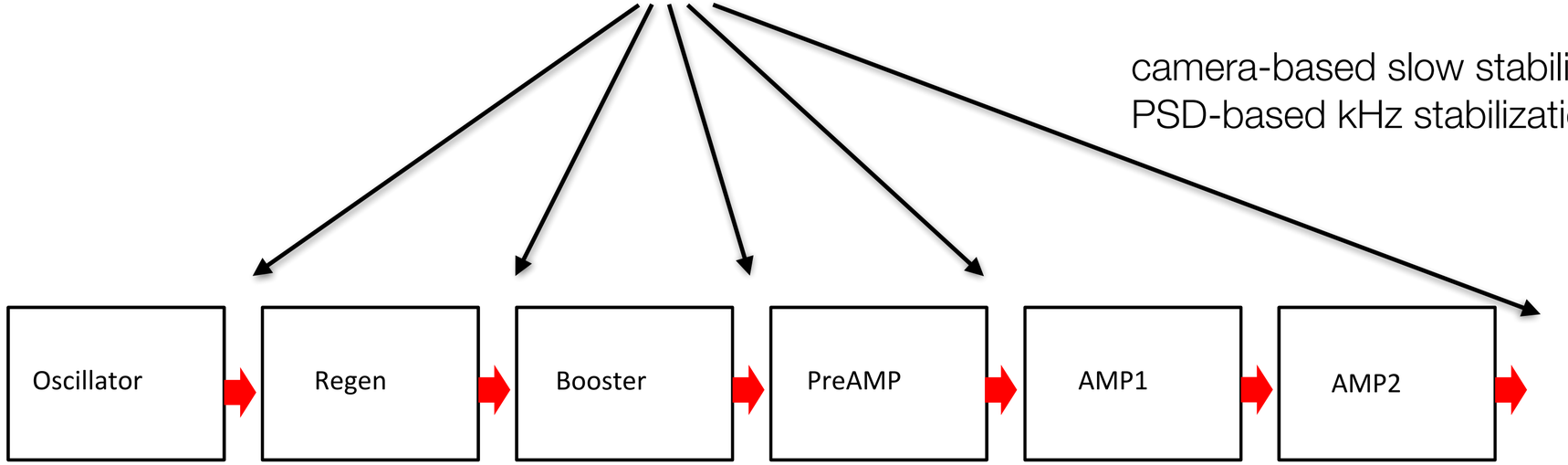


Amp1

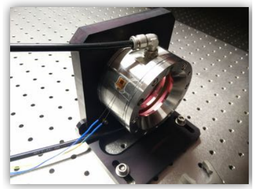
One more thing … beam stabilization



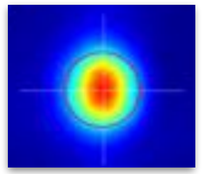
camera-based slow stabilization (drift)
PSD-based kHz stabilization



