On the possibility studies of the parity violation in neutron diffraction.

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Motivation

- No experimental studies of parity violation in neutron scattering.
- **The effects of parity violation in neutron diffraction may be enhanced .**
- **D.F. Zaretsky, V.K. Sirotkin (Jad.Phys., v.40, p.1256, 1984)**
- V.G. Baryshevsky, S.V. Tcherepitsa (Journal of the Belarusian Univ., Ser.1 (1), p.3, 1986)
- V.G. Baryshevsky (Yad.Phys**.**, v.58, p.1558,1995; J. Phys. G: Nucl. Part. Phys. **23,** p. 509 (1997)
- Moreover, in the work of Petukhov, without dynamical diffraction produced the opposite result (Physica B **267-268** (1999) 294

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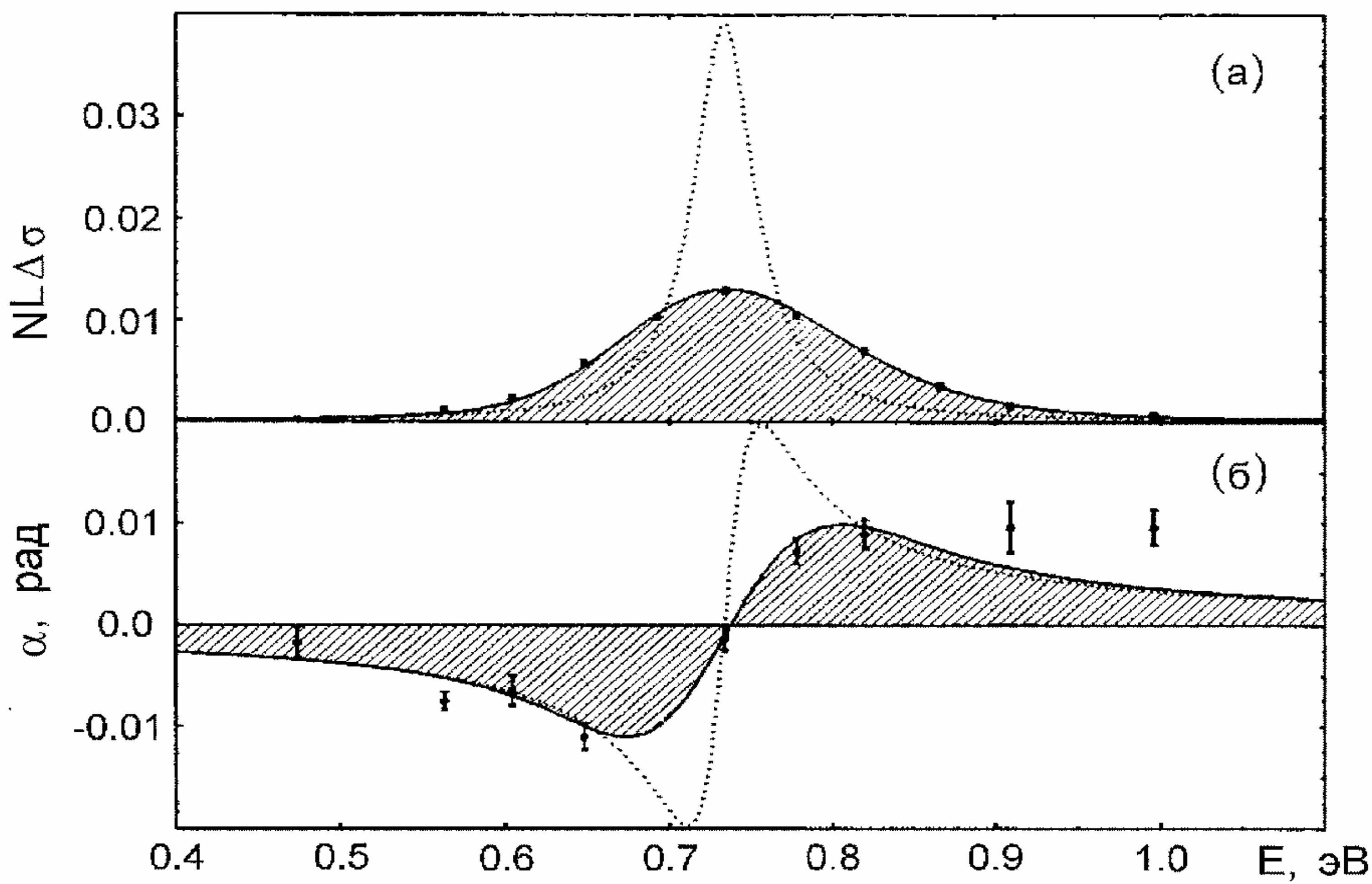
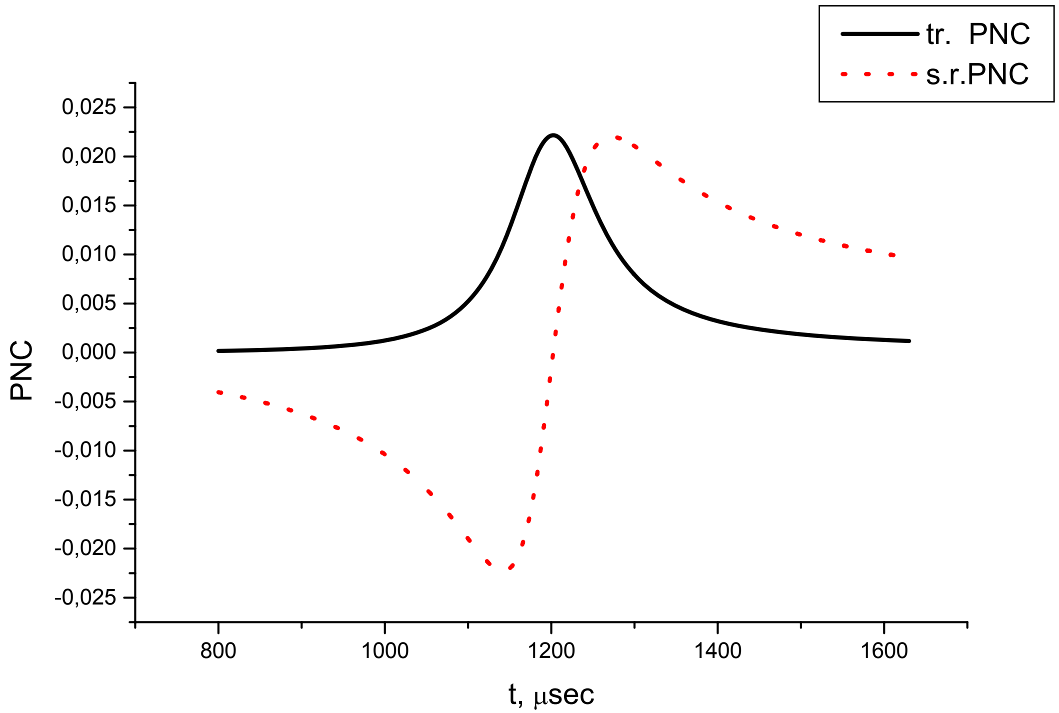
ЭФФЕКТ ПРЕЦЕССИИ СПИНА НЕЙТРОНА ВБЛИЗИ *p*-ВОЛНОВОГО РЕЗОНАНСА ^{139}La

