



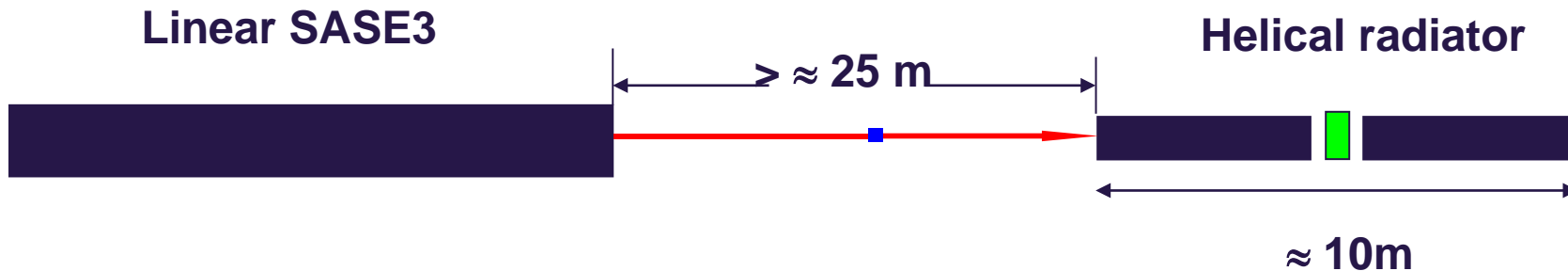
Circular Polarization - Diagnostics

5th Annual X-Ray FEL Collaboration Meeting,
Menlo Park, CA, February 4-6, 2013

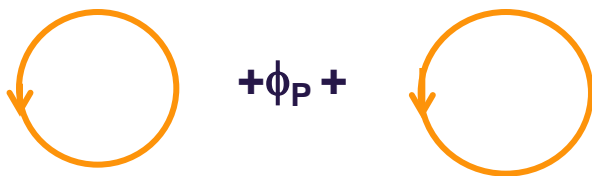
Serguei L. Molodtsov
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Circular polarization at XFEL.EU

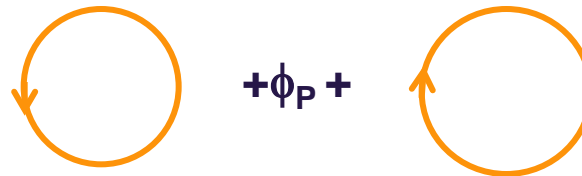
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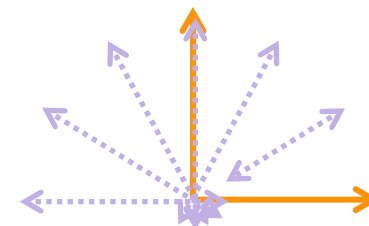
Double: Both left/right $\phi_P = 0, 2\pi, \dots$



One right one left



- operation both at the fundamental (down to C edge) and second (edges of transition and rare-earth metals) harmonics
- both afterburners are of L_G size
- 100% stable polarization (L. or R.) will be ensured by afterburners, solely
- full polarization control (less stability and % of polarization) by phase shifter