Everything goes in the Controls System

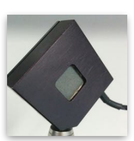


temperature



beam position,
centroids, size, …

spectrum

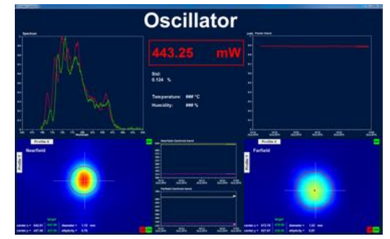


energy

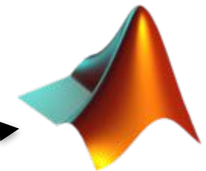
timestamp

data archive

communication



displays

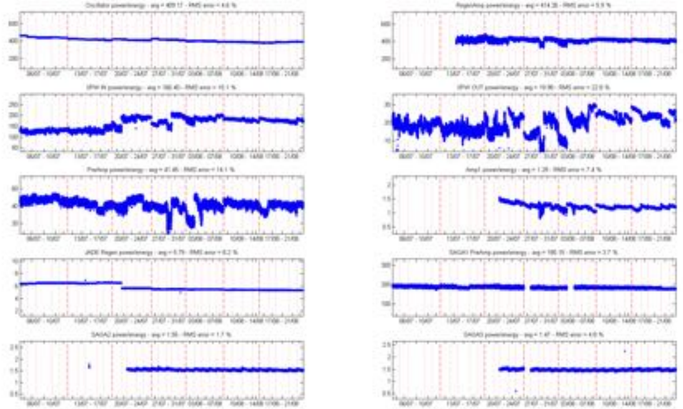


matlab console

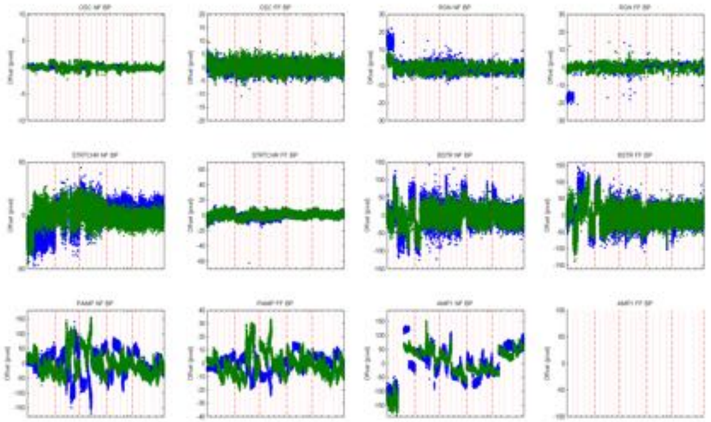
interface to python, C, …

We generate a lot of data…

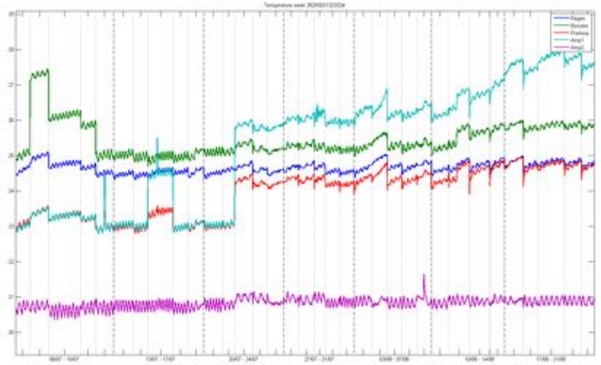
energy/power



