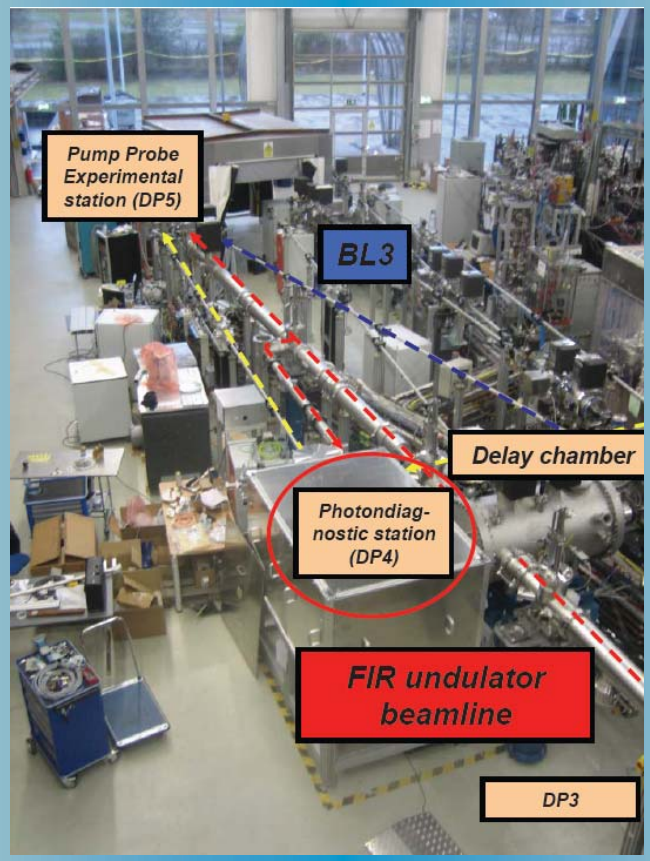
# Light at the FLASH FIR beamline – second coming




*Michael.Gensch @ DESY.DE*

## Status of the beamline

## Comissioning

## Next Steps

# FIR beamline commissioning: Motivation



## timeschedule as presented to PSC in 09/2007

***01/2008***

-*Completion of FIR beamline*

***2007/2008***

*- Development of ONLINE photondiagnostic*
*- Comissioning of FIR beamline*

*- (Pilot) VUV – IR pump probe experiments*

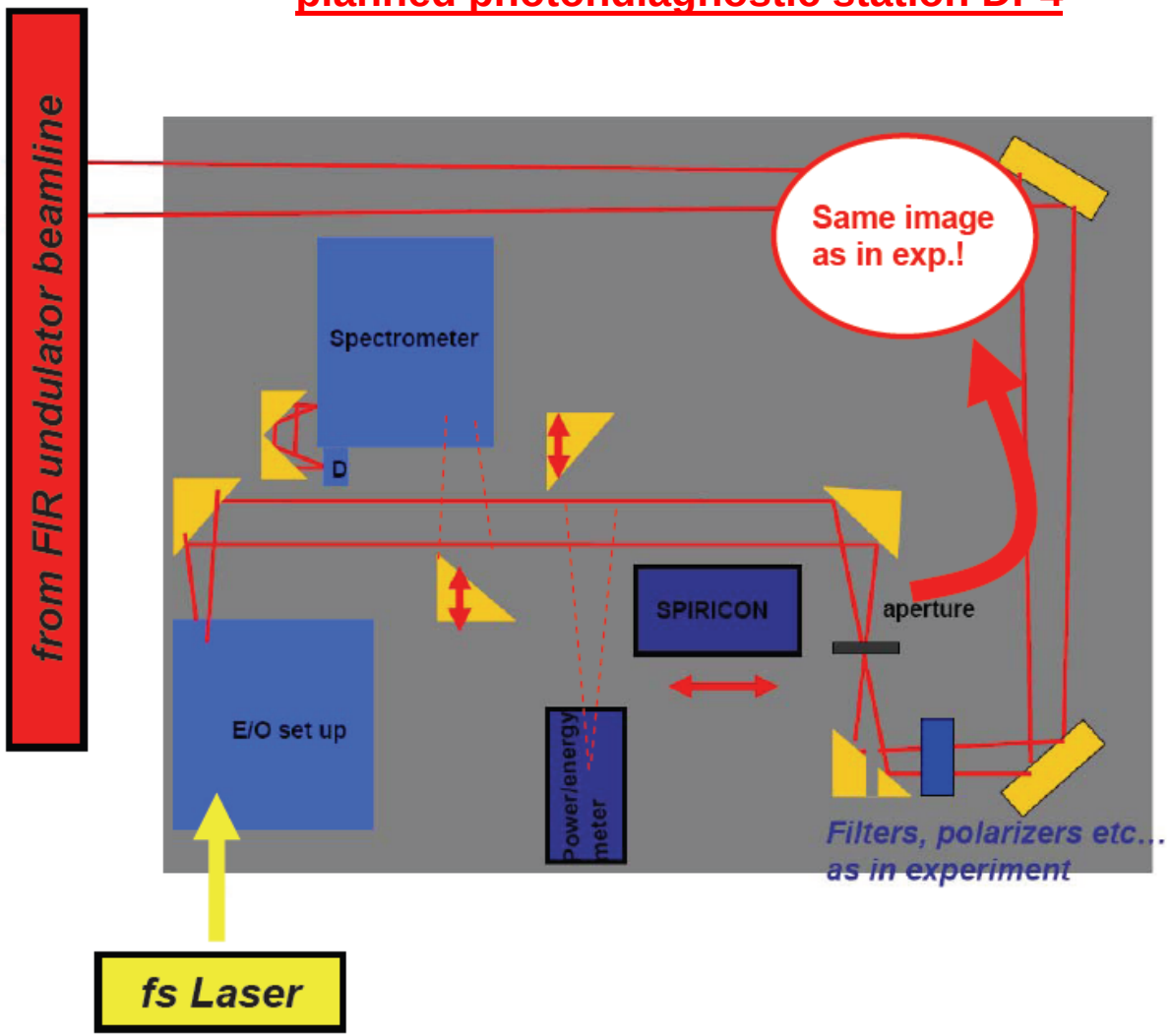
***2009***

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

# FIR beamline commissioning: Motivation



## planned photondiagnostic station DP4




**Aim:**

**ONLINE photondiagnostic of:**

- **beamprofile**
- **power/pulse energy**
- **spectral content**
- **beamprofile**
- **pulse duration**

**-> studies of dependence on areas in beamprofile**

# FIR beamline comissioning: collaboration



## 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

**current Members:**

M. Gensch, M. Yurkov, E. Schneidmiller, V. Kocharyan, U. Fruehling
E. Saldin, S Düsterer, N. Stojanovic (DESY), Wolfgang Seidel
(FZ Rossendorf), Ullrich Schade, Jongseok Lee (BESSY),

Heinz-Wilhelm Hübers, Alexei Semenov (DLR) A. Azima (UHH)

