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Tests of wave length shifters (WLS): preliminary results

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<u>Tests of wave length shifters (WLS): preliminary results</u>

<u>Principle of the measurements and apparatus</u>

Tests with WLS have been conducted with the aim of improving possibly the detection efficiency of the PMT's mounted inside the optical modules (OM) of the AMANDA detector.

For these tests, a fully equipped OM has been installed in a cosmic ray hodoscope in such a way that the Cerenkov radiation originating from the passage of cosmic rays in (distilled) water can be detected by the OM through a hole pierced in a screen. The diameter of the hole (1 cm Φ) has been adjusted for the output signal from the PMT to result essentially from single electron emission from the photocathode. A thin glass plate (0.1 mm thick) on which a WLS has been deposited can be placed on the hole just in front of the OM. A comparison of the output signal distributions <u>with</u> and <u>without</u> WLS would allow one to evaluate the effect of the WLS.

Figure 1 gives a schematic description of the CR hodoscope.

The tank and the screen inside are made of opaque black PVC 1 cm thick plates. Two scintillators, one above the tank, one under and a 10 cm thick layer of lead allow the selection of hard cosmic rays. The thin glass plate with the WLS on it (see the enlarged view on Fig. 1) is placed in front of the OM in such a way that the WLS can be hit directly by the Cerenkov light. The resulting fluorescent light can then cross the thin glass plate and about 2 mm of water to reach the OM.

The output signal of the OM is read out when there is time coincidence between the two scintillators and the PMT of the OM.

The signal of the PMT is recorded via a charge sensitive ADC[1] in the form of a histogram. Besides, the number of coincidences between Scint. 1 and Scint. 2 (#12), i.e. the number of selected CR's traversing the hodoscope, and the number of coincidences between the two scintillators and the OM (#12_OM), i.e. the number of these CR's whose Cerenkov light has been detected by the OM, can be read on scalers. Their ratio:

$$R = \frac{(\#12\_OM)}{(\#12)}$$

is used to make direct comparisons between histograms taken under different conditions.

Therefore the histograms are replotted by replacing the number of counts N_i found in each bin by the reduced number of counts per selected CR:

$$n_i = R \frac{N_i}{\sum_{Total} N_i}$$

As can be seen on Fig. 4, the 1-pe peak of the histograms is selected between abscissa (a = 80) and abscissa (b = 150). By summing the n_i found between these two limits, one obtains the rate per selected CR's of 1-pe signals between a and b.

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[1] LeCroy ADC 2249A

The so evaluated (1-pe/CR) rates from histograms taken with and without WLS would enable one to estimate the effect of the latter on the detection efficiency of the OM.

Preliminary results:

Fig. 2 shows the histograms:

- Q10_1012: taken with the hole open in the screen.
- QP17_121: taken with the hole closed (no Cerenkov light from the water crossed by the selected CR's can reach the OM)

The corresponding (1-pe/CR) rates are 5.79% and 0.96% (= background) respectively. The corrected rate for the hole open would then be: 4.83%

Fig. 3 and Fig. 4 show the histograms:

- Again Q10_1012: taken with the hole open in the screen
- QT14_121: taken with the hole covered with a thin glass plate painted with the following mixture [1]:
  - TMI : 80 mg
  - Paraloïd B72 : 3200 mg
  - Dichloromethane : 25 ml

The (1-pe/CR) rate is 5.42%, after correction for the background : 4.56%. This is less than with no WLS.

Since the (1-pe/CR) rate measured with the hole covered by a plain thin glass plate has been found to be practically the same as with the hole just open, the result obtained with this TMI sample indicate more absorption than re-emission. In fact, the TMI-paraloïd deposit showed some opacity when looked in the air.

The measurement has been repeated reliably several times with the same TMI sample. No significant sign of alteration could be detected after repeated immersion in the water for a whole period of 3 to 4 weeks.

One should mention that as a common procedure the thin glass plates are cleaned in a sulfo-chromic bath, rinsed with mili-Q water and dried in a N_2 flux before application of the WLS layer. This procedure was found to ensure good mechanical resistance of the layer when immersed in water[2].