Method: Photoemission spectroscopy from rare gases

- ✓ Non-invasive (absorption negligible)
- ✓ Tunability by gas pressure

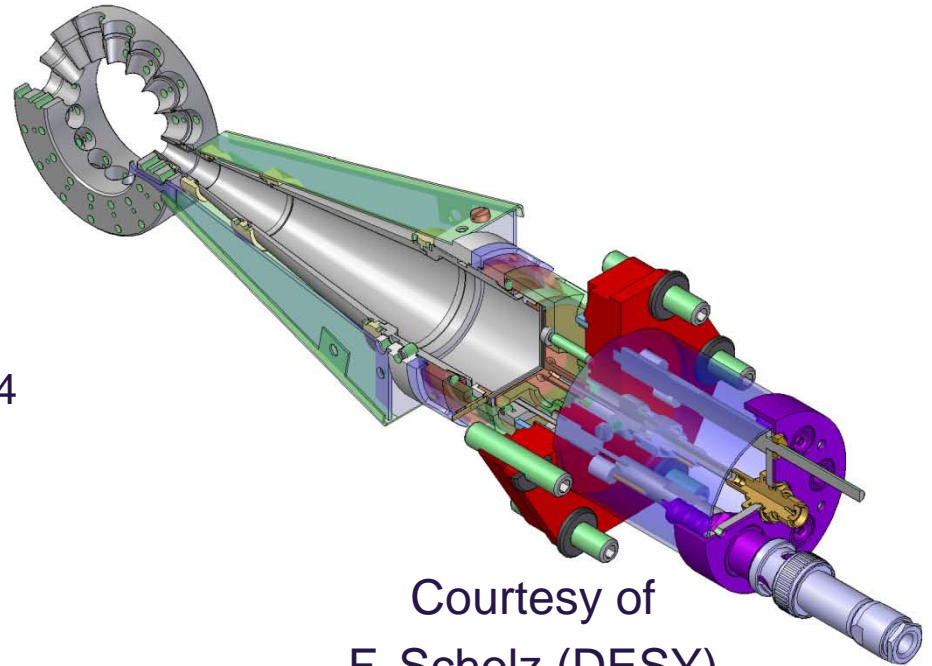
Requirements		
Photon energy resolution		$\Delta hv/hv = 10^{-4}$
Absolute energy calibration		
Linear polarization	Direction	1°
	Degree	better than 1%

Flight tube

- Segmented electrodes for retardation
- Angular acceptance $\approx 7 \cdot 10^{-4}$

MCP detector

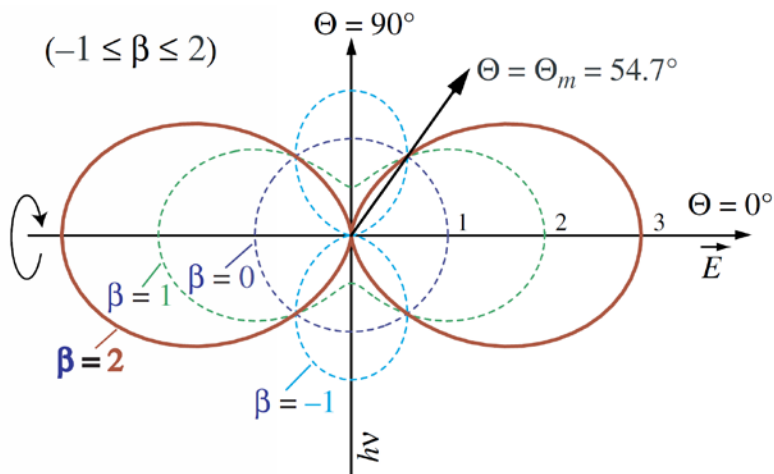
- Z-Stack
- Integral signal readout
- ⇒ fast data acquisition



