Observation of Particle Beam Reflection from Bent Atomic Planes

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Participants

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Elastic quasimosaicity (Sumbaev) effect

- Studied by Sumbaev in 1957
- Resulted in broadening of gamma-ray diffraction peaks from bent quartz plates
- Caused by bending of the reflecting atomic planes (initially flat and normal to large faces of plate) due to crystal anisotropy
- Depends on choice of crystallographic plane and orientation angle of plate cutting relative to a normal to the chosen crystallographic plane

ЖЭТФ, 1957, 32, № 6, 1276-1279.

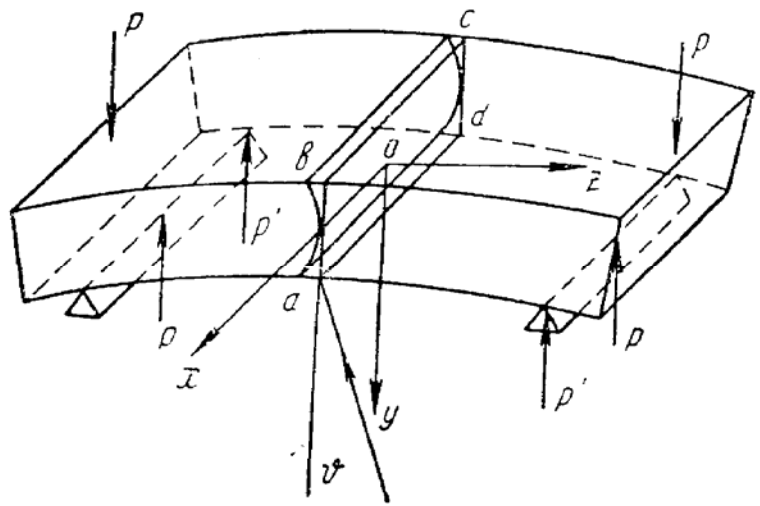


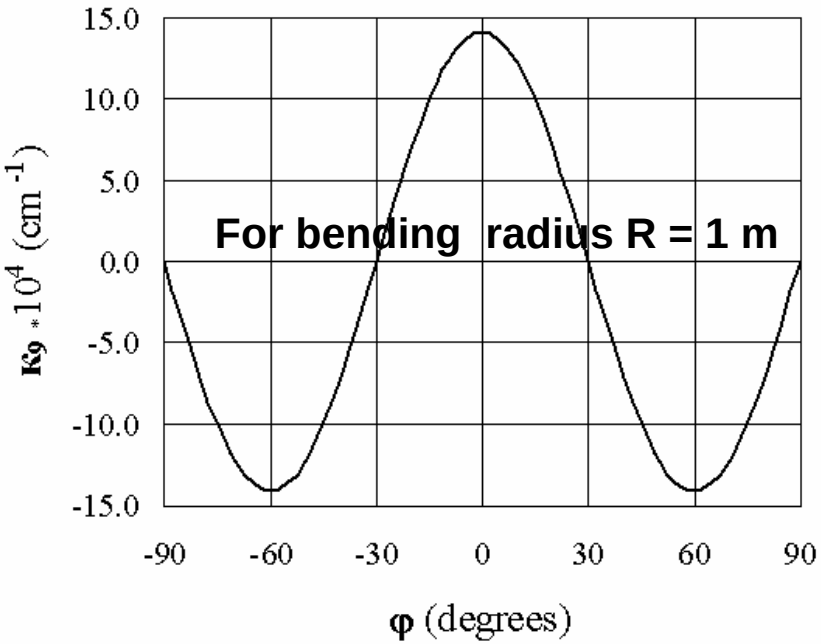
Figure from article: O.I.Sumbaev, Reflection of gamma-rays from bent quartz plates, Sov. JETP 32(1957)1276

