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OF APPLIED PHYSICS**

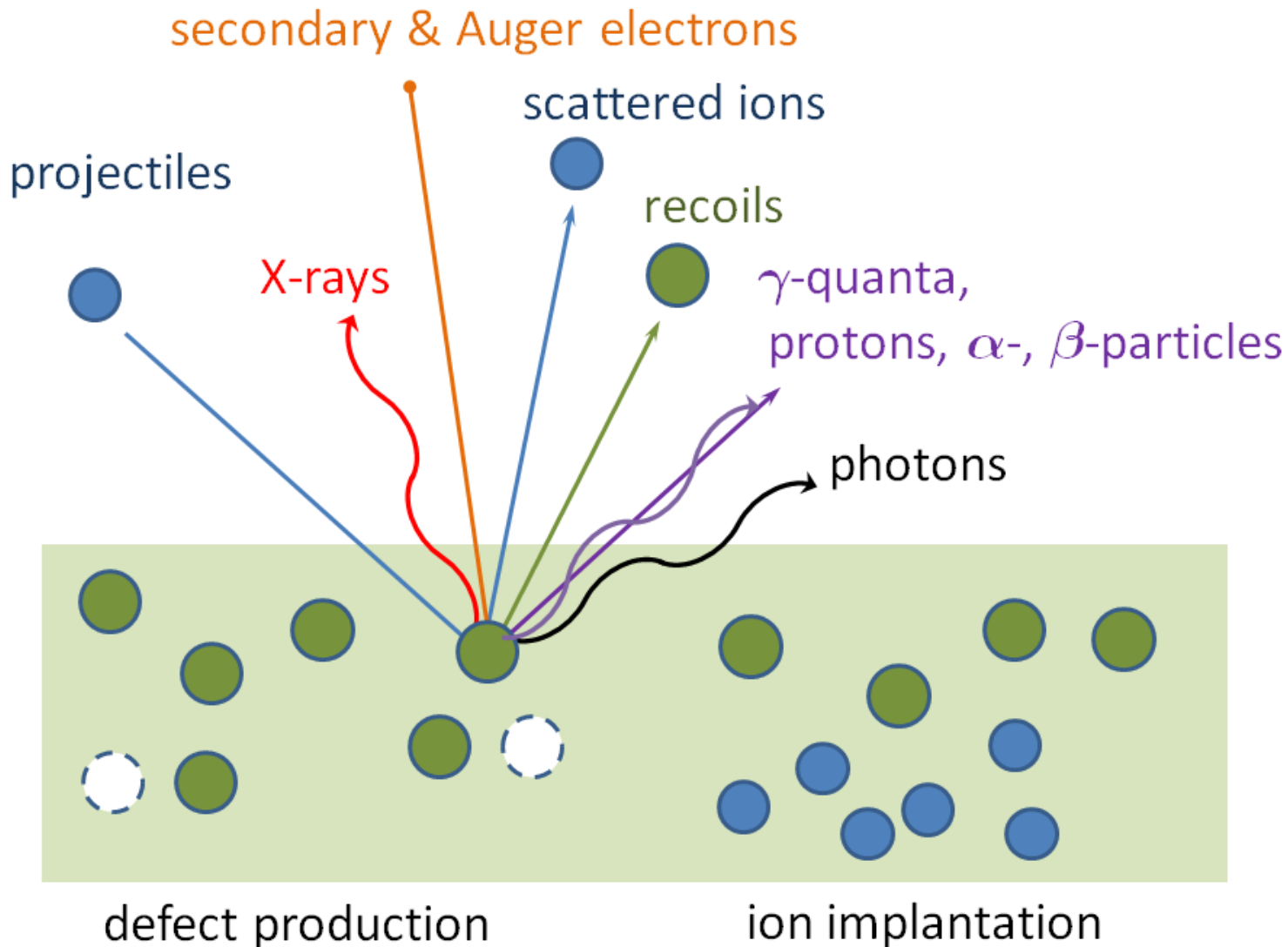
THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE

**Joint LAL-INR NASU Workshop on HEP instrumentation**  
Orsay, France, May, 22-24, 2013

# **The IAP NASU analytical accelerator-based facility**

**Andriy Kramchenkov**

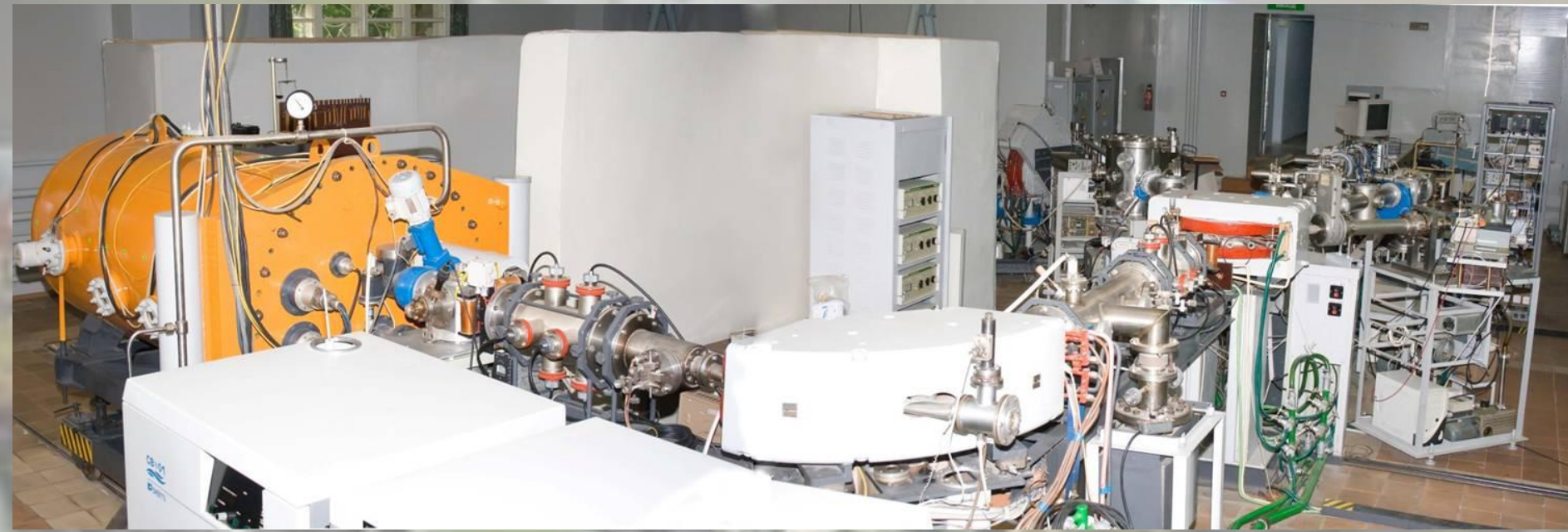
# Ion-matter interaction and IBA techniques



**RBS**  
**PIXE**  
**SE**  
**imaging,**  
**AES**  
**ERDA**  
**NRA,**  
**PIGE**  
**IL**



# IAP NASU accelerator-based facility



## 2 MV electrostatic accelerator

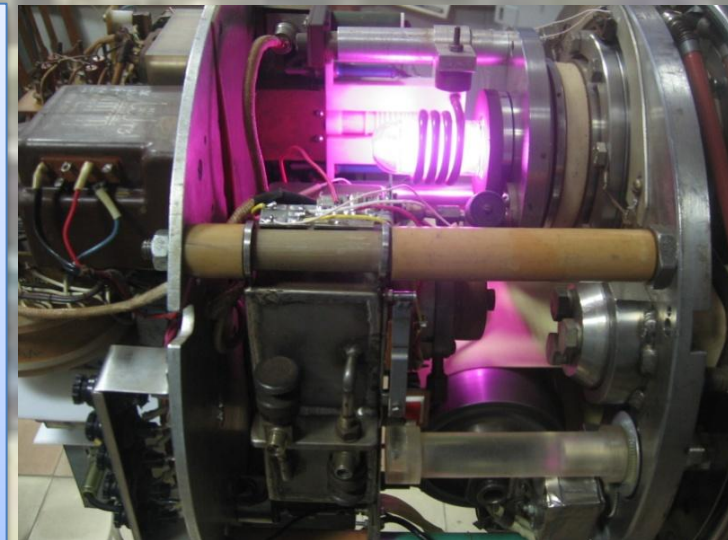
$H^+$ ,  $He^+$  and  $He^{++}$  ions (RF ion source); Accelerator voltage stability < 1 keV at 1 MV on the terminal ( $\Delta E/E < 10^{-3}$ )