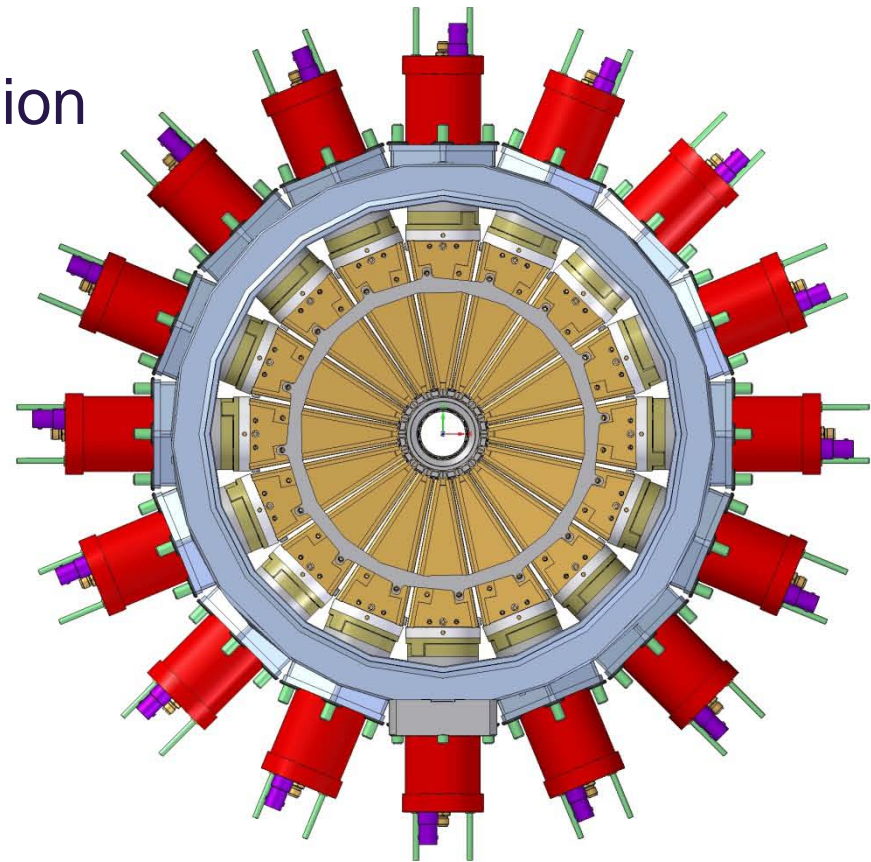
Courtesy of
F. Scholz (DESY)

Length	13.5 cm
Aperture	3.2 mm
Full Opening Angle	12.4°

- 16 channels (max.) \Rightarrow Angular resolution
- Analysis of dipole photoemission
 \Rightarrow Linear polarization

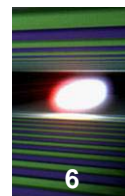


Courtesy of J. Viefhaus (DESY)



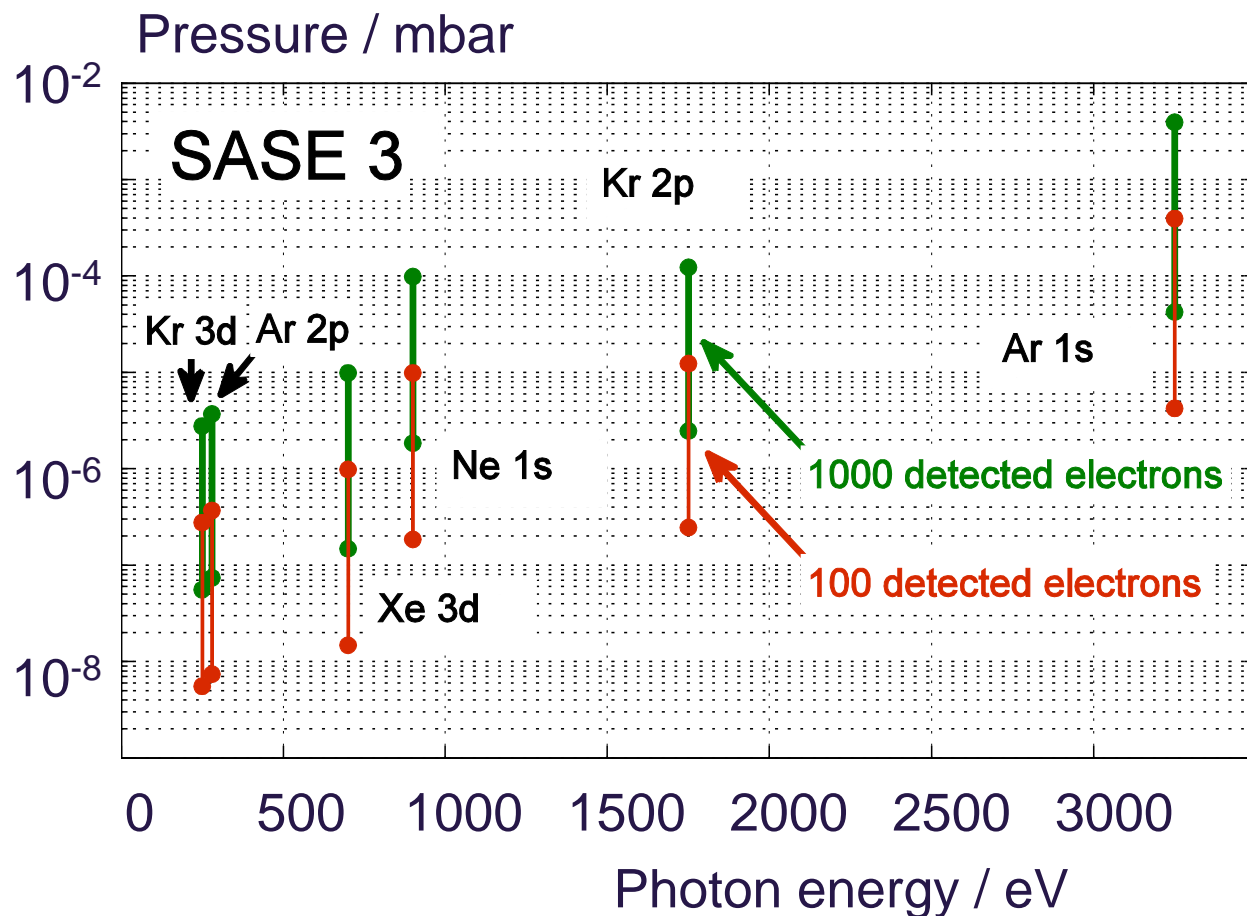
Courtesy of F. Scholz (DESY)

