Accelerator program of the IAP NAS of Ukraine

Materials analysis by means of high-resolution RBS and ERDA

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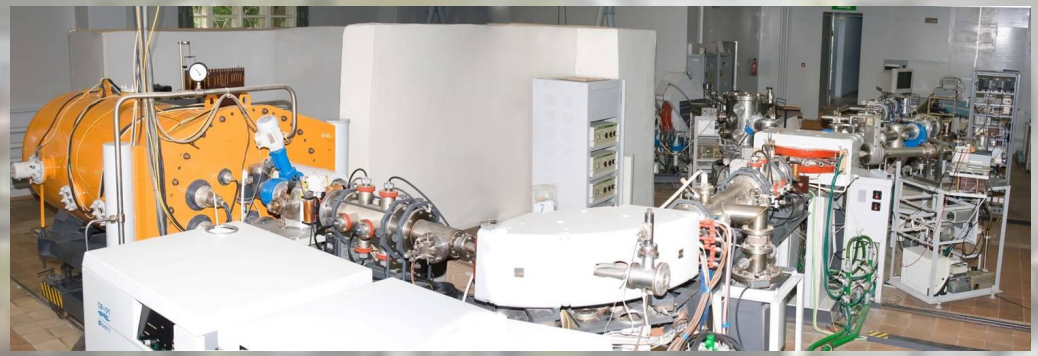
IAP NASU accelerator-based facilities

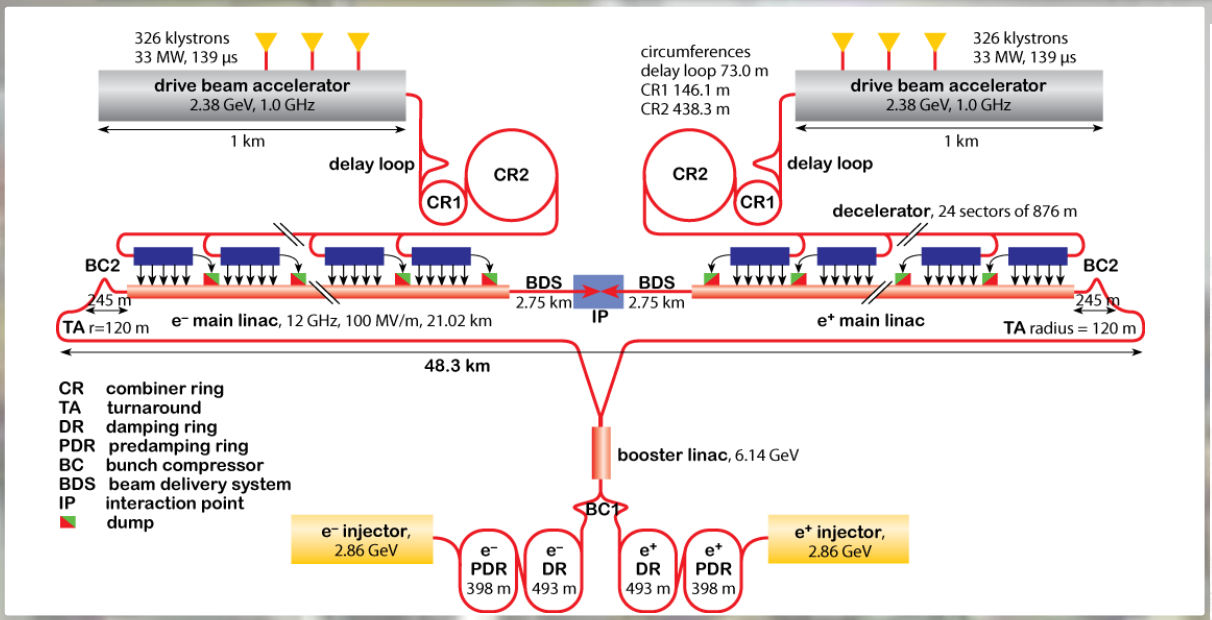


2 MV microanalytical accelerator-based facility

1 MV accelerator mass-spectrometer HVEE

6 MV Pelletron accelerator facility *(under comission)*

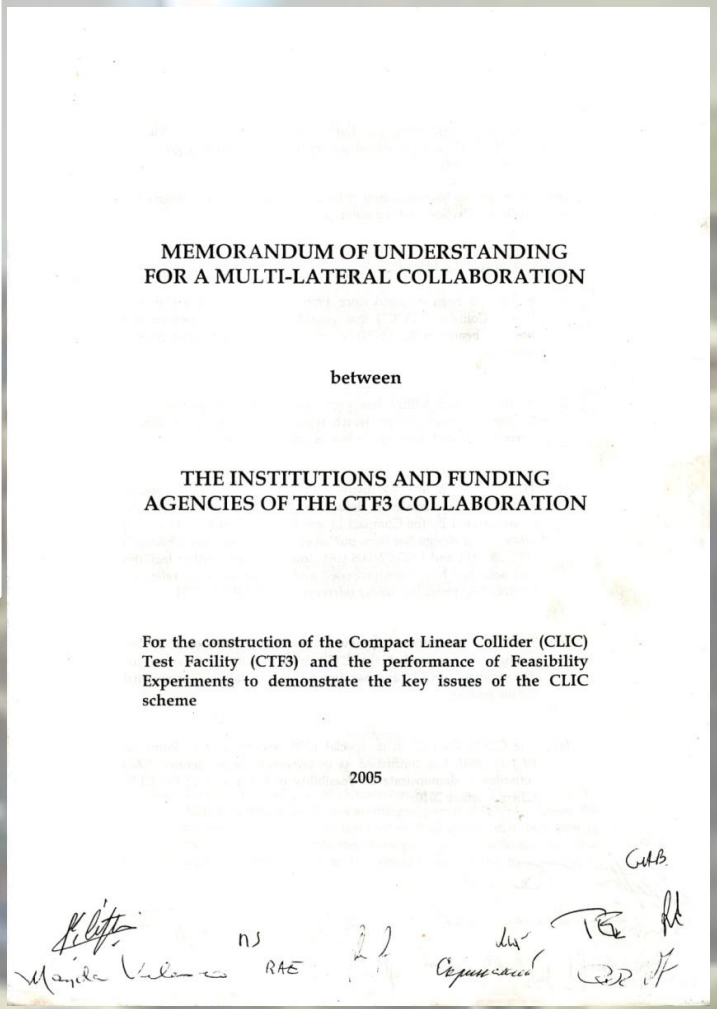
IAP NASU in the CLIC collaboration



In order to reach 3 TeV energy in a realistic and cost efficient scenario, the accelerating gradient has to be very high - CLIC aims at an acceleration of **100 MV/m**. Superconducting technology being fundamentally limited to lower gradients, only **room temperature travelling wave structures at high frequency** (12 GHz) are likely to achieve this gradient.

