Design of Beam Transfer Lines

LA^{3}NET Workshop Aachen, 05.11.2013

Andreas R. Maier

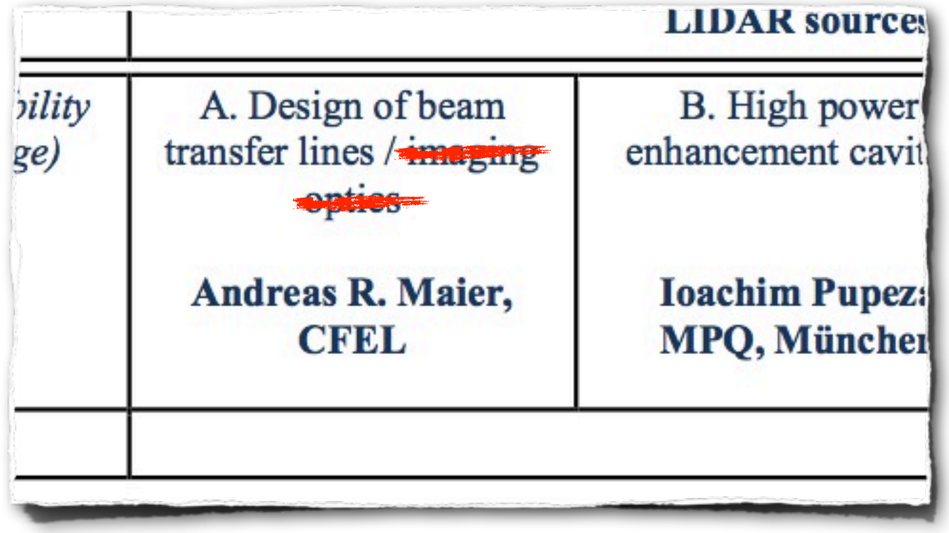
Junior Research Group for Laser-Plasma Driven Light Sources (LUX)

CFEL SCIENCE

LAOLA. is a collaboration of UHH DESY

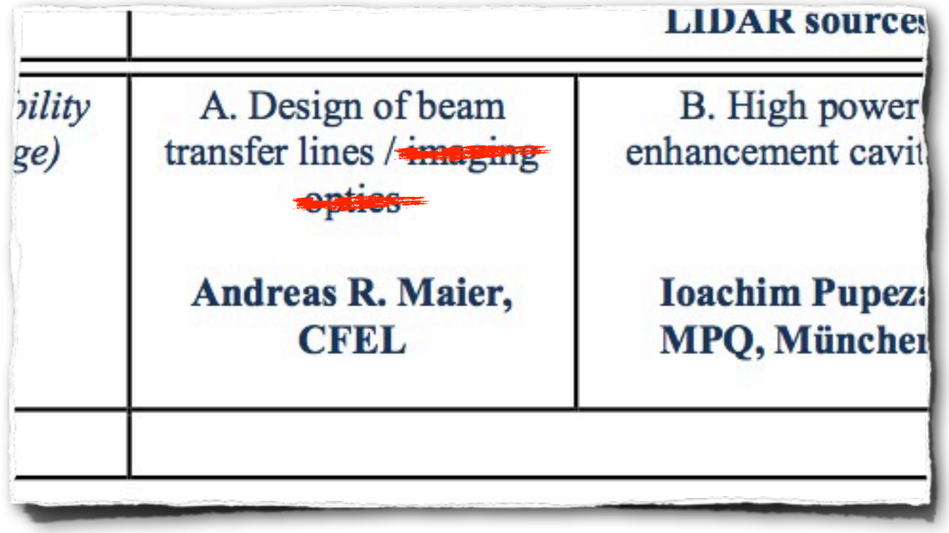
What is this session about?

> Transfer Beamline Design



What is this session about?

- Transfer Beamline Design
- very special parameter set
  (200 TW, 5J in 25 fs, 80 mm beam)



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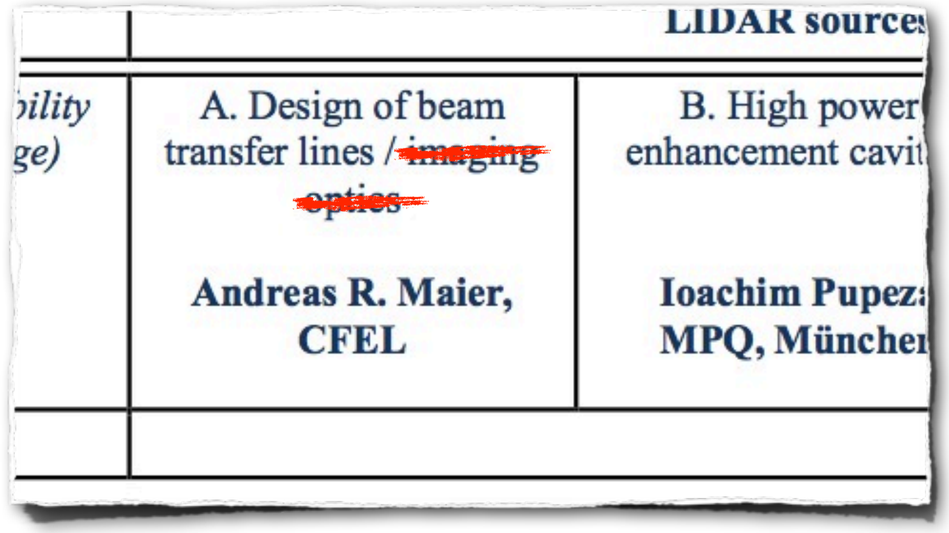
- equations free talk...



