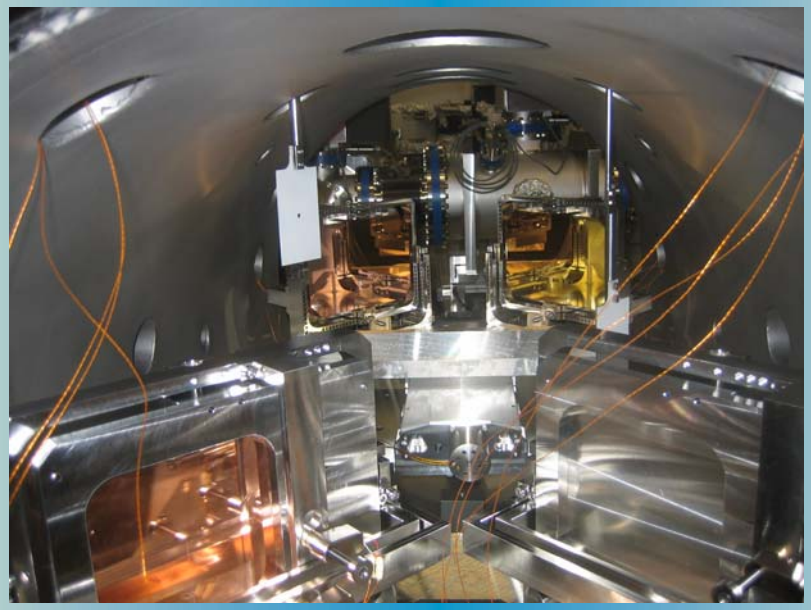
Comissioning of the IR beamline at FLASH



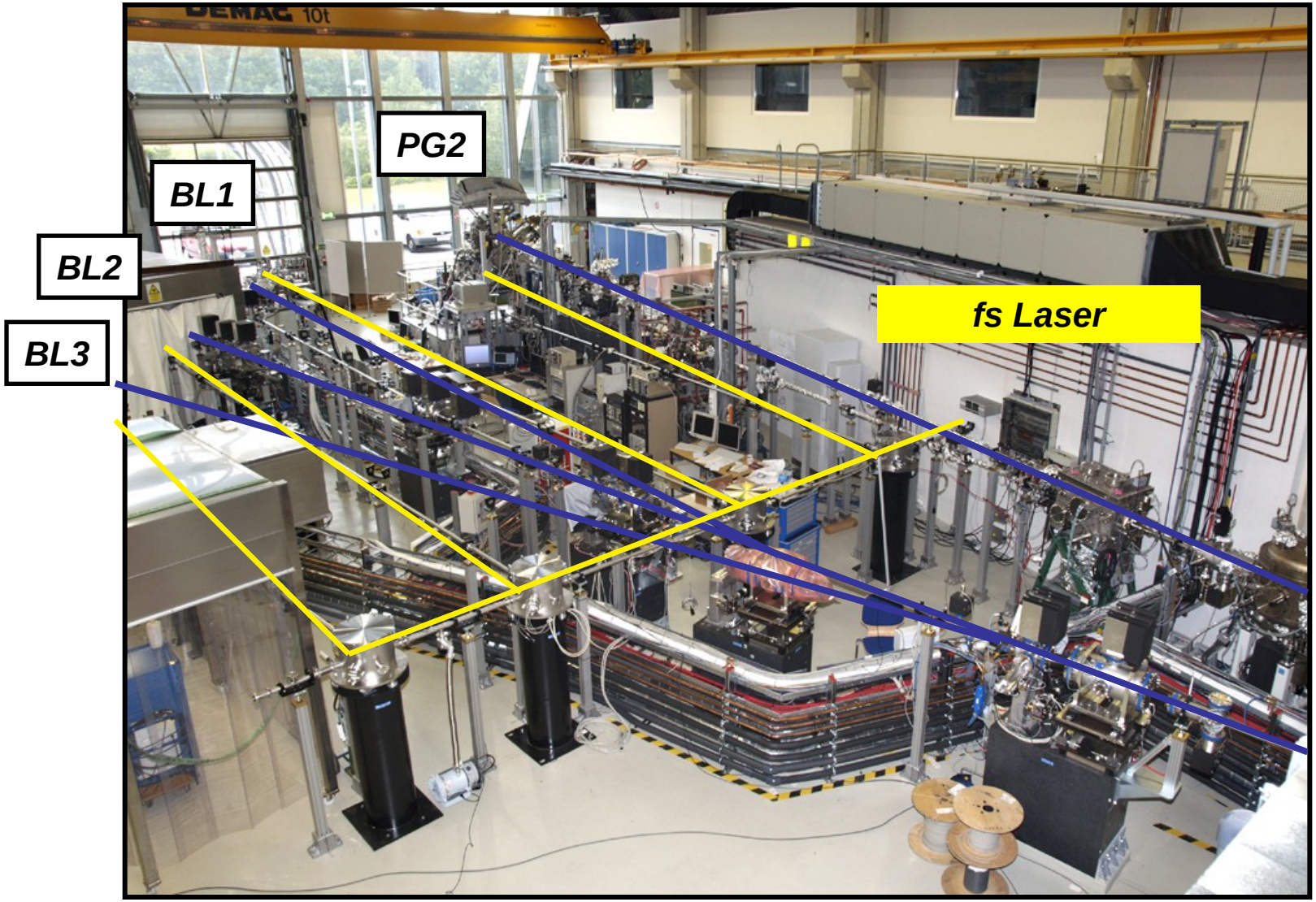
Michael.Gensch @ DESY.DE

IR Undulator Beamline at FLASH

First light

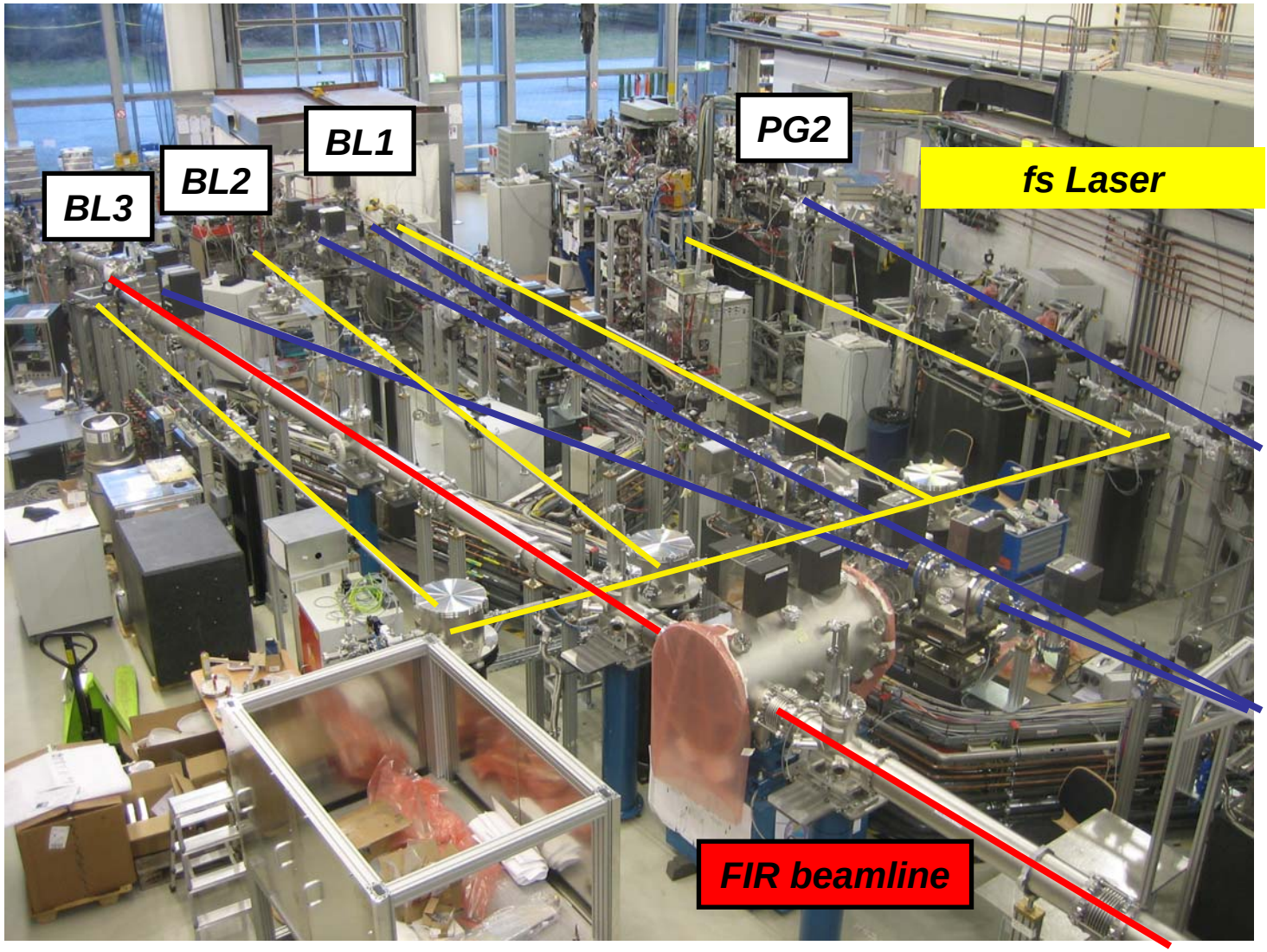
FLASH experimental hall

before installation of IR beamline



FLASH experimental hall

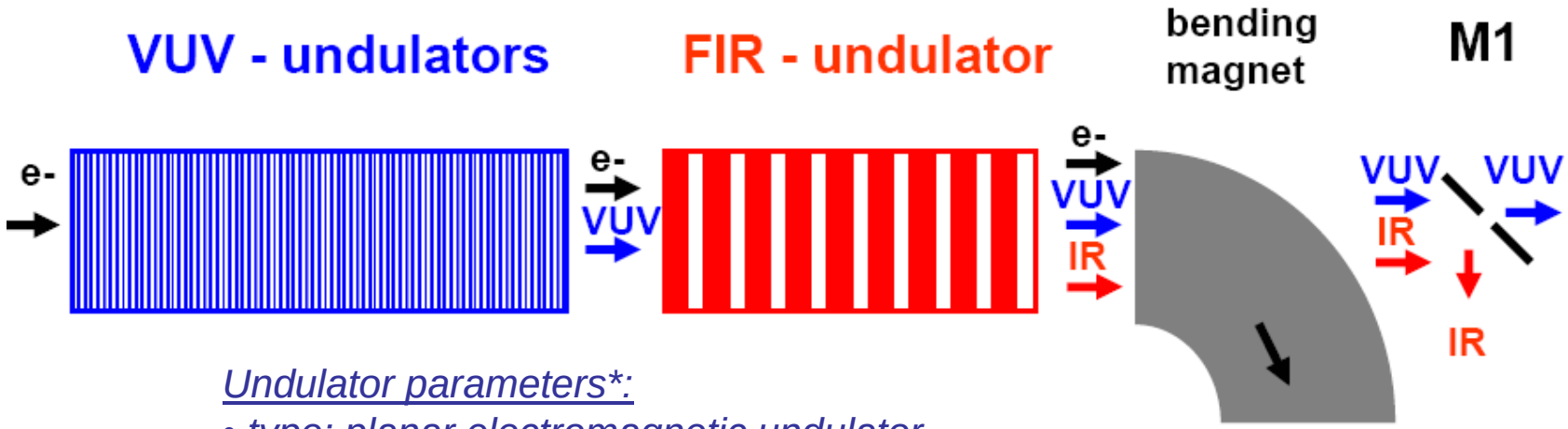
NOW!



