ESRF	**Experiment title:** **Charge density wave and superconductivity in $Lu_5Ir_4Si_{10}$**	**Experiment number**: HS4204
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$Lu_5Ir_4Si_{10}$ shows the coexistence of superconductivity (T_{SC}~4K) and a charge density wave (CDW – T_{CDW}~77K). By applying an external parameter, like pressure [Shelton86] or doping [Singh05], it is possible to reduce T_{CDW} continuously from 77K to 0K (at P=2.1GPa) and increase T_{SC} from 4K to 9K. $Lu_5Ir_4Si_{10}$ (tetragonal space group) is constituted of 1D chains of first neighbours Lutetium atoms along the c-axis, with a strong interchain coupling. At ambient pressure, Becker & al reported the periodic lattice distortion associated with the CDW manifesting by the formation of x-ray superlattice reflections at wave vectors G+/-q_{CDW} where G is a reciprocal lattice vector and q_{CDW}=(0,0, 3/7) [Becker99]. They concluded that the CDW is commensurate with a lattice parameter of 1/7.

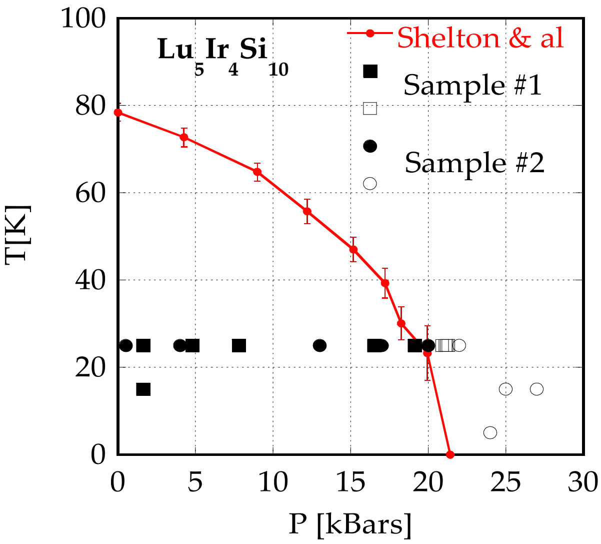

Fig. 1: Phase diagram studied. In red it is the anomaly in the resitivity measurements reported by Shelton & al. The full square (respectively circle) are the pressure temperature were the CDW has been observed in sample #1 (resp. 2). When the CDW was absent, the signs are open.

For this experiment, we loaded 3 diamond anvil cells with Helium as pressure transmitting medium. A membrane offers the opportunity to tune the pressure in-situ during the experiment. The pressure was measured before and after each change of temperature or pressure.

The first pressure cell was used at room temperature and was loaded with a powder of $Lu_5Ir_4Si_{10}$. The cell parameters were measured up to 80kBars. A clear kink in the ratio c/3a and in the compressibility is found around 17kbars.

The two other pressure cells were loaded with single crystalline high quality whiskers of $Lu_5Ir_4Si_{10}$ and installed into an He flow cryostat. At room temperature, the rocking curve of the [001] spot is below 0.4°, showing the excellent quality of the crystals. The intensities are compatible with the structure reported elsewhere [Opagiste10]. At low temperature and low pressure clear extra-peaks along the c-axis are observed

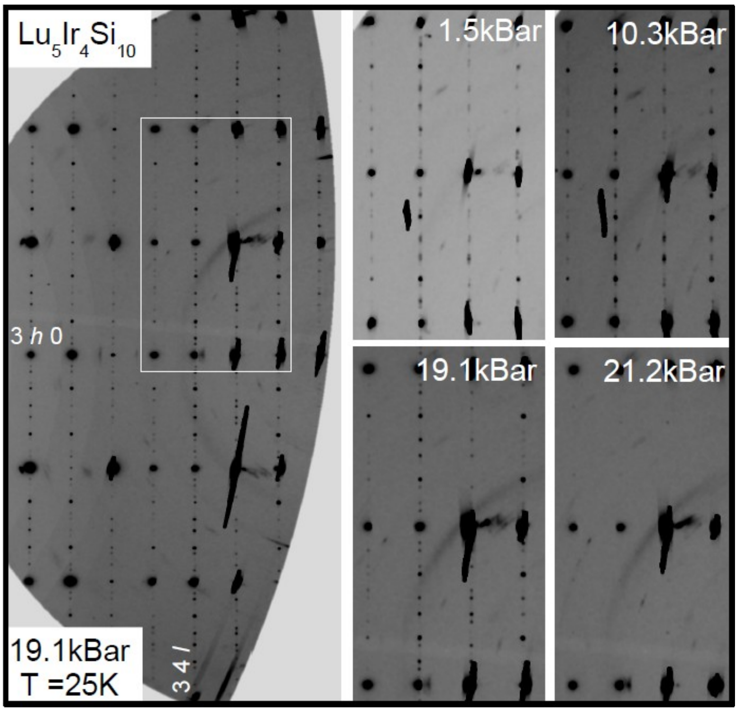

Fig. 2: Reconstruction of the 3hl plane at T=25K for different pressure. On the right, zoom for 4 pressures of the white zone.

