TOMSK POLYTECHNIC UNIVERSITY
&
INTERNATIONAL LABORATORY
"PHOTON"

The comparison of monochromatic X-ray sources based on X-ray tube and 5 MeV microtron for possible application in medicine

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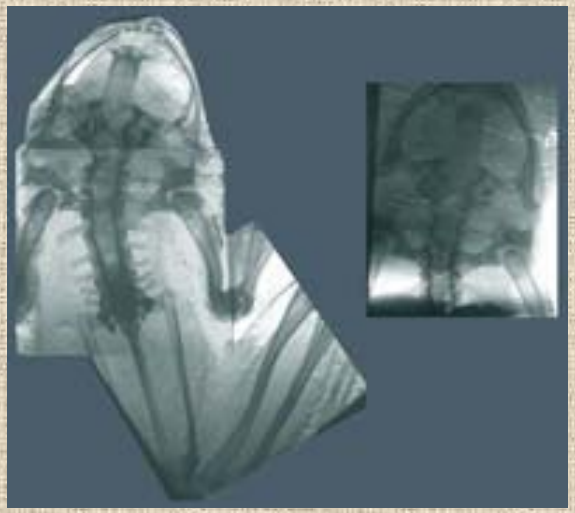
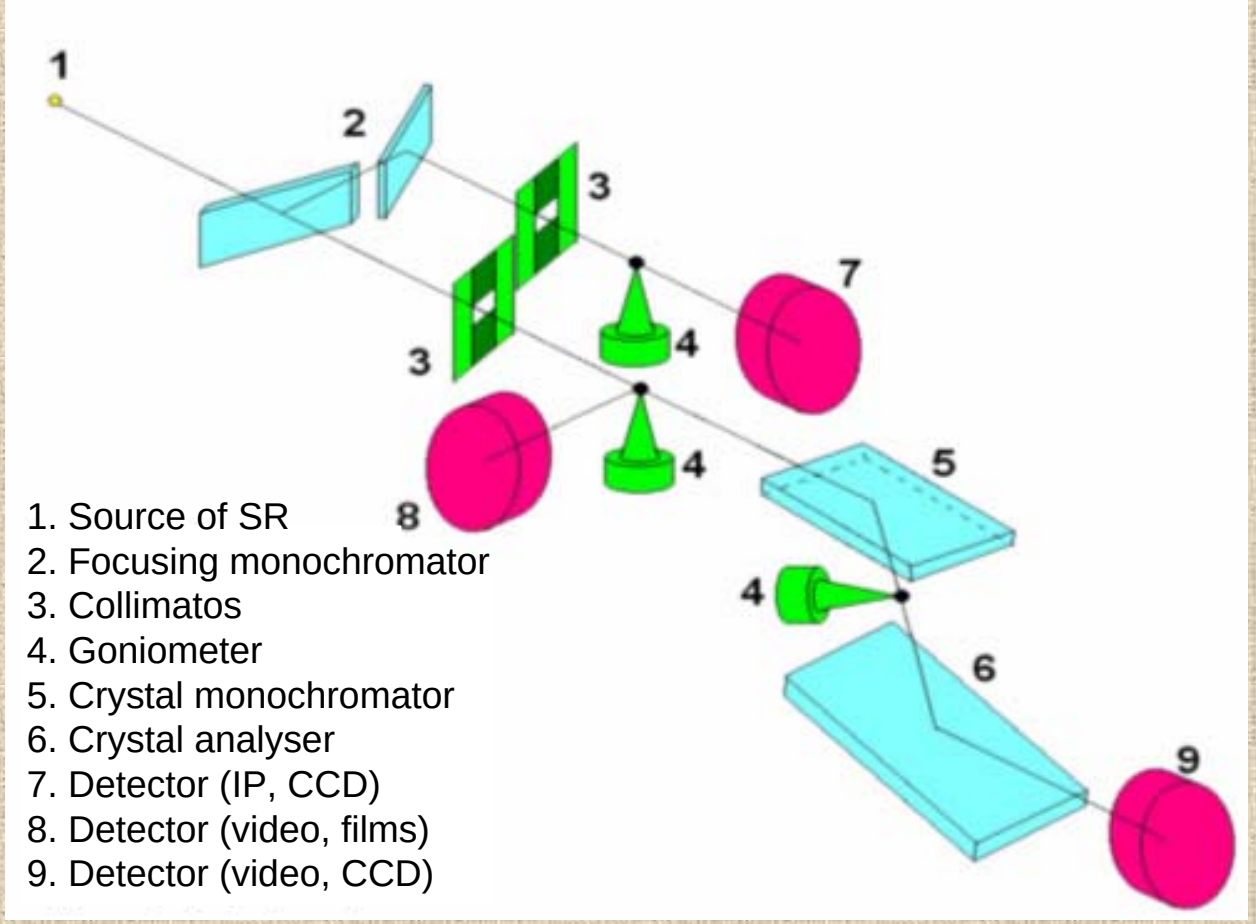
Synchrotron radiation monochromatization in storage rings using crystal diffraction method





1. Source of SR
2. Focusing monochromator
3. Collimatos
4. Goniometer
5. Crystal monochromator
6. Crystal analyser
7. Detector (IP, CCD)
8. Detector (video, films)
9. Detector (video, CCD)

А.В. Забелин и др.//Поверхность. Синхротронные и нейтронные исследования, 2003, №2, с. 56-59

Medical Applications of Synchrotron Radiation. Eds. M. Ando, C. Uyama. Springer – Verlag, 1998

- **Monochromatization of synchrotron radiation**
- **XFEL**
- **Parametric X-ray (electrons, protons, nuclei)**
- ***Diffraction of bremsstrahlung***
- **Et al.**

