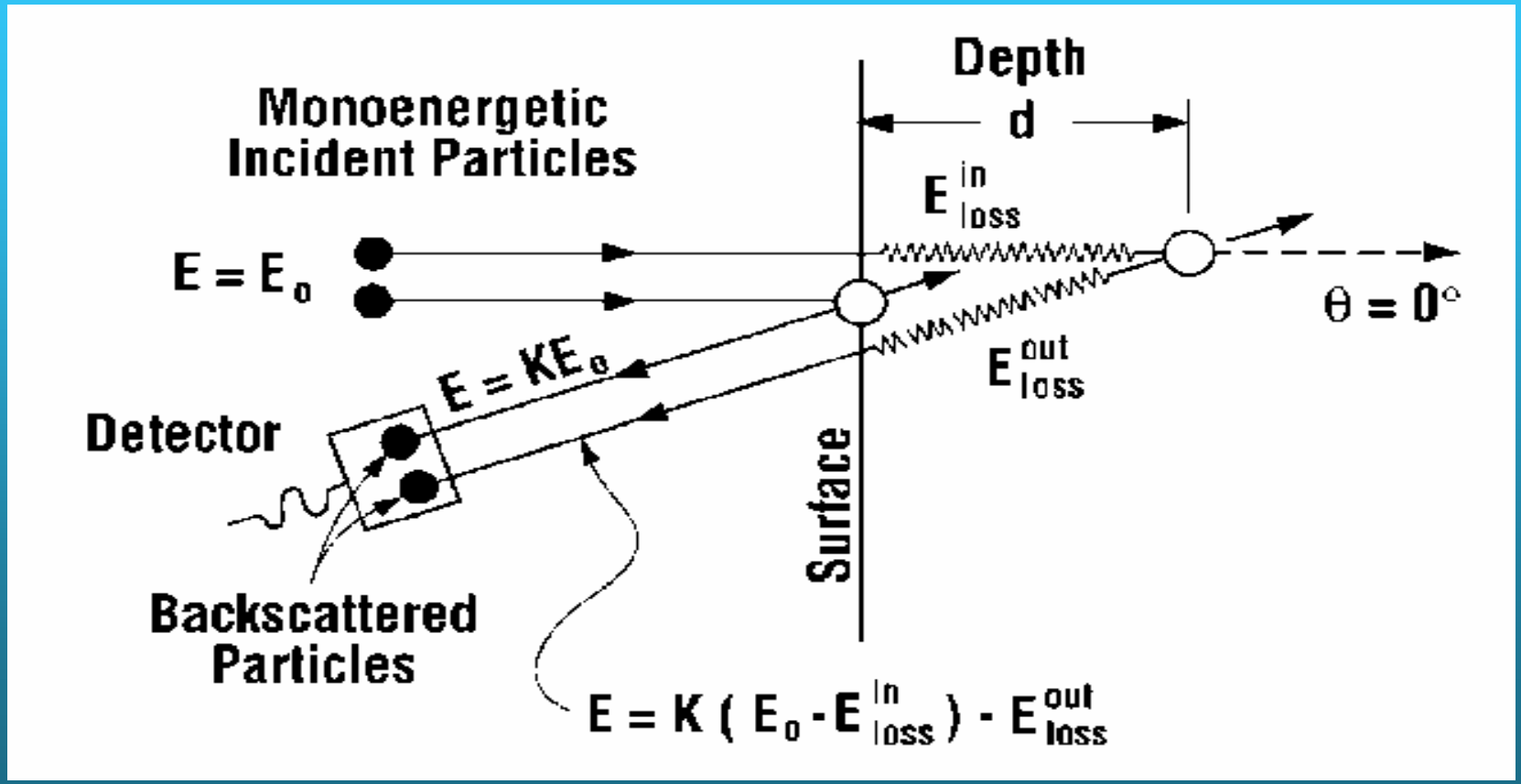

Various beams for RBS at IFIN-HH

Various beams for RBS at IFIN-HH

OVERWIEW RBS

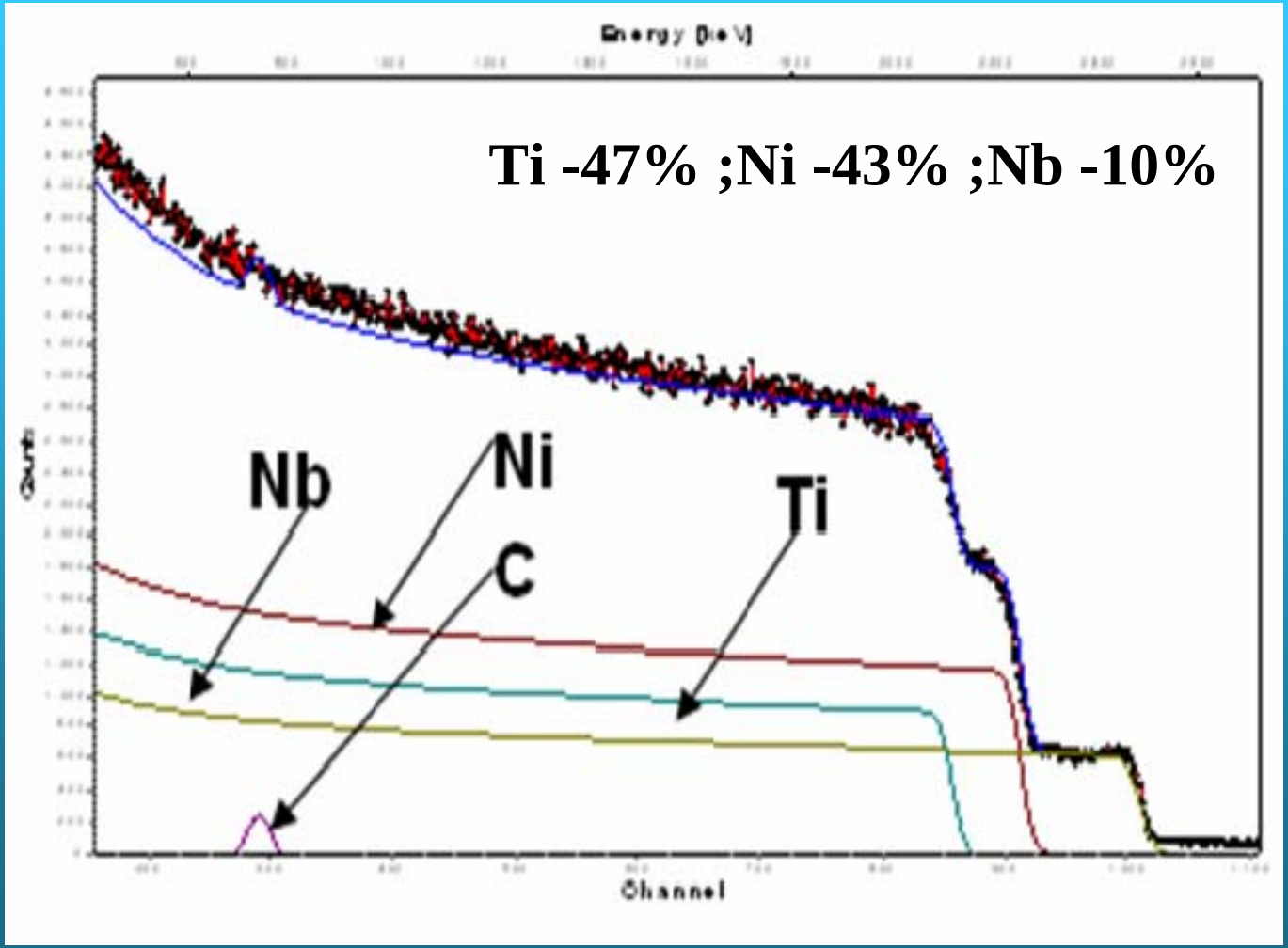
- **E_{sc}: function of K and dE/dx (mass and depth of target nucleus);**
- **Measured spectrum is the sum for all contribution of constitutive elements;**



Various beams for RBS at IFIN-HH

Specific Analysis Performed

COMPOSITION ANALYSIS:



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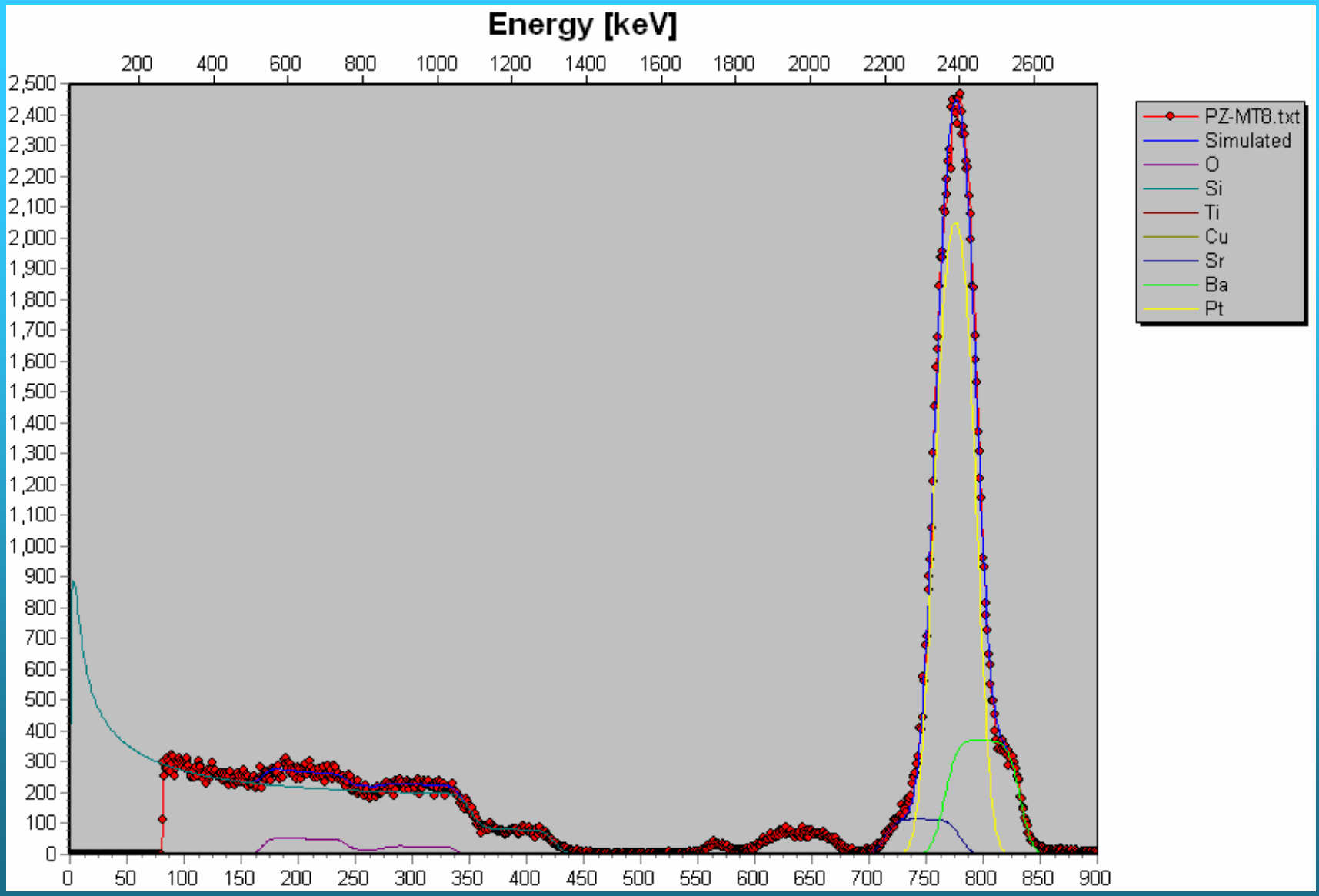

