X-Ray Acoustic Diffractometer

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In these papers it has been shown that the deformation of reflecting atomic planes can be controlled and, therefore, the parameters of the diffracted X-rays in space and time can be governed by using external acoustic fields or temperature gradient in the sample . In its turn, this phenomenon opens new possibilities to produce beams with specified parameters, leading to wide applications of X-ray diffraction in science and technology.

The aim of this work is to show the advantages of monochromatic X-ray beam obtained by the acoustic monochromator (AM) with respect to X-ray beam obtained by the Bragg monochromator.

This is illustrated by using a sample made of powder Al_2O_3.

Experiment investigations carried out on DRON-3M diffractometer illustrate the advantages of acoustic monochromators prepared and processed in IAPP NAS RA.

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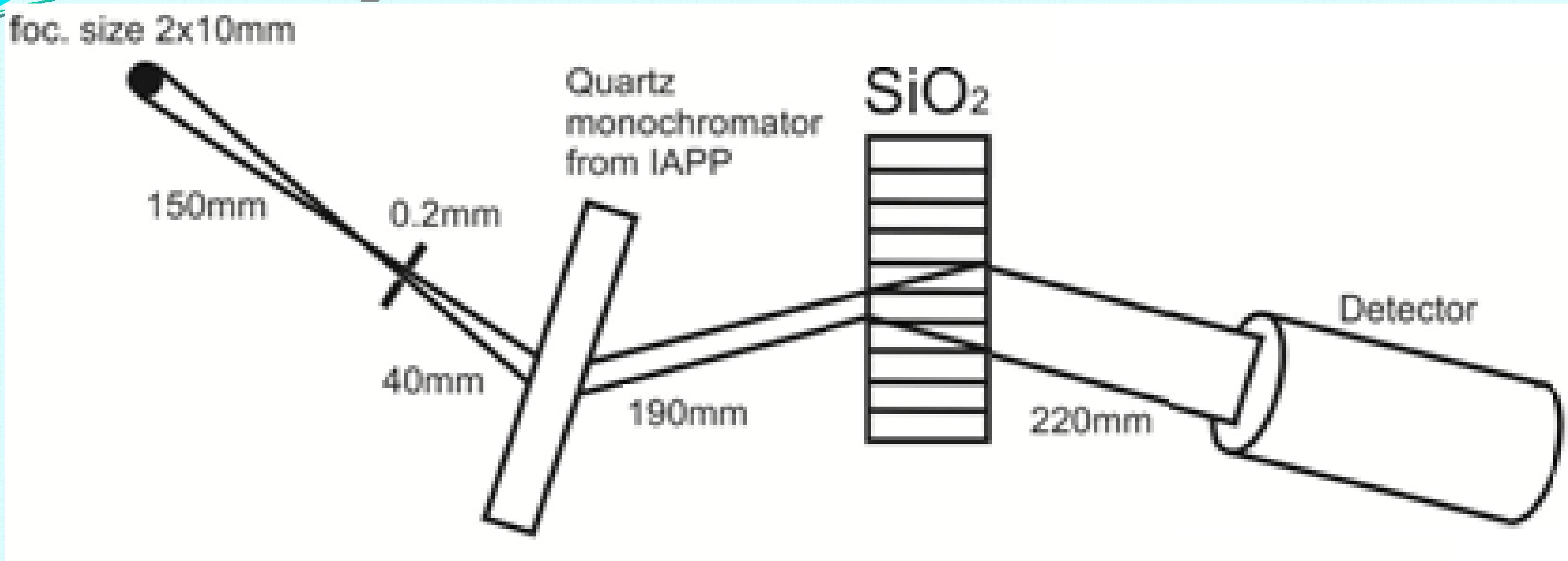
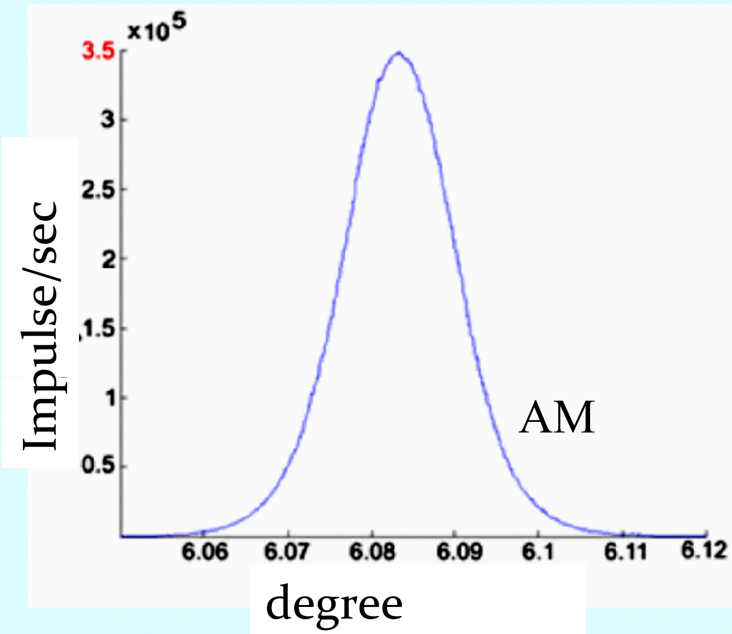
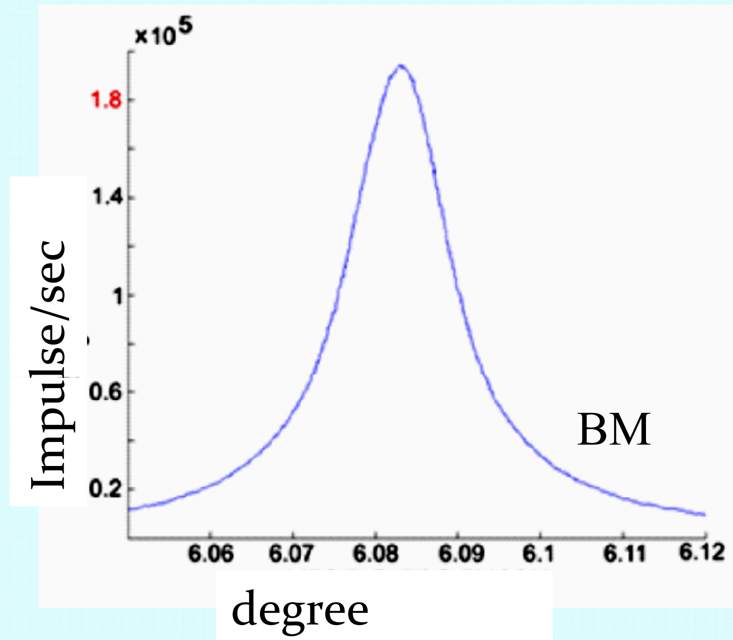
Experimental setup