Bending in dependence on cut angle φ for Si (111) plane

$\Delta\theta = 2k_9 T$, where

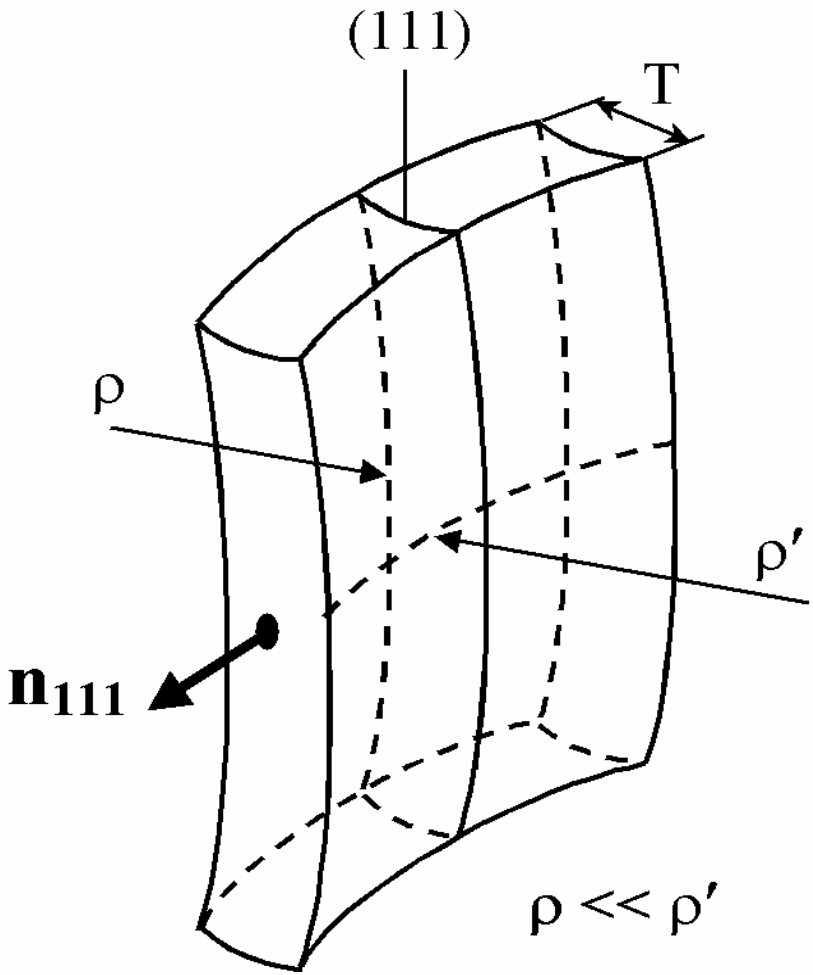
T – thickness of plate

k_9 – deformation coefficient



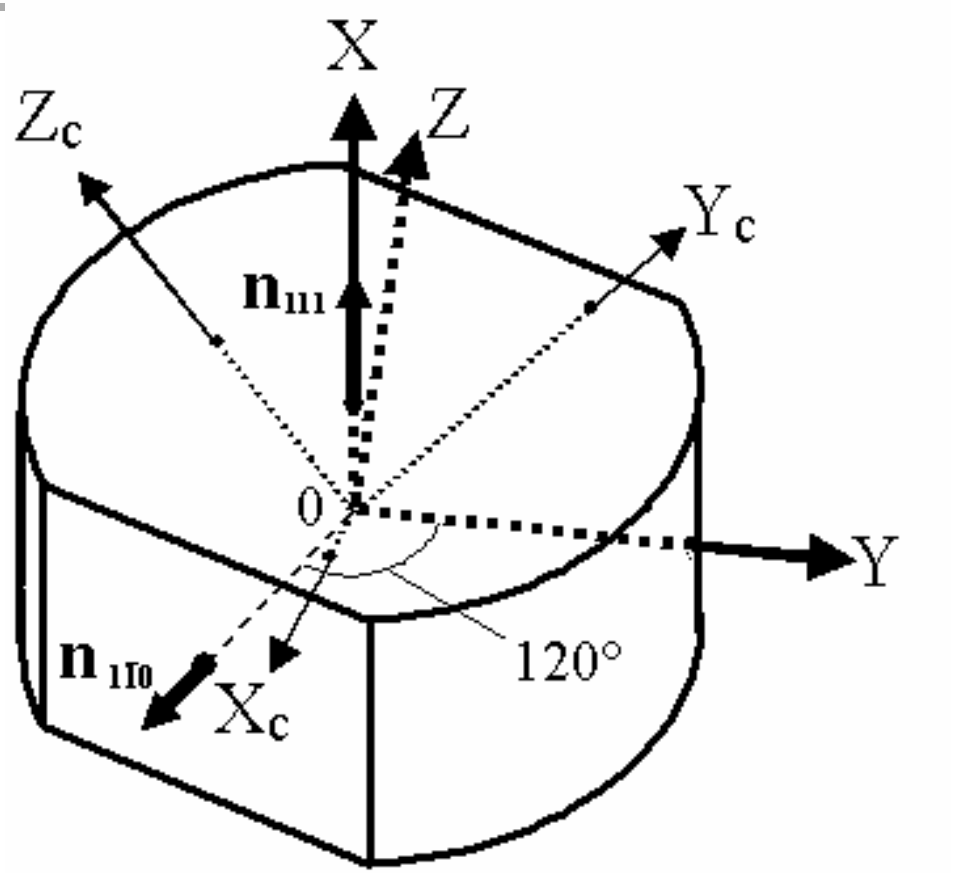
(relationship from:
V.M.Samsonov and E.G.Lapin, Preprint LIYaF-578, 1980)

