increasing the operational bandwidth of the low-level RF; the detailed mechanism of the phenomena have been studied and demonstrated in 2013. The statistics of the downtime and subsystem faults are shown in Fig. 3.

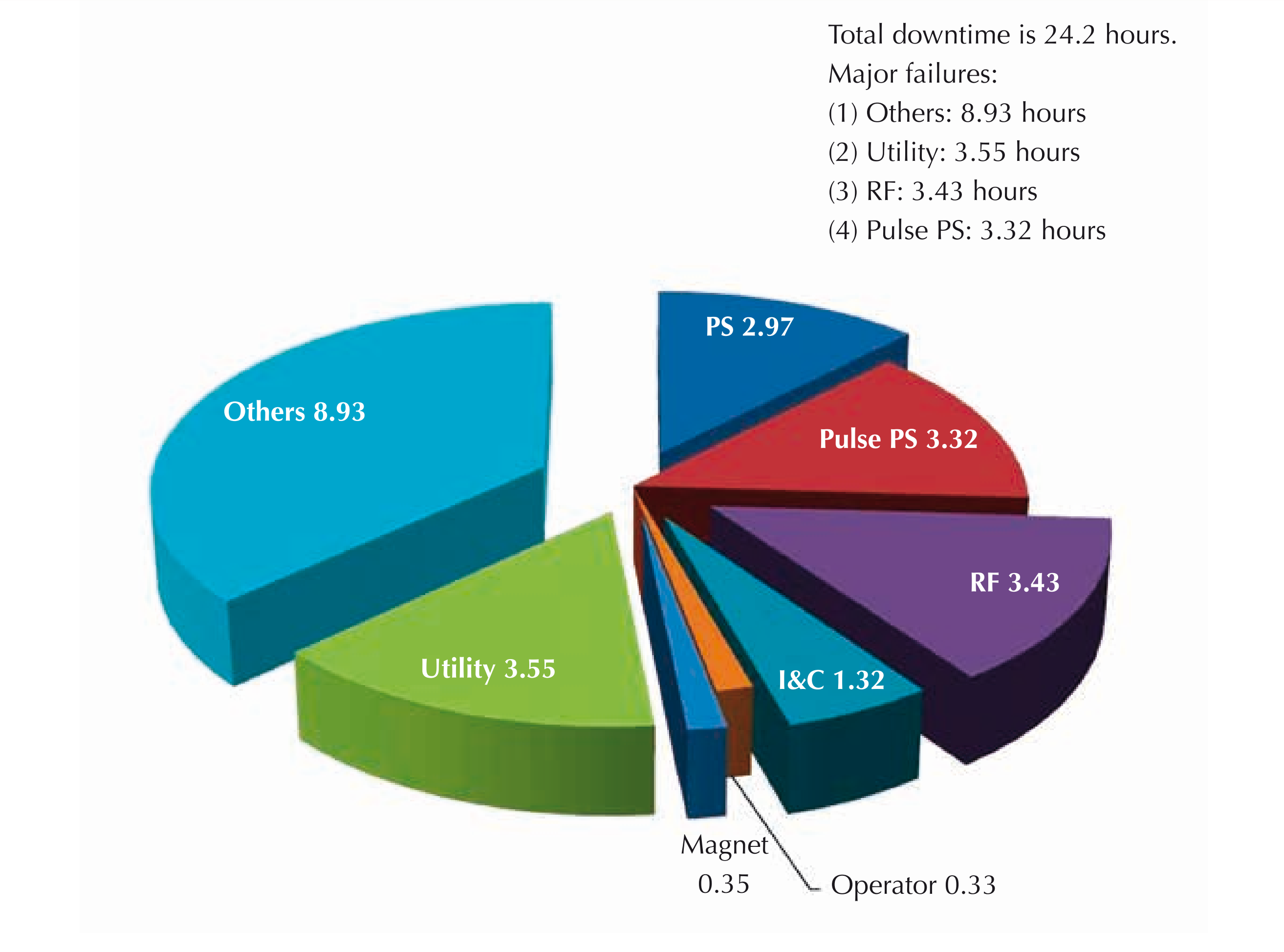

Fig. 3: Statistics of downtime and subsystem faults in 2013.

Beamline for Hard X-ray Photoelectron Spectroscopy

Taiwan Beamline BL12XU at SPring-8 is one of two contract beamlines between NSRRC and Japan Synchrotron Radiation Research Institute (JASRI, Japan). It has an undulator source, a mainline with two branches and a side line (see Fig.1 in the next page). The mainline, which has been fully operational since 2001, is used by many domestic and foreign scientists from Japan, Taiwan, Germany, USA... Inelastic X-ray scattering (IXS) experiments are performed mainly at BL12XU; several other experiments such as high-resolution diffraction or coherent diffractive imaging are also conducted. The side line is dedicated to hard