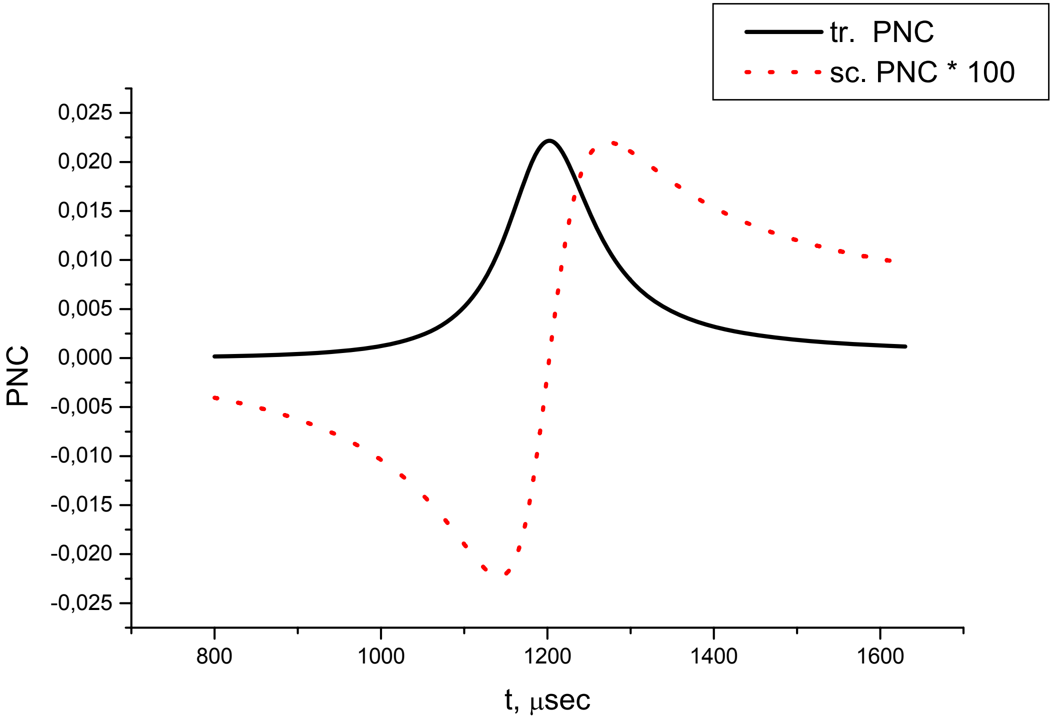
А.П.Серебров, А.К.Петухов, Г.В.Вальский, Г.А.Петров, Ю.С.Плева



Dichroism and spin rotation



The PV dichroism and the PV asymmetry of neutron scattering.



The amplitude of the weak neutron-nuclear interaction

- The neutron scattering amplitude

$$f = f_0 + f_{ss} + f_{pp} + f_{sp}$$

- The amplitude of the f_w, can be represented as:

$$f_{sp} = f_w = f_{PV}\ \mathbf{s}\,(\mathbf{p} + \mathbf{p}') + f_{(PT)\,V}\ \mathbf{s}\,(\mathbf{p} - \mathbf{p}')$$

(here f_{PV}, $f_{(PT)\,V}$ - amplitude of the weak neutron-nuclear interaction with the parity violation and with the parity violation and time reversal, respectively, **s** - spin of the neutron, **p** and **p'** - the unit vectors corresponding to the direction of the momentum of the incident and scattered neutrons.

The amplitude of the f_{sp} depends on k (or the neutron energy) and has the form:

$$f_{sp}(k) = Þ \cdot \sigma_p(E) \cdot (E - E_p)/((E - E_s)\ \Gamma p) \cdot k/4\pi$$

There Þ - the magnitude of the P-odd transmission asymmetry in the p-resonance,

$\sigma_p(E)$ - p-resonance cross section,

E - energy of incident neutrons,

Symmetrically Laue neutron dynamical diffraction

- D.F. Zaretsky, V.K. Sirotkin shown:
- For thermal neutron a crystal enhancement PV-effect is 4,5 times only (the magnitude of the P-odd effect ~ $4{,}5 \cdot 10^{-5}$)
- It is sense to use the integral intensity of the reflected neutrons

- $J_n = \int \sin^2[(\pi t/\Delta)(1+y^2)^{0,5}]/(1+y^2)dy$ (1)

$(y - y_B) \sim 2(\theta - \theta_B)\sin(2\theta_B)10^5$

$y = 1$ is about 10^{-5} radian

t – crystal thickness in cm

Δ – the extinction length

The integral intensity of the reflected neutrons is (approximate formula)

$J_n = (\pi/2)\cdot(1+ (0,8\cos(T + \pi/4))/(T^{0,5}))$ (2)