IR Undulator Beamline at FLASH

First light

Layout: Source



Undulator parameters:*

- *type: planar electromagnetic undulator*
- *Gap: 40 mm*
- *Period length: 400 mm*
- *Number of periods: 9*
- *K-value3 –49*

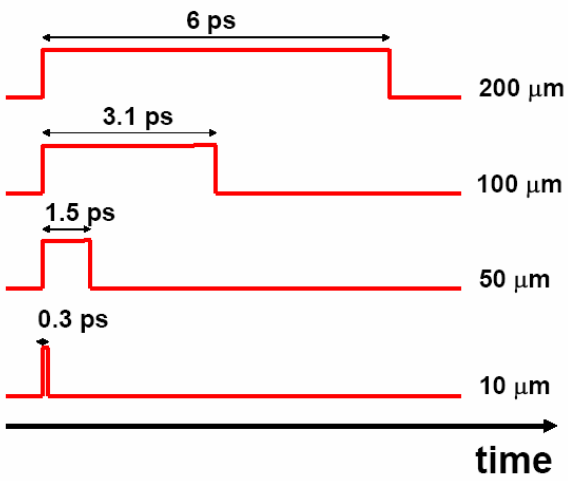
Undulator performance:

- **naturally synchronized to VUV pulse**
- **pulse energy: more than 10 μJ**
- **spectral range tunable from 10 to 200 μm (possibly shorter)**
- **pulse duration 0.3 to 6 ps**

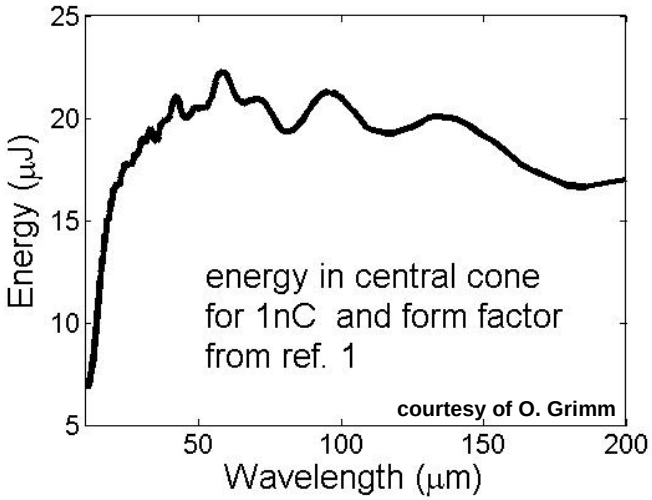
***More information: V. Borisov, Proceedings of EPAC 2006, Edinburgh, 26-30 June 2006, p.3595.; O. Grimm, Proceedings of FEL 2007, Novosibirsk, to be published**

Layout: Source

pulse duration



pulse energy



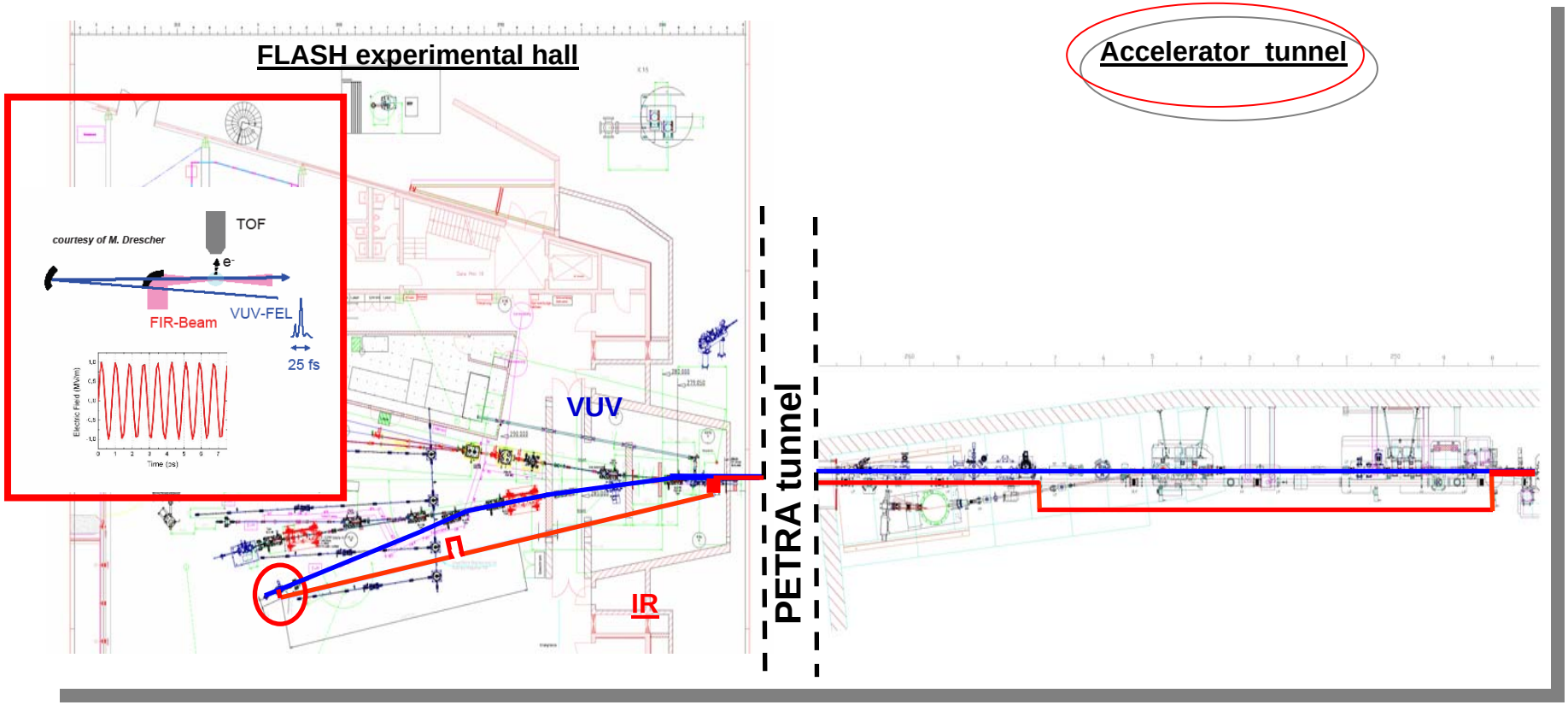
[1] W. Ackermann et. al., Nature Photonics 1 (2007) 336 - 342.

NIR content? -> FIR undulator counts presently as class 4 source, can be Worked only in dedicted shifts (study time!)

Layout: photon transport

requirements:

- spectral range: 1! – 200 μm
- timestructure/wavefront needs to be transported!
- spatial and temporal overlap with VUV pulse from same electron bunch -> upper limit for length!



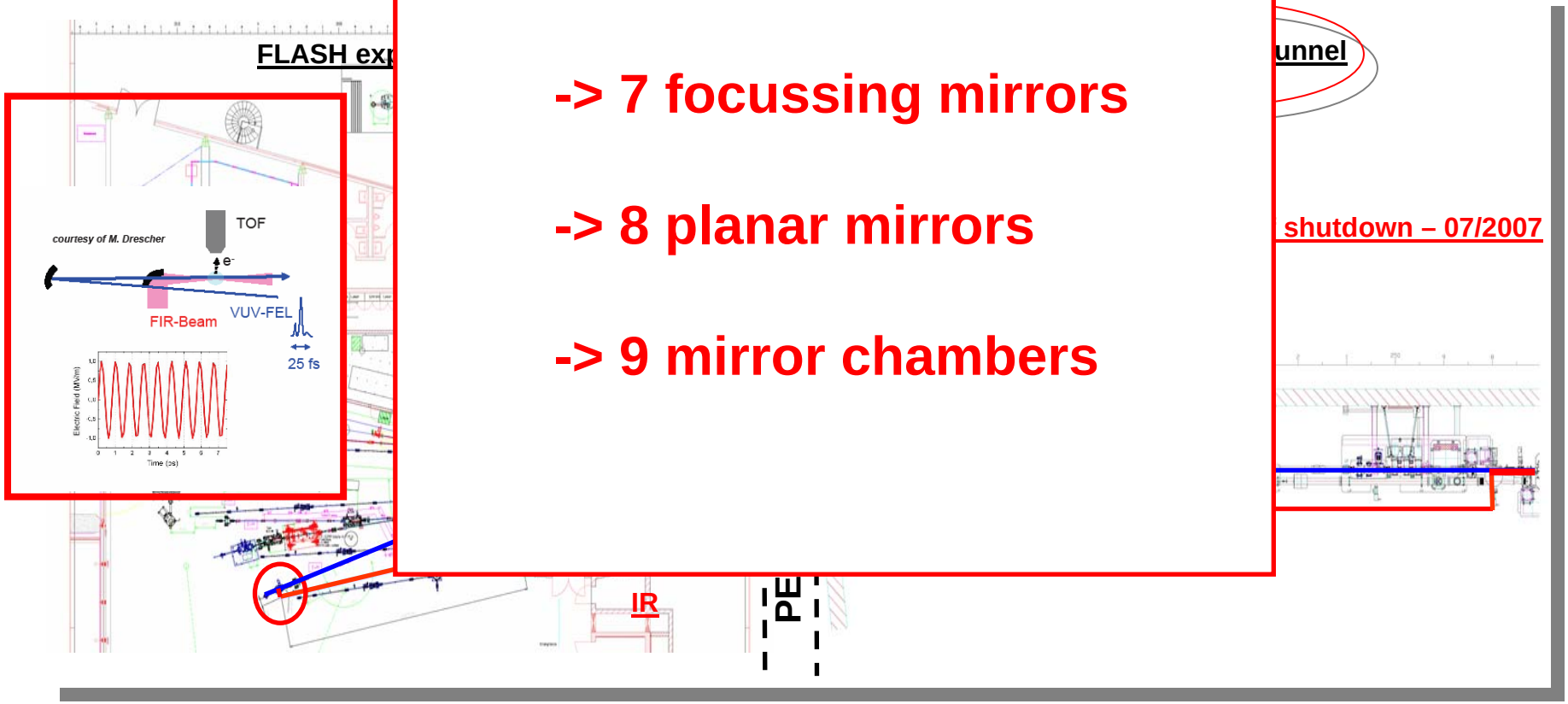
Layout: photon transport

requirements:

- spectral range: 1! – 200 μm

ted!