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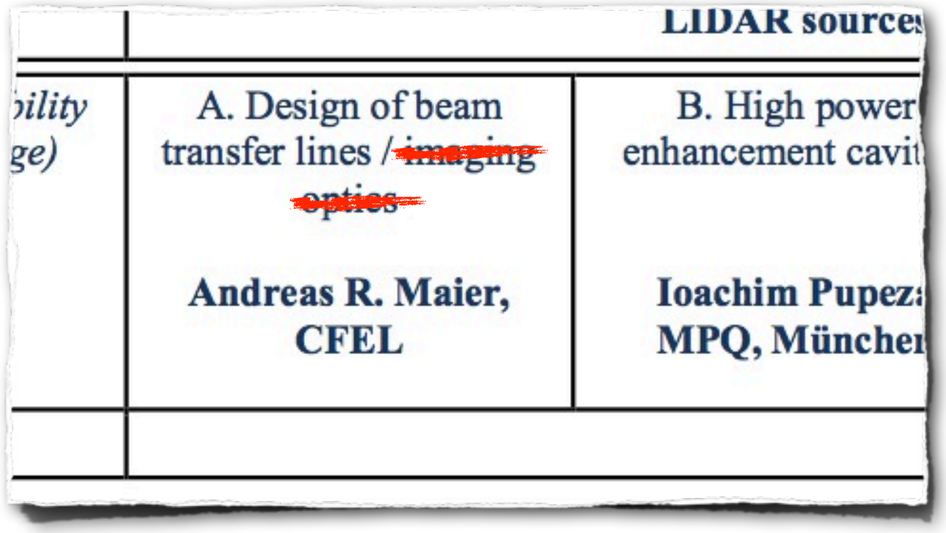
- equations free talk...

- this is not a lecture



Outline

> Laser-Plasma Project in Hamburg: CFEL and LAOLA
> Design Aspects: Laser Transport Beamline

LUX - Junior Research Group

> „Laser-Plasma Driven Light Sources“

> group leader A. Maier

> established September 2013

> context: CFEL/Univ. Hamburg and LAOLA

> setup and operate (a) ANGUS, a 200 TW laser system, and (b) a laser-plasma beamline

CFEL Lab

> we are part of CFEL

> shared office spaces and 100 m^2 laser lab
w/ group Florian Grüner

image: cfel.de

LAOLA Collaboration

LAOLA.

Reinhard Brinkmann	Florian Grüner
Klaus Flöttmann	Andreas Maier
Ralph Aßmann	Benno Zeitler
Holger Schlarb	Bernhard Hidding
Bernhard Schmidt	...
Frank Stephan	
Matthias Gross	
Brian Foster	
Eckhard Elsen	
Jens Osterhoff	
...	

LAOLA Collaboration in Hamburg

LAOLA.

LAOLA@PITZ
self-modulation

LAOLA@FLASH
beam-driven (now called: FLASHforward)

LAOLA@REGAE
laser-driven

LAOLA Collaboration in Hamburg

LAOLA.

LUX is embedded here

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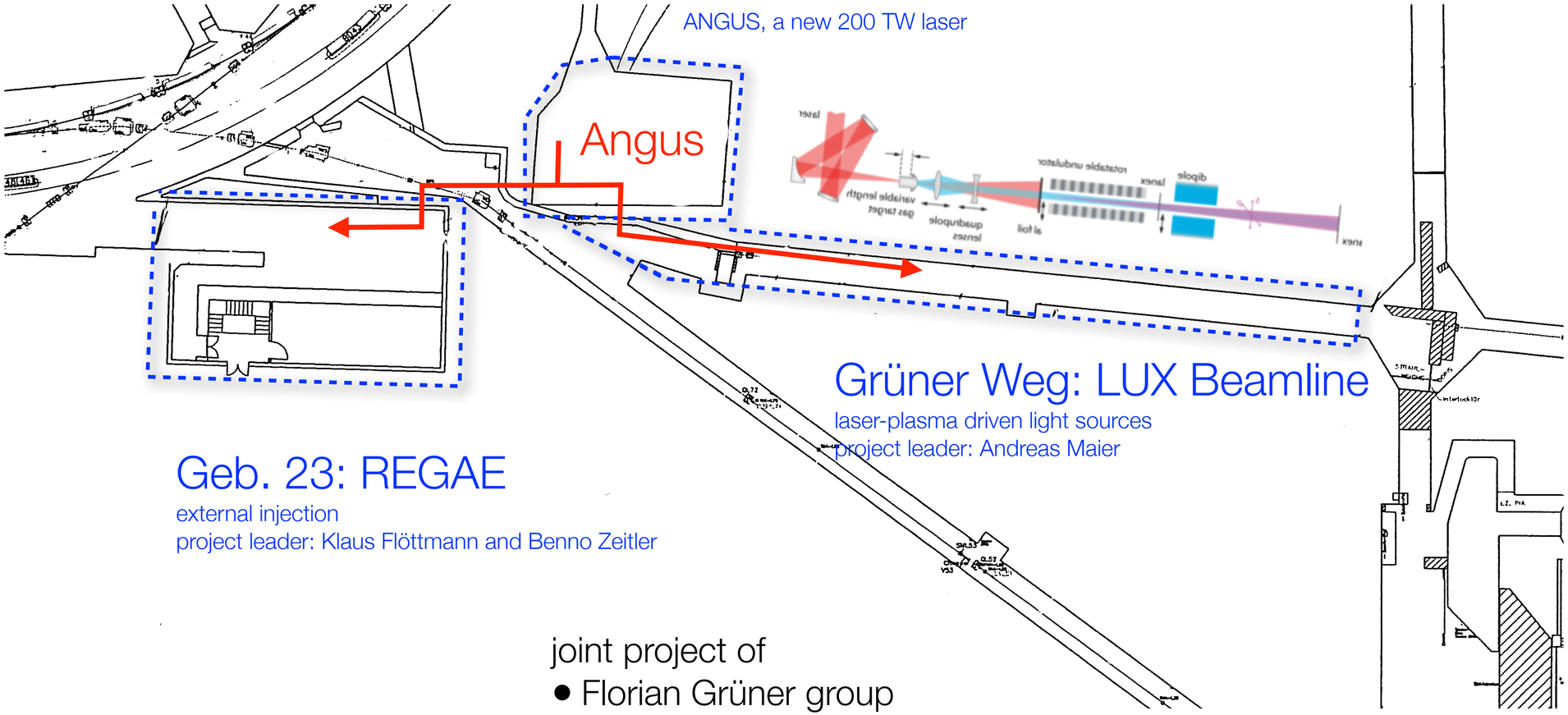
LAOLA@REGAE