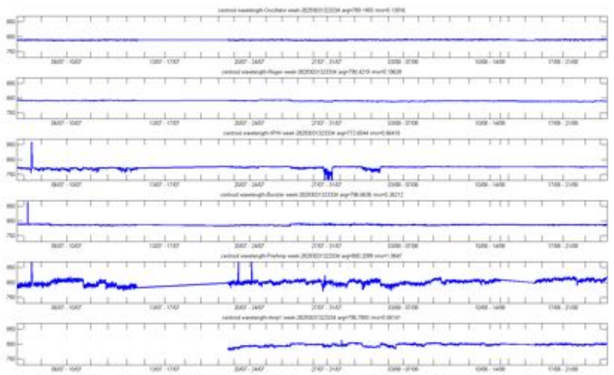
pointing



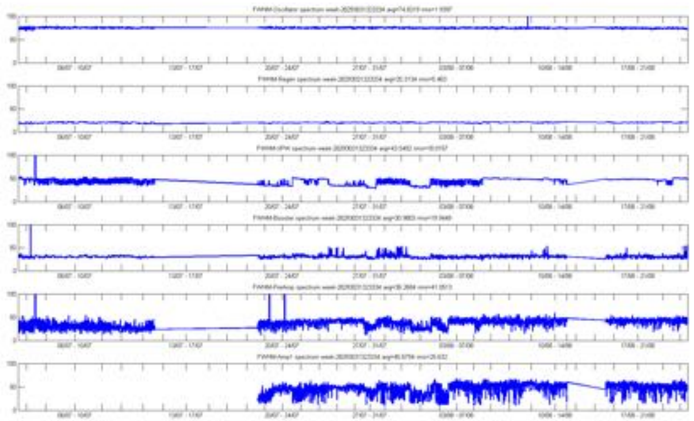
temperature



spectrum centroid



spectrum width

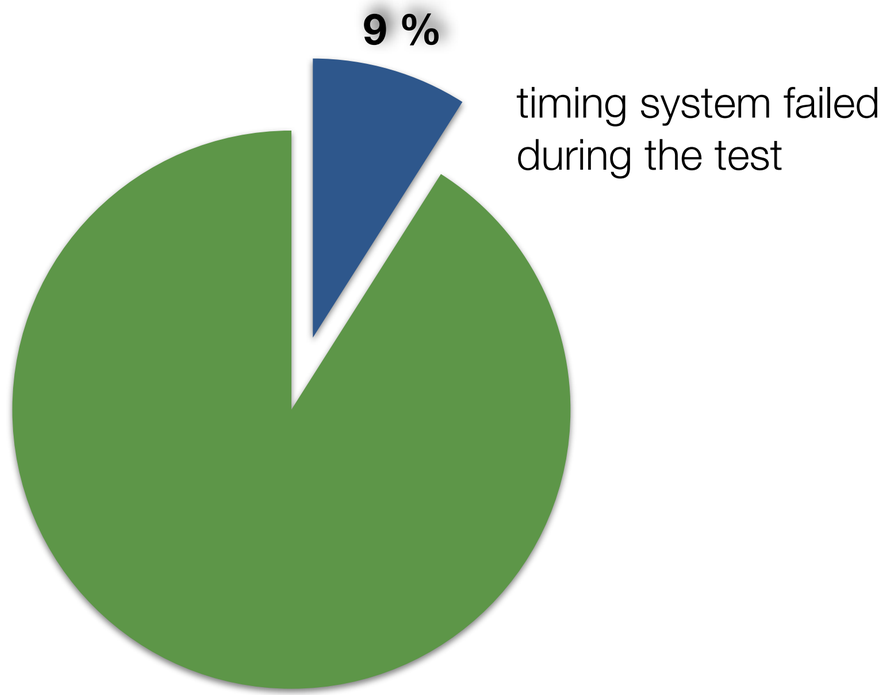


First Results

Availability - 7 Week Performance Test

- 7 weeks, 35 days
- turn on the system every day at 09.00 am
- let it run for two hours
- with all diagnostics channels getting data
- then use the laser…

- test does not include last pump laser
- identified timing system as a major problem



