



- destructive methods
 - crystal / grating spectrometer
 - refraction with prism
 - dispersive XRRS
- online measurements
 - gas based – photoionization
 - beamsplitter + destructive
 - for soft x-rays: grating in first order
- parameters (commissioning!)
 - distance from undulator
 - resolution (spectral / spatial)
 - spectral range
 - shot-to-shot / integrated



Device Parameters



INPUT

- width of entry slit
- size of dispersive element
 - size
 - angle of incidence / footprint
- position in beamline
= size of x-ray beam
- detector (1D / 2D ?)
 - pixel size
 - total size / moving range
- internal distances – lever arms
 - vibration / temperature sensit.
- pulse train capability
 - heat load: absorption, heat conductivity

OUTPUT

- center-of mass of spectrum
- bandwidth (envelope)
- mode structure
- ...

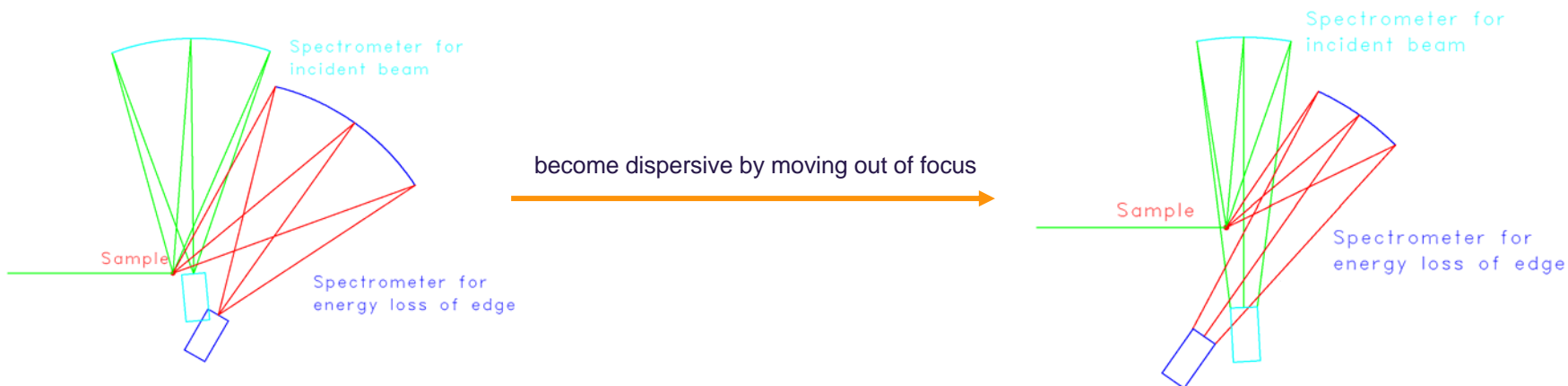
Operating Modes

- single shot vs. train integrated
- non-destructive / destructive
- commissioning / user run
- soft x-ray / hard x-ray

Dispersive x-ray Raman scattering (XRRS)



- Proposal by Wolfgang Caliebe
- Goals
 - single-shot spectrum
 - 25meV energy resolution
- Elements
 - scattering sample (or parasitic ?)
 - bent analyzer as a dispersive element
 - fast position sensitive detector



