The Automatic Beamline Alignment project at ELETTRA

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Agenda

- The Automatic Beamline Alignment problem
- Applying Intelligent System Concepts to the Automatic Beamline Alignment problem
- A portable framework for the Automatic Beamline Alignment problem
- Project status and future developments
- Java Beamline Simulator

Automatic Beamline Alignment: problem scenario

- Heterogeneity of the beamlines
- Heterogeneity of the alignment purposes
- Limitations of actuators
- Limitations of sensors
- On-line and Off-line alignment
- Time constraints
- Availability of beam-time

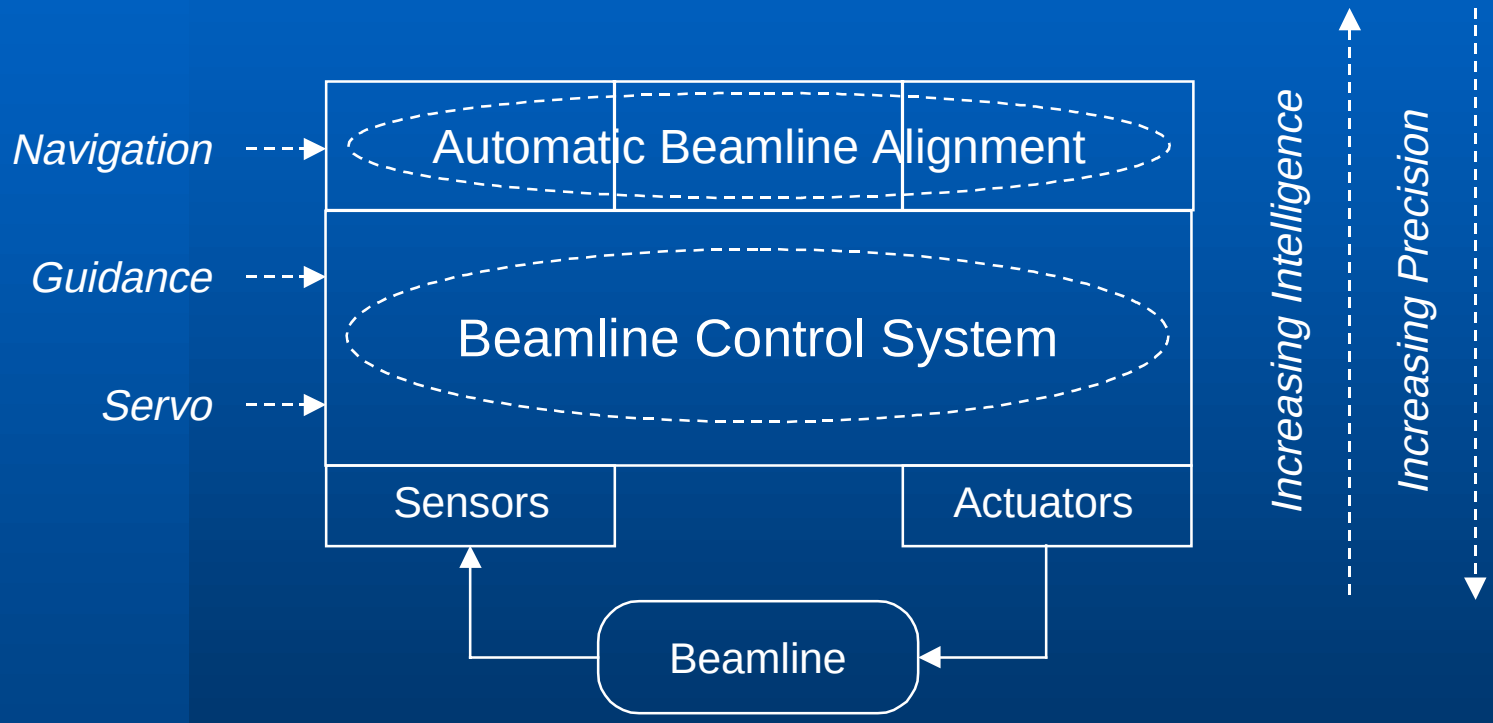
Automatic Beamline Alignment: project goals