CLIC collaboration wants to reach an ambitious aim – accelerating field gradient of 100 MV/m!

Current maximum reached gradient (e.g. SLAC) is about 20 MV/m.



MEMORANDUM OF UNDERSTANDING
FOR A MULTI-LATERAL COLLABORATION

between

THE INSTITUTIONS AND FUNDING
AGENCIES OF THE CTF3 COLLABORATION

For the construction of the Compact Linear Collider (CLIC) Test Facility (CTF3) and the performance of Feasibility Experiments to demonstrate the key issues of the CLIC scheme

2005

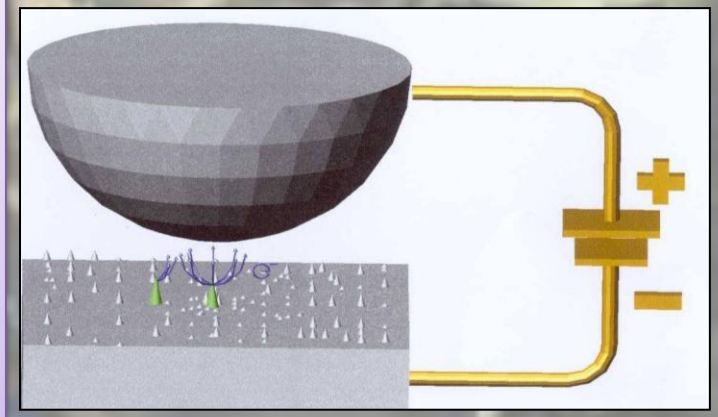
Understanding of RF breakdown

Theory of the RF breakdown process is still not developed.

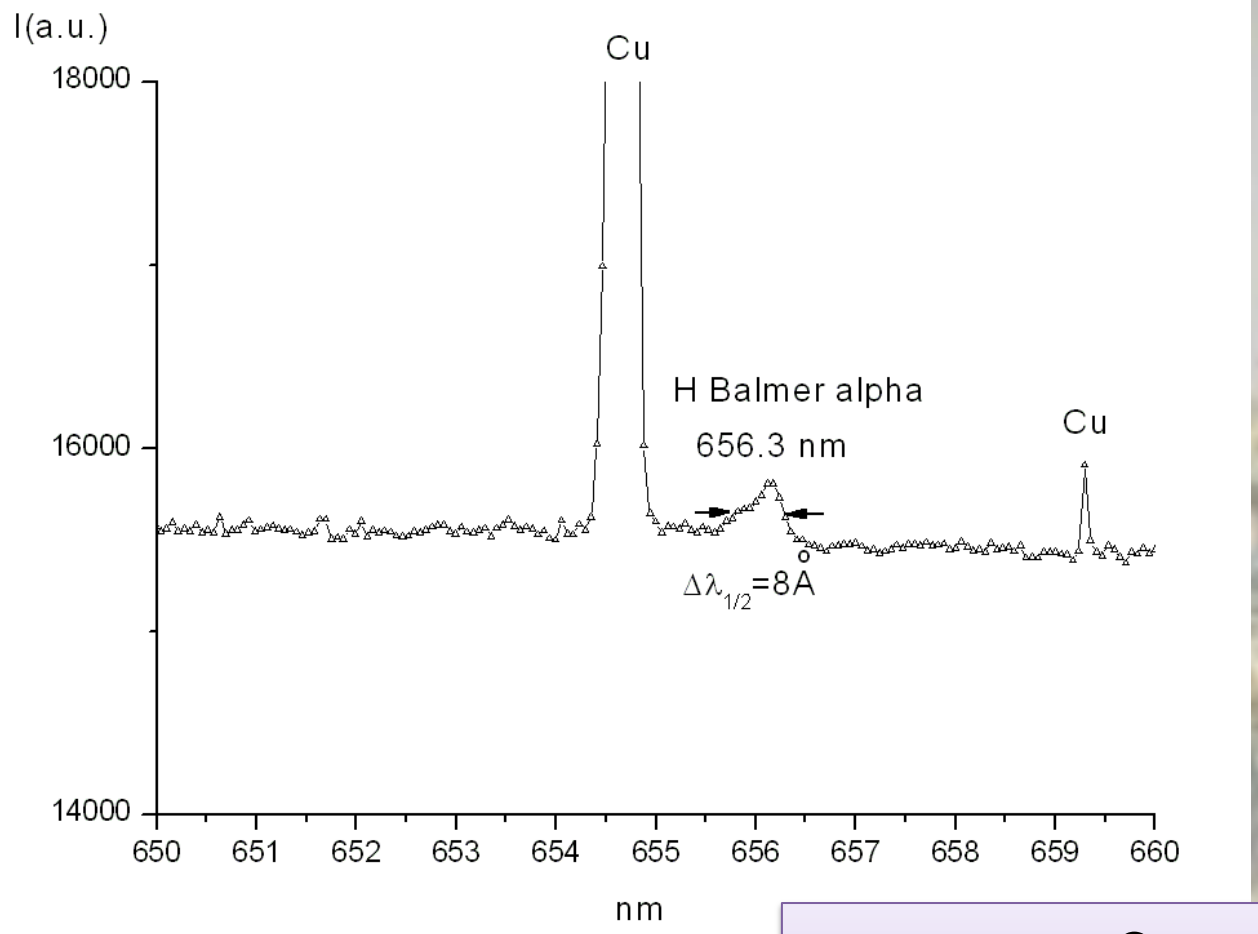
The cheaper way to understand RF breakdown mechanism is a study of DC-spark.

IAP NASU is involved in theoretical investigation of RF-breakdown mechanism and experimental research of high purity copper for CLIC project:

- Optical diagnostics of plasma, obtained on the CLIC DC-spark setup;
- Quantitative investigation of H content in copper by means of HERDA and thermal extractor + gas chromatograph;
- Joint (CERN & IAP NASU) supervision of one PhD student.



Optical spectra from the CLIC DC-spark setup



Plasma density was found to be 10^{16} – 10^{18} cm^{-3} during the breakdown lifetime, and temperature of ion component of the plasma is about 1eV.