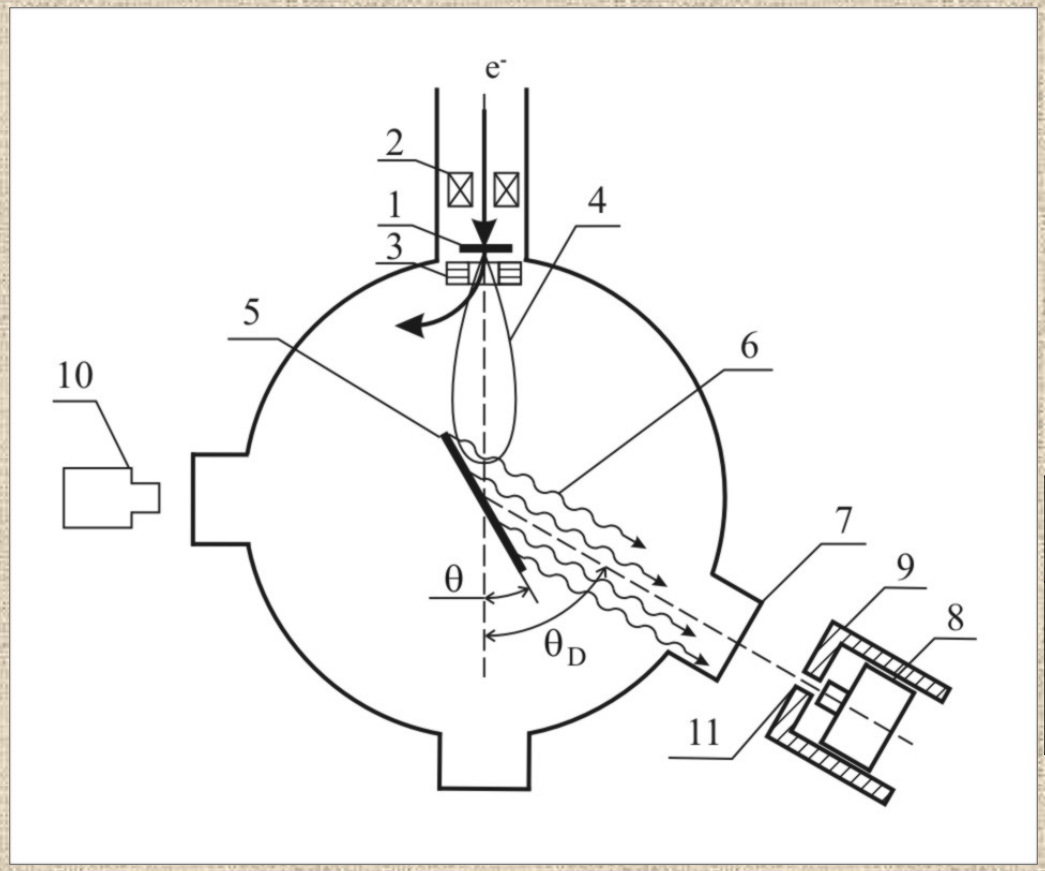
TO SHOW

- The possibility of creation the X-ray monochromatic source based on compact cheap accelerators
- The application of these systems

TO FIND

- The partners (may be sponsors) *-)

•Electron accelerator bremsstrahlung monochromatization



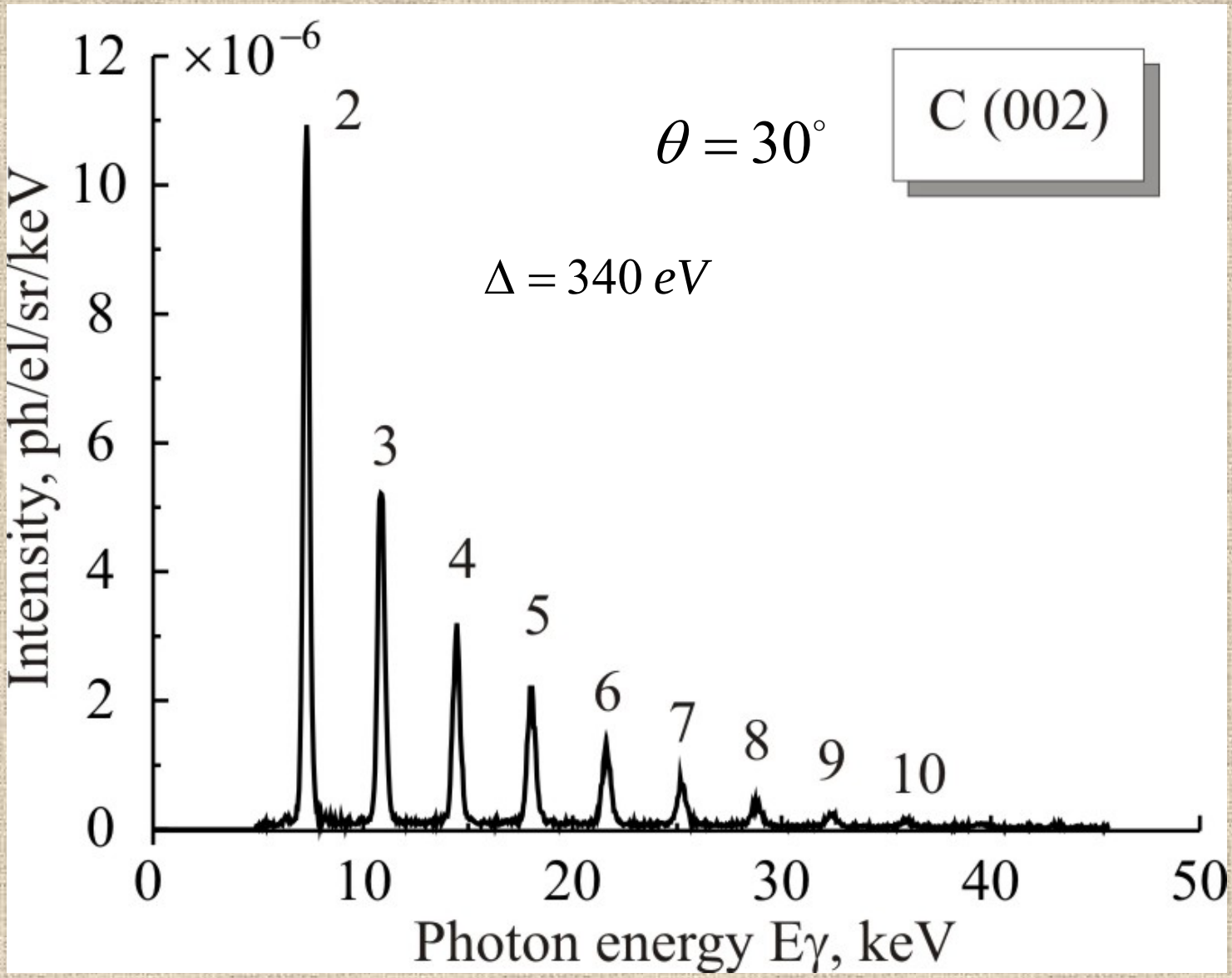
A.R. Wagner, A.P.Potylitsyn, et al., Monochromatic X-ray sources based on a mechanism of real and virtual photons diffraction in crystals, NIM **B** 266 (2008) 3893 - 3897