- Definition of a methodology
- Definition of a portable framework
- Implementation of application development tools
- Development of reusable off-the-shelf components
- Implementation of meaningful prototypes

Applying Intelligent System Concepts to the Automatic Beamline Alignment problem

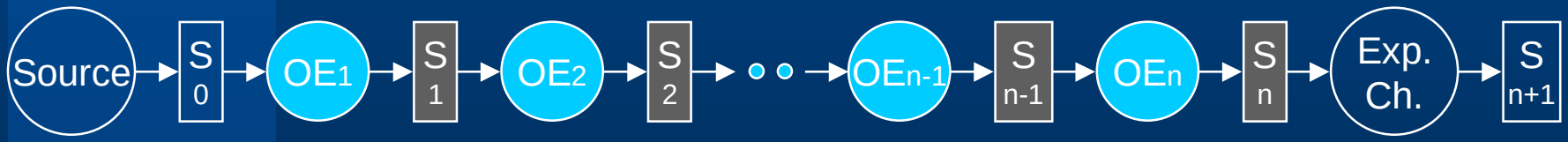
- Intelligent Systems (IS) incorporate the creative, abstract and adaptive attributes of a human while minimising the undesirable aspects such as unpredictability, inconsistency, fatigue, subjectivity and temporal instability
- Hybrid Intelligent Systems integrate Knowledge Based Systems, Neural Network, Fuzzy Systems, Evolutionary Algorithms, Case-Based reasoning, Chaos Theory and traditional techniques to solve effectively complex real world problems.

Applying the Model Reference architecture to beamlines



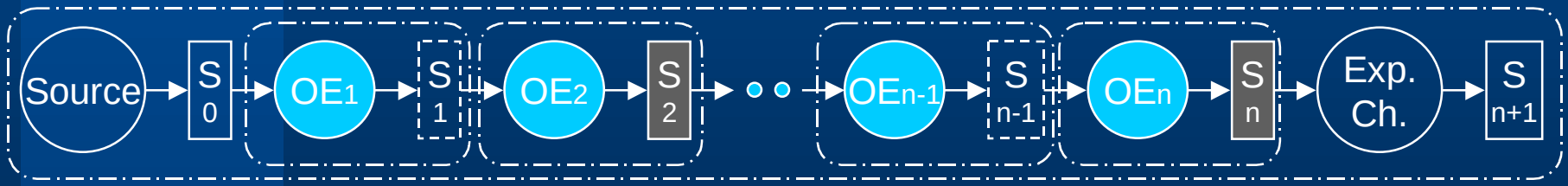
Automatic Beamline Alignment: problem statement

- A beamline is a pipeline of optical elements each with some degree of freedom
- Determine the position of the optical elements which optimise some beam parameters, such as flux and resolving power, at the experimental station.



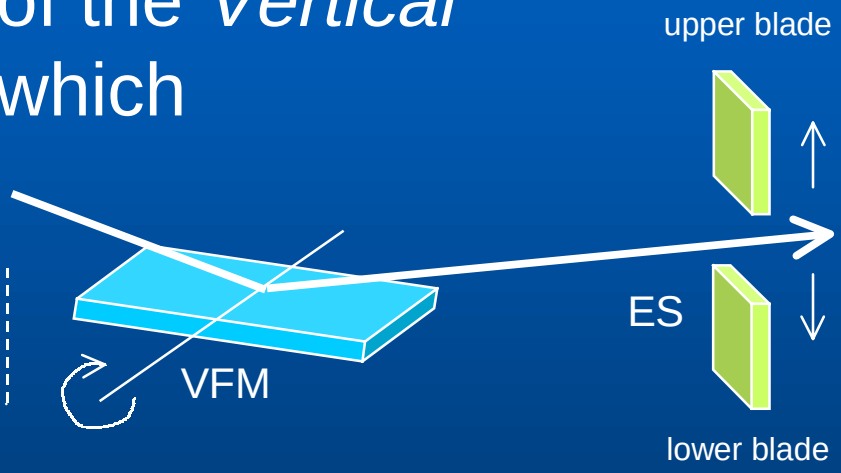
Automatic Beamline Alignment: problem solving strategy