$f_{ch} = f_{ch0}\,(1 \pm f_w / f_{ch0})$ - the scattering amplitude

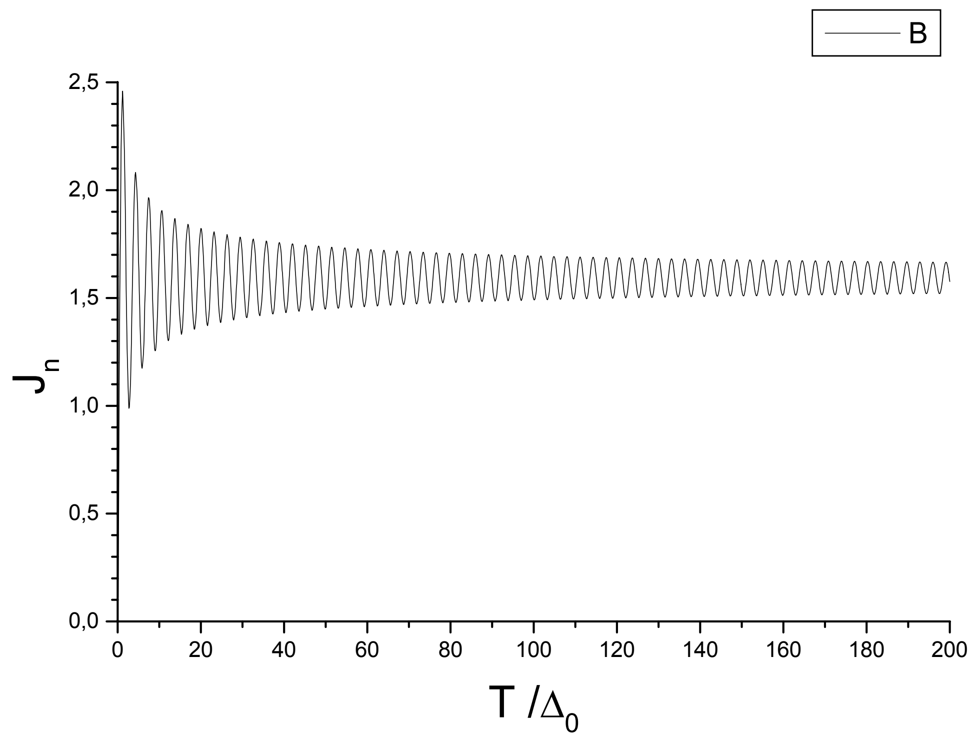
$T = 2B\cdot t\cdot|f_{ch}|\cdot tg(\theta)$ - reduced thickness

$B = 2d_{hkl}N_cF_{hkl}$

$f_{sp} = f_w \sim 10^{-4} - 10^{-5}$.

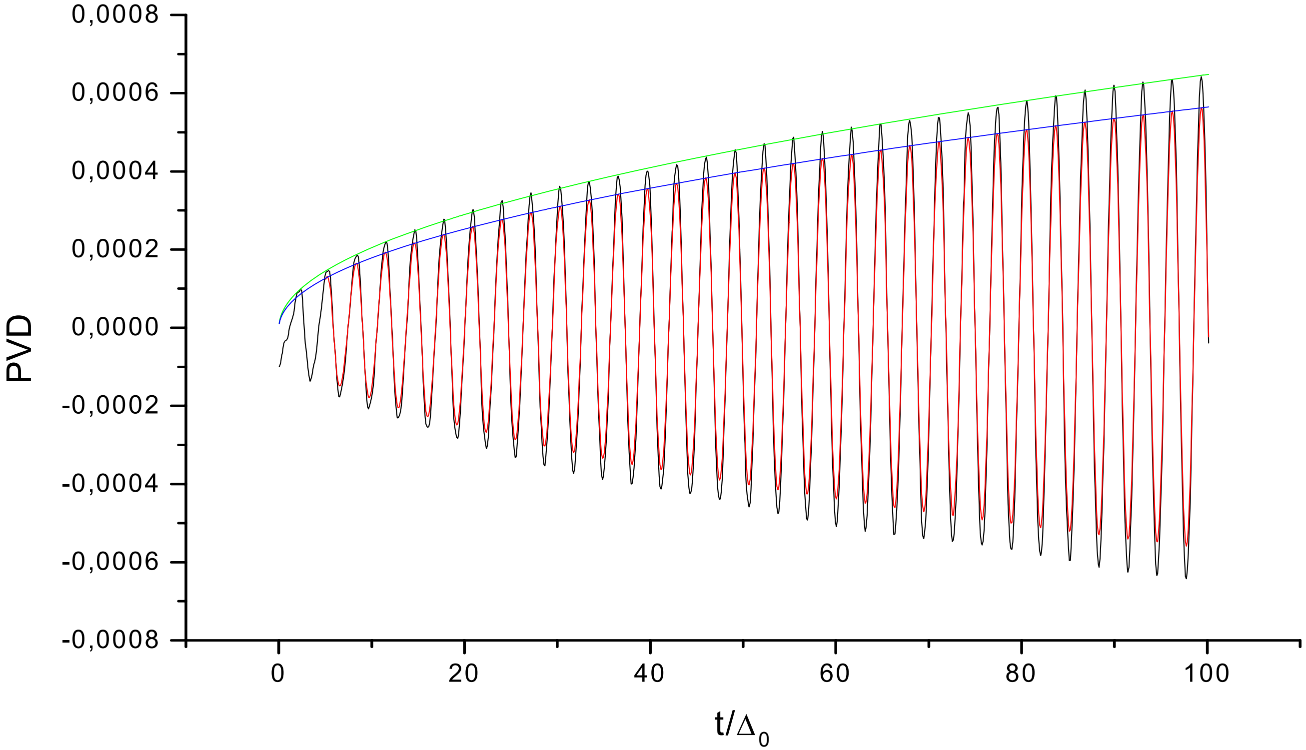
- The length of the extinction is of the form:
- $\Delta_0=\pi\cdot v_c\cdot \cos(\theta)/(\lambda_n\cdot|f(k)|\cdot F_{200}\cdot e^{-2W})$
  Here v_c - unit-cell volume, F_{200} - a geometrical structure factor of neutron reflection from the plane (200) single crystal KBr, e^{-2W} - Debye-Waller factor assumed to be 1, actually it is equal to 0,955. The amplitude f (k) takes into account the violation of spatial parity.
- The divergence of the neutron beam $J(\theta_n) = J_0\cdot \exp(-((\theta_n-\theta)/\Delta\theta_n)^2)$
- **$P_{PVD} = \int(R^+ \cdot J^+ - R^- \cdot J^-)d\theta \,/\, \int(J^+ + J^-)d\theta$**

Pendellosung in the reflected neutron beam.