In order to demonstrate the benefits of the AM here we present some results of experiments carried out on DRON-3M. At a distance of 19cm from the AM a X-cut Quartz single crystal of thickness 0.9 mm is placed and appropriate rocking curves by the schemes (n,-n) and (n, n) in the Laue geometry were registrated. AM is located at the distance 19 cm from the source and is under complete transfer conditions. To eliminate the variance in the scheme (n,-n) we have chosen the reflecting atomic planes (10-11) of the Quartz crystal.

For comparison, the rocking curves have been taken for AM and the Bragg monochromator at the same conditions.





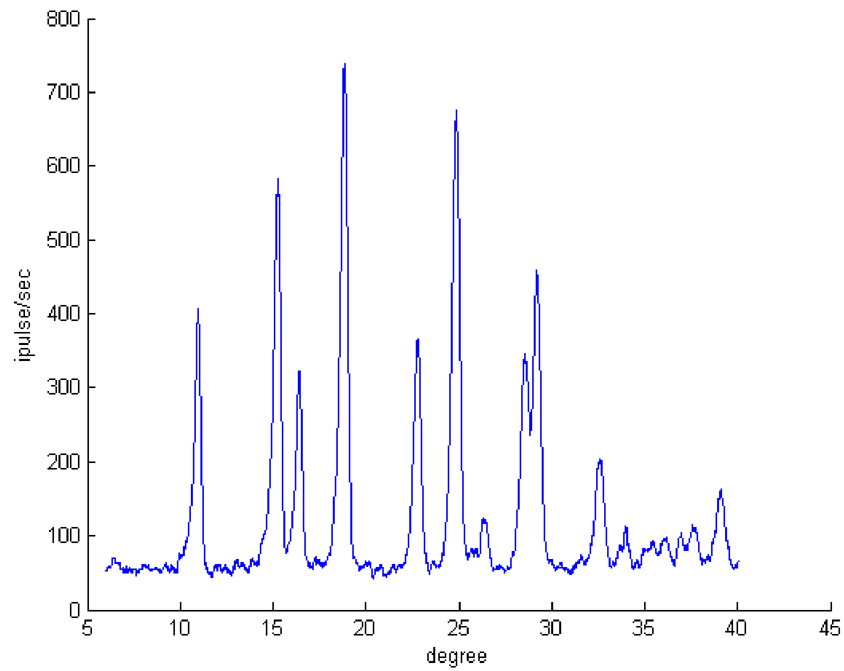
From comparison of the results presented in these two figures it is visible, that acoustic monochromator have a number of advantages: the received X-ray bunches are more monochromatic, are more than 2 times intensive than bunches received with Bregg monochromator, have no background, intensity distribution is homogeneous and symmetric that testifies the absence of absorption.