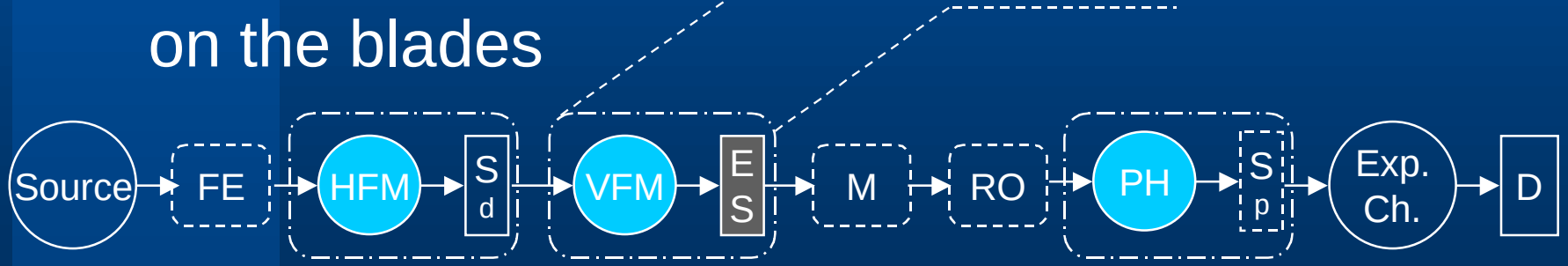
- Split the alignment problem into small *sub-problems* involving, for example, only one optical element and the associated sensor
- Implement for each *sub-problem* an *alignment module* using traditional or soft computing techniques
- Combine the modules using the strategic, behavioural knowledge of the optics expert



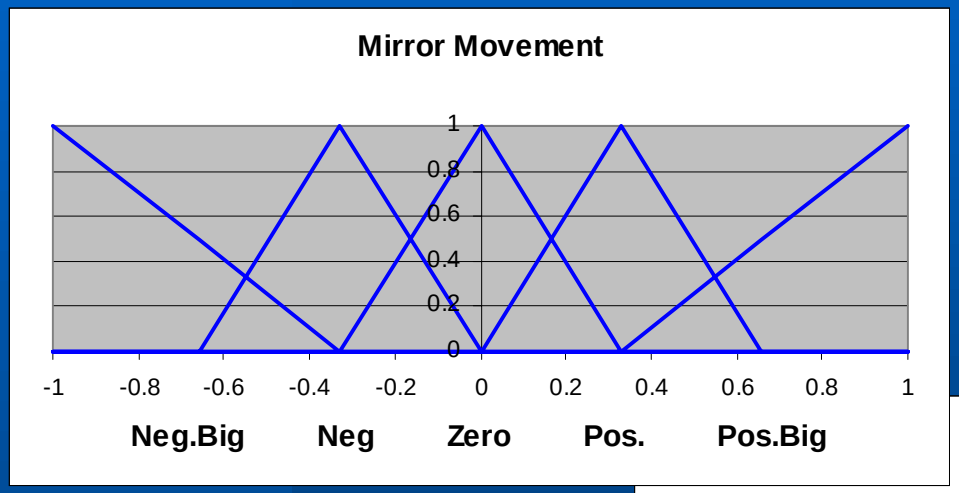
Beamline SpectroMicroscopy: the VFM alignment module

- Determine the position of the *Vertical Focusing Mirror* (VFM) which centres the beam at the *Entrance Slit* (ES) balancing the photo-induced currents on the blades

