



# PHOENEXS: System for Angle- and Spin-Resolved Photoemission at BESSY II

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**Abstract:** Article addresses overall performance, technical features and sample preparation facilities of movable endstation PHOENEXS at BESSY II which is used for spin- and angle-resolved photoemission.

## 1 Introduction

Initially built as a system for photoemission and near-edge X-ray absorption, the PHOENEXS station is now used for spin- and angle-resolved photoemission exclusively.

The system is built around a modified SPECS Phoibos 150 hemispherical analyzer equipped with a mini Mott polarimeter. The latter has been developed as the first of its kind based on the known trajectories from the Phoibos analyzer. It operates by means of retardation and features two pairs of channeltrons for the two perpendicular spin quantization axes in the sample surface plane for normal emission. For off-normal emission, this axis is correspondingly tilted. An adjustable iris-type aperture allows for an angular resolution down to 1°. Energy resolution in spin-resolved experiment is typically limited with 50 meV due to the need of higher photoemission intensity and appropriate statistics in spin-resolved measurements. For experiment planning one has to consider that acquisition of a single spin-resolved spectrum (EDC) with highest angular- and energy resolution requires from 2 to 4 hours.

Samples are mounted on a custom built 5-axes manipulator “Pente.Ax”. Manipulator is fully motorized and computer controlled, hence allowing for careful measurements of band dispersions and for good reproducibility of the sample position. It is additionally equipped with integrated Helmholtz coils for sample (re)magnetization without the need for sample repositioning. Manipulator and all sample preparation facilities are operating with Omicron-type sample holders.

\* **Cite article as:** Helmholtz-Zentrum Berlin für Materialien und Energie. (2018). PHOENEXS: System for Angle- and Spin-Resolved Photoemission at BESSY II. *Journal of large-scale research facilities*, 4, A131. <http://dx.doi.org/10.17815/jlsrf-4-96>



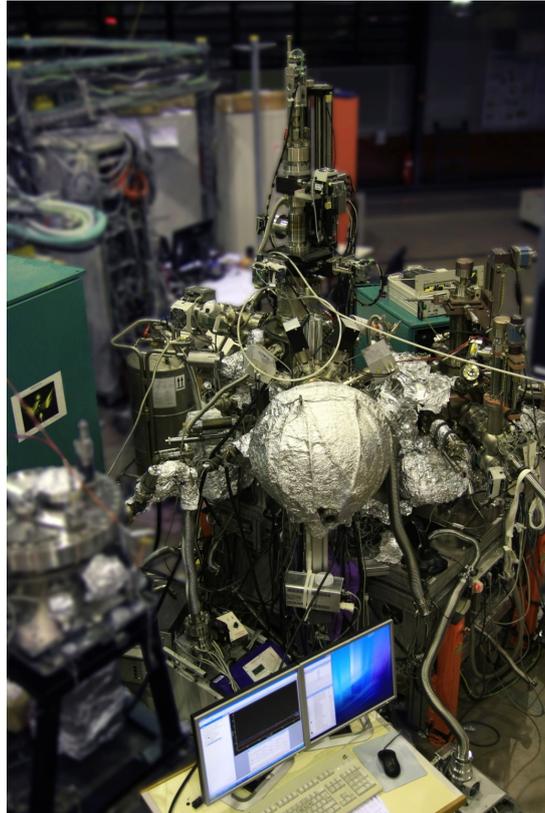


Figure 1: View of the PHOENEXS station.

Currently, the lowest sample temperature on the manipulator is 200 K. Upgrade of the cryostat is planned for 2016, which will improve sample cooling performance.

The system further features two chambers for preparation purposes and a fast entry lock for sample exchange.

## 2 Instrument application

Scientific applications:

- Topological insulators and graphene
- Rashba-split surface and quantum-well states
- Exchange interaction systems

Methods:

- XPS
- Spin-resolved ARPES

Additional techniques and characterization facilities:

- Low energy electron diffraction
- Quadrupole mass spectrometer
- e-Beam evaporators
- Heating stage up to 2000 °C
- Ion gun for sample cleaning

### 3 Technical Data

Monochromator	Moveable Station
Experiment in vacuum	Yes. Base pressure $1 \cdot 10^{-9}$ mbar
Temperature Range	200 K – 300 K
Detector	SPECS Phoibos 150 hemispherical analyser with mini-Mott detector for spin resolution (spin component in plane of sample surface).
Manipulators	5-axes manipulator with two rotational degrees of freedom and integrated Helmholtz coils. All axes are motorized and computer controlled.