Acoustic monochromators AM give the unique chance to control the important parameters of radiation

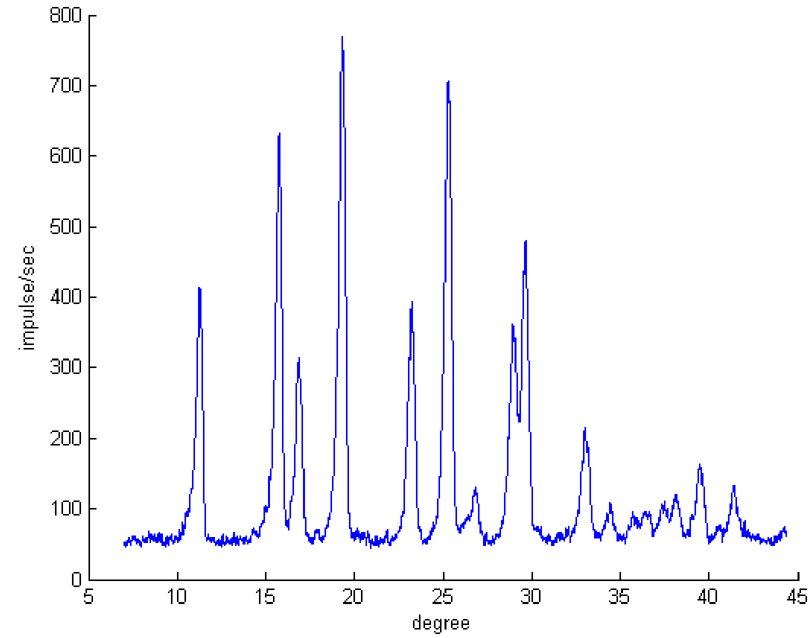
Monochromaticity degree	$\frac{\Delta\lambda}{\lambda} \approx 10^{-3} \div 10^{-5}$
Angular divergence	2 "- 3 "
The focalizing property	focal lenght varies (from -∞ up to +∞)
Modulation frequency	from 0 up to 20 KHz
The mechanical characteristic	can be elastic bend
Stability	good
Intensity of a maxima	very strong
Width of a maxima	controlled

In these figures it is presented typical diffraction pattern for powder samples Al_2O_3 prepared by us for different rotation speeds of sample.

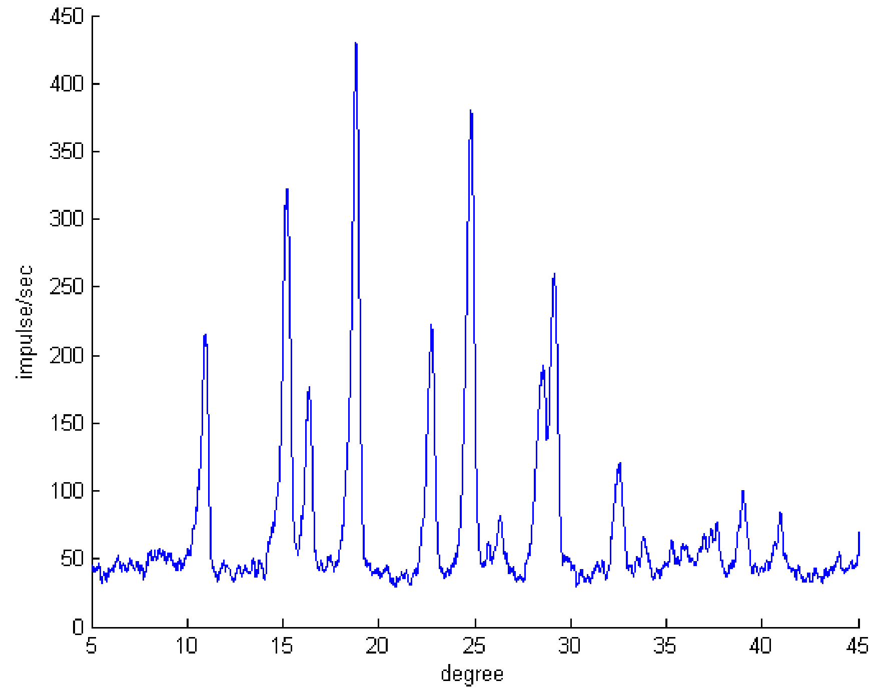
Experiments have been carried out for acoustic monochromators of 0.5 and 1mm thicknesses. The comparison of presented data shows that they are practically the same.



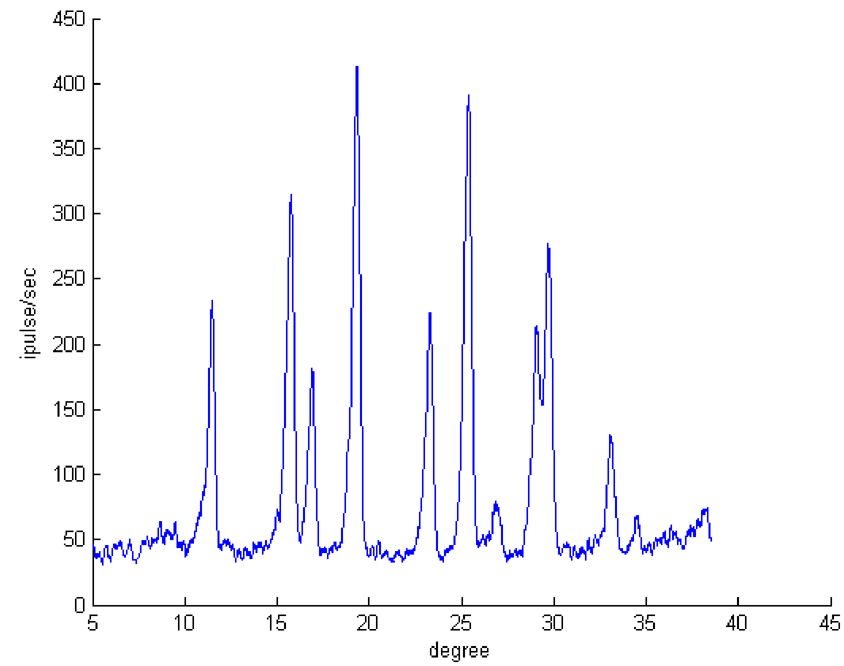
Diffraction pattern of Al_2O_3 . Rotation velocity of sample is 1 degree/minute (0.5mm)