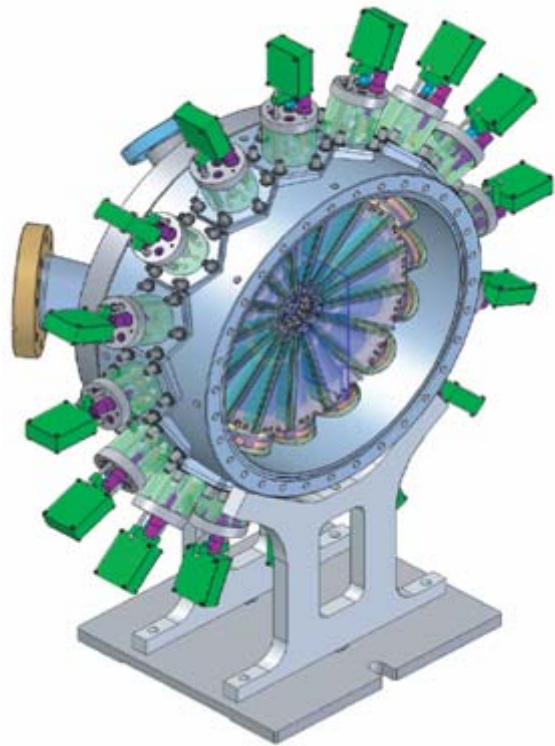
Commissioning requirements



- Spectral distribution (shape, FWHM, com)
- spont. and FEL
- before DCM
- pulse resolved
- accuracy:

350 - 3000 eV	4 - 25 keV	
0,01%	0,01%	energy calibration with e-beam
0,1%	0,01%	undulator checks, BL transmission, setup mono
0,001% within 0,1%	0,0001% within 0,01%	temporal structure

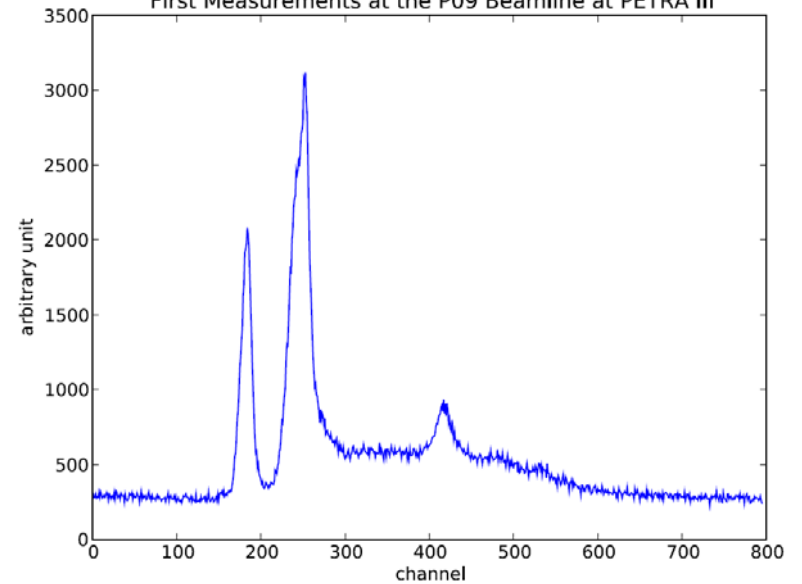
- Possible devices:
 - K-mono (destructive → commissioning)
 - photoelectron spectroscopy (PES)
 - dispersive Raman scattering



PES

photo-electron spectroscopy

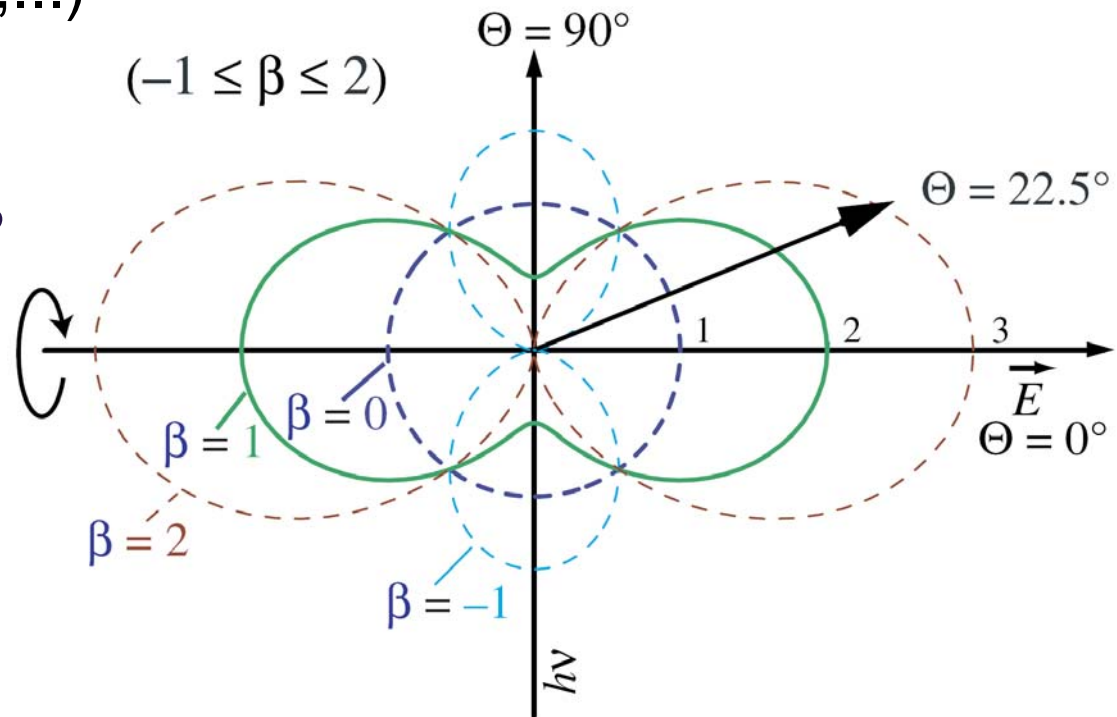
Photoelectron Spectrum of Xenon (5160 eV) at 22.5 deg
First Measurements at the P09 Beamline at PETRA III



