# Spectral properties diagnostics at FLASH

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HELMHOLTZ
ASSOCIATION

DESY

# Outline

> Overview: **spectrometers at FLASH**

> **PG spectrometer** (high resolution spectrometer)

> **Compact spectrometer** (for high harmonics characterization)

# Spectrometers at FLASH

| Spectrometer | Purpose | Working range | Resolving power | Comments | Responsible person |
|---|---|---|---|---|---|
| **Padua spectrometer** | Fast check of approximate wavelength (+-0.1nm) | 4 – 60 nm | Moderate resolution<br>600-1500 (4 -30nm) | Easy to use<br>(operators can do) | R. Treusch |
| **VLS spectrometer** | Online spectra for BL beamlines | 6 – 60 nm | Moderate to high resolution<br>~7000 now ~1000 | Expert needed* | G. Brenner |
| **PG spectrometer** | High resolution / precise calibration | 1.5 –60 nm<br>(exception funda-mental ~ 4.2 nm) | High resolution<br>>10000 | Expert needed* | N. Gerasimova |
| **Compact spectrometer** | High harmonics measurements<br>(Works for fundamental as well) | 1.5 – 40 nm | Moderate resolution<br>~1500 | Non-permanent installation<br>Expert needed* | N. Gerasimova |
| **Online spectrometer (OPIS)** | Maintaining wavelength during operation | 4 – 60 nm | Low resolution<br>~500 | | K. Tiedtke |

* experts needed for all spectrometers in the hall

# Spectrometers features

| | Padua spectrometer | VLS spectrometer | PG spectrometer | Compact spectrometer | OPIS: Online spectrometer |
|---|---|---|---|---|---|
| **Online during user run** (maintaining SASE) | | **OK** for BL beamlines when users agree | | | **OK** not available yet |
| **Online for tuning** | **OK** (but block GMD) | **OK** | **OK** | | **OK** not available yet |
| **Precise wavelength** [1] (<0.1nm) | | | **OK** | | |
| **Bandwidth** [2] (accuracy better then ±0.5%) | | **OK** (when no aperture) | **OK** | | |
| **Spikes** [3] | | **OK** not available yet | **OK** | | |
| **High harmonics** | | **OK** (>6nm) | **OK** | **OK** | **OK** not available yet (limited) |
| **Fluctuations within bunch train** [4] | | **OK** not available yet | | | **OK** not available yet |

[1] for precise calibration check by 0th order needed (plus full beam)

[2] for bandwidth measurements slitless instrument needed (to accept full beam)

[3] for spikes measurements high resolving power needed (more then 10 spikes means more then 1000 resolving power)

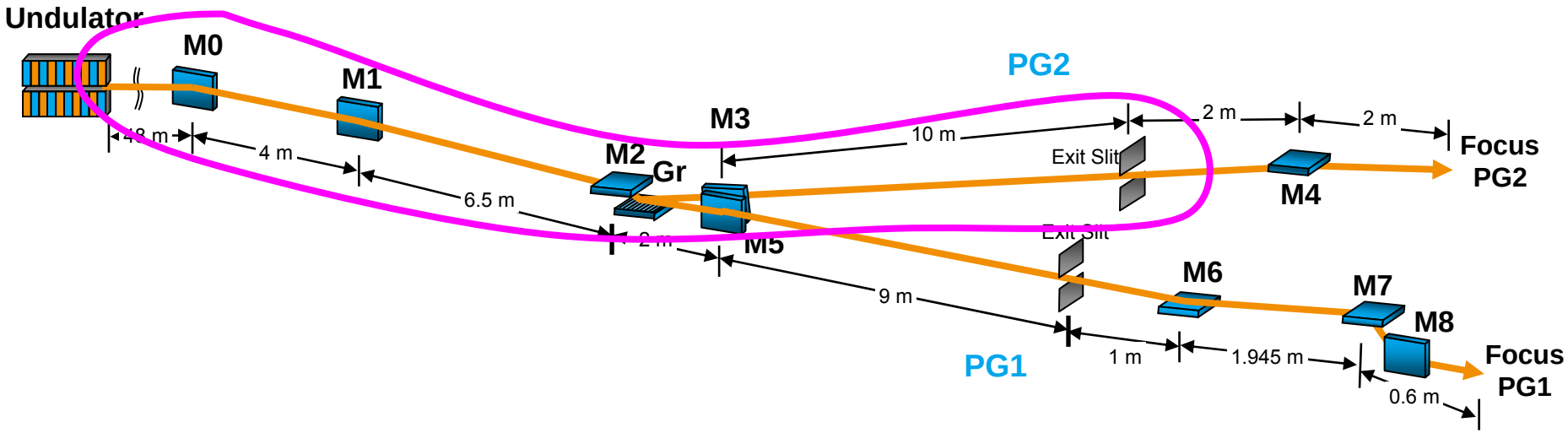
[4] high repetition rate >100 kHz needed

# PG spectrometer

- High resolution
- Precise calibration
- High sensitivity
- Online for tuning

# PG beamline at FLASH

**M. Martins**, **M. Wellhöfer, J.T. Hoeft, W. Wurth, J. Feldhaus, R. Follath**,
*Monochromator beamline for FLASH* // Rev. Sci. Instrum. 77 (2006) 115108