## Six analytical end-stations (+seventh is under construction):

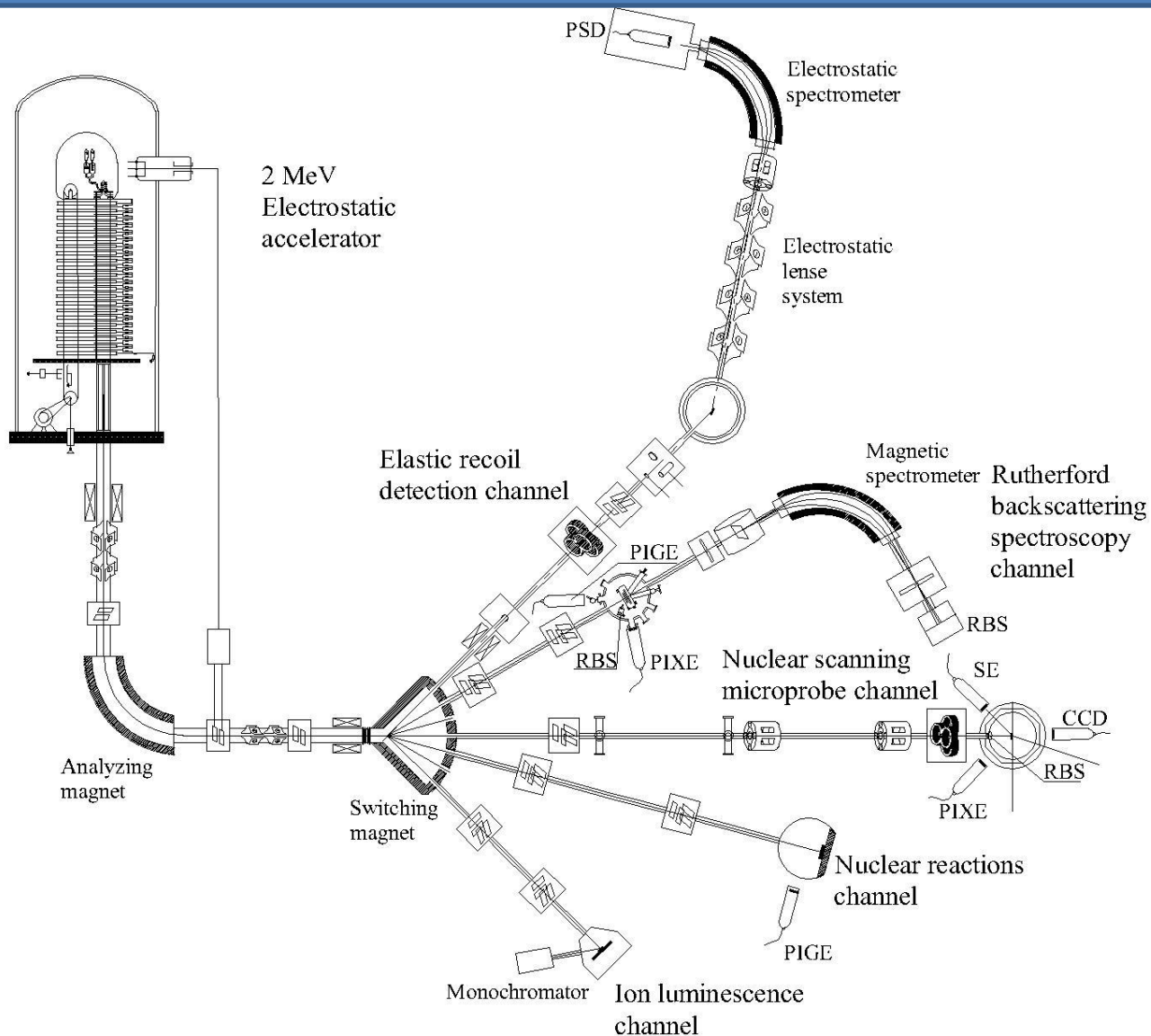
- Resonant nuclear reactions (NRA, PIGE);
- ion induced luminescence (IL)
- scanning ion microprobe;
- high-resolution Rutherford backscattering spectrometry (HRBS);
- high-resolution elastic recoil detection analysis (HERDA);
- quasimonochromatic X-ray source based on the electrostatic accelerator;
- *proton beam writing - under construction* .

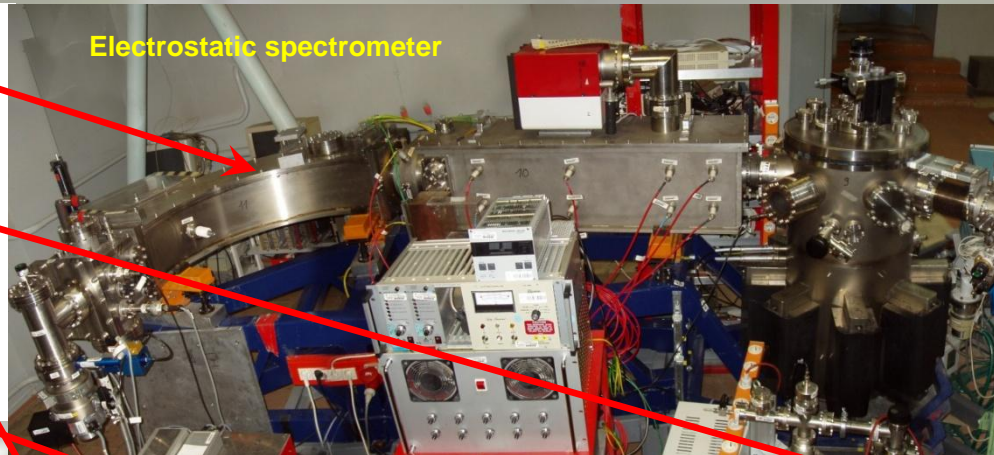
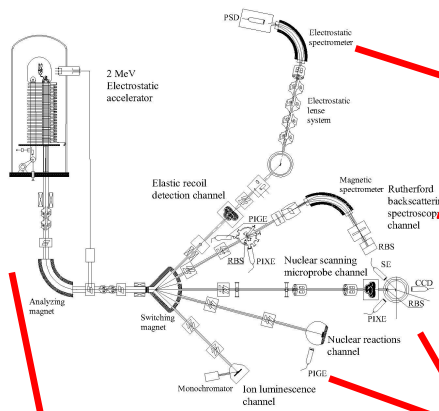
24.05.2013