Electron energy	5.70 MeV
Beam current	0.15-0.30 mA

1 - aluminum converter (125 μm), 2 - current sensor, 3 - deflecting magnet, 4 - bremsstrahlung flux, 5 – crystal target fixed on goniometer, 6 - diffractions X-ray radiation, 7 - kapton window (150 μm), 8 - semiconductor silicon detector with a sensitivity region about 13 mm^2, 9 - lead chamber, 10 - TV-camera, 11 - collimator

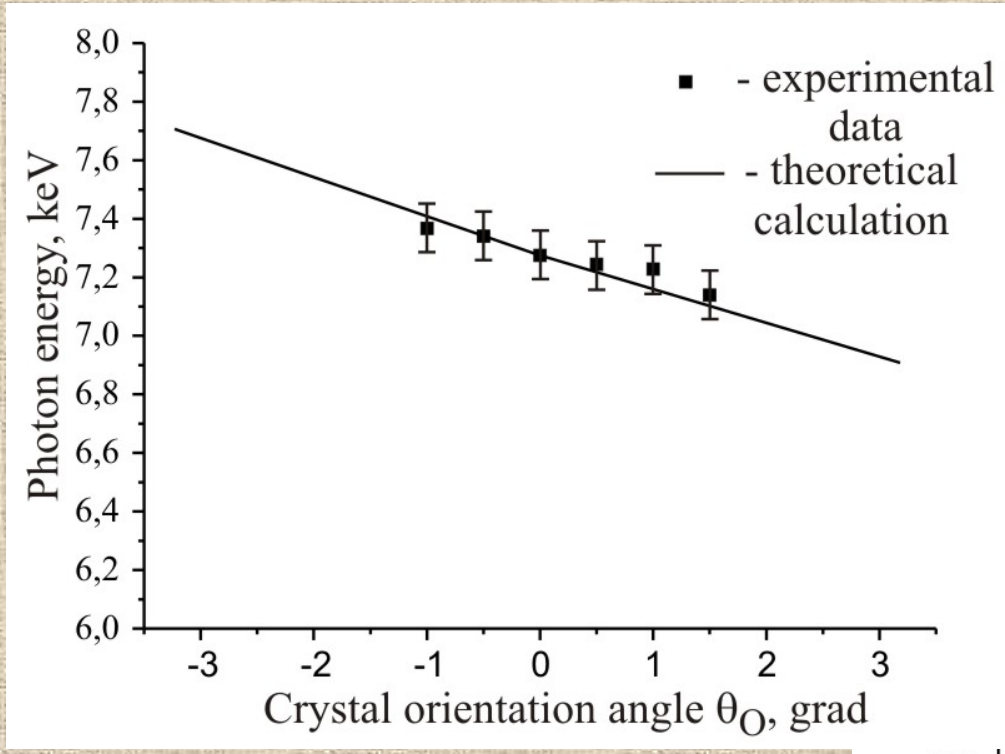
Crystals parameters				
Parameters	C(002)	Ge(111)	W(111)	Unit
Linear dimensions	20×30	20 ×20	10×16	mm
Mosaicisity	~4	~1	~0,3	mrad
Thickness	350	2000	100	μm

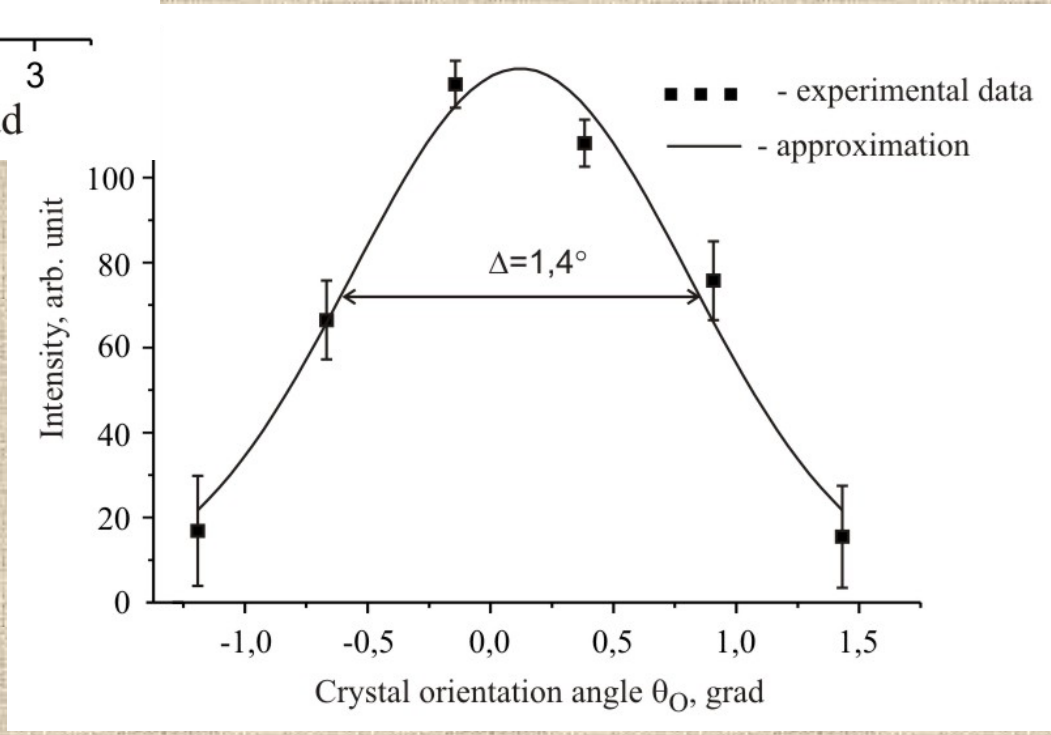
- **Electron accelerator bremsstrahlung monochromatization**