Crystal design

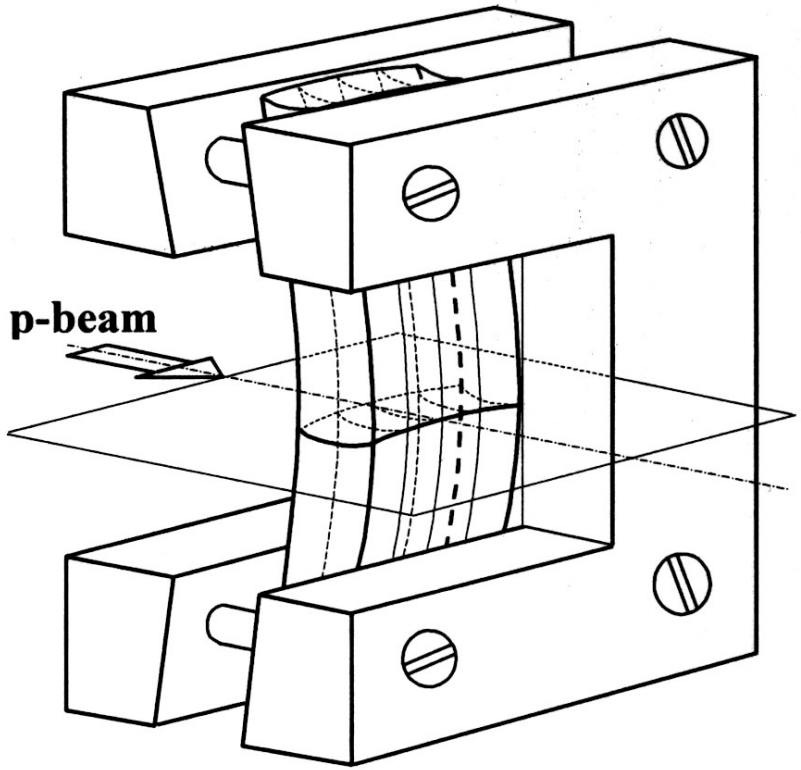


Cut $\varphi = 0°$ for Si(111) planes

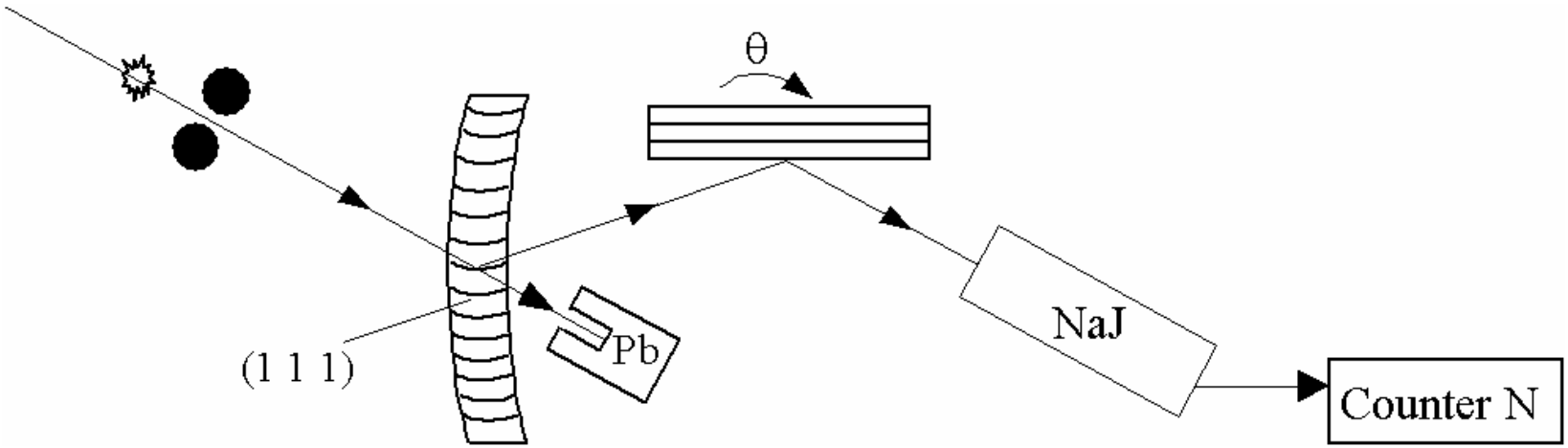
Yu.M.Ivanov, A.A.Petrunin, and V.V.Skorobogatov, JETP Lett. 81(2005)99