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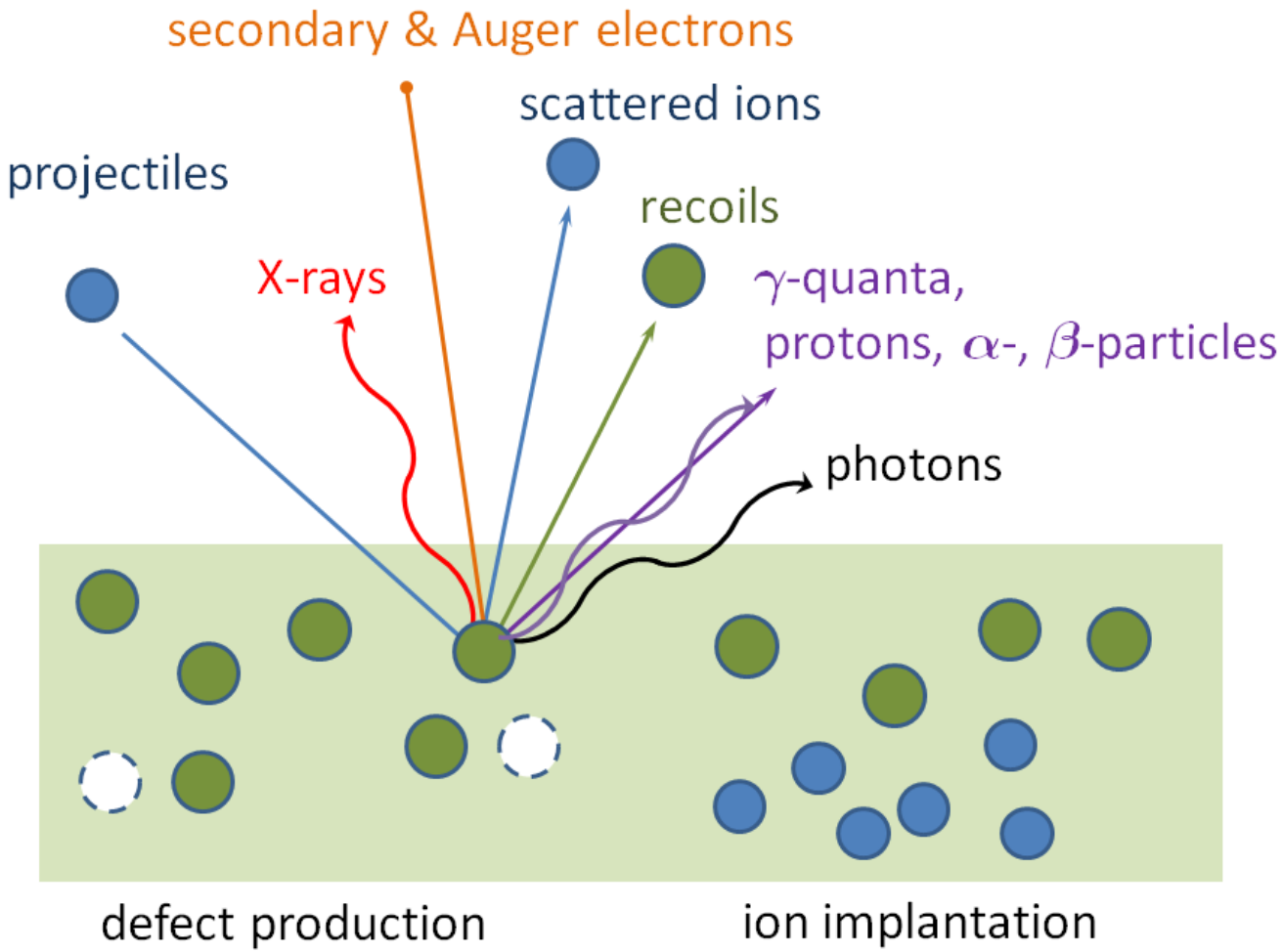
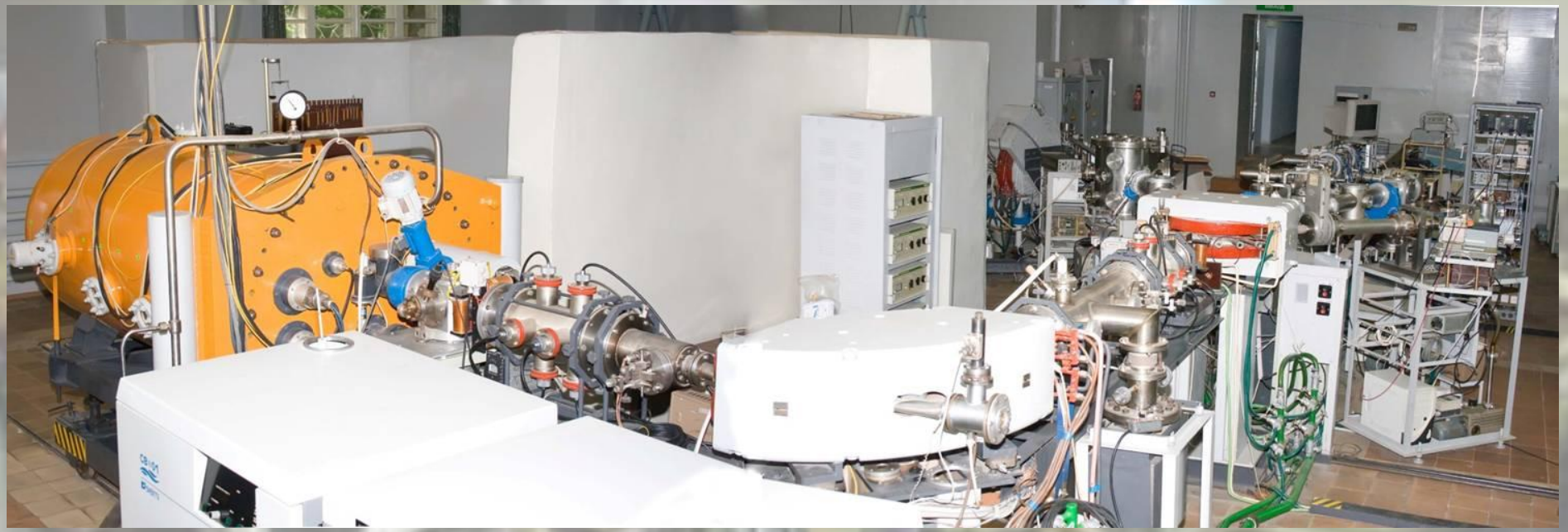
Elementary processes of ion-matter interaction