IAP NASU accelerator-based facility



# IAP NASU accelerator-based facility

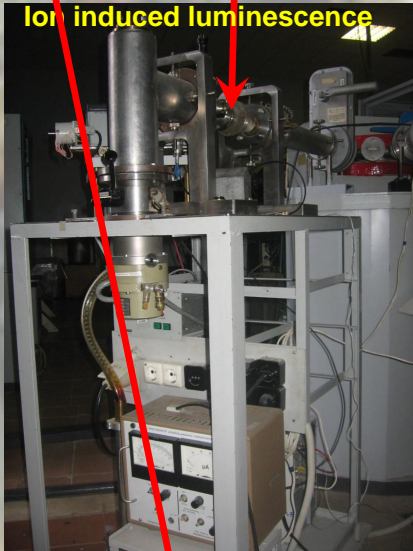




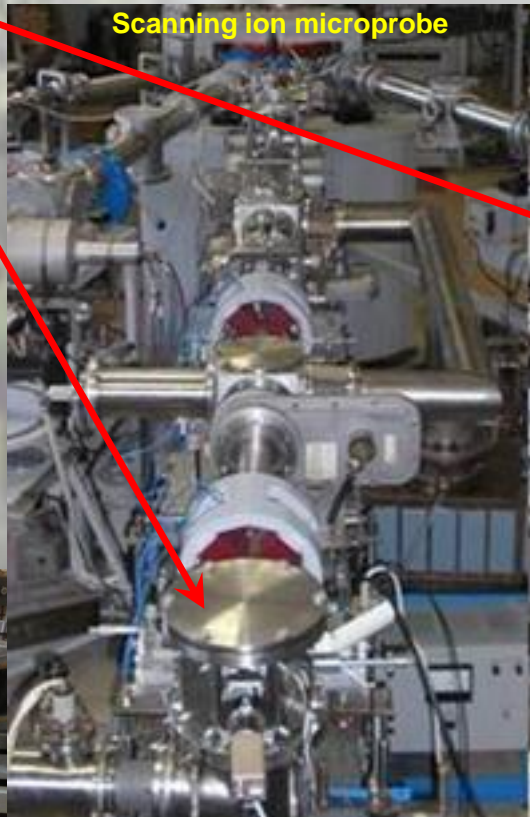
Electrostatic spectrometer



Magnetic spectrometer



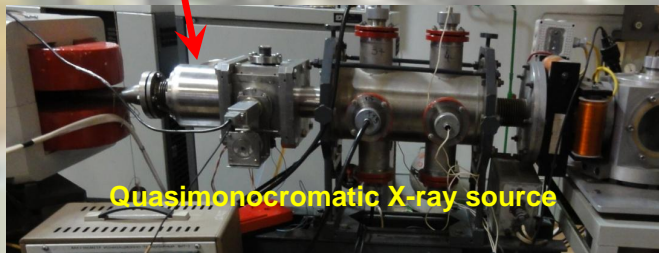
Ion induced luminescence



Scanning ion microprobe

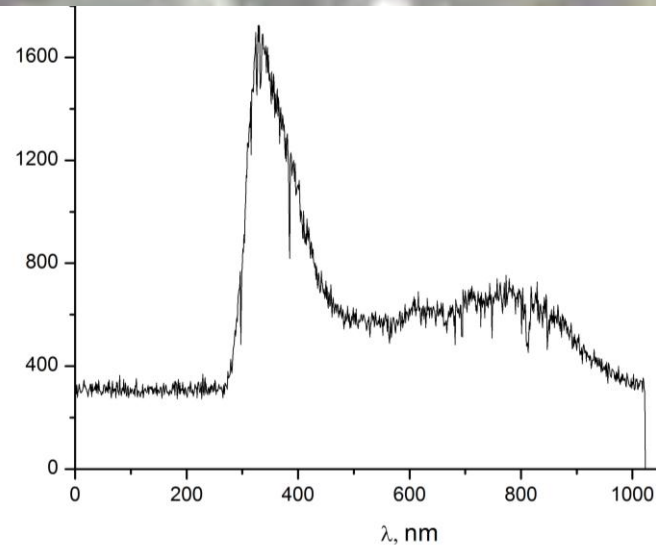
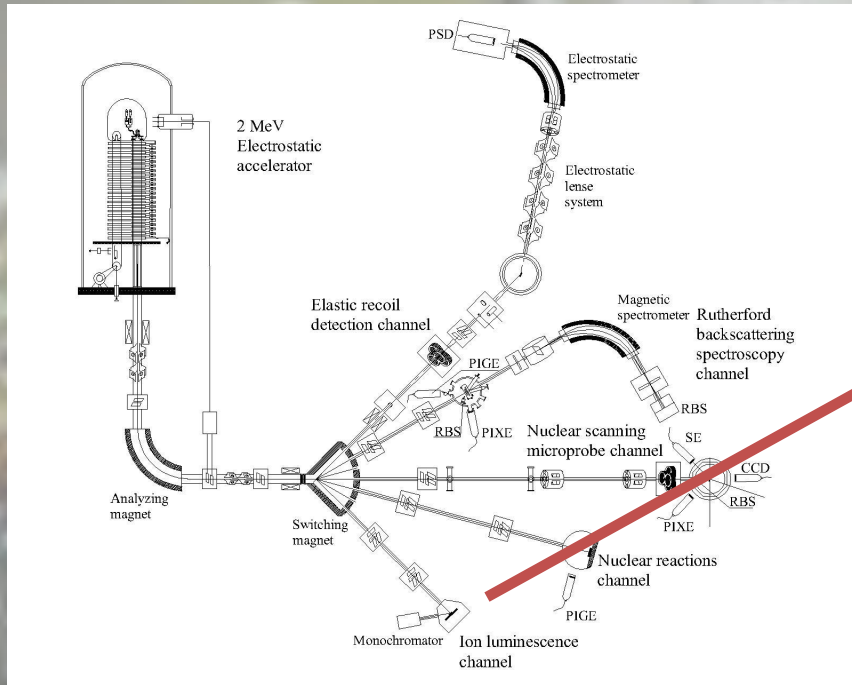


Nuclear reactions



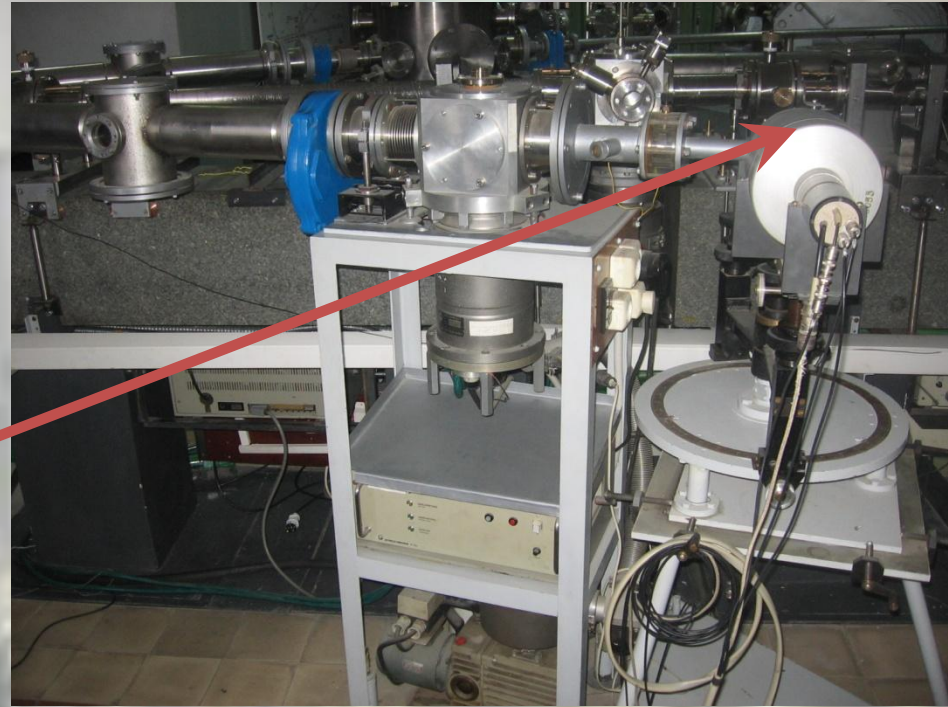
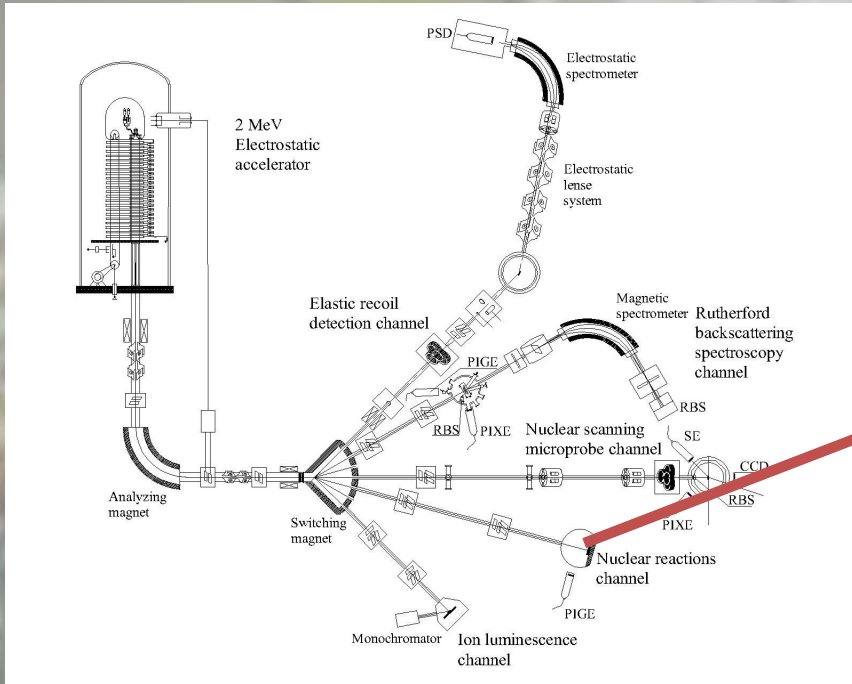
Quasimonochromatic X-ray source