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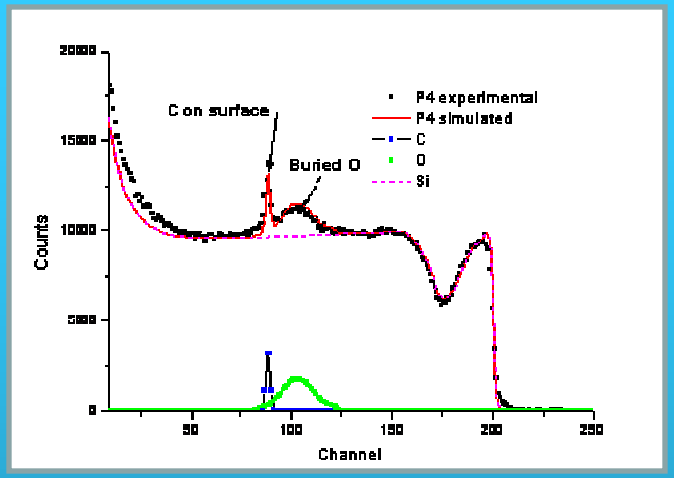
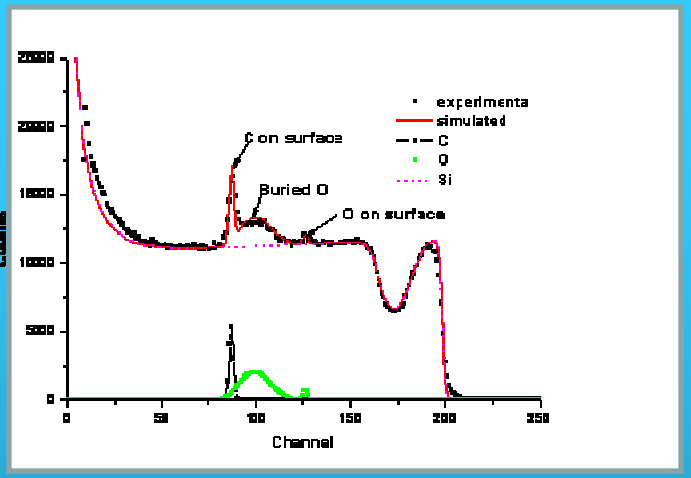
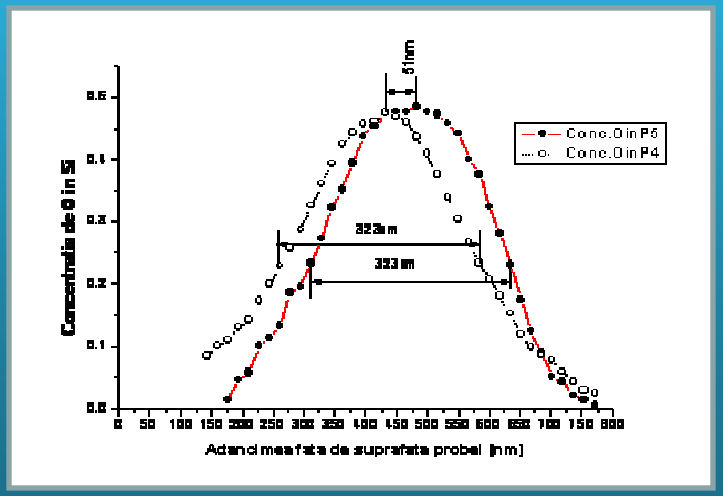
DEPTH PROFILLING OF ELEMENTAL CONCENTRATION:

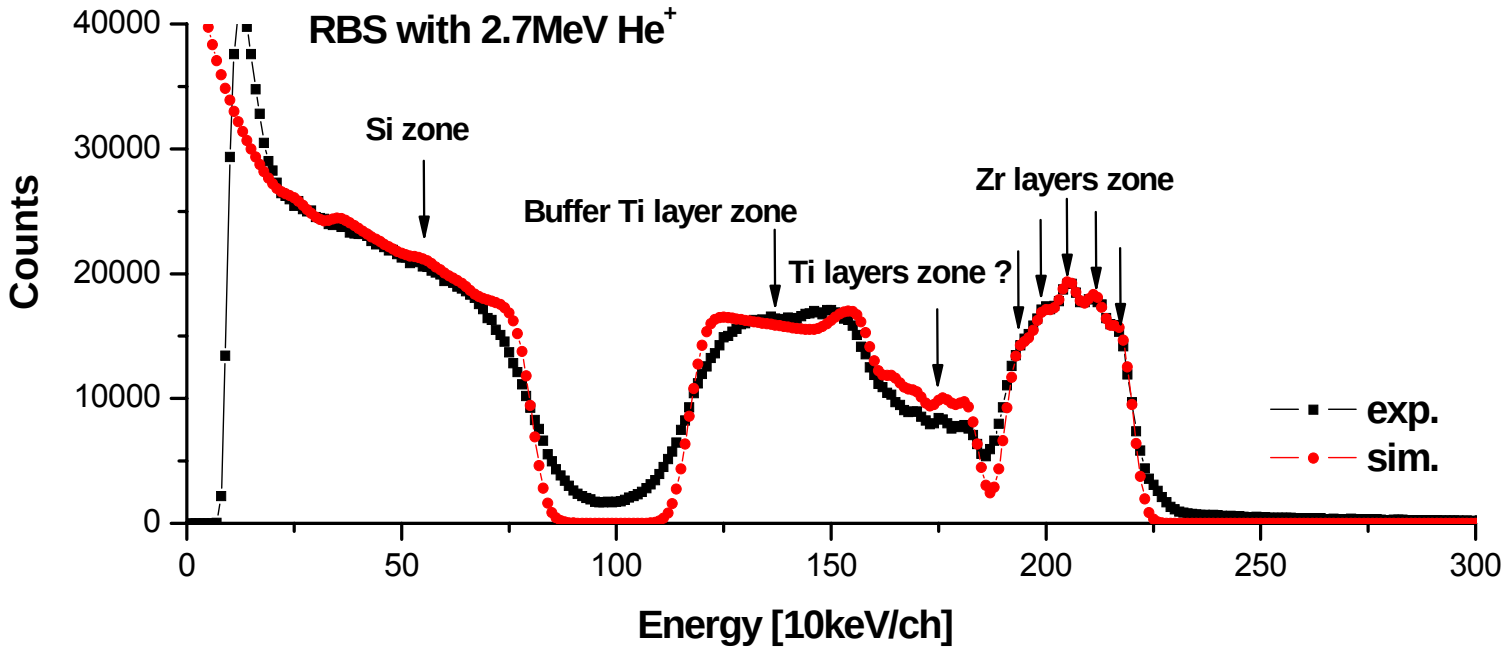






Experimental and simulated RBS spectra and corresponding calculated concentration for a buried oxygen layer in Si before and after thermal annealing at 1000ºC

Various beams for RBS at IFIN-HH



Various beams for RBS at IFIN-HH

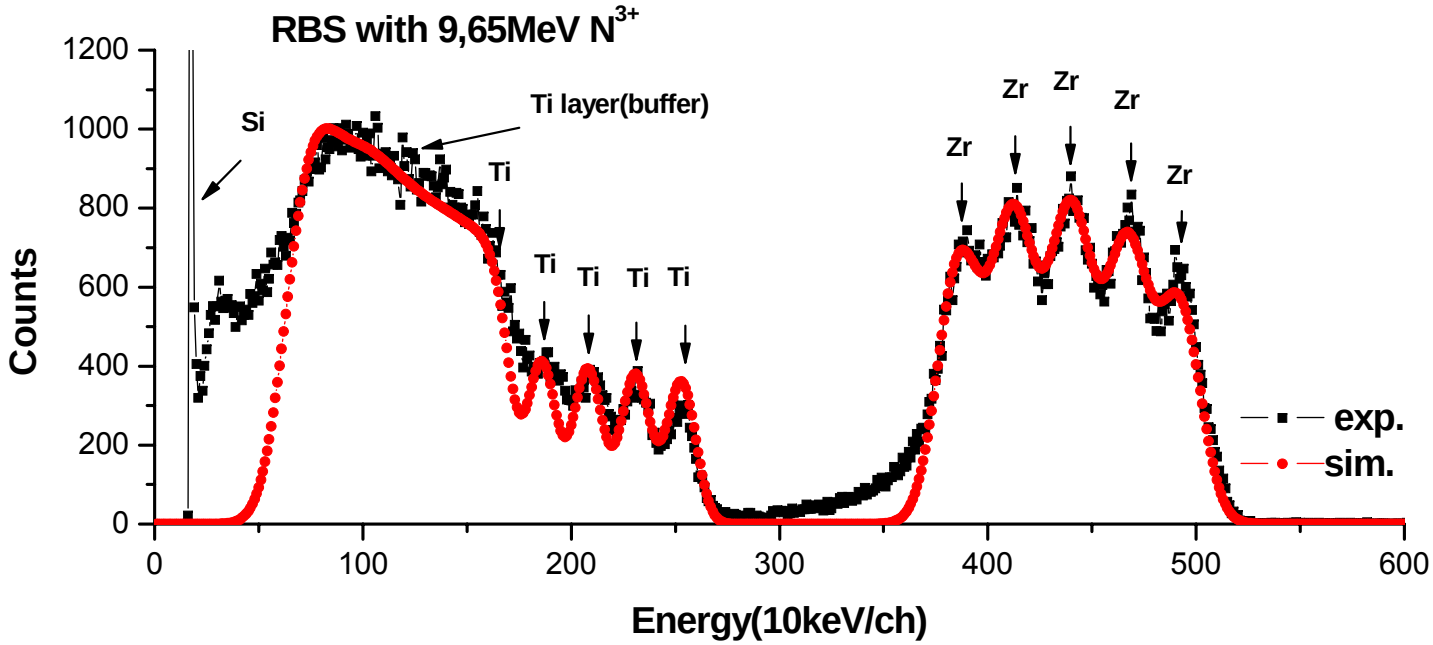
➢**For real characterizations different ions, energies and incidence angles are used.**