X – ray sources

- **Electron accelerator bremsstrahlung monochromatization**





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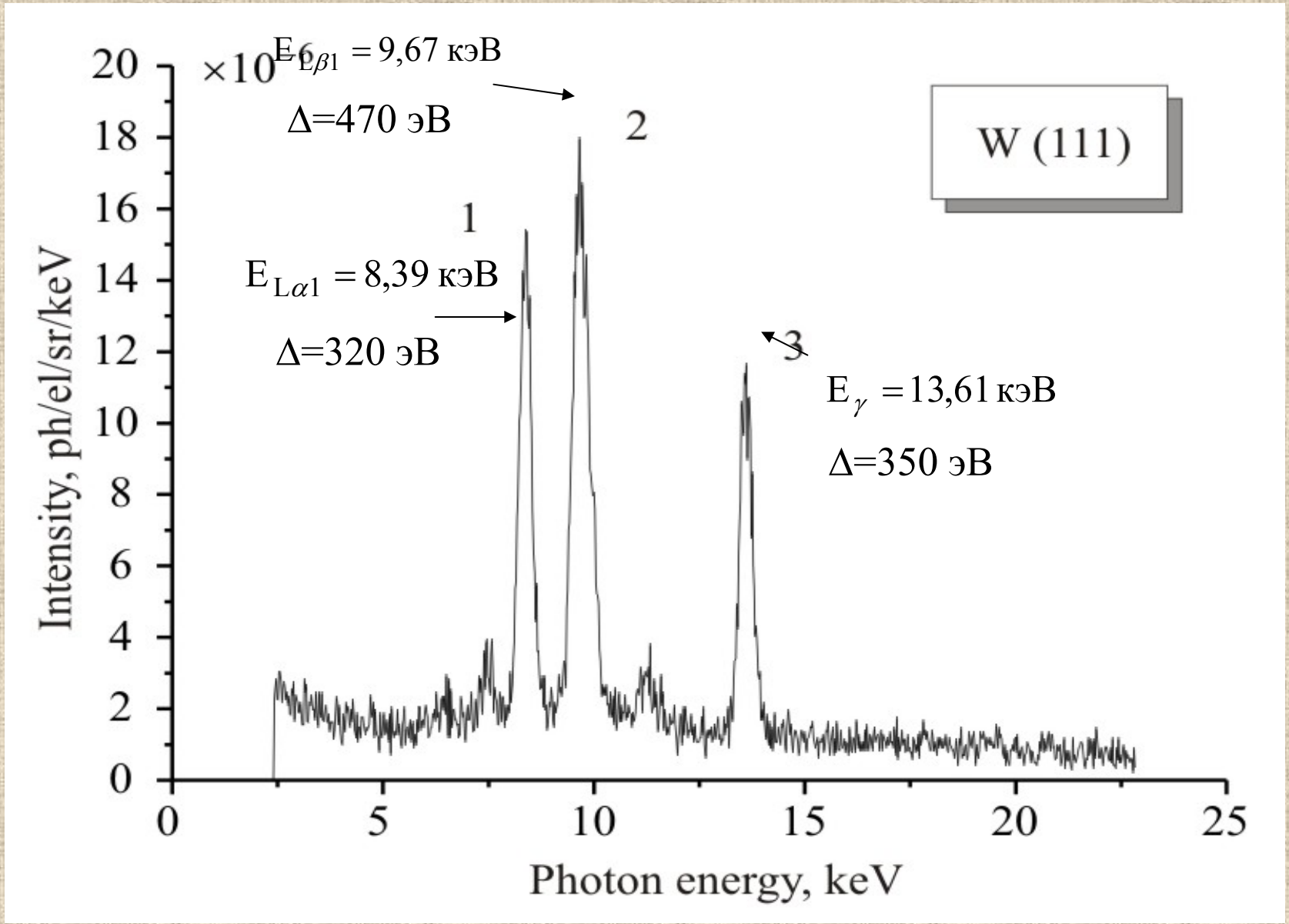
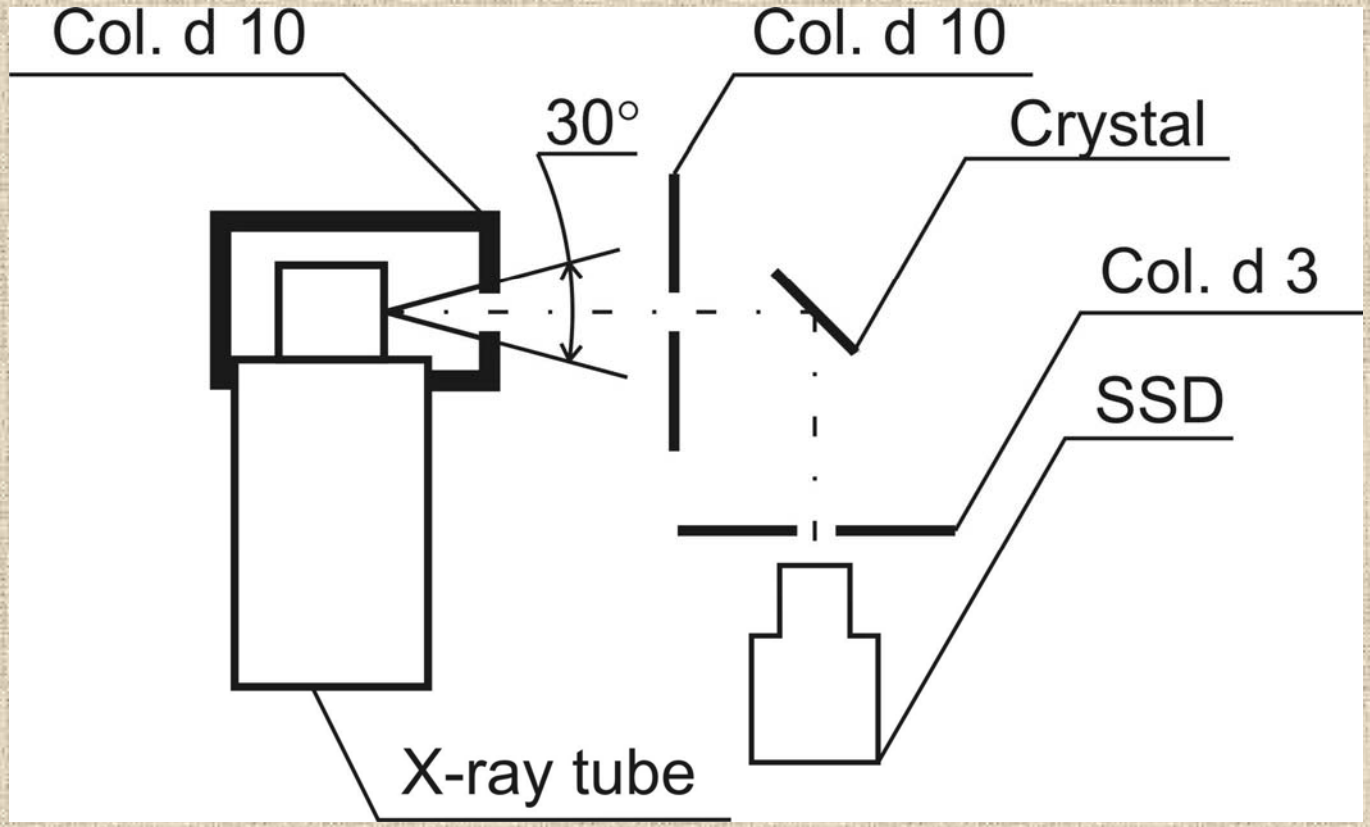
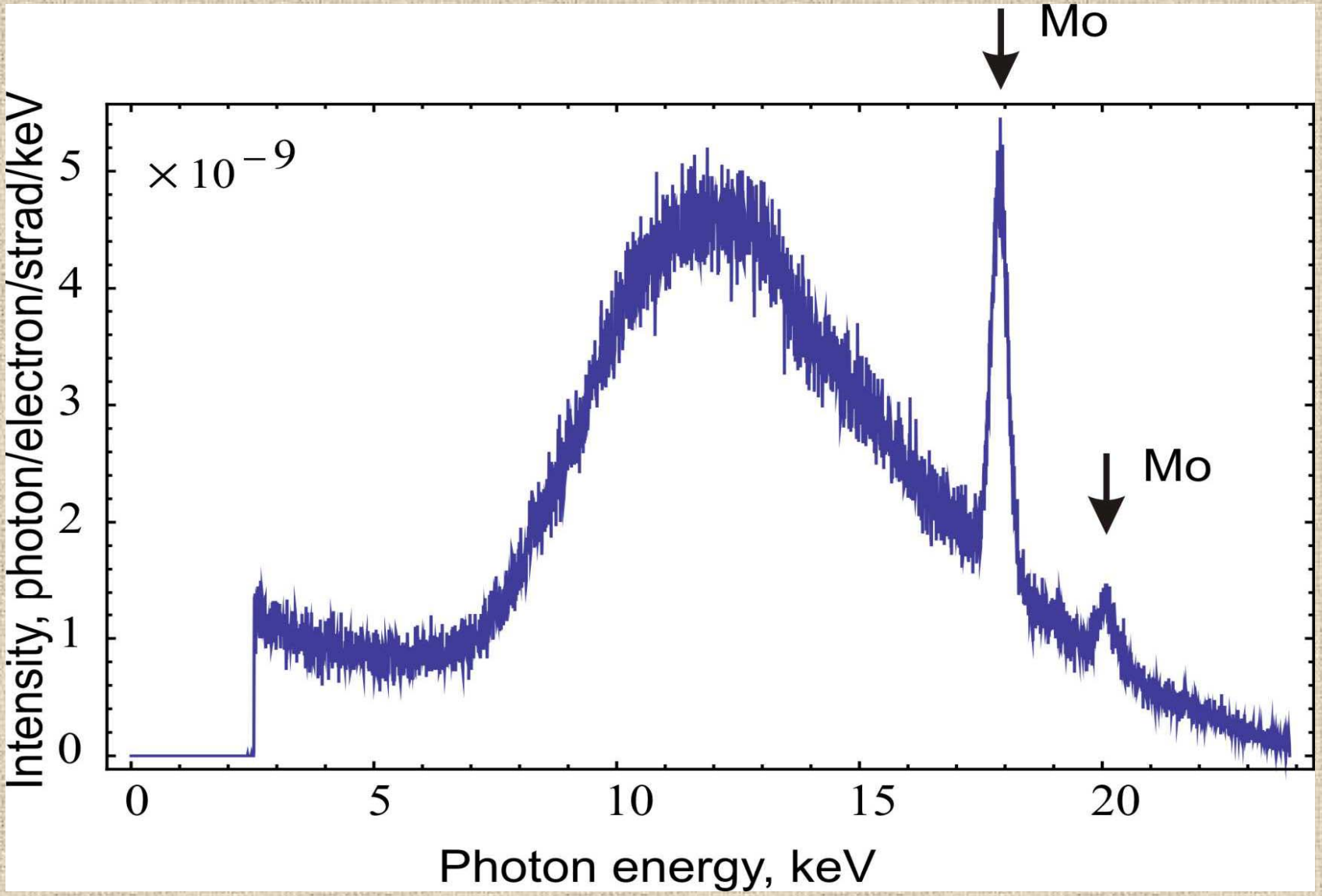