Diffraction pattern of Al_2O_3. Rotation velocity of sample is 0.5 degree/minute (0.5mm).



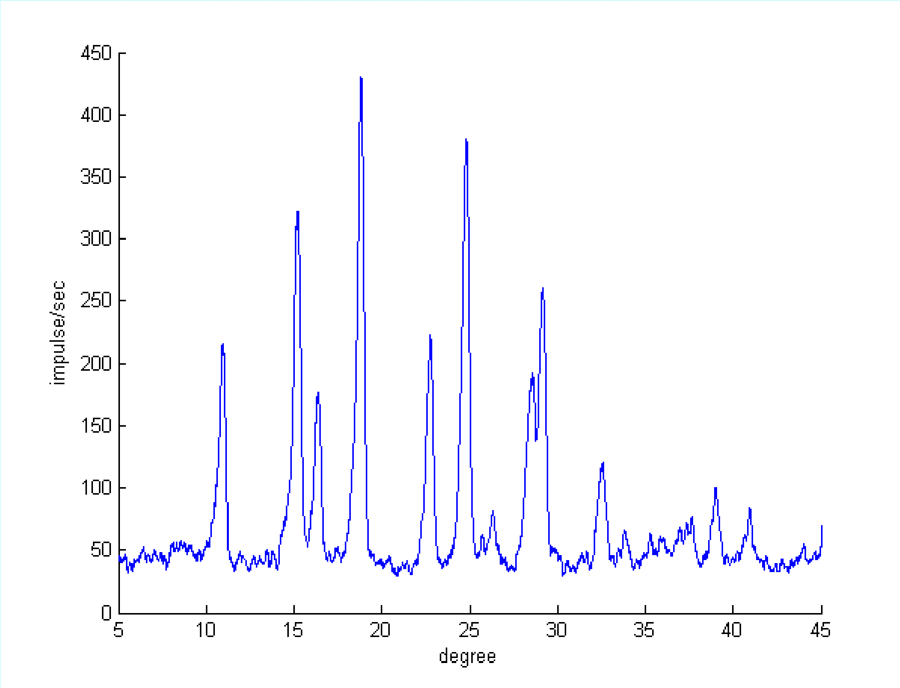
Diffraction pattern of Al_2O_3 . Rotation velocity of sample is 1 degree/minute (1mm)



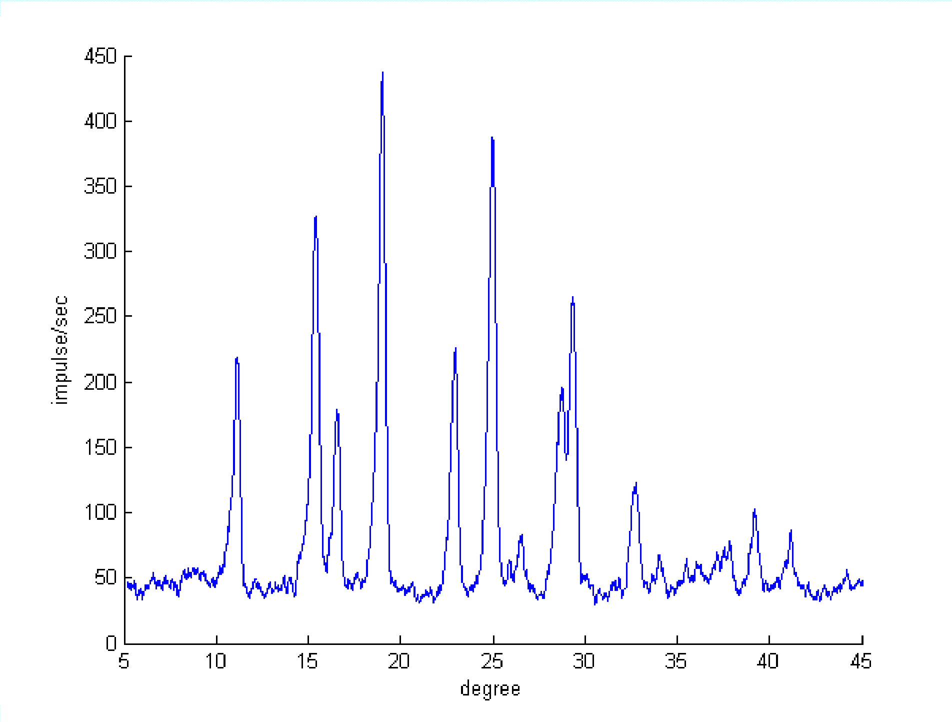
Diffraction pattern of Al_2O_3. Rotation velocity of sample is 0.5 degree/minute (1mm).