rom



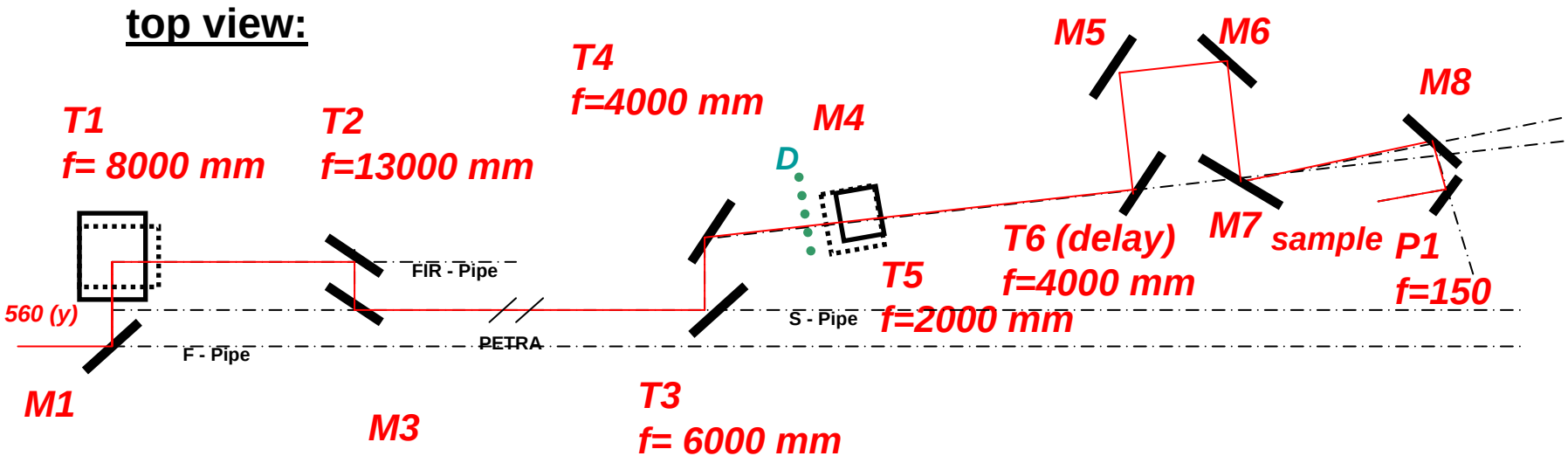
-> 63 m beamline

-> 7 focussing mirrors

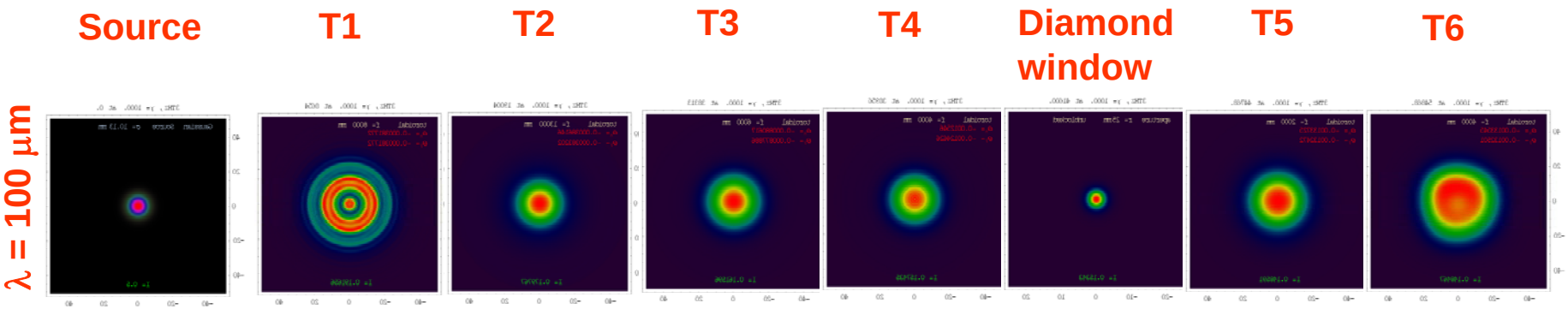
-> 8 planar mirrors

-> 9 mirror chambers

Layout: photon transport

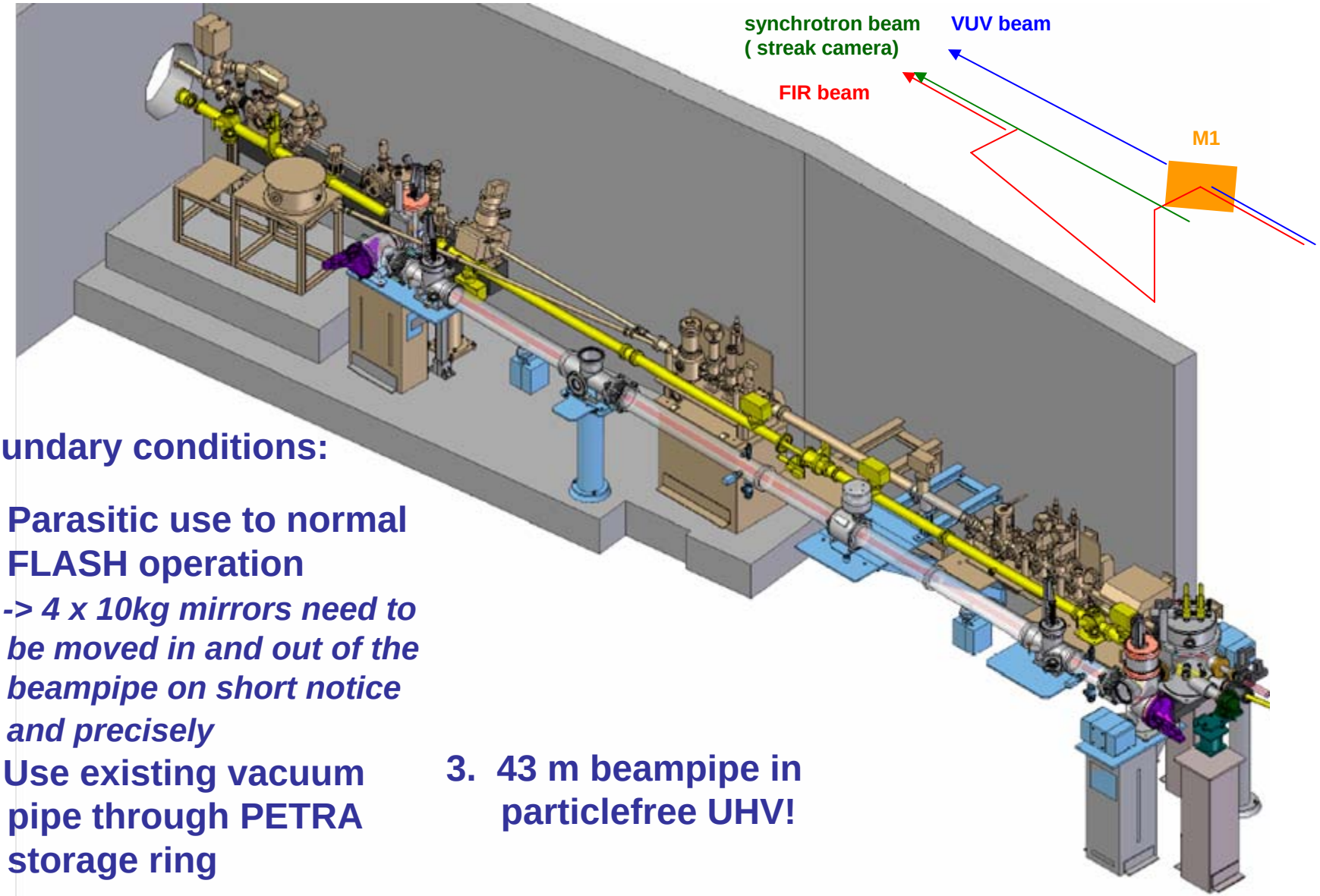


Evaluation with THz Transport* & ZEMAX using Gaussian beams and numerical sources



* www.desy.de/schmidtb/THzTransport/ THztransport.m

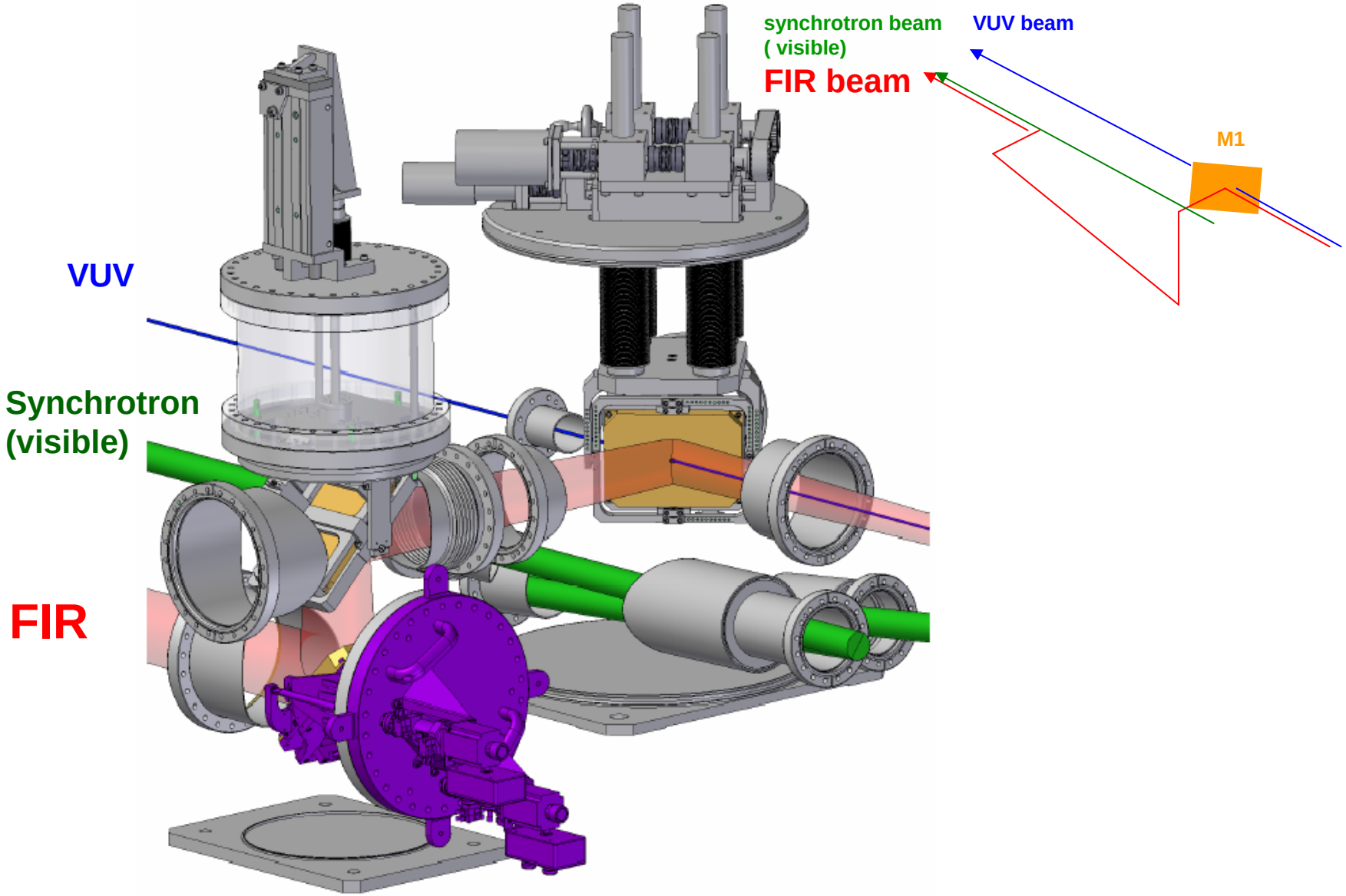
Layout: beamline - accelerator tunnel



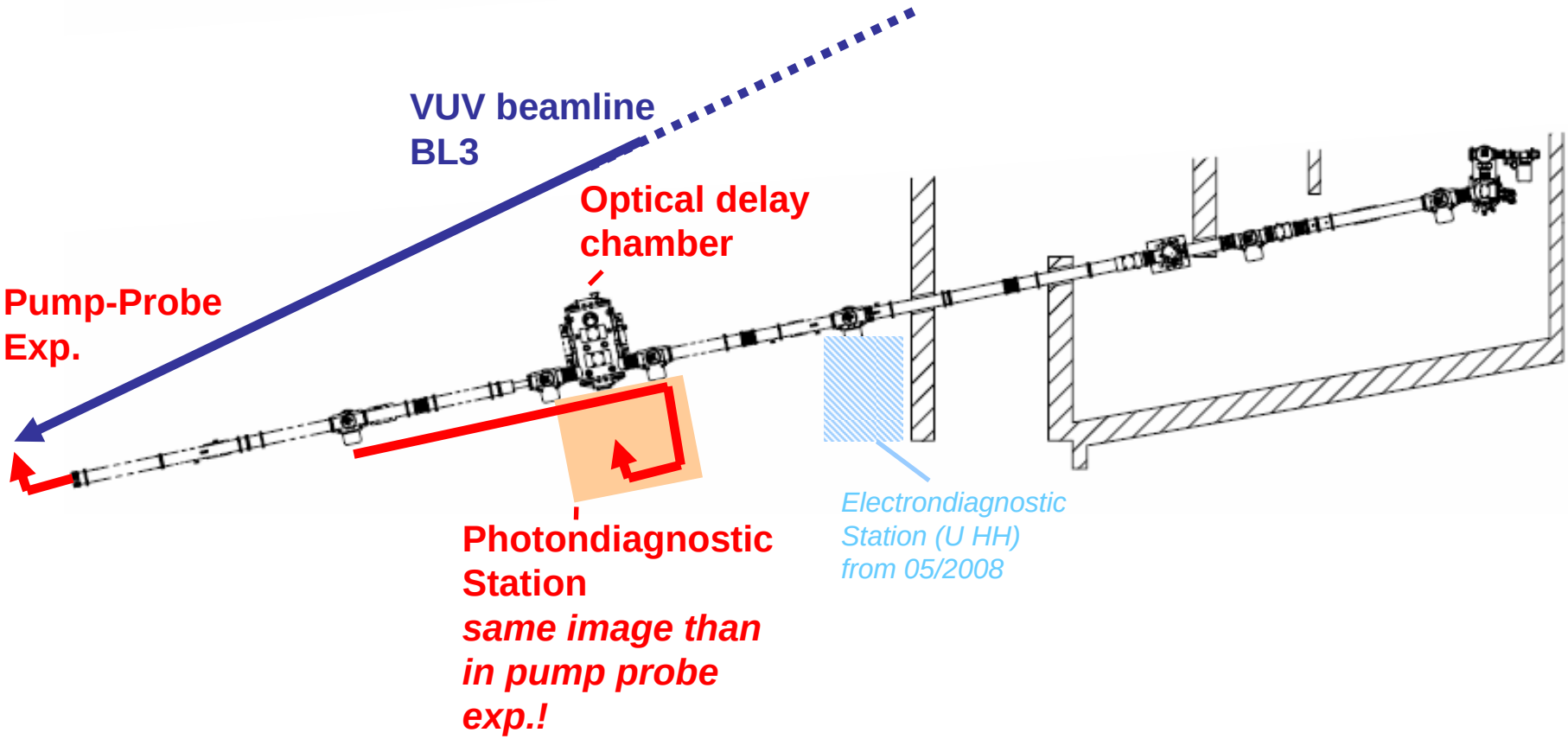
Boundary conditions:

1. **Parasitic use to normal FLASH operation**
   -> 4 x 10kg mirrors need to be moved in and out of the beampipe on short notice and precisely
2. **Use existing vacuum pipe through PETRA storage ring**
3. **43 m beampipe in particlefree UHV!**

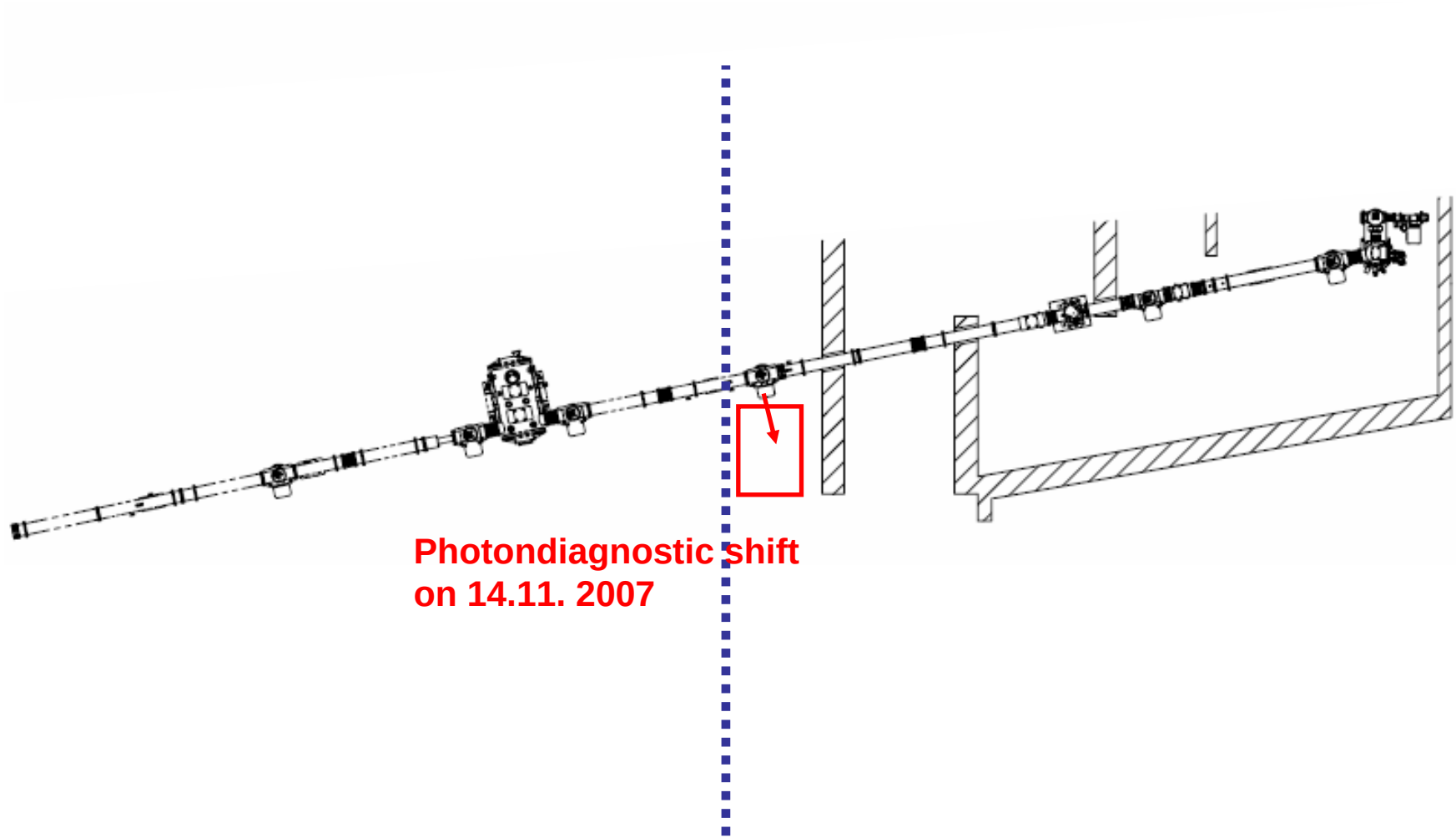
Layout: beamline - outcoupling



Layout: beamline - experimental hall close to completion!