- online = non-destructive measurement of
 - polarization (accuracy $\sim 1\%$) \rightarrow SASE3
 - photon energy (shown for XUV: $\Delta E/E < 10^{-4}$)
 - (flux, beam position,...)

The anisotropy parameter β

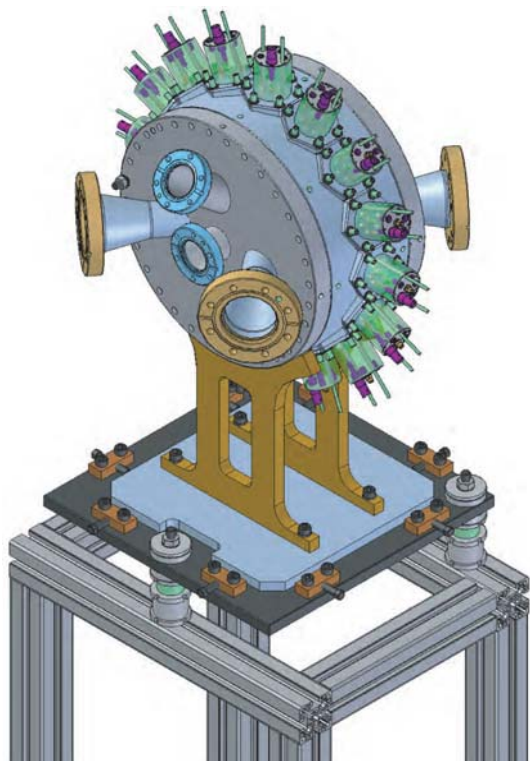
- 1 vertically orientated to plane of polarization
- 0 isotropic distribution
- +1 intermediate state
- +2 horizontally orientated to plane of polarization