## Two branches: PG1 and PG2

**PG1** equipped with Raman spectrometer

**PG2** provides beam for user experiments

# PG beamline at FLASH

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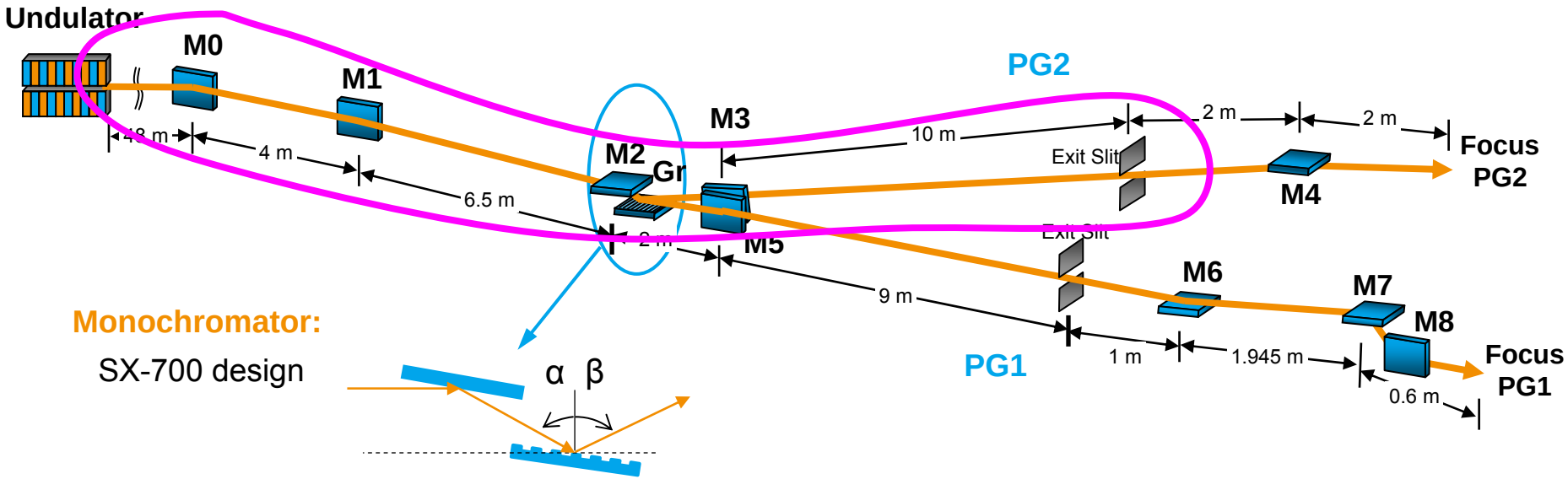


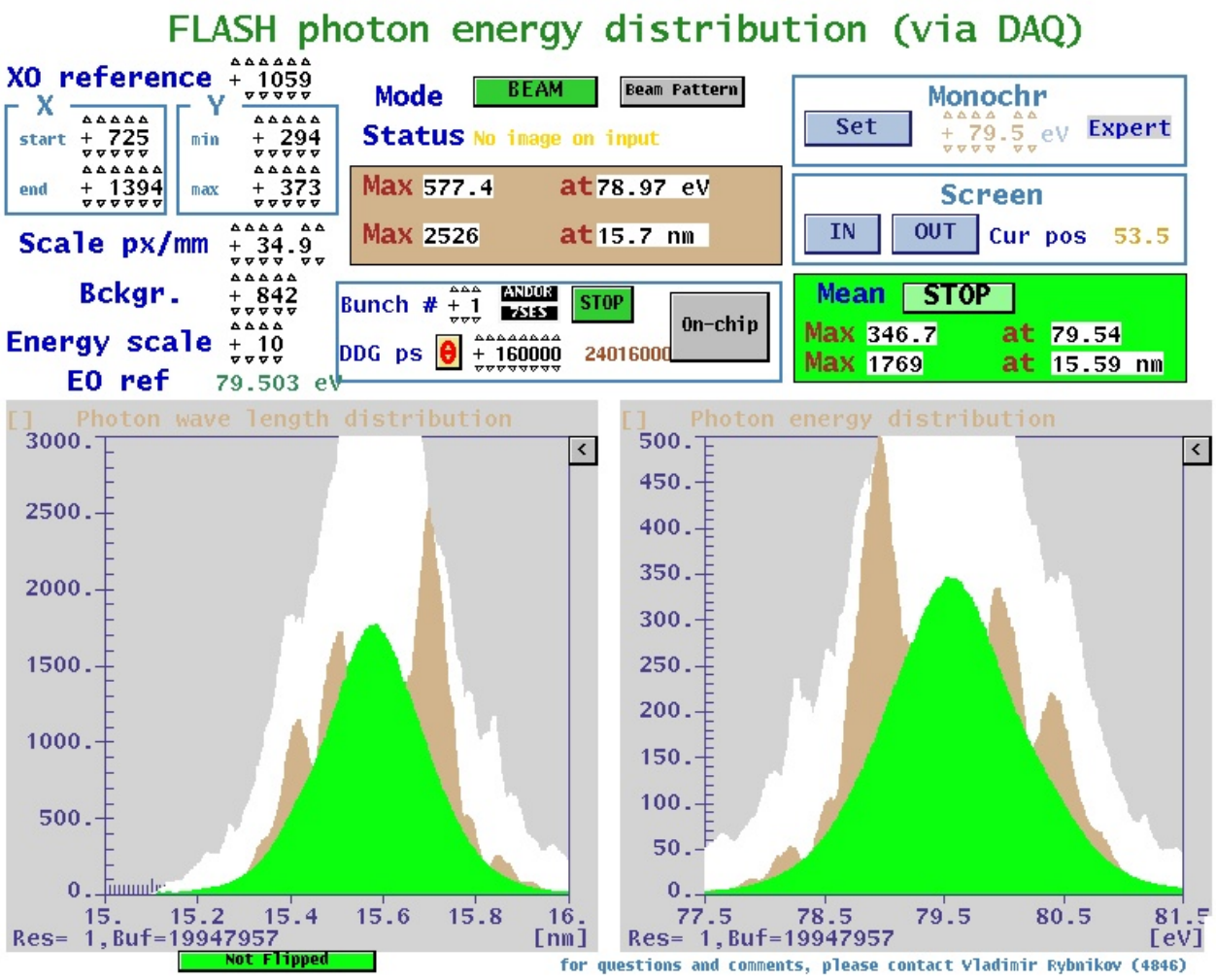

**Monochromator:**

SX-700 design

- **Slitless**
- In collimated light
- **Free choice** of best **compromise between flux and resolution** on the **same grating** by varying cff
- Possible operation in **0th order**