# Ion-induced luminescence end-station



IL spectrum from fluorite ( $\text{CaF}_2$ ) sample

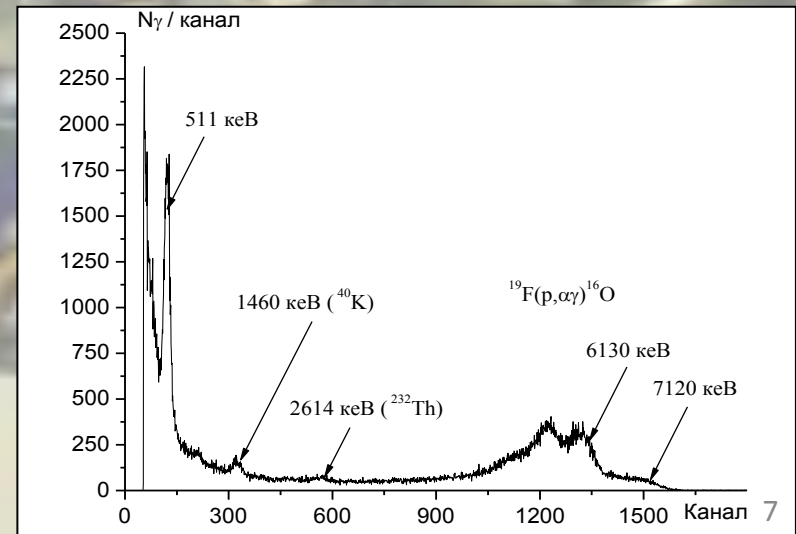
# NRA end-station

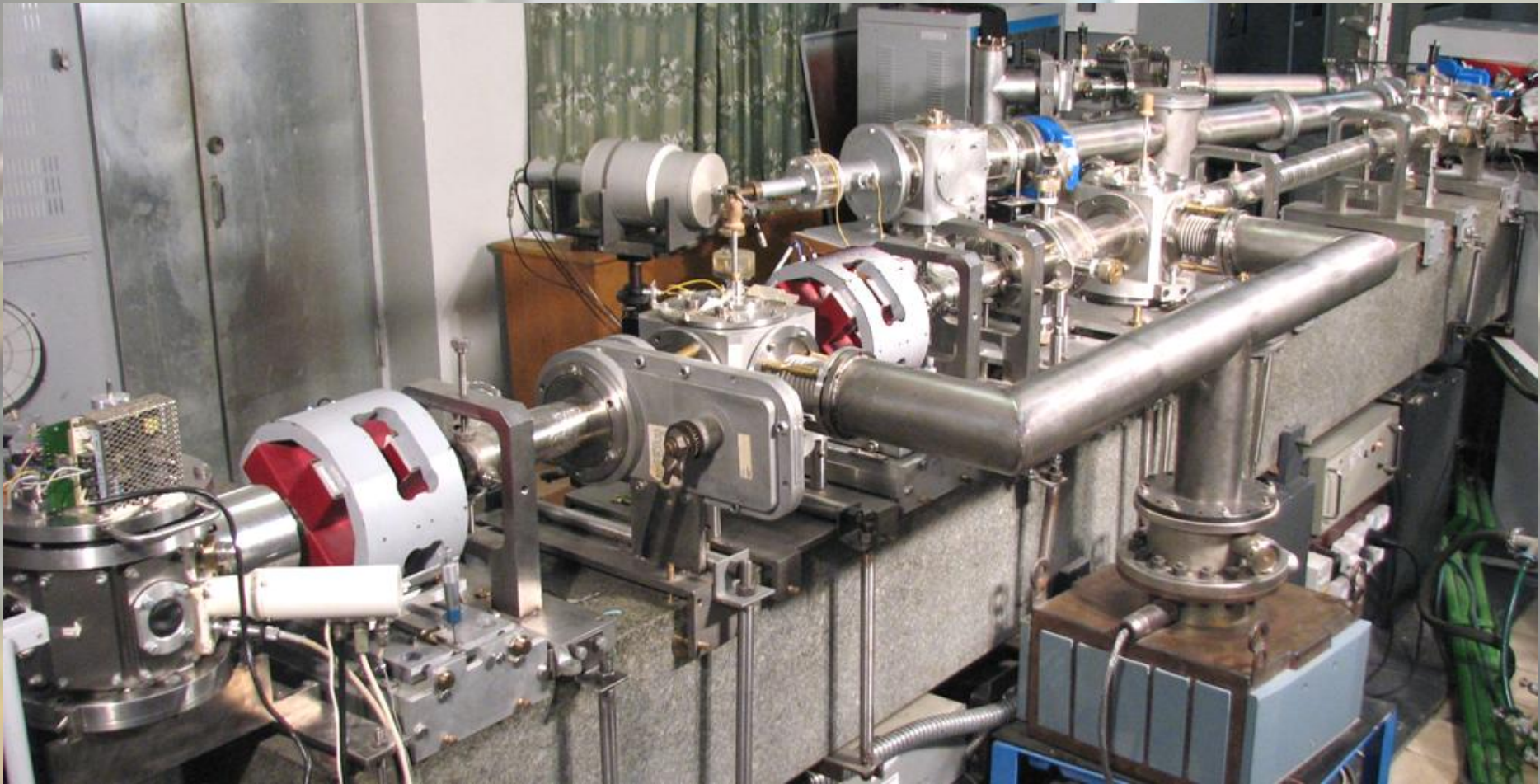


NRA end-station is equipped with two types of gamma detectors – NaI scintillator detector and HpGe detector.

On the right side there is a PIGE spectrum of LiF sample.

**$^{19}\text{F}(p,\alpha\gamma)^{16}\text{O}$**

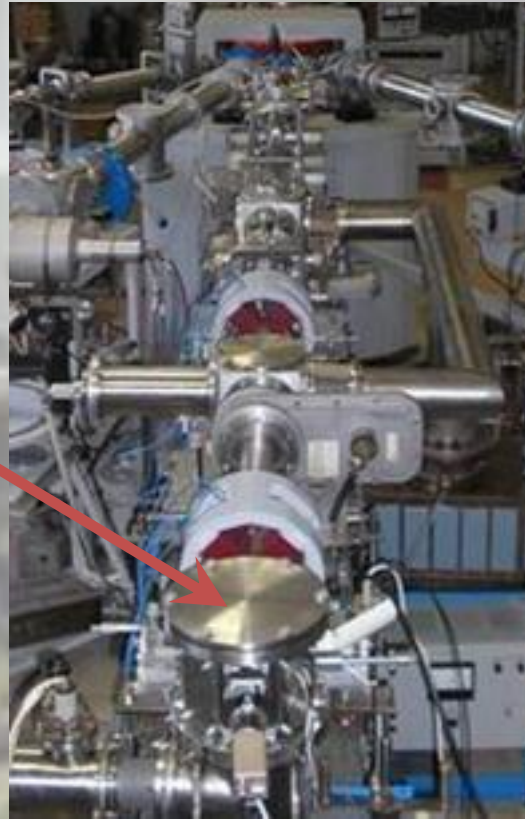
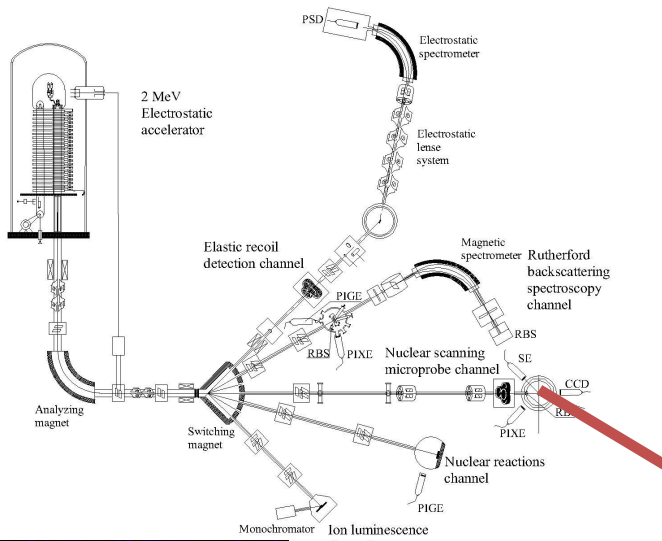