Cyclotron beams used for IBA

No.	Ion	Energy (MeV)	Cross section[mm^2]	Beam intensity[nA]
1	$^{4}He^{+}$	2.7-5	0.25-25	3-100
2	$^{2}H^{+}$	1,35-2,5		
3	$^{14}N^{+2}$	3		
4	$^{14}N^{+3}$	10		
5	H_2^{+}	1,35-2,5		

Various beams for RBS at IFIN-HH

THICKNESS OF NANOSTRUCTURED LAYERS:



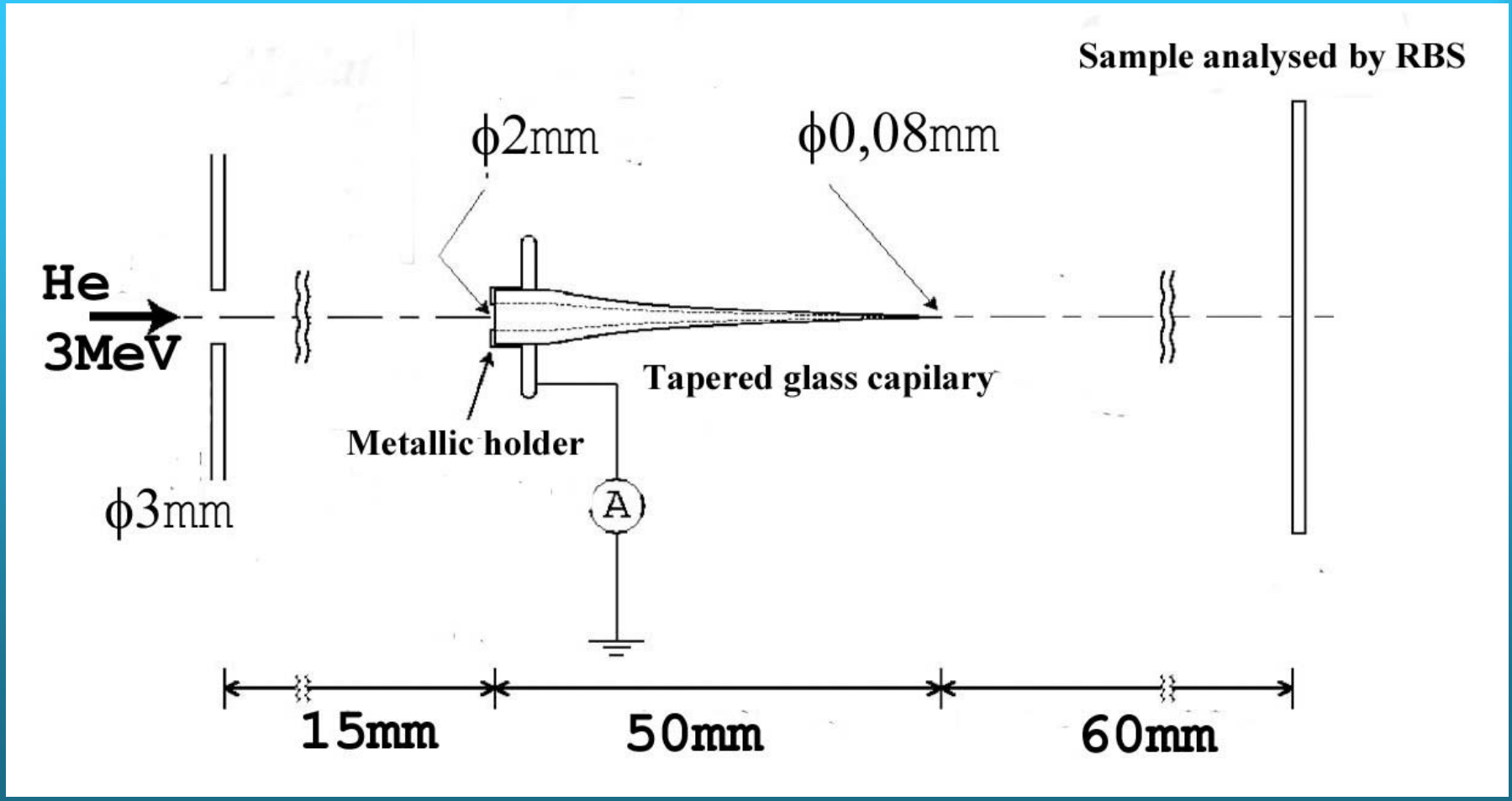
Experimental and simulated spectra for RBS analysis for 5 pairs of ZrN/TiN layers having 15nm/layer deposited on Si with a Ti buffer layer of 300nm obtained using 2.7MeV He beam (before) and 9.65MeV N beam; the use of N beam lead to better mass separation as well as better depth resolution.

Various beams for RBS at IFIN-HH

What to do for characterization of surface micro-structured materials?

- **MICRO-BEAMS**

There is NEW solution for low cost micro-beams systems



Various beams for RBS at IFIN-HH

- **FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES**

RESULTS (estimate of focusing effect)

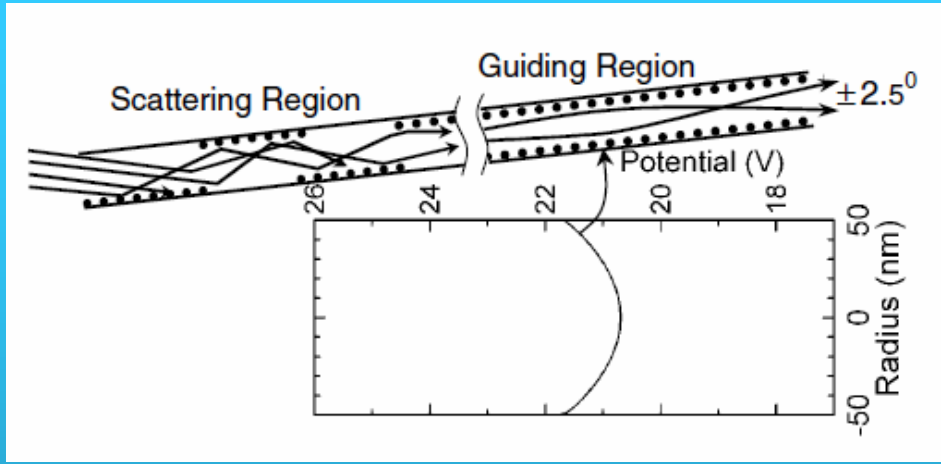
I_{IN}[nA]		J_{IN}[nA/mm^2]	I_{OUT}[nA]	J_{OUT}[nA/mm^2]	Gain[J_{OUT}/J_{IN}]
Collimator 3mm	60	8,48	60	8,48	1
Capillary 2/0,15mm	26,66*	8,48	6	339,5	40
Capillary 2/0,08mm	26,66*	8,48	3	596,8	70,38

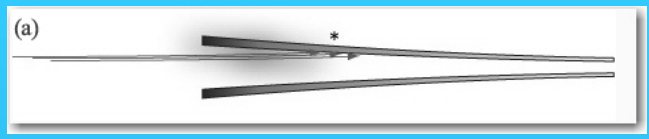
* Beam intensities at the input of capillaries are reduced proportional to the cross sections ratio (4/9).

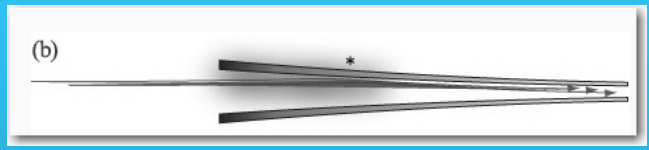
- NOTE: Measured currents are only approximations of real ones, possible contributions of electron currents being neglected!