The difference in diffraction pattern intensities for monochromators 0.5mm and 1mm, is mainly due to the higher absorption.

On the next pictures are shown the time dependency of results. The AM and specimen working stability was tasted every 20 min during 48 hours. The test shoes high stability of both..



taken 16.november.2010, 8.00 am

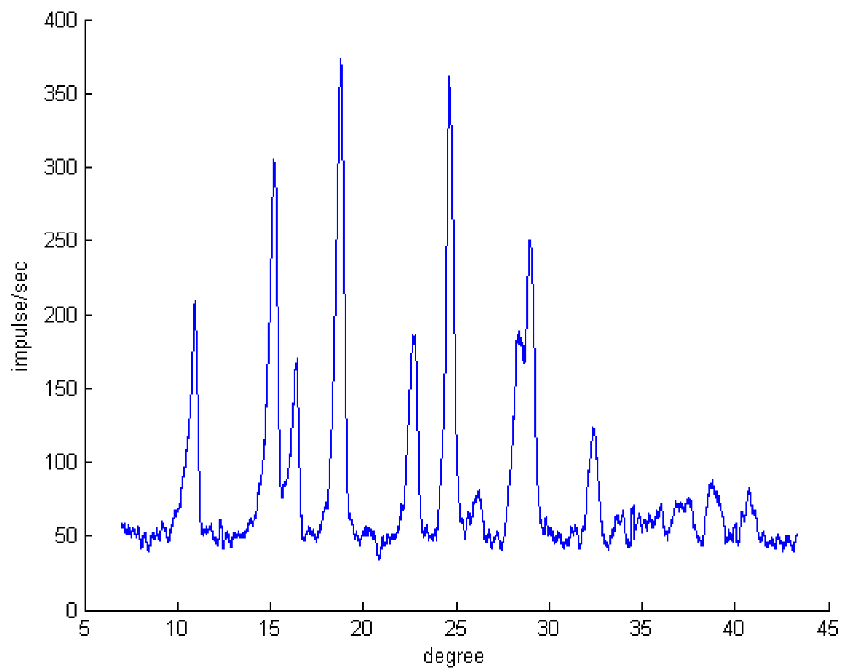


taken 17.november.2010, 4.00 pm

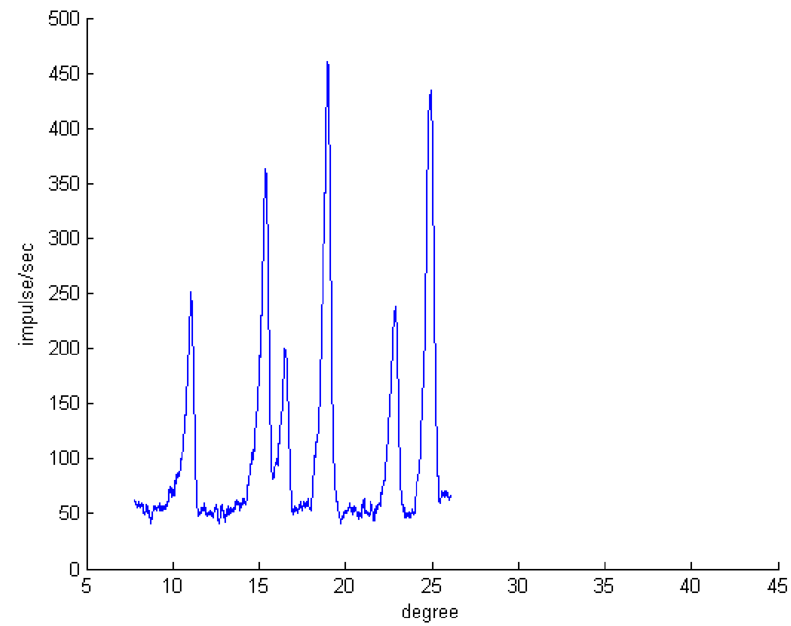
Diffraction pattern of Al_2O_3. Rotation velocity of sample is 0.5 degree/minute (1mm)

The same efforts have been made by using 1mm thick quartz monochromator with (10-11) reflection. The results abstained for this case confirm the results of previous experiments.

Similar experiments have been done for monochromators under the influence of thermal field also designed in IAPP .



Diffraction pattern of Al_2O_3 . Rotation velocity of sample is 1 degree/minute (150 °C/cm).