# PG2 beamline as spectrometer

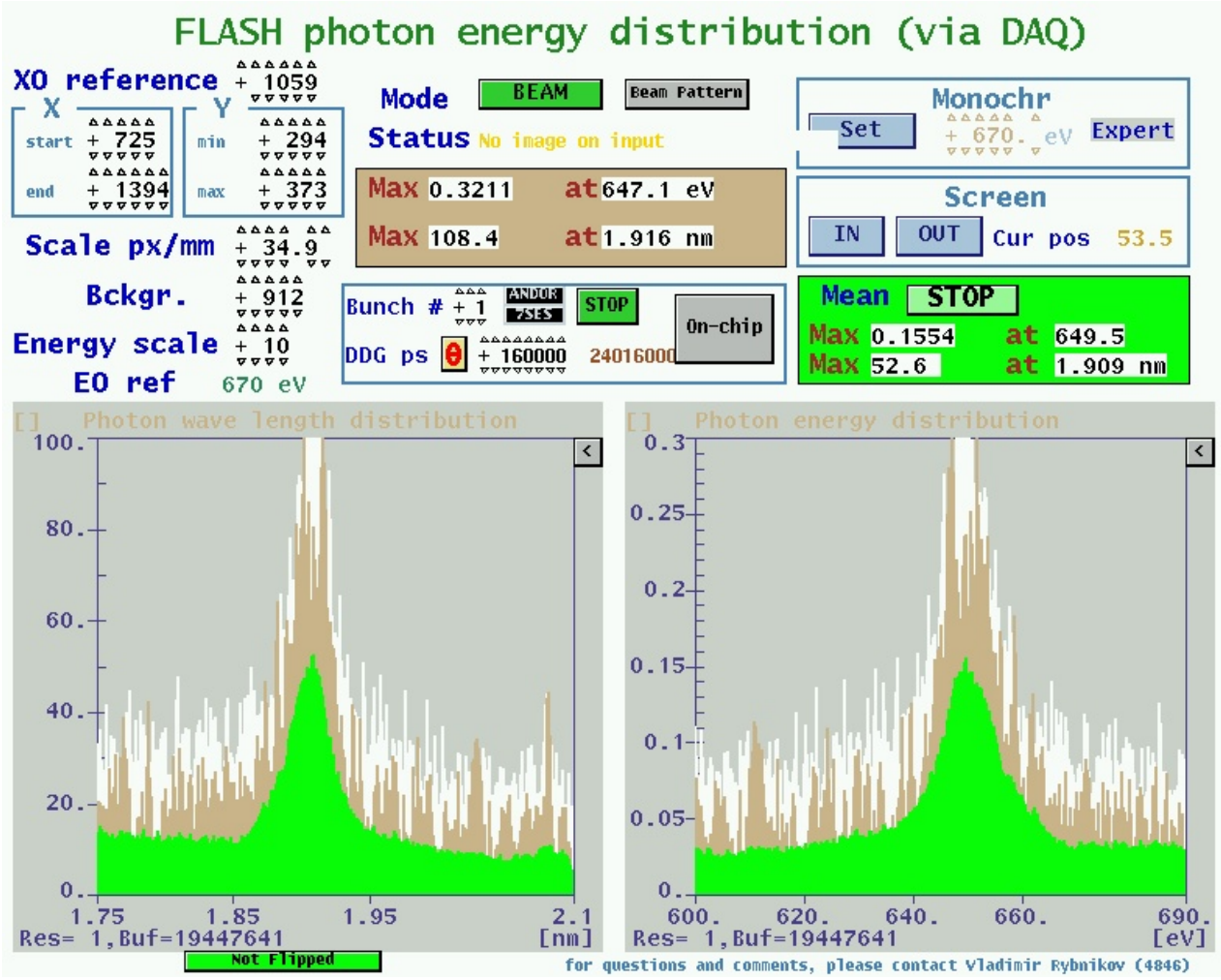
2008




*DAQ, spectrometer server:* *Vladimir Rybnikov*

# PG2 beamline as spectrometer

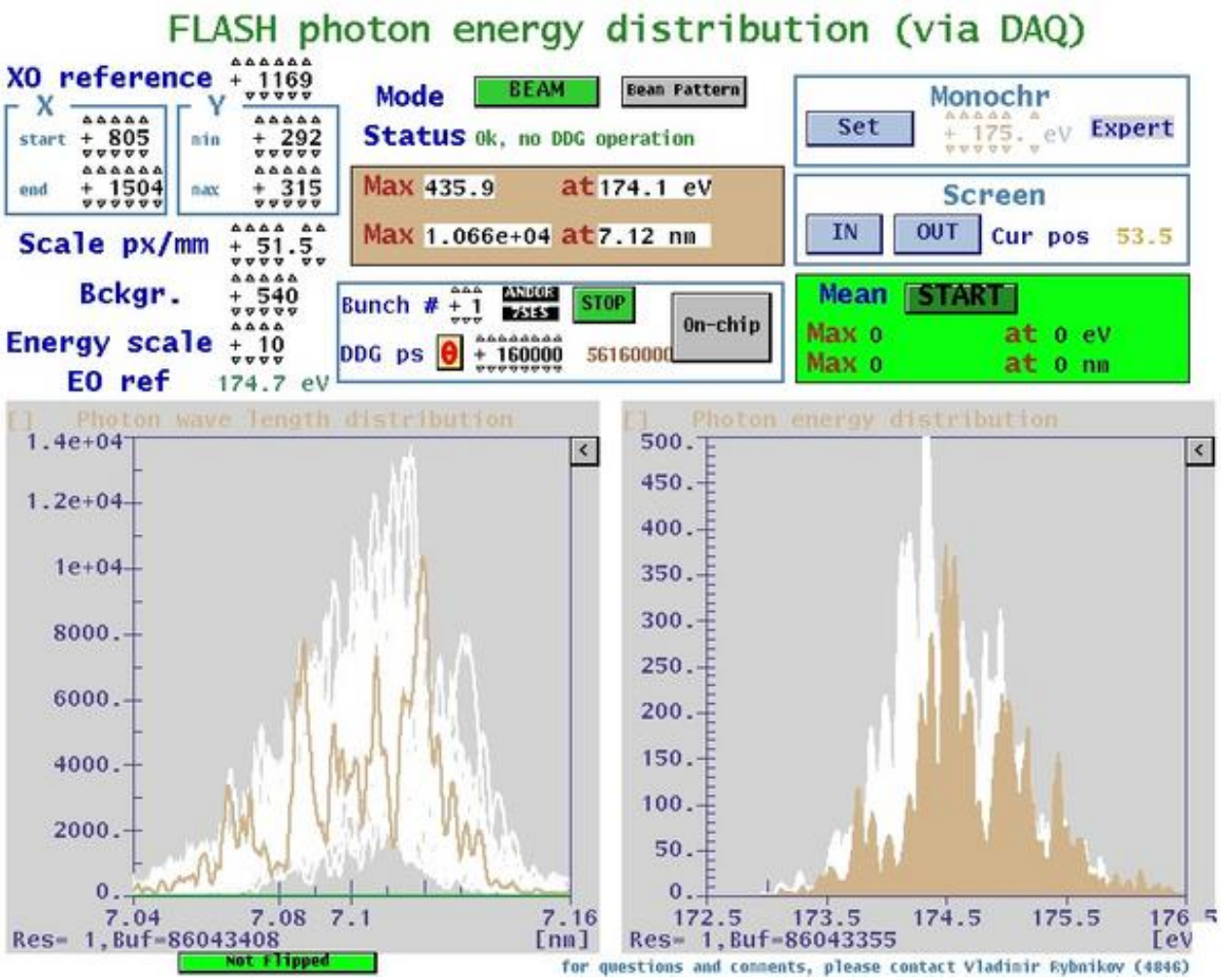
2008