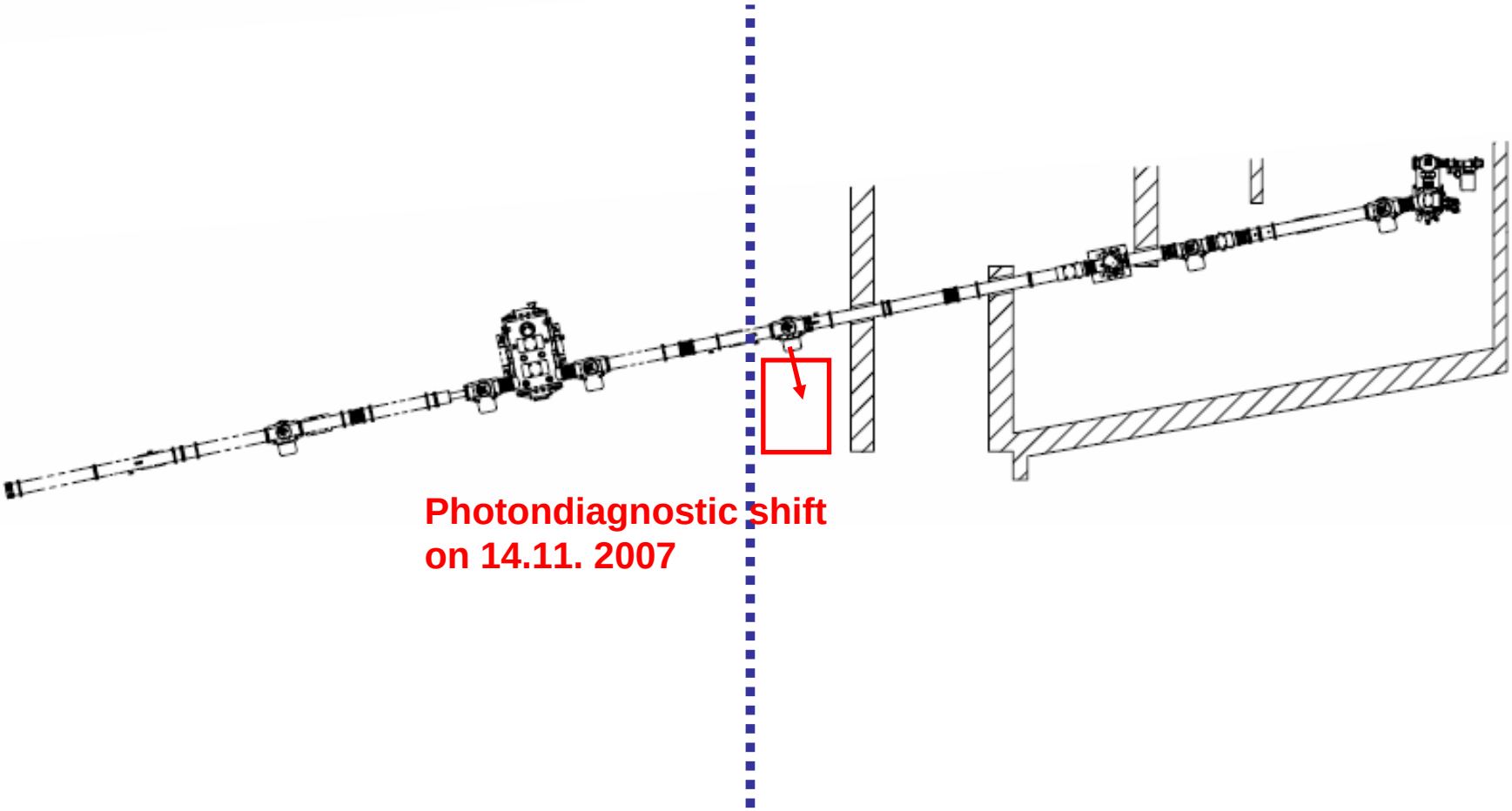
# Status of the beamline

## Comissioning

## Next Steps

# beamline - experimental hall/end of 2007

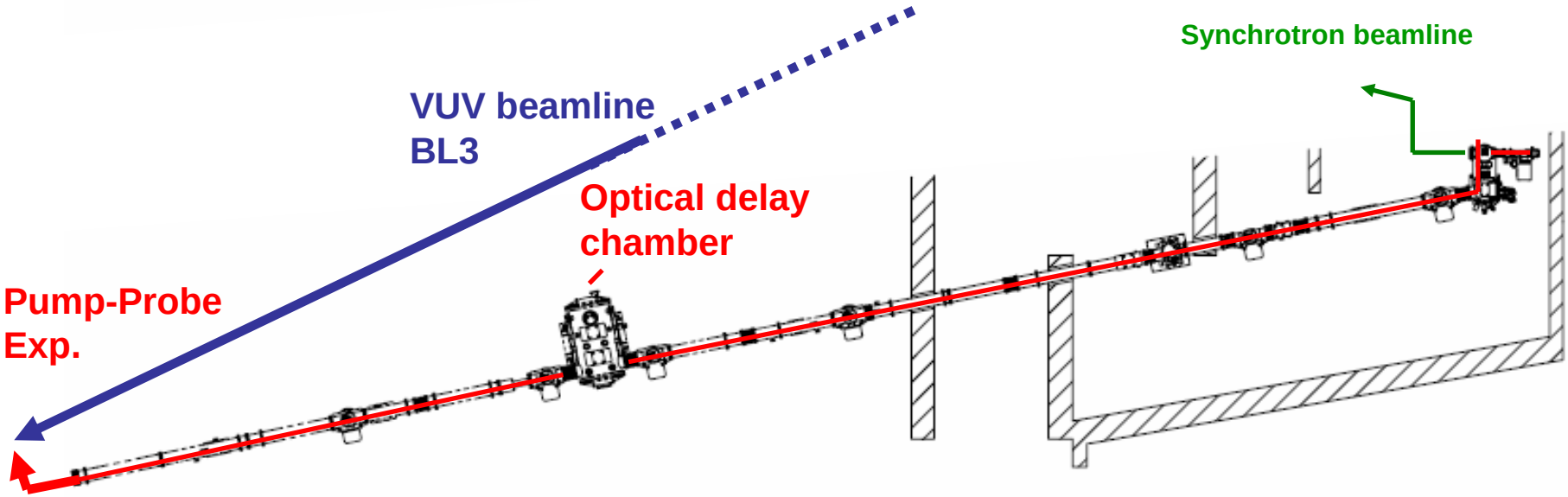





**Completed at time of measurement 14.11. 2007**

# Status: beamline - experimental hall



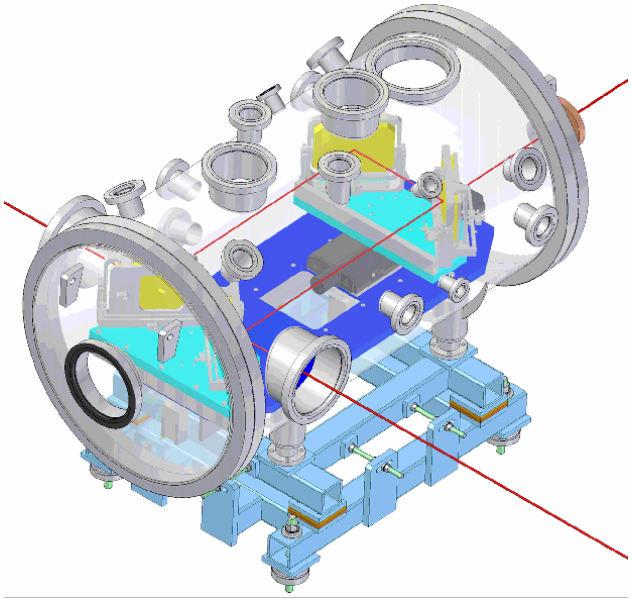


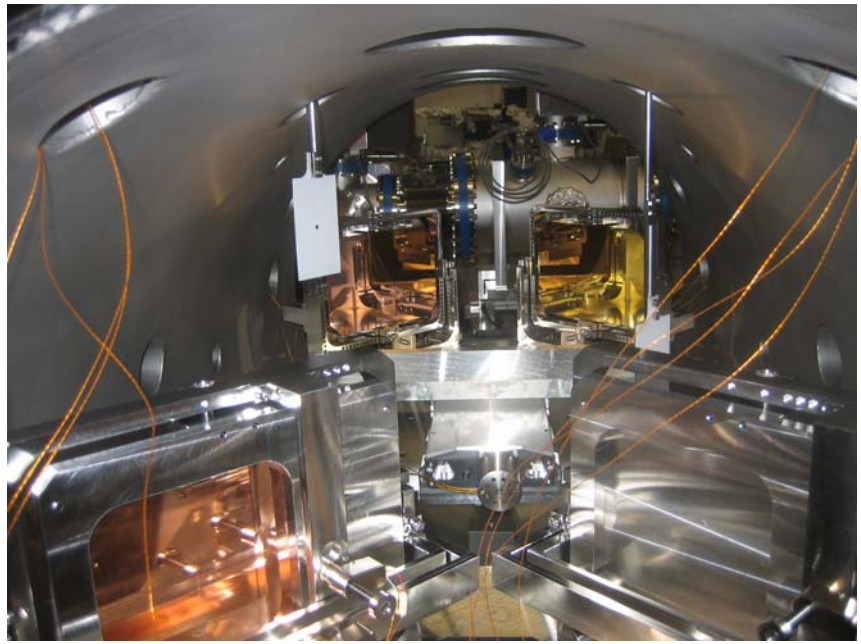

**beamline length aligned on 6.1.2008 by arrival time of ps laser pulses at fast photodiode in exp. (uncertainity 30 ps).**

**-> found temporal overlap central on delay translational stage!**

# Status: beamline – optical delay





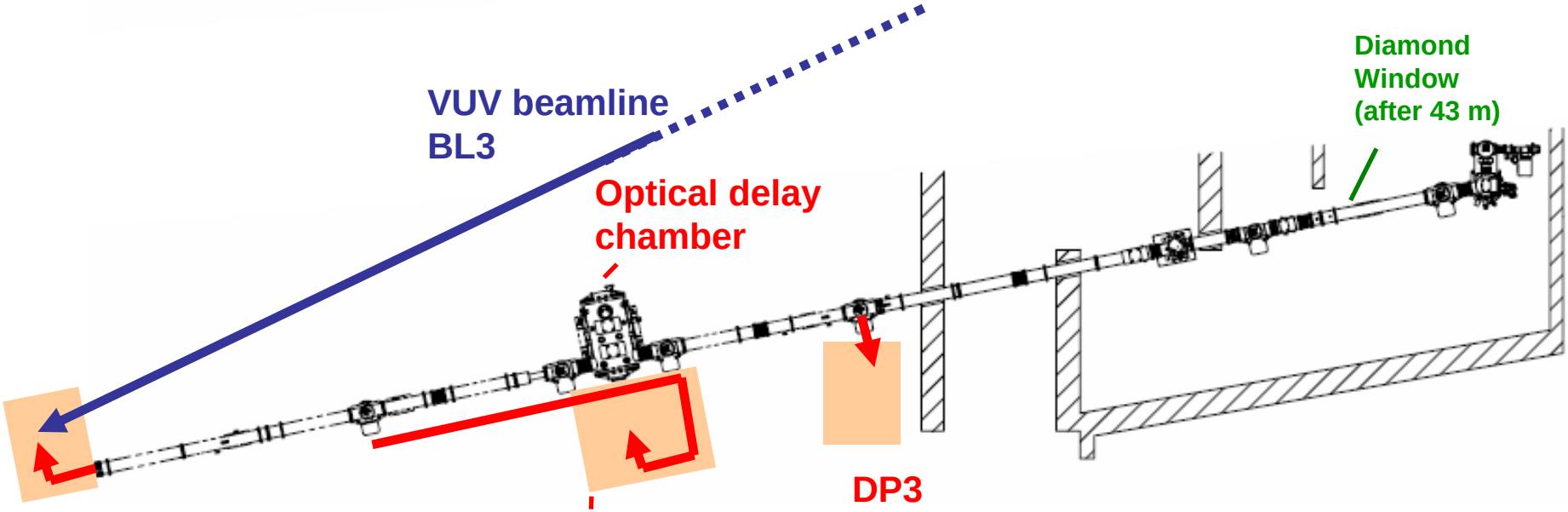


*view into optical delay chamber*

- **bidirectional repeatability: < +/- 5 μm (measured and specified)**
  **-> allows scans with 30 fs steps**

- **maximum translation 200 mm**
  **-> maximum delay +/- 0.66 ns**

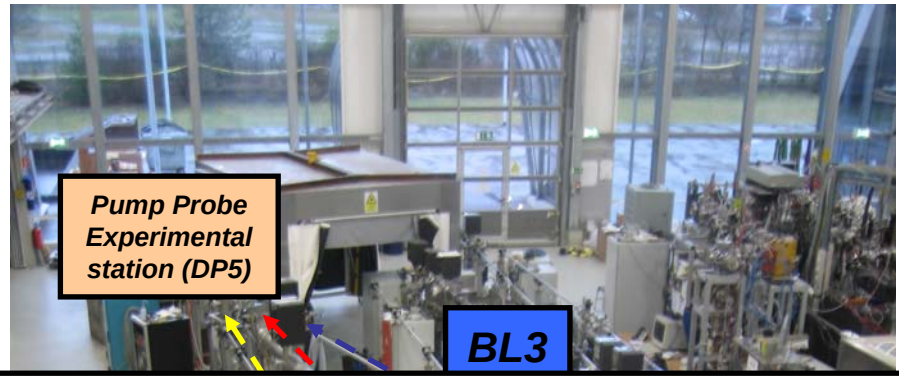
# Status: beamline - experimental hall



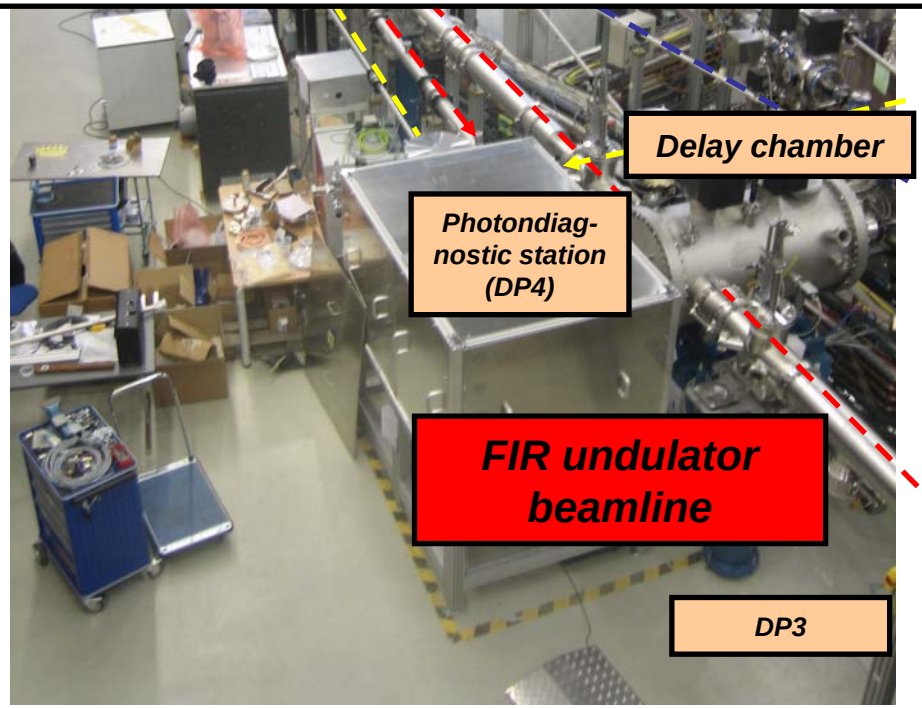

*completed (pumped down) 15.1. 2008*

# Status: beamline - experimental hall






M. Gensch et. al., „New infrared undulator beamline at FLASH“, Infrared Phys. Techn. (2008), doi: 10.1016/j.infrared.2007.12.032