Geb. 22: New Laserlab

ANGUS, a new 200 TW laser

Grüner Weg: LUX Beamline

laser-plasma driven light sources
project leader: Andreas Maier

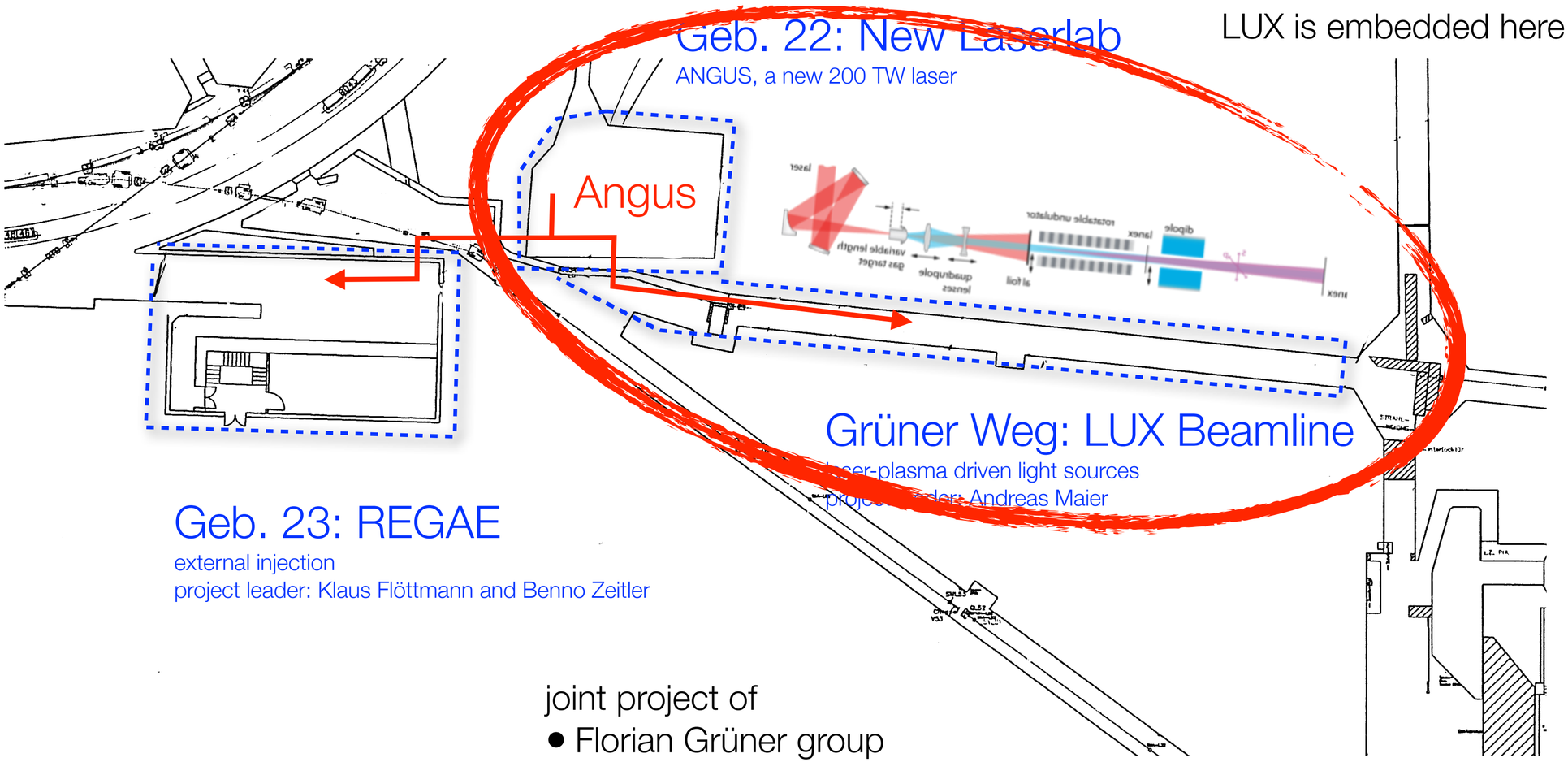
Geb. 23: REGAE

external injection
project leader: Klaus Flöttmann and Benno Zeitler

joint project of

- Florian Grüner group