*DAQ, spectrometer server:* *Vladimir Rybnikov*

# PG2 beamline as spectrometer

Nov 10, 2010




*DAQ, spectrometer server:* *Vladimir Rybnikov*

# 7 nm

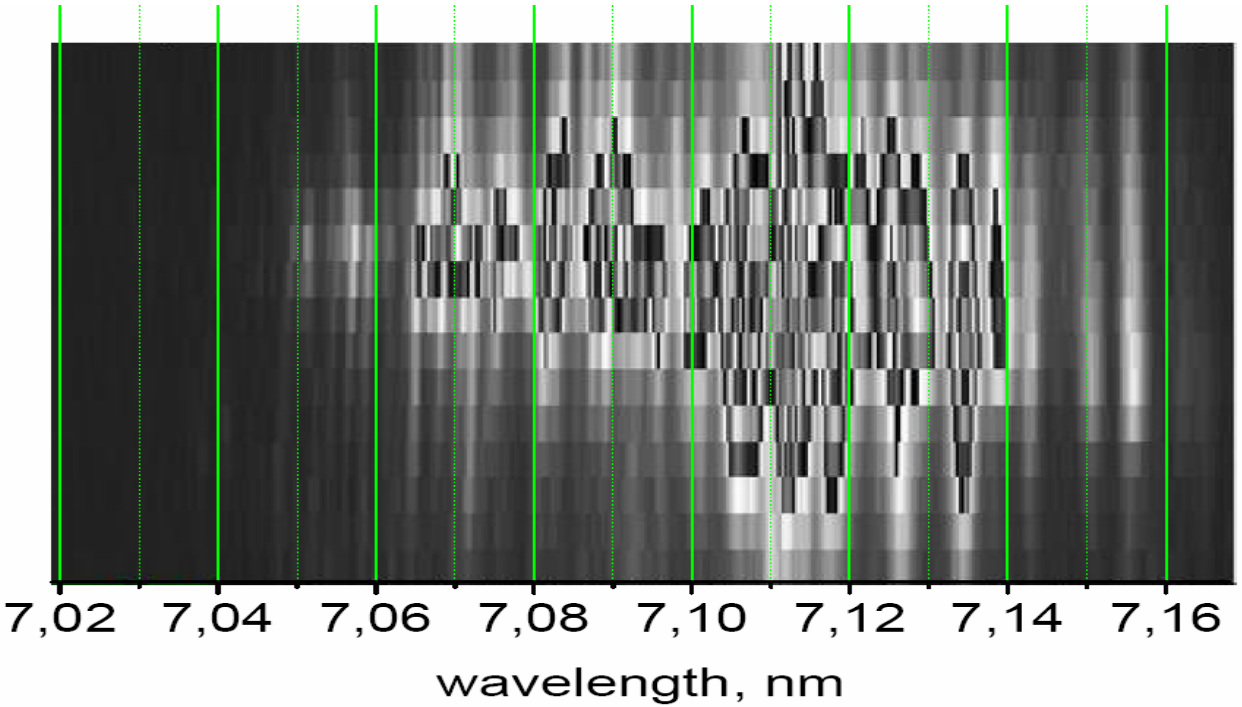
Nov 10, 2010

100 uJ

Bandwidth ~ 1%

