Accelerator mass spectrometry (AMS) and ion beam analysis (IBA) with the new 6 MV accelerator at FZ Dresden-Rossendorf

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Ion beam analysis @ FZD

Since more than 30 years ion beam analysis is performed at the Forschungszentrum Dresden-Rossendorf (FZD) for the determination of element distributions. Due to continuous upgrades of the different experimental set-ups, we are able to routinely perform:

- Rutherford Backscattering Spectrometry (RBS) & Channeling (C-RBS)
- Nuclear Reaction Analysis (NRA)
- Elastic Recoil Detection Analysis (ERDA)
- Particle-Induced X-Ray Emission (PIXE)
- Particle-Induced Gamma-Ray Emission (PIGE)

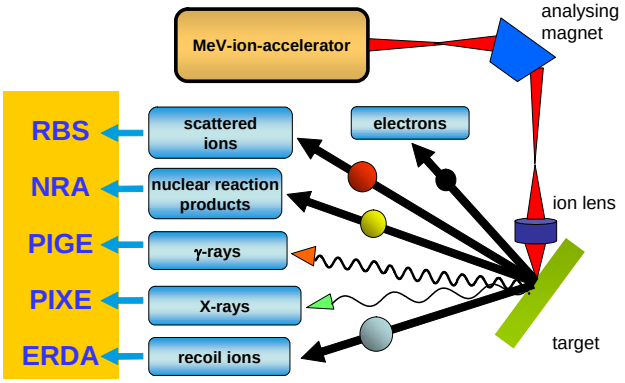

Fig. 1: IBA-methods applied @ FZD.

State-of–the art with "old" 5 MV accelerator [1]

Most of our applications lie within material sciences. We are able to measure non-destructively "all natural" elements, i.e. hydrogen to uranium, most elements with lateral, some even in 3-D resolution with the following typical parameters (highly depending on matrix and elements):

- depth resolution: 1-30 nm
- depth range: nm-µm
- lateral resolution: few µm
- usual mapping area: 2x2 mm^2
- maximum sample size: 3x10 cm^2 (vacuum) & "unlimited" (external beam)
- detection limits: ~10 µg/g (H)
  500 µg/g – 1% (He-F)
  10-100 µg/g (Na-U)

For some elements, e.g. H/D, isotope analysis is possible.

Outlook for "new" 6 MV accelerator

In summer 2009, the 30-year-old Russian-made van-de-Graaff 5 MV accelerator will be replaced by the latest 6 MV Tandetron model from HVE [2], which is even more sophisticated than the lately installed 5 MV version from Southern France [3]. Our new accelerator will need of course less maintenance allowing more beam time for real measurements with respect to our old one. It might be also possible to expand from two to three 8-hour-shifts a day with the new fully automatic system.

Scientifically, the main advantages for ion beam analysis are an increased depth range by a factor of 2 for ERDA and improved detection limits for NRA.

In addition, the machine will be installed with special equipment for accelerator mass spectrometry (AMS) [4].

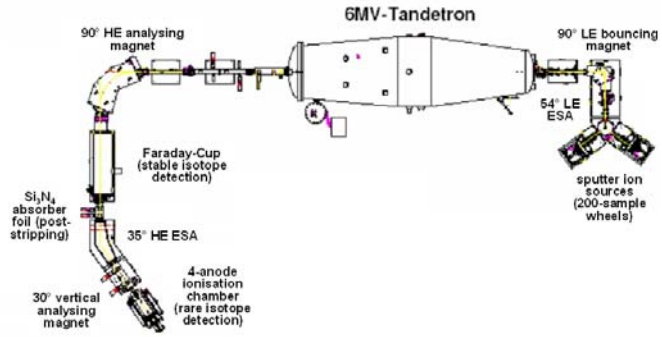

Fig. 2: The new 6 MV set-up @ FZD.

AMS

There is a main advantage of using a high-energy accelerator for mass spectrometry: The background and interfering signals, resulting from molecular ions and ions with similar masses (e.g. isobars) are nearly completely eliminated. Thus, AMS generally provides much lower detection limits in comparison to conventional mass spectrometry (typical isotope ratios 10^{-10}-10^{-15}). Our AMS system will offer excellent measurement capabilities also for external users.

In contrast to common low-energy AMS facilities in Europe, which have mainly specialized in radiocarbon analyses (^{14}C), the FZD-AMS is the first modern-type facility in the EU that will run at a terminal voltage of 6 MV.

Especially in environmental and geosciences, the determination of long-lived ($t_{1/2} > 0.3$ Ma) cosmogenic radionuclides like ^{10}Be, ^{26}Al, and ^{36}Cl became more and more important within the last decades [5]. Using these

nuclides dating of mass movements, e.g. volcanic eruptions, rock avalanches, earth quakes, and glacier movements is possible.

[1] http://www.fzd.de/fwia (November 2008).
[2] A. Gottdang *et al.*, *Nucl. Instr. and Meth. B* **2002**, *190*, 177-182.
[3] M.G. Klein *et al.*, *Nucl. Instr. and Meth. B* **2008**, *266*, 1828-1832.
[4] http://www.fzd.de/ams (November 2008).
[5] J.C. Gosse and F.M. Phillips, *Quat. Sci. Rev.* **2001**, *20*, 1475-1560.