- Andreas Maier group
- DESY Machine division

LAOLA@REGAE



joint project of

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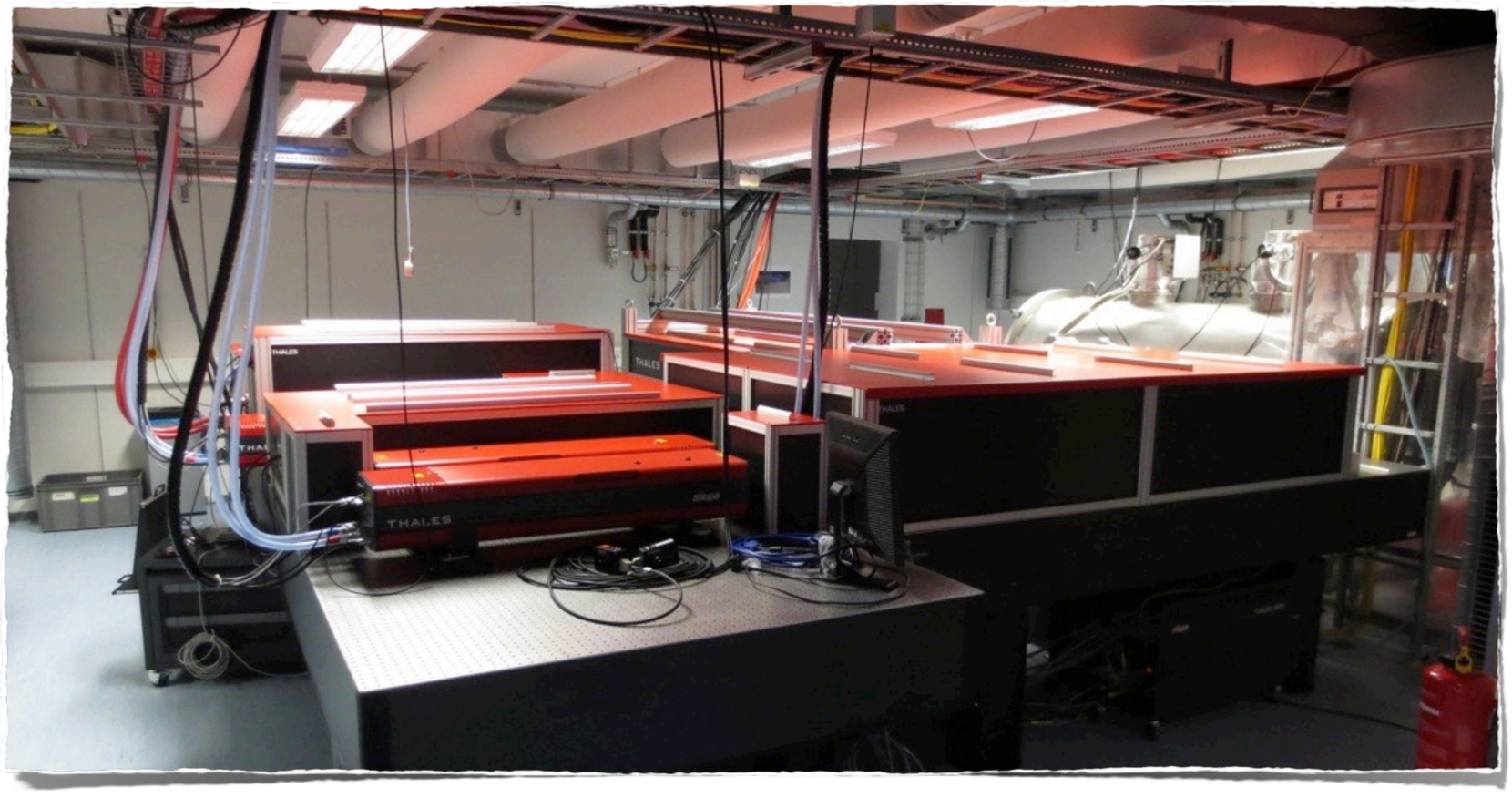
Laser Lab

Laser parameters:
>5 J in 25 fs @ 5 Hz
>commercial THALES system
>80 mm beam diameter
>currently doing site-acceptance

