



A 'Focus Finder' for Micro Focus and Beam Characterization.

Frank Scholz, Ivan Shevchuk, Kai Bagschik, Jens Buck, Jörn Seltmann, Florian Trinter, and Moritz Hoesch

Motivation

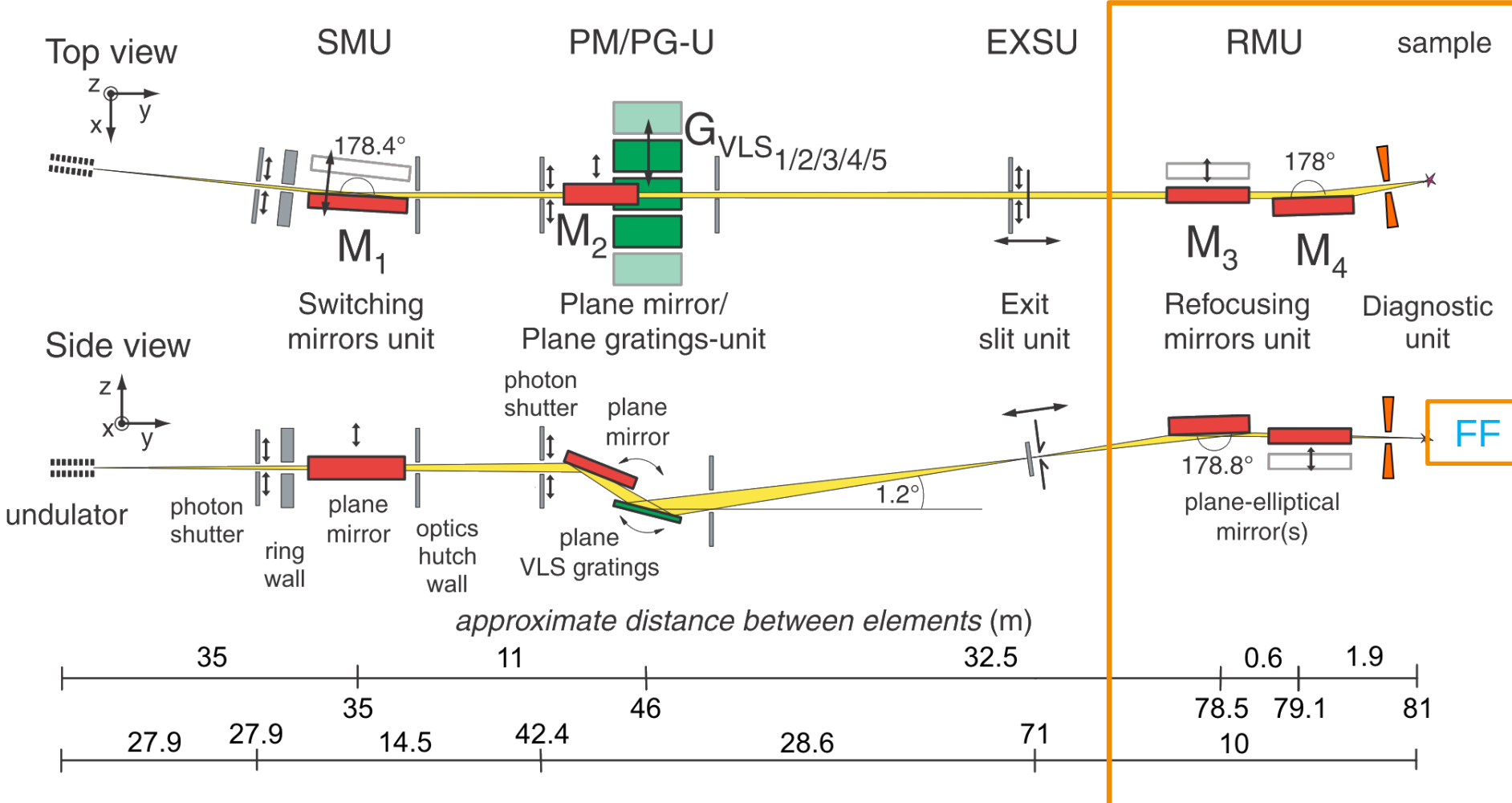
The exact position of the focus is crucial in an experimental setup, especially at modern beamlines with small foci. Because of the inaccuracy in manufacturing, measuring, and assembling, it is hard to predict the exact position and size of the actual focus. Also the use of bendable mirrors makes the characterization of the beam necessary.