- **High current mode:** beam spot  $1,2 \times 2 \mu\text{m}$ , ion current 100 pA; **Low current mode:** beam spot  $100 \times 100 \text{ nm}$ , ion current 20 nA. **Techniques available:**  $\mu\text{RBS}$ ,  $\mu\text{PIXE}$ , SE imaging, IBIC.



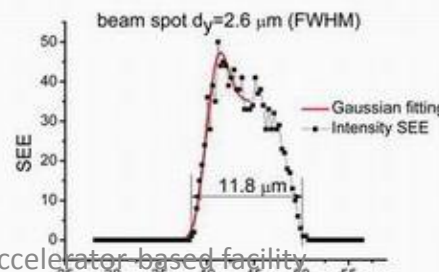
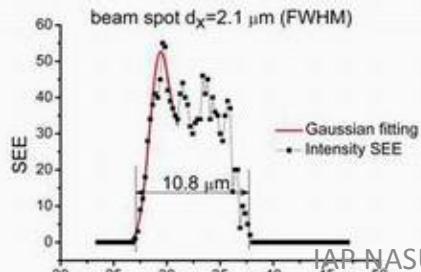
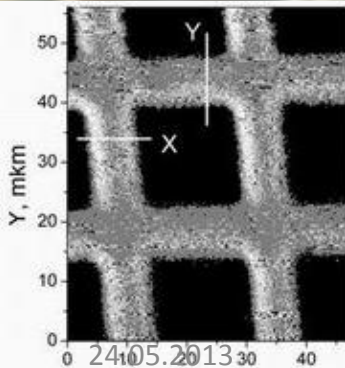
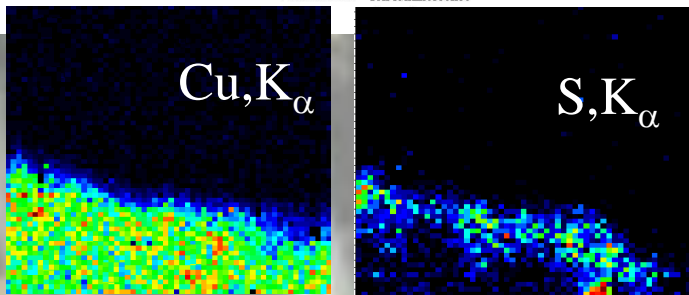
# Scanning ion microprobe



Ion microprobe is based on two integrated doublets of magnetic quadrupole lenses ("russian quadruplet").

$\mu$ PIXE,  $\mu$ RBS,  $\mu$ ERDA, SE imaging, IBIC techniques are available.

Proton beam writing beamline is now being constructed.



# Quasimonochromatic X-ray source based on the electrostatic accelerator

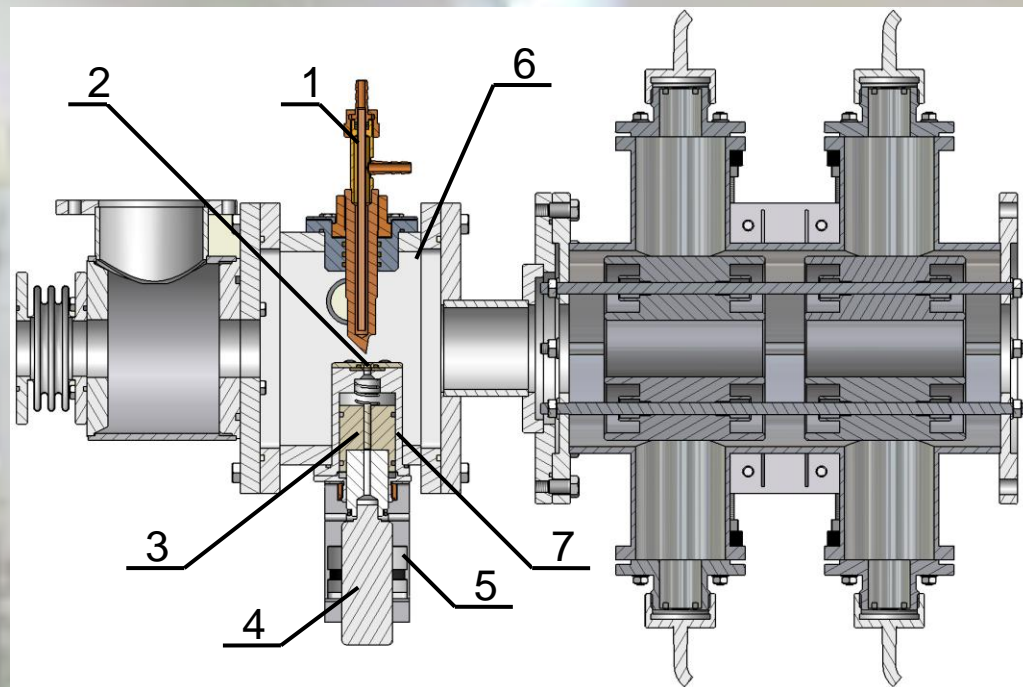
3D model and a general view of the quasimonochromatic X-ray source with ion excitation.

X-ray spectra from copper converter:

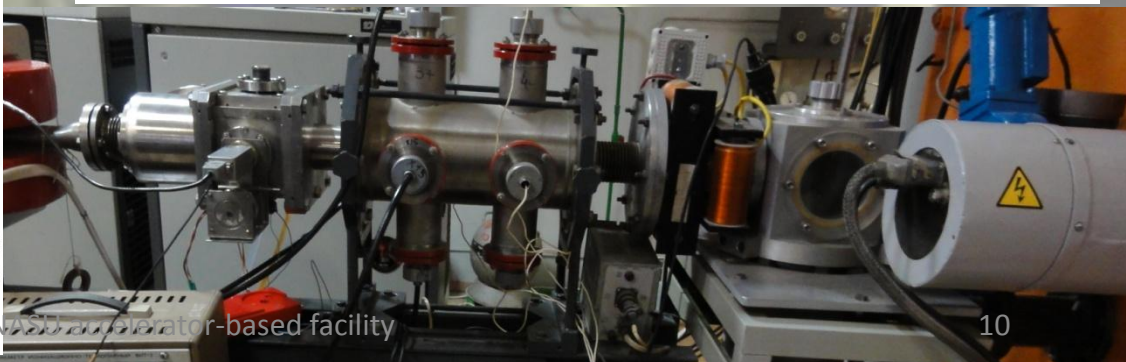
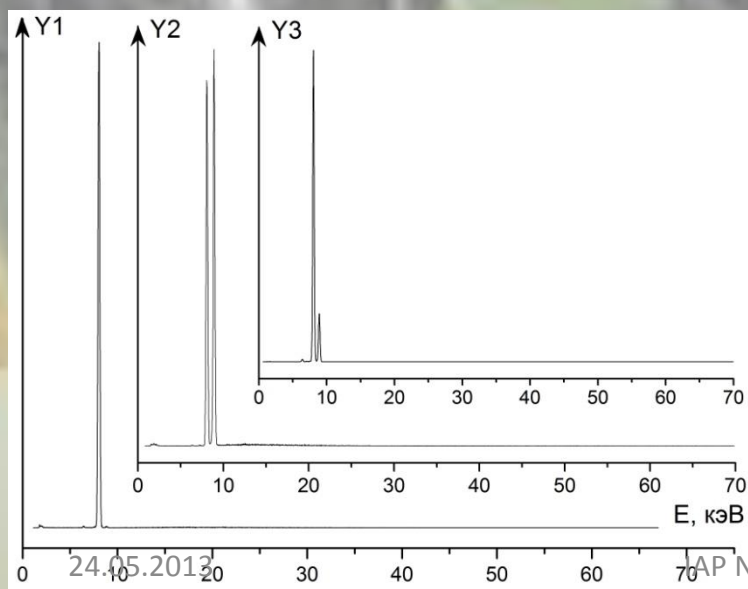
Y1 – with a Ni filter;