PES with hard x-rays at PETRA3

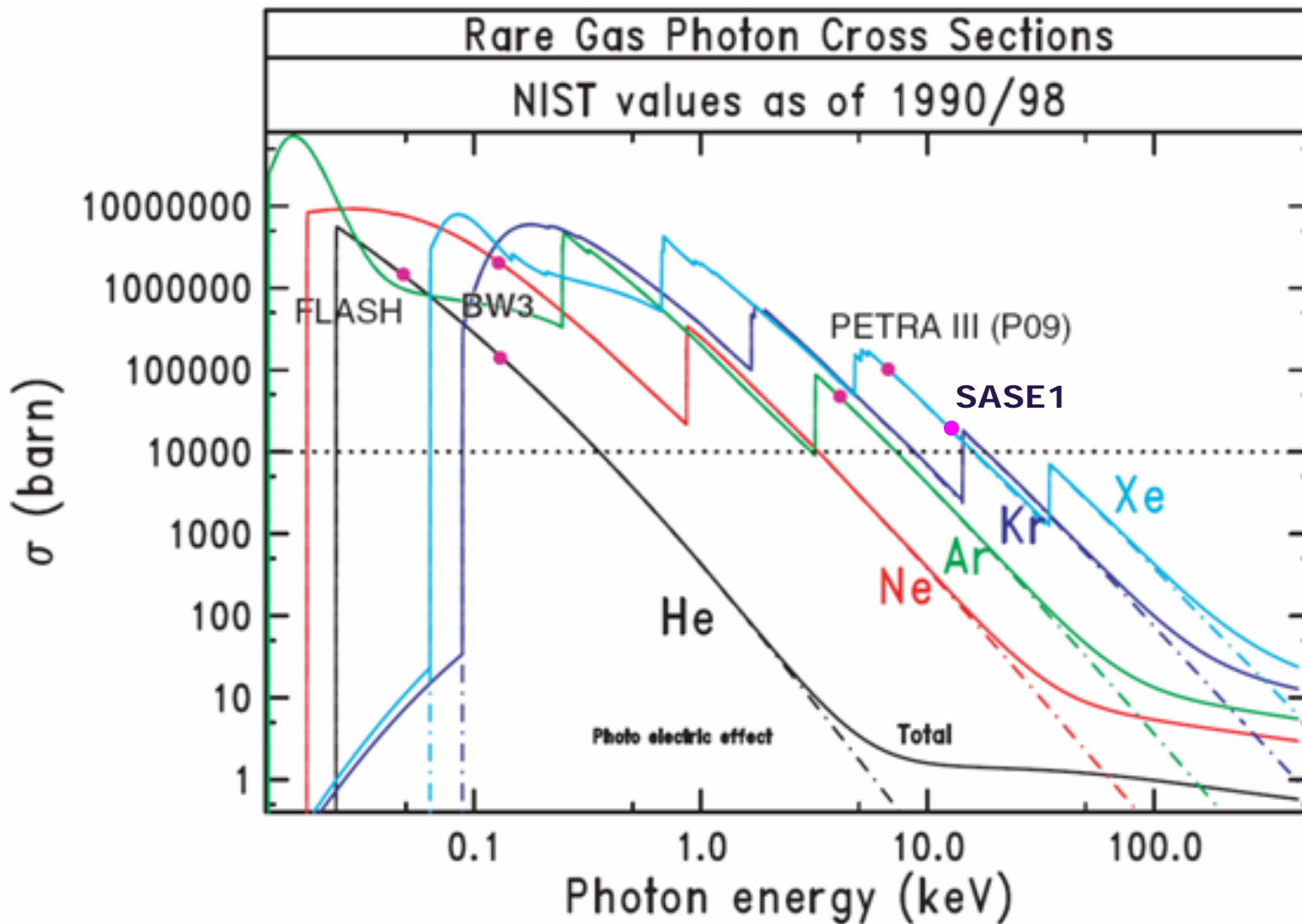


- mobile setup at PETRA3 for BL P04, test at P09
 - collaboration with Jens Viefhaus group + J.Stremper/S.Francoual
 - angle resolved time-of-flight spectrometer (4 detectors at 0 – 90°)
 - ~ 4–15keV (Ar,Kr,Xe)

