



# **IAEA Technical Meeting on Developments in Instrumentation and Novel Techniques for X-Ray Spectrometry Applications**

**IAEA Headquarters, Vienna, Austria  
28 September–2 October 2015**

**Ref. No:F1–TM–47480**

## **Announcement and Call for Papers**

### **A. BACKGROUND**

X-ray spectrometry (XRS) techniques have an instrumental role amongst available analytical tools required for an advanced characterization not only of modern technological but also of Cultural Heritage related materials. The capabilities of X-ray spectrometry techniques fulfil a broad range of requirements related to the type of analytical information (elemental, chemical, structural, dynamic and crystalline), the spatial resolution/range of analysis (from few tens of nanometre to macro-areas,  $\sim\text{m}^2$ ), and the capability to overcome limitations commonly imposed by the sample physicochemical state (liquid, frozen or heated samples state analysis) and/or analysis environment (atmospheric pressure, anaerobic conditions, field/in-situ measurements, etc.). Summarizing the progress from early 1970s up to modern times, the various developments in the analytical performance and utilization of XRS techniques for interdisciplinary applications have been always motivated and driven by advances in relevant X-ray instrumentation (sources, detectors, x-rays focusing devices) and from the analytical requirements to provide a more integrated characterization of complex and 3D heterogeneous materials. For example, with the introduction of liquid nitrogen cooled semiconductor detectors (Si(Li), Ge(Li)), the X-ray Fluorescence (XRF) analysis was gradually established as an excellent analytical technique for the quantitative elemental analysis of a great variety of samples. Later on, in mid-1990s the components miniaturization and detector's thermoelectrical cooling allowed the portability of the related instruments and thus paved the way for field analyses and planetary explorations. Most notably, with the worldwide installation and operation of plenty synchrotron radiation facilities, a plethora of XRS techniques and applications has been developed taking advantage of their unique and unprecedented properties.

The trend in X-ray spectrometry over the last few years is the development of larger area X-ray detection systems having higher throughput and being customized for the given type of application. Silicon drift detectors (SDDs) represent the best choice for high resolution, large

dynamic range and high-speed detection of X-rays up to 20 keV energy when coupled with latest technology read-out electronics; large arrays of small area SDDs can now offer megapixel elemental maps in few hours supported by novel data acquisition and analysis strategy. For large area detection of hard X-rays ( $>40\text{KeV}$ ), cadmium telluride (Cd-Te) based sensor arrays have been also developed and tested for various purposes including security and medical applications. The detection systems made by large arrays of sensors are used to improve considerably the throughput in laboratory and especially synchrotron radiation based experiments employing micro- or nano-focused excitation X-ray beams. In this field considerable progress has been attained using new generation polycapillary X-ray lenses (with few tens of micrometre spatial resolution) or more efficient optics devices such as Kirkpatrick-Baez mirrors, Fresnel zone plates, multilayer Laue lenses (MLLs) or compound refractive lenses (CRLs) which are able to focus X-ray beams close to the diffraction limit, in the region of few tens of nm. A different, but emerging, methodology called Full-Field X-ray Fluorescence Analysis offers micrometer spatial resolution by using novel pixelated X-ray detectors combined with pinhole geometry or sophisticated polycapillary structures. Among the pixelated detectors a particular generation of charge-coupled devices (CCDs) called pnCCDs offers energy and position resolution at a high quantum efficiency from the near infrared up to 20 keV with a high frame rate collection ( $\sim 400\text{ Hz}$ ).

Beyond the solid-state energy dispersive detection systems, High Resolution (HR) X-ray spectrometry supports a wide range of applications related to the materials science, (bio)chemistry, solid state physics (study of phase transitions in particular), physical chemistry as well as fundamental atomic and molecular physics studies. Cryogenic detectors such as Super Tunnel Junctions (STJ), Micro-bolometers or transition edge sensors (TES), and Bragg optics based spectrometers using bent analyzers offer certain advantages and disadvantages. For example, a resolving power of 10000 is aimed and 1000 can be attained in the soft X-ray region, whereas in the mid-energy regime, crystals are the best dispersive elements providing a resolving power even better than 10000. Moreover, crystal-based HR spectrometers in conjunction with position sensitive detectors offer high resolution ( $\sim .5\text{ eV @ }5\text{keV}$ ) time-resolved one-shot experiments at X-ray FEL facilities.