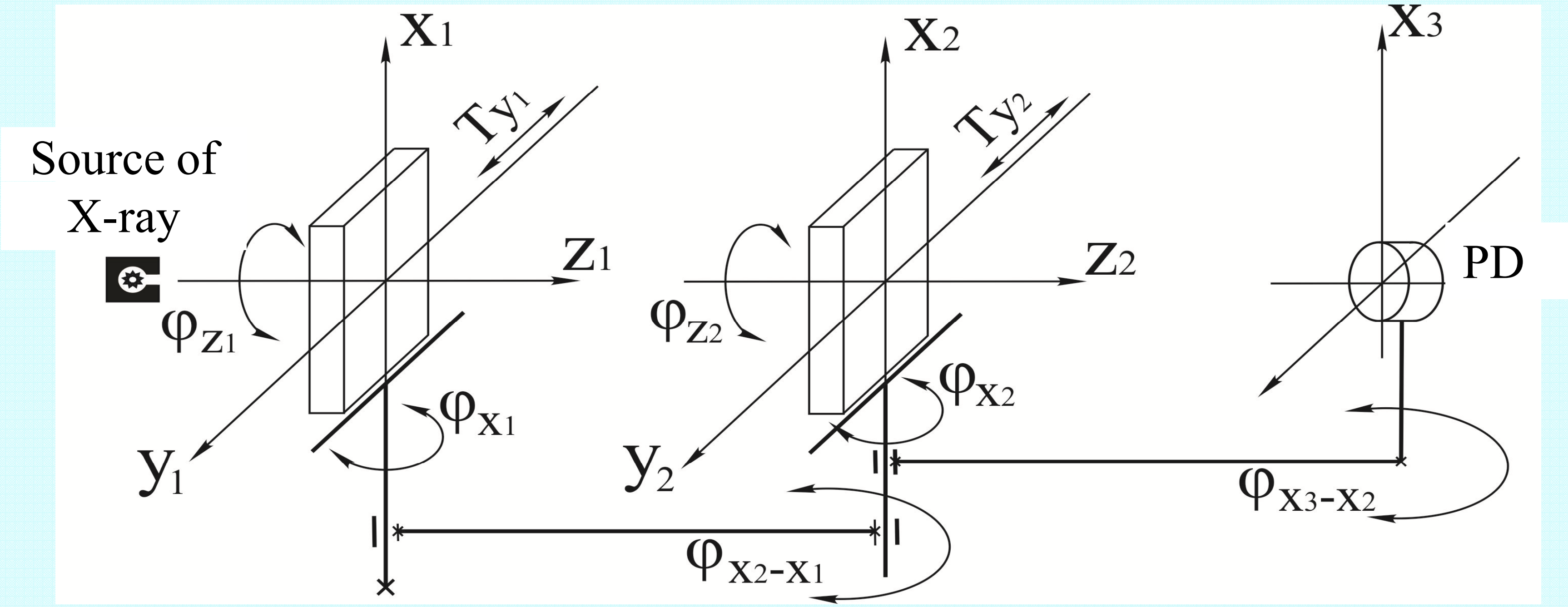
Diffraction pattern of Al_2O_3 . Rotation velocity of sample is 1 degree/minute (200 °C/cm).

These results we compared with the results obtained for acoustic monochromators. Our results indicate, that acoustic monochromators are more effective then thermal monochromators (monochromatization is higher).

Of course, both acoustic and thermal monochromators are acceptable for controling X-ray beam parameters in space and time.

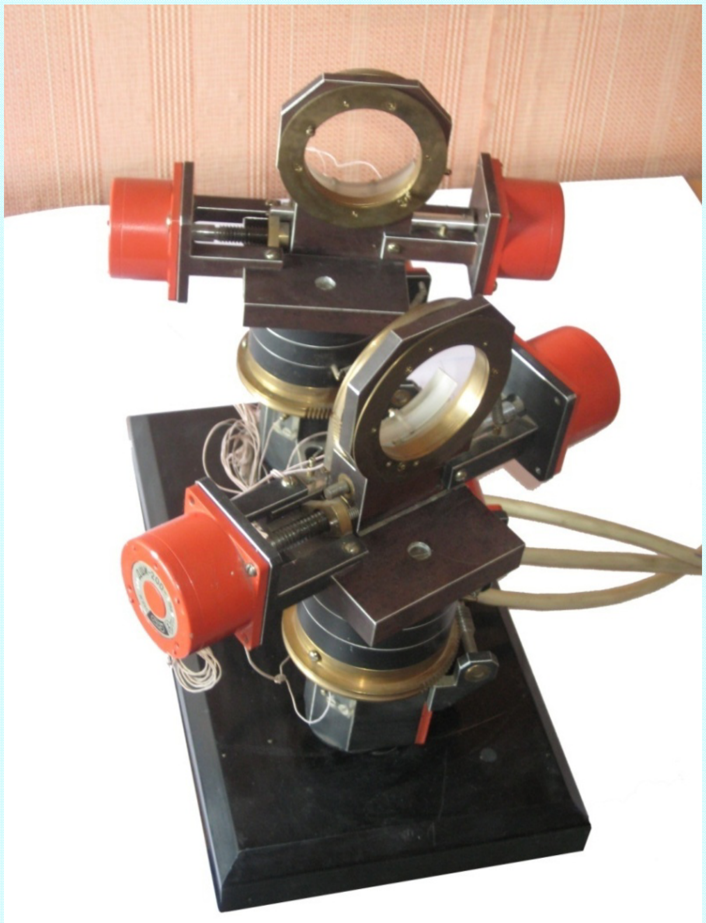
Nevertheless one can’t use thermal monochromator in vacuum environments, due to the suppression of free thermo-conductivity in such environments.