The results of calculation of parity violation in neutron diffraction (PVD) by numerical integration - black curve, $PVD=(J^{+} - J^{-})/2J$ ($J_n = \int \sin^2[(\pi t/\Delta)(1+y^2)^{0,5}]/(1+y^2)dy$) and using ($J_n = (\pi/2)\cdot(1+ (0,8 \cos(T + \pi/4))/(T^{0,5}))$) red curve.

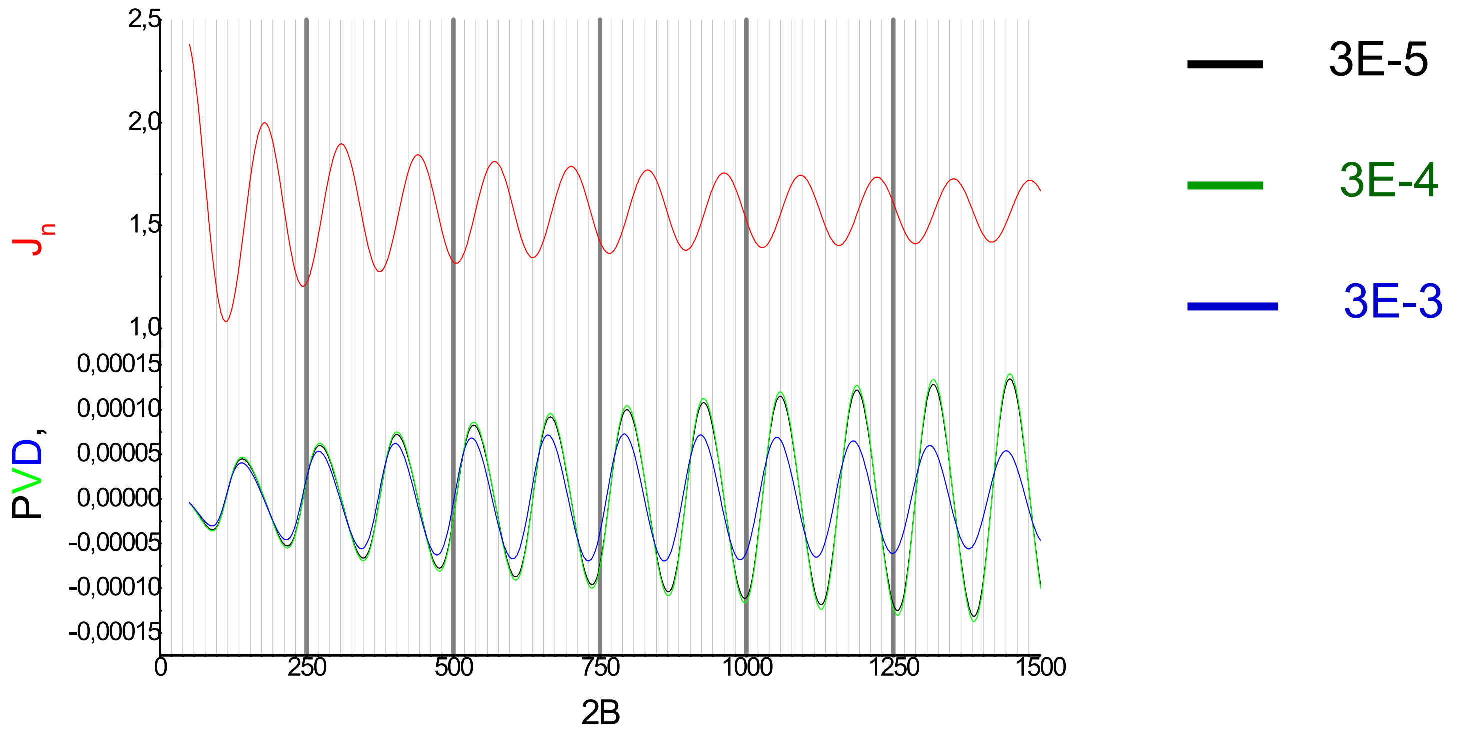
Our result in π times less than in the work /1/.



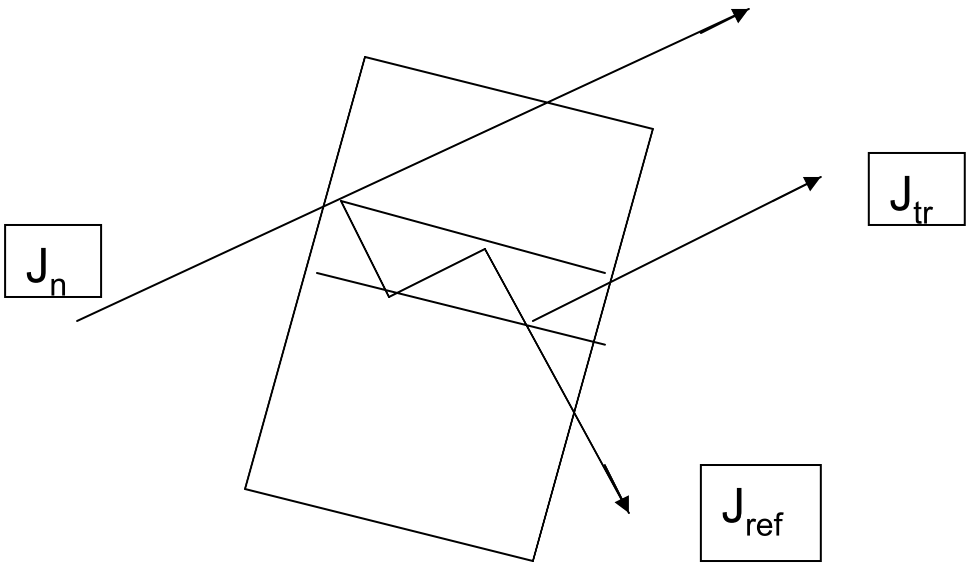
Pendellosung of the reflected neutron beam and PVD depending on the neutron beam divergence.