## Status of the beamline

# Comissioning

## Next Steps

# Comissioning: schedule KW05



**IR Beamline Comissioning – project description**

**Project leader**: M. Gensch

**Collaborators:** M. Gensch, M. Yurkov, E. Schneidmiller, E. Saldin (DESY), U. Schade (BESSY), W. Seidel (FZ Rossendorf), H.W. Hübers, A. Semenov (DLR)

**Number of shifts required:** 6 (of which 3 shifts can be carried out parasitically provided electron beam is going through the FIR undulator, we would like to work in multi bunch mode most of the time)

*Abstract:*
This project is aiming to continue the IR beamline commissioning part in the "IR-VUV pump probe beamline commissioning" project which was appointed several shifts in the previous beamtime period. Constructional delays caused that the IR Beamline was not completed in time to perform the aspired commissioning tasks. Apart from one single shift the time was used to align and prepare the VUV diagnostic and optics for the VUV-IR overlap in the pump probe experimental chamber.
For this one shift in November 2007 the first 50 meters of the future IR Beamline, were provisionally taken into operation (in a tremendous effort by the HASYLAB vacuum group). The radiation was then analyzed at a provisional measurement port in the FLASH experimental hall. Spectra, beamprofile and power of the undulator could be measured for the first time using various equipment provided in parallel by a recently formed photondiagnostic collaboration. Although these measurements seem exceptional for the very limited time that was available they are by no means satisfactory. A number of alignment problems within the beamline but also of the FIR undulator could be identified and now have to be tackled by the different responsible technical groups. This means that the provisional alignment of the beamline into the experimental hall will be lost. It is presently hoped that in December mounting of the hardware of the beamline in the experimental hall will be completed. First rough alignment of the various sophisticated optics is hoped to take place in January but will again have to start from scratch. The below described goals of the in all required 6 shifts are mandatory before work on the electrondiagnostic (A. Willner) or the VUV photondiagnostic project (U. Frühling) can start.

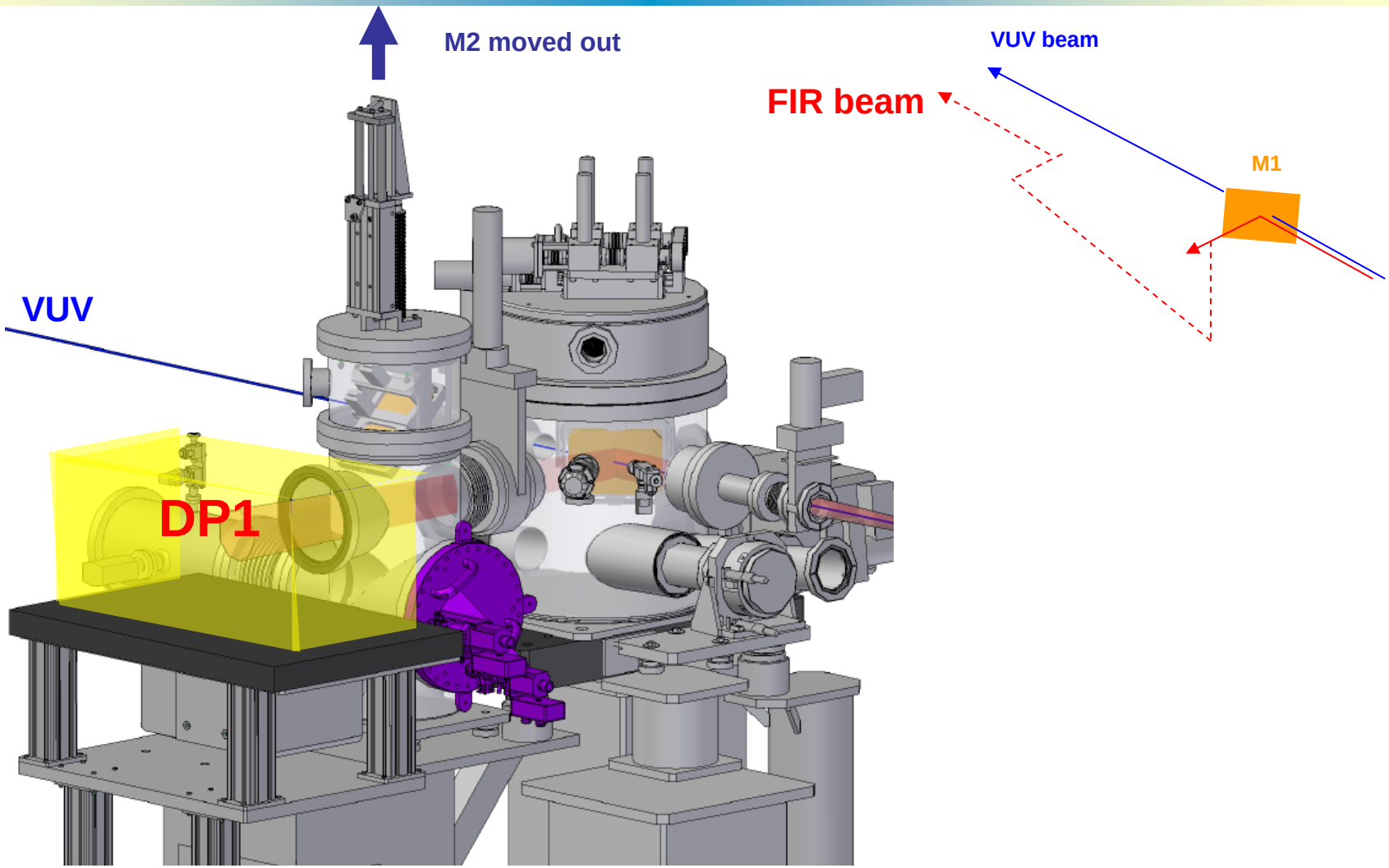
## planned work in KW05

- alignment of beamline with laser´s (including all DP´s in exp. hall)
- alignment with undulator radiation
- power measurement
- spectral diagnostic
- studies of beamprofile at DP3/DP4
- check dependencies on undulator tune
- measurement of pulse duration using direct detectors and possibly E/O sampling