> 40 spikes

~0.001 nm width



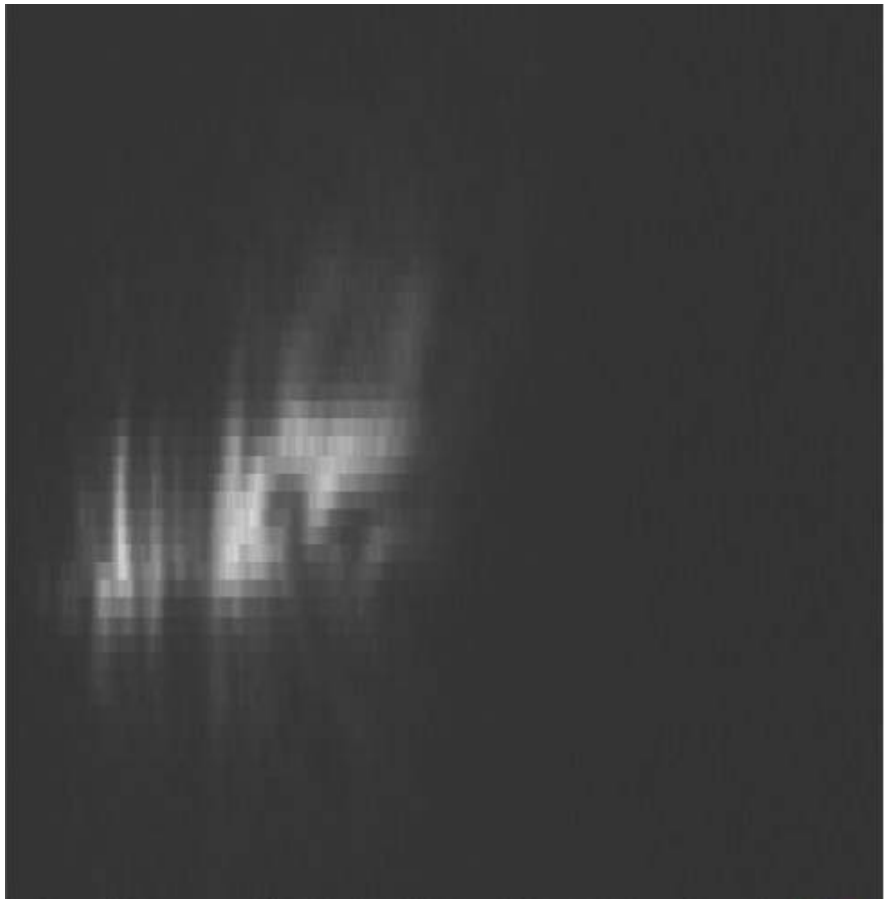

**Low estimate of pulse length:**

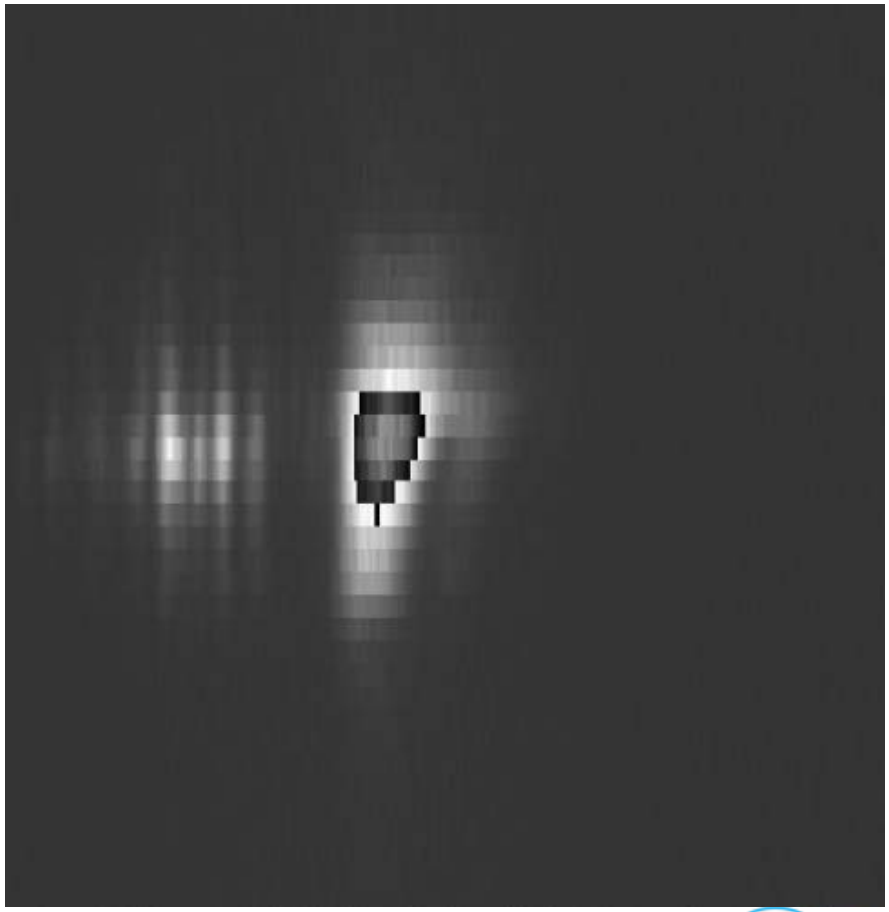
Pulse length – spike width product > 0.44 (Gauss shape)

tpulse > 0.44*λ2/(Δλ*c)