In this landscape of X-ray instrumentation developments and analytical performance merits, the trend is that various techniques and methodologies are integrated in the same set-up and are exploited in new applications. Grazing incidence XRF (GIXRF) analysis in combination with X-ray reflectometry (XRR) and absorption techniques are developed for the characterization of heterogeneous micro- and nano-scaled materials (for energy storage and conversion: batteries, fuel cells, photovoltaics, among other applications), 3D confocal set-ups in combination with X-ray transmission micro-tomography (CT) and X-ray fluorescence micro-tomography (XRF-CT) investigate 3D elemental distribution and structure of a broad range of 3D heterogeneous materials or of single microscopic inclusions with importance in biology, biomedicine, geology and cultural heritage. Modern HR techniques such as X-ray Emission Spectroscopy (XES), Resonance Inelastic X-ray Scattering (RIXS) and X-ray Raman Scattering provide unique information related to the local electronic structure, the chemical environment, bonding to the ligands, delocalization of valence electrons in modern materials or in the surface/interface related science.

## B. OBJECTIVES

The Technical Meeting aims at providing a forum for technical discussions amongst specialists with the following objectives:

1. To review the current status, developments, and trends in X-ray instrumentation, analytical techniques and interdisciplinary applications
2. To identify needs and requirements for further improvement and optimization of the analytical performance of X-ray instrumentation and relevant analytical techniques
3. To support exchange and sharing of cross-cutting information and know-how between scientists working in research and development of X-ray instrumentation, techniques and analytical applications
4. To provide recommendations to the IAEA and Member States on how to support and foster advances in the development of X-ray instrumentation and relevant techniques as well as increase access and utilization of relevant technologies by the IAEA Member States

## C. PARTICIPATION

A person will be eligible to participate only if nominated by the Government of an IAEA Member State (Ministry of Foreign Affairs or National Atomic Energy Authority) or by an Organisation invited to participate. **Nomination** for participation (see [Form A](#)) and title of contribution ([Form B](#)) with **abstract** should be received by the IAEA not later than **31 May 2015**. The participant should be a developer and/or user of advanced analytical techniques for laboratory and industrial applications.

## D. SUBMISSION OF ABSTRACTS AND PAPERS

A contribution from the participant in the **form of a 1 page abstract** covering his/her work **relevant to the objectives of the meeting** will be necessary in order to be considered for participation. Please see the guidelines on formatting papers.

**Important:** Contributors of material to be included in the Agency proceedings are required to assign all copyrights or rights to publish to the Agency.

The authors should make sure that the files do not include copyrighted fonts or other impediments for reproduction.

**The abstract** shall be prepared according to the following instructions:

- 1) Page size: A4 (21 cm by 29.7 mm) – vertical orientation
- 2) Margins 25mm all around
- 3) Layout:
  - Title: single-spaced, 14-point size, Times New Roman Font (TNR), **bold**
  - Authors: single-spaced, 12-point size, TNR Font
  - Affiliation: single-spaced, 12-point size, TNR Font, *italic*
  - Text: 1.5 spaced, 12-point size, TNR Font
  - Length: one page

**Important:** In case of sending Microsoft Word files, authors should use True Type Embedded Fonts (when saving the file, click Tools, then Options, and tick Embed True Type

fonts. This will help to prevent change of fonts when the file is read in a different system, as it will be in most of the cases).

## **E. FINANCIAL SUPPORT**

As a general rule, the IAEA does not pay the costs for attendance to the meeting. However, limited funds may be made available to assist the attendance of selected participants and approved in accordance with the current Agency rules and regulations. Generally, not more than one financial grant will be awarded to any one Member State. If Governments wish to apply for financial support on behalf of their nominees, they should address specific requests to the IAEA Scientific Secretary (see [Form C](#)).

## **F. MEETING FORMAT**

To facilitate proceedings, participants are invited to contribute an oral presentation on a subject relevant to the scope and objectives of this meeting. Participants should submit an abstract of their proposed presentation along with their nomination. The official language of the meeting is English. No interpretation will be provided. It is expected that the meeting will start at 9:00 on Monday 28 September 2015 and conclude by 13:00 on 2 October 2015.

The output of discussions will be recorded for possible dissemination to Member States as an IAEA technical publication. Contributors of material to be included in the Agency proceedings are required to assign all copyrights or rights to publish to the Agency. Please complete and sign the **Form B and attach it to your abstract** and send it to the IAEA Scientific Secretary by post or email. The authors should ensure that material they make available for possible publication by the IAEA does not include copyrighted material or other impediments for reproduction.

## **G. LOCAL ARRANGEMENTS**

It is the responsibility of all participants to make their own travel arrangements to/from Austria. Detailed information on accommodation, local transport to/from the meeting venue, and other organisational details, will be sent to all designated participants well in advance of the meeting.

## **H. VISA**

Designated participants who require a visa to enter Austria should submit the necessary application to the nearest diplomatic or consular representative of Austria well in advance of entry. An official letter of invitation will be issued to all designated participants by the IAEA Scientific Secretary.

## **I. DEADLINES**

- **31 May 2015:** Submission of requests to the IAEA for participation (Forms A and B), financial support (Form C) and of paper contribution, **including abstract**.
- **30 June 2015:** Participants informed of their acceptance of participation and request for financial support.

**IAEA SCIENTIFIC SECRETARY**

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