PWO transmittance measurements at IPN-Orsay

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While CRYTUR completes its manufacturing procedures and is able to deliver PWO crystals, the group at IPN-Orsay has started setting up the necessary infrastructure to perform crystal quality tests. Using crystals originally manufactured by BTCP (Russia), borrowed from the University of Giessen, we have performed transmittance measurements, both longitudinal and transverse to the crystal axis.

We have used a Varian Cary 5000 spectrometer (Fig. 1, left) currently available on Campus at the Institute of Molecular Chemistry and Materials of Orsay (ICMMO). This spectrometer can take absorption measurements along and across the crystals with a 1 nm wavelength resolution between 200 and 800 nm. Collimators are installed in front of the beam source in order to produce a clean beam spot. Typically, 4 absorption spectra were measured: three of them transverse to the block at positions shown in Fig 1 (right) and one longitudinal. The spectrometer is calibrated each time a crystal is changed or moved.

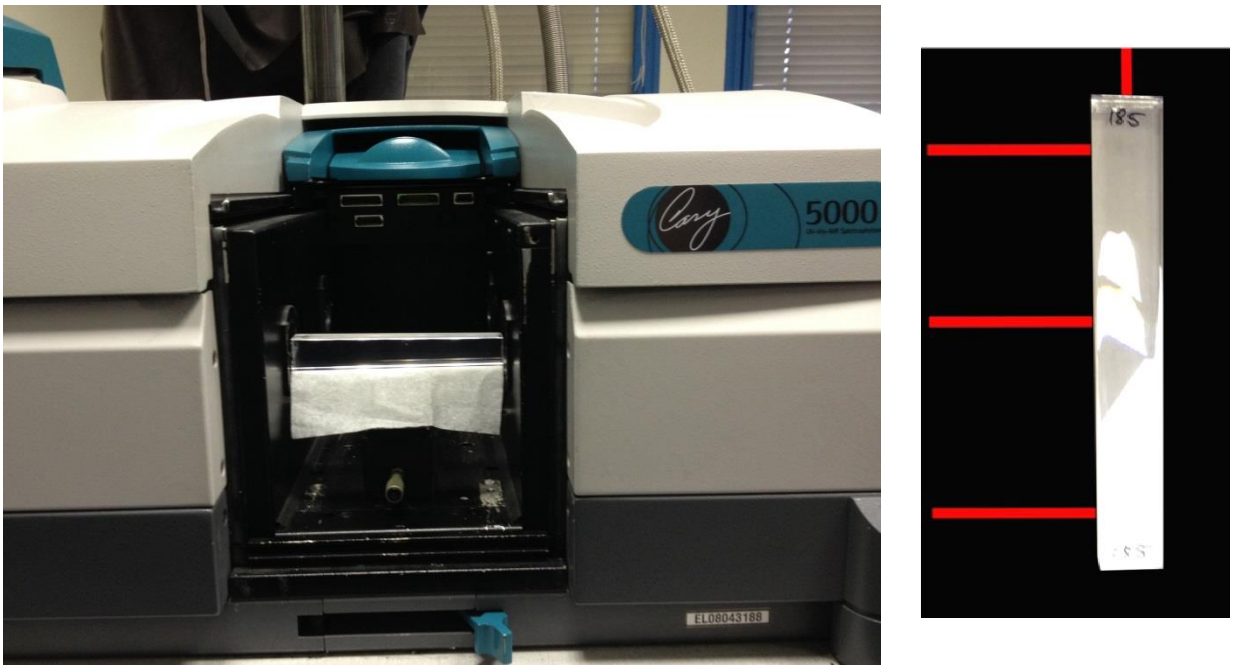

Fig. 1: Varian Cary 5000 spectrophotometer with a crystal ready to be tested (left). The approximate positions and directions of the beam used to measure the crystal absorption are shown in red (right).

Transmittance results obtained for a sample crystal are shown in Fig. 2, for all four positions and as a function of the incident beam wavelength. Transmittance starts around 350 ns and reaches values close to 90% at higher wavelengths.