The purpose of the Focus Finder is to find and characterize the focal spot of the P04 XUV beamline at PETRA III but also of any focused X-ray beam. The device is designed to simplify and speed up the alignment of a beamline and its optical components.

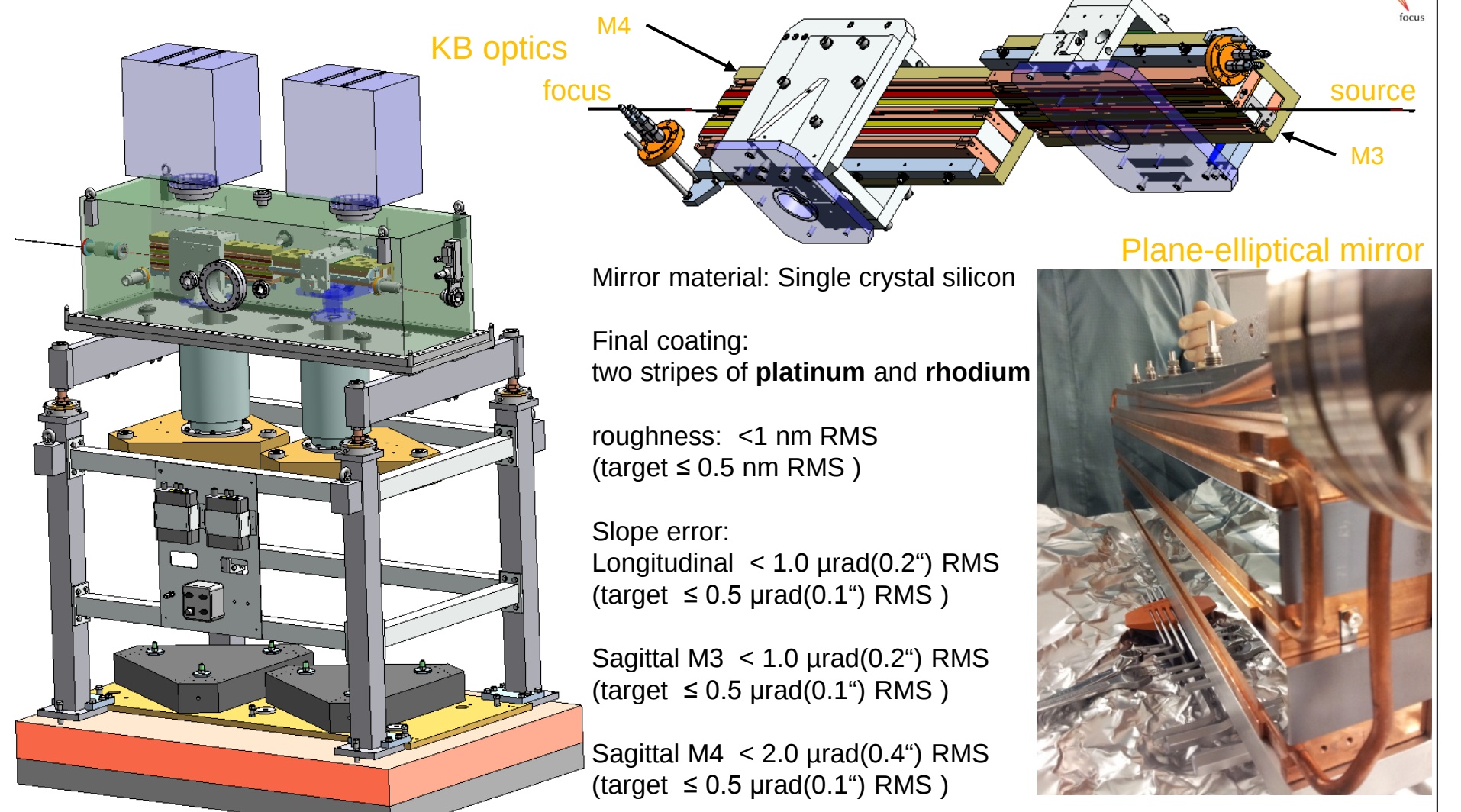
The working principle is the optical analysis of the longitudinal beam shape. A YAG screen is used to make the X-ray radiation visible for a high-resolution camera. Mounted on a precision slide, images of the current beam shape are taken and processed.

With the implemented fiducial marks, one is able to measure the absolute position of the focus. The measurements can take place under UHV conditions.