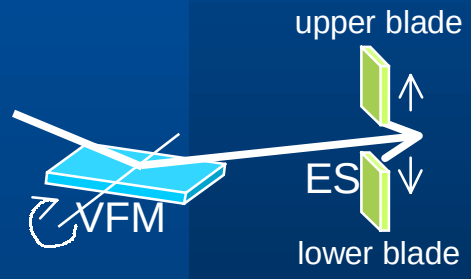


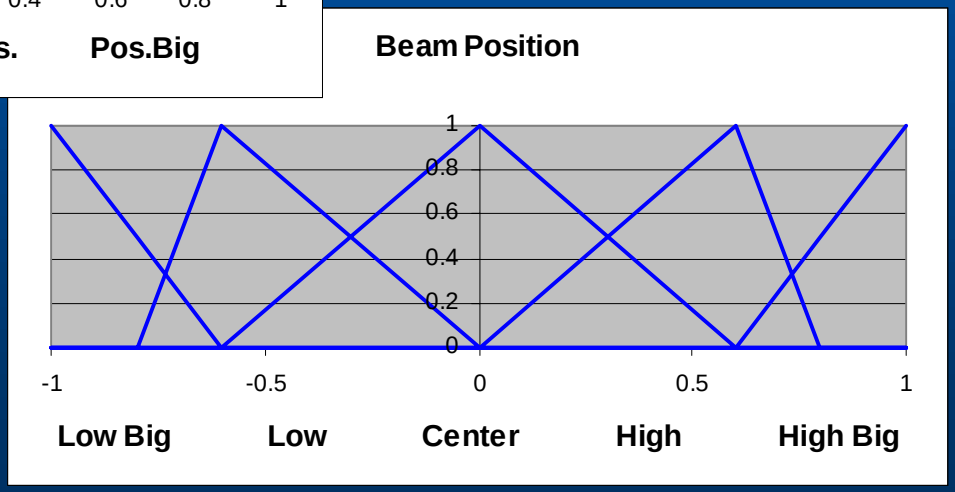


Beamline SpectroMicroscopy: the VFM fuzzy alignment algorithm



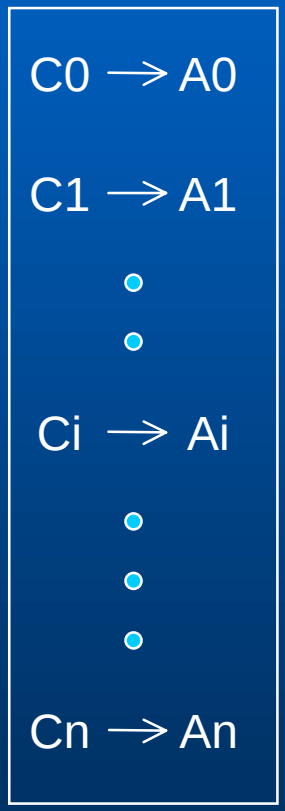
N&F		D&D
	IF **BP** *IS* **LB** *THEN* **MM** *IS* **NB** *IF* **BP** *IS* **L** *THEN* **MM** *IS* **N** *IF* **BP** *IS* **C** *THEN* **MM** *IS* **Z** *IF* **BP** *IS* **H** *THEN* **MM** *IS* **P** *IF* **BP** *IS* **HB** *THEN* **MM** *IS* **PB**	
BCS		