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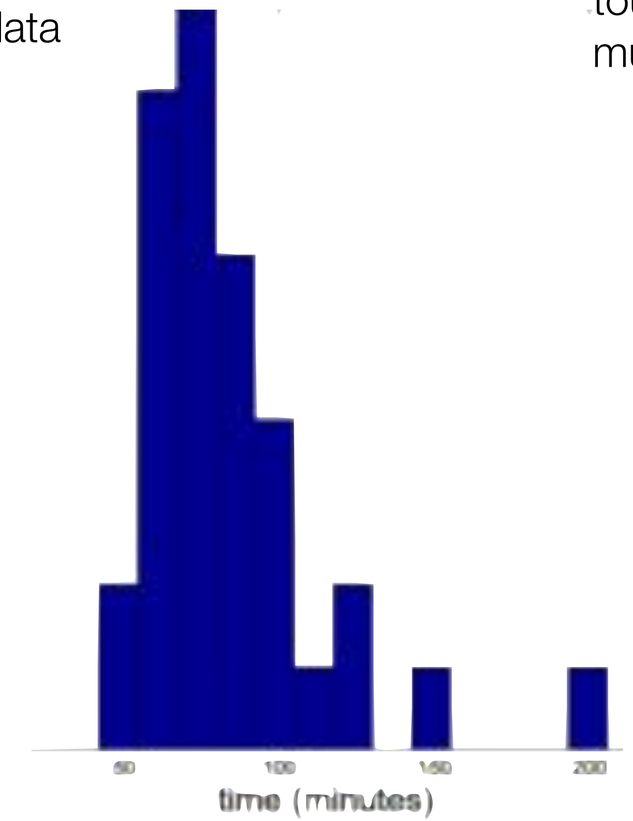
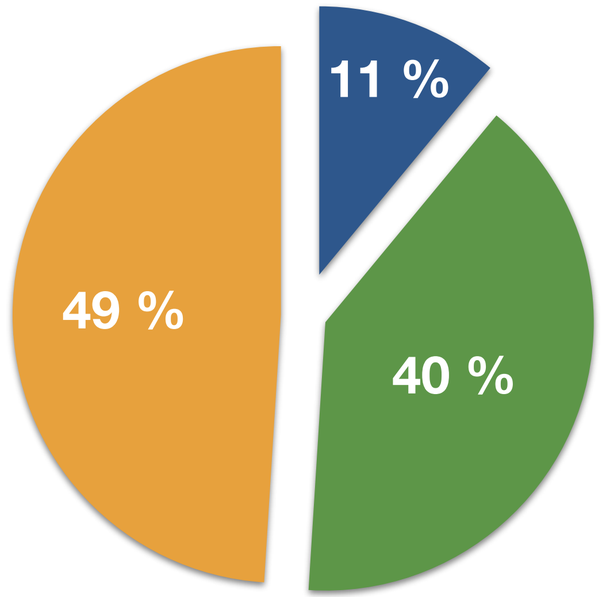


daily startup time
including warm-up

touch only 5Hz
multipass mirrors

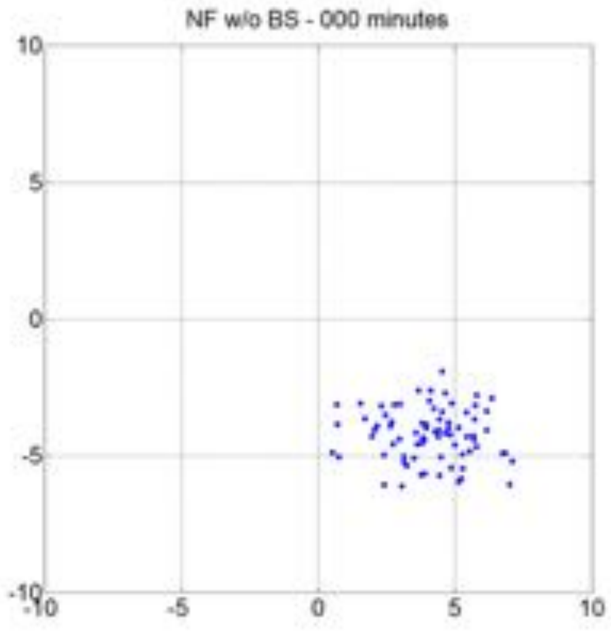
only pushing buttons
not opening covers or
touching mirrors