# PG spectrometer

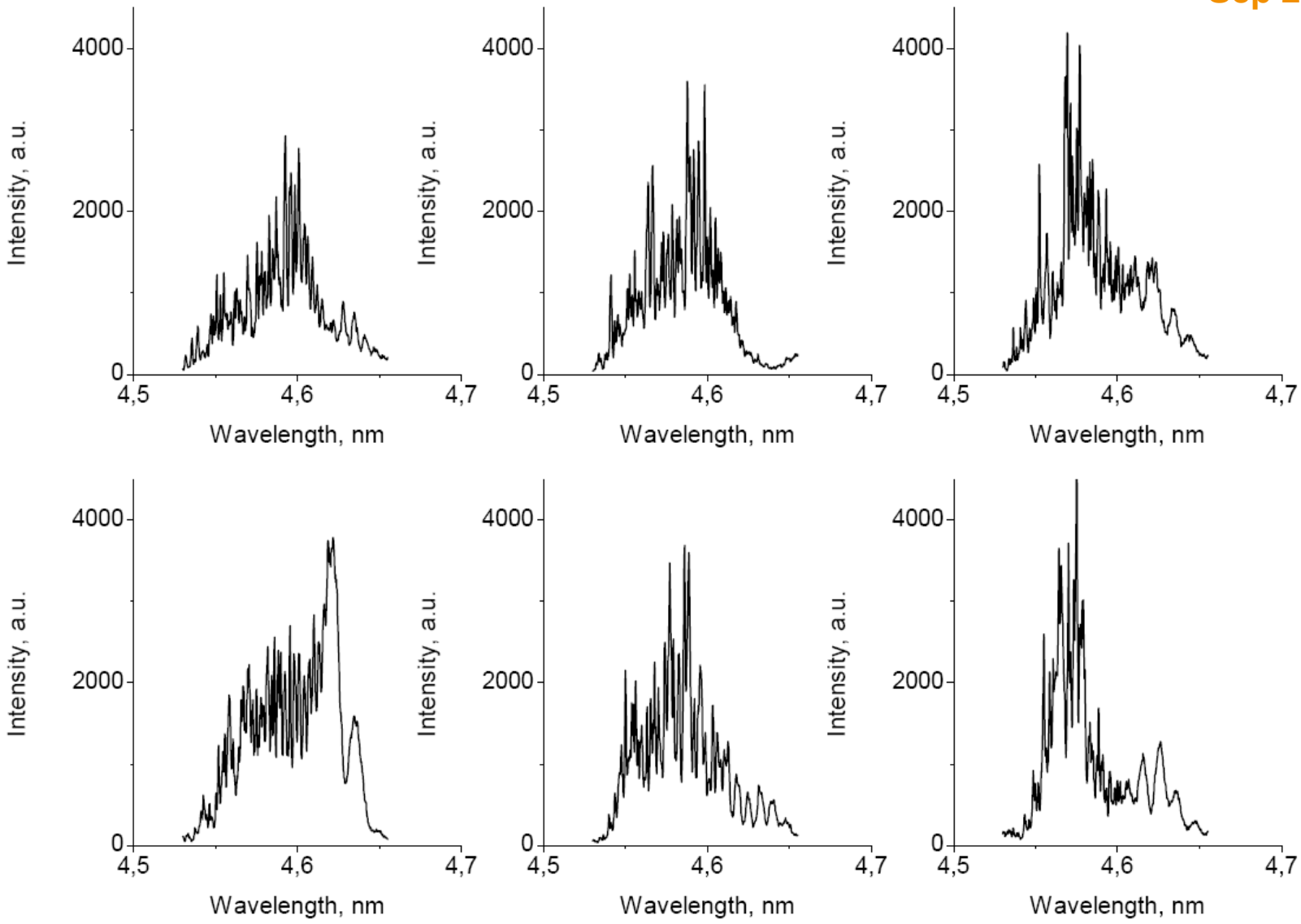
**March 14, 2008, 7 nm**





# 4.6 nm

Sep 24, 2010



# PG2 beamline as spectrometer

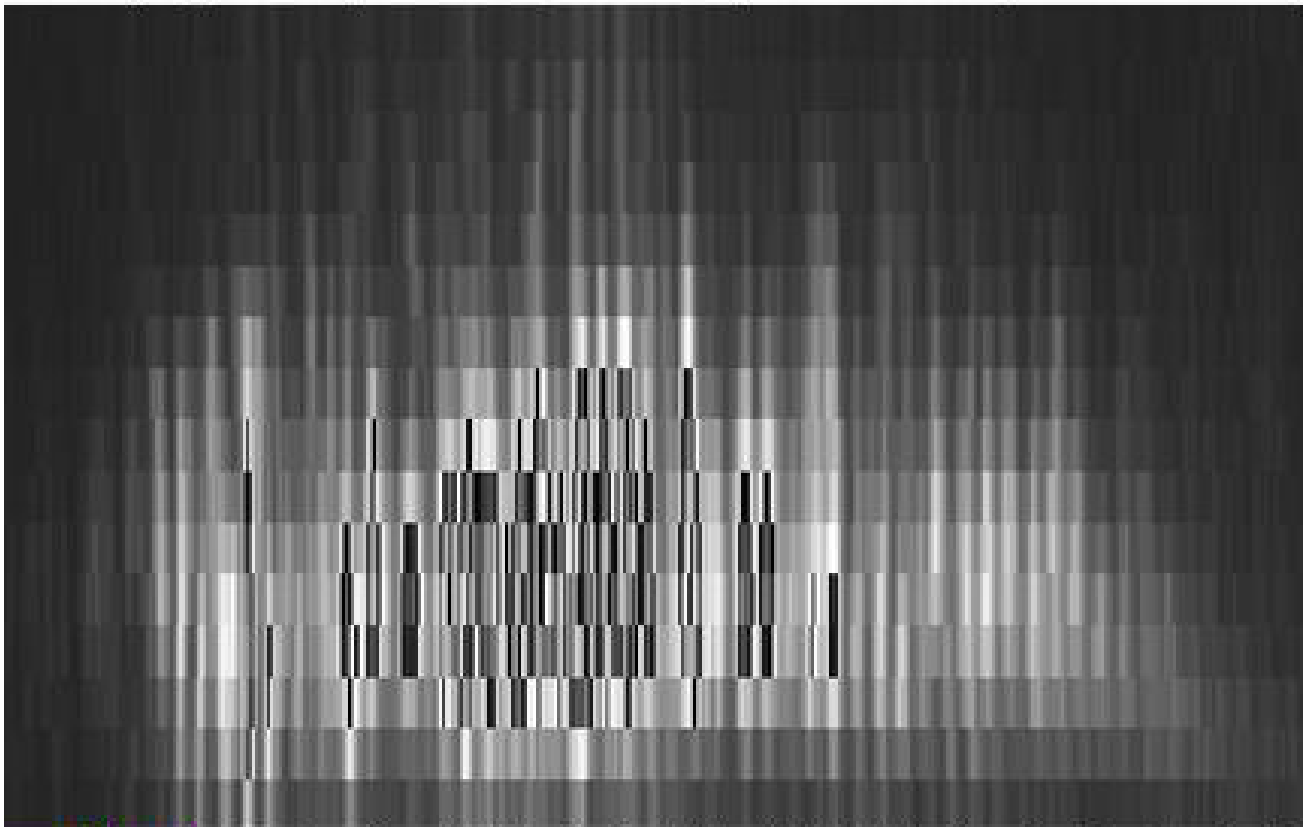
Sep 24, 2010

120 uJ

Bandwidth ~ 1% - 1.5%

~ 50 – 60 spikes

~0.001 nm width



# 13 nm

**Oct 22, 2010**

42 uJ

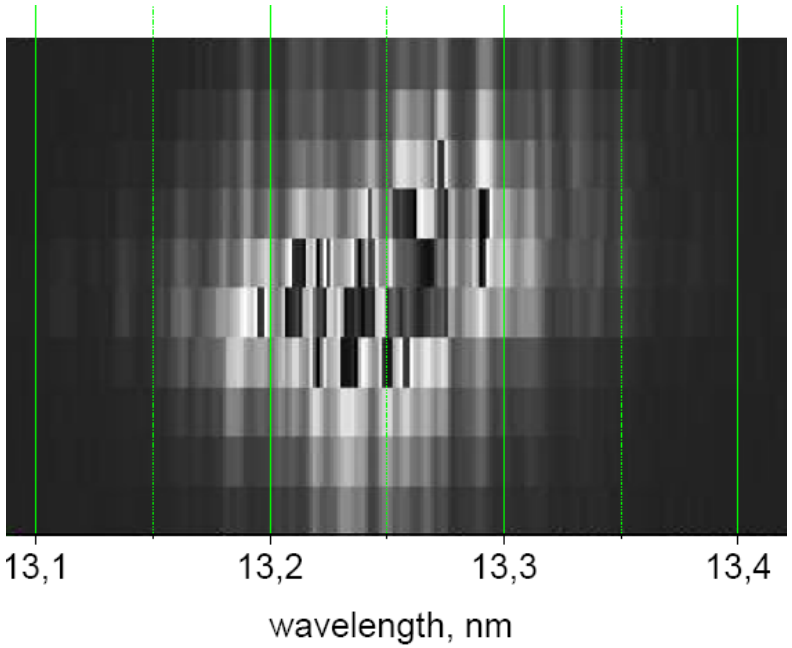
Small bandwidth (<0.85%)