Lab
>0.1 °C temperature stability

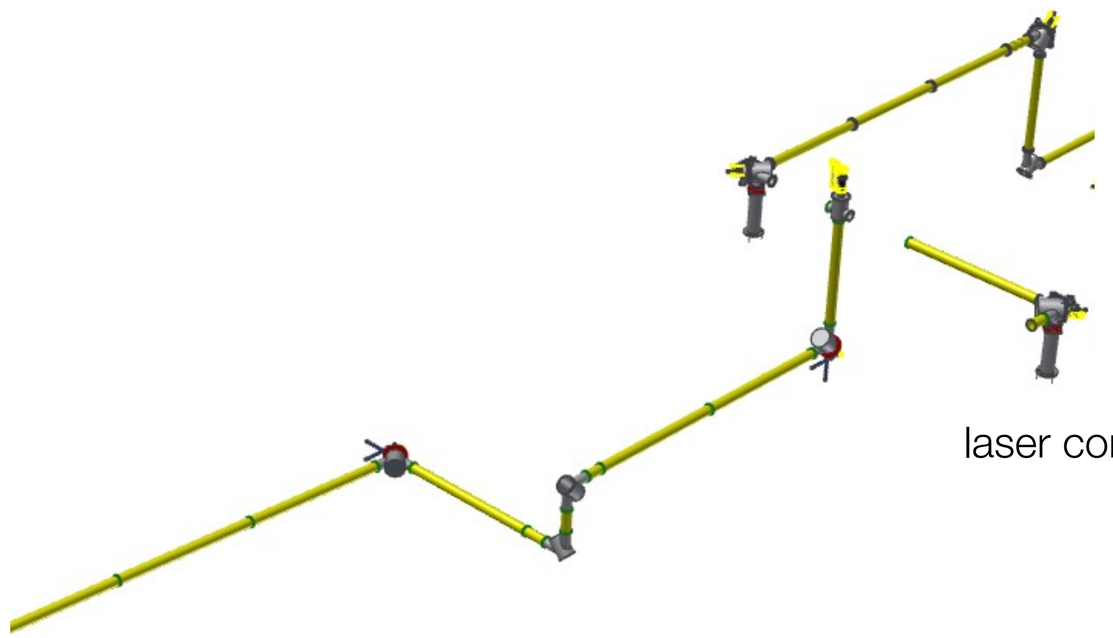


Laser Transport Beamline

enough chit-chat...

Most important lesson: Know your boundary conditions

Laser parameters:
>5 J in 25 fs @ 5 Hz
>80 mm beam diameter
>flat-top profile



Most important lesson: Know your boundary conditions

Laser parameters:
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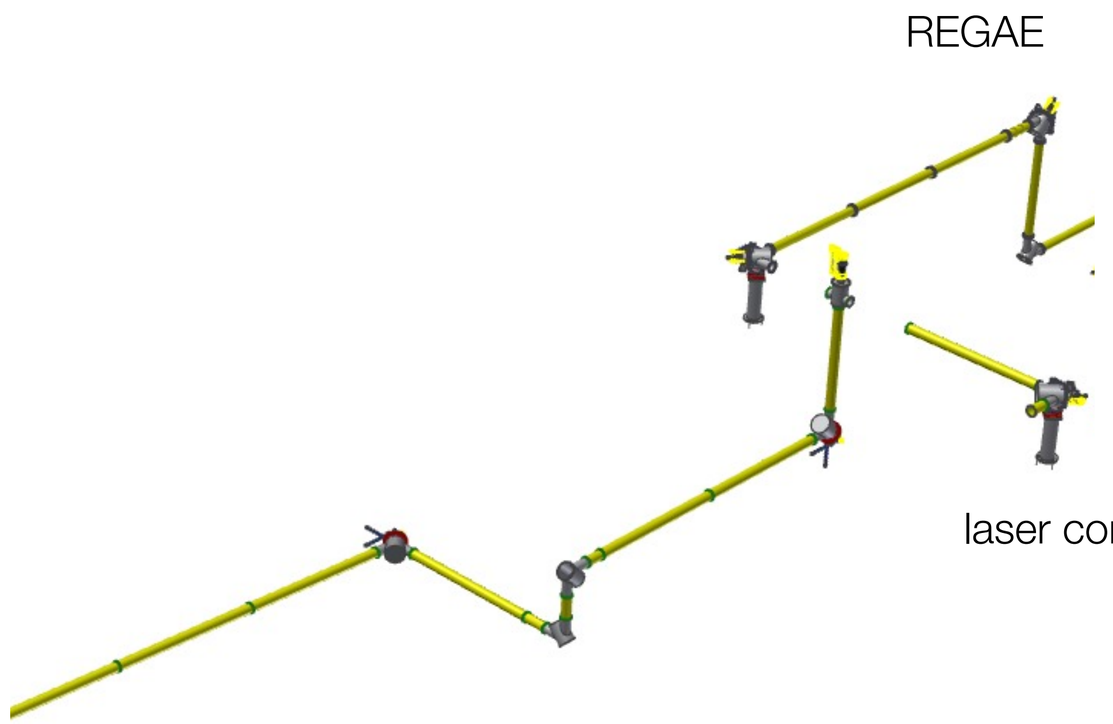
>80 mm beam diameter
>flat-top profile