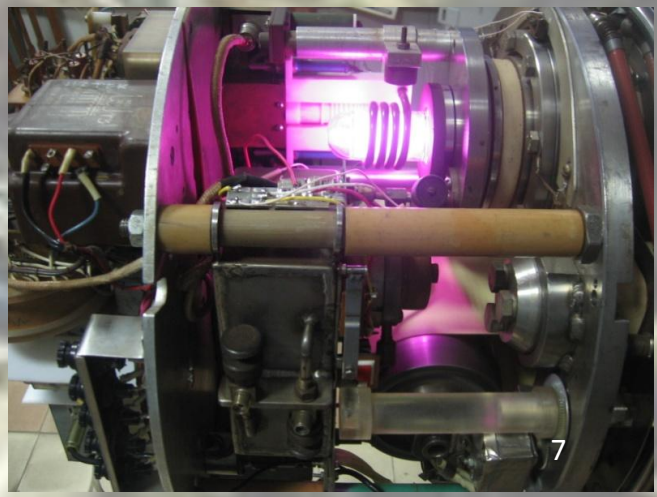
RBS,
resonant BS
PIXE
SE imaging,
AES
NRA (PIGE)
ERDA
IL

2 MV accelerator-based facility

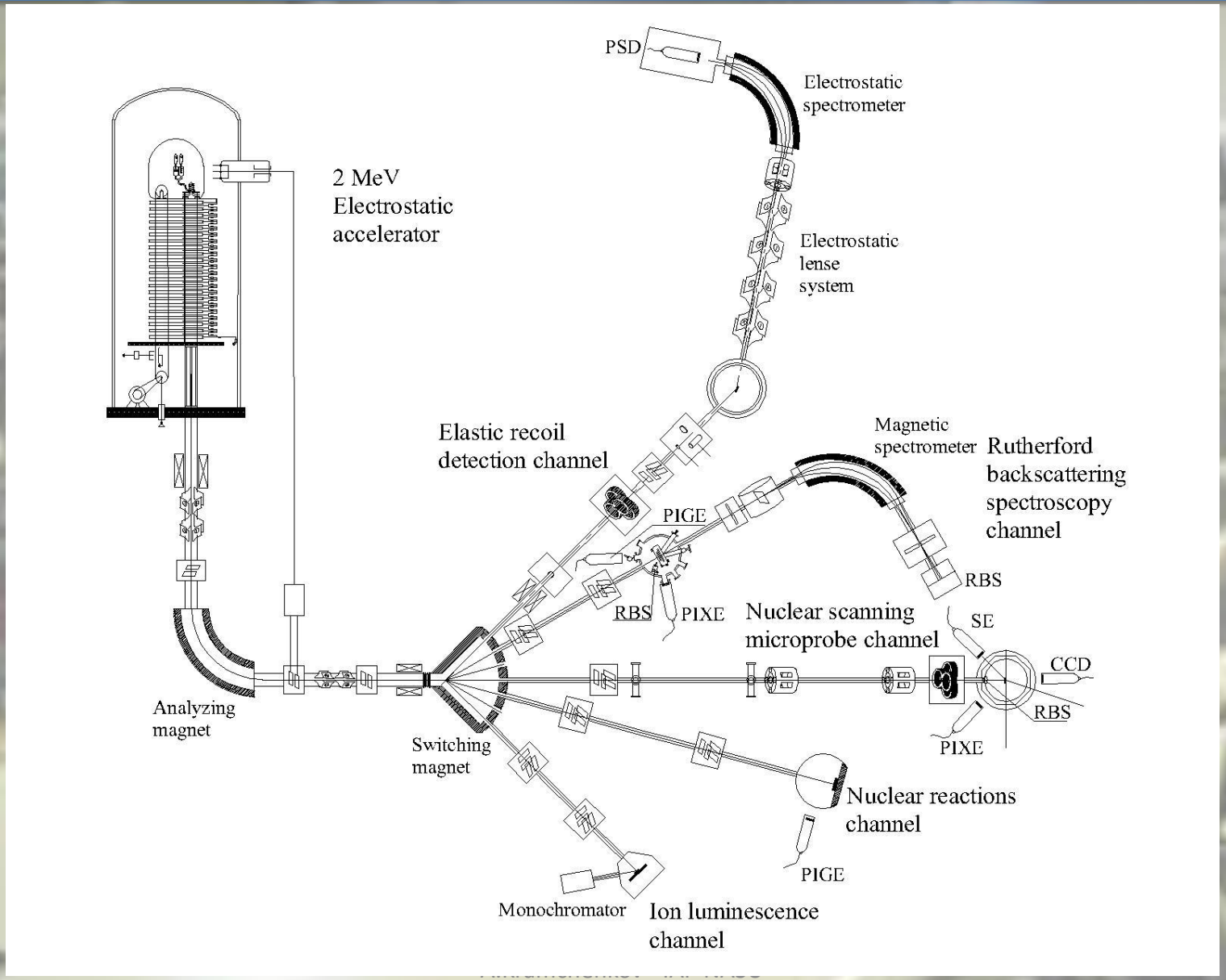


2 MV electrostatic accelerator
H+, He+ and *He++* ions (RF ion source);
Accelerator voltage stability < 1 keV at 1 MV on the terminal (*ΔE/E*<10-3)