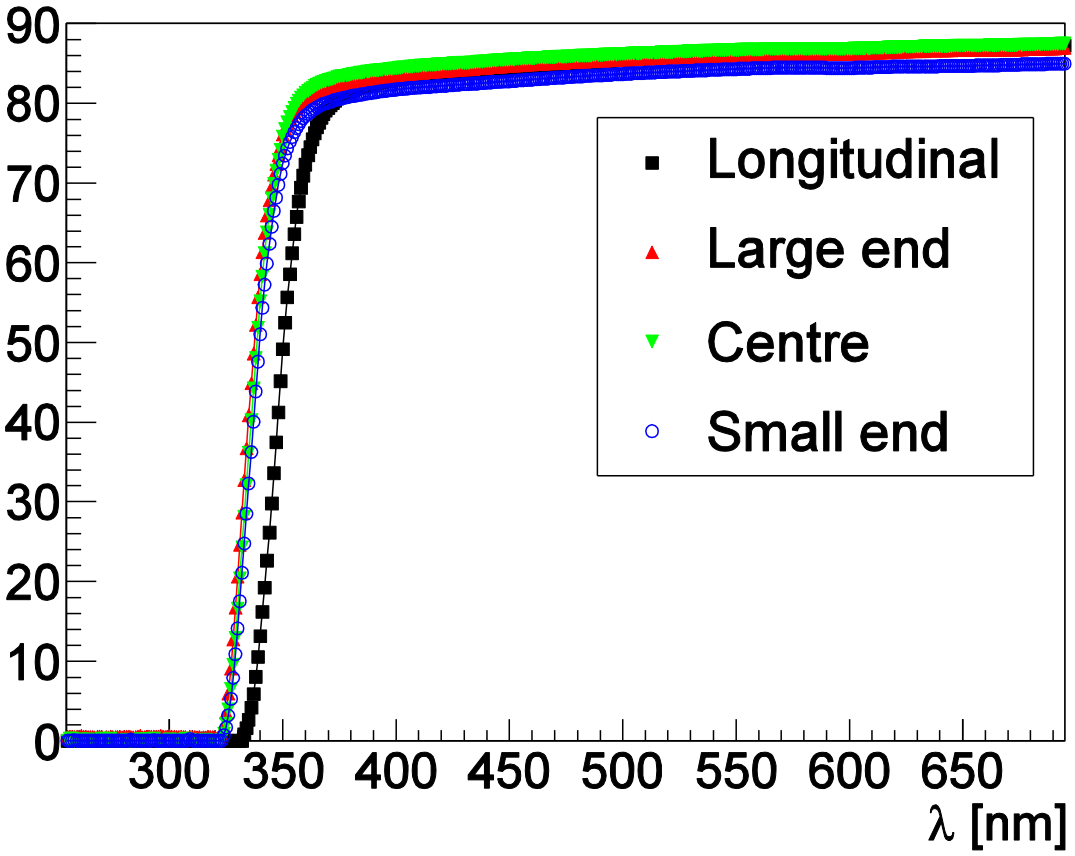

Fig 2: Crystal transmittance (%) as a function of the wavelength for different incident beam positions (3 transverse to the crystal, and one longitudinal).

The sample compartment of the Varian Cary 5000 spectrometer only allows fitting blocks up to 15 cm long. In order to perform measurements on longer crystals, IPN-Orsay has ordered a fiber-based spectrometer that will allow a more versatile configuration for measurements. Its delivery is expected end of June 2015.

Additionally, a setup to measure the crystal light yield is being implemented, using a radioactive source and a calibrated PMT. Initially, the setup is being tested with cosmic rays in order to get the data acquisition and detector systems ready. Two scintillators in coincidence are used to trigger cosmic events through the PbWO block placed between them. A PMT is attached to the block and its gain was calibrated using the single photo-electron peak. Fig. 3 shows the results of the PMT calibration. The cosmic spectrum in the block is shown in Fig. 4 where we can see that the cosmic signal is well separated from the pedestal. The mean value of the Gaussian fit is 182 ADC channels with a pedestal at channel 72. Using the data below for our setup, this yields 117 photons per MeV at room temperature, which is very close to values measured for these crystals by other groups.