Various beams for RBS at IFIN-HH

➢ **FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES**







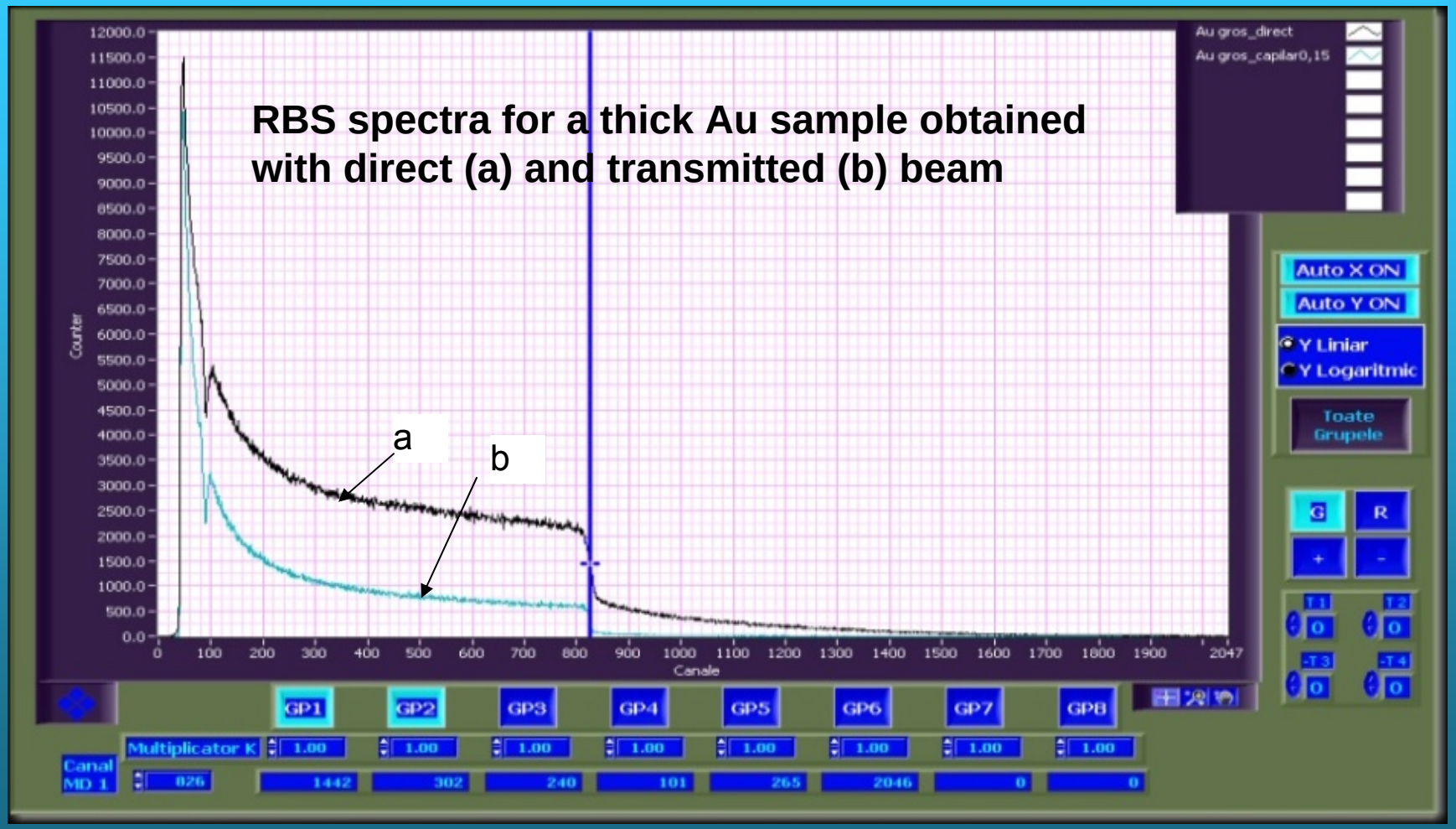
MODELS

- low energy ions of Ne^{7+} are guided trough capillary tubes even for small angles of misalignment with the beam axis (N. Stolterfoht et al., Phys. Rev. Lett. 88, 133201/2002)
- the transmitted beam of 8keV Ar^{8+} trough a tapered glass capillary need some tens of seconds to reach its maximum of intensity (T. Ikeda et al., (Phys. Rev. Lett. 89, 163502/2006)
- experiments with beams of MeV ions transmitted through tapered capillaries revealed a focusing effect most probable based on total reflection at small angles (T. Nebiki, *et* al., J. Vac. Sci. Technol. A **21**, 1671 /2003).

Various beams for RBS at IFIN-HH

➢ FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES

RESULTS (energy spectrum of transmitted beam)

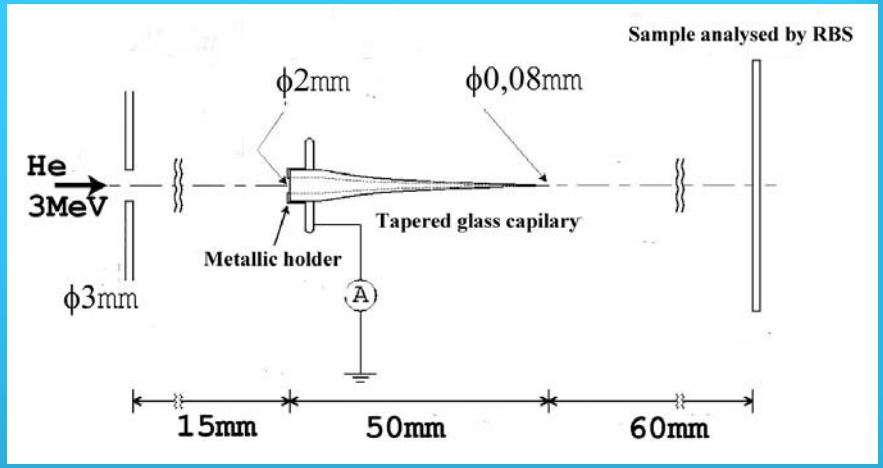


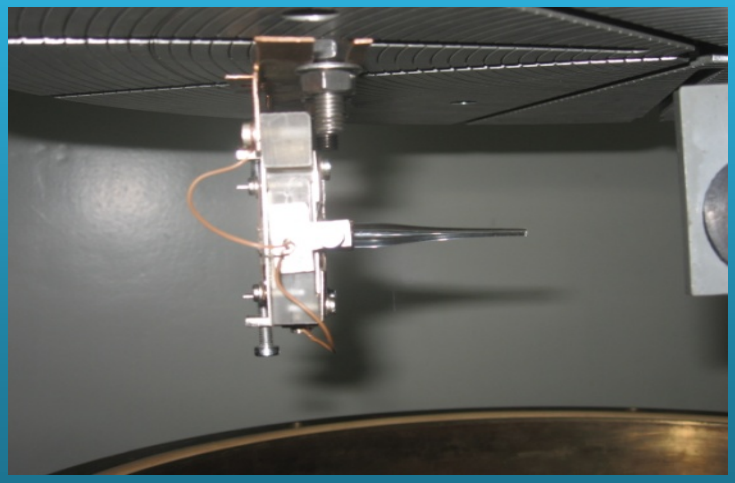
Various beams for RBS at IFIN-HH

- **FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES**

EXPERIMENTAL SETUP

experimental setup for the transmission of 3MeV He beam through a tapered glass capillary

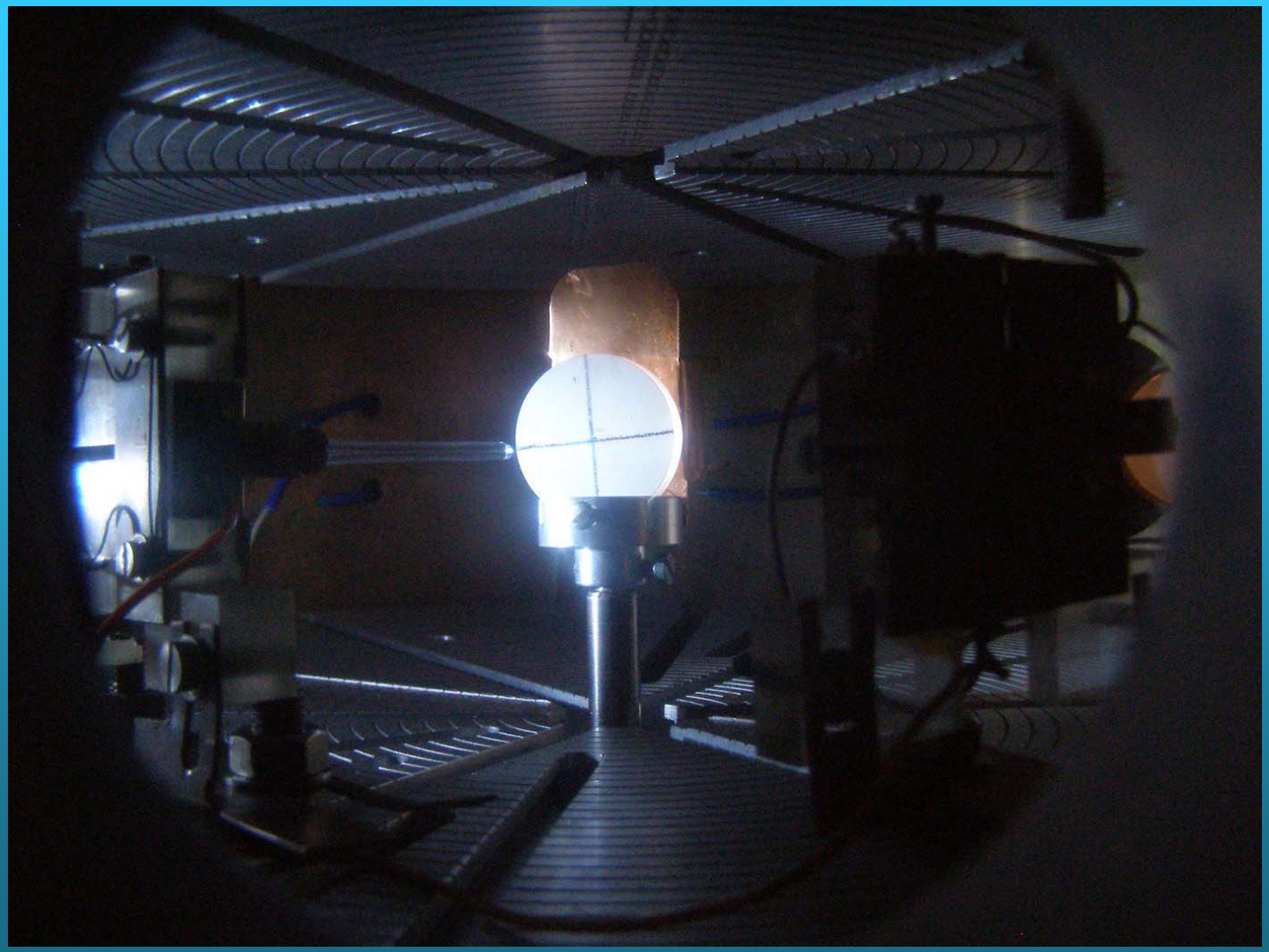




Conical glass capillary and its mounting fixture used in beam focusing experiments