Low shot-to shot fluctuations

Uniform spike width

~ 20 – 25 spikes

~0.005 nm width

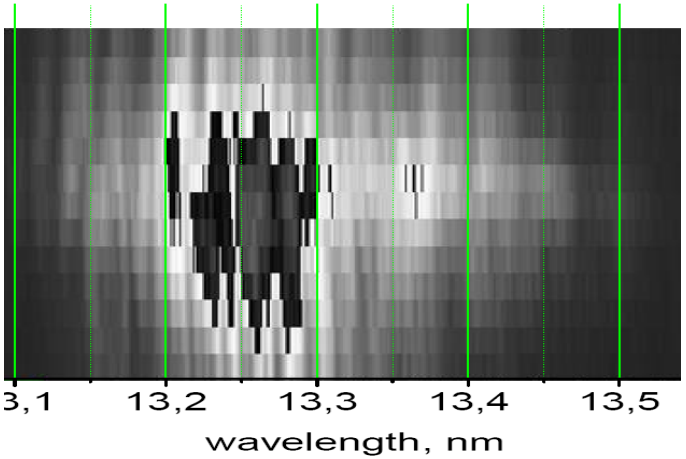


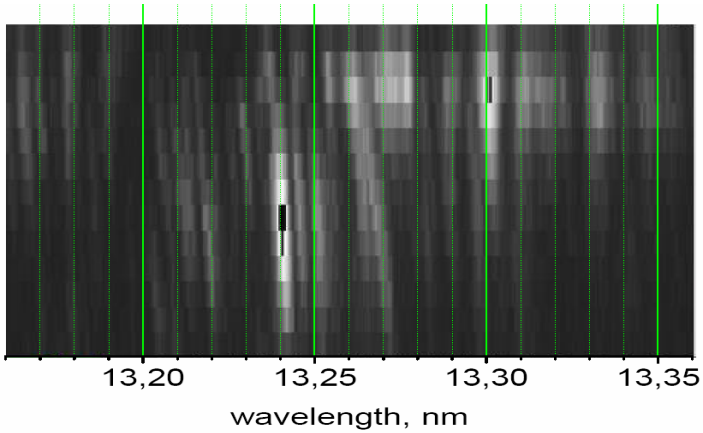

**Oct 1, 2010**

115 uJ

bandwidth ~1.6%

~ 0.0015 nm width

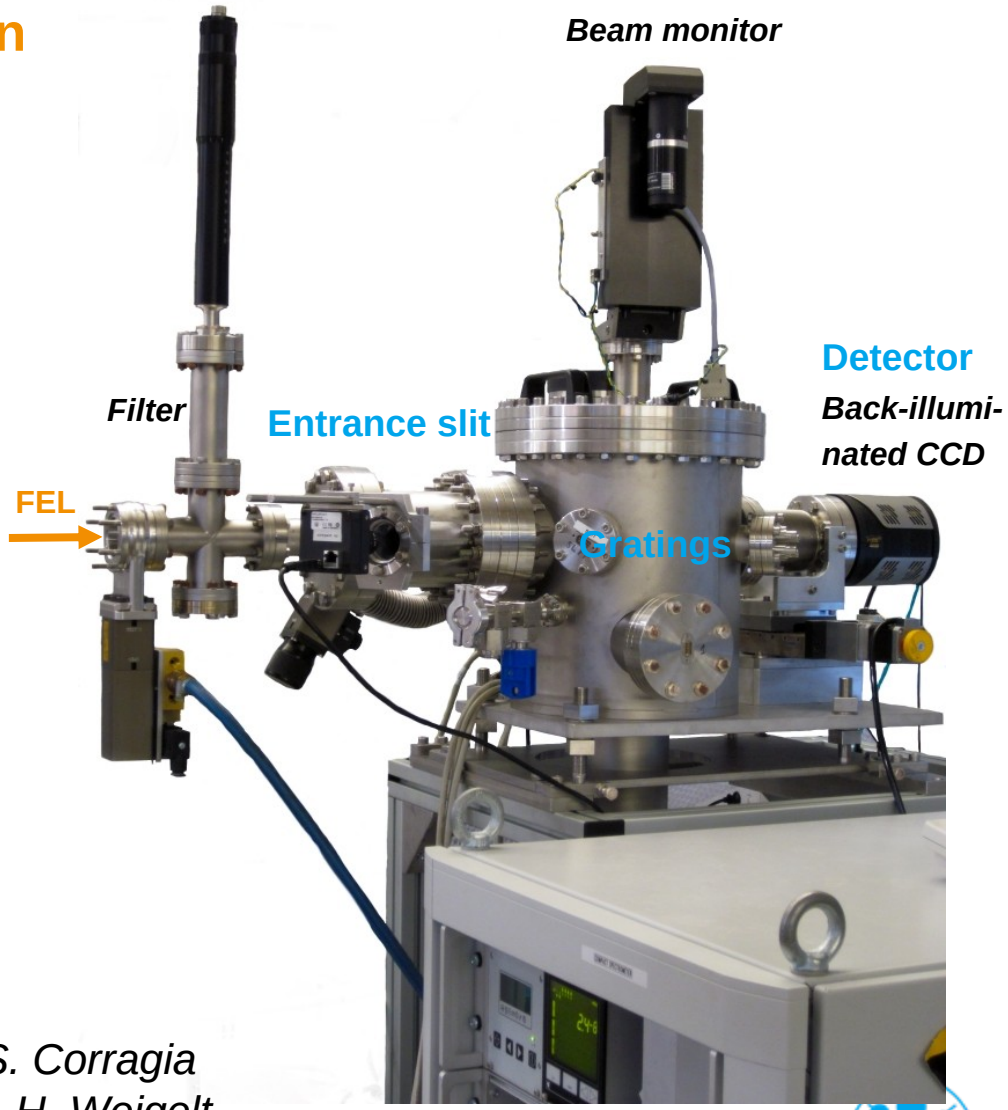


# Compact spectrometer

## High harmonics characterization

- Flat-field design
- 1200 l/mm and
  2400 l/mm gratings
- 1.5 – 40 nm working range
- >1500 resolving power
- Single shot / 10 Hz




***Collaboration***

*INFM Padua: L. Poletto, F. Frassetto, S. Corragia*

*DESY: N. Gerasimova, S. Dziarzhytski, H. Weigelt*