P04 XUV-Beamline Layout

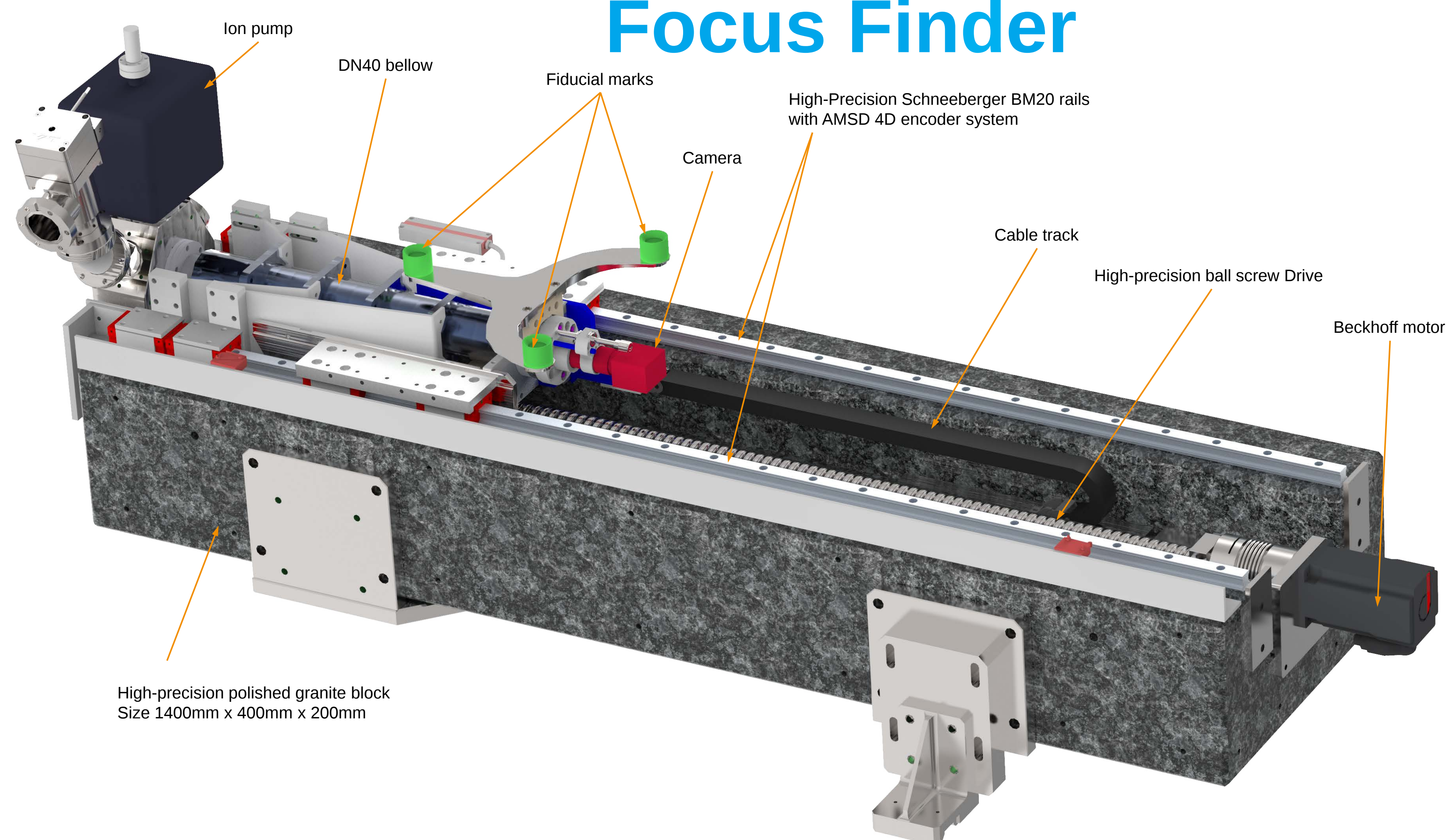


Refocusing Mirror Unit (RMU)



Characteristics

- Beckhoff motor control
- Beckhoff synchron motor
- Schneeberger rails with incremental encoder (1 μ m resolution)
- Minimum focus size $\sim 2 \mu\text{m} \times 2 \mu\text{m}$ (at present)
- Target focus size $< 1 \mu\text{m} \times 1 \mu\text{m}$
- Focus point longitudinal tolerance $\pm 1 \mu\text{m}$
- Lateral tolerance 5 $\mu\text{m}/1000$ mm
- Fiducial marks for absolute positioning
- Lifetime of bellow 100.000 cycles
- Scan speed 30 mm/s
- 1006mm scan distance
- Ratio ball screw drive 10 mm/1revolution
- High reproducibility $< 10 \mu\text{m}$
- Overall weight ~ 400 kg (250 kg granite block)
- Overall length 1600 mm
- Overall width 960 mm
- Beam height adjustable ~ 1300 -1500 mm