Various beams for RBS at IFIN-HH

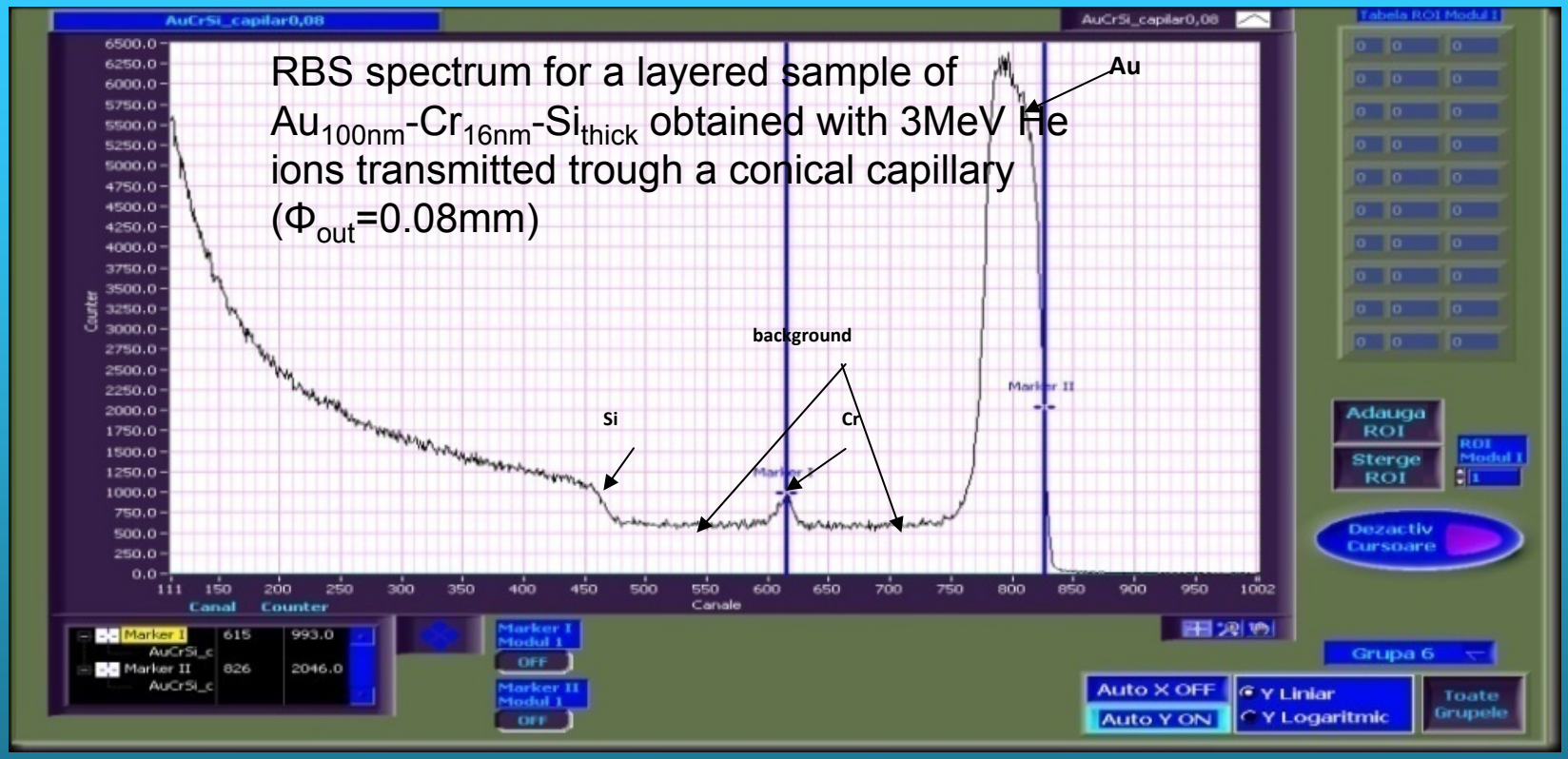
- **FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES**



Various beams for RBS at IFIN-HH

➢ FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES

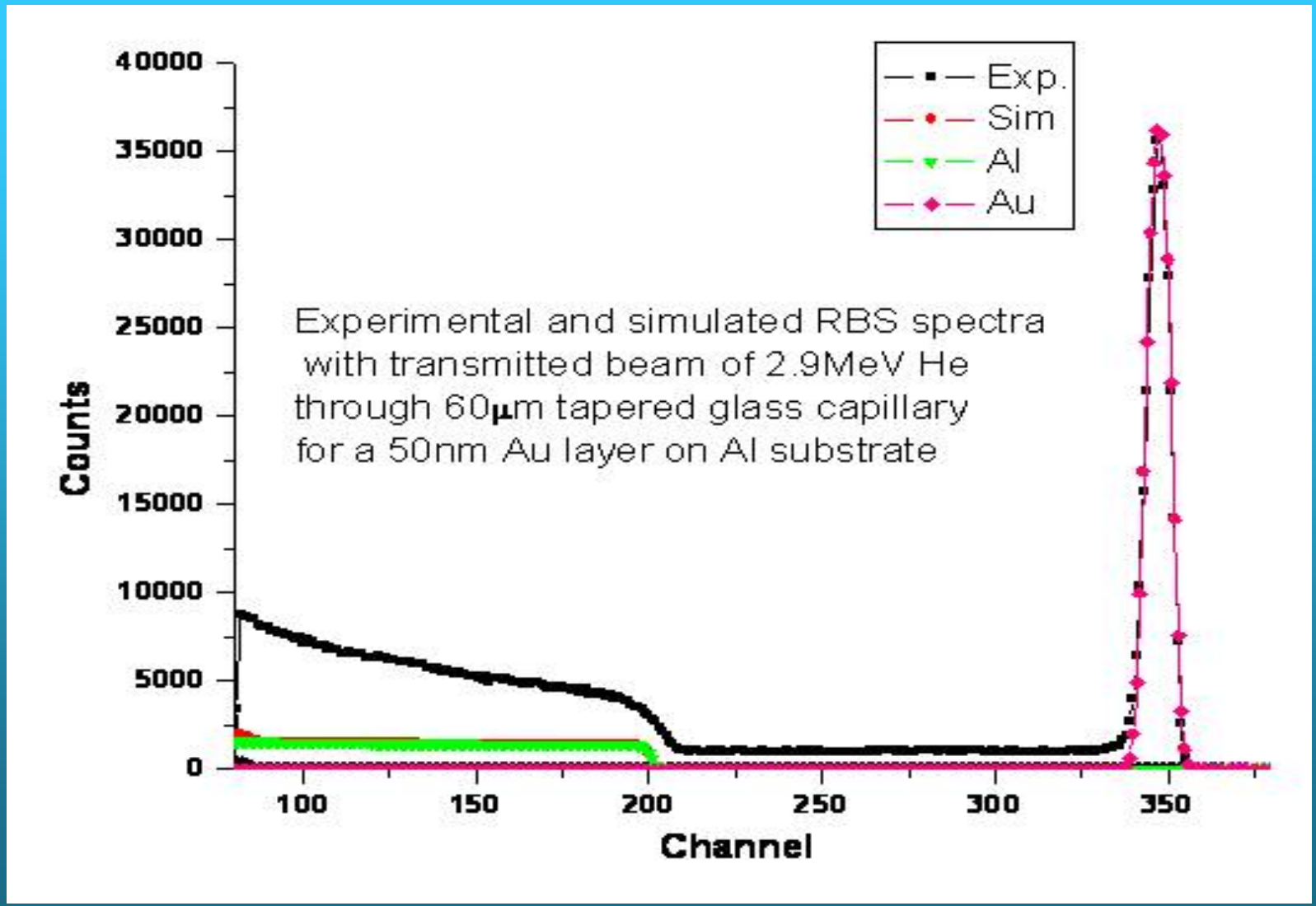
RESULTS (energy spectrum of transmitted beam)



The two RBS spectra shows two components of transmitted beam:
-an undisturbed beam (initial energy and energy dispersion are conserved)
-a fraction of the initial beam having a large energy dispersion

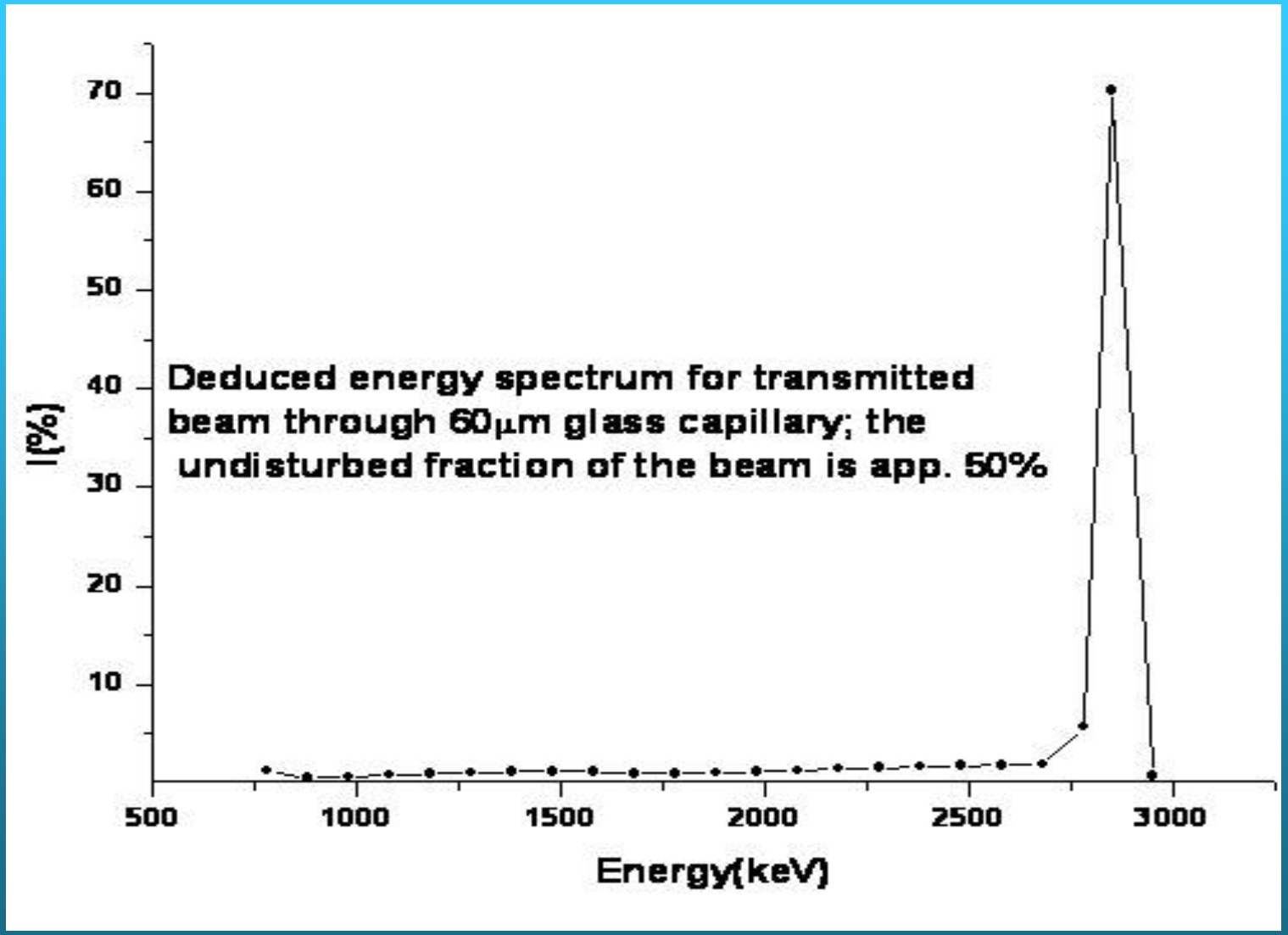
Various beams for RBS at IFIN-HH

RESULTS (energy spectrum of transmitted beam)