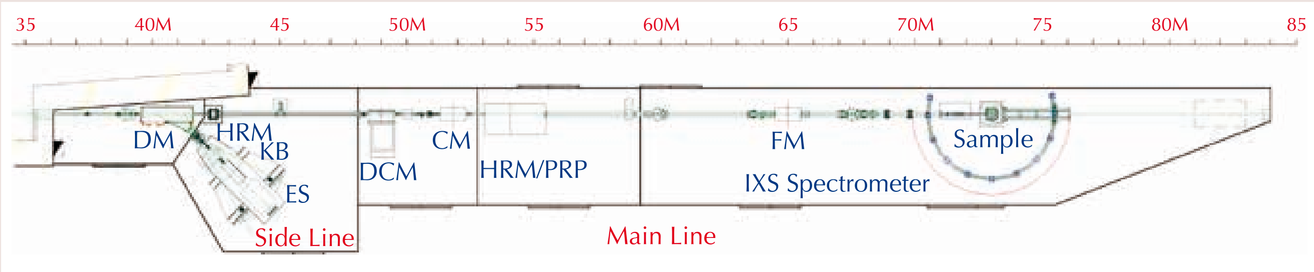

Fig. 1: Schematic diagram (top view) of BL12XU: DM is a diamond monochromator for the side line, DCM a double-crystal monochromator for the mainline, CM a collimating mirror, HRM a high-resolution (channel-cut) monochromator, PRP a phase-retarding plate, FM a focusing mirror, and IXS an inelastic X-ray scattering spectrometer.

X-ray photoelectron spectra (HAXPES); a new end station has been built to incorporate two analyzers of electron energy.

The range of photon energy for HAXPES experiments performed at the side line is 6 to 12 keV. The photoionization cross section has typically a strong angular dependence, and is characterized with a so-called asymmetry parameter β; β = 0 implies isotropic, whereas β = 2 or -1 is most anisotropic. For many core levels β in this range of photon energy is generally larger than unity; the photoionization cross section thus becomes maximized for a detection geometry in which the direction of photoelectron emission is along the (linear) polarization vector (typically in the horizontal plane). This detection geometry is the most popular, the so-called horizontal geometry, of HAXPES end stations worldwide. Its advantages are that the rate of photoelectron signals becomes greatly enhanced near grazing incidence for samples as a thin film with a flat surface, and that the normal geometry of emitted photoelectrons also ensures the largest probing depth for bulk sensitivity. For transition-metal compounds that typically exhibit a strong correlation effect due to their open shell 3*d*-orbitals in the valence bands, the angular cross section for photoionization of valence band 4*s*-orbitals, which play only a minimal effect in correlation, is enhanced at this horizontal geometry because their β values are near 2.

This problem is compounded by the fact that, in this range of large photon energy, the cross section for photoionization of a valence 4*s*-orbital of a transition-metal element exceeds that of the 3*d*-orbitals; the measured spectra of the valence band thus contain a large component due to the *s*-orbitals, which complicates the analysis of a correlation effect due mainly to *d*-orbitals. To overcome this problem, a vertical geometry is adopted such that the detected photoelectrons are along the vertical direction to be perpendicular to the (horizontal) polarization; as a result the contribution from the *s*-orbitals becomes almost vanished. Both geometries have been tested in our systems to achieve excellent results, but the end station must be reconstructed to meet individual needs and it is impossible to switch during beamtime. We have built a new end station equipped with two analyzers of electron energy in both horizontal and vertical geometries to be easily switched during beamtime to satisfy the needs of varied measurements even on the same samples. The test results are satisfactory; see Fig. 2.

The side line of Taiwan Beamline BL12XU at SPring-8 is constructed as a collaborative research program of NSRRC in Hsinchu, Taiwan and Max Planck Institute for Chemical Physics of Solids (MPI-CPfs) in Dresden, Germany, and is dedicated to HAXPES for material research. The source is a SPring-8 standard undulator IVXU3.2-4.5 m in vacuum. A diamond monochromator selects a photon energy in the range 6 - 12 keV. A subsequent high-resolution monochromator is equipped with a two-bounce channel cut to decrease further the bandwidth. Currently Si(333), Si(331) and Si(311) channel cuts are available. A KB mirror system focuses the beam to size 40 x 40 μm^2 at the sample position. The end station is equipped with two hemispherical analyzers of electron energy; they are mounted to collect photoelectrons emitted normal to the horizontal incident beam, either in the horizontal plane containing the polarization vector (horizontal geometry) or normal to the polarization vector (vertical geometry). These geometries are chosen for varied differential photoionization cross sections to identify various orbital contributions to the valence band. For instance, the *s*-orbital would maximize its cross section in the horizontal geometry whereas its signal becomes strongly suppressed in the vertical geometry. This feature is useful particularly for measuring 3d transition-metal compounds. The large inelastic mean free path (~ 4 - 10 nm) of photoelectrons with large kinetic energy from hard X-rays also enables a reliable measurement of the bulk electronic structure with much less surface contribution than conventional in-house XPS and PES in the soft X-ray range. This condition also opens an opportunity to study the electronic properties of the buried interface of samples as thin films. The end station is designed for solid-state samples in the UHV (~ 10^{-10} mbar) condition. The sample can be cooled to 15 K. This beamline and end station have been partially open to general users beginning in cycle 2013-3.

Fig. 2:
HAXPES end station equipped with two analyzers of electron energy for both horizontal and vertical geometries.