Automatic focusing of X-ray optical components

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ESRF

Introduction

- Collaboration within the ESRF:
  - Olivier Hignette (algorithms)
  - Elia Chinchio (wavefront and intercorrelation code)
  - Jens Meyer (matrox device server)
  - Vicente Rey (ID 23), Alejandro Homs (ID 22), Laurent Claustre (BM 05) and many more collegaues in the BLISS group
- Algorithms
  - Wavefront method
  - Intercorrelation
- Implementation - how can we share software?

ESRF: Status of automatic focusing

ID13, ID19, ID30, ID22, BM05	KB	AF is essential to obtain small spot size
ID29, ID23, ID14, ID03, ID24	Bender or Toroidal Mirror	Automation in progress
ID18/22, ID28, ID16, ID10B	Bender or KB	Manual focusing
ID26, ID11, ID08	Bender or KB	Not commissioned yet, interest in AF

Wave-front Optimization

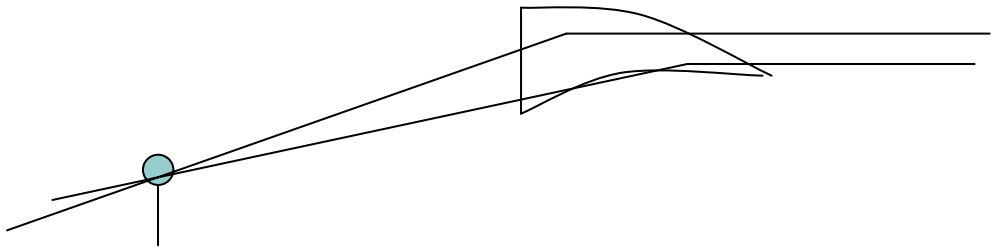
- A linear procedure derived from adaptive optics techniques:
  - Acquire the nominal wave-front
  - Identify the system by sending a small displacement on each actuator, acquire wave-front after each displacement
  - Store the differential metrology
  - Build the interaction matrix H
  - The correction vector C to be sent to all the actuators is

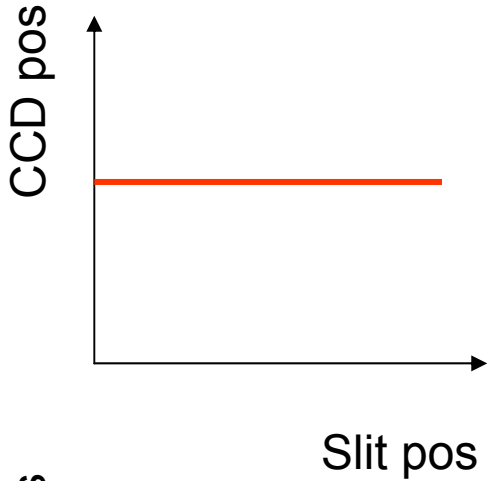
$$C = \left(H^T H\right)^{-1} H^T Y$$

- Purely geometrical – the intensity information is not used.

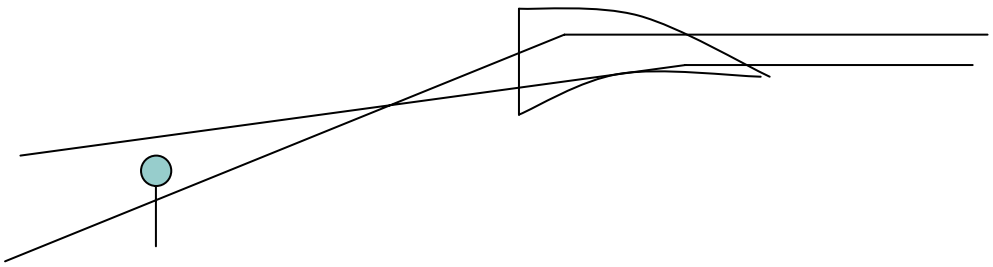
Example 1 – KB mirror

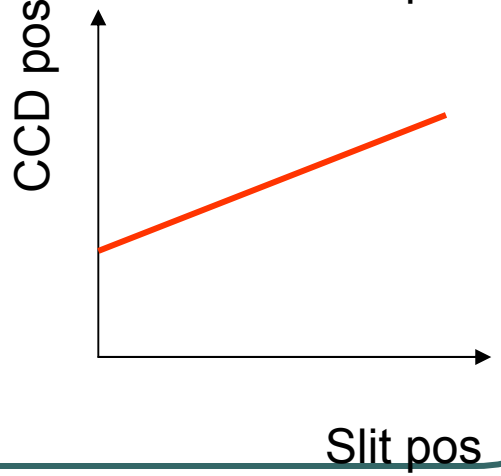
- Well focused:



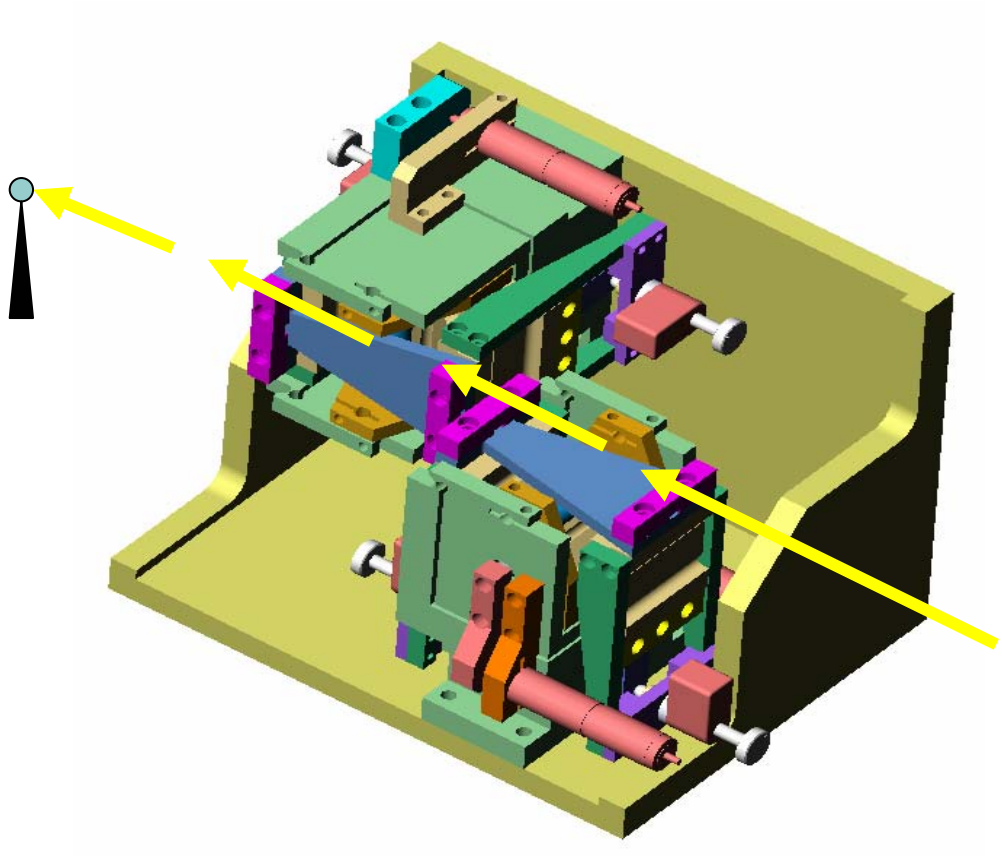


- Unfocused:

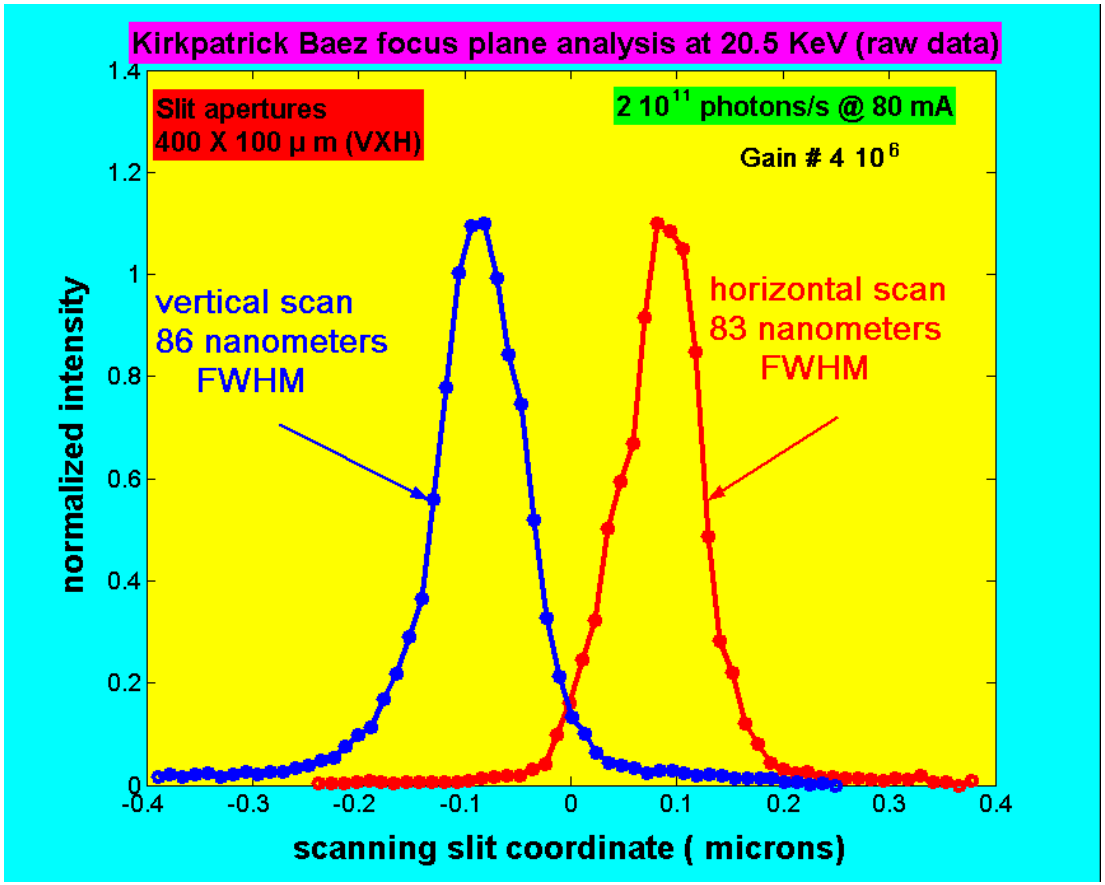




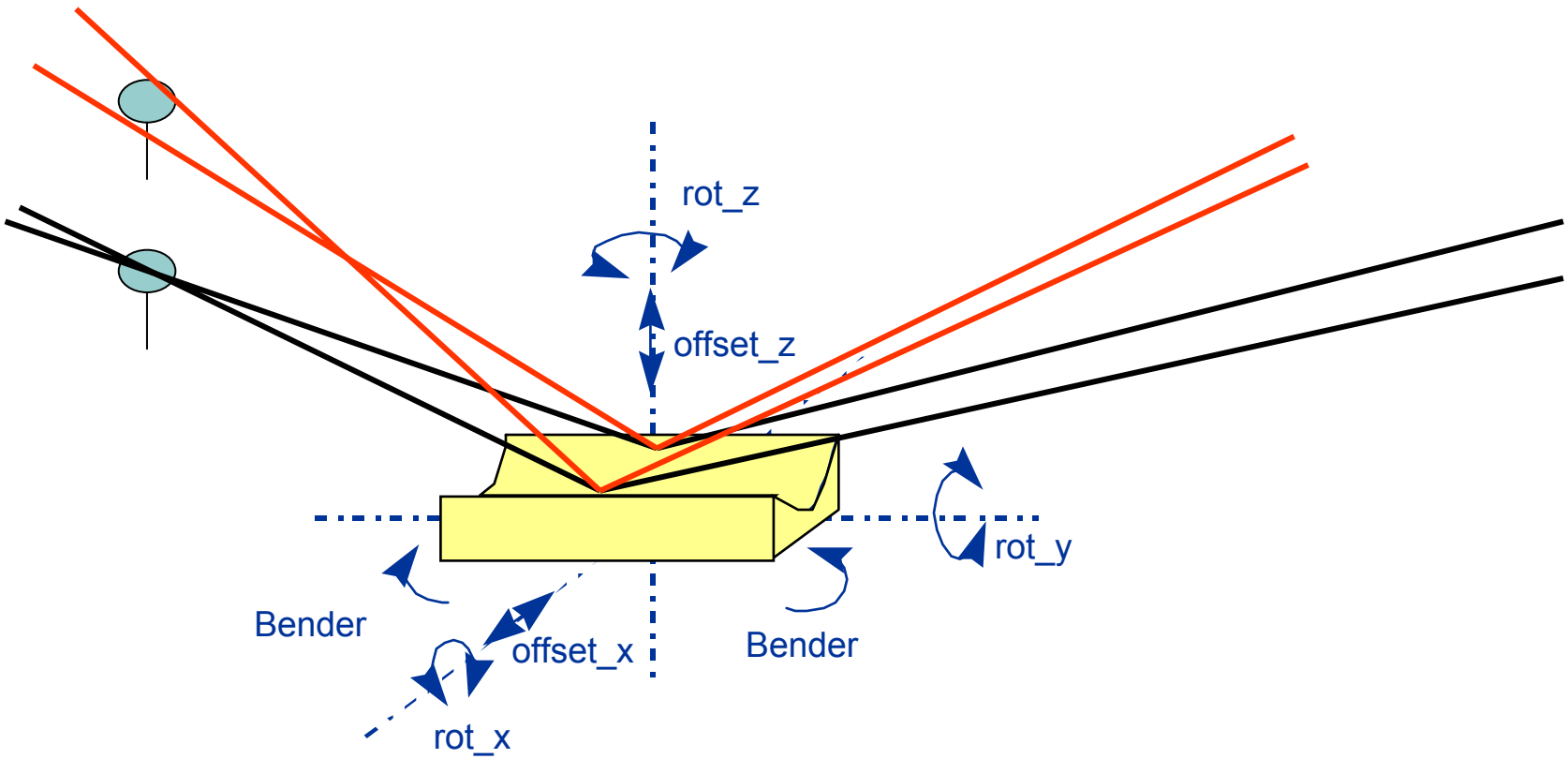
Submicron focusing KB system



Results ID19

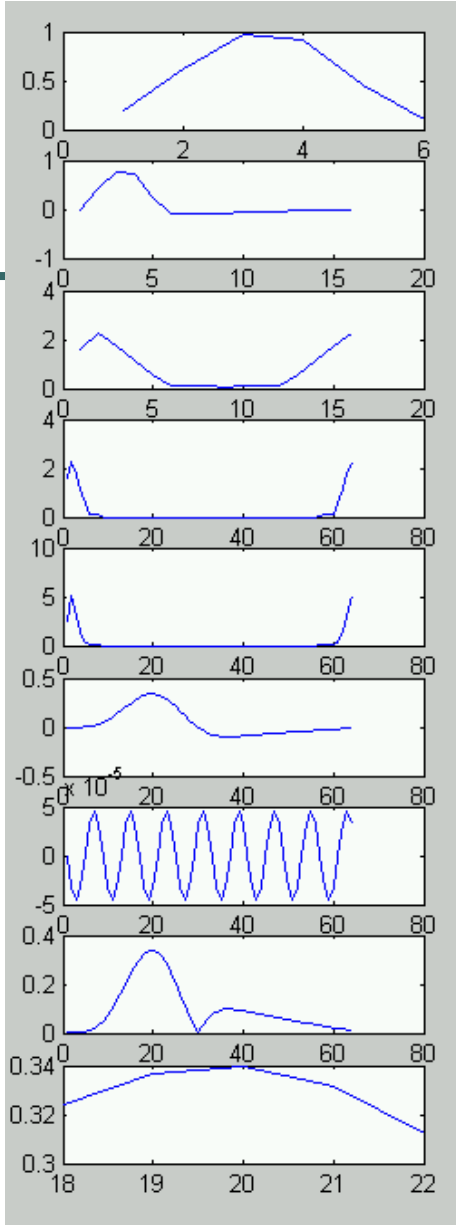


Example 2 – toroid shaped mirror

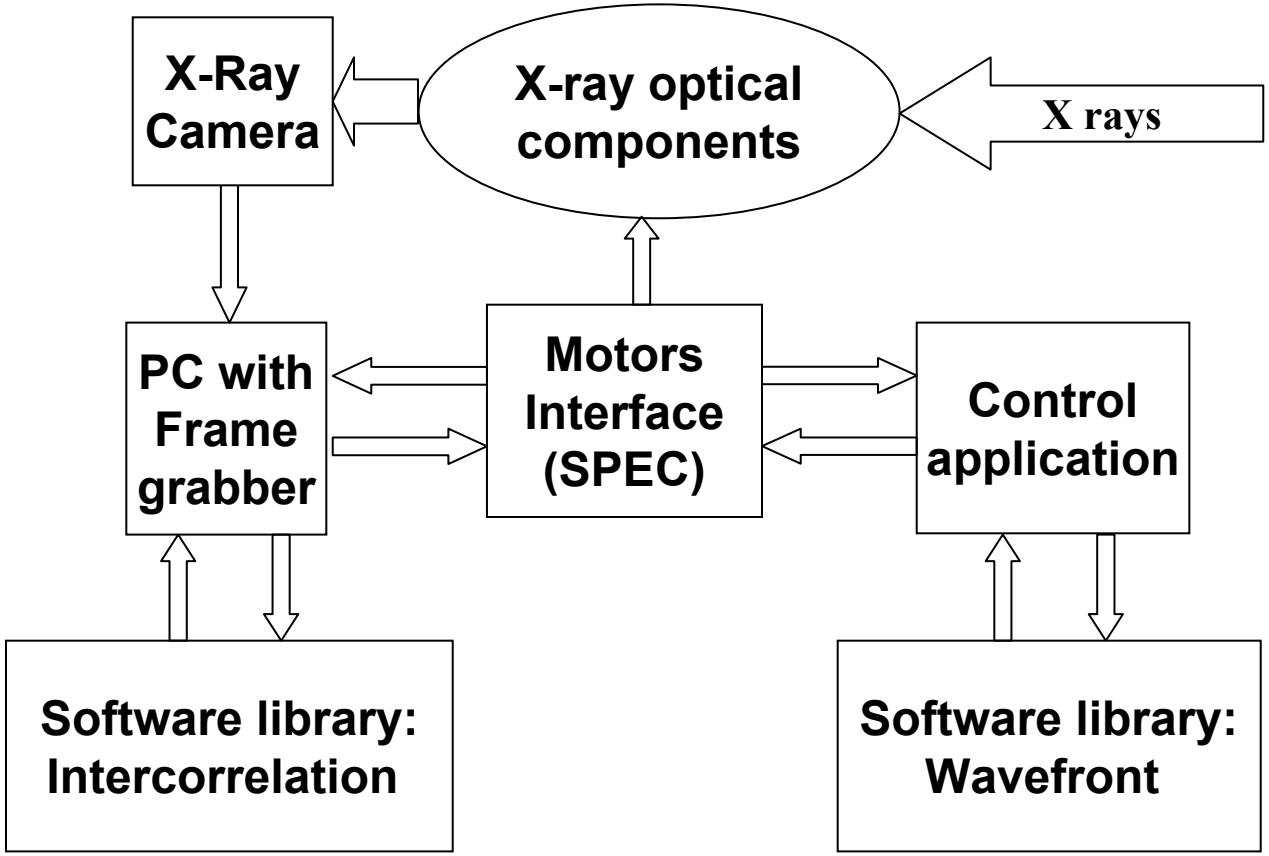


Intercorrelation

- The wavefront method need a robust and accurate algorithm for finding the position of the beam on the CCD detector.
- Using the centre of gravity works only up to a certain accuracy, for very small spots it fails.
- Intercorrelation: parabolic regression on a ‘frequency-interpolated’ profile.
- The intercorrelation method has been proved to be both robust and very accurate.



Implementation



Collaborations – How can we share software

- Introduction to the discussion session…
- Possible levels of collaboration:
  - Algorithms: Very easy to share
  - Software libraries: Possible to share – we should aim for this!
  - Control application: Not easy to share due to facility dependencies.