Various beams for RBS at IFIN-HH

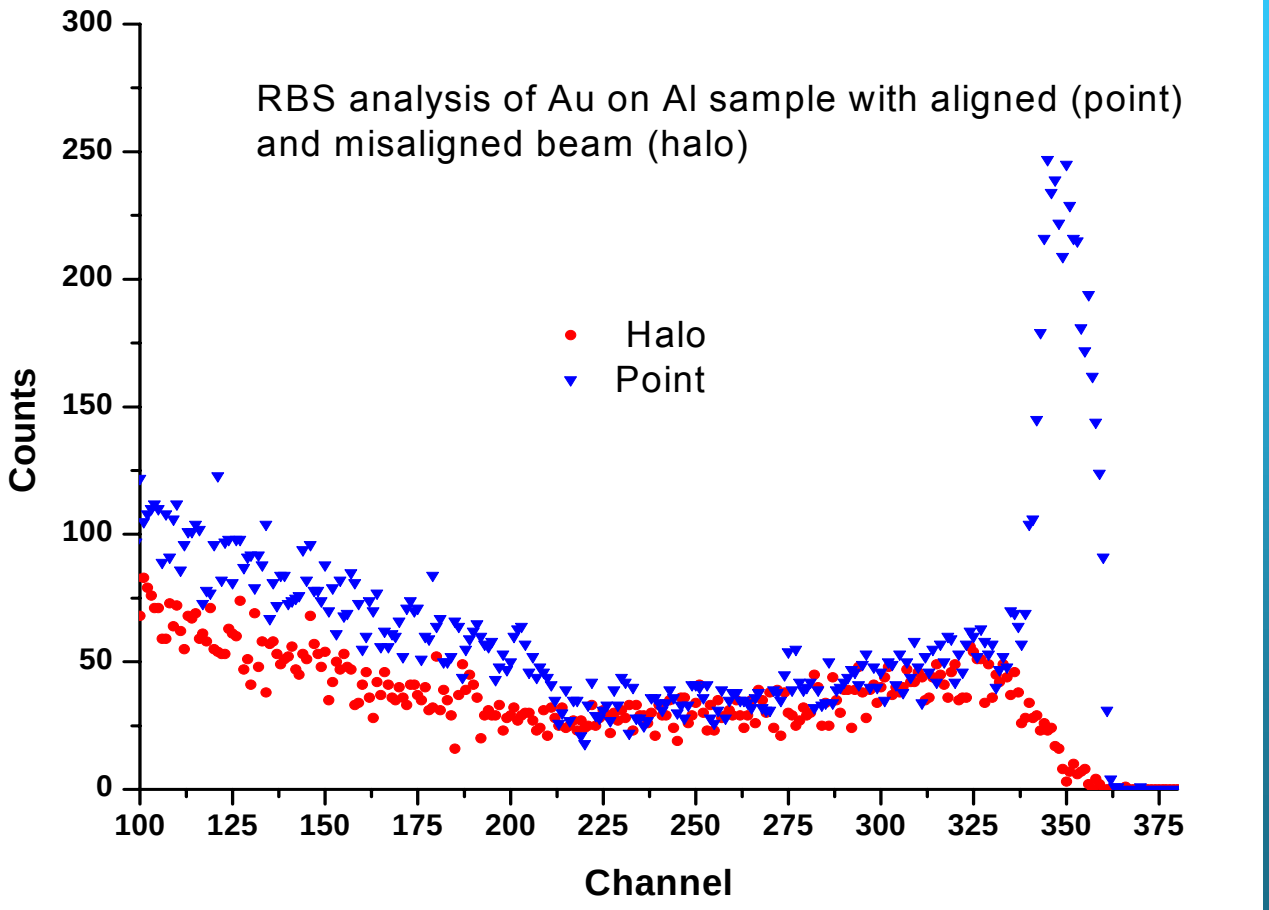
RESULTS (energy spectrum of transmitted beam)

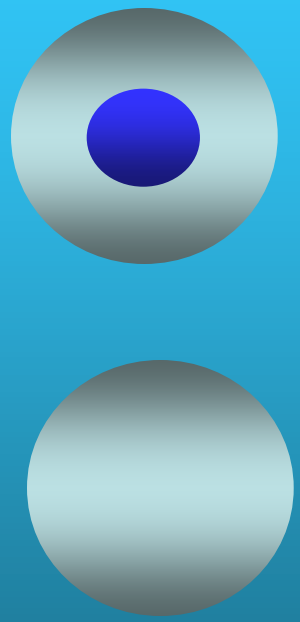


Various beams for RBS at IFIN-HH

RESULTS (energy spectrum of transmitted beam)

Transmitted beam with proper alignment (up) and misalignment (down)