Bending device

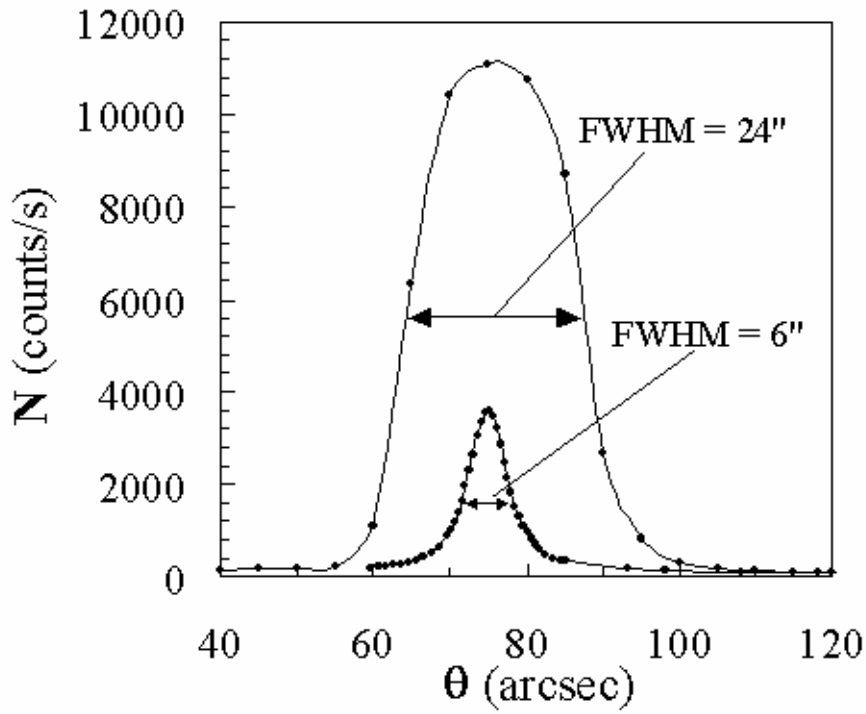


Crystal rocking curve measurement with X-rays



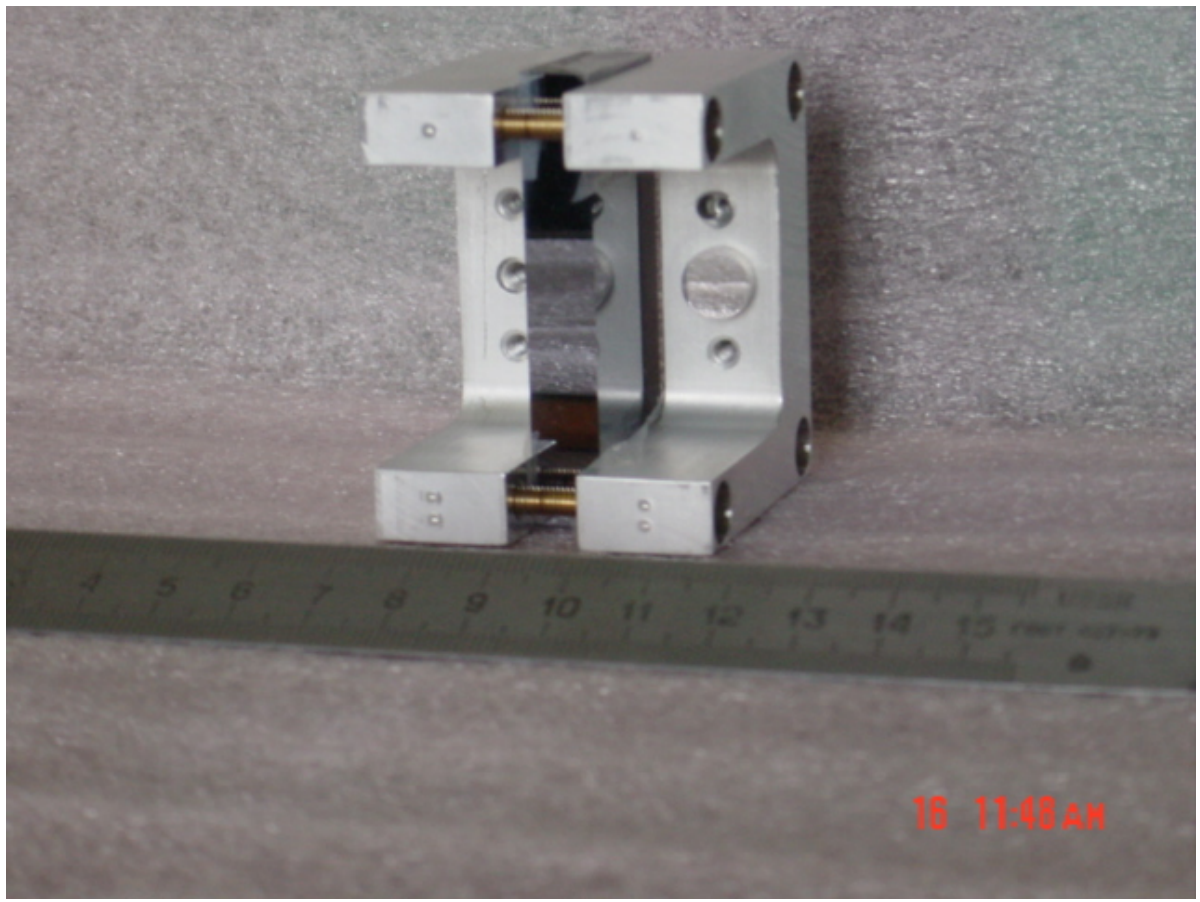
Experimental result with X-rays

Rocking curves for plate with cut angle $\varphi = 0°$ before and after bending.