Layout: beamline - experimental hall



Completed at time of measurement 14.11. 2007

IR Undulator Beamline at FLASH

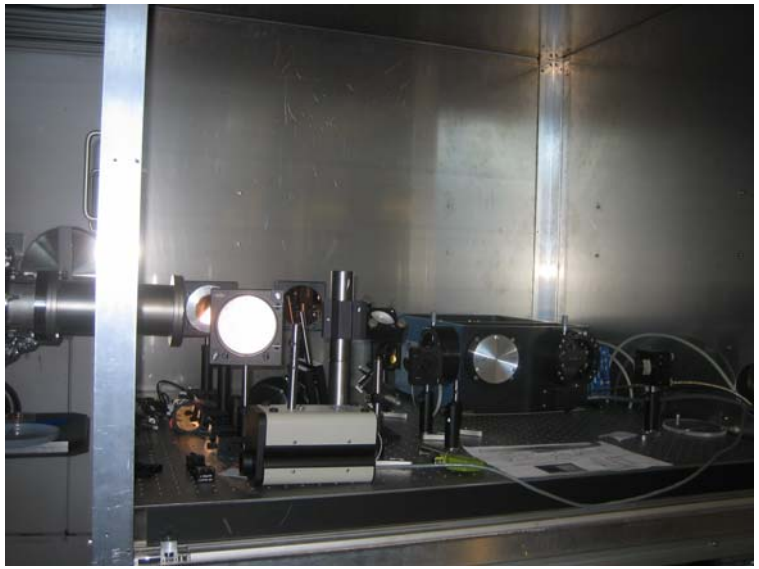
First light

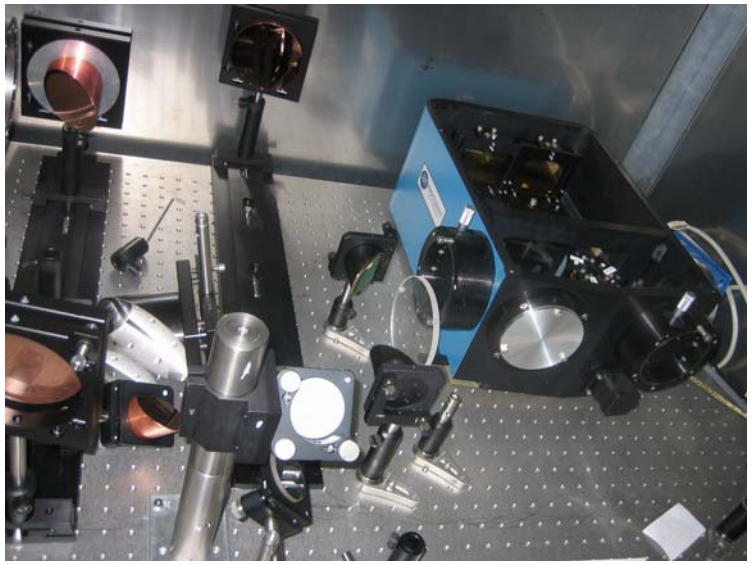
provisonal experimental station

diagnostic port 3

completed 13.11.2007 – just in time for shift!

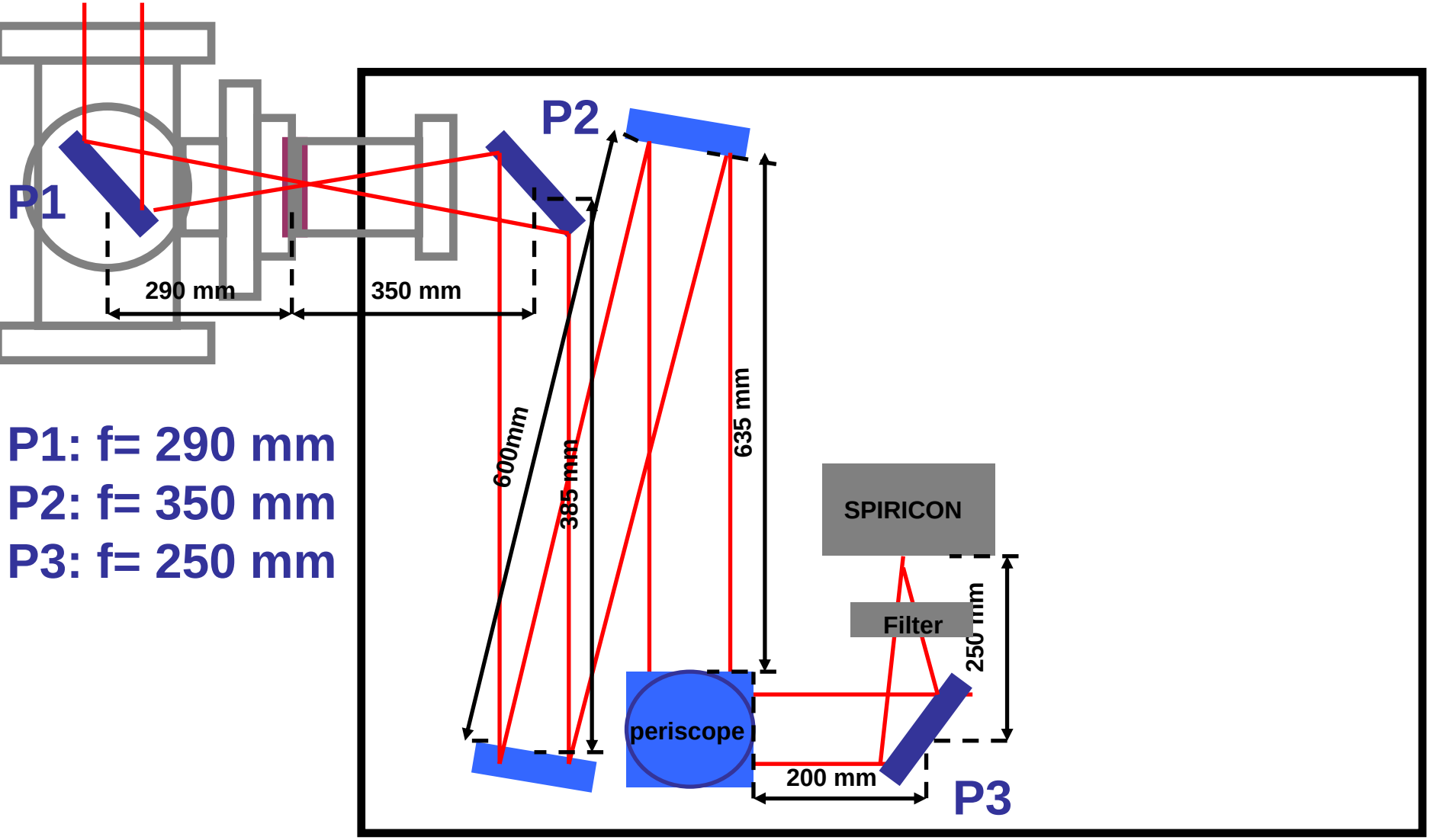
provisonal experimental station





completed 13.11.2007 – just in time for shift!

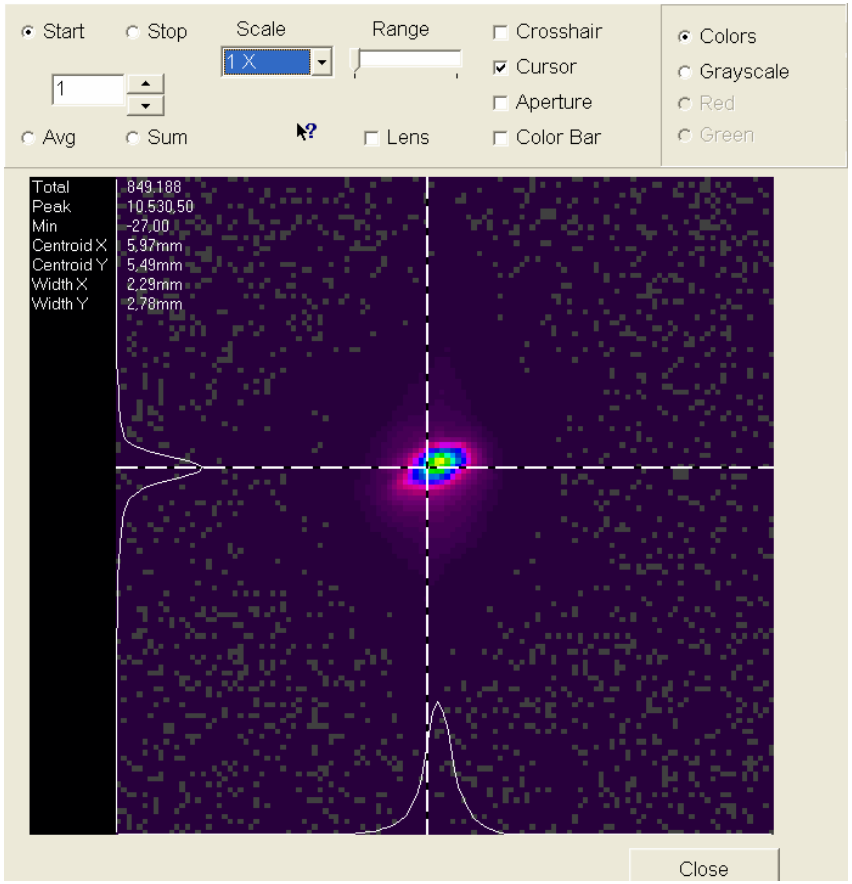
First light: beam profile



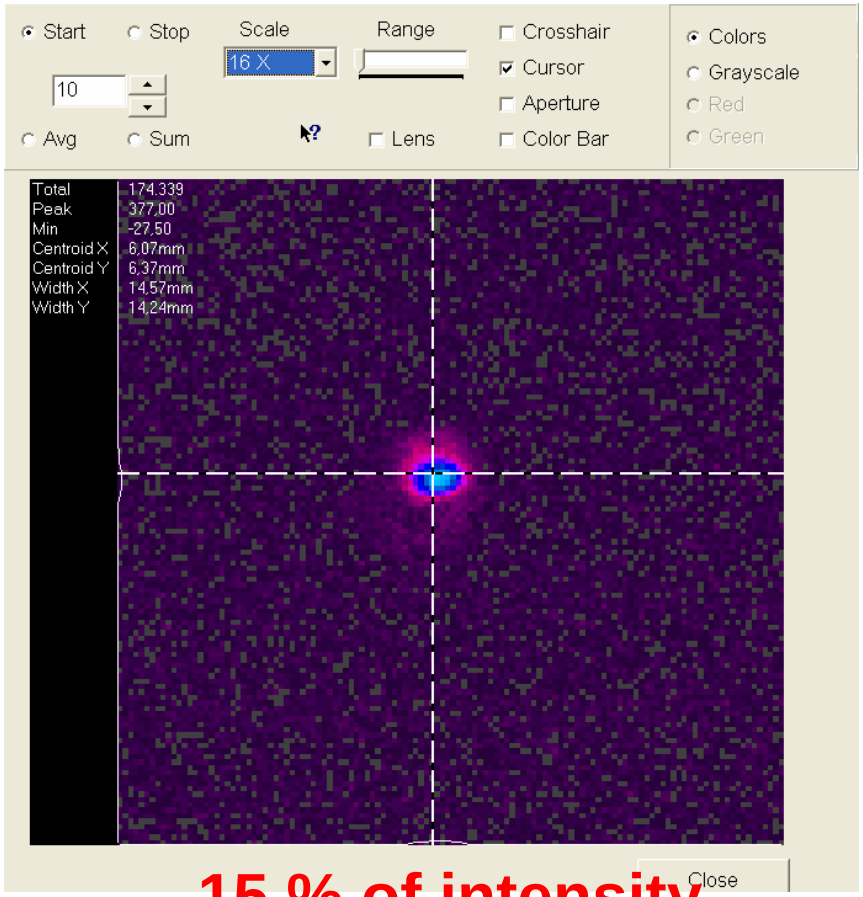
P1: f= 290 mm
P2: f= 350 mm
P3: f= 250 mm