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 .*



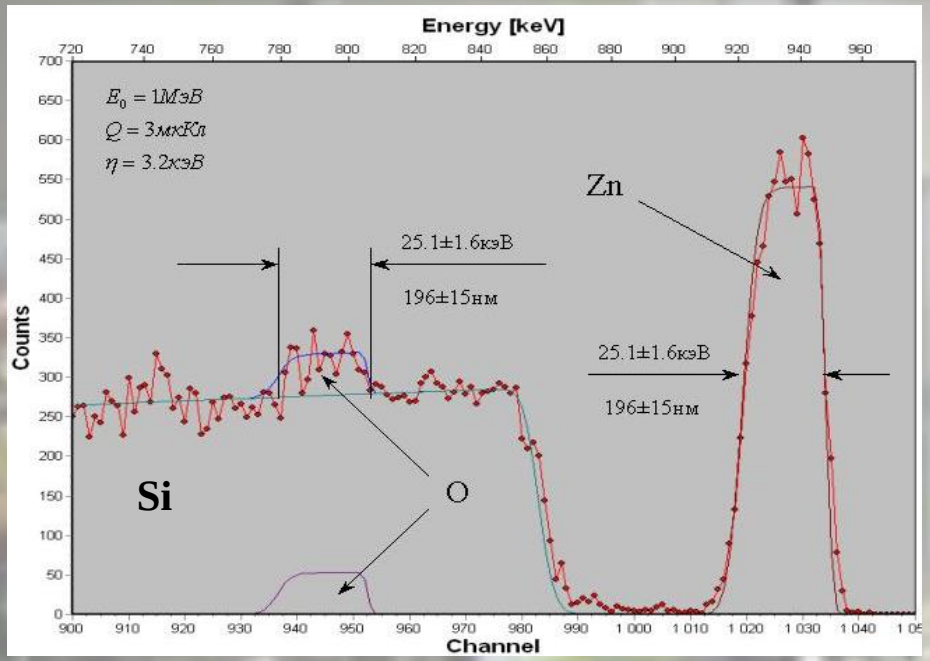
2 MV accelerator-based facility



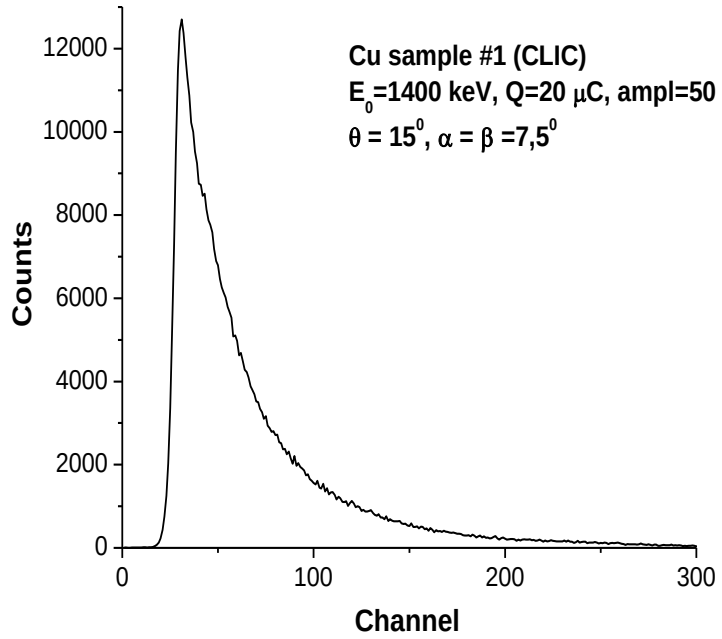
HP copper samples for CLIC project

- **Question**: How a small and old 2 MV VdG ion accelerator can help to born it's bigger and younger brother (3 TeV CLIC electron machine)?
- **Answer**: ion beam analysis of CLIC materials, especially hydrogen concentration measurements.

High-resolution RBS and ERDA



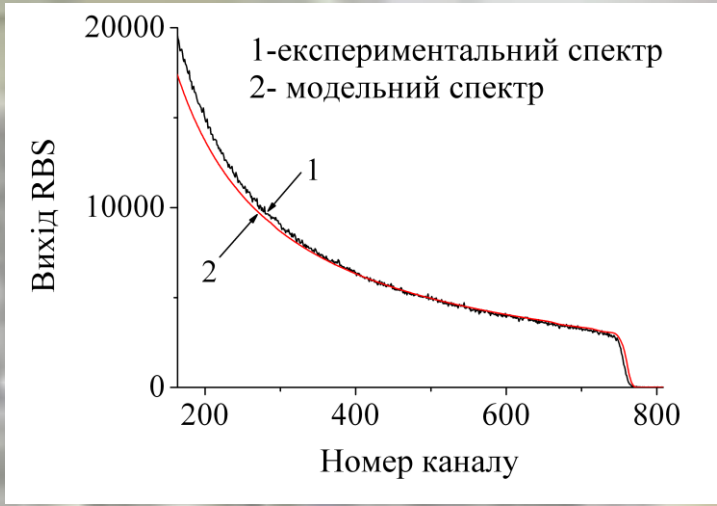
High-resolution magnetic spectrometer ($\Delta E/E$=3,2×10^{-3})