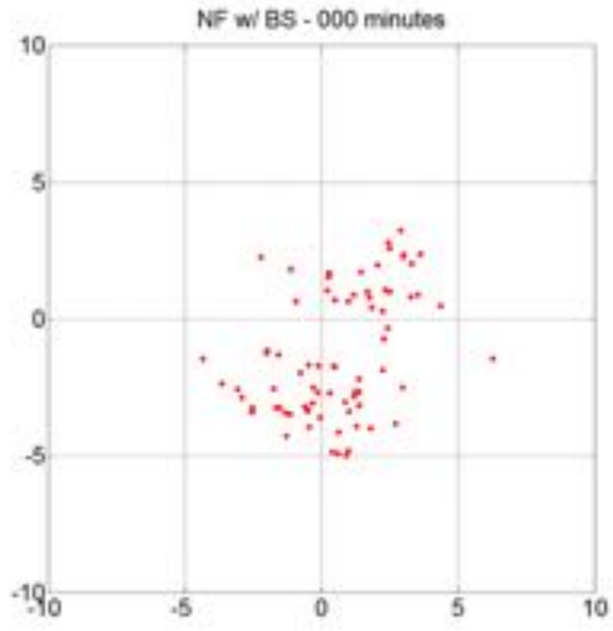
more
significant
work

Case Studies

Beam Stabilization works…



stabilization OFF

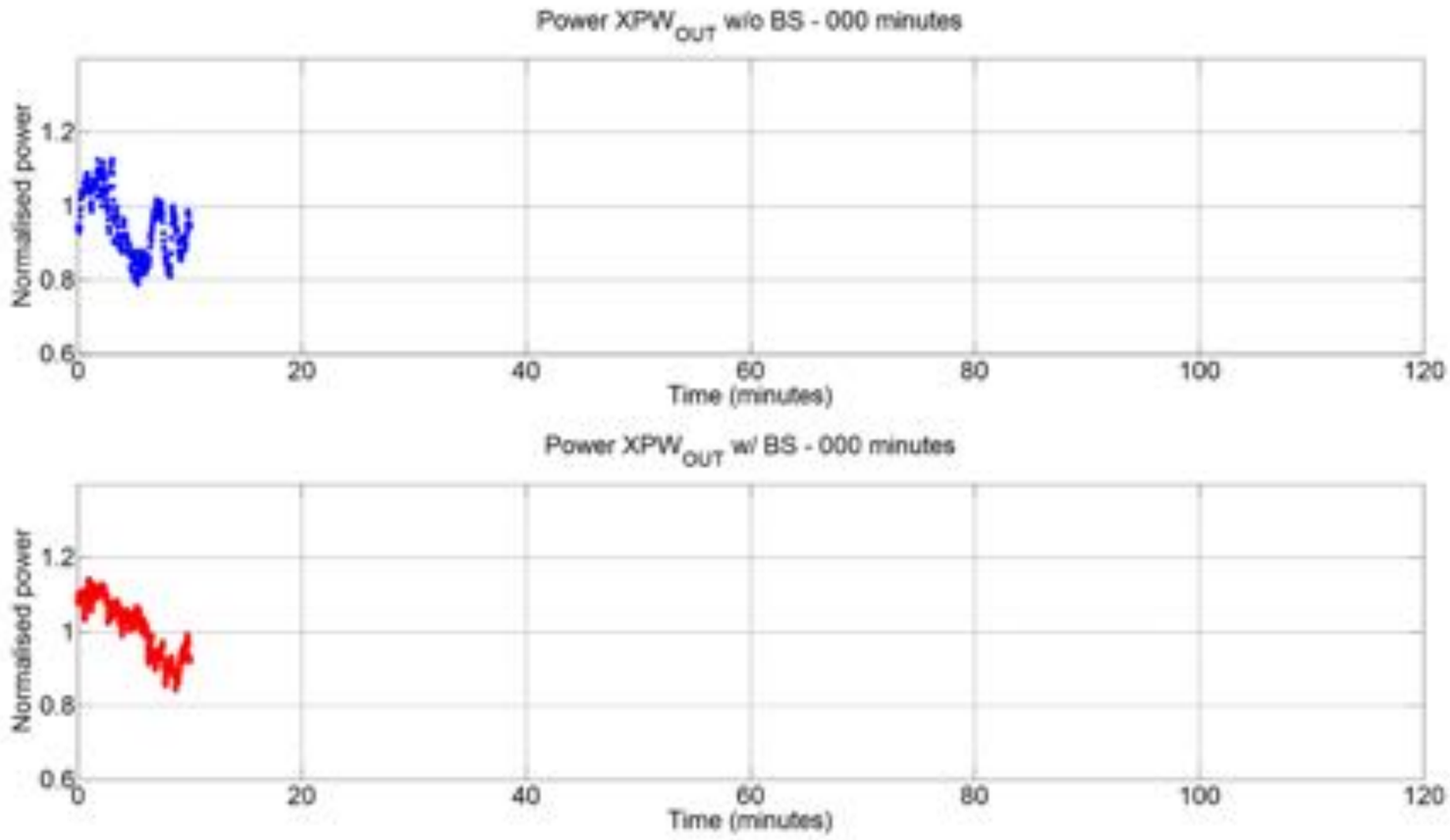


stabilization ON

Stabilizes energy