It is seen that the gain does not increase.

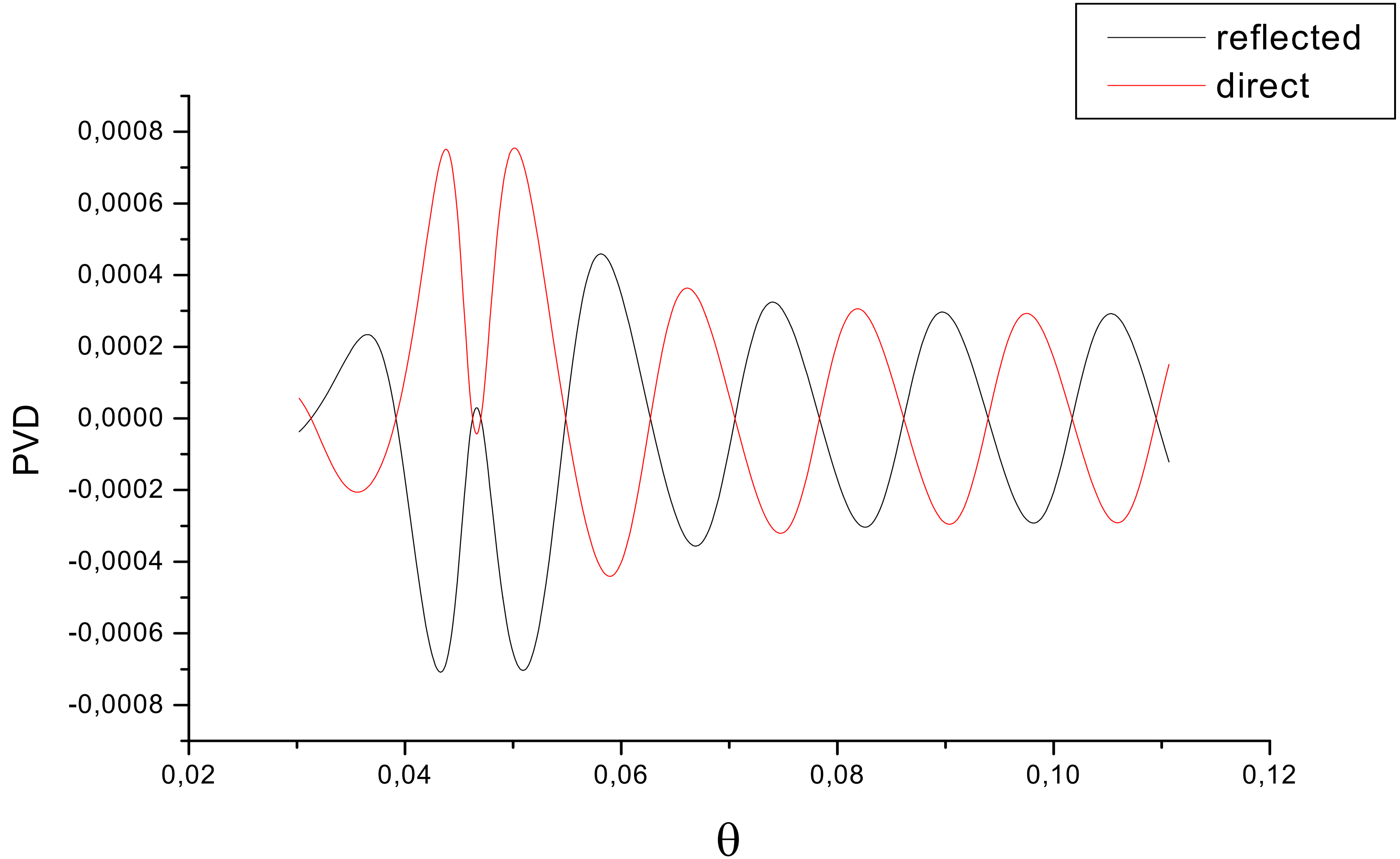
The enhancement is π.



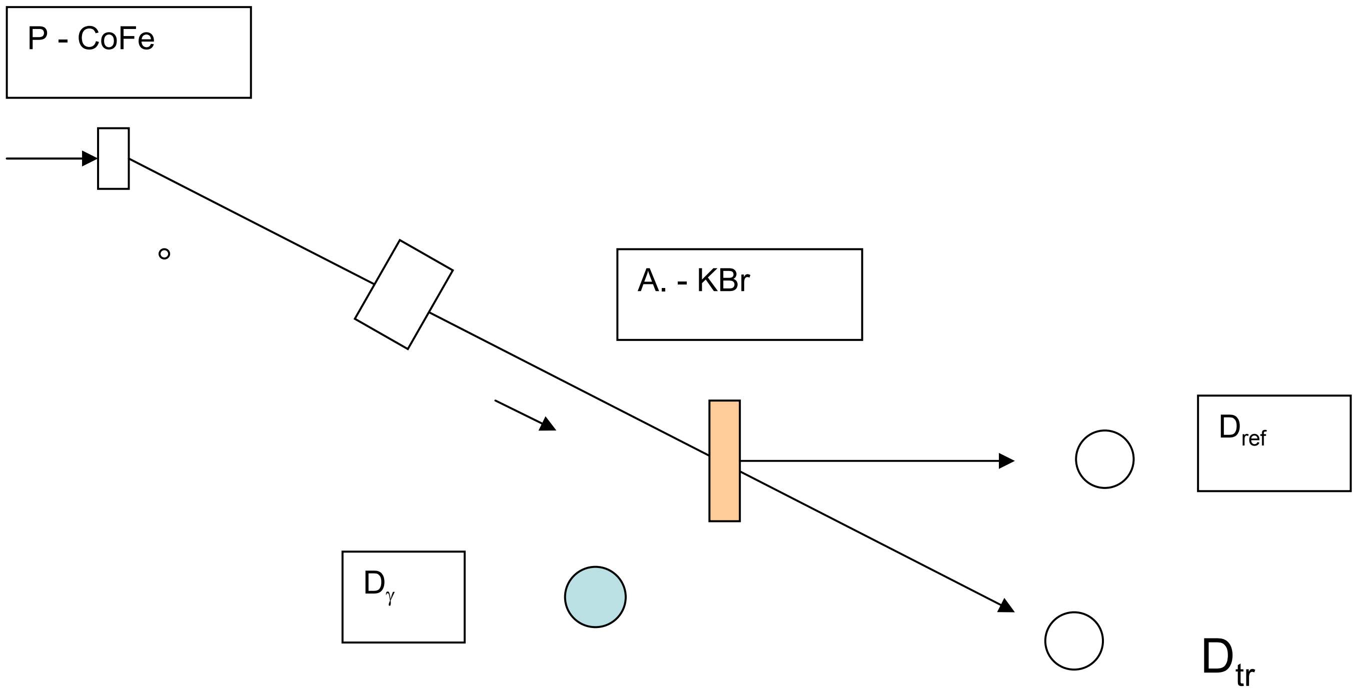
Neutron diffraction on a single crystal.