Vacuum
>machine vacuum
>particle-free
>free of carbon-hydrats
>no fluoride



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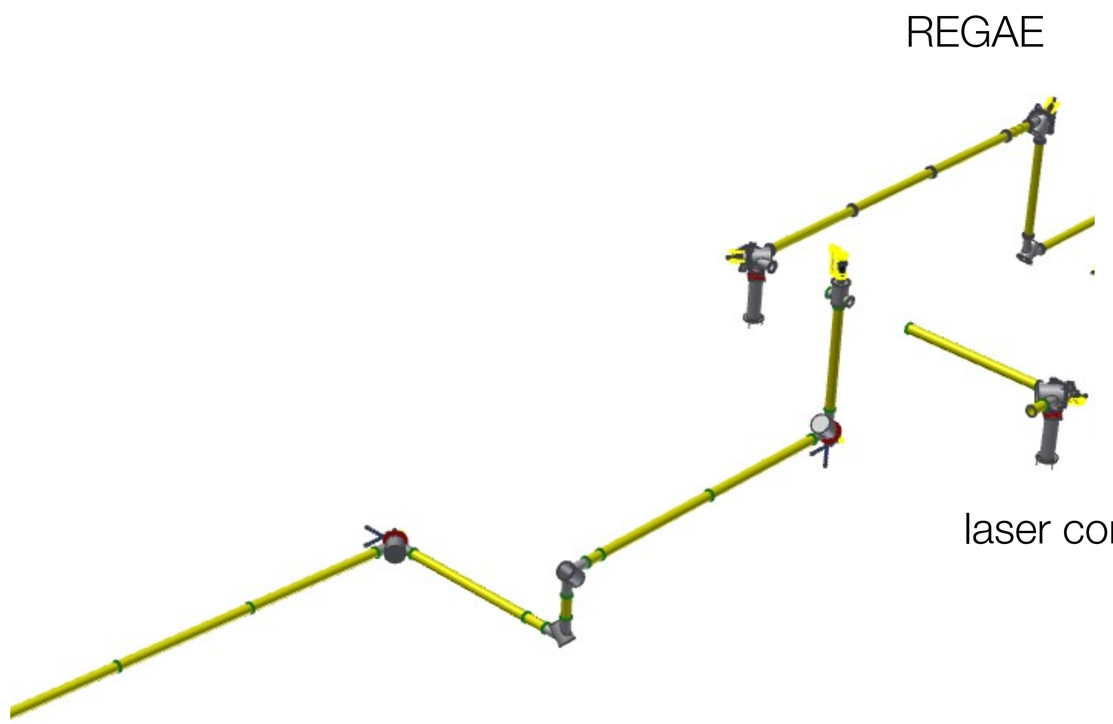
Environment
>vibrations of building?
>temperature stability
0.1° C for Angus, 1° C for beamline



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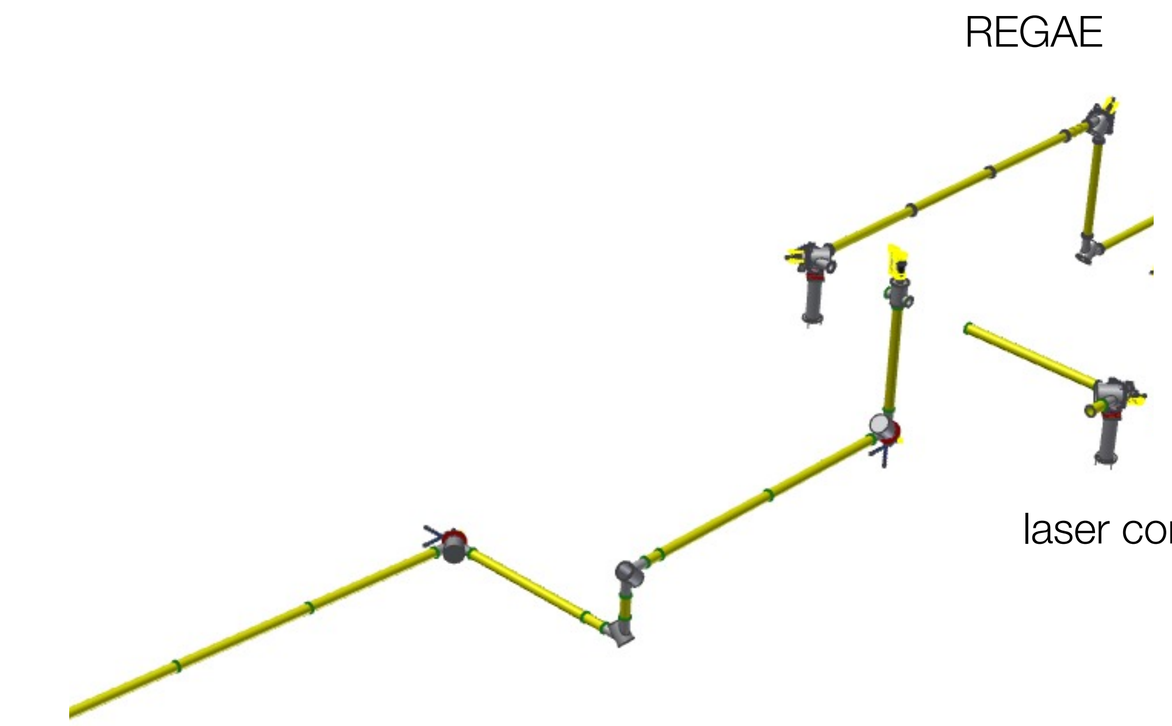
>vibrations of building?
>temperature stability
0.1° C for Angus, 1° C for beamline

>Target
>few 100 µm channel transverse size
>more than 10 m distance from compressor



Lesson 2: The clash of cultures

laser guys

laser PhD:
1) wait for „typical“ lucky record shot
2) write paper
3) run away

accelerator guys

accelerator PhDs have to:
> build a machine for users
> stability
> reliability

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what they belive in...