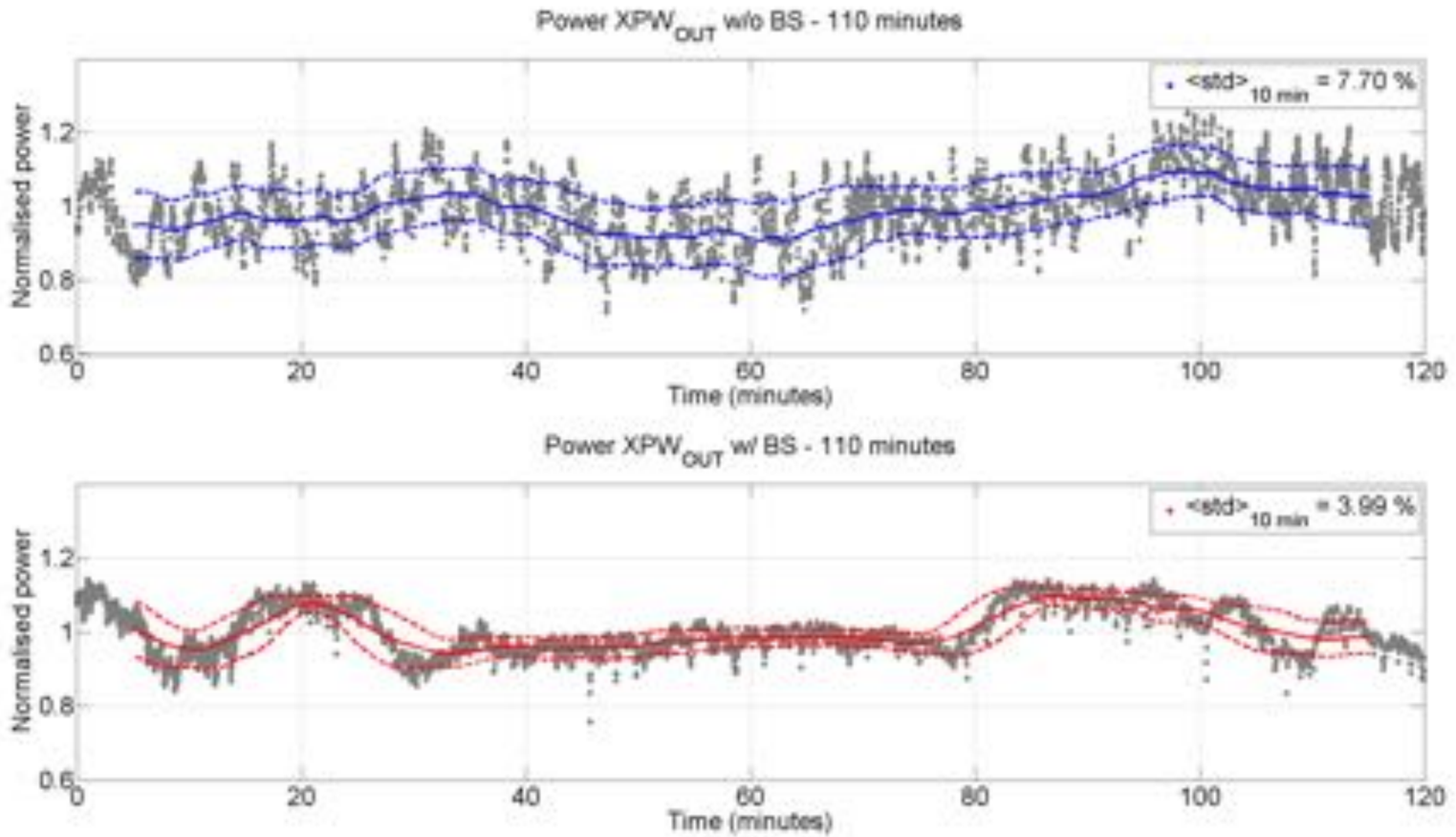
stabilization OFF

stabilization ON



Helps to identify problems…

stabilization OFF



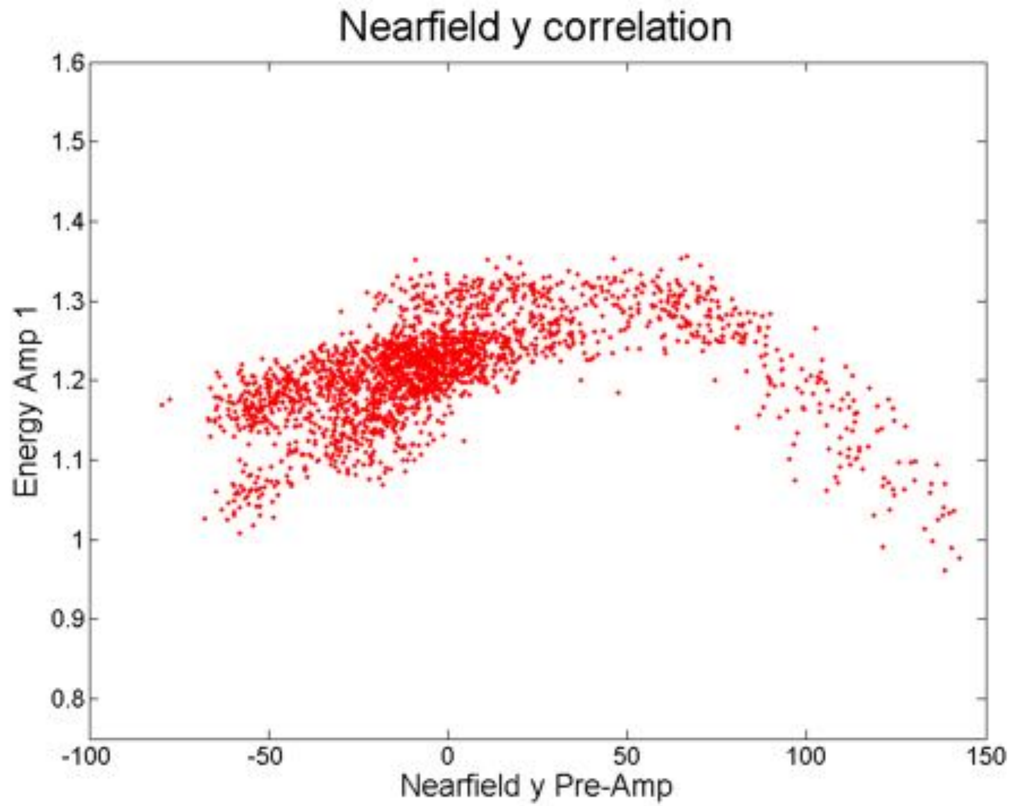
stabilization ON

> eliminated drift
> only S2S jitter
> where do the jumps come from?
seems like correlation w/ spectrum

Think about auto-tuning…

> Preamp output into Amp1 not yet stabilized
> Clear correlation between pointing and energy

> Stabilize!!
> auto-tune??