Expected signal at SASE 3 beamline



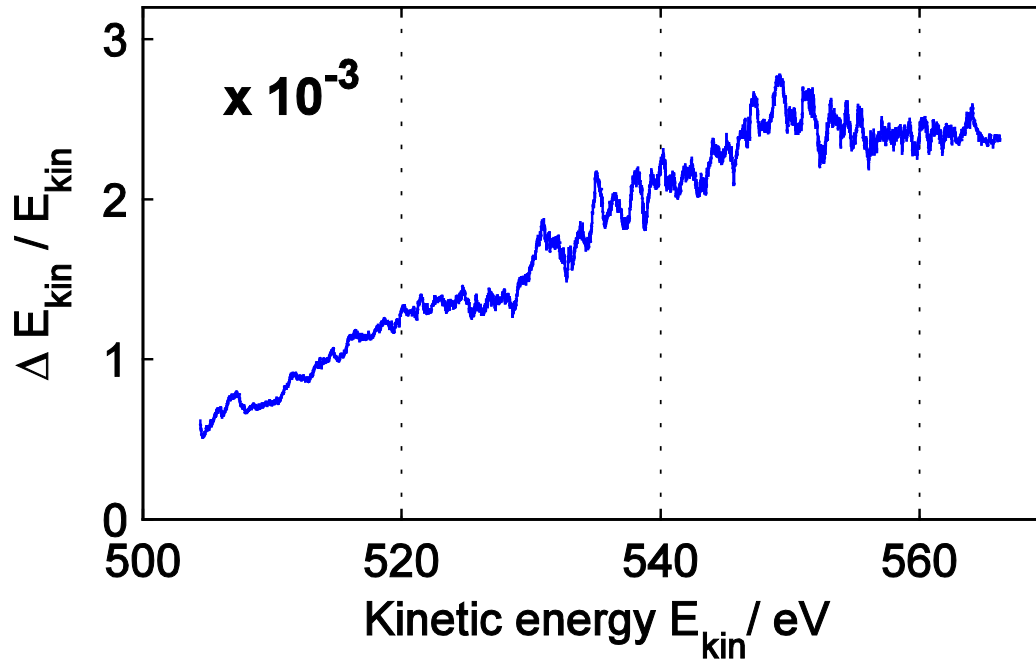
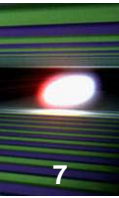
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- Neon, Argon, Krypton, Xenon
- $h\nu$ range:
from 280 ...
to 3000 eV
- Photons / pulse:
from 10^{11} ...
to 10^{13}