Samples 0.3 mm and 2.7 mm with ~0.4 mrad bending angle

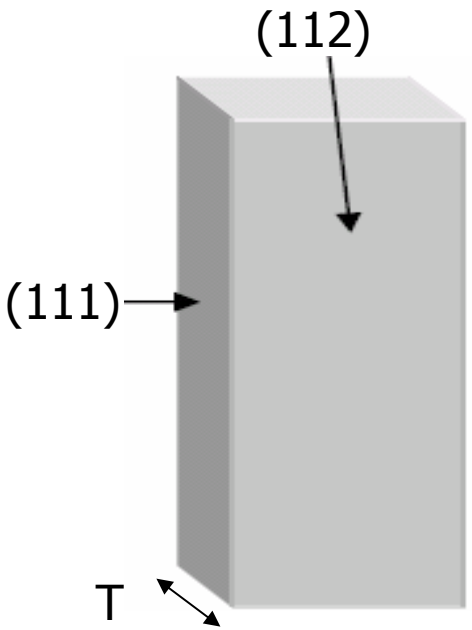
Sample 10 mm with ~100 μrad bending angle

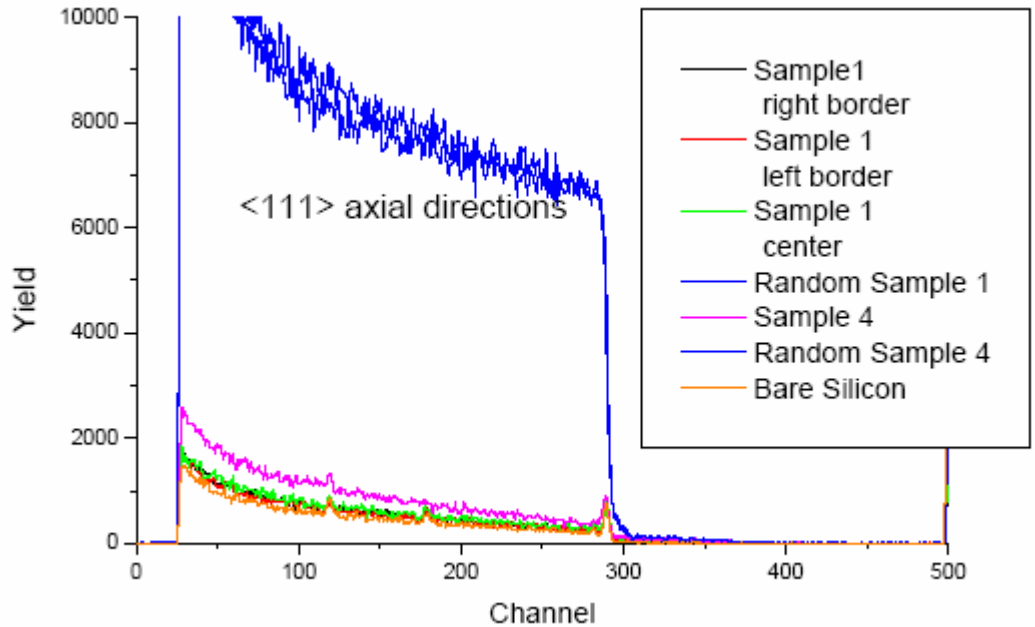


RBS measurements at LNL (A.Vomiero, V.Guidi)