**New issue:**
**measurement of VIS-NIR content in VUV BL3 (laser safety)**

# available diagnostic ports: tunnel



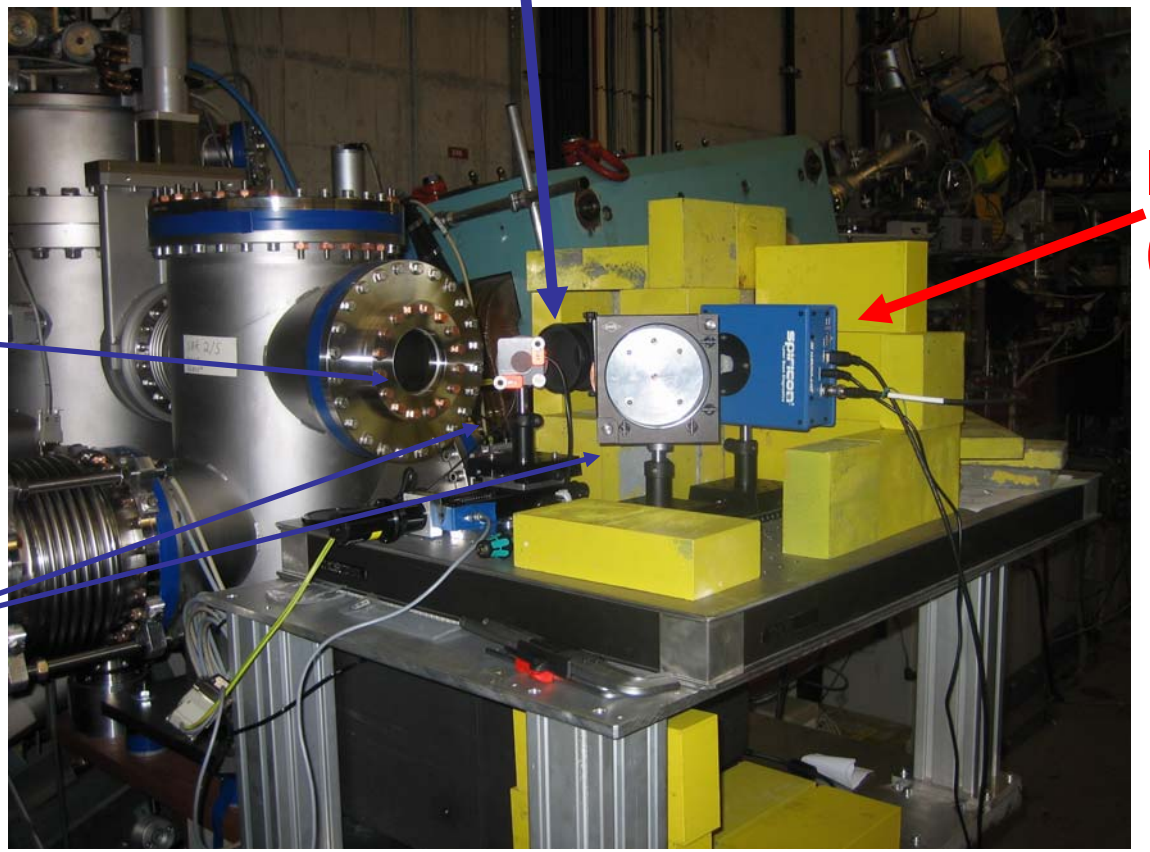



*Source diagnostic in diagnostic port 1 (DP 1)*

# available diagnostic ports: tunnel



**ICCD, power meter, …**



**IR camera (1 – 1000 μm)**

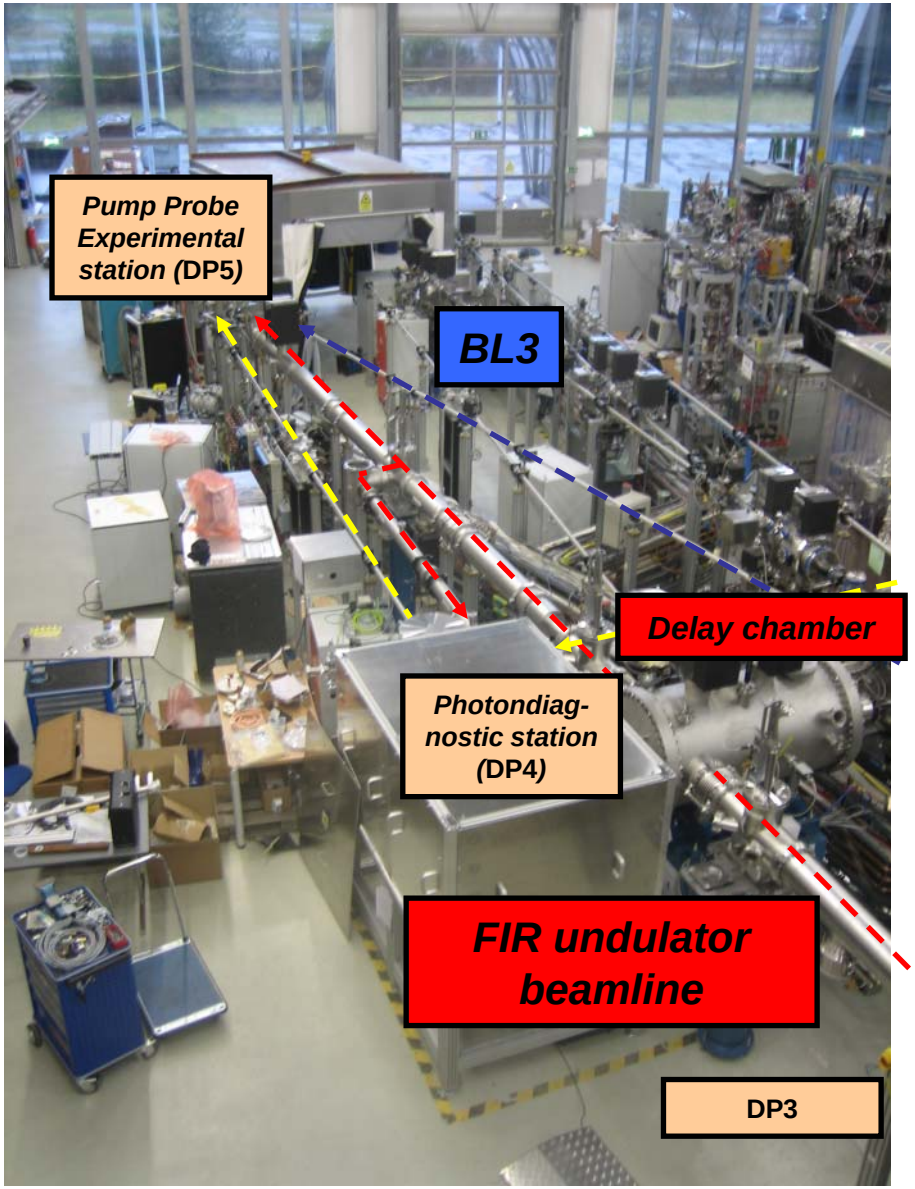
viewport

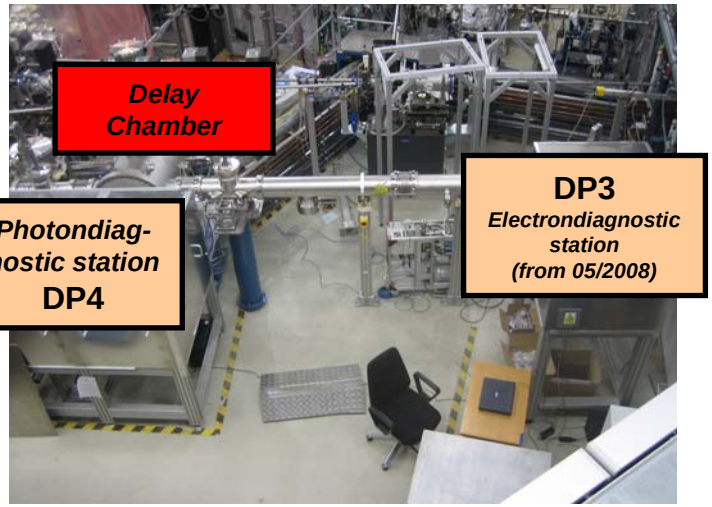
mirrors

**photon diagnostic station DP1: looking on M1**

# available diagnostic ports: experimental hall



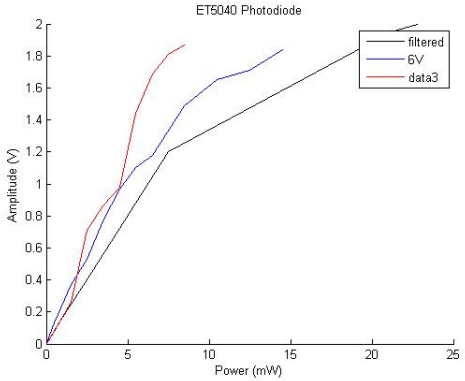



*view showing Photondiagnostic station and DP3 (soon to be electrondiagnostic port)*

← *view down stream in the experimental hall*

# + photodiode at the end of VUV BL3



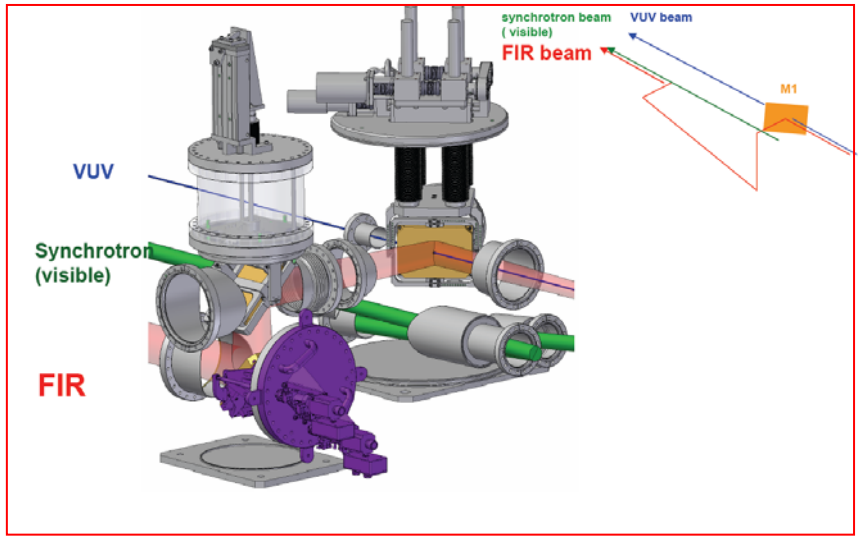

VUV beamline
BL3

Optical delay
chamber

Diamond
Window
(after 43 m)

DP3

InGaAs
Photodiode
Model EOT 3040
spectral range: 900 – 1700 nm

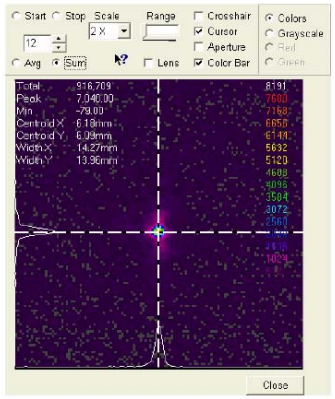



*measurements were done „parasitically“ during a electron beam diagnostic shift at DP3*

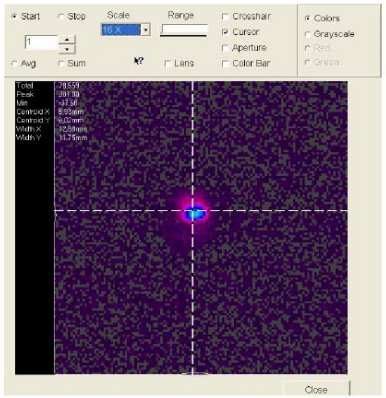
# Comissioning on 14.11. 2007



## DP1

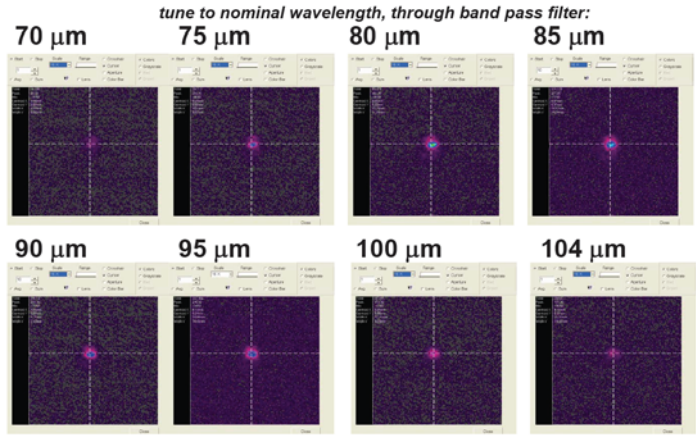


## DP3



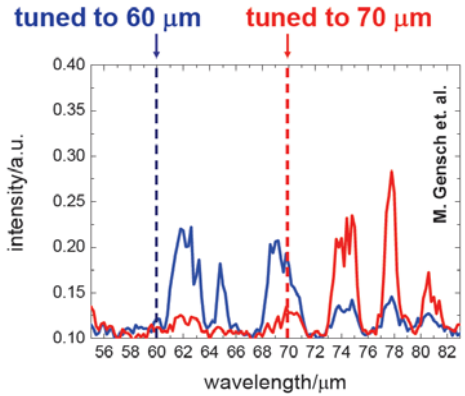
good beamprofile/optimum transmission

## at DP3



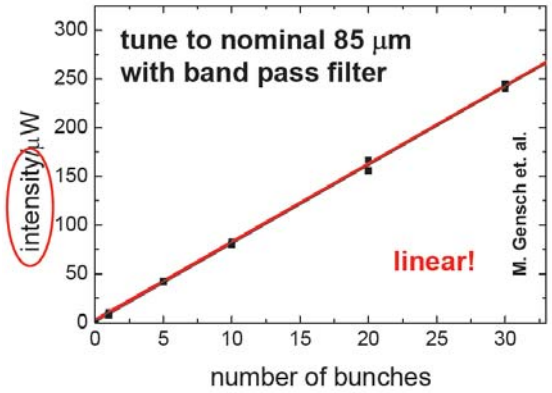

Pointing stability for different tunes OK?

## at DP3




slightly detuned?!

