EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** **Investigation of Local Magnetism in FeAs Superconductors: a Spin-Resolved Circularly-Polarized Resonant Photoemission Study**	**Experiment number**:
Beamline: ID08	**Date of experiment**: from: 09 Dec. 2009 to: 16 Dec. 2009	**Date of report**:
Shifts: 18	**Local contact(s)**: Dr Nicholas Brookes	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

*Dr Hidenori Fujiwara , *Dr. Z. Hu, *Dipl. Phys. Nils Hollmann, *Akfiny Hasdi Aimon,

Dr. Thomas Koethe, Prof.Dr. L.H. Tjeng

II. Physikalisches Institut Universitaet zu Koeln Zuelpicherstrasse 77 D-50937 Koeln Germany

Prof. Giacomo Ghiringhelli

Politecnico di Milano, Dipartimento di Fisica Piazza Leonardo da Vinci 32 I-20133 Milano Italy

*Dr Nicholas Brookes *Dr. Julio Criginski cezar

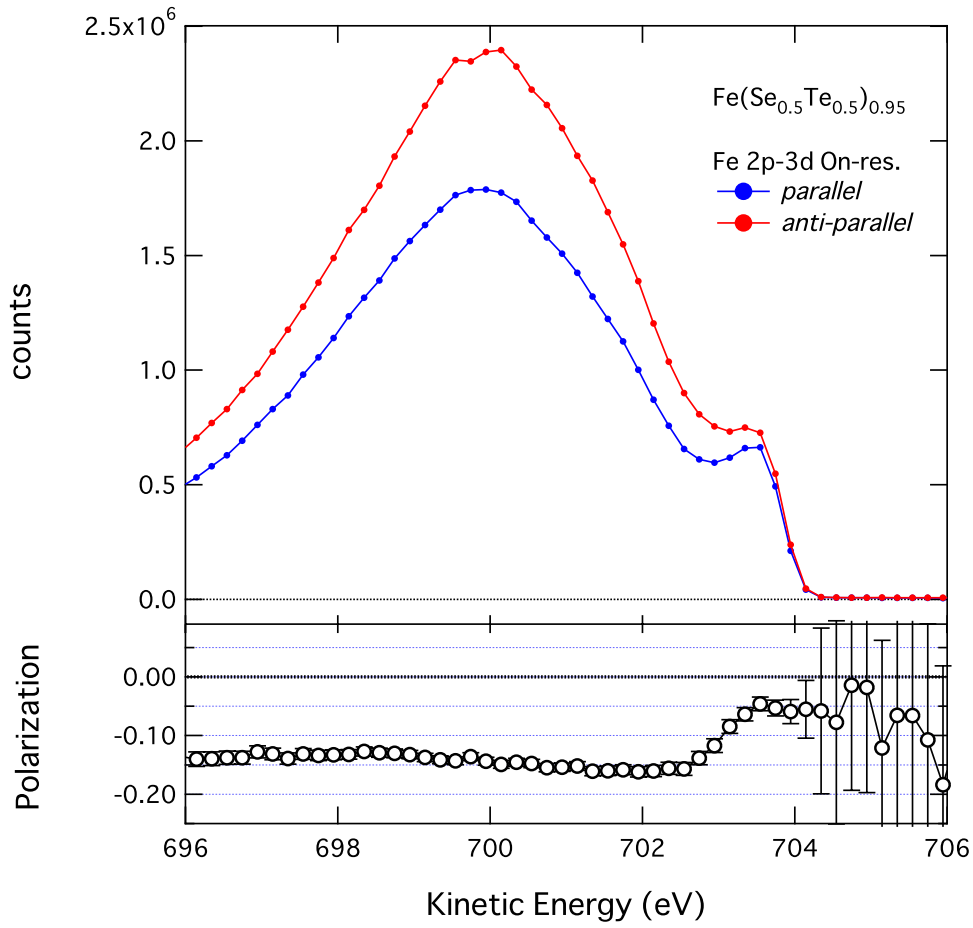
E.S.R.F. 6 rue Jules Horowitz B.P 220 F-38043 Grenoble Cedex France