Y2 – without Ni filter;

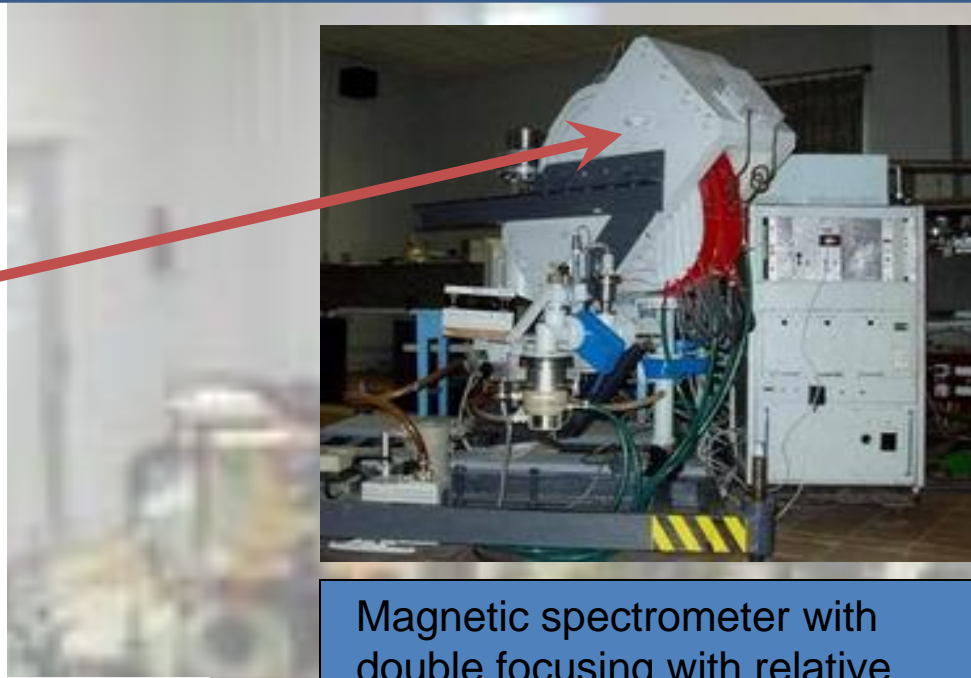
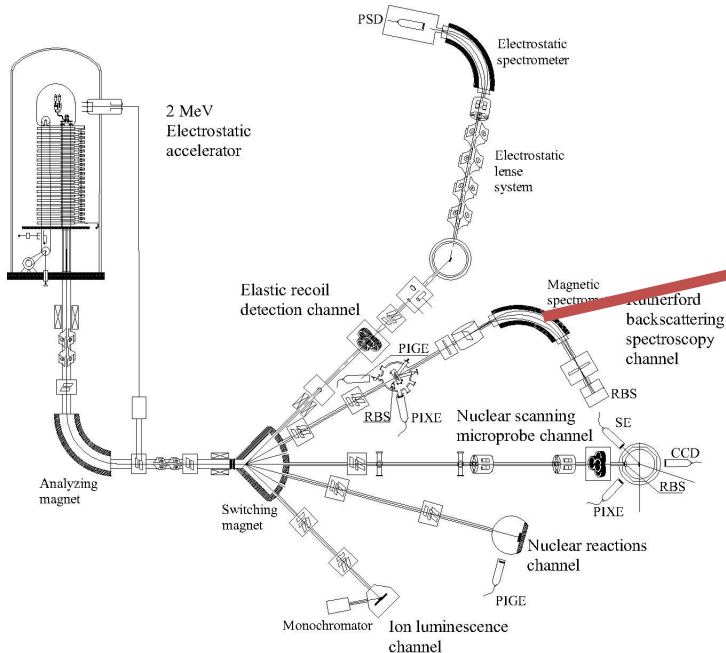
Y3 – without Ni filter, detector is in vacuum



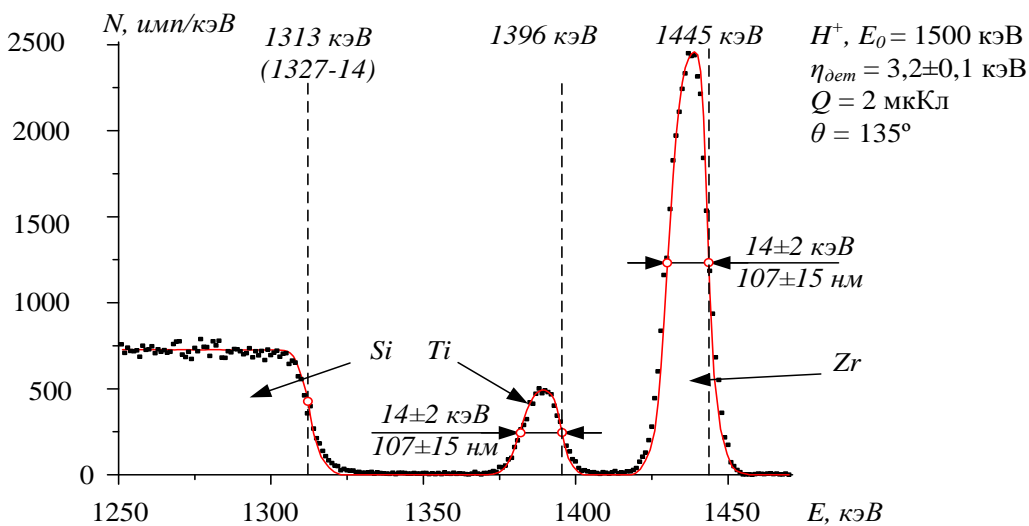
**Converter chamber and a doublet of electrostatic quadrupole lenses:**  
 1 – converter; 2 – window for X-rays extraction to atmosphere; 3 – polycapillary X-ray lens holder; 4 – X-ray detector; 5 – positioning system; 6 – converter chamber; 7 – cartridge.