- **X-ray tube beam monochromatization**



X-ray tube anode voltage	40	kV
X-ray tube anode current	10	mA
Anode material	Molybdenum	

- **X-ray tube beam monochromatization**



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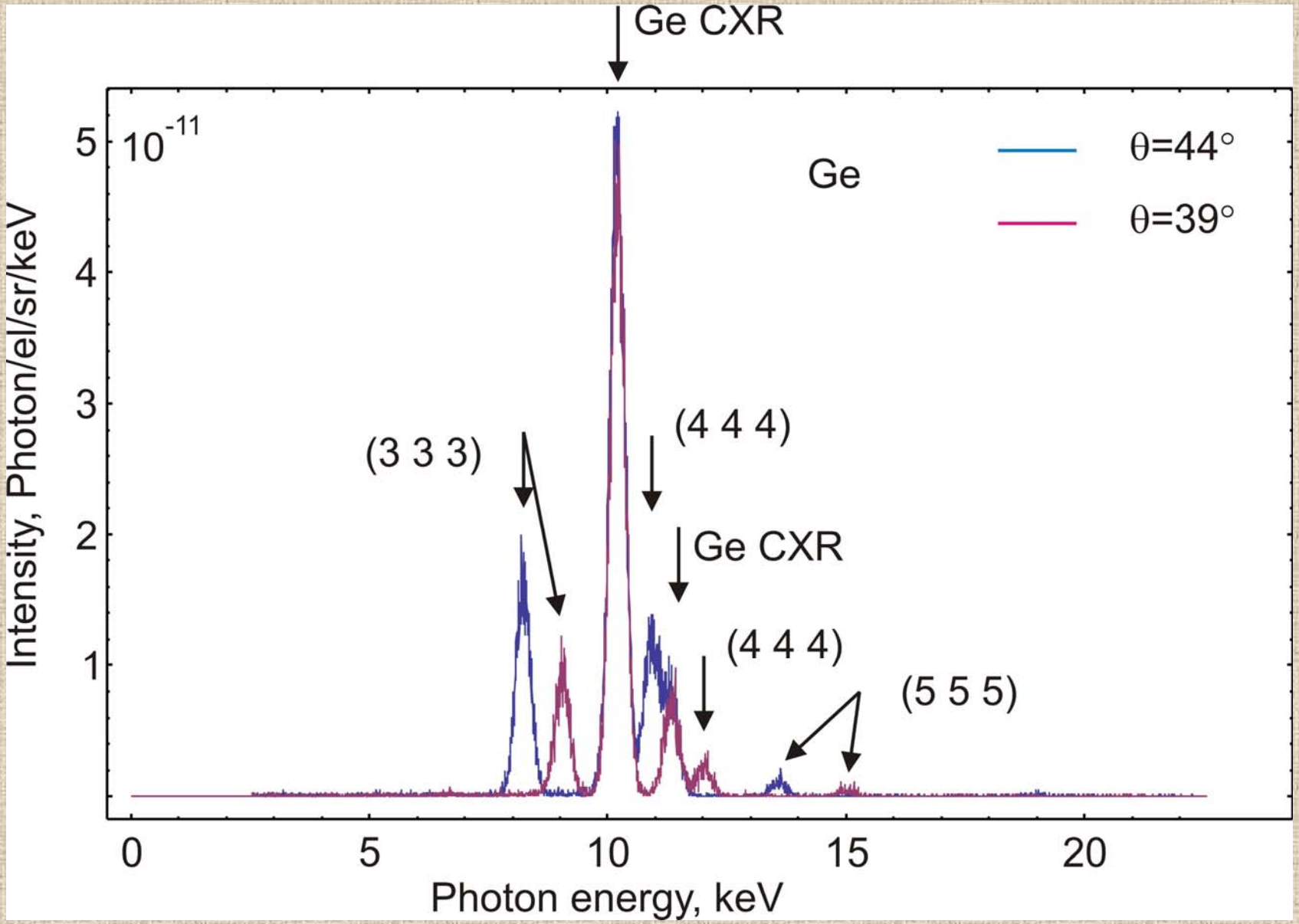