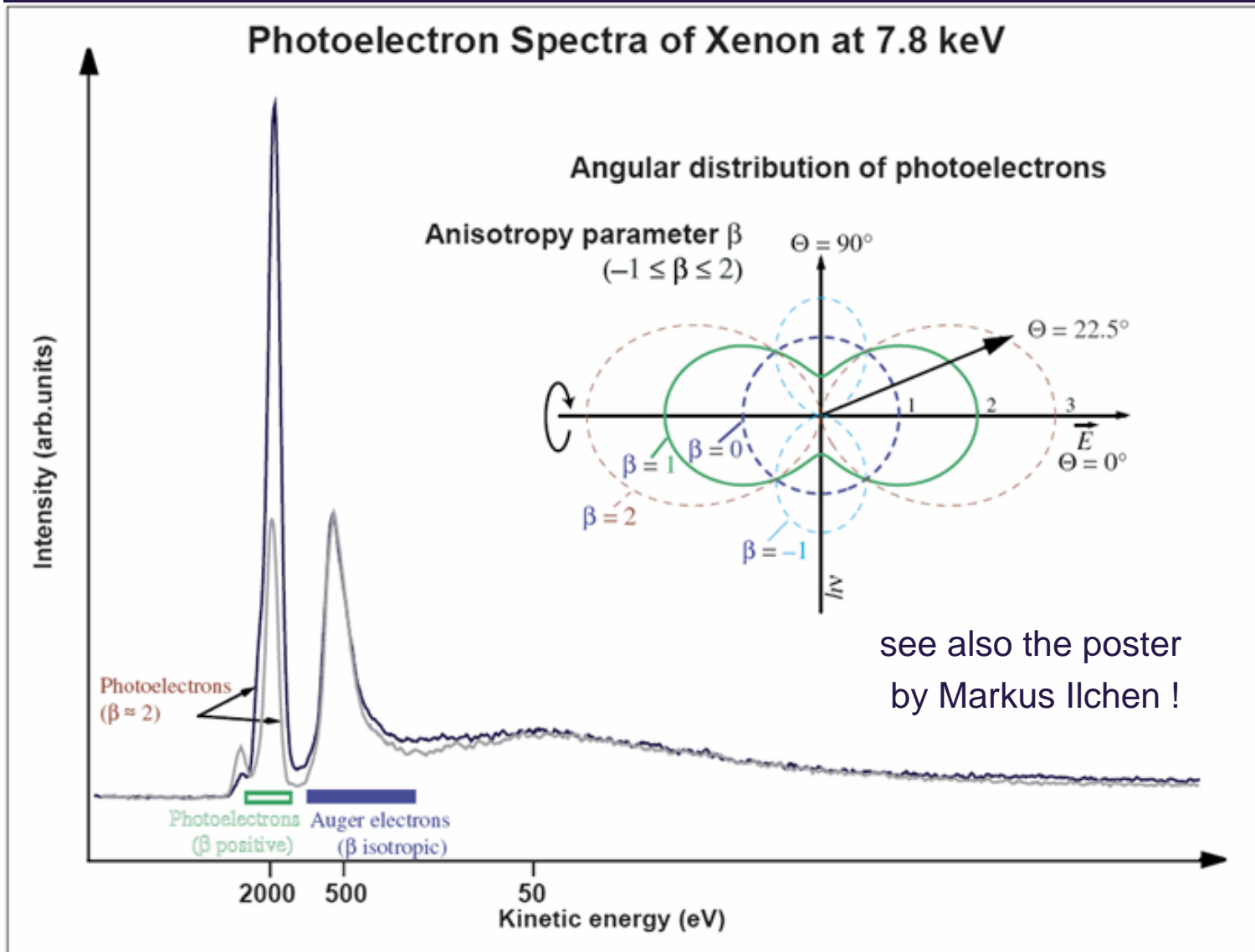


PETRA3-P04 setup
(courtesy J.Viefhaus)