Conclusion:

The results we have shown gave us confidence that the measurement procedure is reliable.

The emphasis is presently put on improving the method used to deposit thicker transparent layers doped with various WLS [1] on thin glass plates.

Reference:

[1] "Increase of the Amanda-OM sensitivity to UV light using wave length shifters (preliminary results from DESY)" AMANDA internal document: L. Kuzmichev, B. Lubsandorzhiev, C. Spiering

[2] From a study made by the "Centre de Recherche en Modélisation Moléculaire" of the University of Mons-Hainaut

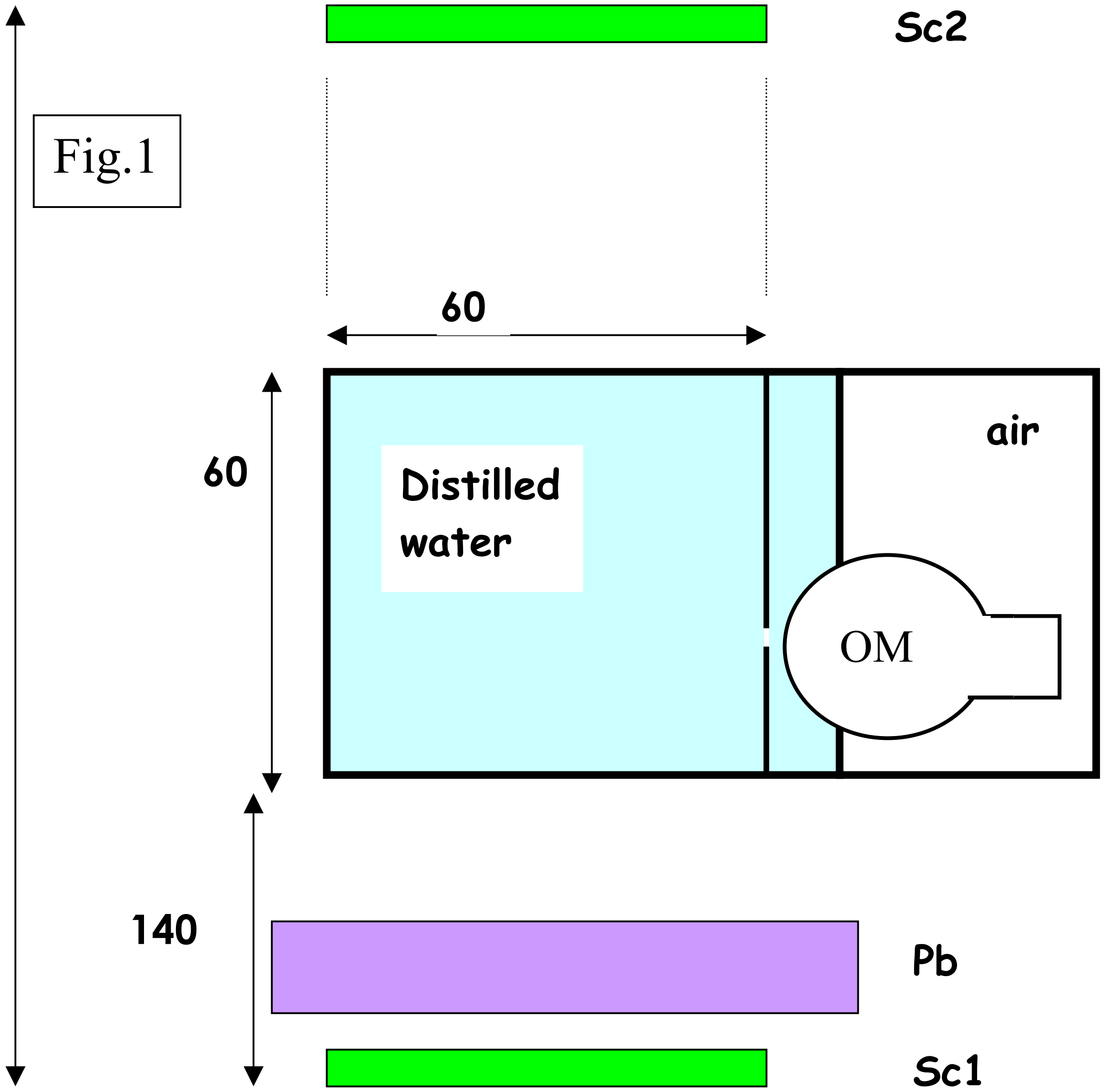
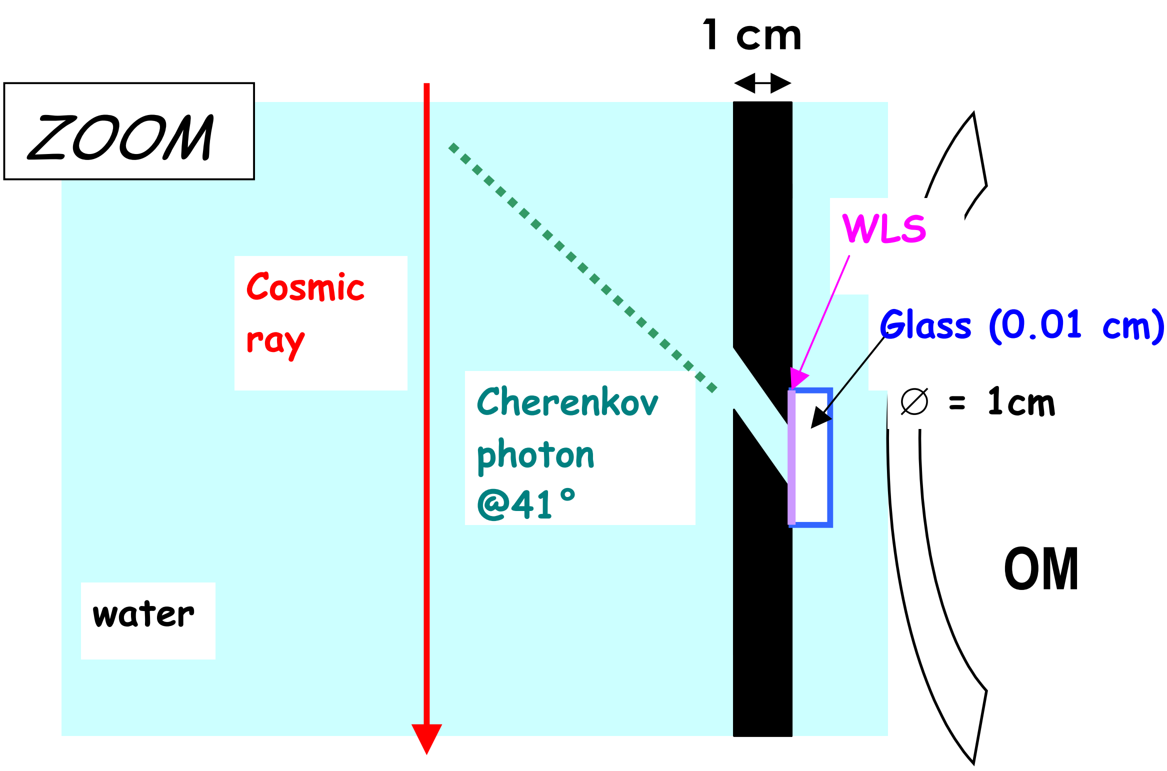
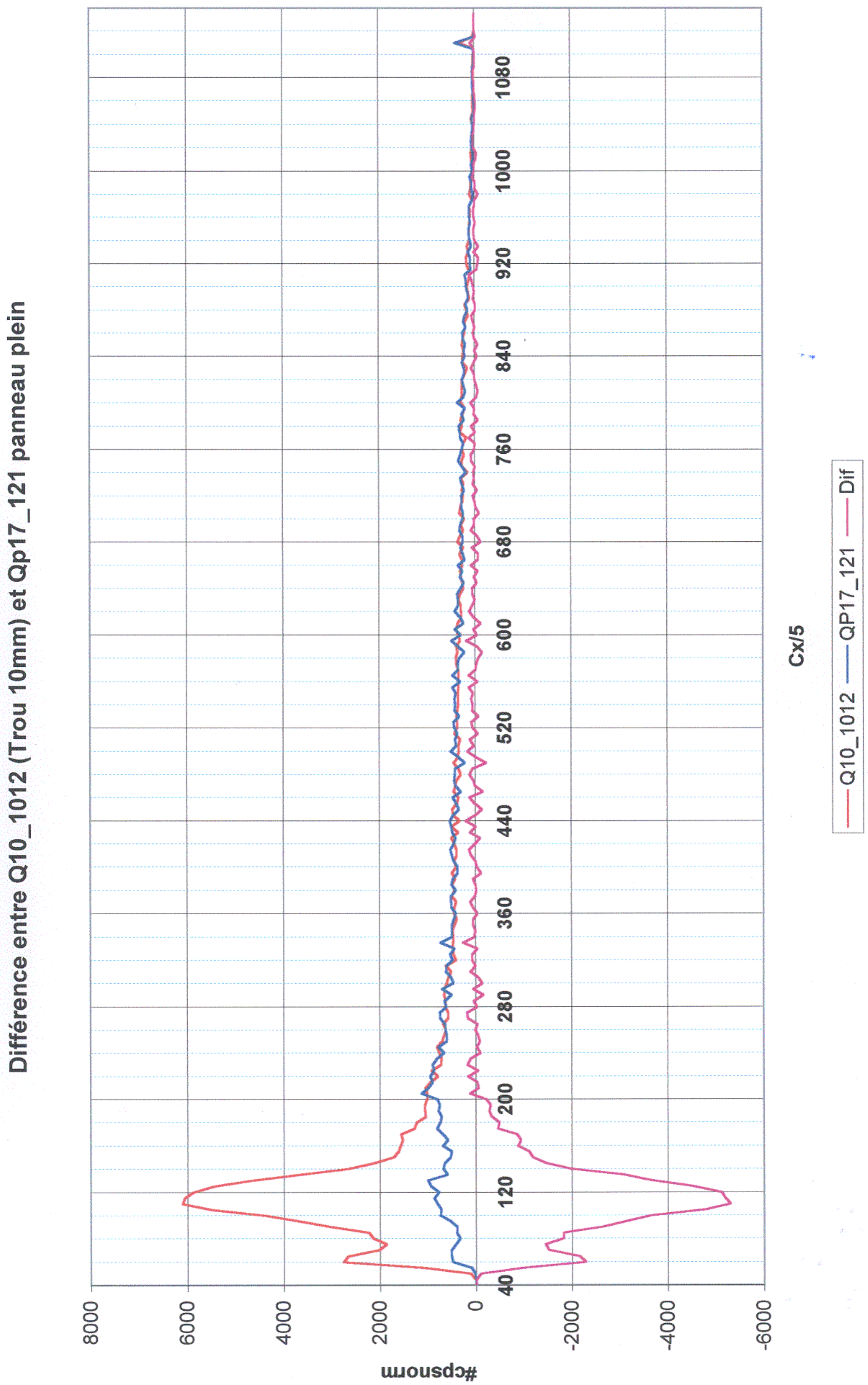