Table 1: Technical parameters of the PHOENEXS station.

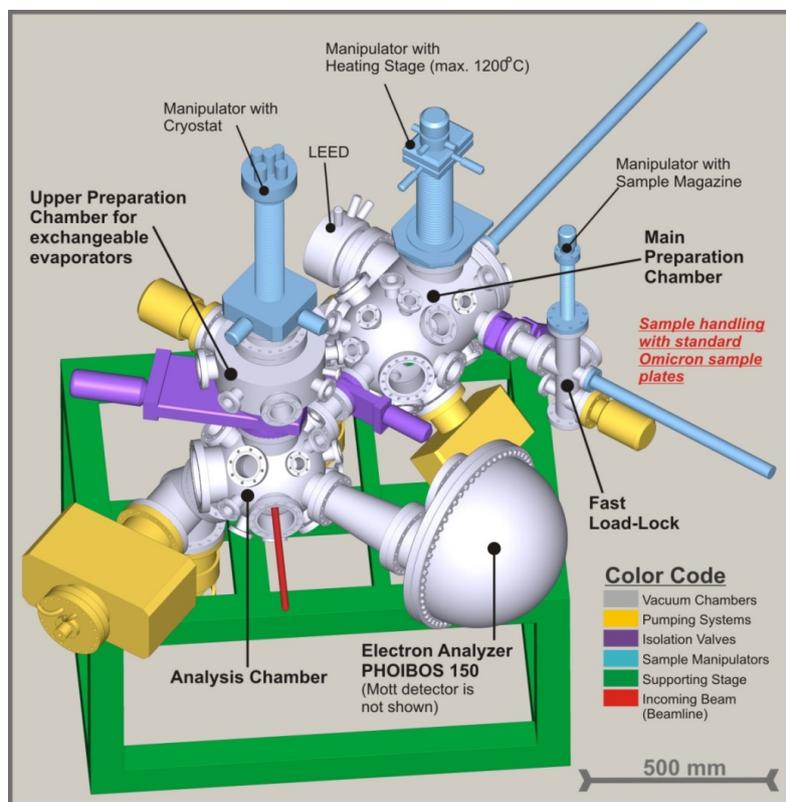


Figure 2: Schematic view of the PHOENEXS station (spin-detector is not shown).

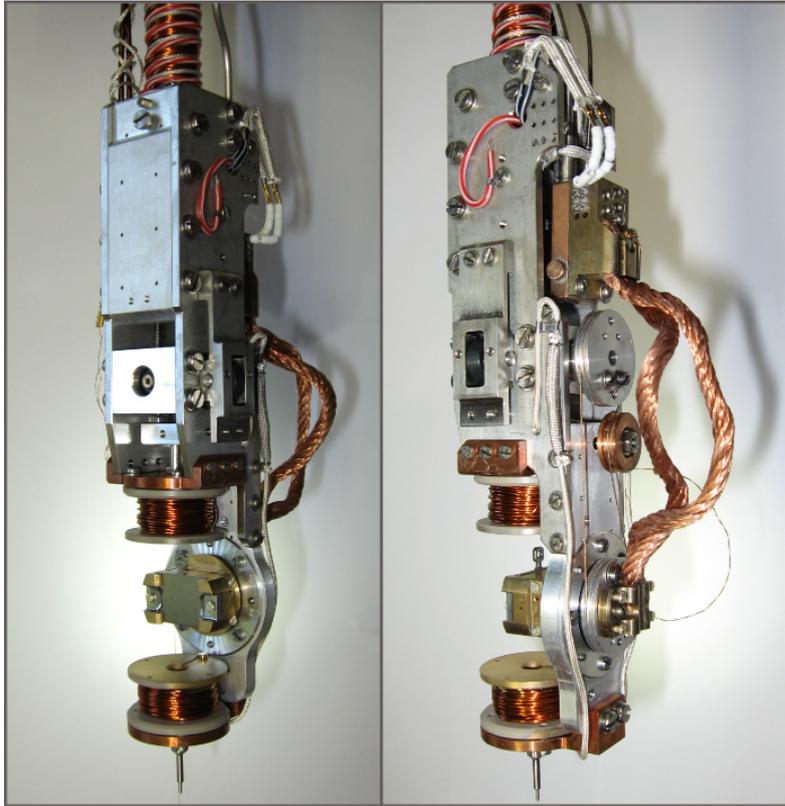


Figure 3: 5-axes manipulator “Pente.Ax” with integrated Helmholtz coils (designed by A. Varykhalov).

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