First light: beam profile/filter measurements

full beam



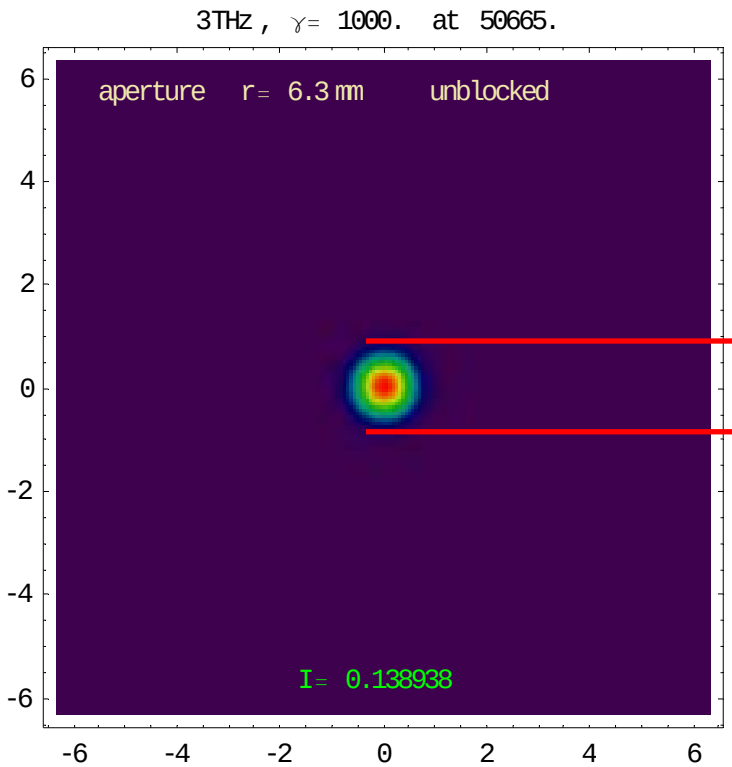
100 μm band pass filter system



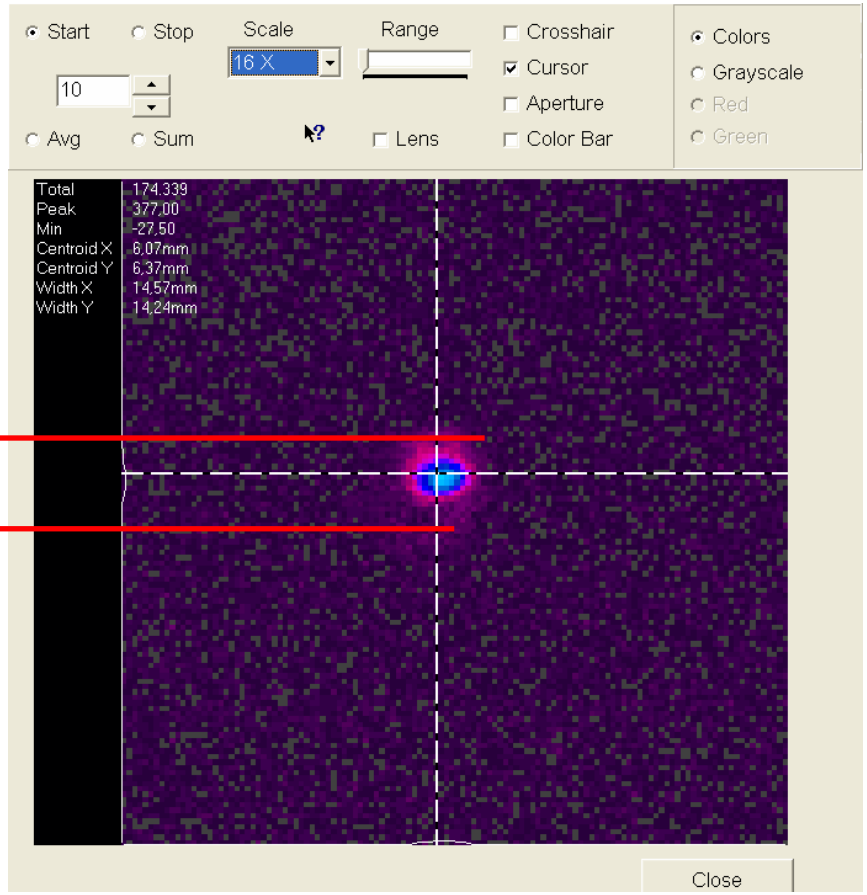
15 % of intensity

First light: beam profile/filter measurements

calculation

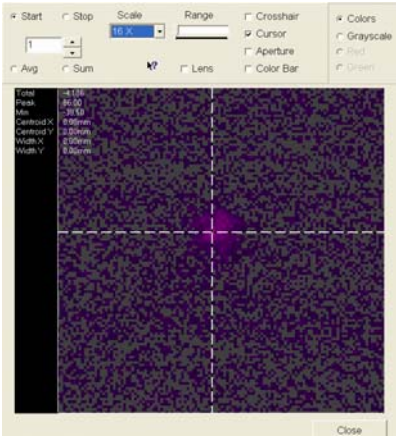


100 μm band pass filter system

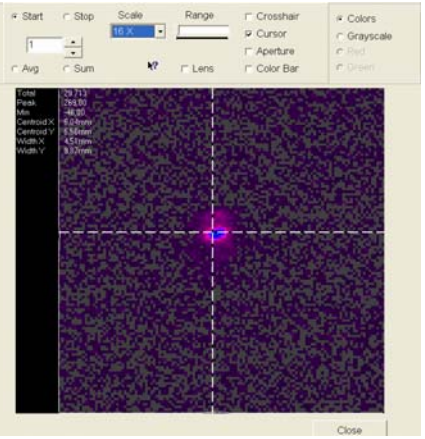


First light: beam profile/filter measurements

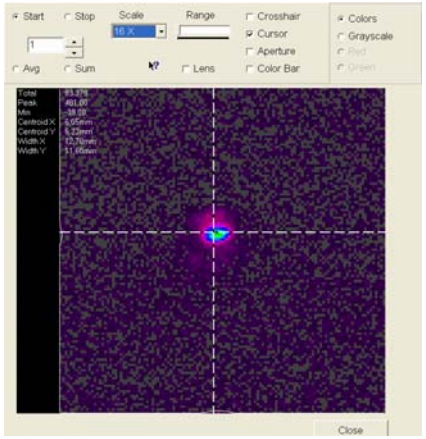
70 μm



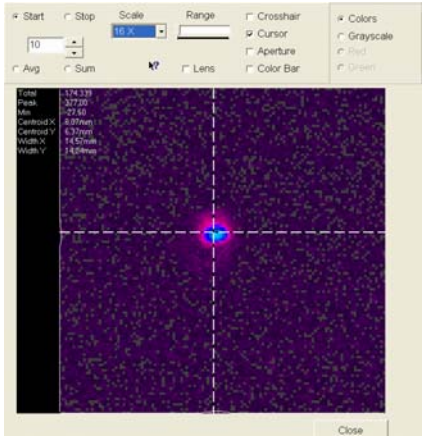
75 μm



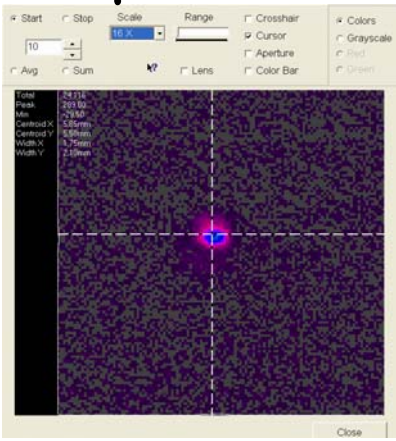
80 μm



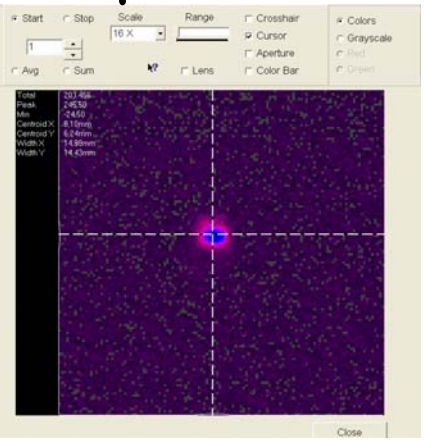
85 μm



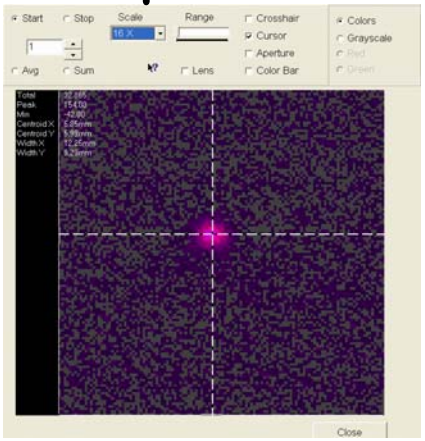
90 μm



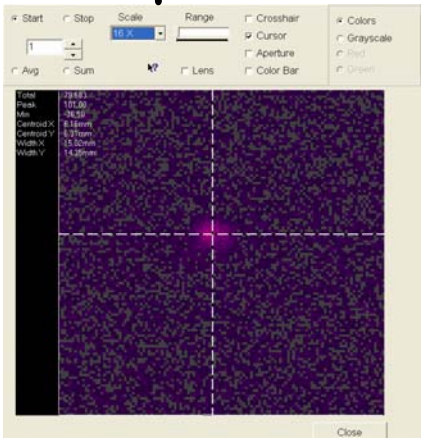
95 μm



100 μm



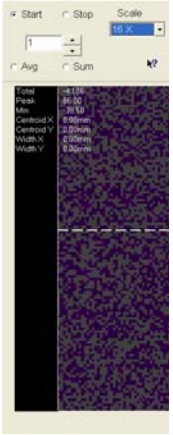
104 μm



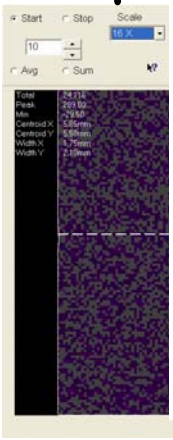
Pointing stability OK?

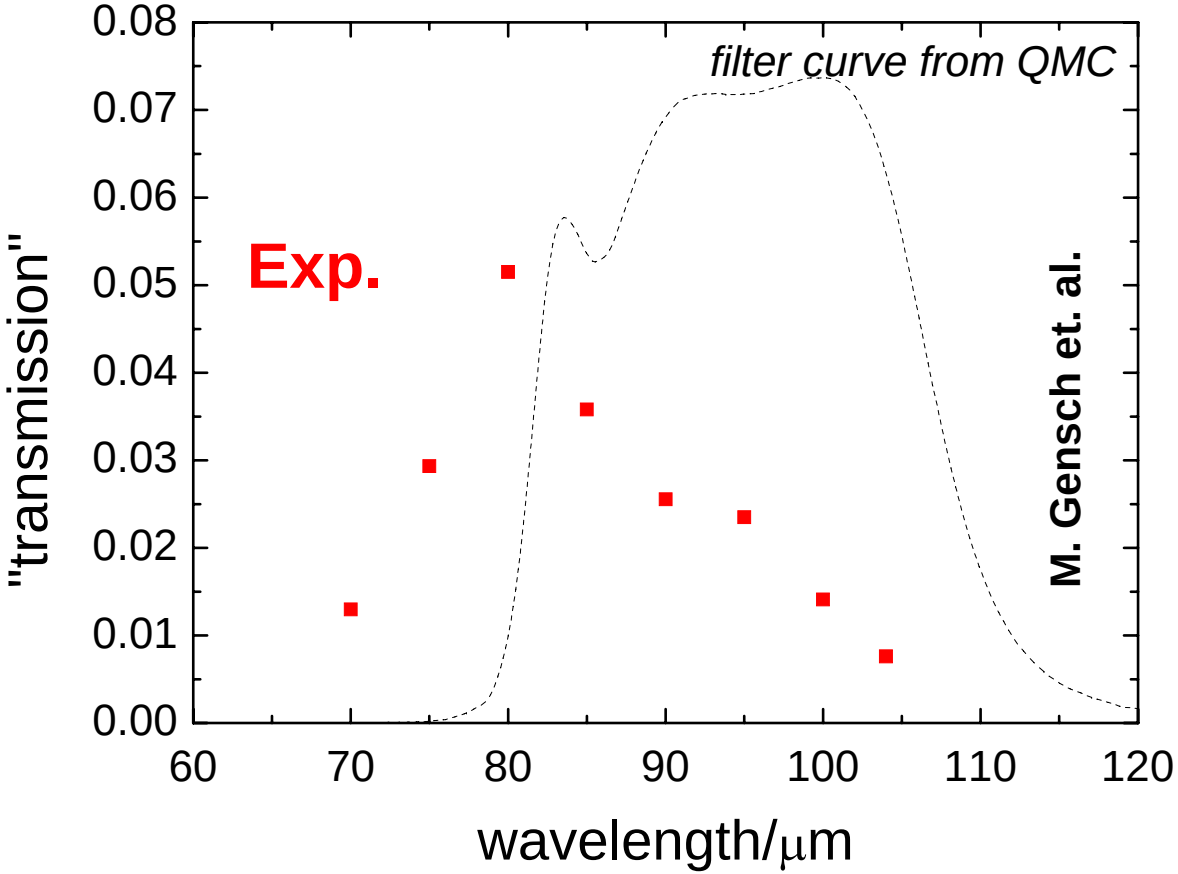
First light: beam profile/filter measurments