Fig.1
Sc2
60
60
Distilled water
air
OM
140
Pb
Sc1



1 cm
ZOOM
WLS
Cosmic ray
Glass (0.01 cm)
Cherenkov photon @41°
∅ = 1cm
OM
water

Fig. 2



Différence entre Q10_1012 (Trou 10mm) et Qp17_121 panneau plein
8000
6000
4000
2000
0
-2000
-4000
-6000
#cpsnorm
40
120
200
280
360
440
520
600
680
760
840
920
1000
1080
Cx/5
Q10_1012
QP17_121
Dif

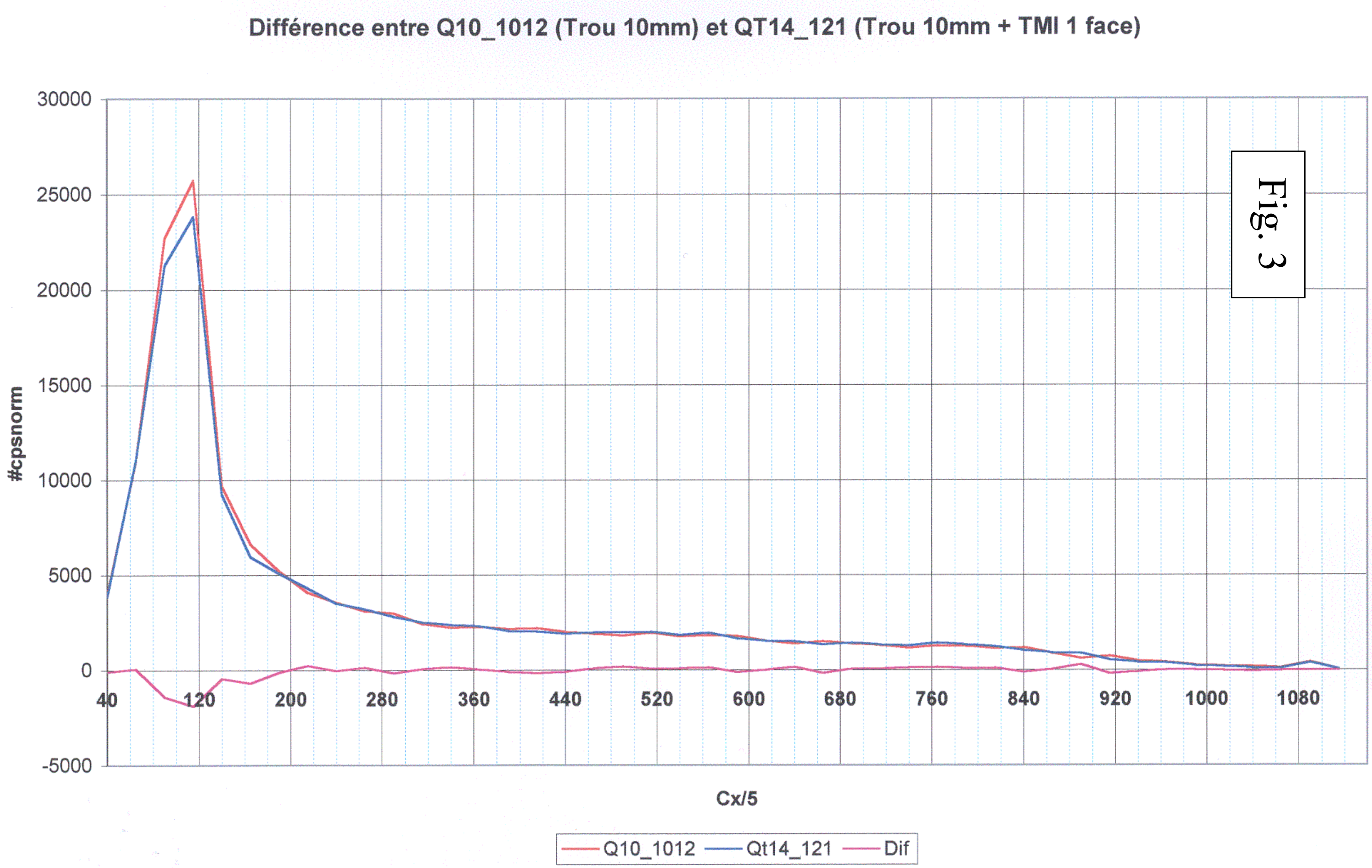

Différence entre Q10_1012 (Trou 10mm) et QT14_121 (Trou 10mm + TMI 1 face)
#cpsnorm
30000
25000
20000
15000
10000
5000
0
-5000
40
120
200
280
360
440
520
600
680
760
840
920
1000
1080
Cx/5
Q10_1012
Qt14_121
Dif

Fig. 3

Fig. 4

Différence entre Q10_1012 (Trou 10mm) et QT14_121 (Trou 10mm + TMI 1 face)