# High-resolution RBS end-station

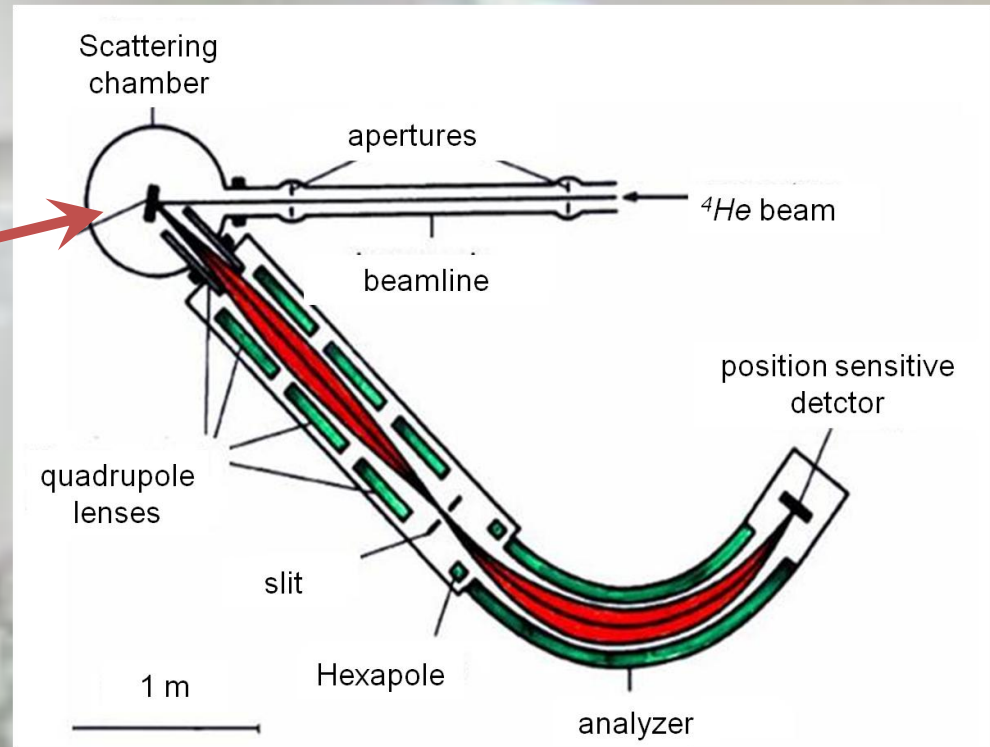
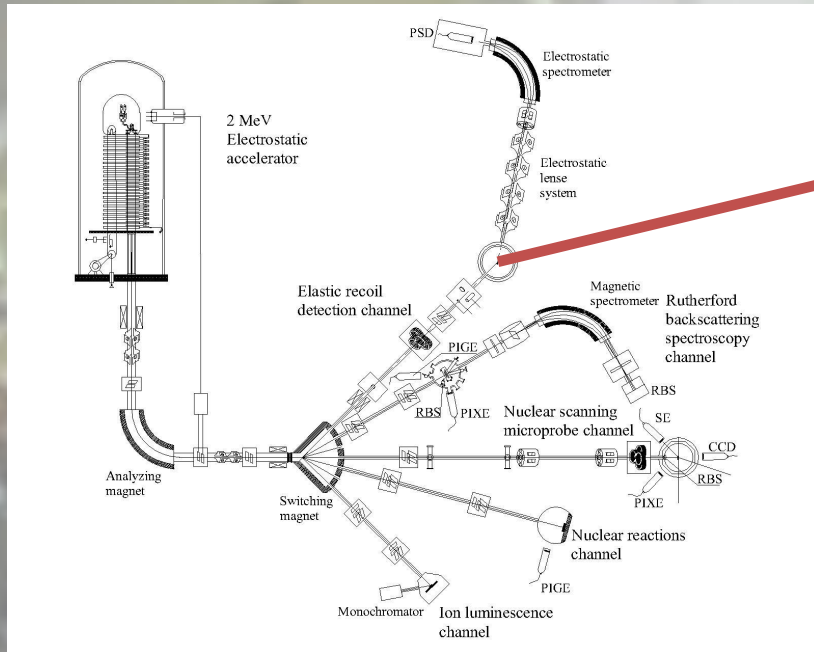


Magnetic spectrometer with double focusing with relative energy resolution ( $\Delta E/E=3,2 \times 10^{-3}$ )

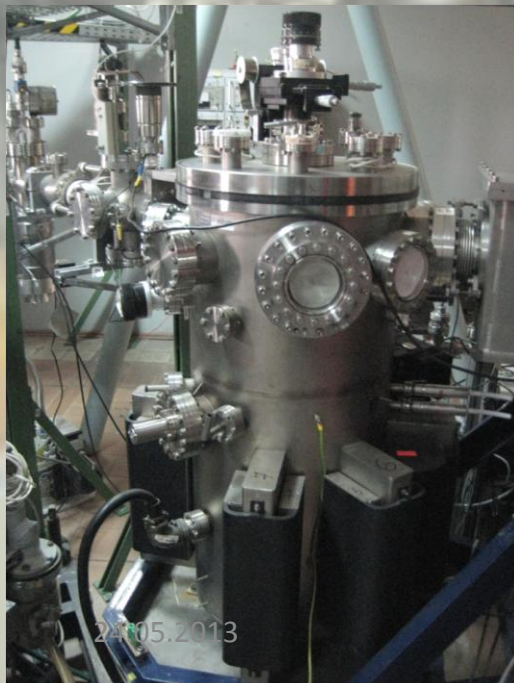
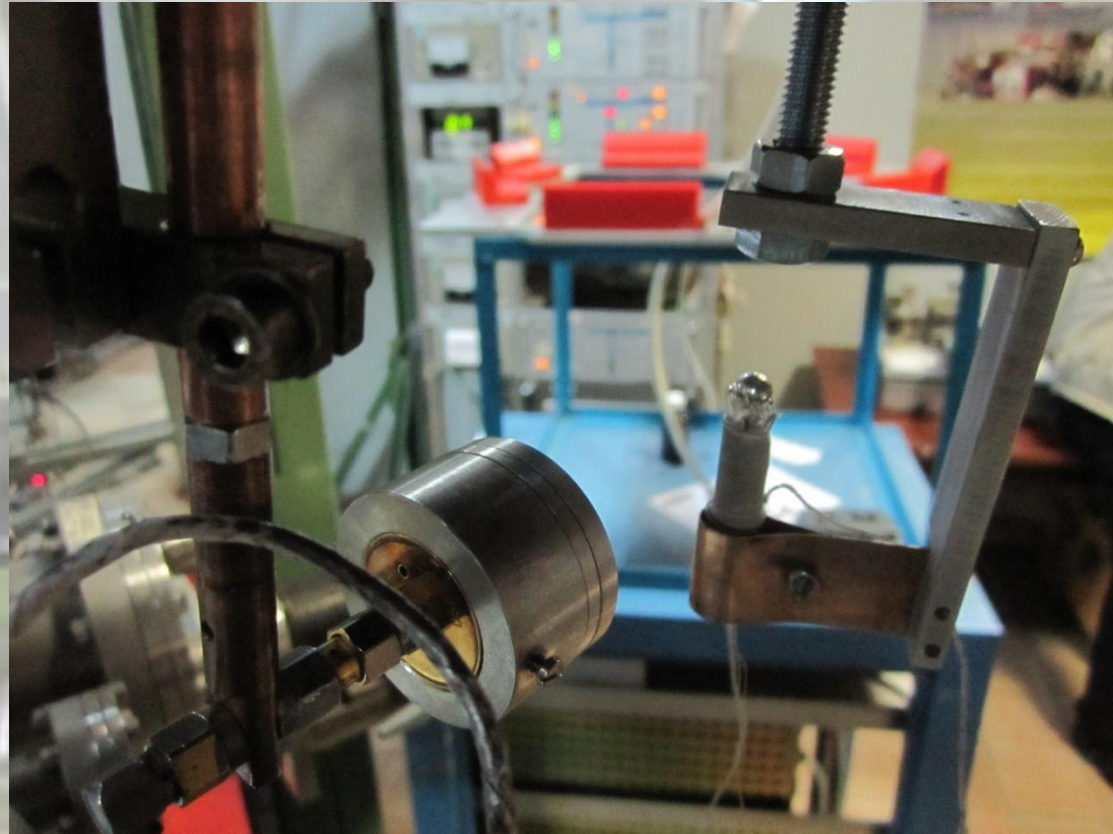
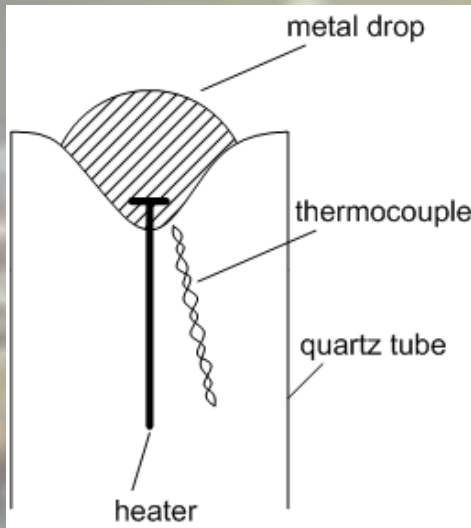


HRBS energy spectrum from Zr-Ti thin film deposited on silicon substrate.