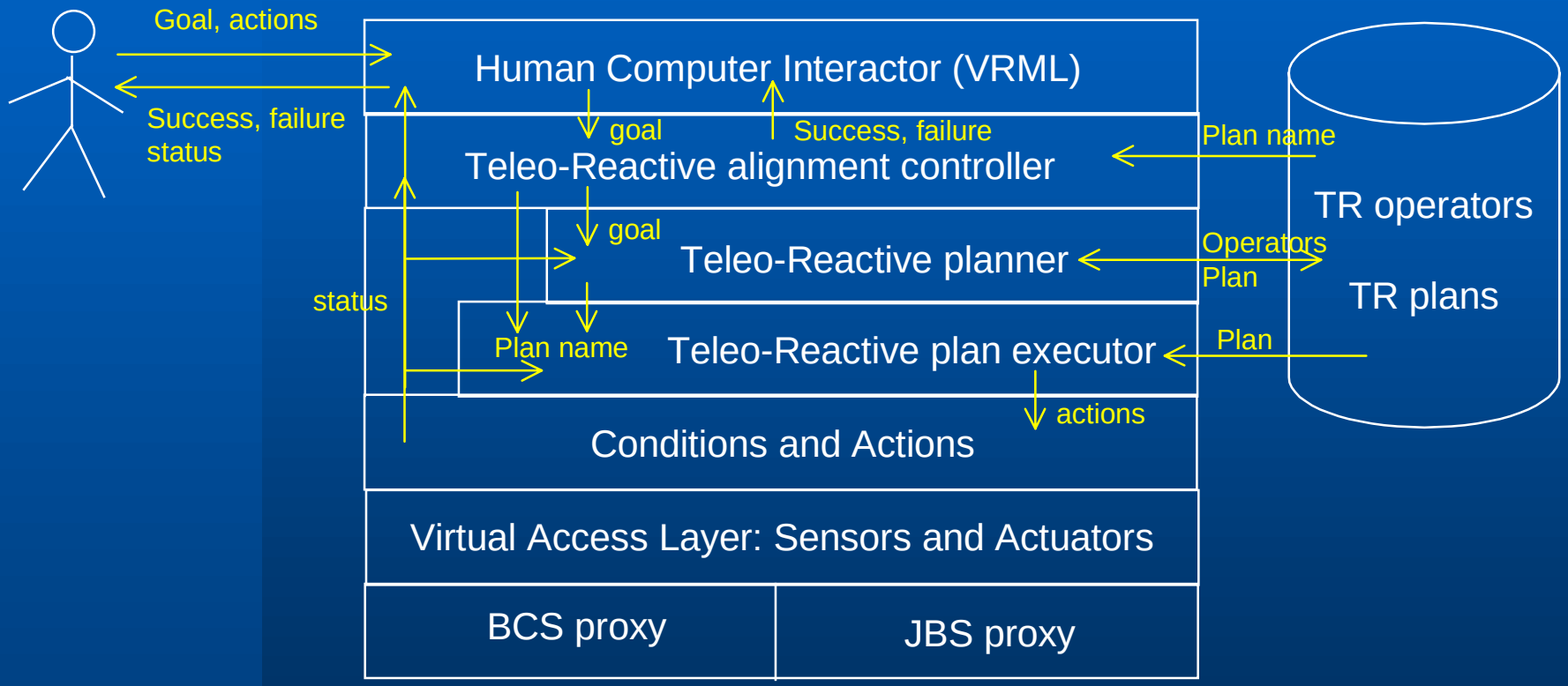


Teleo-Reactive (TR) control

- TR control occupies a region between feedback control and discrete action planning:
  - actions can be either discrete or continuous
  - actions are not guaranteed to achieve their goals
  - actions can be interrupted in response to changes in the environment
- TR plans can be represented as a sequence of condition-action pairs called TR operators.
  - TR plan execution is adaptive and opportunistic: conditions are evaluated from top to bottom and the action associated o the first true condition is performed.