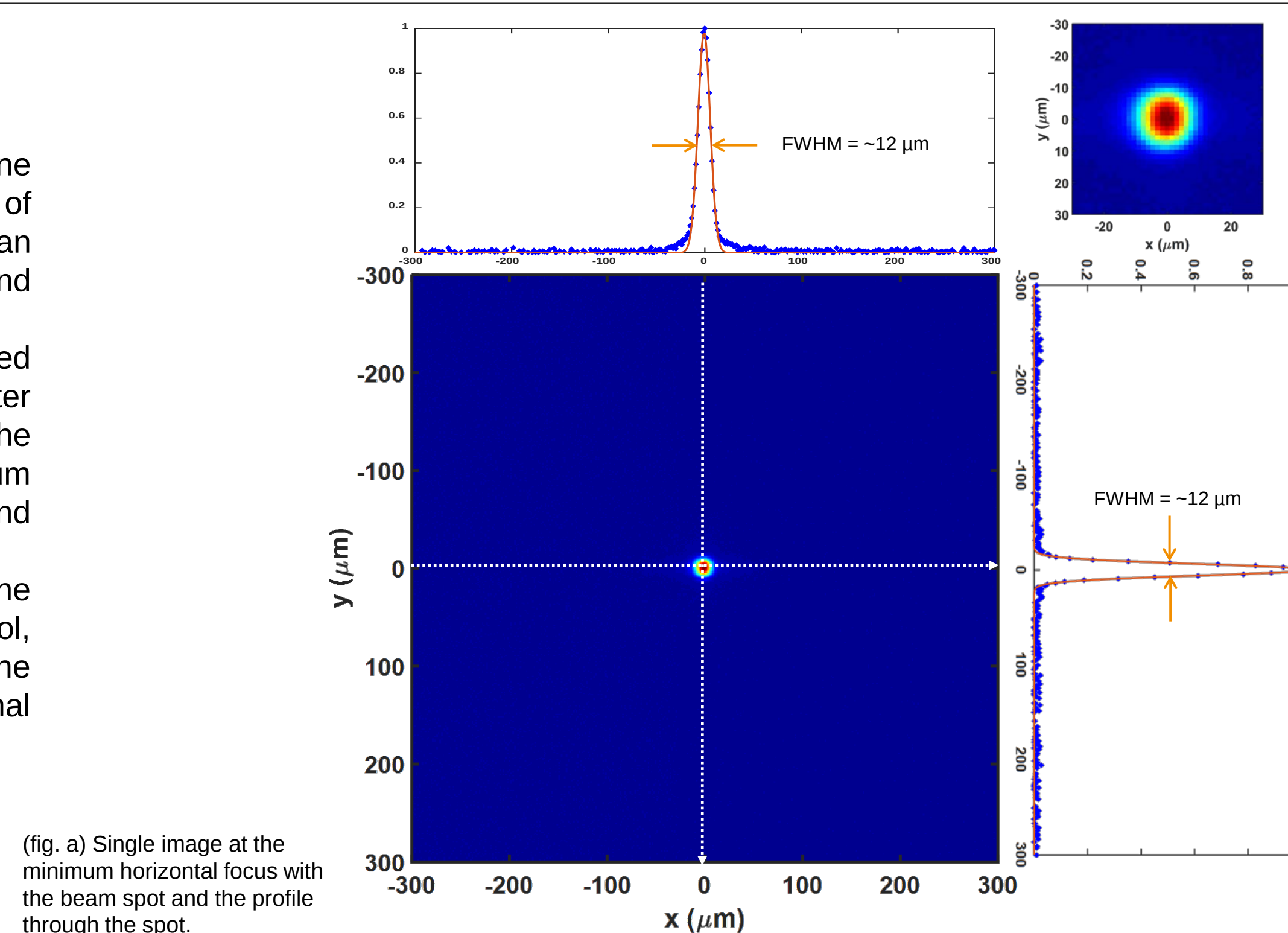
Focus Finder

Results

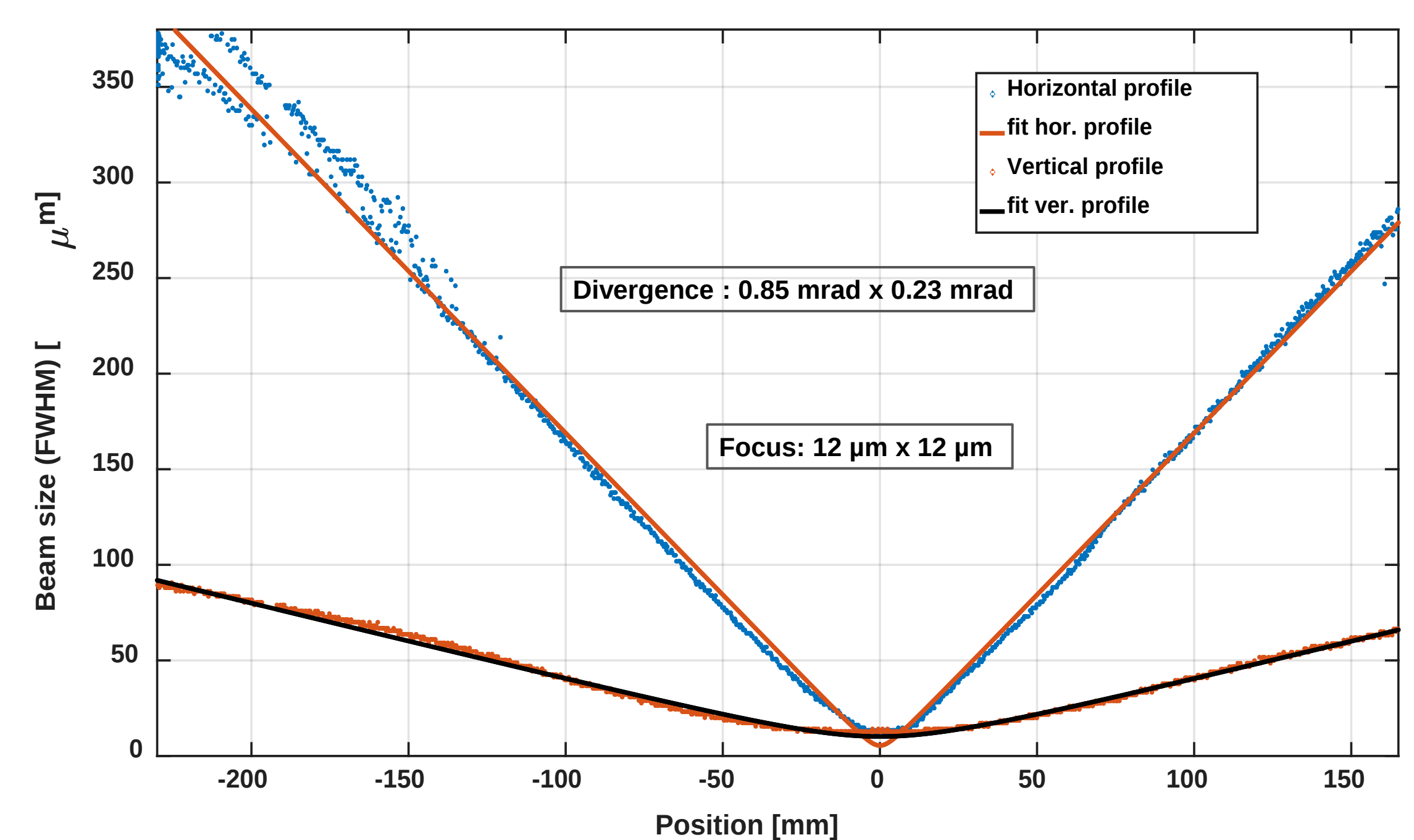
The last measurement at the P04 beamline in March 2018 gave us the present status of the focus at the P04 Beamline. As you can see (fig. a) we measured a vertical and horizontal spot size of about 12 μm .

To find the focus the beam size is measured along the longitudinal axis. (fig. b). After fitting a polynomial function into the measured values we calculate the minimum position (830mm) for the vertical and horizontal foci after the user valve.

With these results we can show that the 'Focus Finder' is a useful and versatile tool, which helps to characterize the beamline conditions and to have the beamline optimal prepared for the user.



(fig. a) Single image at the minimum horizontal focus with the beam spot and the profile through the spot.



(fig. b) The measured spot size (FWHM) along the beam axis. In this scan 1270 images were taken in approximately 30 seconds.



Outlook

Even after three successful measurement campaigns at PETRA III and one at Diamond Light Source (2015) there is still room for improvement. Vibrations are still a problem and need to be minimized. The camera mounting does not have sufficient stability and tends to vibrate. Furthermore we assume that the bellow guide is introducing vibrations into the system because of a stick-slip effect.

There is the possibility to have a higher magnification of the YAG screen with the existing camera but at the expense of a smaller field of view.