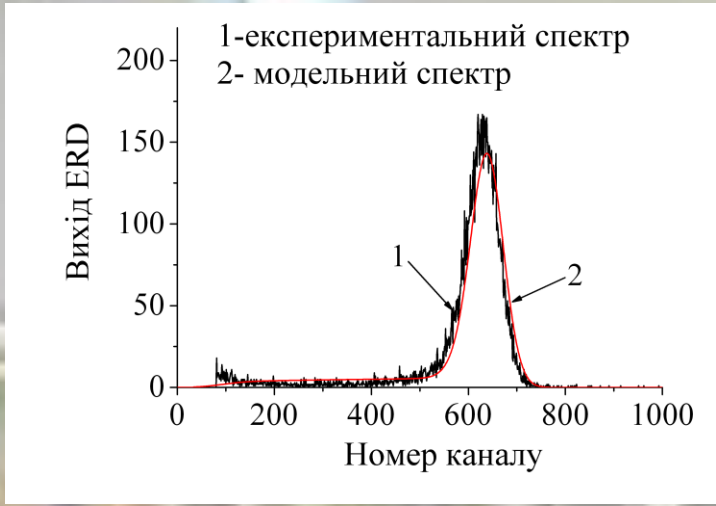


RBS

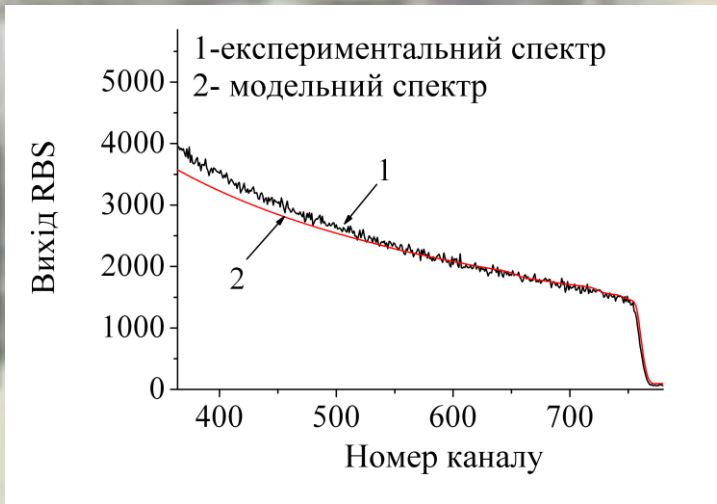
ERDA

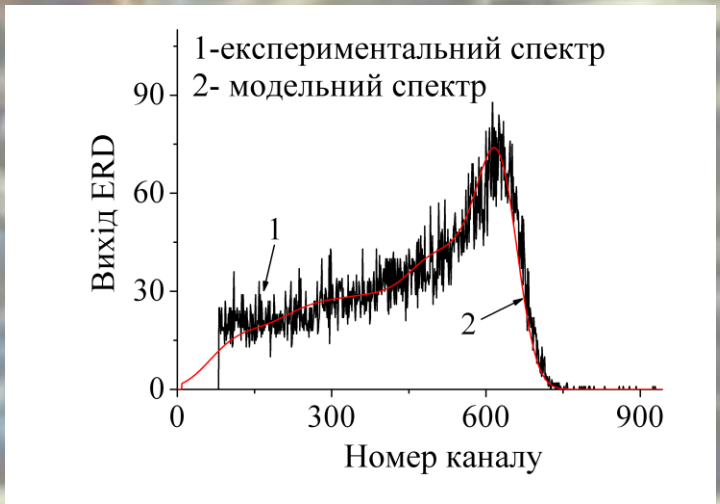
Cu



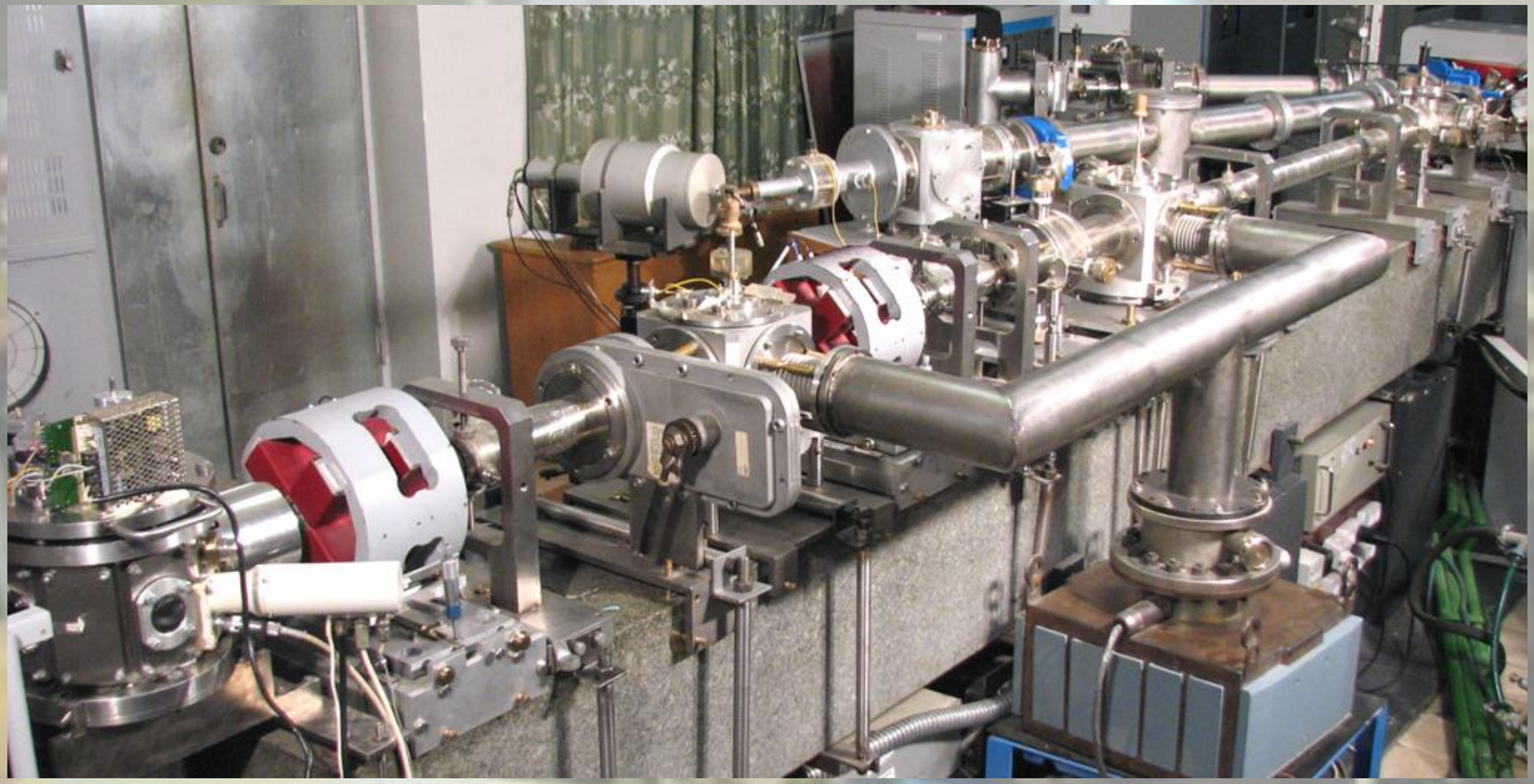


Cu+ 3%Zr





Scanning ion microprobe



High current mode: beam spot 1,2×2 μm, ion current 100 pA; **Low current mode:** beam spot 100×100 nm, ion current 20 nA. **Techniques available:** μRBS, μPIXE, SE imaging, IBIC.

Ion microprobe

Fig. 1 and 2. Element distribution in composite stainless steel/Cu/Nb/Zr,Nb(1%).
Fig. 3 Sulphur segregation to the grain boundaries in copper.
Fig. 4 Copper calibration grid imaged by SE imaging (1000 mesh per inch).g