signing the superstructure formed by the charge density wave. At 25K, the destruction of the CDW occurs above 20kbars, in excellent agreement with the phase diagram measured by electrical resistivity [Shelton86]. Typical reconstruction in the 3hl plane is shown in fig.2. Interestingly, at low pressure the superlattice reflections can be indexed with a wave vector of G+n/7c*. However, few extra peaks seem to be visible in fig.3. Note, that this was already observed by Becker & al on single crystals grown by Czocralski techniques. This was attributed to a poor monochromaticity of the x-ray beam. When the pressure is increased up to approximately around 17kbars, the number of extra peaks increases and the intensities of the peaks at n/7c* decrease strongly. A new periodicity is found with n/20c*. For example the peaks at [3 4 3/7] are thinner under pressure and shift slightly at the wave vector 0.45c*. This result suggests that two commensurate charge density waves compete one with q=c*/7 and the other with q= c*/20. An article is being written.

[Shelton86] R.N. Shelton & al. *Electronic phase transition and partially gapped Fermi surface in superconducting $Lu_5Ir_4Si_{10}$*; Phys. Rev. B **34**, 4590 (1986)

[Singh05] Y. Singh & al; *Competition between superconductivity and charge-density-wave ordering in the $Lu_5Ir_4(Si_{1-x}Ge_x)_{10}$ alloy system* Phys. Rev. B **72**, 045106 (2005)

[Tamegai2008] T.Tamegai & al; *Two-gap superconductivity in $R_2Fe_3Si_5$ and $Sc_5Ir_4Si_{10}$*; Sci, Technol. Adv. Mat. **9** (2008) 044206.

[Becker99] B. Becker & al; *Strongly coupled charge-density wave transition in single-crystal $Lu_5Ir_4Si_{10}$*; Phys. Rev. B **59**, 7266 (1999)

[Opagiste10] C. Opagiste & al; *$Lu_5Ir_4Si_{10}$ whiskers: Morphology, crystal structure, superconducting and charge density wave transition studies;* J. of Crystal Growth **312** (2010) 3204

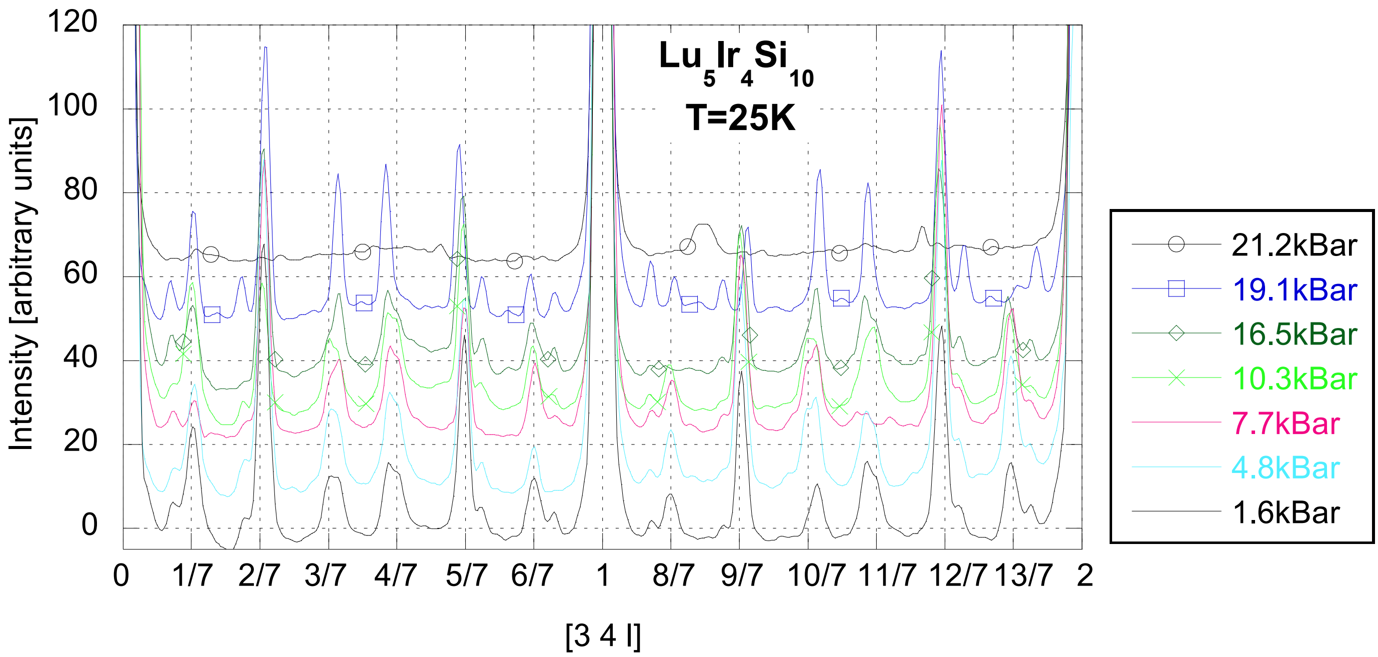

Fig. 3: Pressure dependence of the weak extra peak between the Bragg spot. Note how at high pressure the peaks are shifted from the dashed lines which indicate the 1/7 c periodicity.*