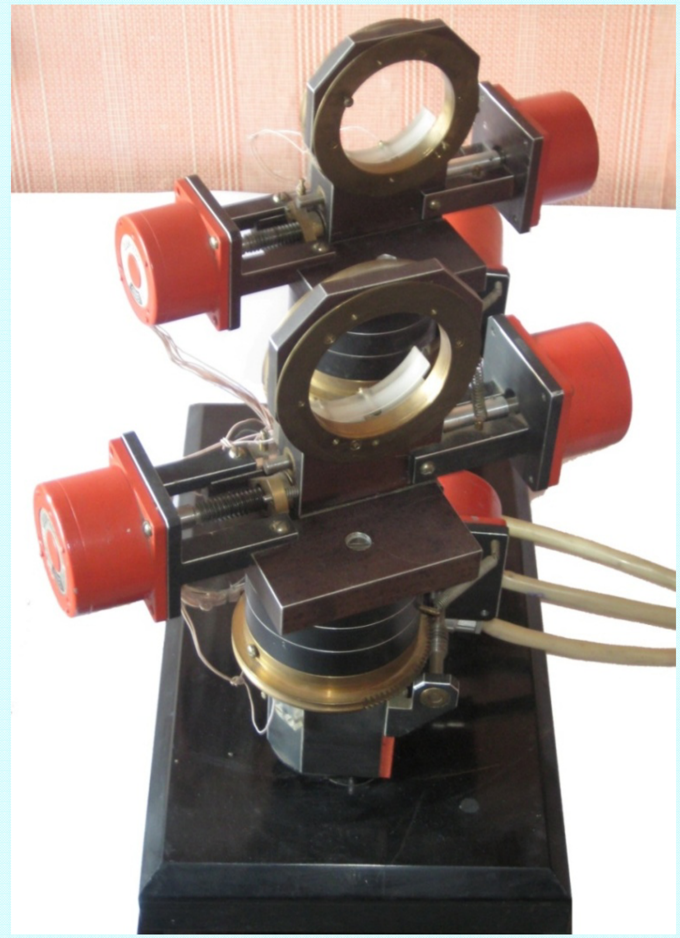
On picture the scheme high-speed and automated diffractometer for structural researches with high accuracy developed and created in IAPP NAS RA is resulted the block. The structure of diffractometer includes acoustic monochromator, the detector of x-ray radiation working on the basis of porous materials (PM) and goniometer with two heads developed in IAPP NAS RA, and with use usual (old) diffractometers only x-ray tubes.



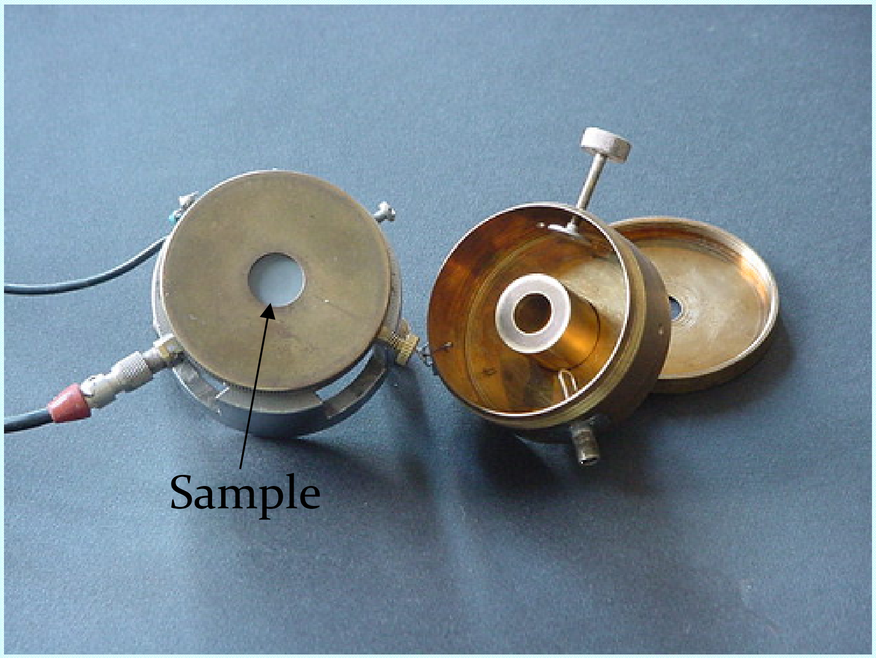
Goniometer with the holder for X-ray detector and with two independently working heads with remote control

For realisation of fast and exact structural researches by means of acoustic monochromators to is applied automated goniometer with two heads and the counter of x-ray radiation with the corresponding software.