- Average thickness of the crystal: 2.1 cm
- ADC sensitivity: 0.25 pC/channel
- PMT gain: 4.1 10^5

- PMT QE: 25%
- Light collection efficiency: 70%

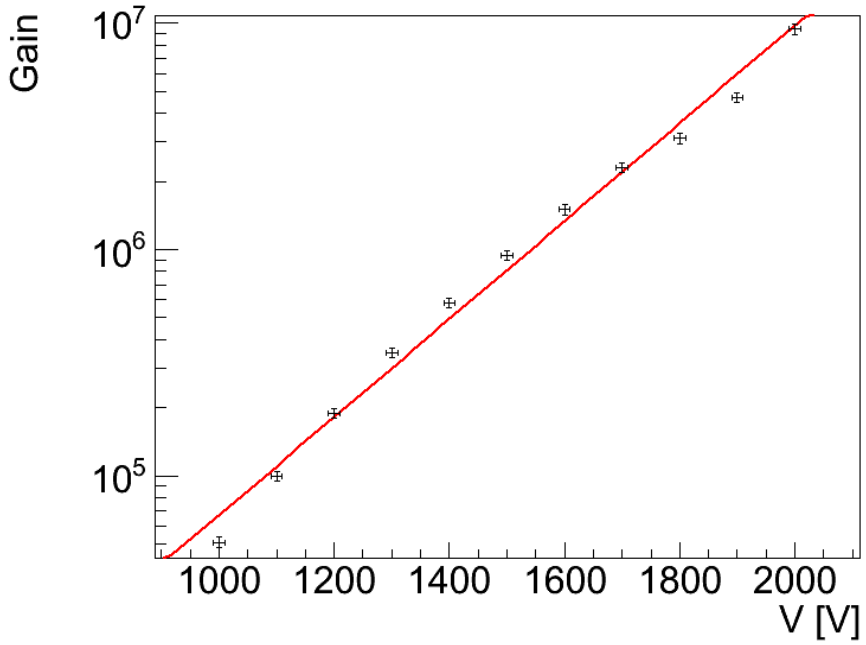

Fig 3: Calibration of the PMT used for the light yield measurement. The single photo-electron peak was used in order to calibrate its gain. The red line is an exponential fit to the gain as a function of the PMT voltage.

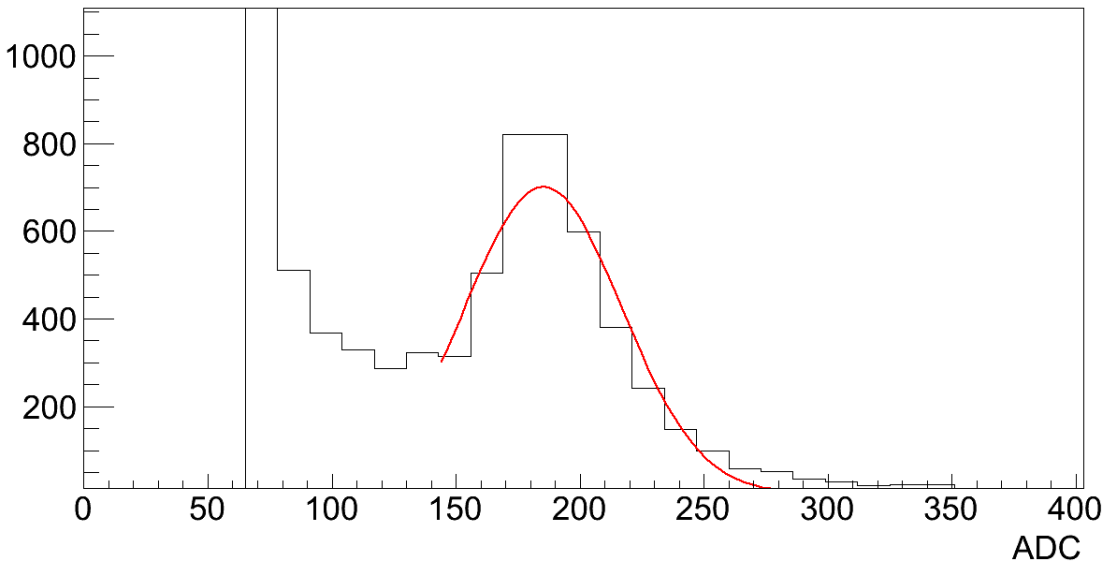

Fig 4: Cosmic ray spectrum in one PbWO block. The minimum ionizing peak is clearly visible and can be used to estimate the light yield at room temperature.