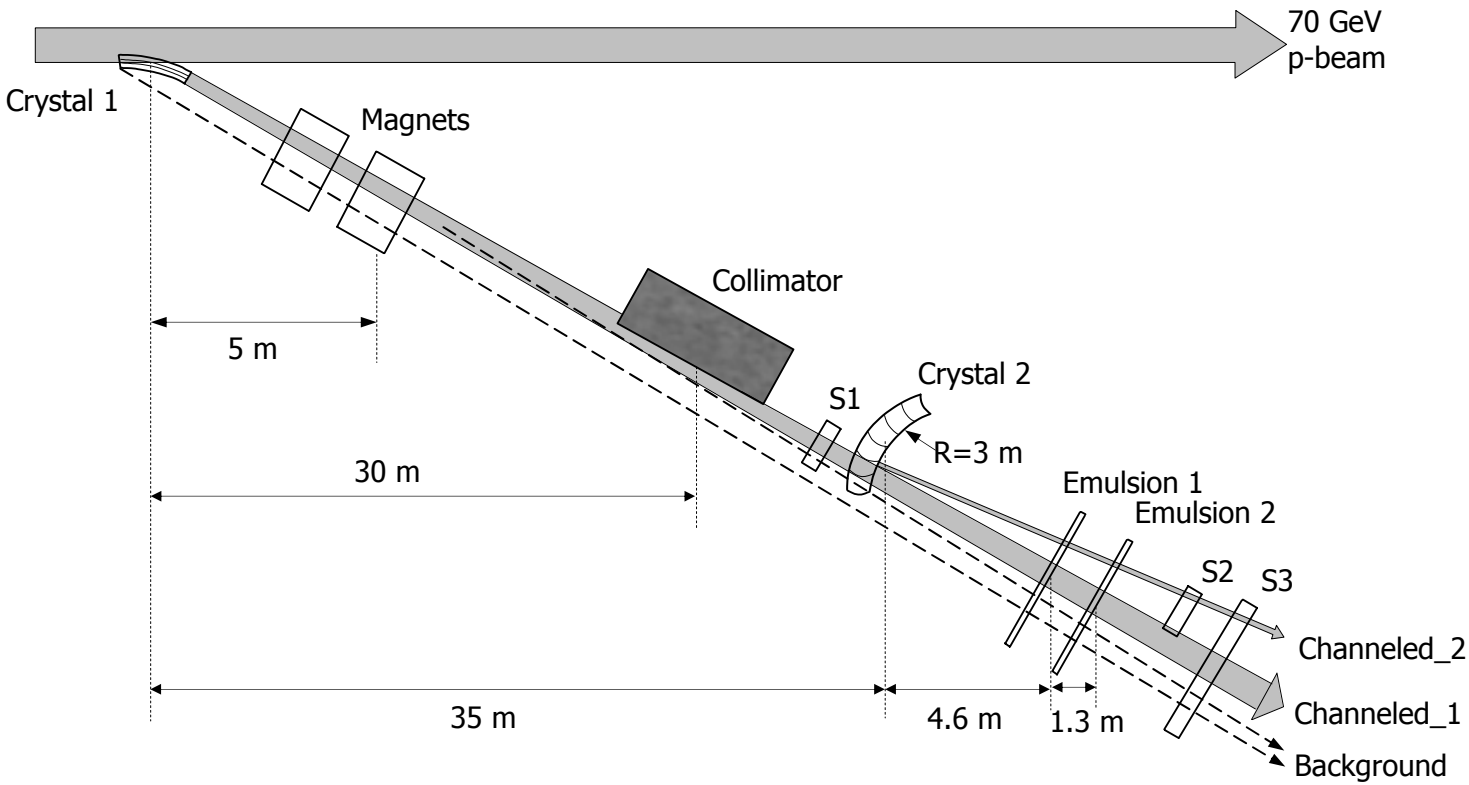
Sample 1 - T ≈ 3 mm

Sample 4 - T ≈ 0.5 mm



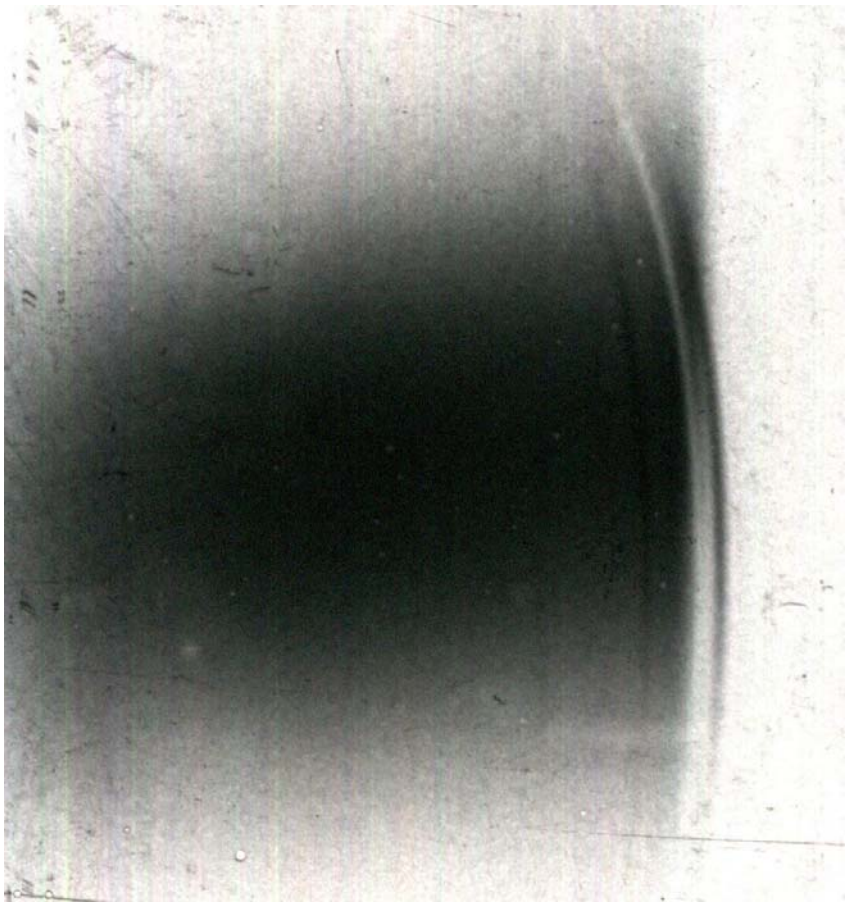


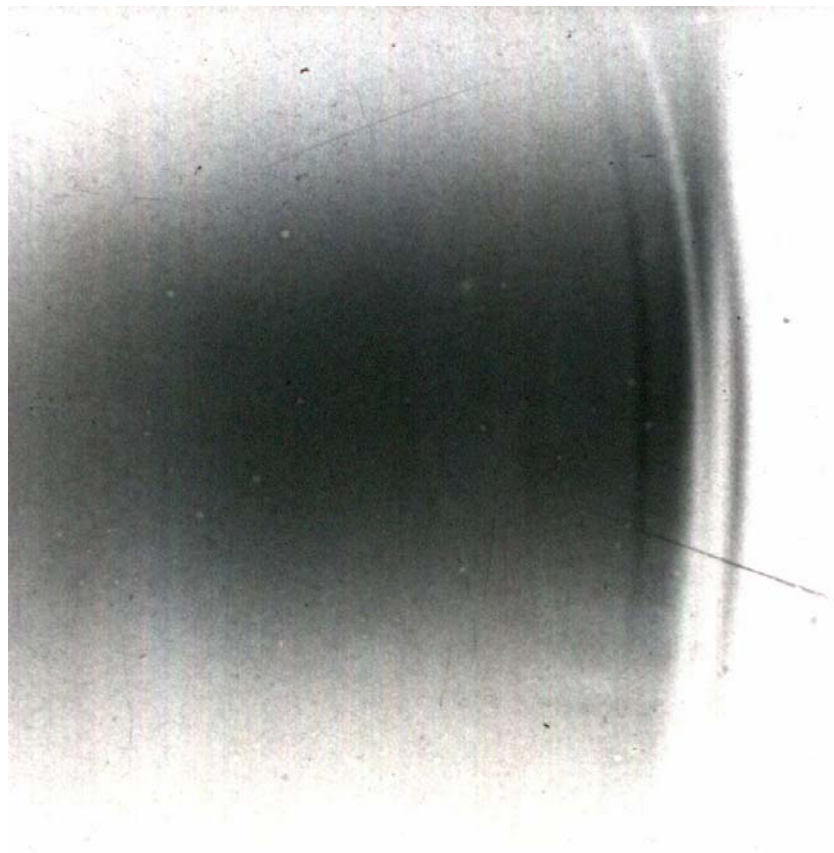
Scheme of experiment with 70 GeV protons