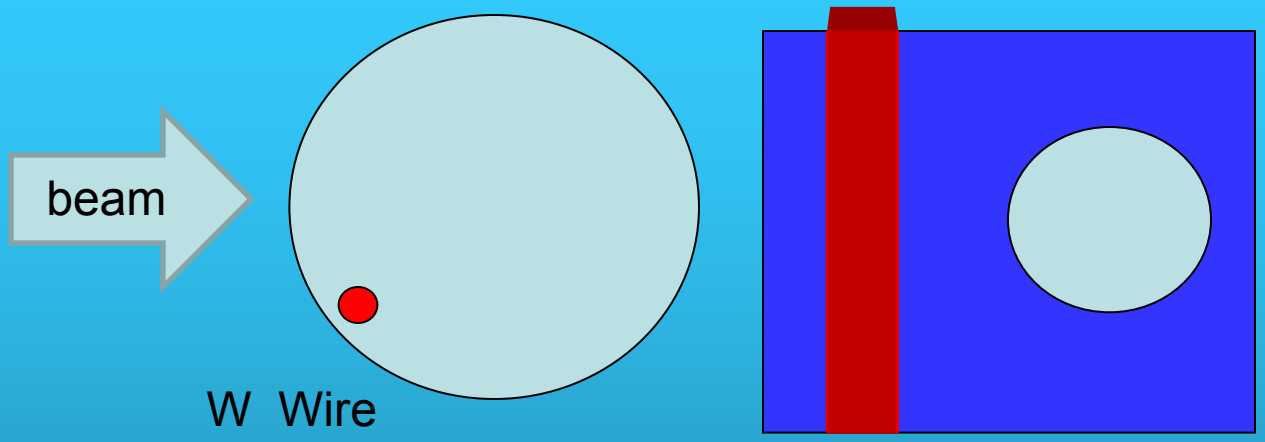




Various beams for RBS at IFIN-HH

➢FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES

Beam profile



Various beams for RBS at IFIN-HH

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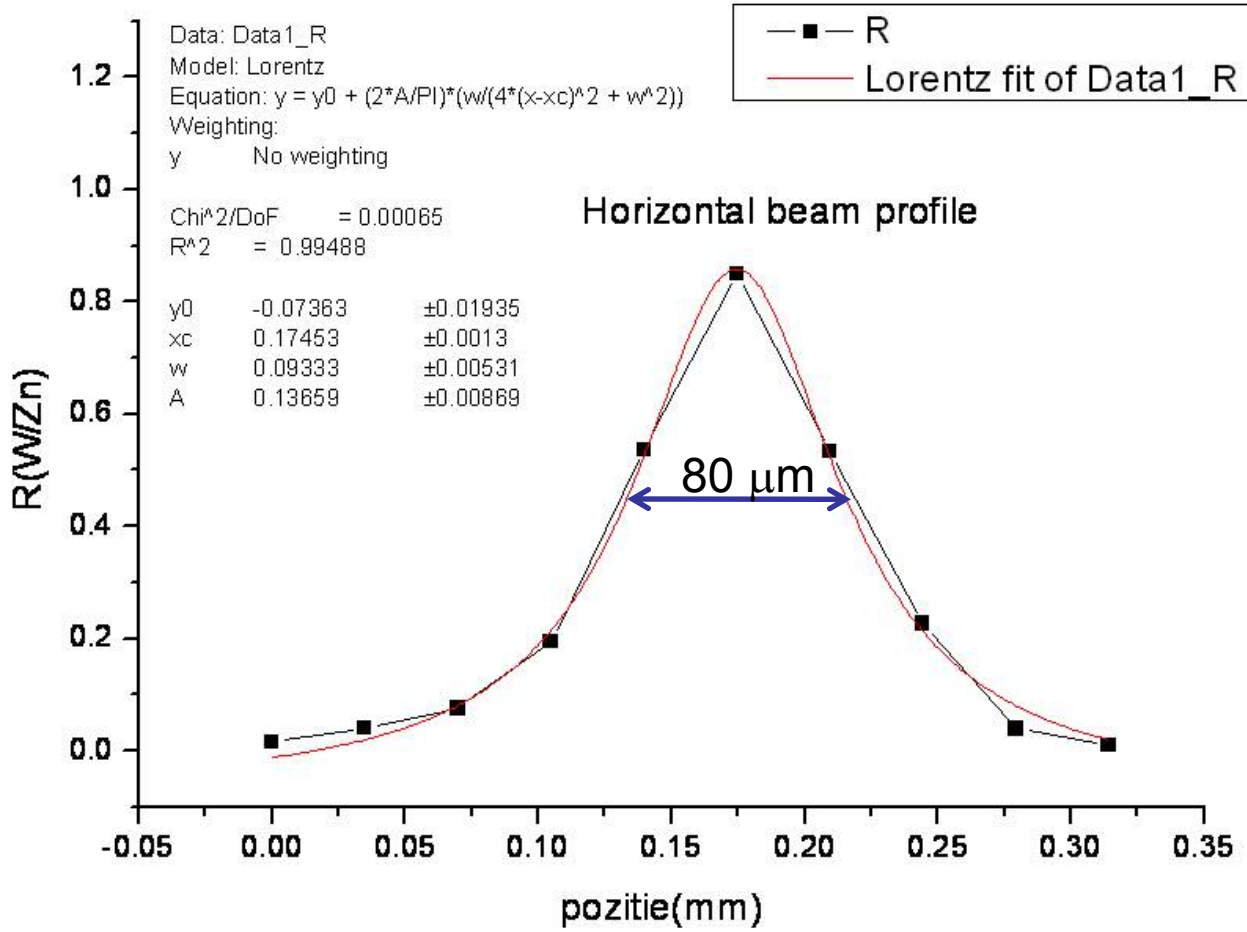
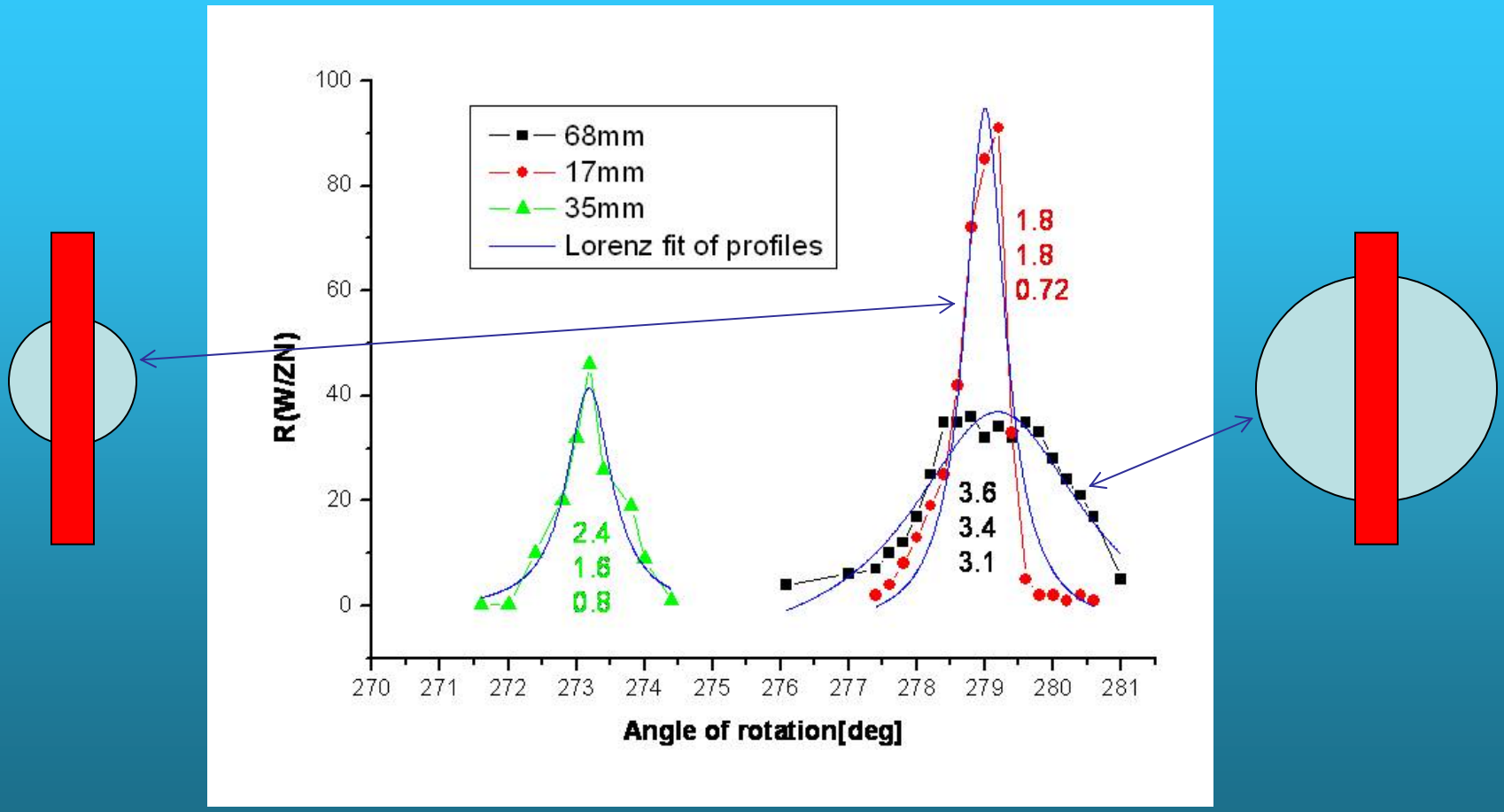
Beam profile



Various beams for RBS at IFIN-HH

➢FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES

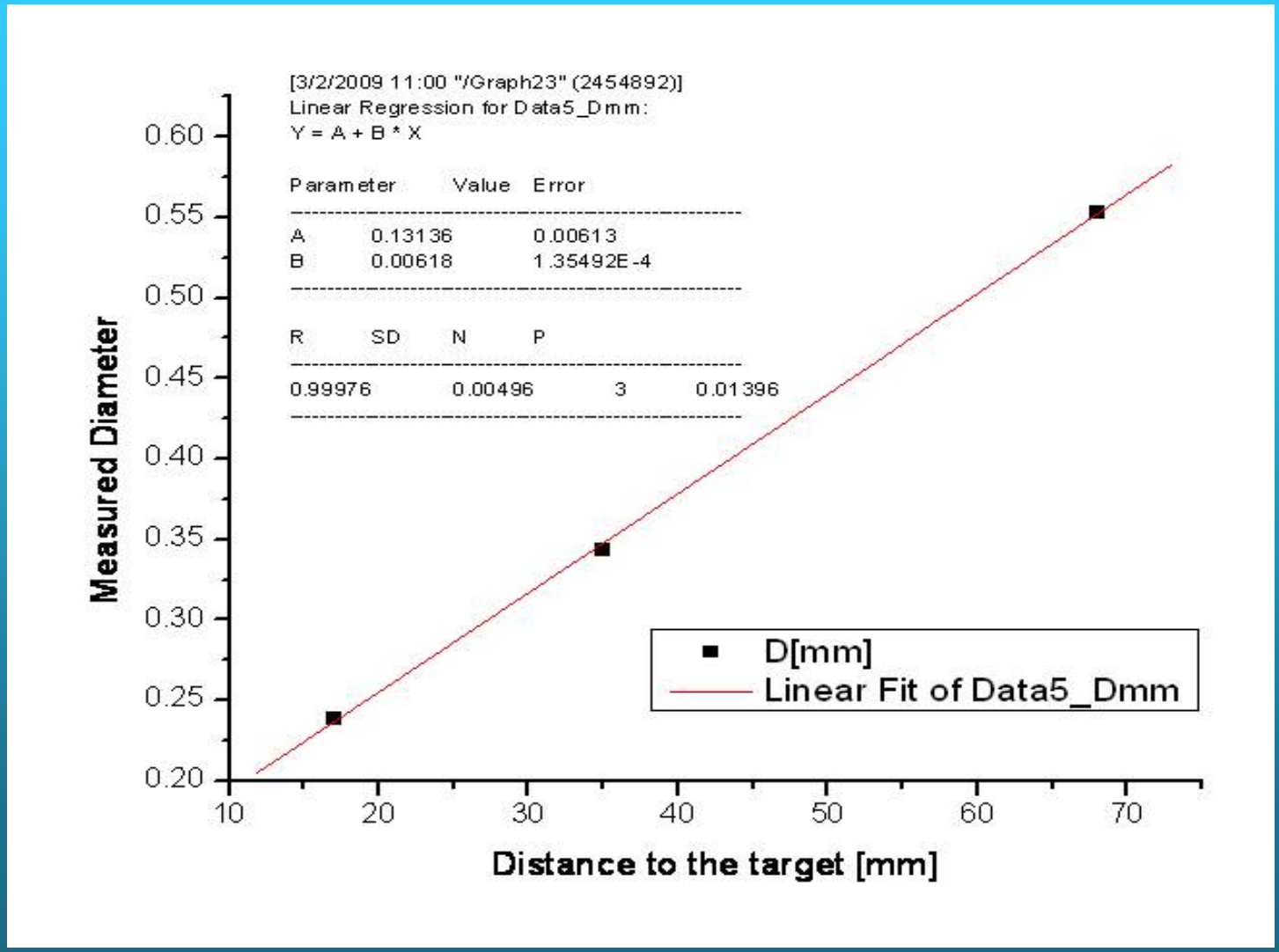
Divergence of the beam



Various beams for RBS at IFIN-HH

➢**FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES**

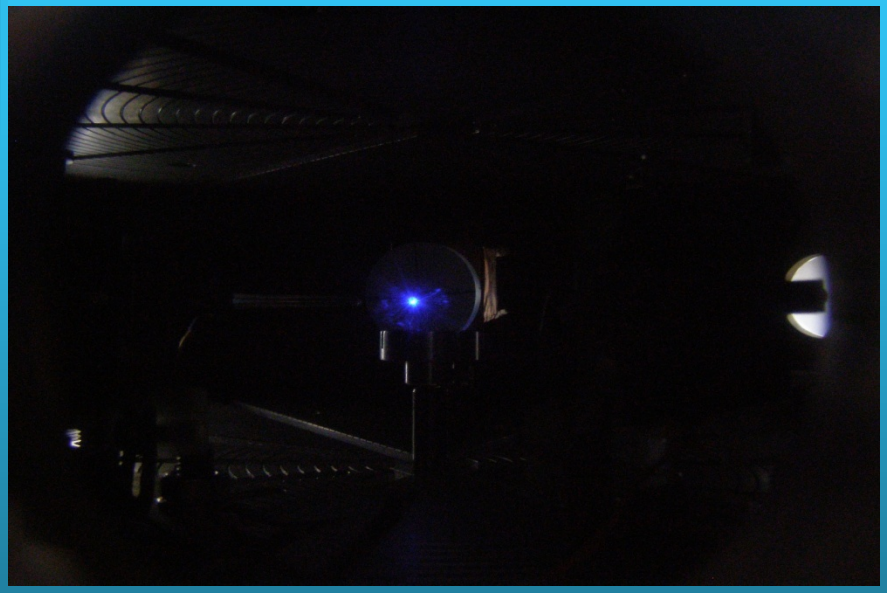
Measured divergence for 200μm out capillary = 6mrad