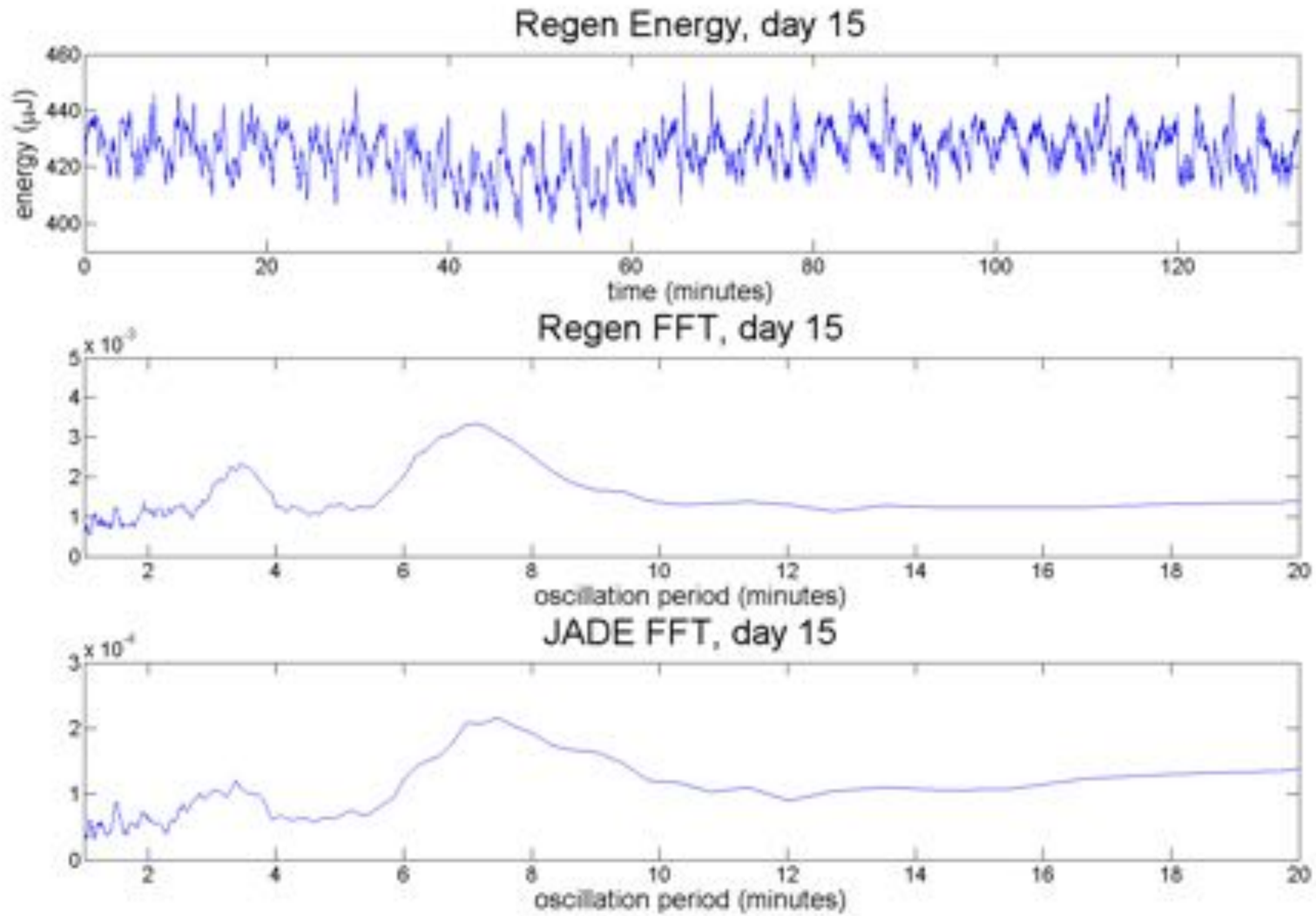
Found Oscillations in the REGEN Energy…

> even with stabilization there seem to be some oscillations in the energy.

> yeap, there are real.

> obviously caused by pump laser

> is it the chiller? - add temperature sensors…



Conclusion

> Conclusions…

> we think the software is as important as the hardware

> make the laser a klystron and do laser shooting - no trouble shooting

> … although we are fare from being done…

Special thanks to

> Falko Peters
> Lutz Winkelmann
> Vladimir Rybnikov
> Phil Duval
> Mark Lomperski
> Chris Staats
> Hilda Tamras
> … and many others.

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group Georg Korn


group
Johannes Bahrdt


group
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