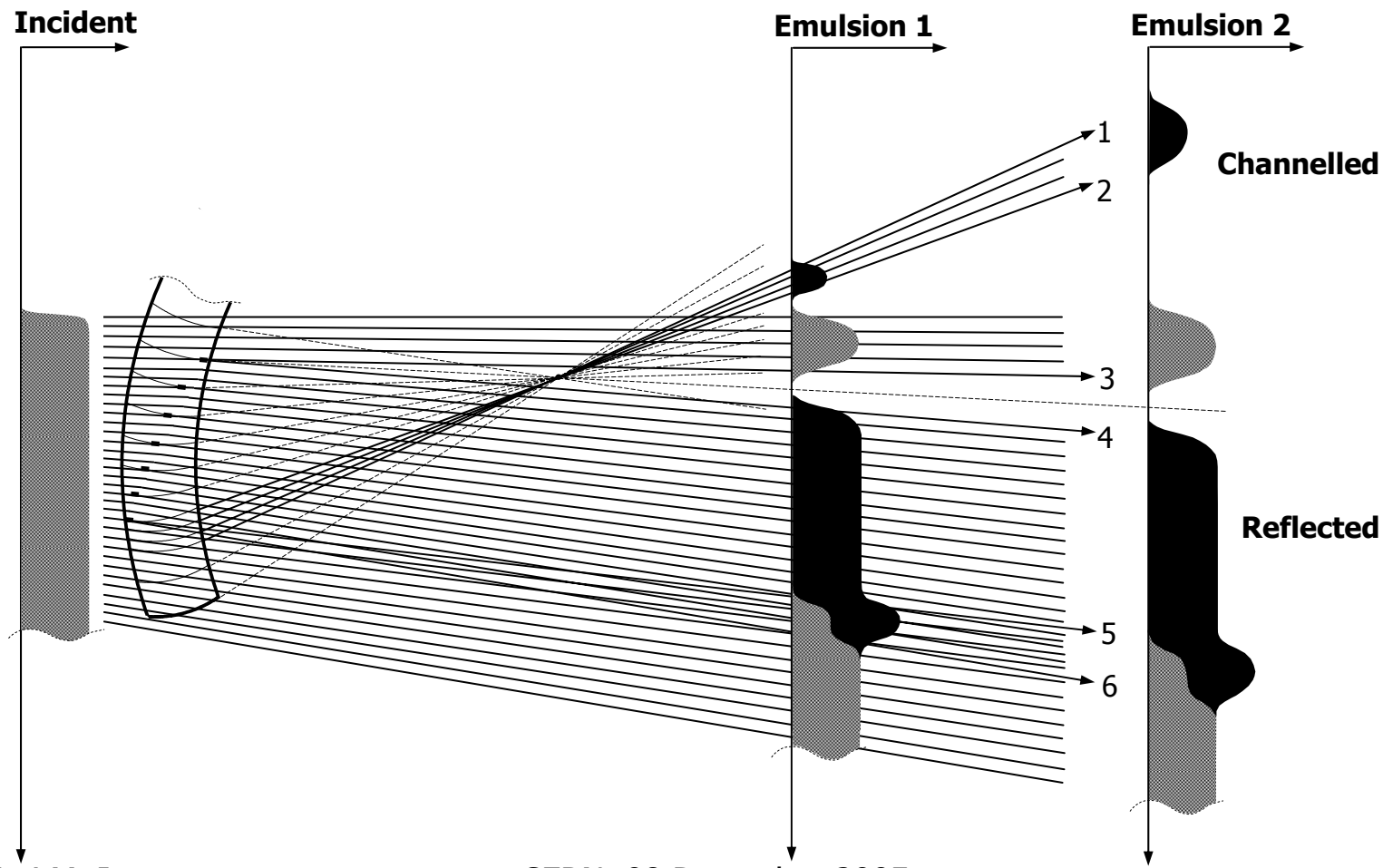
Some details of experimental setup

Emulsions 1 and 2





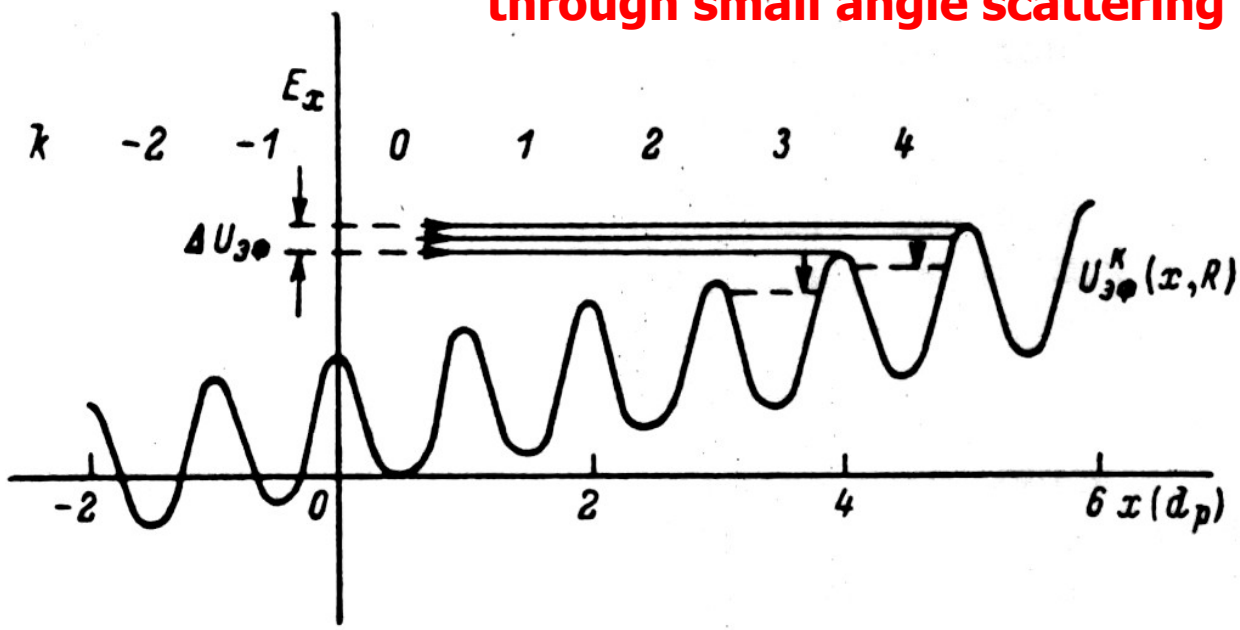
Interpretation



A.Taratin and S.Vorobiev, 1985

Explanation of volume capture through small angle scattering

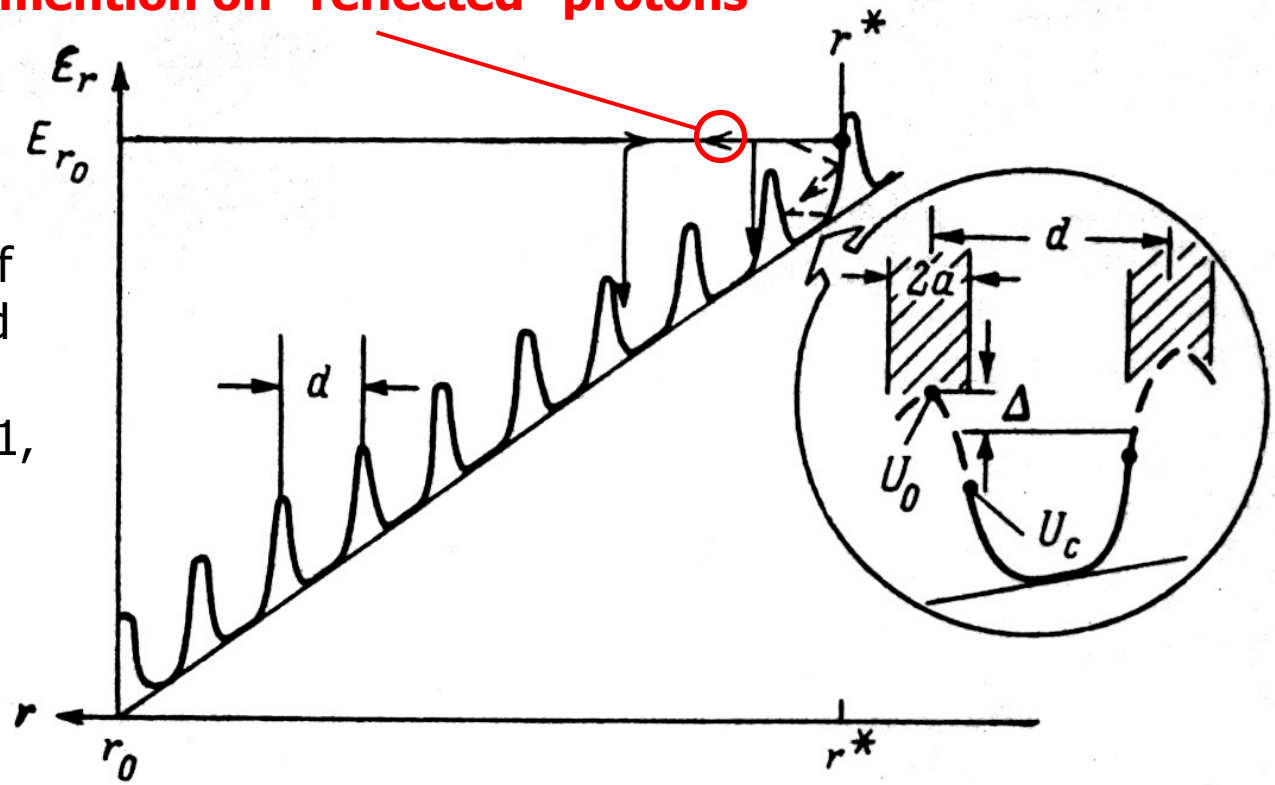
A.M.Taratin and S.A.Vorobiev, Sov. Jourlnal of Technical Physics, v.55, p.1598, 1985 (in Russian)



O.Sumbaev, 1986

Probably, first mention on "reflected" protons