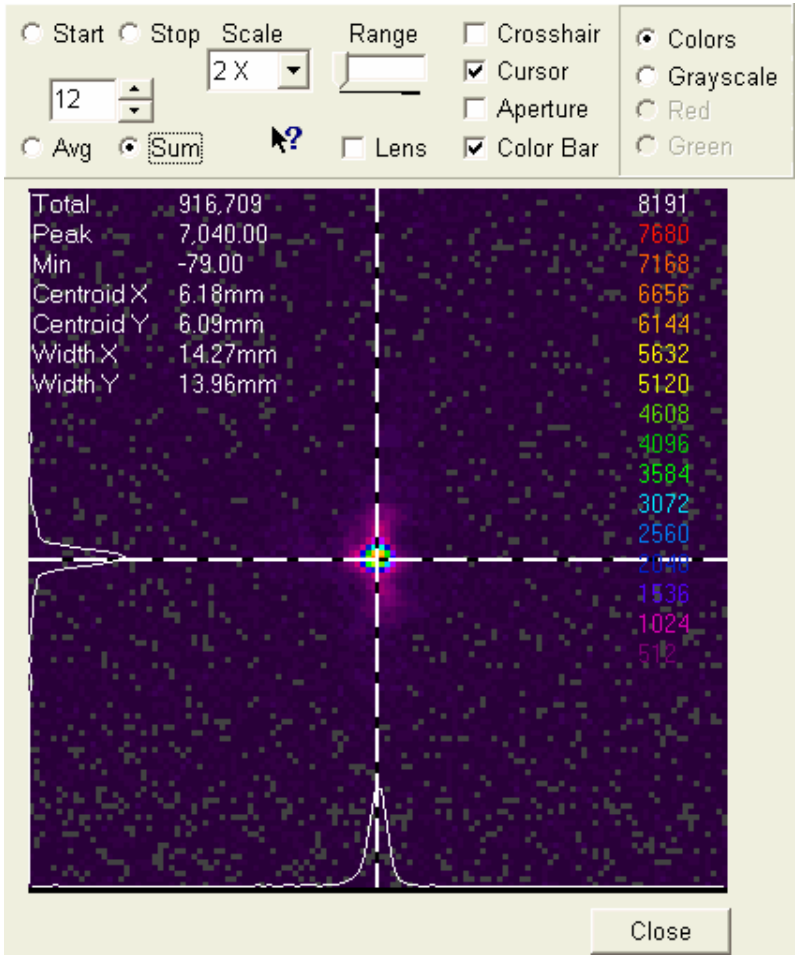
## at DP3



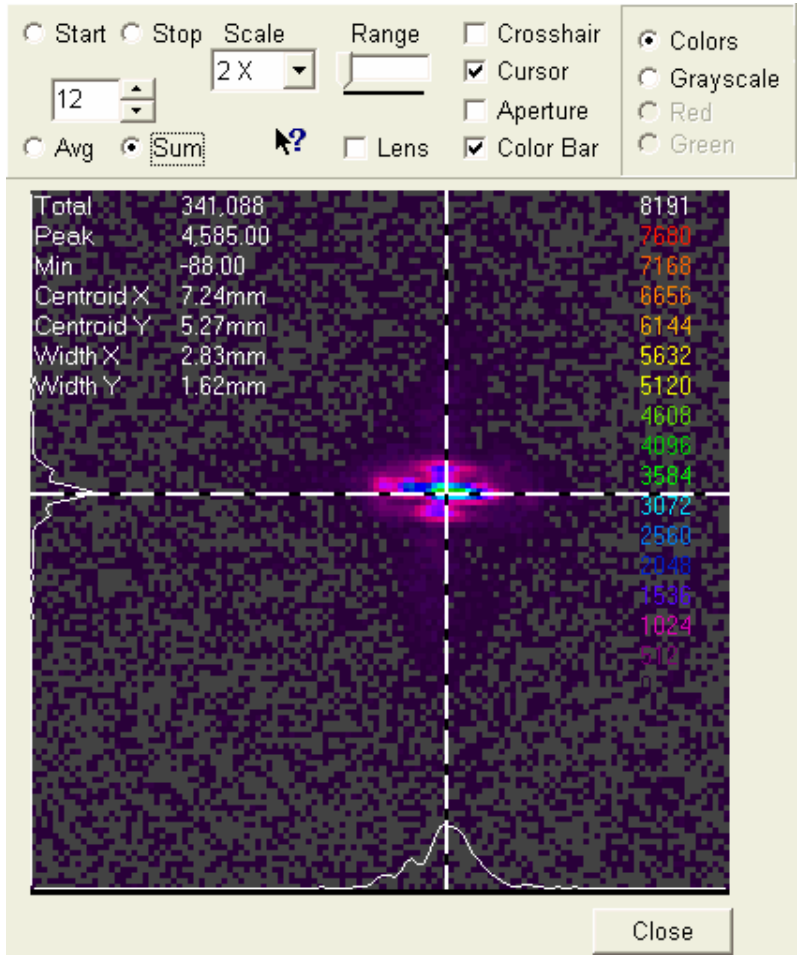

-> 1.8 +/- 0.3 µJ pulse energy -> calibration underway

# beamprofiles on DP1: comparison

**09/2007**



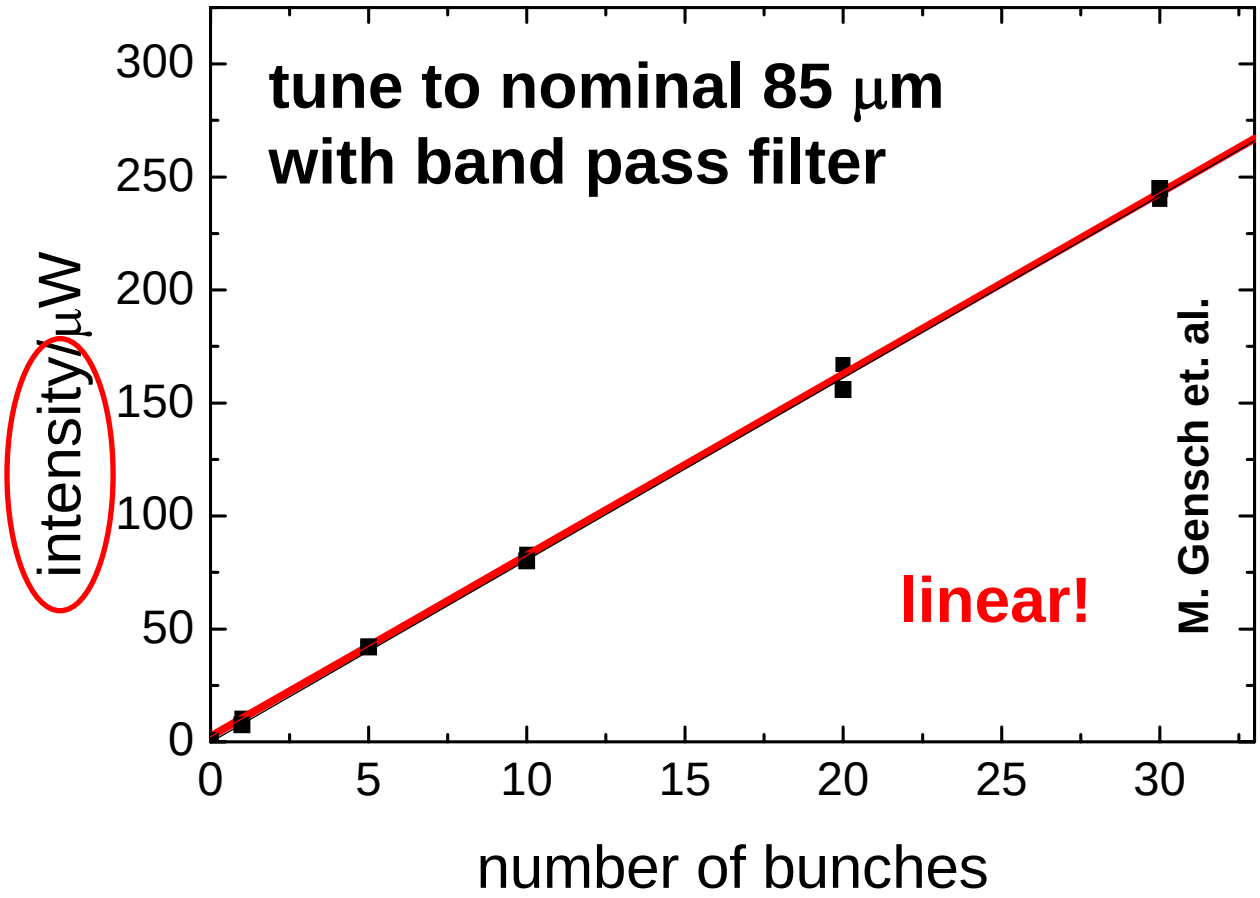

**01/2008**




**What happened? Do we see more of the source? Misalignment of M1? Waveguide effects?**

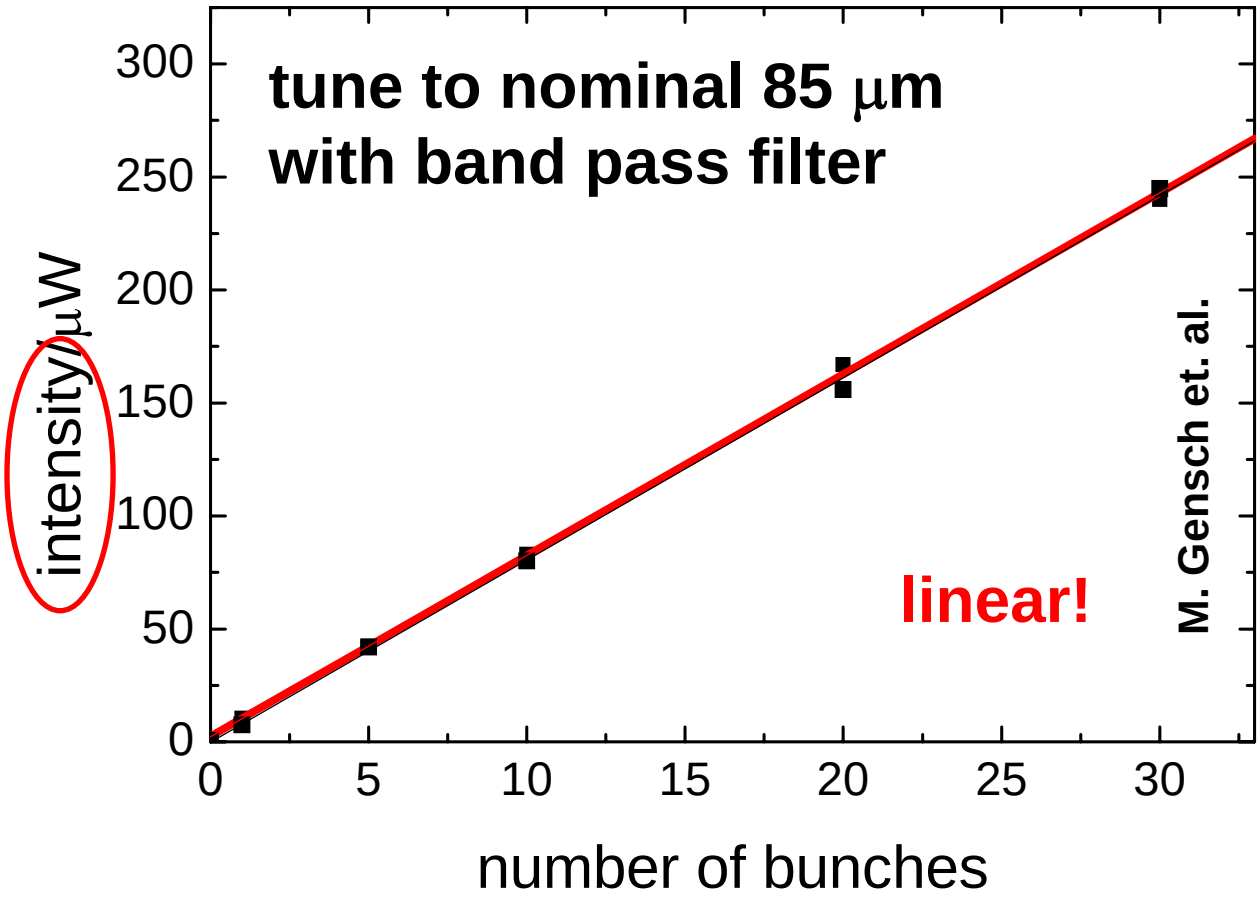
# power measurements at DP3






**-> 11/2007: 1.8 +/- 0.3 μJ pulse energy**

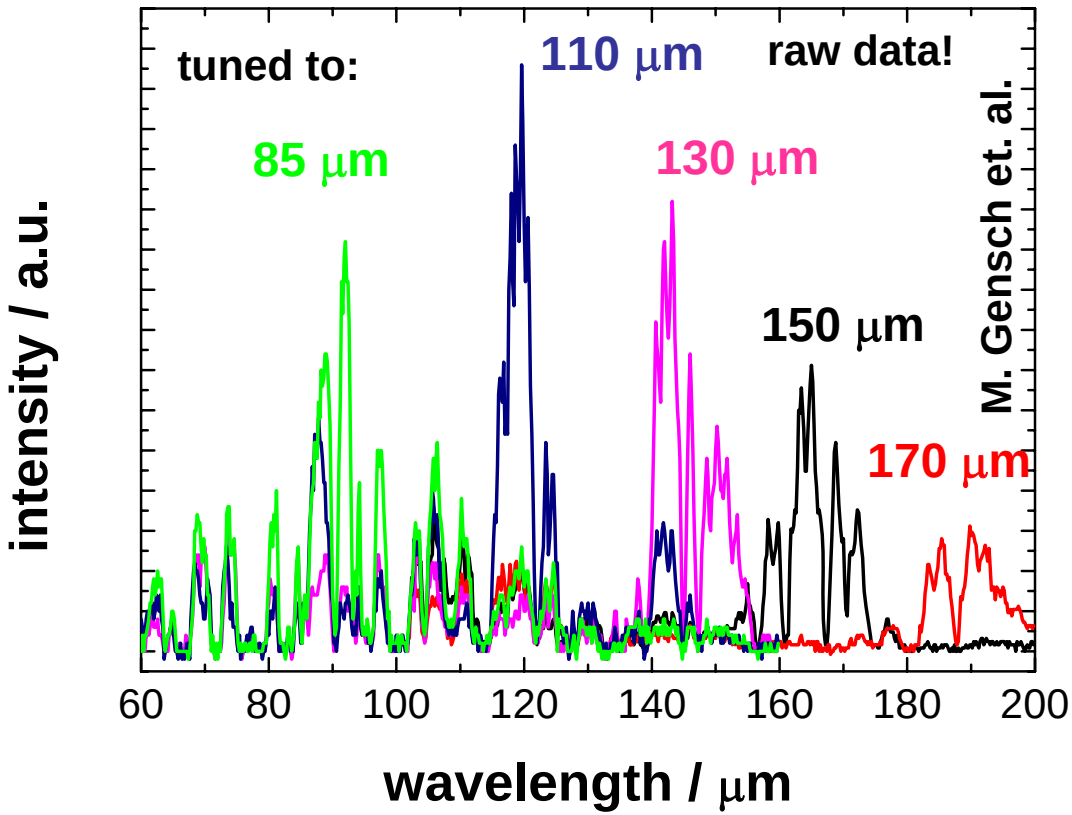