$10^2 \dots 10^3$ *detected* electrons per shot & channel are sufficient
 ✓ shot-to-shot analysis

Simulated energy resolution

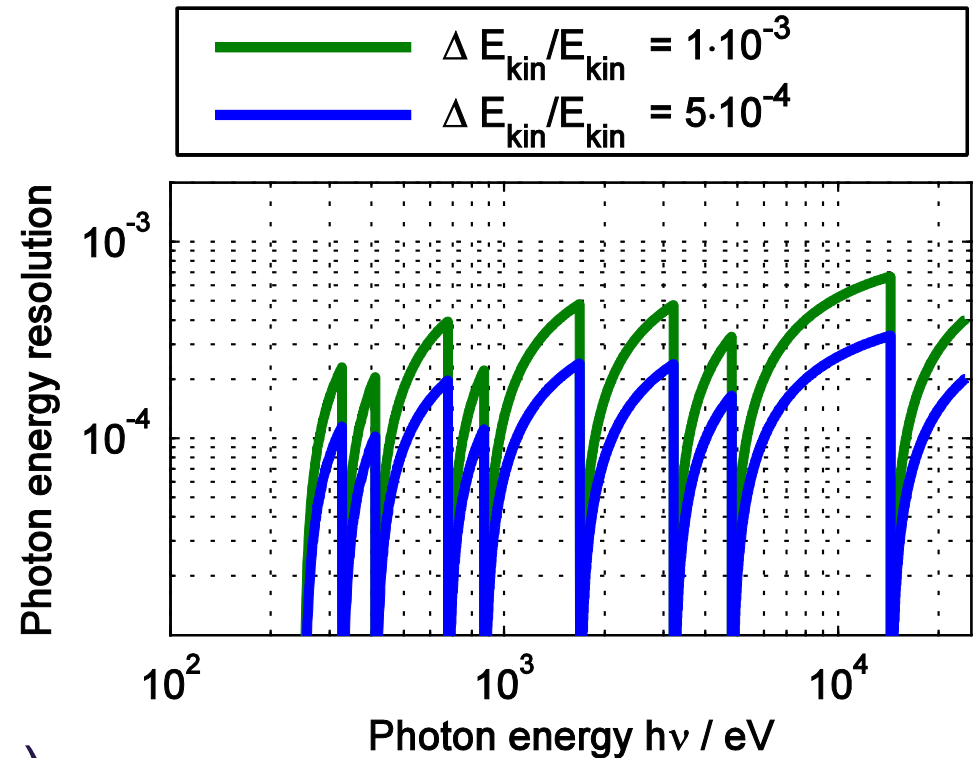


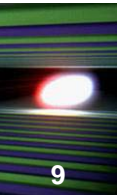
- Optimized for $E_{\text{kin}} = 500 \dots 520$ eV
(= distance from absorption edge)
- Observation window of a few % of E_{kin}

- Spectral width of FEL radiation: 10^{-3}
- Nearest core level for every photon energy among rare gases

$$\Delta E_{\text{kin}}/E_{\text{kin}} = \Delta h\nu / (h\nu - E_B)$$

$$\Delta h\nu / h\nu = \Delta E_{\text{kin}}/E_{\text{kin}} (1 - E_B/h\nu)$$





WP-74 @ XFEL.EU

- **Jens Buck**
- Jan Grünert
- Wolfgang Freund
- Cigdem Özkan
- Bin Li
- Marc Planas

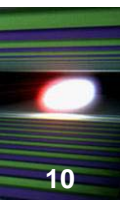
XFEL.EU

- Patrick Geßler
- Christopher Youngman
- Michael Meyer
- Harald Sinn

**PES spectrometer was
designed and constructed by**

P04 group @ PETRA III, DESY

- Jens Viefhaus
- Leif Glaser
- Frank Scholz
- Markus Ilchen (now XFEL.EU)
- Sascha Deinert
- Jörn Seltmann



@ LCLS: joint commissioning of the afterburner and the polarization diagnostics device (PES spectrometer), Aug./Sep. 2013

@ LCLS: joint commissioning of SXRSS
???

@ SACLA ???