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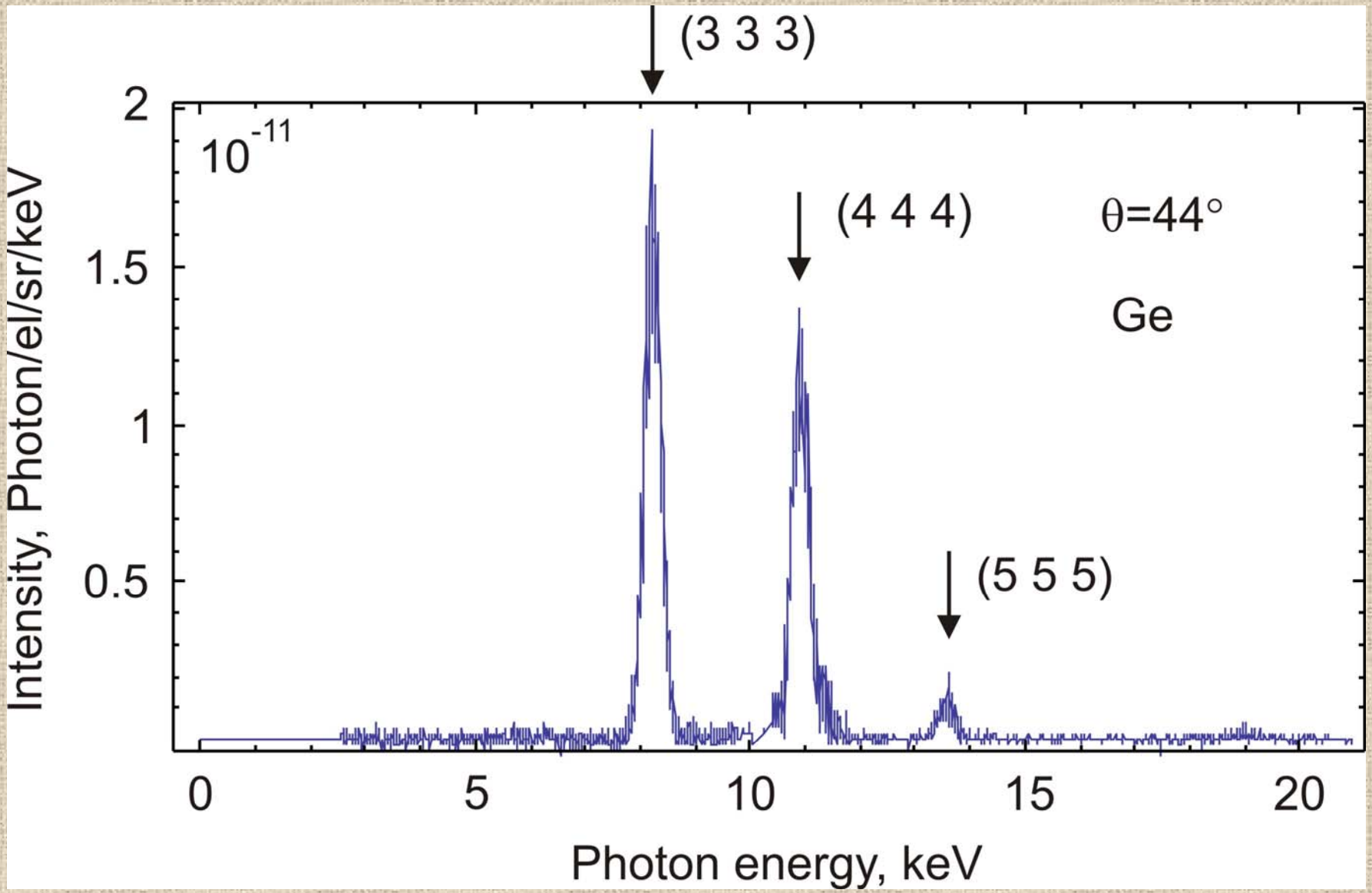

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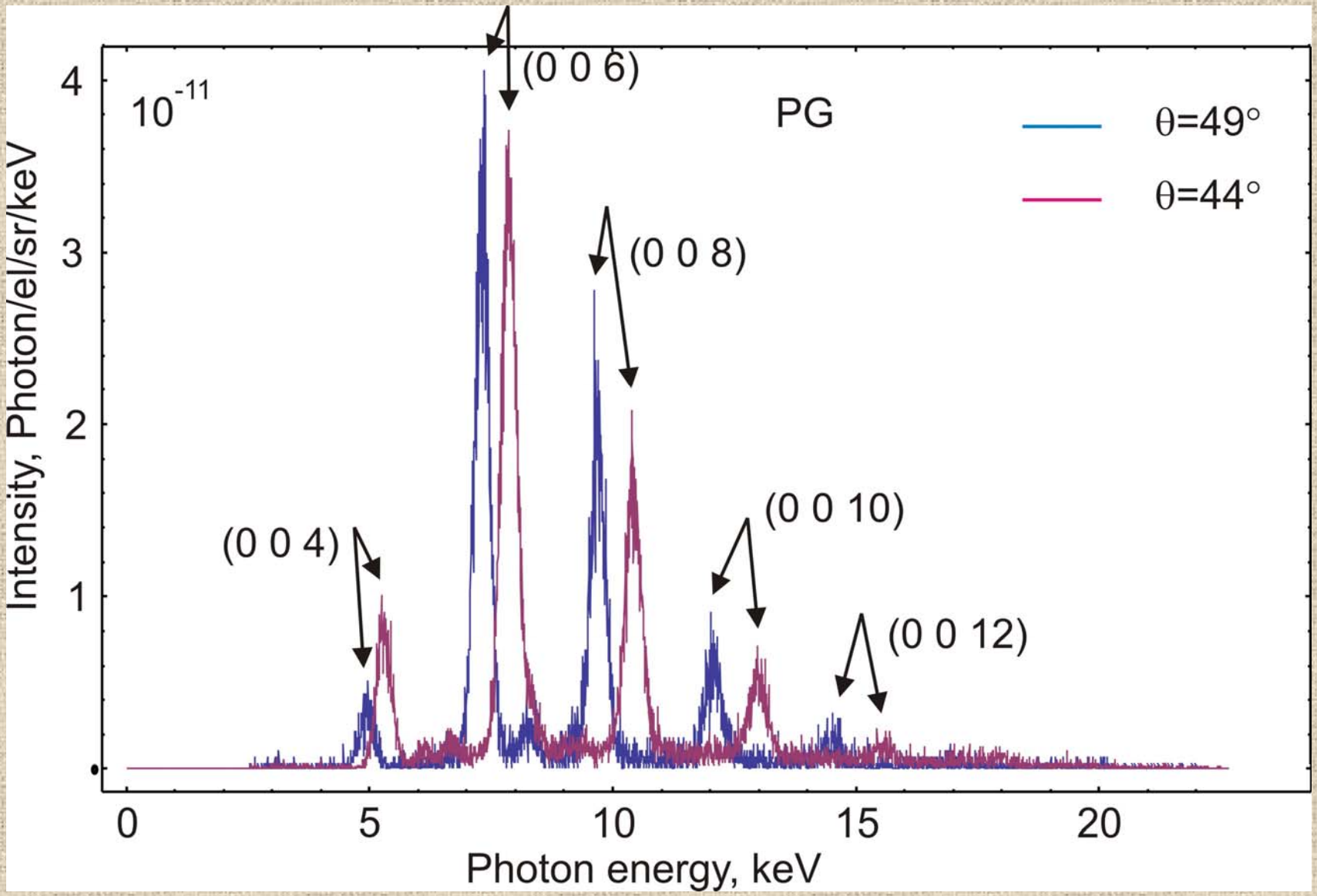