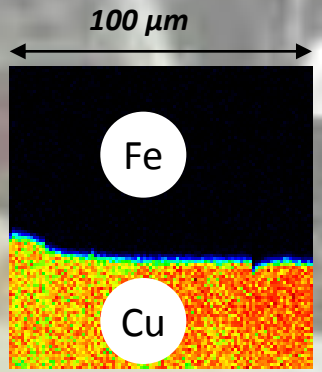


Fig. 1

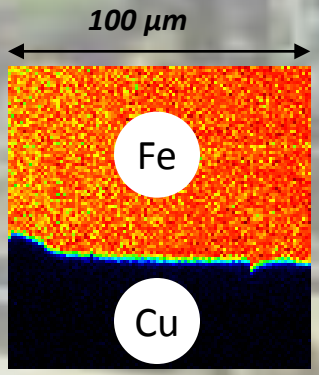


Fig.2

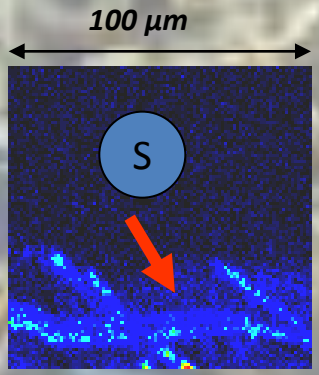


Fig.3

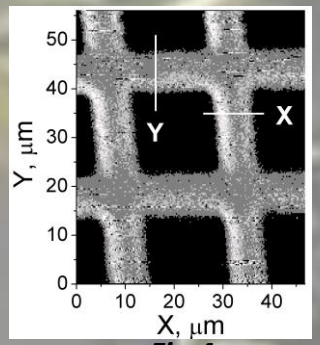


Fig.4

Gas chromatography with a thermal extraction

- Quantitative
- Express
- destructive

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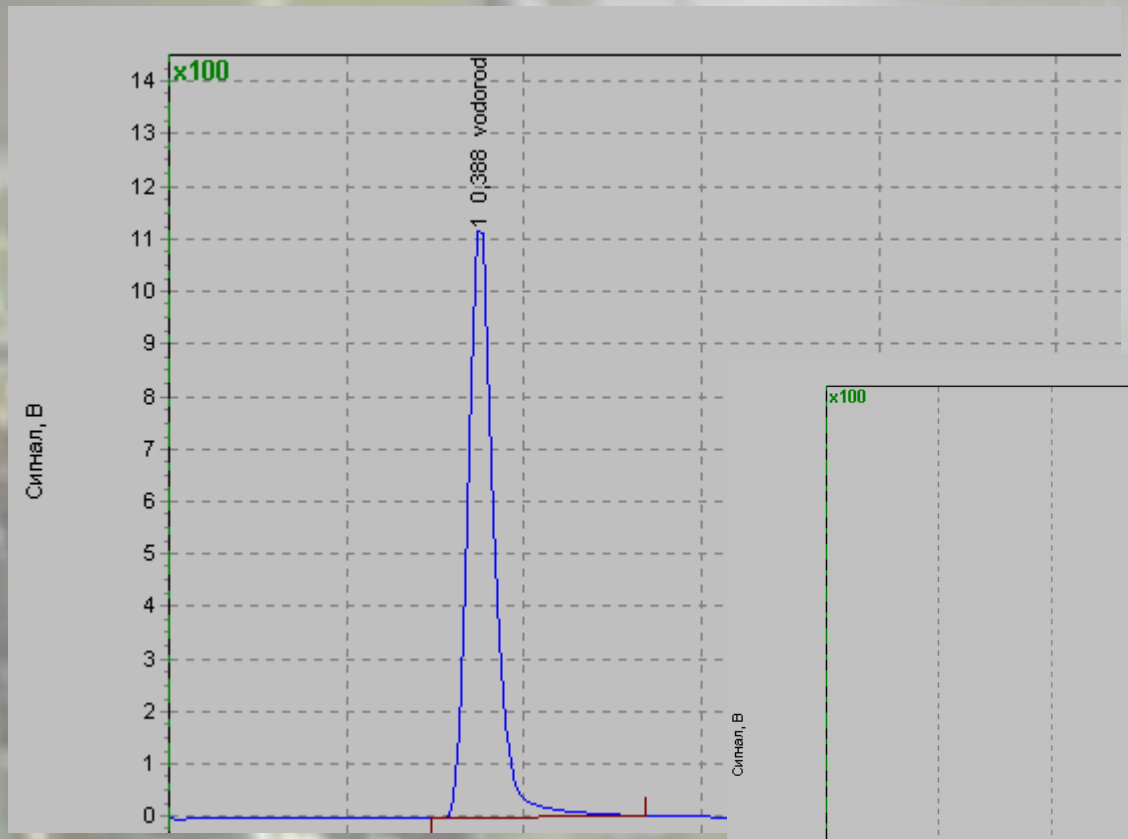
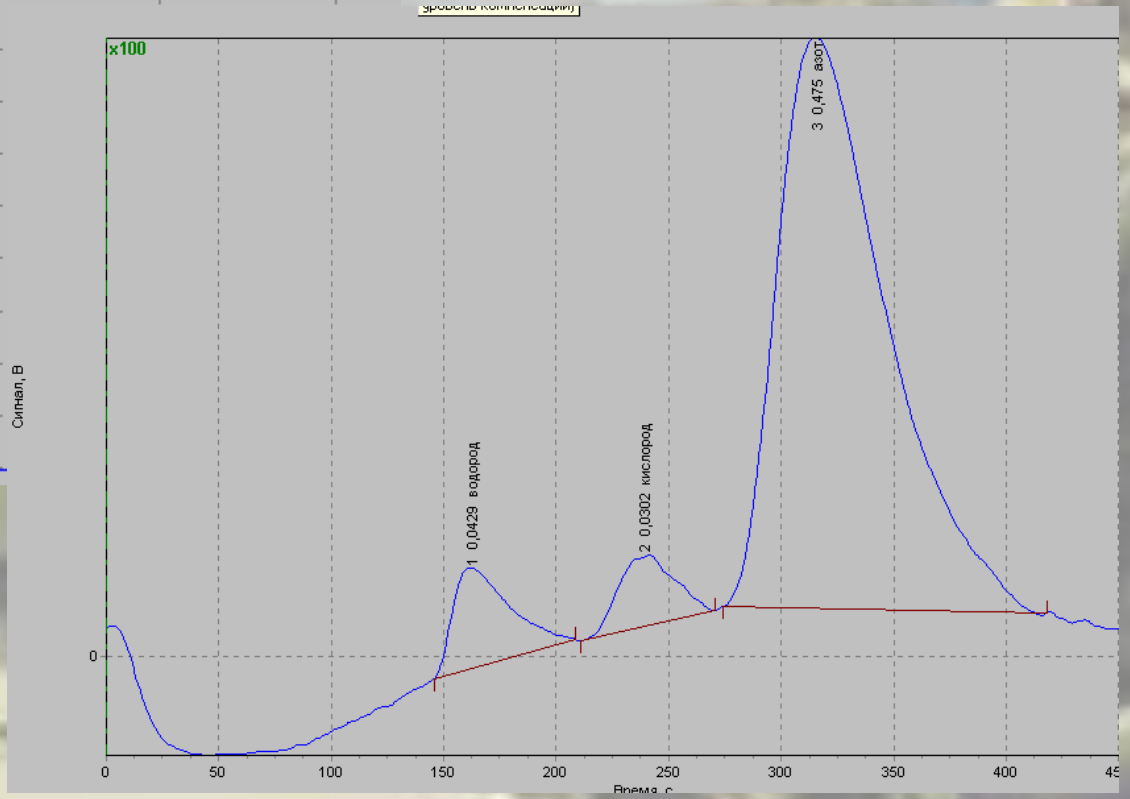
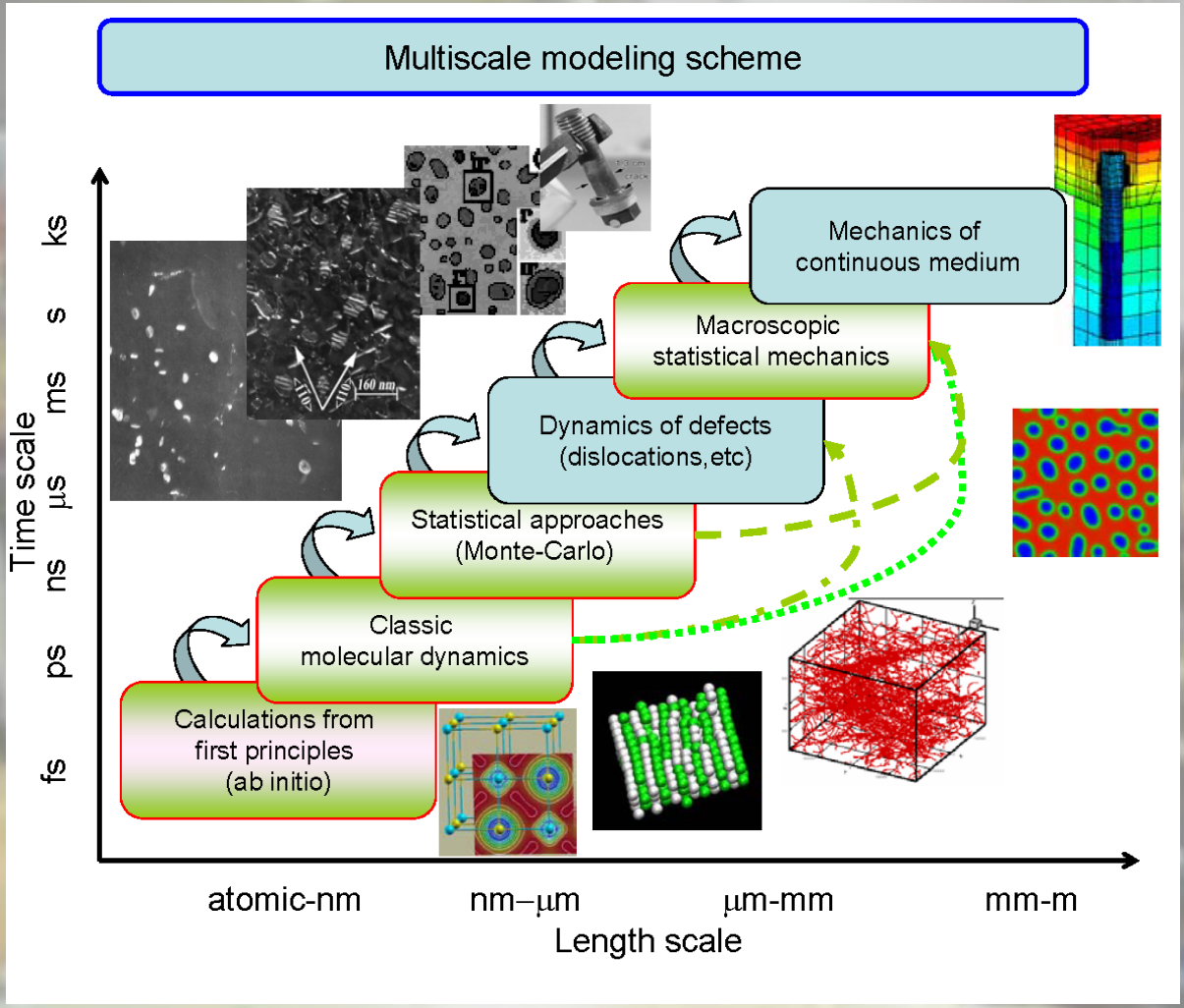
H content measurement by gas chromatography