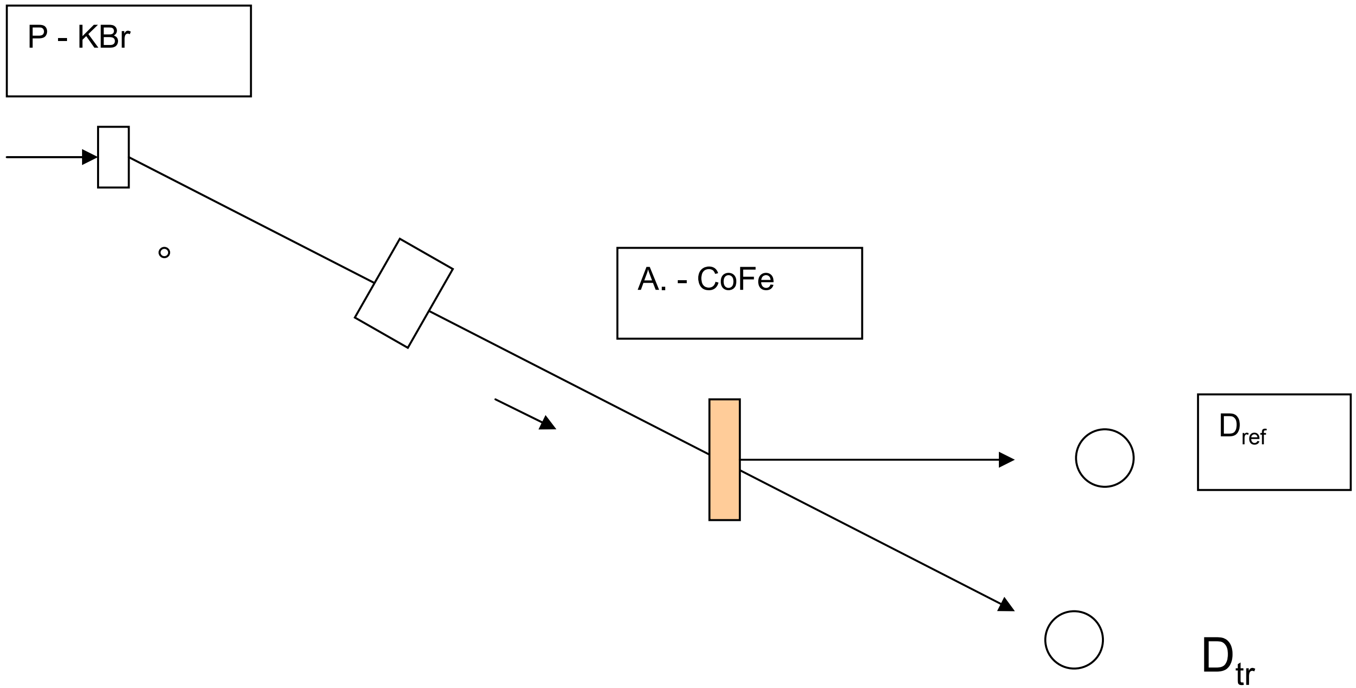
PVD in reflected and transmitted beam. For $\Delta\theta < 10^{-5}$ and f_w=2E-5.



PVD set up 1.



PVD set up 2.