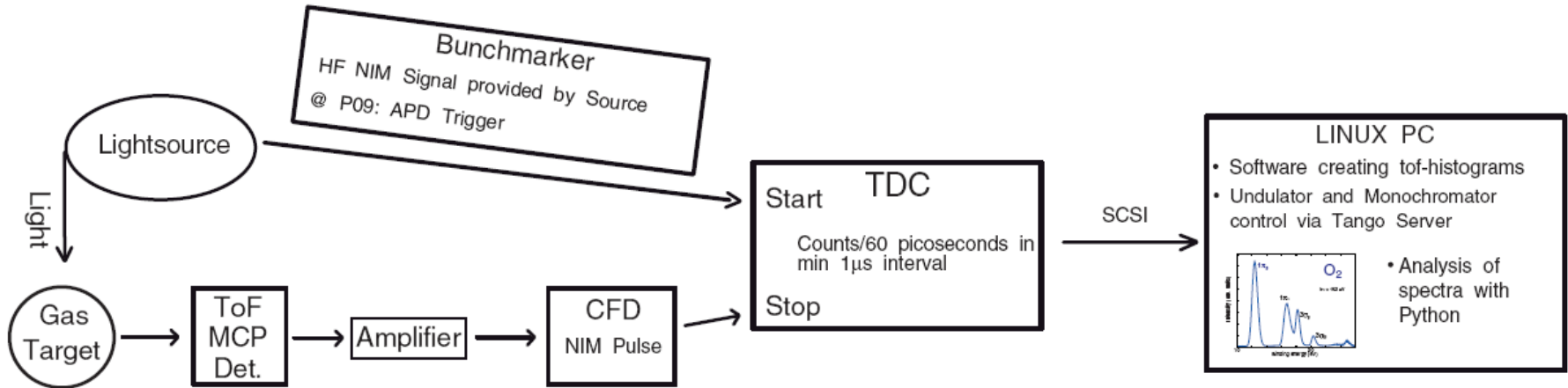
Cross sections



Results of P09 test

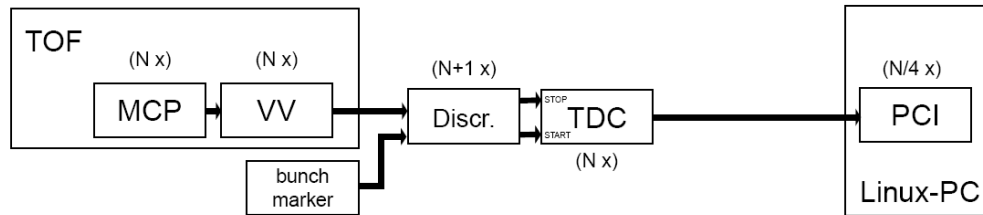


Setup and Electronics

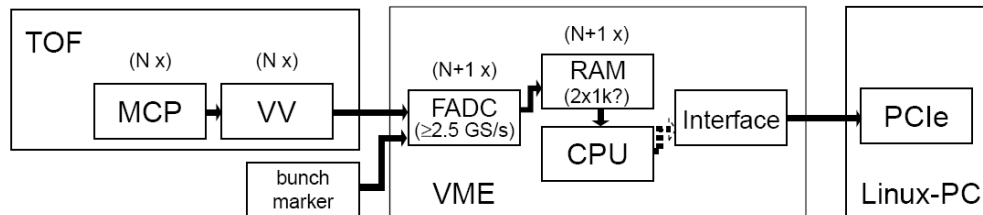


Schematic view of the experimental components

“Traditional” TDC
(arrival time histogram)

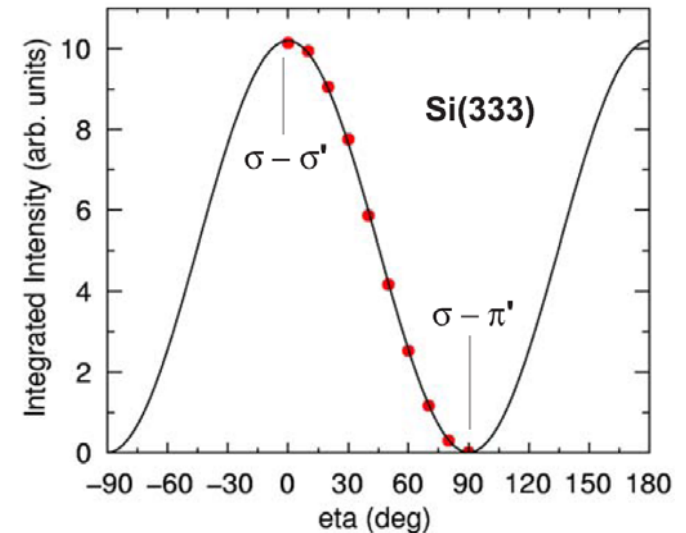


Flash ADC – VME
(shot resolved spectra)



- Tests of fast 5Gb/s DAQ electronics (local supplier)
- Work towards a data base of β -values which will allow to determine the total degree of polarization
- Cross-check directly with destructive polarization measurement: Si(333) Bragg reflection and pyrolytic graphite (006) crystal as an analyser