Multiscale modeling of radiation resistant materials



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- Characterization of zirconium alloys and hydrides, structural transformations in such materials;
- Dynamics of defects in crystalline systems at elevated temperatures.
- Microstructure transformations in crystalline systems and dynamics of defects of different dimensions;
- Understanding of behavior of crystalline systems with magnetic properties
- Understanding diffusion processes on grain boundaries, studying dynamics and morphology of islands of new phase Pattern formation at the surface during ion-beam sputtering, molecular beam epitaxy;
- Nano-size pattern formation at condensation in systems with interacting adsorbate

IAP NASU in the FAIR project

Agreement of collaboration
between Stored Particles Atomic Physics Research Collaboration (SPARC)
at Facility for Antiproton and Ion Research (FAIR) project
and the Institute of Applied Physics,
National Academy of Sciences of Ukraine

Hereby both parties have entered into an Agreement of collaboration free of any monetary obligations concerning investigation of processes of quantum electrodynamics (QED) in strong external fields for the FAIR project.

The collaboration expects scientific data exchange, joint academic meetings, co-publications, mutual academics visits, joint post-graduate study.

Within the Agreement of collaboration the Parties are planning the joint works as follows:

- investigation of resonant and non-resonant processes of quantum electrodynamics (QED) of the first and the second order on the fine structure constant in strong impulse field of laser (PHELIX), namely, the processes of scattering of electrons by nuclei (by electrons, by positrons, by mu-mesons); the processes of spontaneous bremsstrahlung, photo-production of electron-positron pair at a nuclear field and the Compton scattering of photons by electrons;
- investigation of QED processes of the first and the second order on the fine structure constant in bi-chromatic strong laser field, namely study of interference effect related to the most probable radiation and absorption of combination frequency photons by electrons;
- investigation of the QED phenomena at relativistic heavy ions collisions, electron-positron pair creation, in particular;
- investigation of resonant and non-resonant QED processes in strong magnetic field between colliding nuclei, in particular, electron-positron pair production, photon polarization shift, etc.

Date: 16.11.2012

Spokersperson of Stored Particles Atomic Physics Research Collaboration

Prof. Reinhold Schuch

Director of the Institute of Applied Physics, NAS of Ukraine

Academician of NAS of Ukraine
Prof. Volodymyr Yu. Storizhko

Thank you for attention!

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