# power measurements at DP3: comparison




**-> 11/2007: 1.8 +/- 0.3 μJ pulse energy**

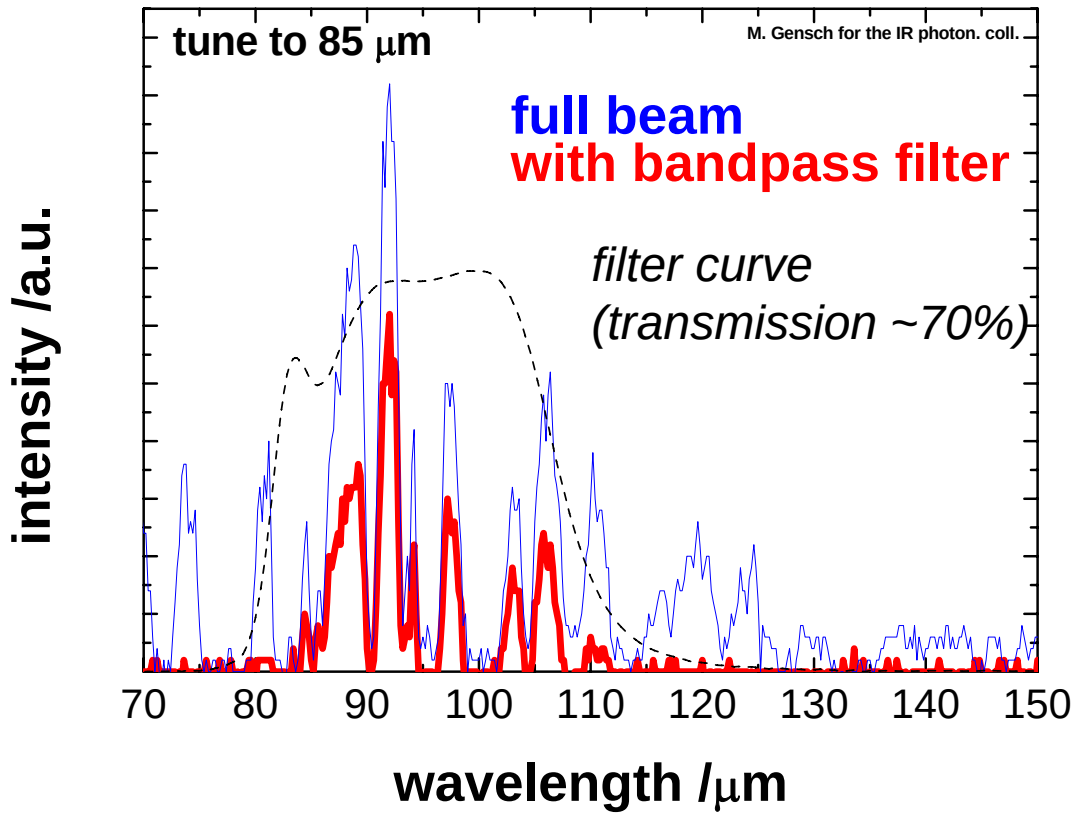
**-> 01/2008: ~ 0.5 μJ pulse energy?!**

# spectral diagnostic




**detune seems to scale with the wavelength**

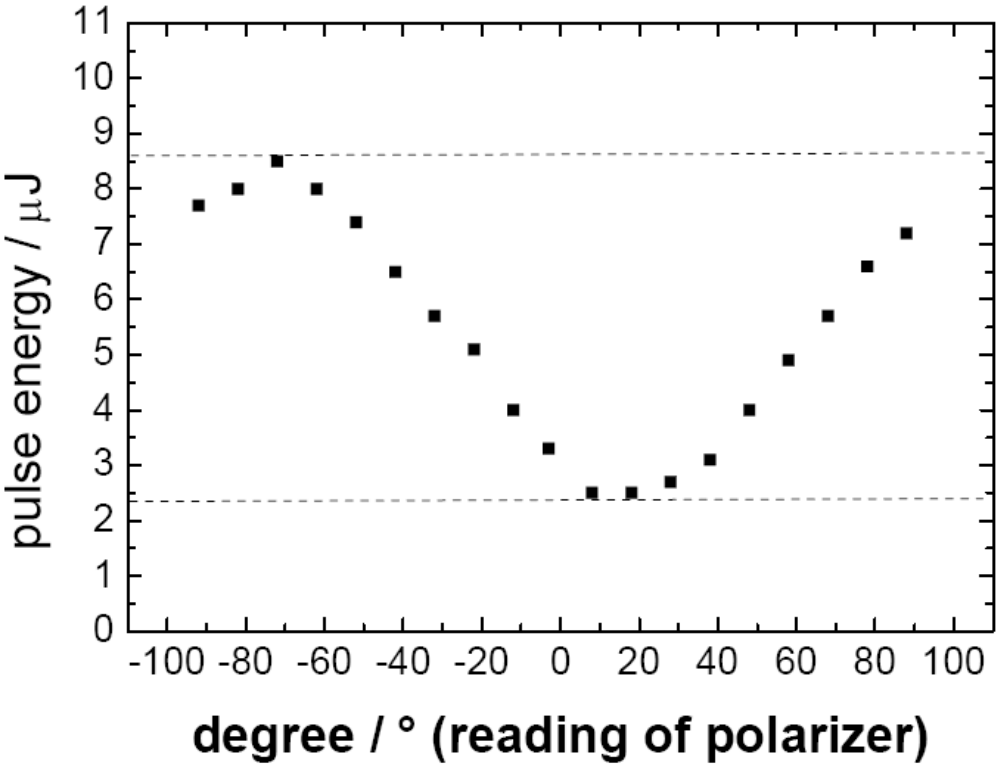
# spectral diagnostic




**tune for pump probe experiment**

**pulse energy at beginning of shift:**
**0.5 μJ (with b.p.)**
**6 μJ (full beam)**

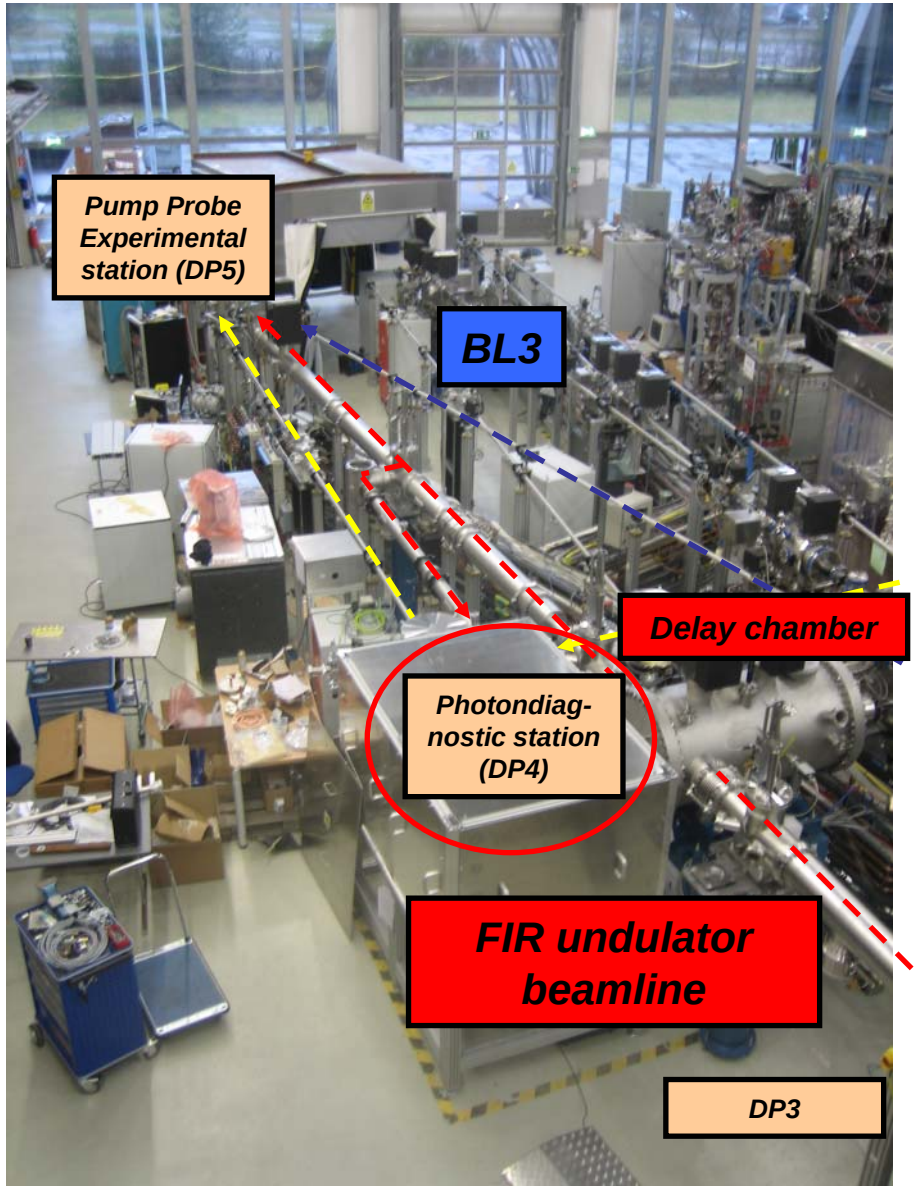
# polarization



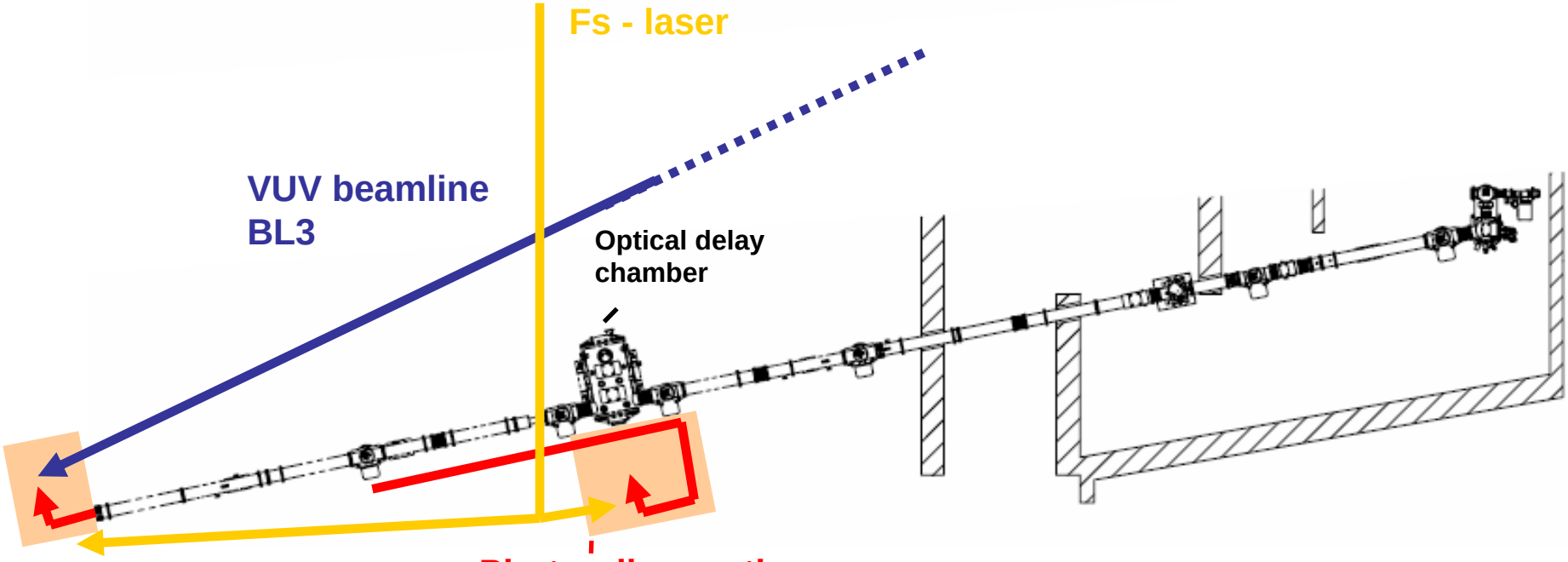

unpolarized background of 4.7 μJ

considering unpolarized background beam seems almost to 100% polarized!