Report:

The discovery of iron-pnictide (FeAs) based superconductors [1] with a T_C of up to 55 K is evidence of how complex the many body problem really is. Similar to the cuprates, the iron pnictides have a layered structure and the superconductivity emerges from a parent compound with magnetically ordered layers. For Fe^{2+} in a tetrahedral coordination of As, which inverts the energies of the e_g and t_{2g} orbitals, one would expect a local spin of 2 and an orbital degeneracy because of the singly occupied minority spin e_g state. However, neutron scattering does not at all suggest a local moment of $S = 2$ but rather suggest at most a small local moment (0.36 μ_B at 8 K) [2] in contrast to the predicted value (~2.3 μ_B) by the band structure calculation for the parent compound [3]. Most important is that it is unclear why there is not a large local Fe moment in spite of the rather narrow *d* bands and the rather atomic nature of the *3d* states. Our aim is to investigate experimentally the local magnetic properties of these materials.

We have carried out the spin-resolved Fe *2p-3d* resonant photoemission using circularly polarized light for $Fe(Se_{0.5}Te_{0.5})y$ (y = 0.80, 0.90, 0.95) and $SrFe_{4.15}Co_{0.85}As_5$, in order to investigate how the local magnetism works on the Fe based superconductor via the spin polarization in the valence band on the Fe-site [4]. This type of photoemission has been developed only recently with very promising results for determining the local 3*d* spin polarization *independent* of the orientation of the local moment [4,5,6]. It makes use of the net spin polarization of photoelectrons emitted under circularly polarized light in the presence of spin-orbit interaction due to dipole selection rules. Long-range magnetic order or external fields are not required, in contrast to standard spin-resolved electron spectroscopies. In order to facilitate a transparent analysis of the spectra, we set the photon energy at the Fe *2p-3d* resonant maximum ($h\nu$ = 708 eV). Most important is that the resonant enhancement of the Fe *3d* contribution allow us to detect the local spin asymmetry of the Fe *3d* states on the Fe site.

Figure shows the preliminaly analysis of the valence band spectra of $Fe(Se_{0.5}Te_{0.5})_{0.95}$ obtained by the spin-resolved circular polarized photoemission with *hv* = 708 eV at low temprature. One can observe a clear difference between the spectra taken with the photon spin (given by the helicity of the light) parallel (blue line) or antiparallel (red line) to the electron spin. The broad peak structure around 700 eV observed in both spectra is mainly due to the Auger electron. One can also see the peak structure in the parallel spectrum near Fermi-level (E_F) at ~704 eV in contrast to the broad shoulder structure in the antiparallel spectrum. These structures are mainly due to the Fe *3d* states. Most important is the degree of spin polarization defined as the ratio between the difference and the sum of the spectra taken with the parallel and antiparallel spectra. The Fe *3d* components near E_F shows the non-zero but small polarization of 5%. This small spin polarization on the Fe site is qualitatively consistent with the results of the neutron scattering [2] and the magnetic circular dichroism on the x-ray absorption spectroscopy [7]. Interestingly, this small spin polarization on the Fe site is much smaller than that of the Cu-based super conductor, which has ~70% for the Cu 3d states near E_F [6]. This discrepancy opens up the further discussion for modeling of the mechanism of the superconductivity on the Fe based compounds.



References

[1] Y. Kamihara *et al.*, J. Am. Chem. Soc. **130**, 3296 (2008): H. Takahashi *et al.*, Nature **453**, 376 (2008).
[2] C. de la Cruz *et al.* Nature **453**, 899 (2008).
[3] C. Cao *et al.*, PRB **77**, 220506 (2008).
[4] B. Sinkovic *et al.* PRL **79**, 3510 (1997).
[5] L. H. Tjeng *et al.*, PRL **78**, 1126 (1997).
[6] N. B. Brookes *et al.*, PRL **87**, 237003 (2001).
[7] N. Hollman, Z. Hu, and L.H. Tjeng, *to be published.*