Boundary conditions

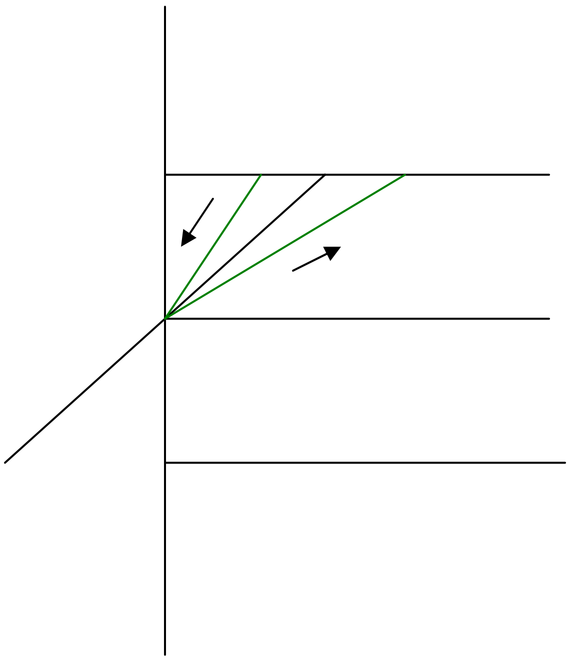
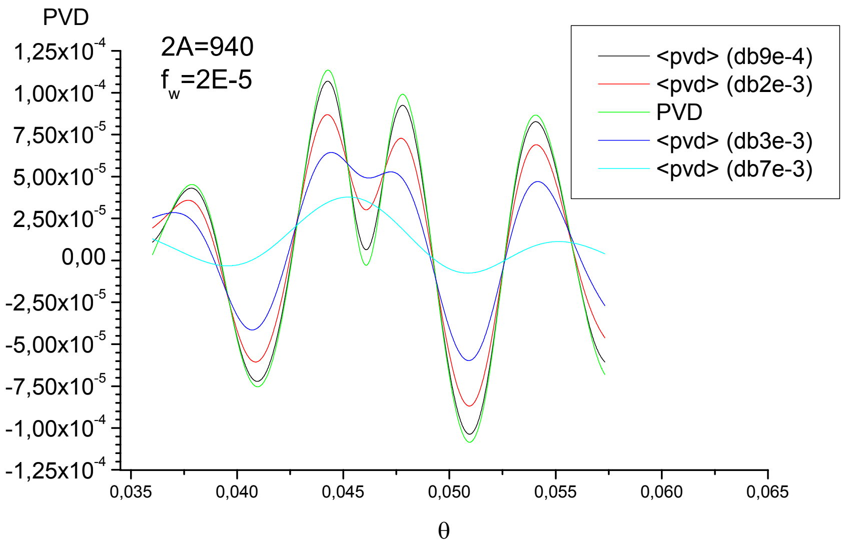
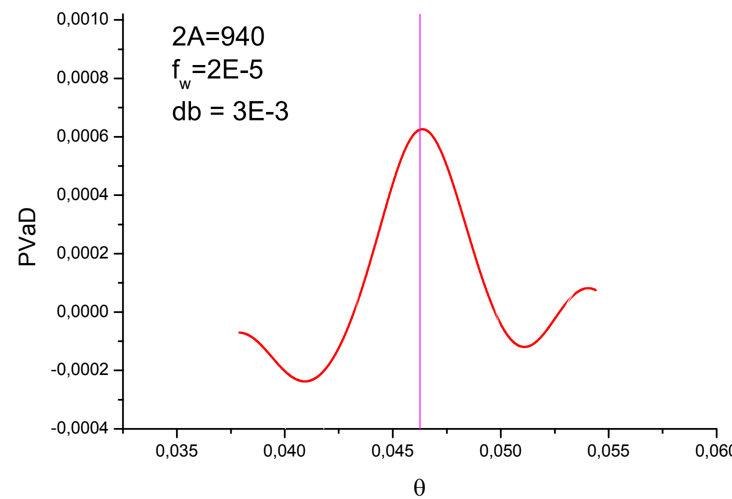
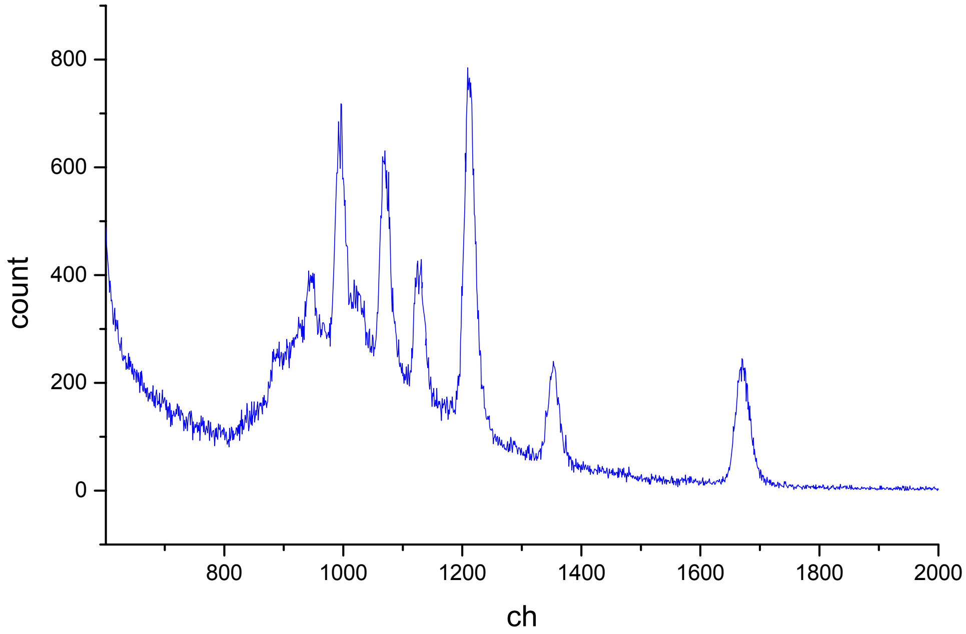


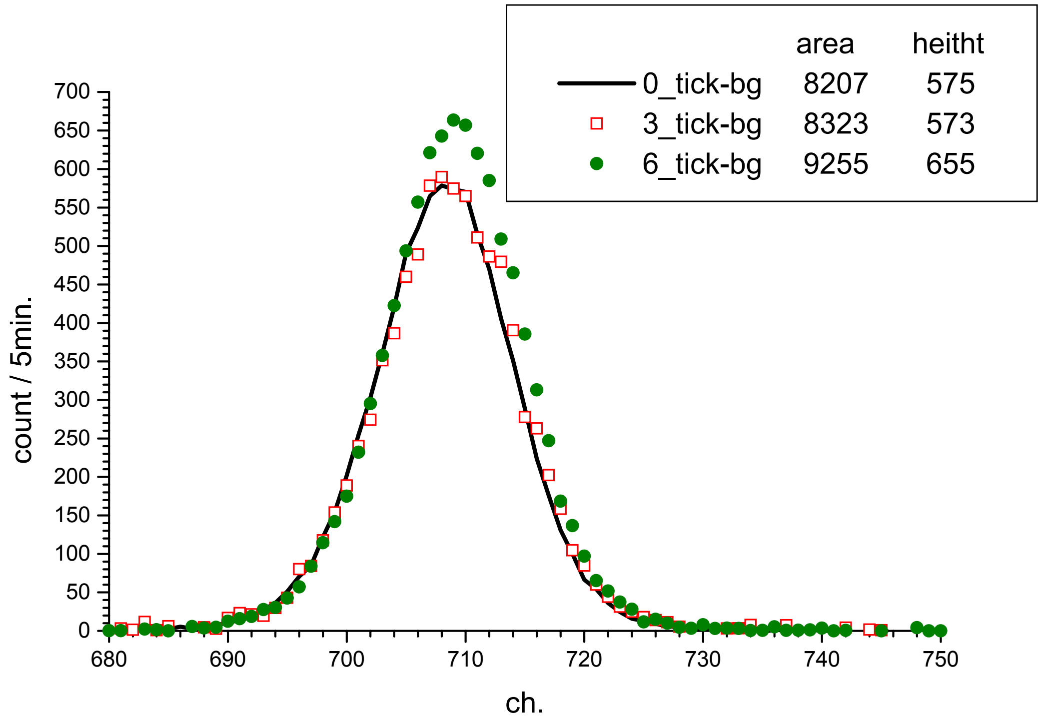
Fig. to the left, the boundary conditions are not considered.
Fig. to the right , the boundary conditions are taken into account.