>we even hide pizza in the chamber...

>UHV vacuum

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>UHV vacuum

>we never open the vacuum system

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> we even hide pizza in the chamber...

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> we motorize each and every mirror

> UHV vacuum

> we never open the vacuum system

> we just couple in and out of the beamline - nothing else

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what they belive in...

>we even hide pizza in the chamber...

>we never actually close it

>we motorize each and every mirror

>the laser is the center of our universe

>UHV vacuum

>we never open the vacuum system

>we just couple in and out of the beamline - nothing else

>the electron beam is the center of our universe

More details...

... in no specific order

Laser Parameters

Laser parameters:

> 5 J in 25 fs @ 5 Hz

> 80 mm beam diameter

> flat-top profile

Laser Parameters

no curved optics
only flat mirrors
-> pointing translates into offset

Laser parameters:
> 5 J in 25 fs @ 5 Hz
> 80 mm beam diameter
> flat-top profile

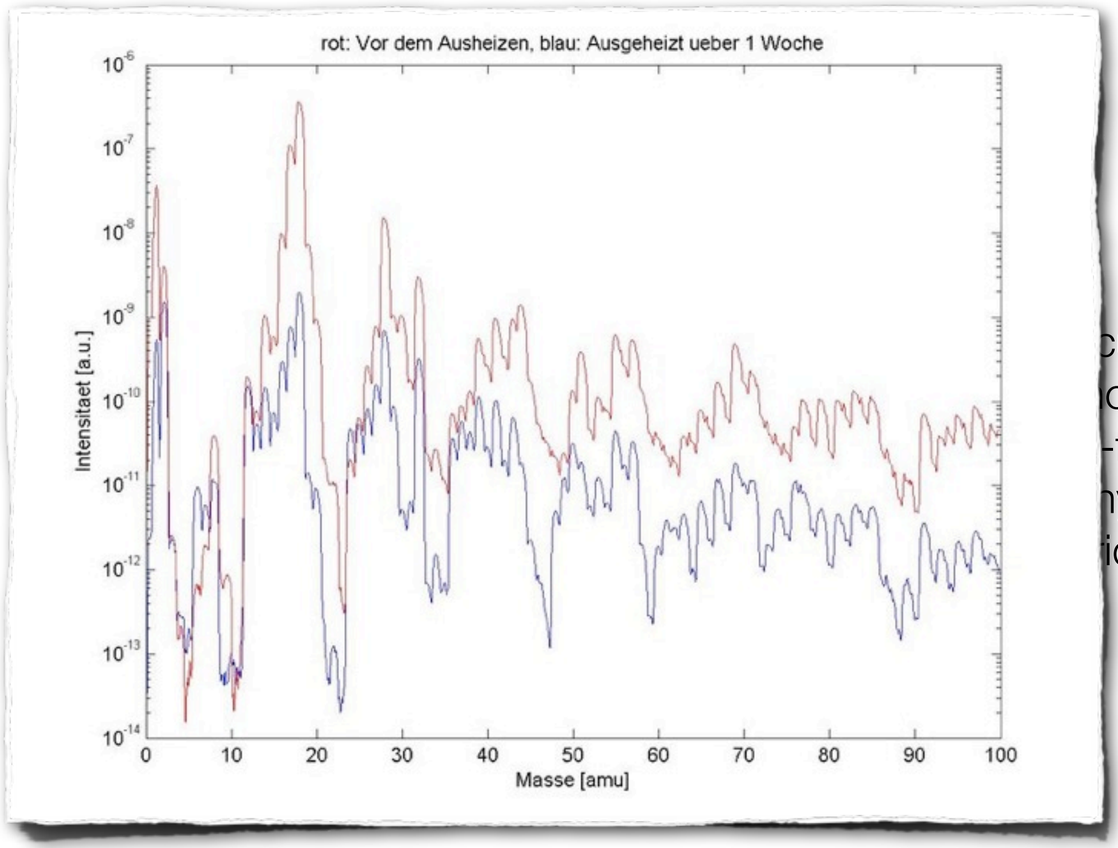
> absolutely now windows
(B-integral)
> no transmittive optics

focus is not a Gaussian

Vacuum Specs

Vacuum
> machine vacuum
> vacuum is not defined by pressure, but:
> particle-free
> free of hydrocarbons
> no fluoride

Vacuum Specs



cuum

ot defined by pressure, but:

-free

ydrocarbons

ide

vacuum is not defined by pressure:
example of mass spectrum before and after baking the a test chamber

Vacuum Specs

Why machine vacuum? -> Connection to REGAE gun.
No window, because of power and pulselength.