70 μr

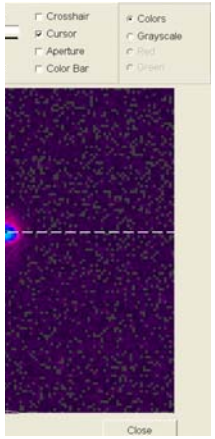


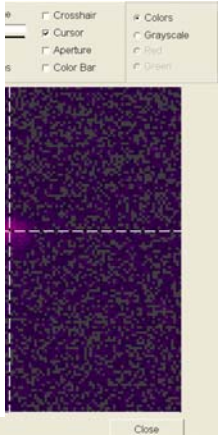
90 μr



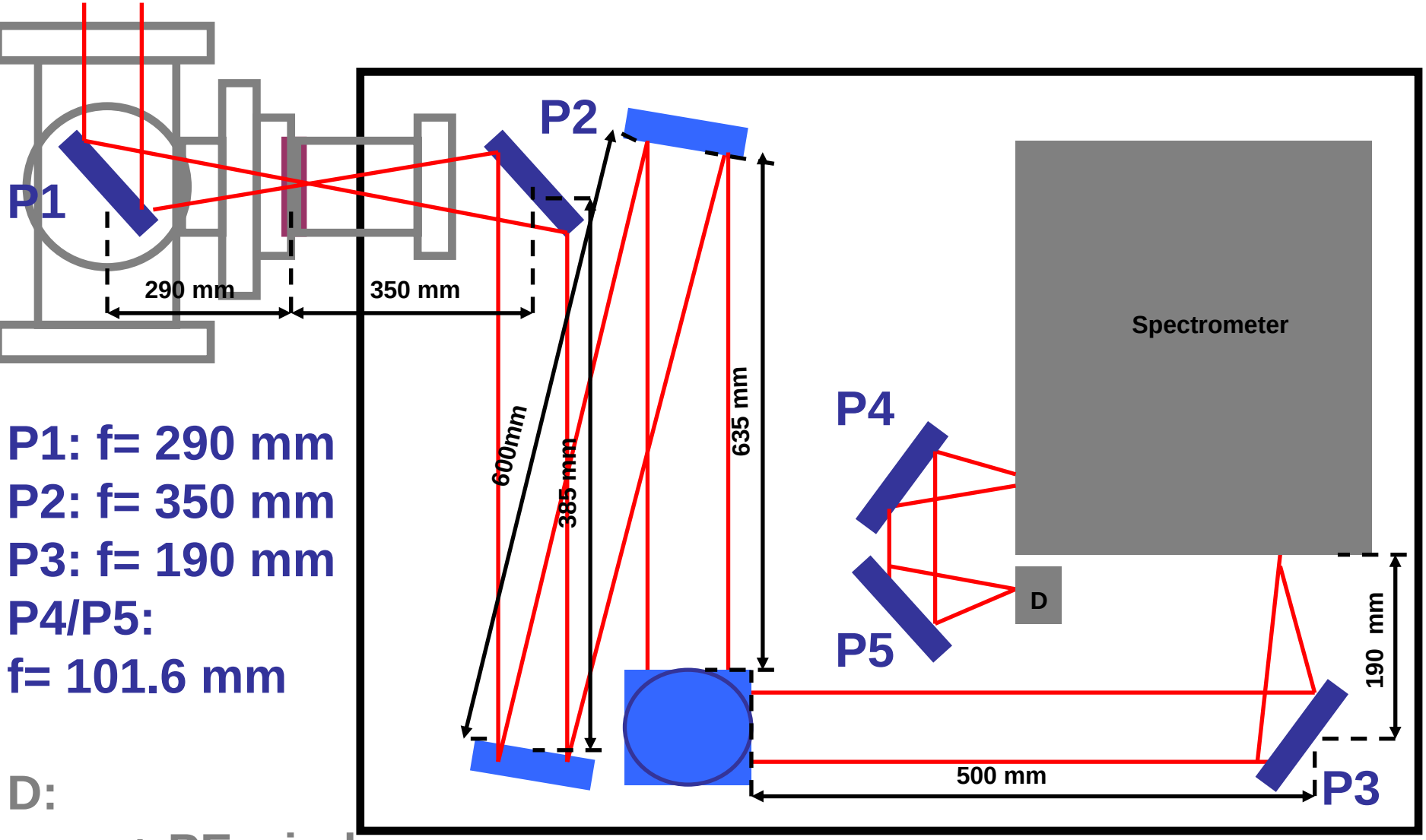


n





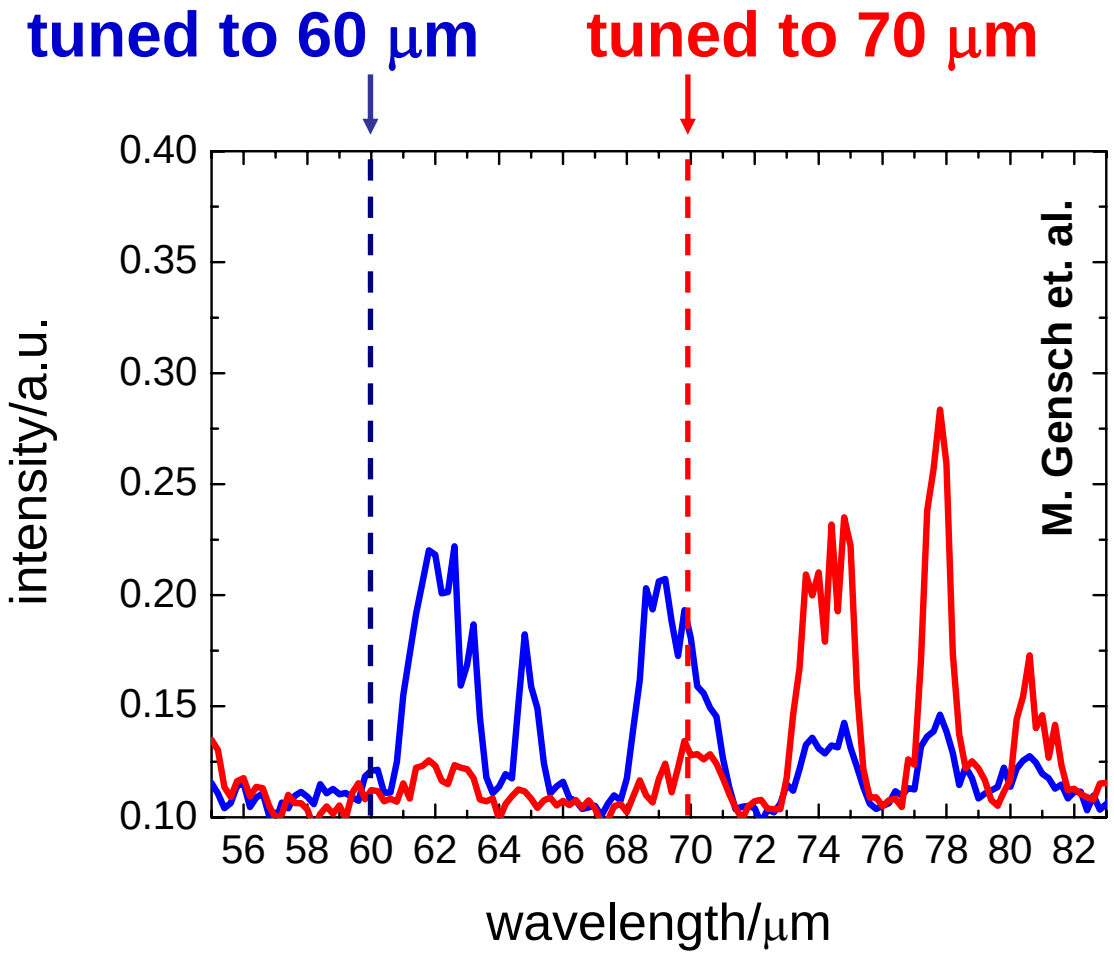
First light: spectral diagnostics



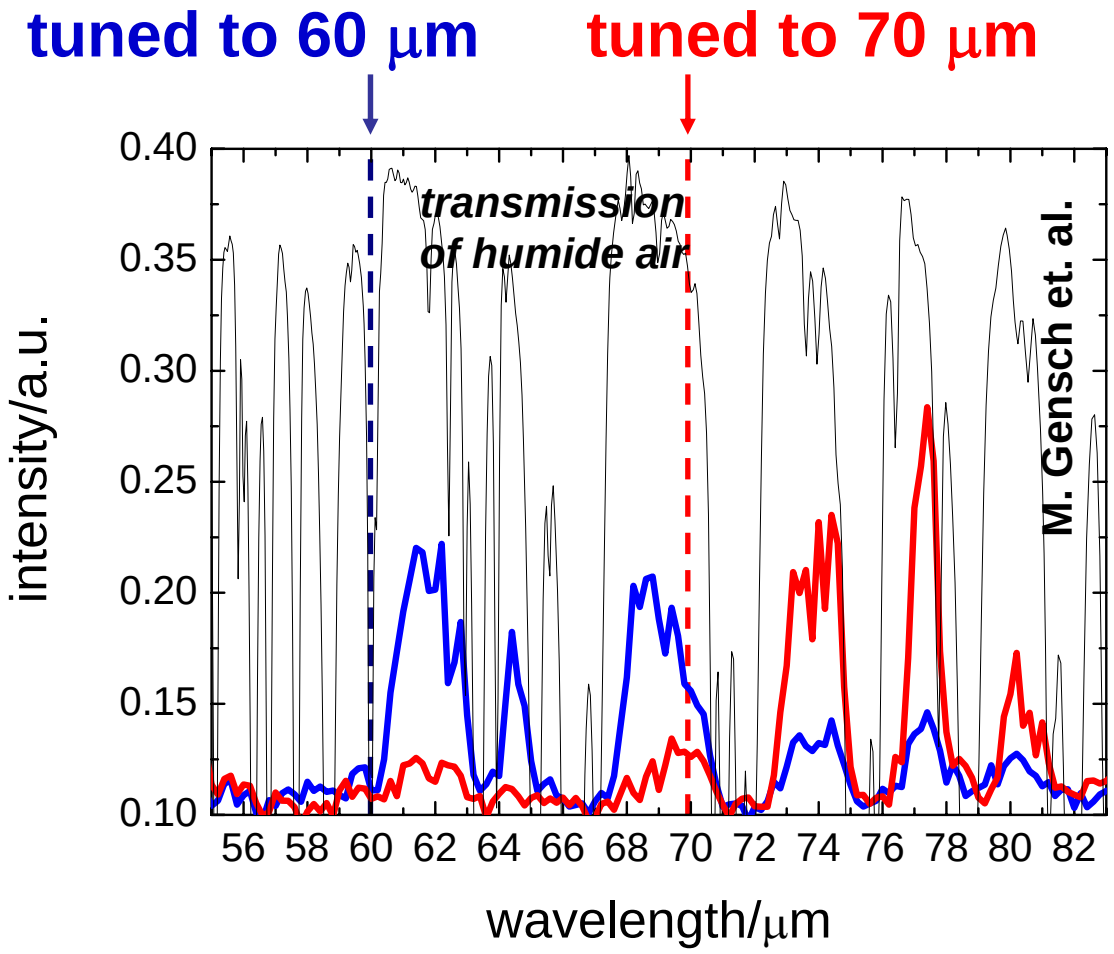
P1: f= 290 mm
P2: f= 350 mm
P3: f= 190 mm
P4/P5:
f= 101.6 mm

D:
pyro + PE window

First light: spectral diagnostics

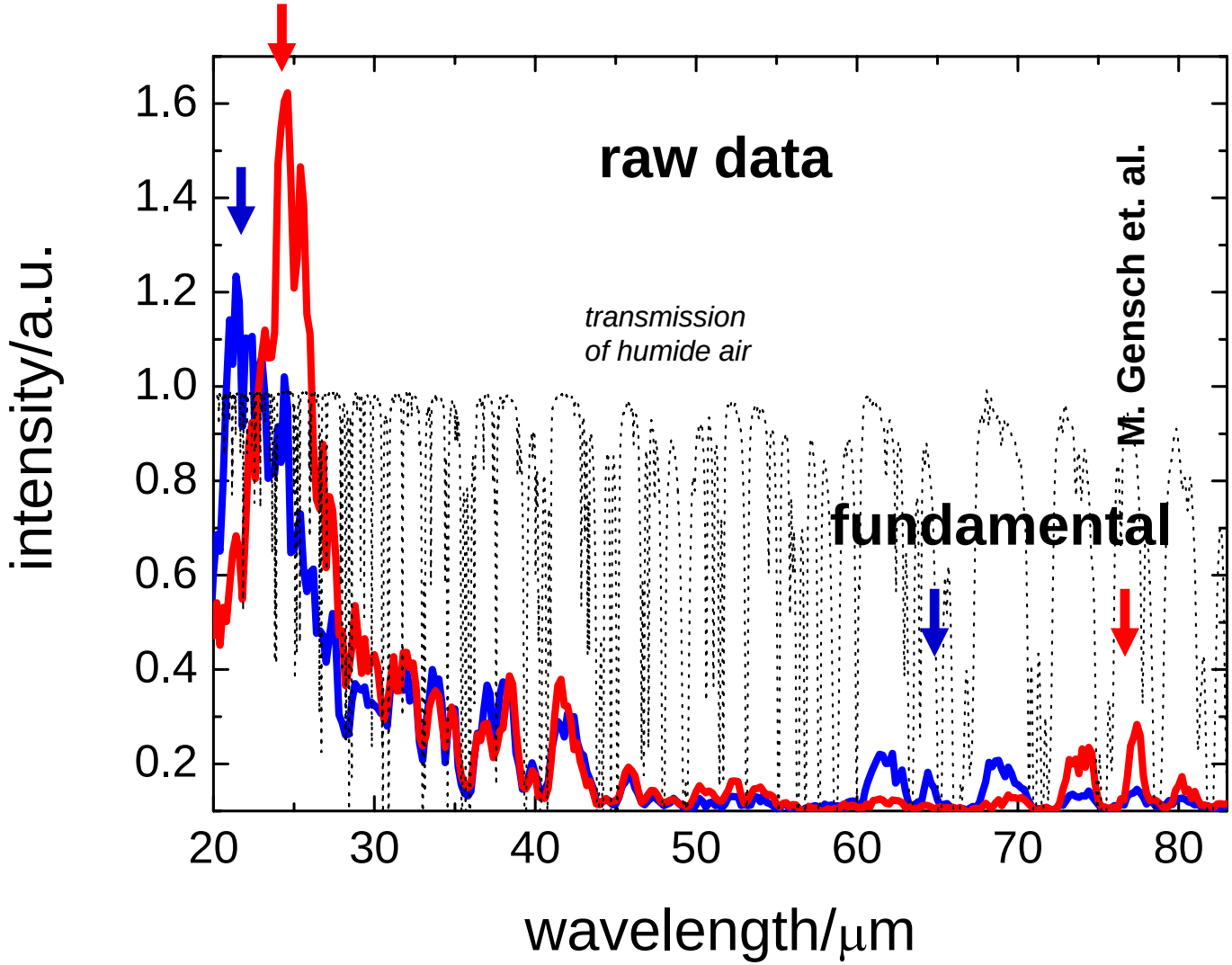


First light: spectral diagnostics



First light: spectral diagnostics

3rd harmonic?