Diffraction on a polycrystal (iron)





area heitht
0_tick-bg 8207 575
3_tick-bg 8323 573
6_tick-bg 9255 655
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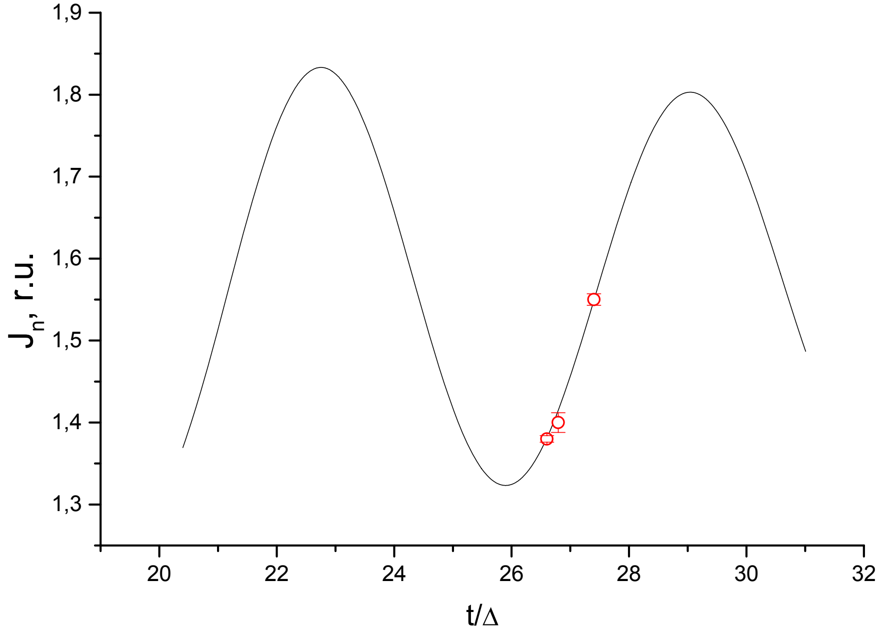
May be the Pendelosung?



Thank you for attention !

$R^{\pm} = \pi/2\{1–0,798\cos(2B\cdot tg(\theta)+\pi/4)/(2B\cdot tg(\theta))^{0,5}\}$

θ – Bragg angle, $B = 2\cdot d_{200}\cdot N_c\cdot t\cdot|f(k)|\cdot F_{200}\cdot e^{-2W}$,

$2\cdot d_{200} = 6{,}59$ Å,

$N_c = 3{,}478\cdot 10^{21}$ – namber of cells in 1 cm^3,

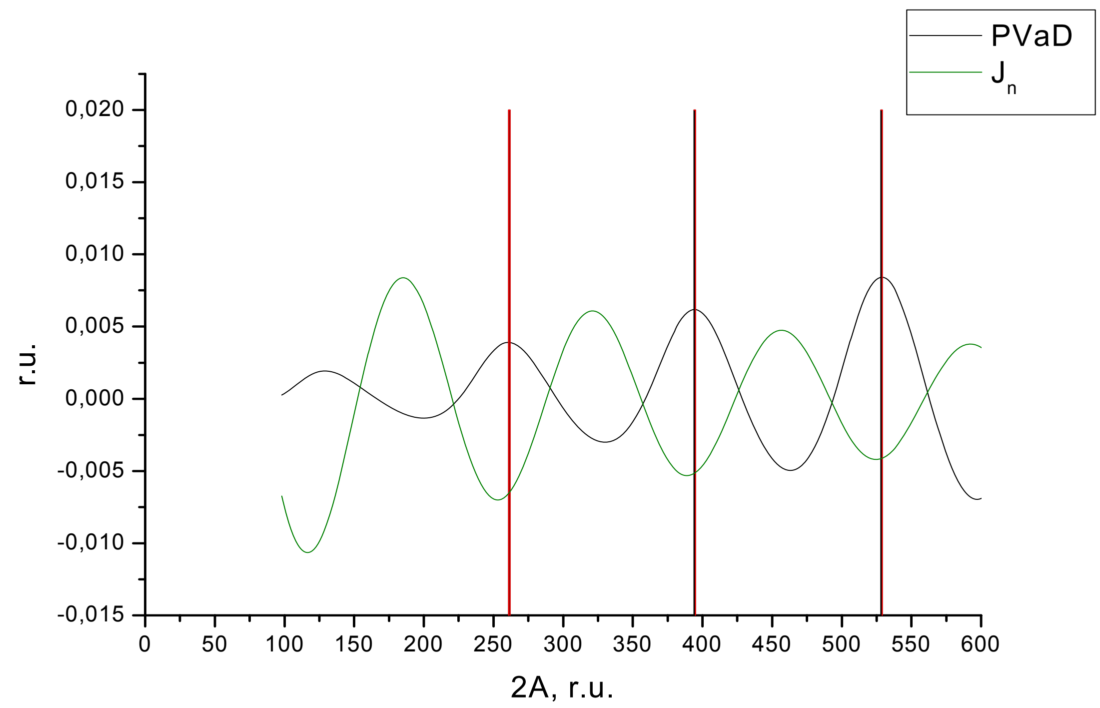
t – thick single crystal.

angular divergence of the neutron beam :

$J(\theta_n) = J_0\cdot\exp(-((\theta_n-\theta)/D\theta_n)^2)$

Polarization:

$P_{PVD} = \int(R^+\cdot J^+ - R^-\cdot J^-)d\theta \;/\; \int(J^+ + J^-)d\theta$


PVaD
J n
0,020
0,015
0,010
0,005
0,000
-0,005
-0,010
-0,015
r.u.
0
50
100
150
200
250
300
350
400
450
500
550
600
2A, r.u.

Maximum spatial parity violation in neutron scattering is at a neutron energy

$$E_n = E_p + \Gamma/2$$

equal to