Vacuum
>machine vacuum
>vacuum is not defined by pressure, but:
>particle-free
>free of hydrocarbons
>no fluoride

RF cavities

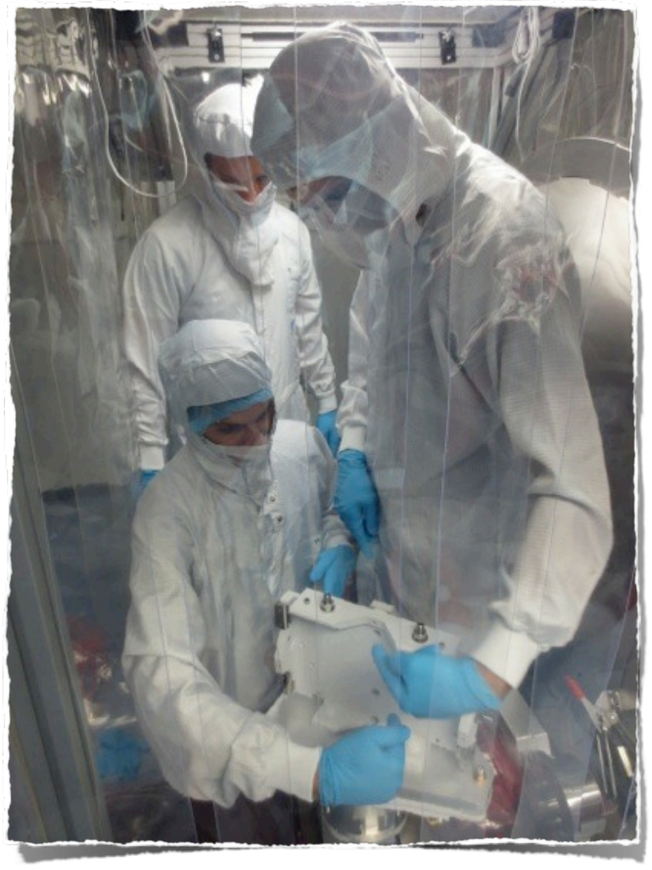
hydrofluoric acid

mirror coating

Vacuum Specs - Consequences

> Get all motors out of the vacuum
> Design own mirror mounts

> assemble everything under clean room conditions, w/ 25 particles per cubic foot



Vacuum
> machine vacuum
> vacuum is not defined by pressure, but:
    > particle-free
    > free of carbon-hydrats
    > no fluoride

Design philosophy

> use two mirrors to couple in
> two mirrors to couple out
> leave rest untouched

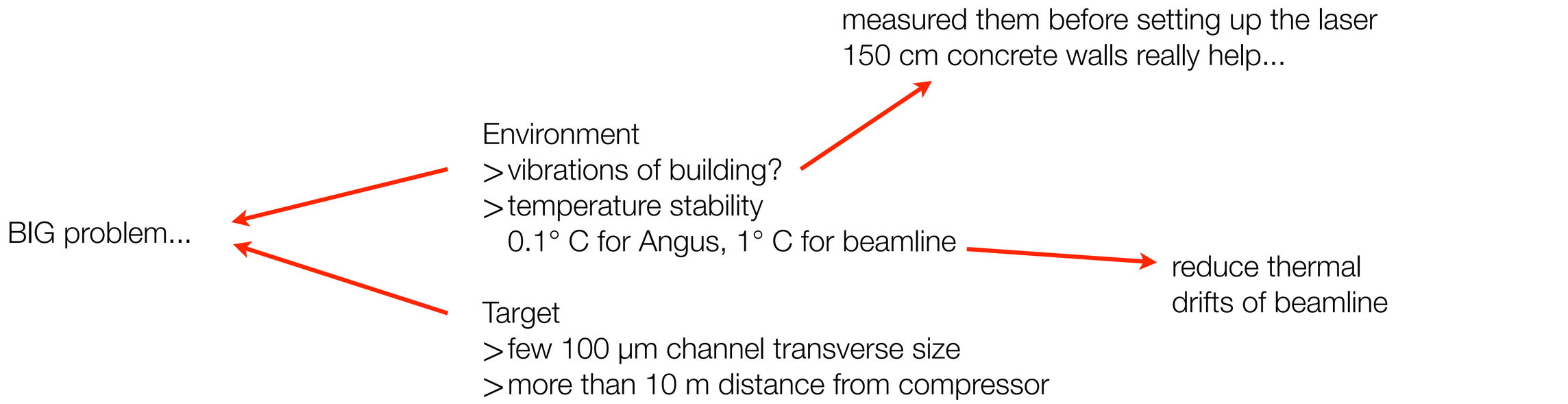
> no panic mirrors
> save money on mirror mounts and motors

Environment

Environment
> vibrations of building?
> temperature stability
  0.1° C for Angus, 1° C for beamline

Target
> few 100 µm channel transverse size
> more than 10 m distance from compressor

Environment



What should I do different?

> Everything!

What should I do different?

> Everything!

> Use windows (if you can)
> Use lenses (if you can)
> ...

Lessons learned... ?

1) Know your boundary conditions.
2) Know your design philosophy.
3) Questions? Write me an email: andreas.maier@cfel.de

Thanks

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UHH DESY LAOLA.

eli beamlines

Federal Ministry of Education and Research

acknowledgement

MBI Max Born Institute

HELMHOLTZ GEMEINSCHAFT Helmholtz-Institut Jena