# Comissioning at DP4: 02/2008



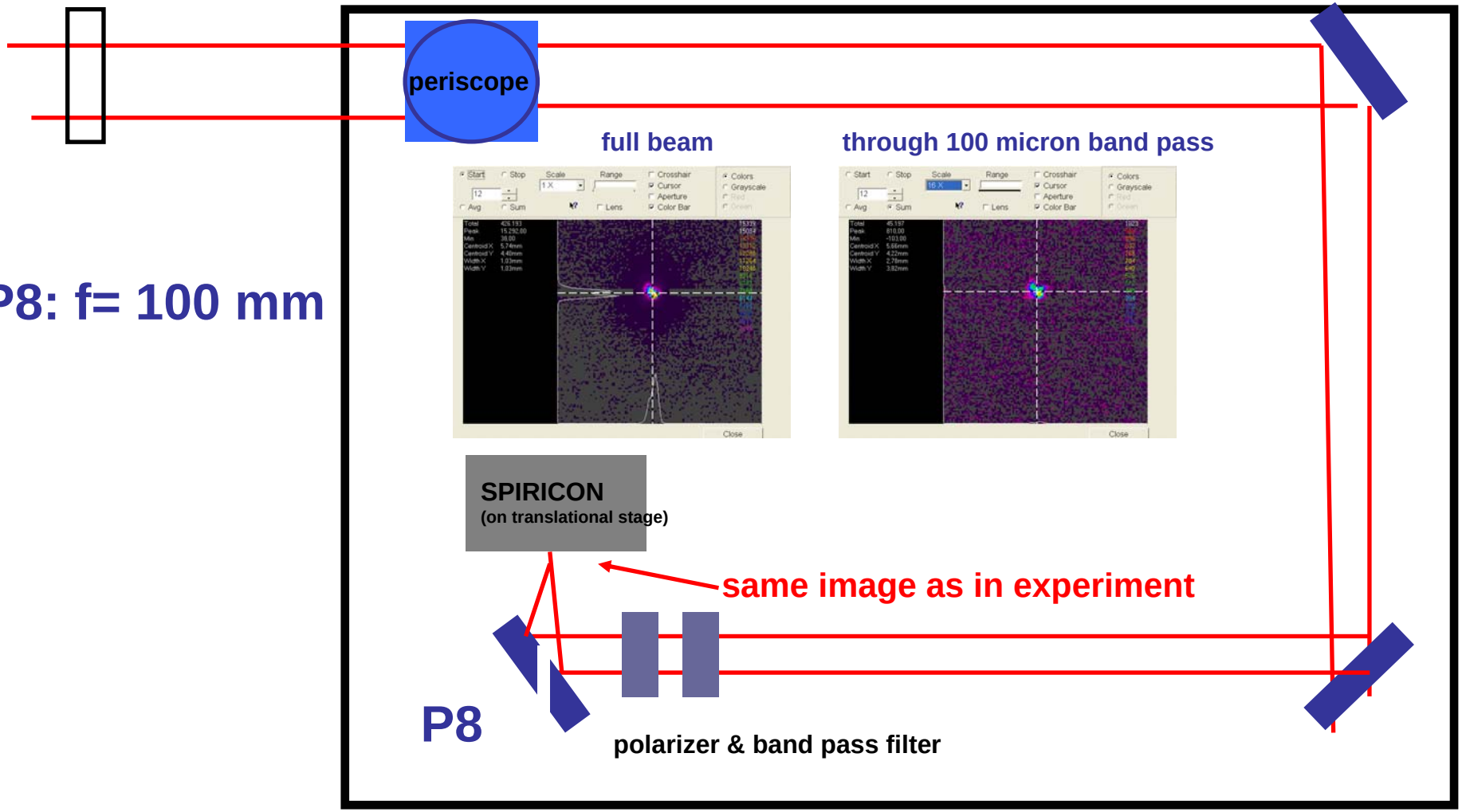
# Comissioning at DP4: 02/2008



# Comissioning at DP4: focus in pump probe exp.



Crystalline quartz window



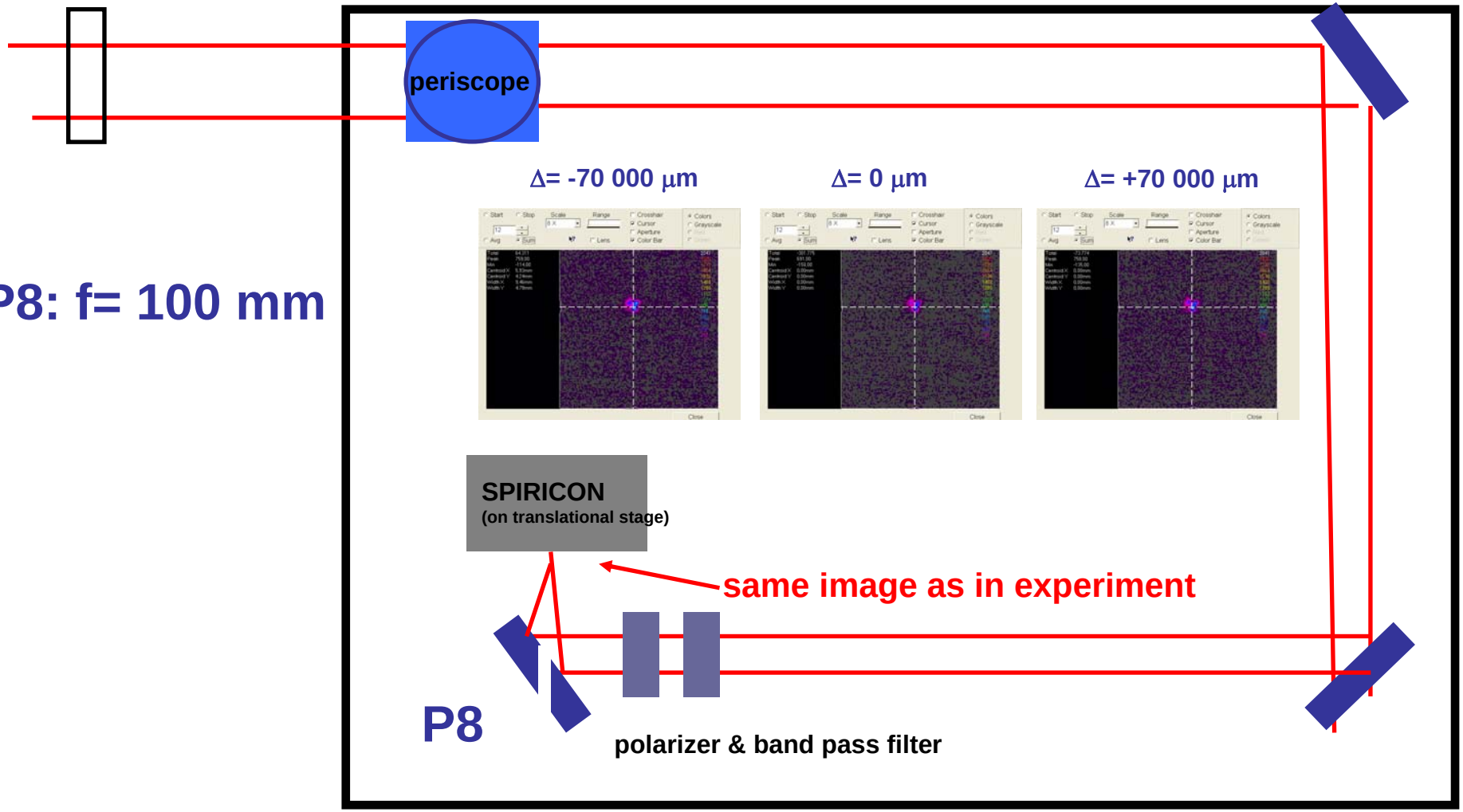

P8: f= 100 mm

# Comissioning at DP4: focus in pump probe exp.



Crystalline quartz window

*pointing OK for whole delay travel range!*



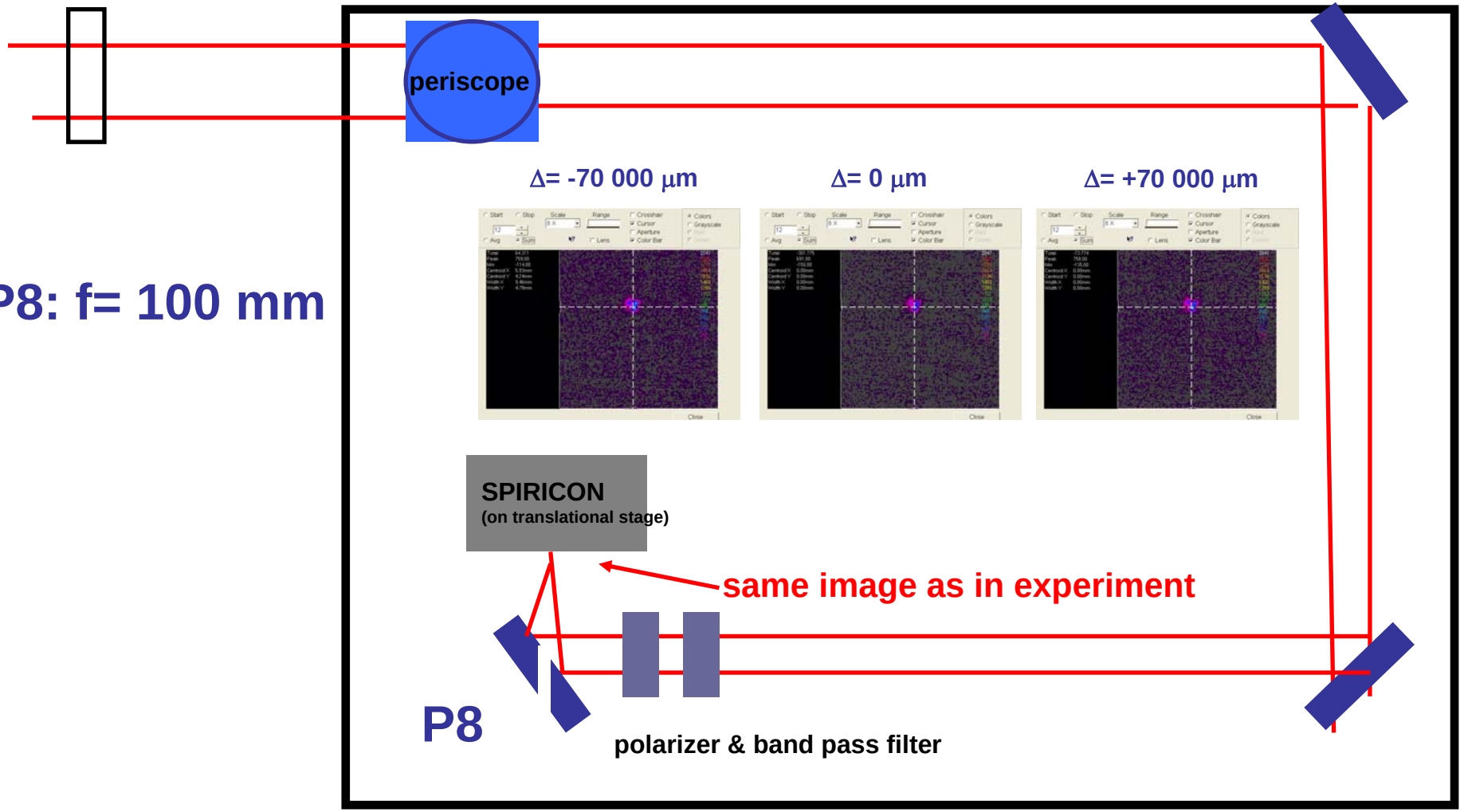

**P8: f= 100 mm**

# Comissioning at DP4: focus in pump probe exp.



**Crystalline quartz window**

***pointing OK for whole delay travel range!***




**P8: f= 100 mm**

**InGaAs diode at the end of BL3:**


**Special thanx to Oliver, Arik and Elke for doing even studies during their shift**

**for more info see log book**

# Summary of beamline comissioning

**Power:** sub μJ in diagnostic ports?

**Spectral content:** fundamental shifted by 5 – 15 micrometers
detune scales with wavelength

**Timestructure:** ps established (present limit of detection by HeB 180 ps)

**Studies of focus in pump probe experiment at DP4:**
-> sub 1 mm size
-> Alignment of optical delay checked

**First attempt to do E/O sampling -> not enough time**

**Optical delay works nicely and reliably**

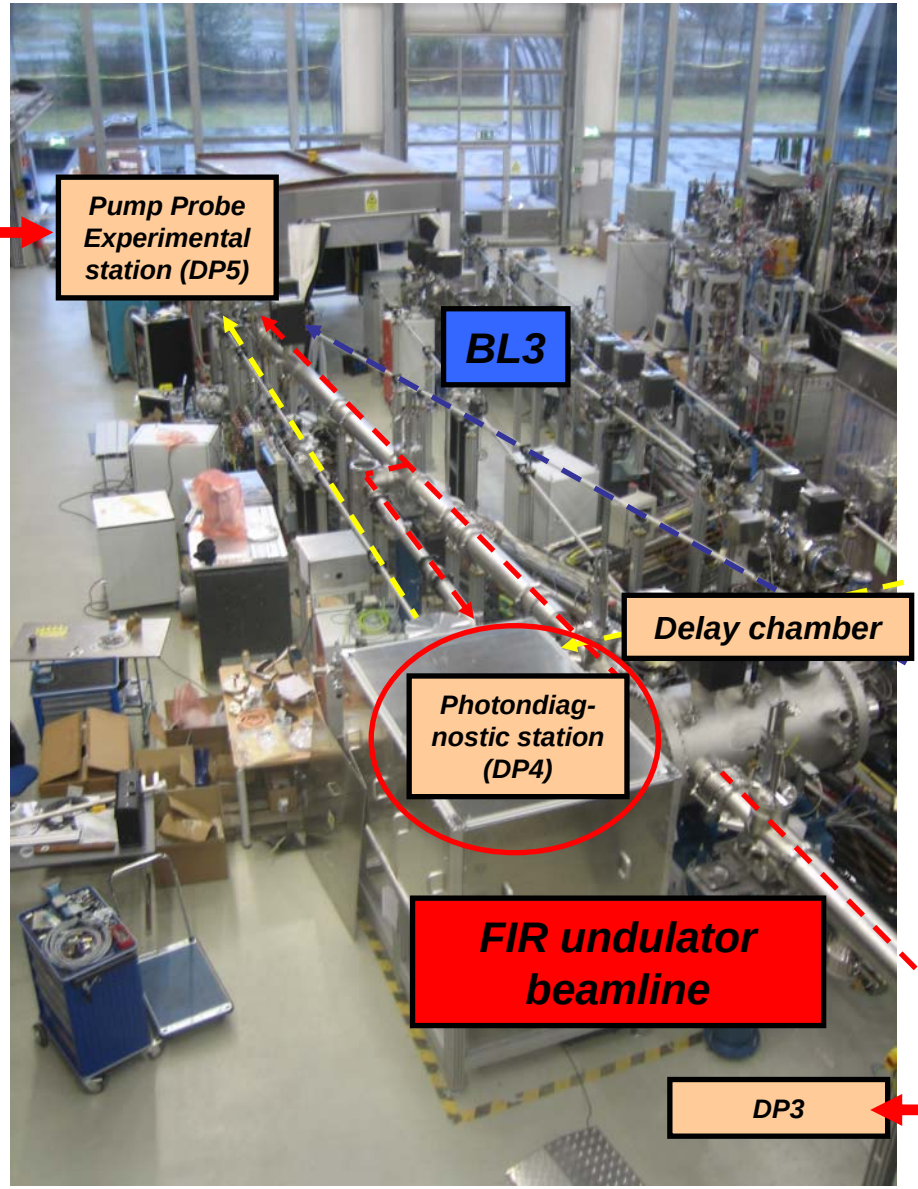
**Beamline alignment/undulator performance: suboptimal**

**-> start of „pilotexperiments“**

# Pilotexperiments 02/2008



**Pump-probe Experiment 6 shifts**




**Electron beam Diagnostic 5 shifts**

Status of the beamline

Comissioning

# Next Steps

# Next steps: Beamline development



## Lessons learned or first „User“ request:

## pump probe:

- power/pulse energy measurement (optimum shot to shot) X
- attenuator (broad band?) (X)
- finer steps for delay (as fine as possible) (X)
- exchangable spectral filters (X)
- measurement of spectral content during the experiment X
- automatize delay/data aquisation X