# Compact spectrometer

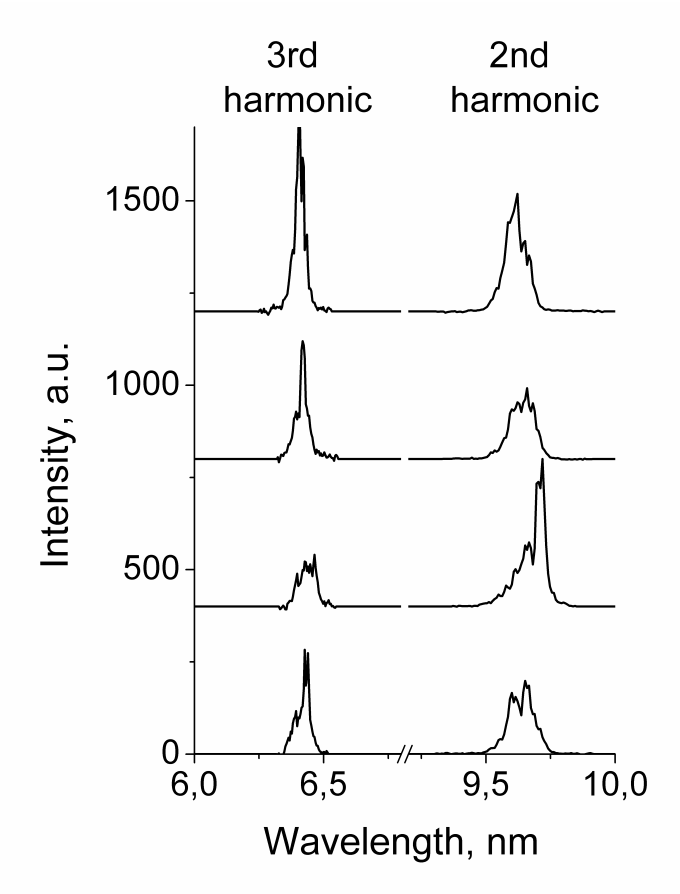
- Calibration: BW3 of DORIS III, May 2010
- Commissioning with FEL: August 2010 (4 shifts)
- In operation now

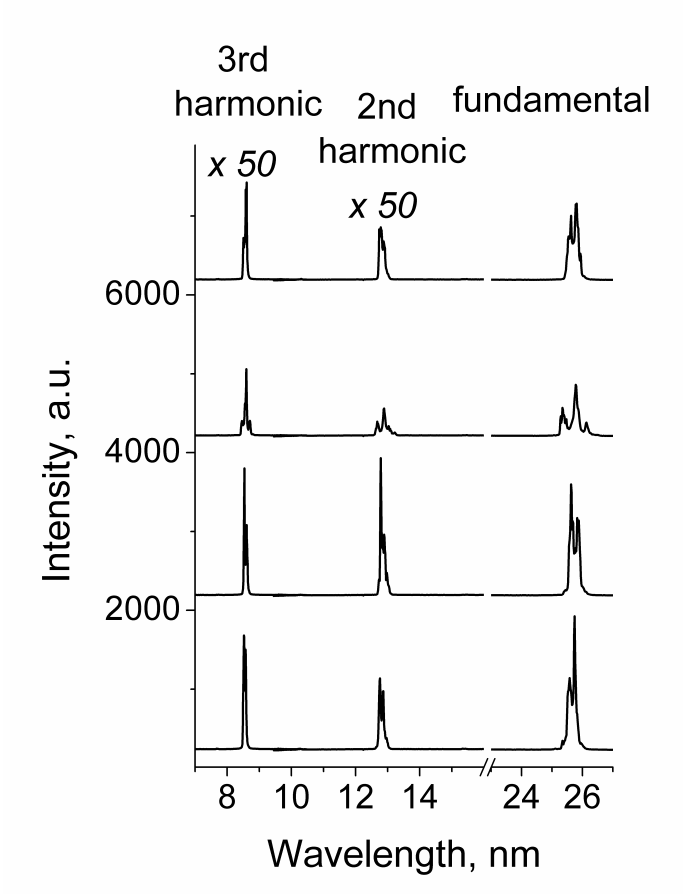
- Pending: implementation into FLASH DAQ
  in progress, V. Rybnikov

# Compact spectrometer

## **Commissioning with FEL:** August 2010 (4 shifts)

**19 nm** **Single-shot spectra** **26 nm**



# Acknowledgments


- **Siarhei Dziarzhytski**, **Holger Weigelt**, *DESY*
- **V. Rybnikov, G. Grygiel**, *DESY*
- FS-EC (especially **T. Nunez, T. Kracht**), *DESY*
- FS-FL, *DESY*
- FLASH machine crew

# Acknowledgments

Thank you