Polarization determination at P09



Parameters = optimization knobs



➤ **Number of ToF detectors** ↔

- accuracy of polarization meas.
- detected solid angle

➤ **Flight tube length** ↔

- energy resolution
- detected solid angle
- detection and spatial efficiency

➤ **Retarding Potentials**
for decelerating electrons ↔

- longer time of flight
- energy resolution
- ☞ more retardation → more optimization (now max. ~3keV)

IDL tool (JV)

➤ **MCP** (type, voltage, \varnothing) ↔

- detected solid angle
- energy resolution

➤ **Gas** (type, pressure) ↔

- eff. pressure ~ # of interactions
- ☞ less gas type changes → larger error bars but faster acquisition

➤ **Acquisition time** ↔

- accuracy



$$\beta_{un} = \frac{1 - K \frac{A_{un}(\theta_2)}{A_{un}(\theta_1)}}{K \frac{A_{un}(\theta_2)}{A_{un}(\theta_1)} F(\theta_1) - F(\theta_2)}$$

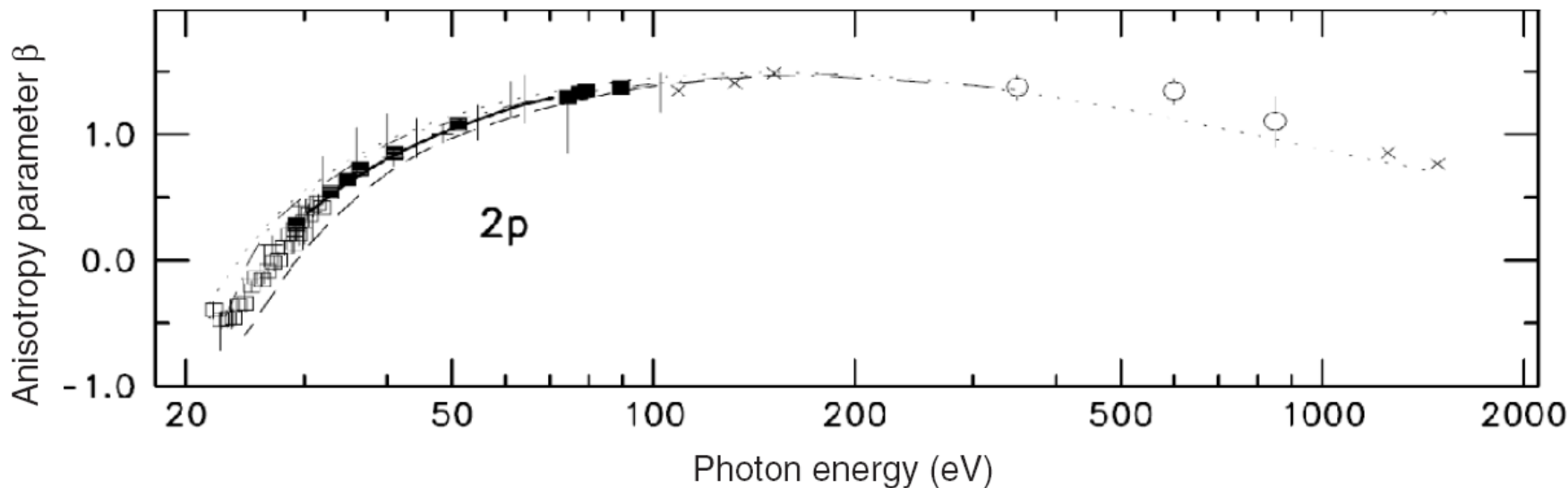
$$K = \frac{A_{Kal}(\theta_1)(1 + F(\theta_2)\beta_{Kal})}{A_{Kal}(\theta_2)(1 + F(\theta_1)\beta_{Kal})}$$

$$F(\theta_i) = \frac{1}{4} + \frac{3}{4} P_1 \cos(2(\theta_i - \lambda))$$

A_{un} = integrals from fit procedure
for unknown target

A_{Kal} = integrals from fit procedure
for known target





β -values for the Neon 2p orbital dissociation (theoretical and experimental data)

- Characterize material properties with known radiation
- Create database of beta-parameters

