ESRF	**Experiment title:** Calibration of the platinum pressure gauge up to 200 GPa	**Experiment number**: HC-2181
Beamline: ID27	**Date of experiment**: from: 12/09/2015 to: 14/09/2015	**Date of report**: 20/02/2016
Shifts: 6	**Local contact(s)**: M. Mezouar	*Received at ESRF:*

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Report:

The aim of this proposal was to extend the pressure range for the calibration of the platinum X-ray pressure gauge (wich gives Pressure *P* for a given atomic volume *V*). In fact, our team had measured this calibration up to 96 GPa only (see [1] for original data, and [2] after update of the ruby pressure gauge), and shock-wave [3] but also one recent diamond anvil cell study [4] suggested that it underestimated the pressure. In this experiments, the primary X-ray pressure gauge was tungsten, which we have calibrated up to 160 GPa and for which a good agreement between static and schock wave calibration has been obtained.

For these experiments, a highly focused X-ray beam (2x3 microns) was used on ID27 and monochromatic X-ray diffraction data were collected on a MAR-CCD detector. Samples were small (~3 microns size) grains of Pt and W pressure gauge. They were loaded in neon pressure transmitting medium. We chose neon instead of helium, which is more hydrostatic, in order to prevent failure of diamond anvils, which become very likely when helium is used above ~150 GPa. The conditions of the two pressure runs are summarized in Table 1.

Run name	Sample	*P* medium	*P* range (GPa)	*P* gauge	Gauge calibration
PtW_1	Fe powder	Neon	0-187	W	[6]
PtW_2	Fe powder	Neon	0-146	W	[6]

Table 1: Conditions of experimental runs. *P*: pressure.

We plot in **Figure 1** the lattice parameter of platinum calculated using the (111) diffraction peak vs pressure measured using the tungsten X-ray gauge. In fact, (111) diffraction peak is expected to be least affected by non-hydrostatic stresses [5]. In the current experiments, the difference between lattice parameters yielded by different diffraction peaks was relatively large, reaching 0.3%; we interpret this by the small size of the cristallites in the starting sample, which must have induced important micro-stress.

Even with this difficulty, the lattice parameters measured in this experiment are less scattered than those collected in 2004, and the measurements of PtW_1 and PtW_2 agree with each other. The data do not agree with the fitted equation of state curve published in 2004 [1], but agrees with a curve published 3 years after on the basis of the same data but with an updated calibration of pressure [2]. The plotted curve is a Rydberg-Vinet equation of state, with the following parameters: V_0=15.09 Å^3/at, K_0=277.3 GPa, K'_0=5.12. Our data suggest that this equation of state can be used for pressure calibration purpose, up to 200 GPa. The pressure estimated using this calibration is ~5 GPa (2.5%) lower than the one found in refs [3,4] at 200 GPa.

It can be noted that the platinum equation of state from ref [3] is completely independent from ours, and that the platinum equation of state from ref [4] has been obtained using a similar technique, but with a different pressure gauge. The 2.5% difference may thus appear as an absolute pressure uncertainty for diamond anvil cell measurements around 200 GPa.

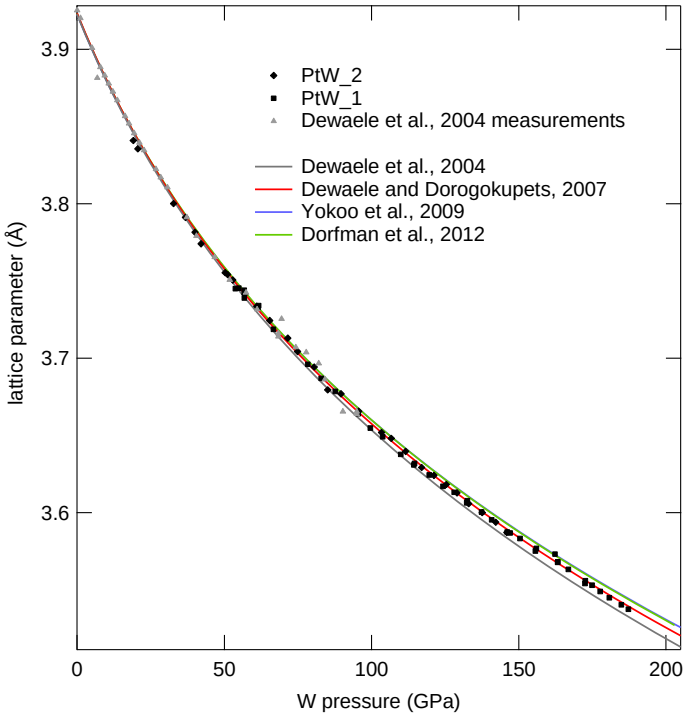

Figure 1: lattice parameter of platinum measured in this experiment using the (111) diffraction peaks vs pressure. The continuous lines are fitted equations of state publised in refs [1] (grey), [2] (red), [3] (blue) and [4] (green).

References:

[3] Dewaele et al., Equations of state of six metals above 94 GPa, Phys. Rev. B 70, 094112, 2004;
[2] P. Dorogokupets and A. Dewaele, Equations of state of MgO, Au, Pt, NaCl-B1, and NaCl-B2: Internally consistent HP-HT pressure scales, High Press. Res. 27, 431, 2007
[3] M. Yokoo et al., Ultra-high-pressure scales for gold and platinum at pressures up to 550 GPa, Phys. Rev. B 80, 104114, 2009
[4] S.M. Dorfmann et al., Intercomparison of pressure standards (Au, Pt, Mo, MgO, NaCl, Ne) up to 2.5 Mbar, J. Geophys. Res. 117, B08210, 2012
[5] K. Takemura and A. Dewaele, Isothermal equation of state for gold with a He-pressure medium, Phys. Rev. B 78, 104119, 2008