O.I.Sumbaev, The theory of volume capture by a curved crystal in the channeling regime, Preprint LIYaF-1201, 1986 (in Russian)



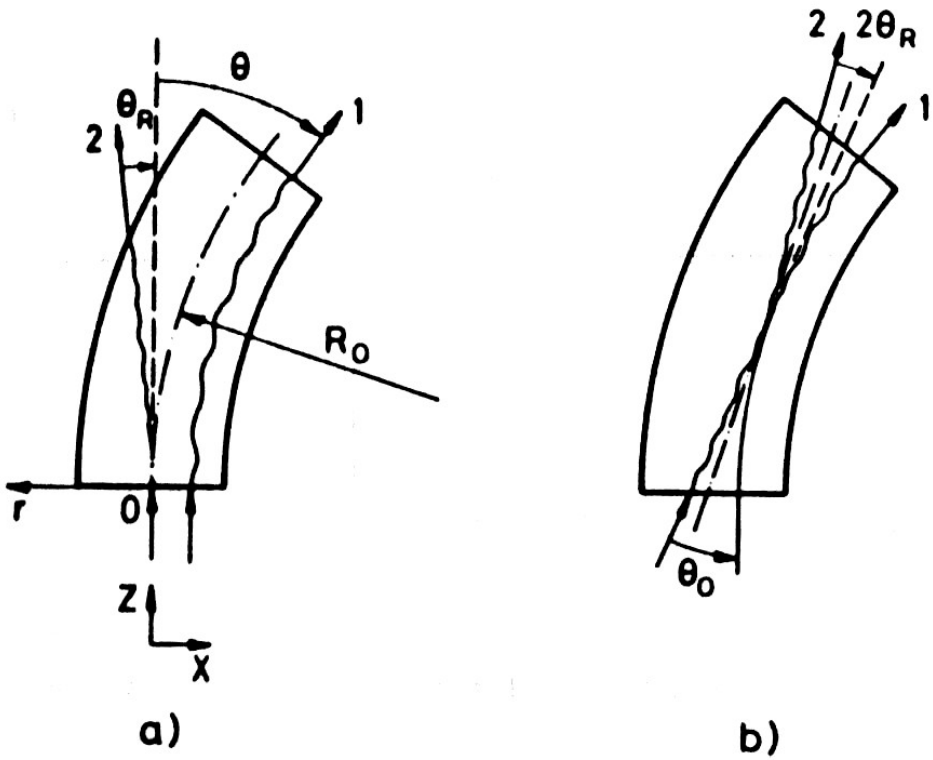
A.Taratin and S.Vorobiev, 1987

Prediction of deflection for reflected particles

A.M.Taratin and S.A.Vorobiev, Phys.Lett. A119 (1987) 425

and

A.M.Taratin and S.A.Vorobiev, NIM in PR B26 (1987) 512



Channeling and reflection in bent crystal