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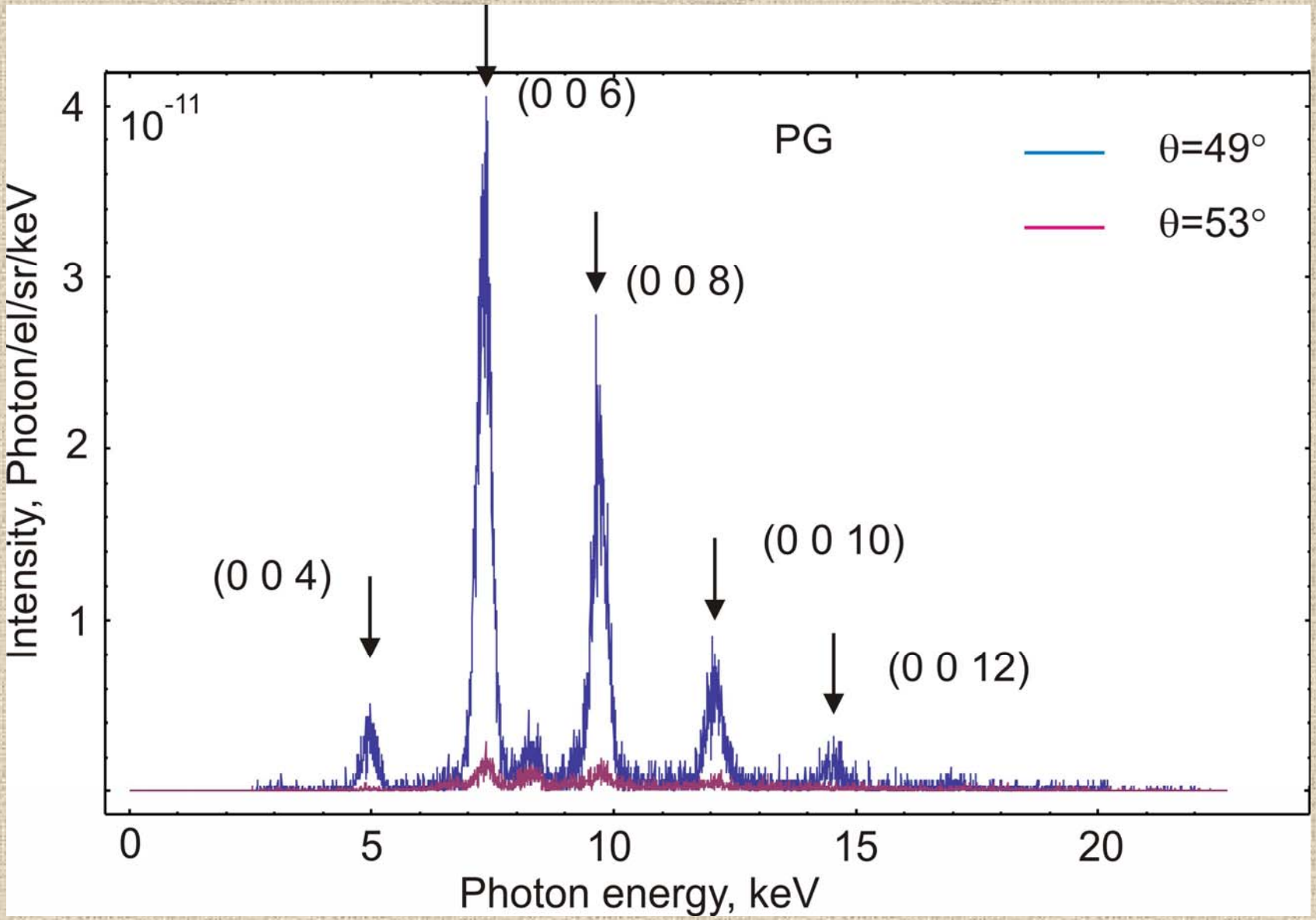

- Application and comparison

Microtron	0,3 mA	Pyrolytic graphite	7,29 keV	$8,5 \cdot 10^{-6}$ *ph / el / sr*
X-ray tube	10 mA		7,9 keV	$1,3 \cdot 10^{-11}$ *ph / el / sr*

The application of such source can be realize in radiography and angiography to improve an image contrast and to reduce a radiation dose obtained by patient.

The one image exposure time during coronary angiography is ~ 1 ms.

Microtron	0,6 μs	Pyrolytic graphite	$1,6 \cdot 10^{10}$ *ph / sr*
X-ray tube	1 ms		$1,5 \cdot 10^{3}$ *ph / sr*

Purposes

• To carry out research to show feasibility of monochromatic X-ray source construction based on compact pulse **betatron**

Performance attributes

The maximum of bremsstrahlung energy	4 – 10	MeV
Frequency	100 – 300	Hz
Dose rate on 1 m distance	1 – 16	cGy/min
Focal point size	0,2 x 2	mm

Advantages

•From comparison one may see the DBS photons' energy while tilting the crystal overlaps approximately one quarter of used in medicine X-ray energies range
(ex.: Ge (333) $\Delta\theta \sim 10° \div 80° \rightarrow \Delta E \sim 33\ \text{keV} \div 5\ \text{keV}$)

•In X-ray imaging using energy of X-ray is vary between 10 and 100 keV (10 – 20 keV in mammography, 40 – 50 keV in thorax radiography, limbs, head, 50 – 70 keV in organography)

•The application of such source in medicine (radiography, mammography, angiography) can be reduce a radiation dose obtained by patient more then two order of magnitude[1]

[1]Potylitsyn A.P., Wagner A.R, et al. //Nuclear Physics Methods and Accelerators in Biology and Medicine-2007, Editors: C. Granja, C. Leroy, I. Stekl, AIP Conference Proceedings, Vol. 958, American Institute of Physics, New York,USA (2007) P. 250

Advantages

- Useful increase of image contrast

(Medical Applications of Synchrotron Radiation. Eds. M. Ando, C. Uyama. Springer – Verlag, 1998)

- Cheapness of method generation in comparison with synchrotron radiation monochromatization or XFEL
- There is possibility of object dynamics observation in order to reveal its functionality

Thank you for your attention!