# High-resolution ERDA and RBS end-station

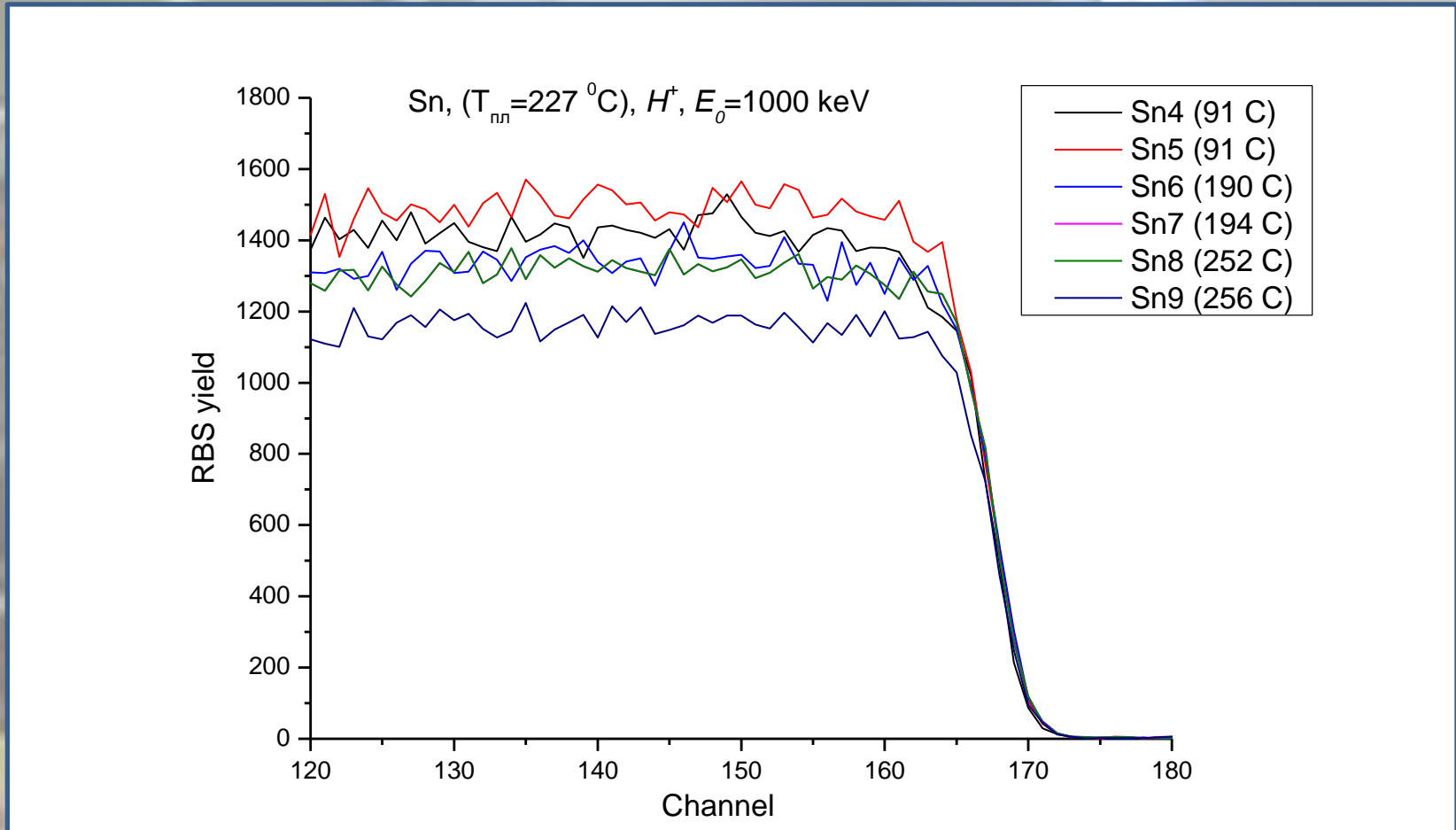


# Special specimen holder for investigation of melted metals by means of HRBS



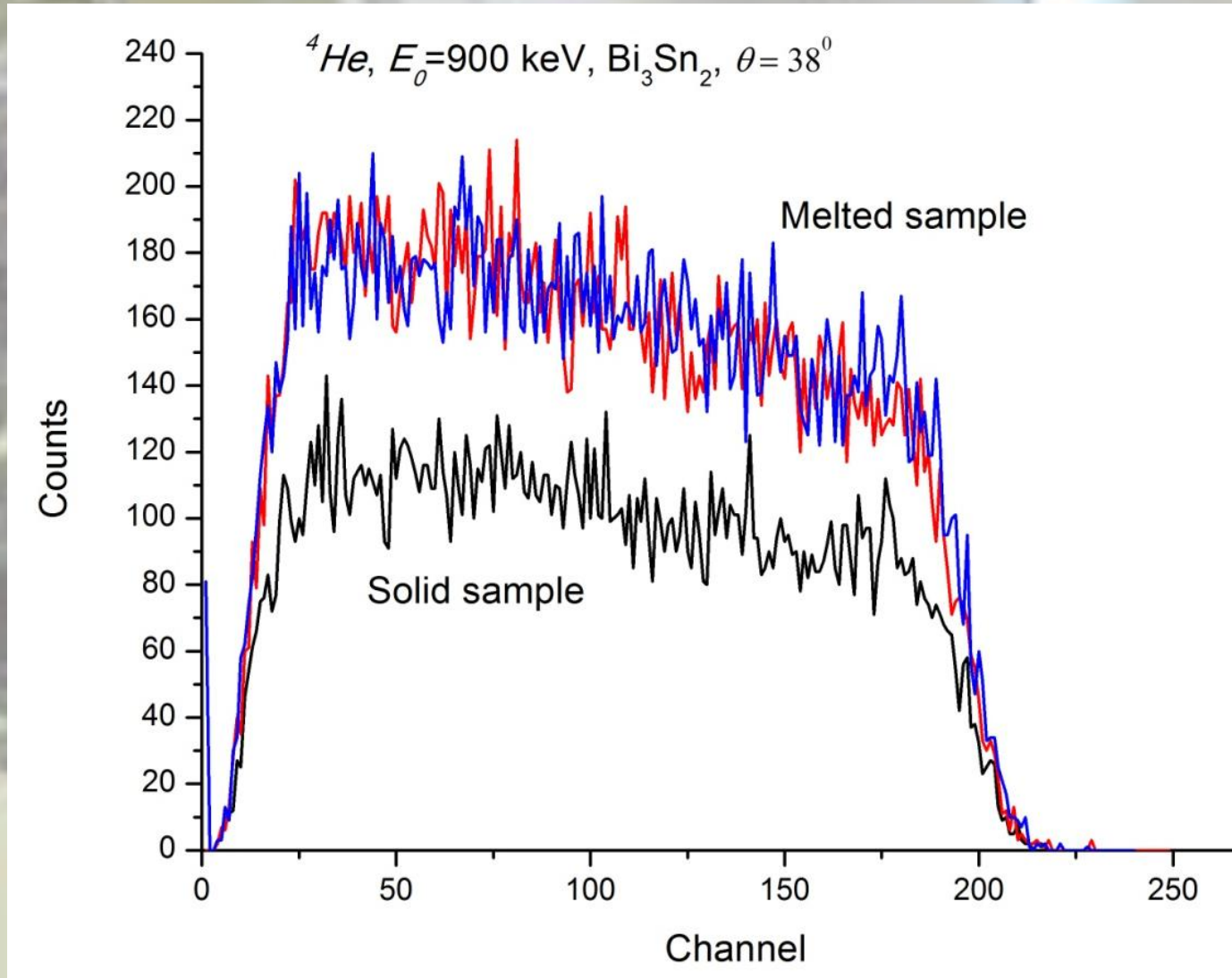
A special specimen holder for *in situ* investigation of metal melts by means of high-resolution Rutherford backscattering spectrometry: a quartz tube with a heater and thermocouple for temperature monitoring.

# In situ study of tin melting by means of RBS



RBS spectra of pure tin at different temperatures

# Bismuth-tin alloy melting investigation by means of HRBS





**Thank you for attention!**

**Institute of Applied Physics,  
National Academy of Sciences**

***Andriy Kramchenkov***

**[akramchenkov@yandex.ru](mailto:akramchenkov@yandex.ru)**

**58, Petropavlivs'ka str.,**

**Sumy, Ukraine**

**40000**