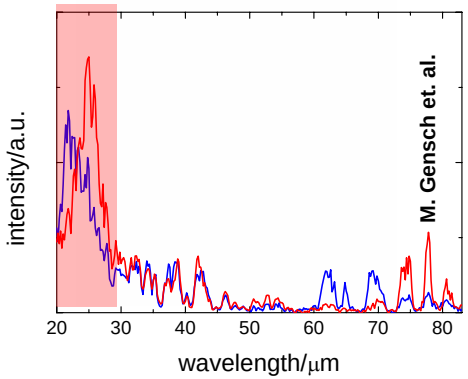


First light: spectral diagnostics

with correction:

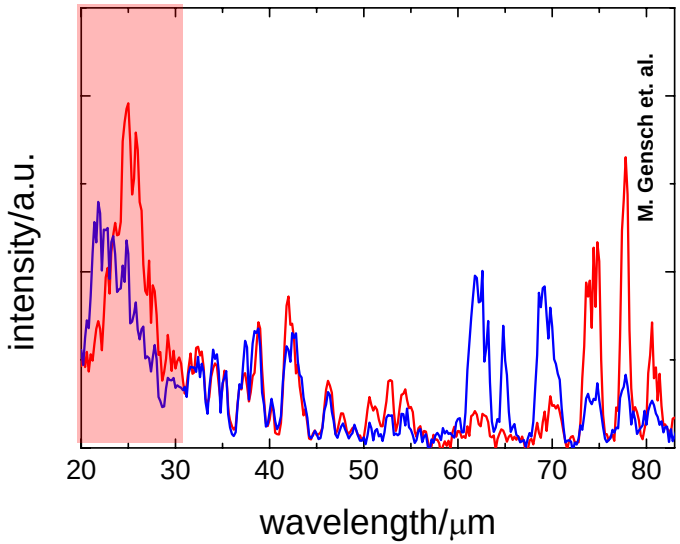
for comparison
of spectral contents
-> purged set up needed

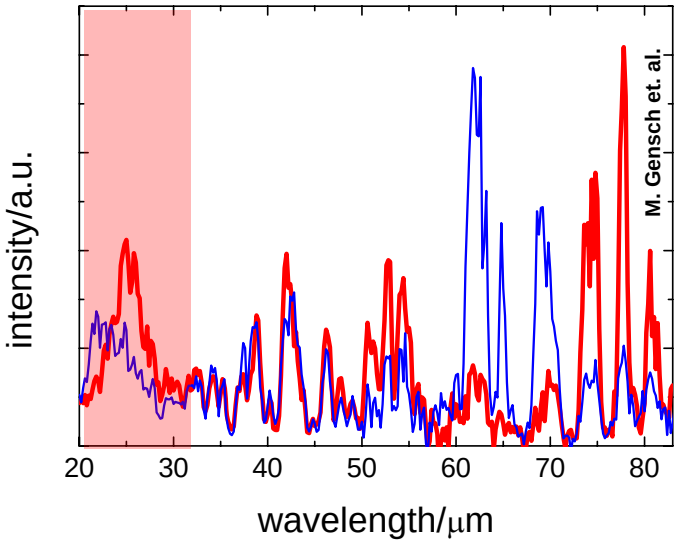
1. for instrument function



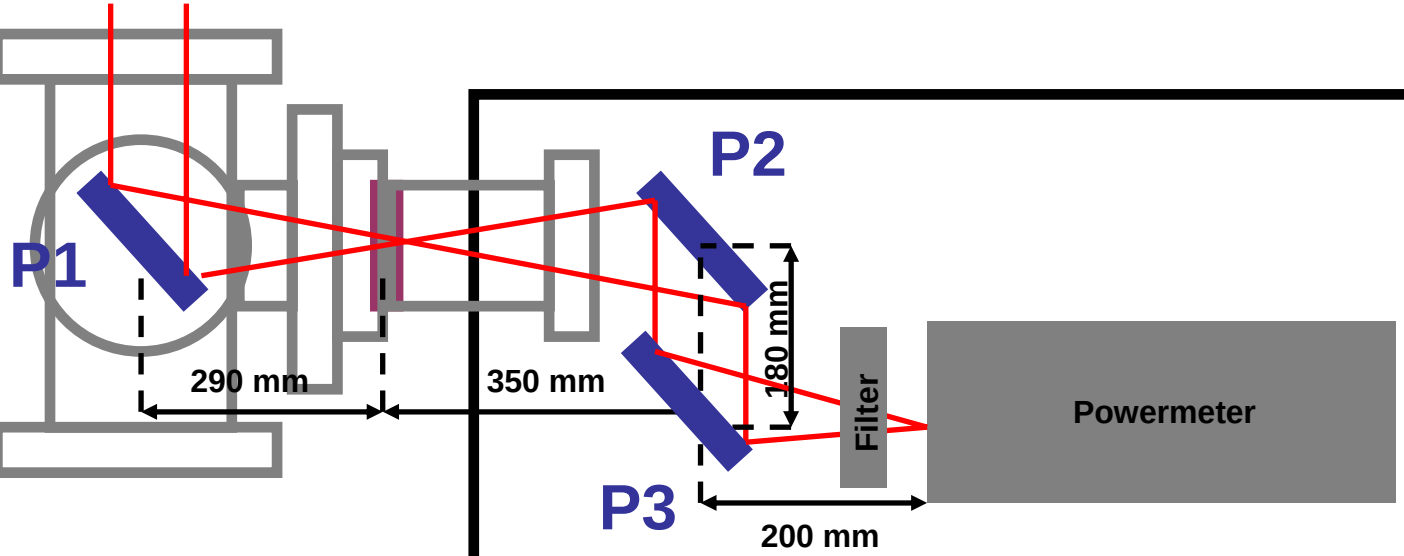
+

2. ….different assumed water vapor contents





First light: power measurements

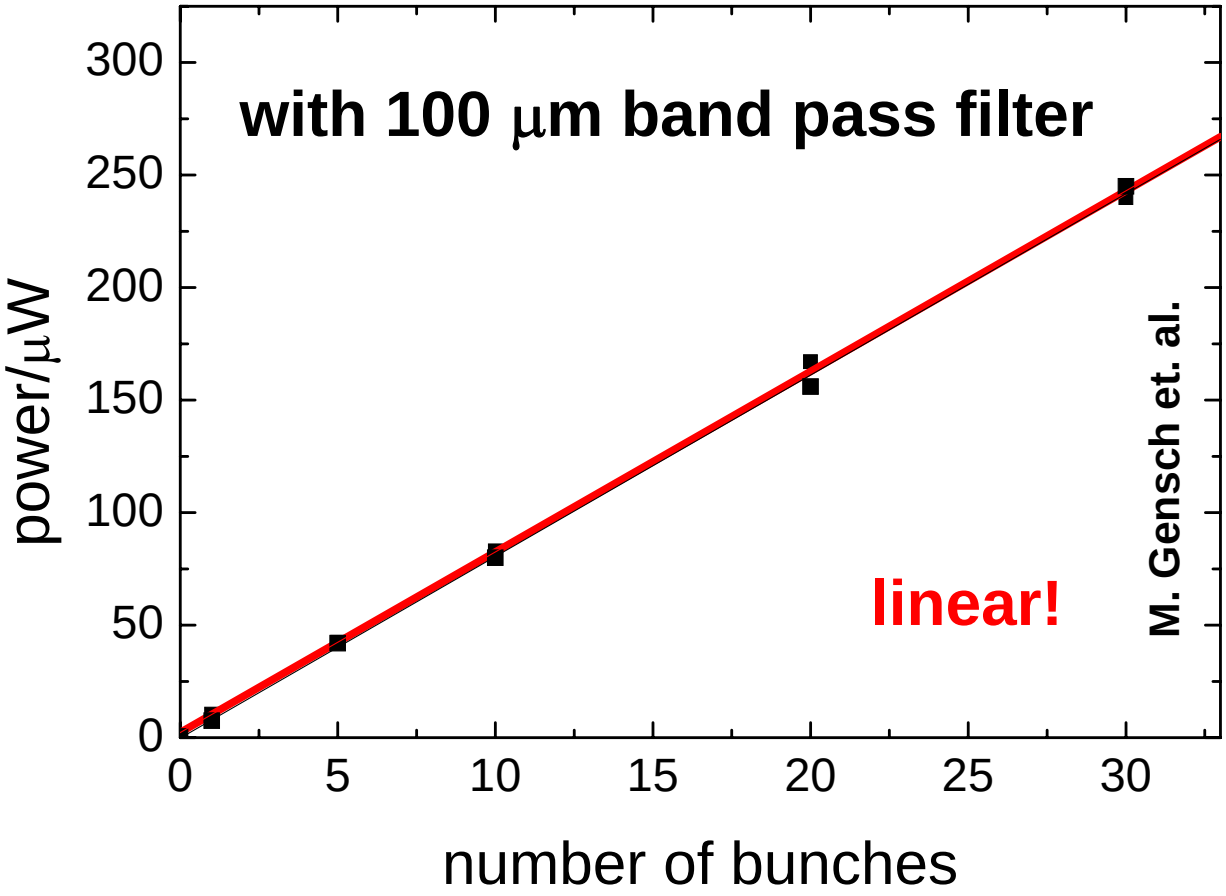


P1: f= 290 mm
P2: f= 350 mm
P3: f= 200 mm

0 bunches -> 1.5 μW full beam
0.5 μW with filter

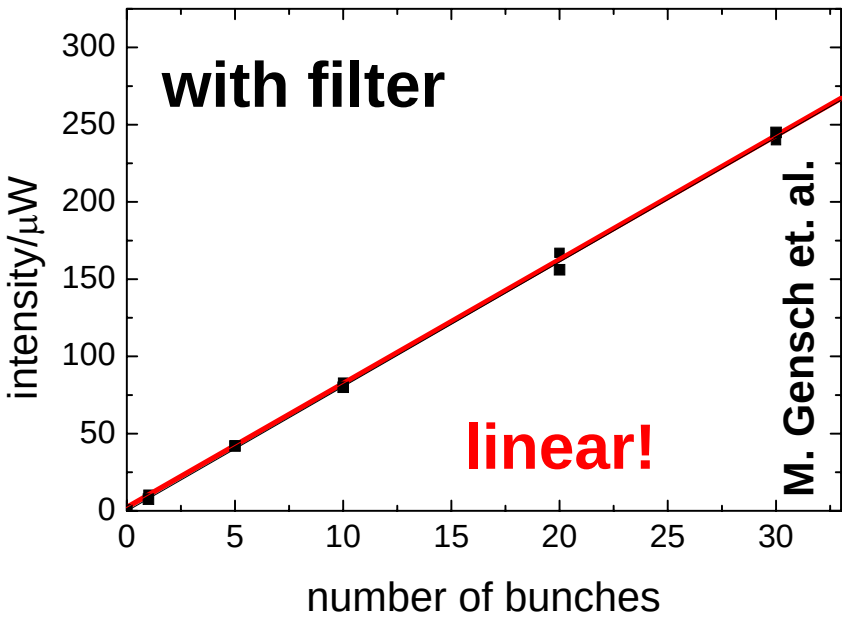
Calibration measurement before each measurement (filter produces 30 μW)