- more pulse energy X

## Electrondiagnostic:

- take DP2 into operation
- ..... ?

## General beamline issues:

- take cameras into operation X
- remote control of picomotors in tunnel
- improve positioning of M2, (M3, T4)
- aditional screen chambers in s- beamline and infront of pump probe exp. (X)
- „laser shutters“/interlock (X)

# Next steps: Comissioning

*-> will continue throughout 2008, need to still use DP3 until 05/2008*

- optimize power and beamprofile
- measure pulse duration with E/O sampling
- analyze spectral content of higher harmonics
  -> are 2/3 color pump probe experiments possible?
- study spectral content, power, polarization, pulse duration across beamprofile in Pump Probe experiment
  -> there will be dependencies, which?
- study properties of residual optical/NIR radiation
  -> ideas for a crosscorrelator?!
  -> laser safety
- source diagnostics -> waveguide effects
- take new beamline features (e.g. attenuator) into operation.

# Next steps: Pilot experiments



## *timeschedule as presented to PSC in 09/2007*

***01/2008***

*-Completion of FIR beamline*

***2007/2008***

*- Development of ONLINE photondiagnostic*
*- Comissioning of FIR beamline*
*- (Pilot) VUV – IR pump probe experiments*

**contact for FIR beamline related issues: M. Gensch (J. Feldhaus)**

**-> collect ideas for pump probe experiments**
*to be prepared for future requirements/modifications of beamline or FIR photondiagnostic*

# Next steps: Pilot experiments

**Streaking of photoelectrons *running (DESY/UHH)***

***U. Fruehling, M. Gensch, E. Ploenjes, M. Wieland, M. Drescher***

?

***FLASH – Spider (DESY/Celia/UHH), medium term?***


**contact for FIR beamline related issues: M. Gensch (J. Feldhaus)**

**-> collect ideas for pump probe experiments**

*to be prepared for future requirements/modifications of beamline or FIR photondiagnostic*


THANK YOU !