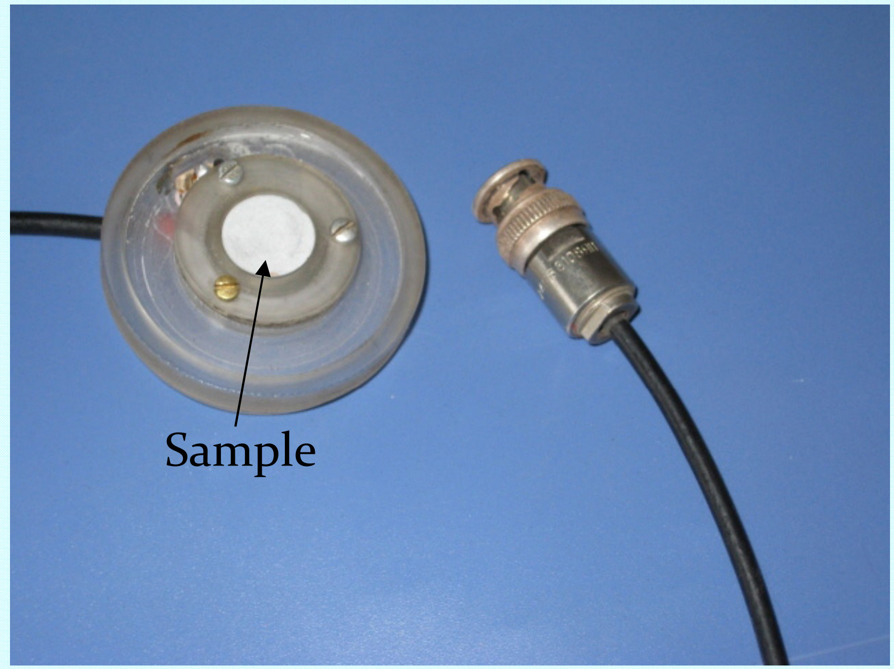




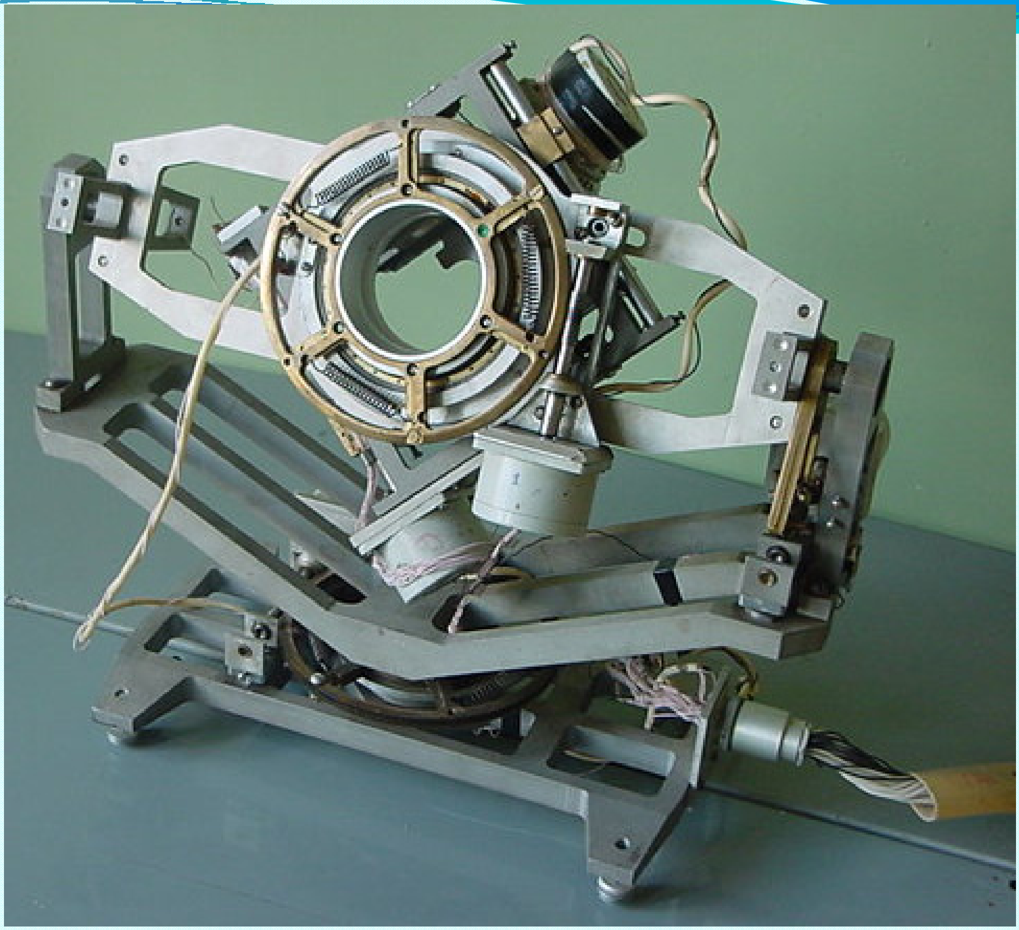
Some units of acoustic diffractometer



GHz Resonator



MHz Quartz



Goniometer with 6 degrees of freedom

Thank you for attention!