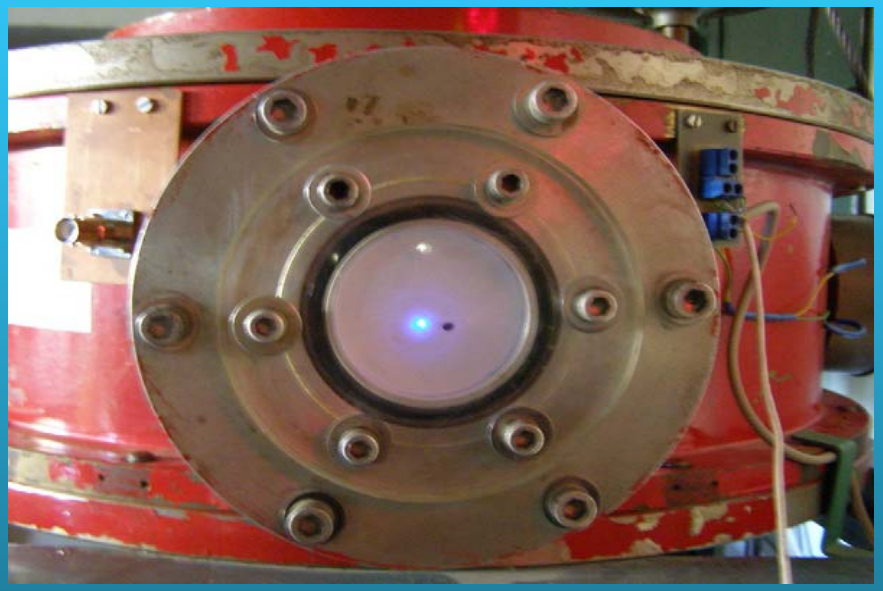


Various beams for RBS at IFIN-HH

- **FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES**

RESULTS (transmitted beam)

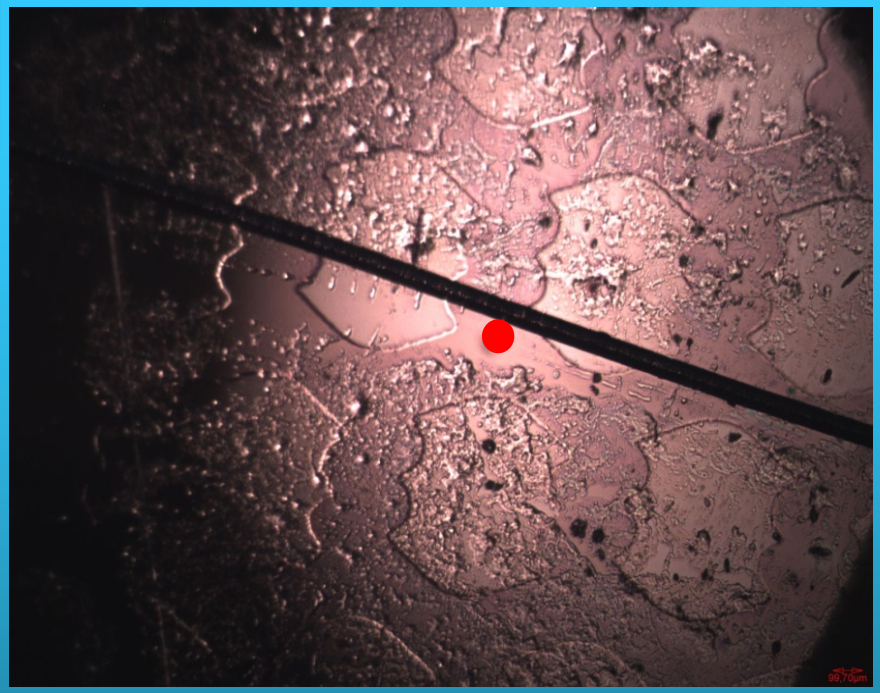


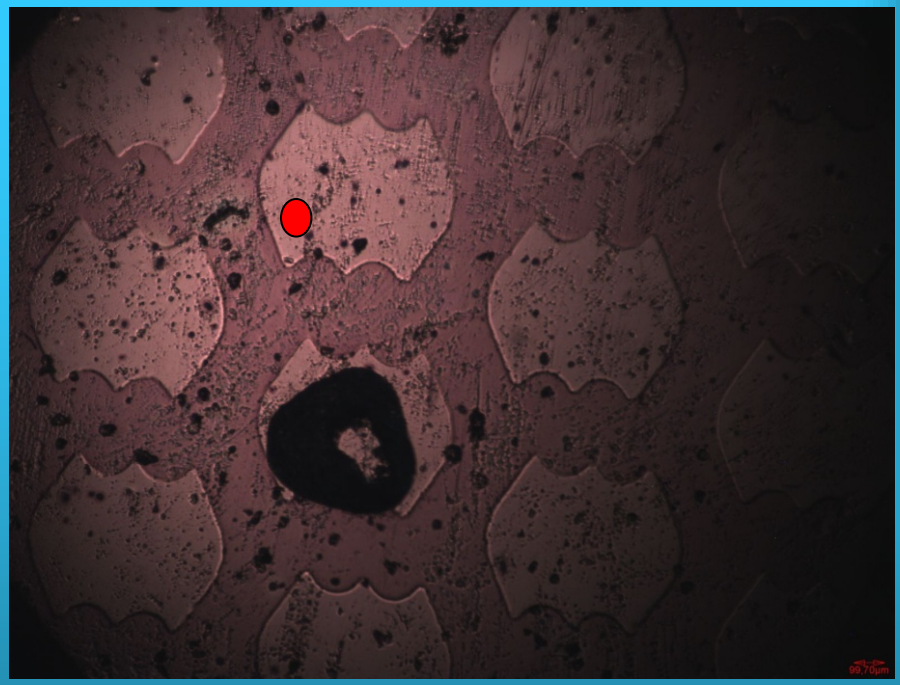


Visualization of transmitted beam at 60mm (left) and 360mm (right) distance from the output of glass capillary.

Various beams for RBS at IFIN-HH

➢FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES





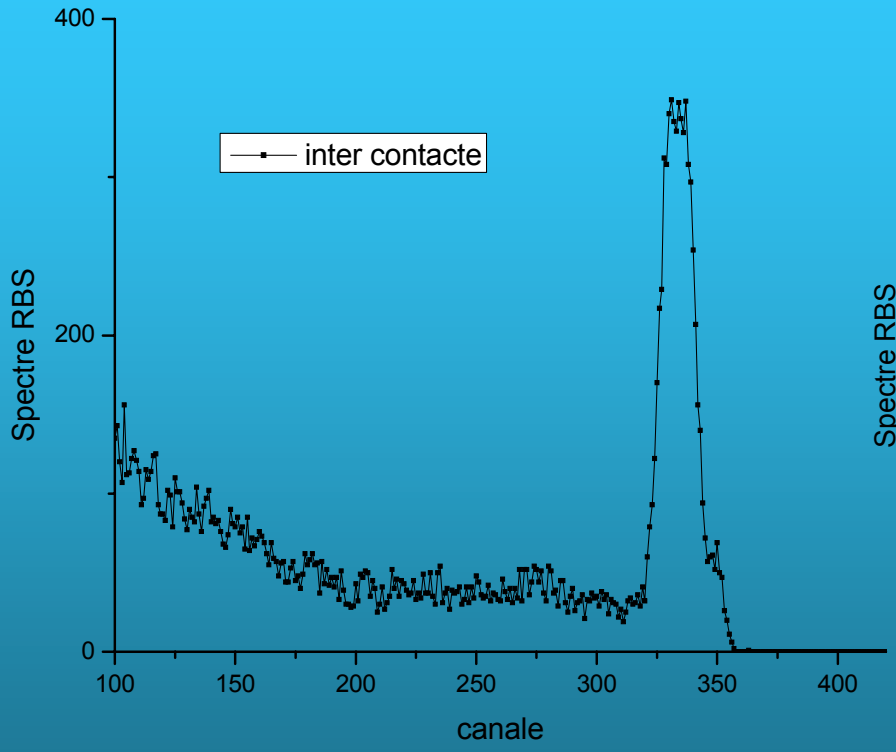
Wire: 60 micron

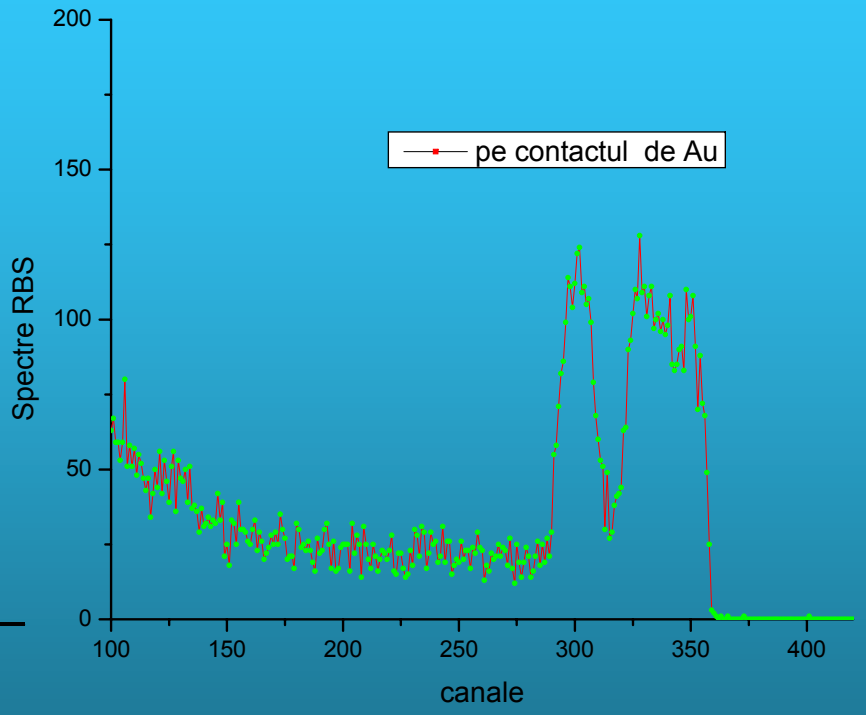
Beam circa 50 micron

Contacts (Au)
De 500 micron

Various beams for RBS at IFIN-HH

➢FOCUSING OF MeV ION BEAMS BY TAPERED GLASS CAPILARIES





Various beams for RBS at IFIN-HH

Conclusion:

Even a cyclotron is not dedicated for RBS, we can achieve interesting results

Further steps:

Standardization of (simple) RBS for our customers (EN17025)

More detailed studies on capillary focusing and new applications with “micro” beams

New analyzing chamber with better adjustment possibilities

Channeling experiments

New accelerator (tandem) is planned

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Thank you for your attention