Automatic Beamline Alignment: system architecture

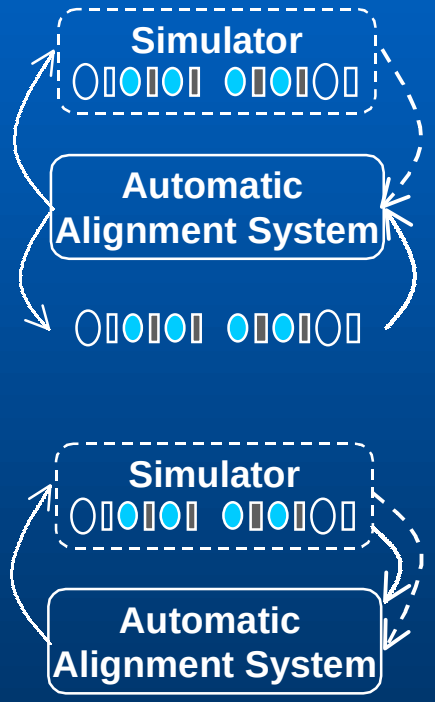


Project status and future developments

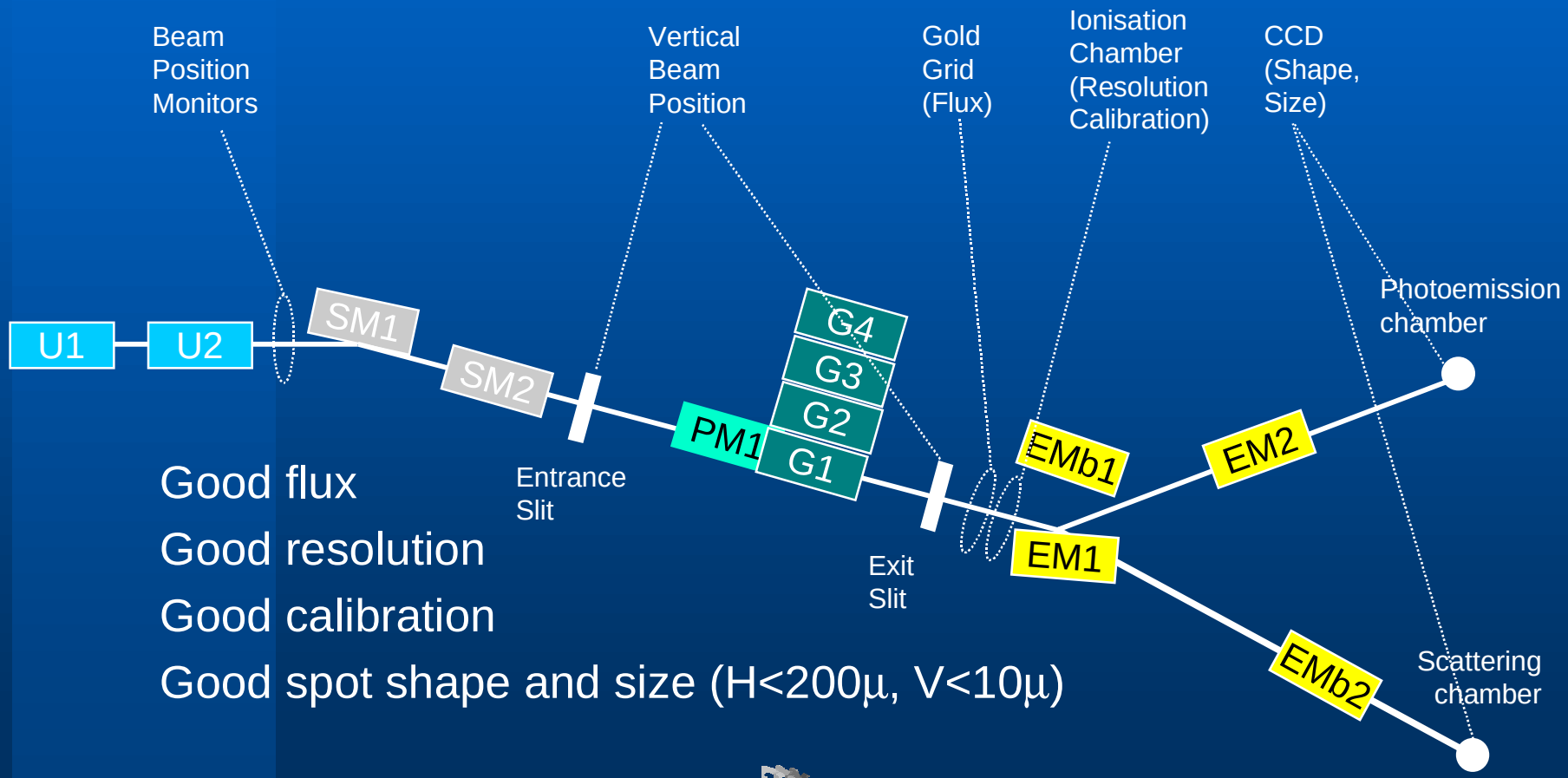
- The Automatic Beamline Alignment is now one of the official projects of ELETTRA
- A *framework* for the conceptual development of Automatic Beamline Alignment systems has been designed
- We are currently developing a set of *tools* which support the proposed framework
- The *framework* and the *tools* will be tested on on a challenging automatic alignment problem

The Beamline Simulator: much more than a development tool

- Based on object oriented ray tracing, provides an operational model of the beamline
- Can be used on-line and off-line
- Designed to be extendible, flexible, integrable and portable
- Implemented using JavaBeans and CORBA



Beamline for Advanced diCHronism (BACH): Automatic Alignment Goals



Good flux

Good resolution

Good calibration

Good spot shape and size (H<200μ, V<10μ)

Acknowledgements

- Daniele Cocco, Claudio Scafuri, Fulvio Bille' from ELETTRA
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