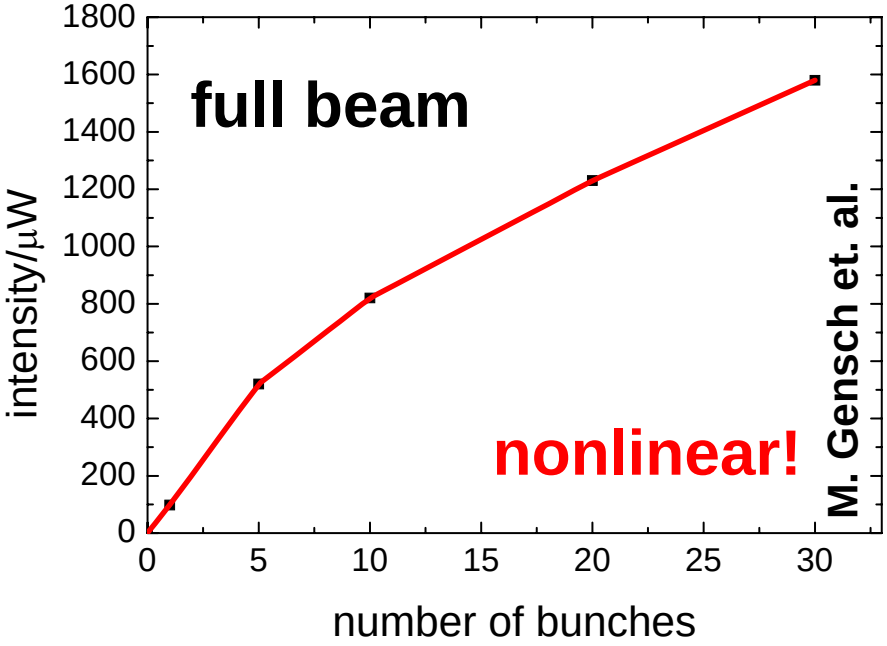
First light: power measurements



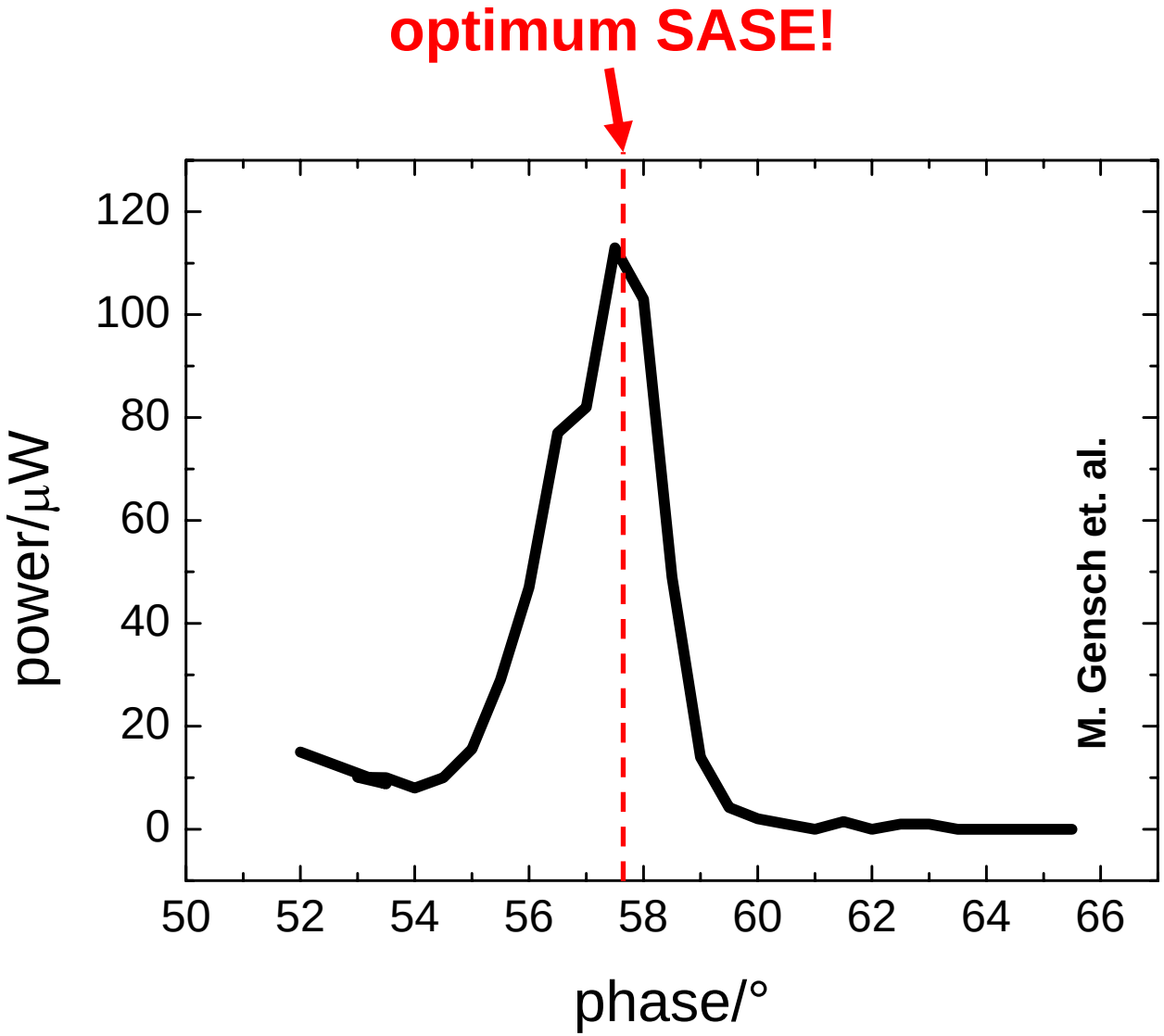
5 bunches/s = 9 μW -> (1.8 +/- 0.3) μJ pulse energy?

First light: power measurements

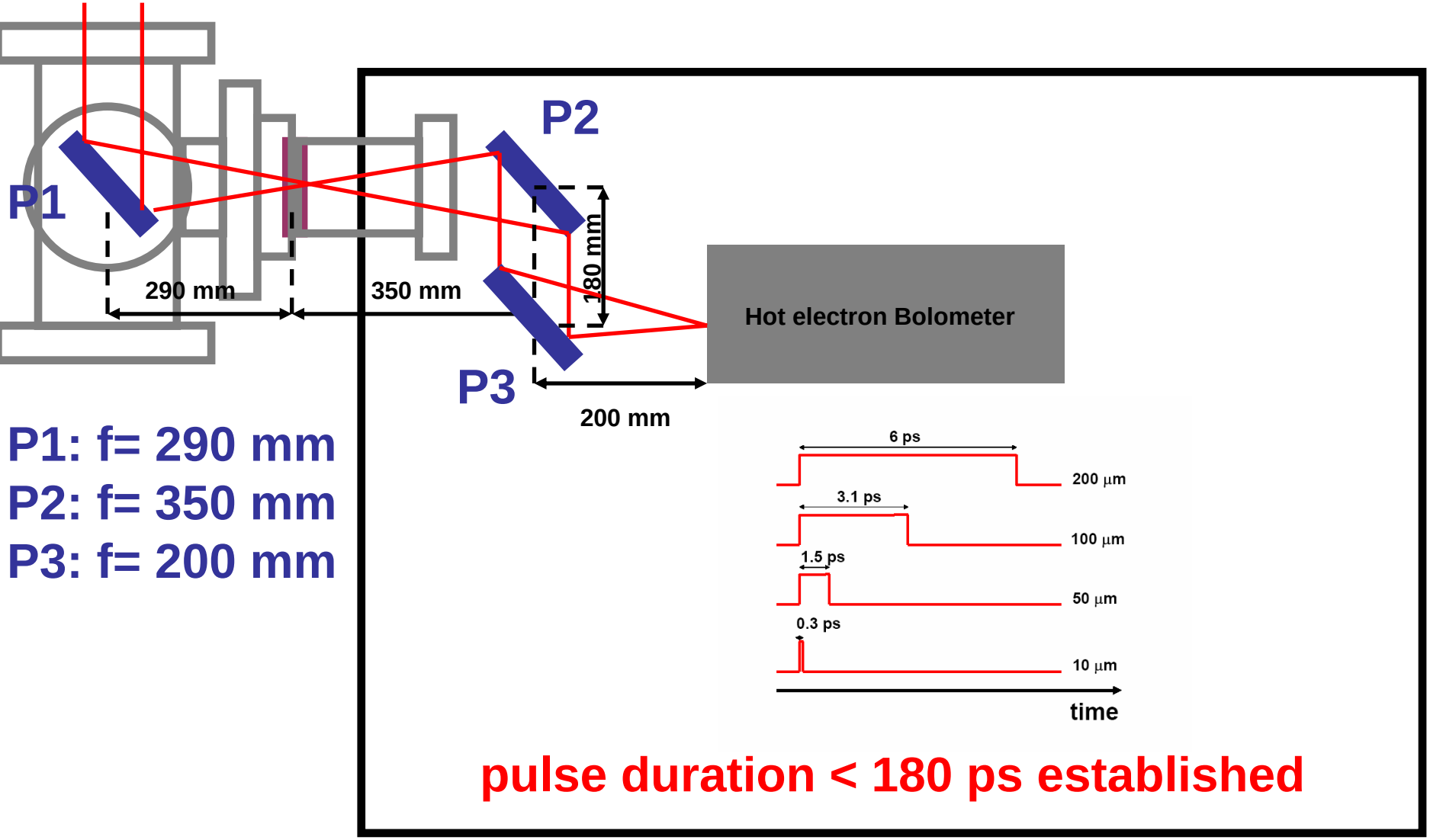




First light: power measurements



First light: time structure



P1: f= 290 mm
P2: f= 350 mm
P3: f= 200 mm

pulse duration < 180 ps established

First light: Summary

Measurement of:

Beamprofile: close to simulation, slightly elliptically

Power: calibration under way, μJ Level ???

Spectral content: fundamental shifted by 5 – 10 micrometers

Timestructure: sub ns established (present limit of detection)

-> next shifts end of january!
-> photondiagnostic collaboration established

Photondiagnostic collaboration for the FIR undulator beamline at FLASH

Goal:

- gather expertise and equipment to perform source and beamline diagnostic during comissioning of the beamline

- develope dedicated (ONLINE) photondiagnostic for the user facility

Members (so far):

M. Gensch, M. Yurkov, E. Schneidmiller,
U. Fruehling, E. Saldin, V. Kocharyan (DESY),
Wolfgang Seidel (FZ Rossendorf),
Ullrich Schade, Jongseok Lee (BESSY),
Heinz-Wilhelm Hübers, Alexei Semenov (DLR)

Next steps

01/2008

-***Completion of FIR beamline***

2008

- Development of ONLINE photondiagnostic
- Comissioning of FIR beamline

- (Pilot) VUV – IR pump probe experiments

2009

if approved: -> establish FIR beamline as optional user facility for pump probe experiments at FLASH

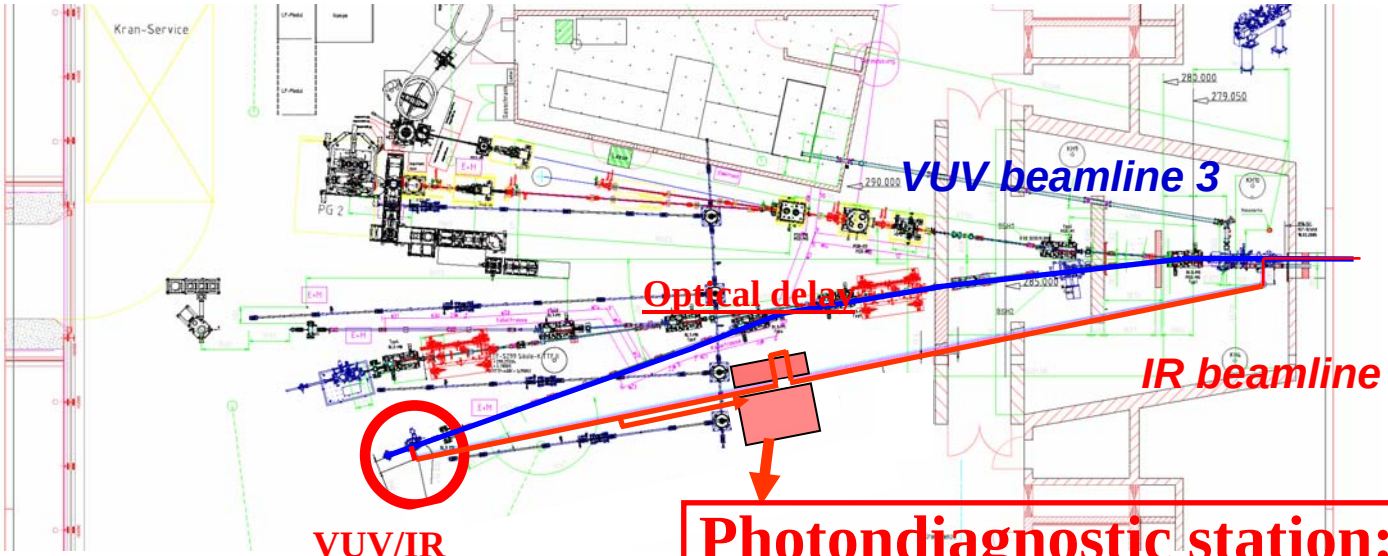
Outlook 2009: user facility for VUV/IR pump probe experiments

foreseen photondiagnostic:

- Single shot spectrometer
- Single shot E/O, spatial decoding
- Single shot beam profile
- IR - FIR Powermeter

} *ONLINE!?*

(currently under development in collaboration with external groups: ELBE, DLR,BESSY, PTB)



VUV/IR

pump-probe experimental station

Photondiagnostic station:

-> same image as in experiment!

THANK YOU !