IAEA Panel on
IBT Roadmap
Aliz Simon

IAEA
Division of Physical and Chemical Sciences
Physics Section
TECHNOLOGICAL ROADMAP

Tool to show the path to the future for long-range planning.

Roadmap process is to connect vision, values and objectives with strategic actions that are required to achieve those objectives.

Excellent communication tool
Effective link between strategic operations, collaborative ventures and business plans.

Requires collaborative effort.
Creating a ROADMAP  4-Phase Process

<table>
<thead>
<tr>
<th>Preliminary design;</th>
<th>Development of the ROADMAP itself.</th>
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<tbody>
<tr>
<td>setting the framework, vision, timing and organization goals.</td>
<td>Follow-up and implementation activities.</td>
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<tr>
<td></td>
<td>Updating the ROADMAP.</td>
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</tbody>
</table>
### Key aspects of the ROADMAP framework

<table>
<thead>
<tr>
<th>Perceived need for the IBT Roadmap</th>
<th>IBA Conference, AKP, TM, AccApp, ?</th>
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<tbody>
<tr>
<td>Someone with a vision is needed; high level, respected stakeholder.</td>
<td>IAEA</td>
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<tr>
<td>Key leadership group to develop the framework.</td>
<td>Steering Committee (dynamic)</td>
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<tr>
<td>Selection of appropriate techniques.</td>
<td>Questionnaire, TM</td>
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<td>Specific boundaries defined.</td>
<td>Questionnaire, TM</td>
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<tr>
<td>Involvement of key stakeholders such as industry, government, suppliers, academia.</td>
<td>TM and follow-up</td>
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IBT ROADMAP

IBA & IBMM & AMS

<table>
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<th>PRIMARY GOALS</th>
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<td>To keep Accelerator Based Ion Beam Techniques at the forefront of scientific endeavour</td>
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</table>
Ian Vickridge

INSP Paris, France
The Ion Beam Technology Roadmap

Why?

**Lobbying tool** for high level decision makers
EU, Ministries, Funding Agencies, Regional Agencies ...

**Unifying tool** For the IBT community
- Common datasets
- Collective promotional material and actions
- Federative umbrella for existing actions

**Strategic thinking tool** Thinking beyond the local and immediate context

**Initiative tool** Becoming proactive, seizing the initiative
How will the Roadmap be made? by whom? With what resources?

**What is it?**

A *dynamic collective document* expressing observed and desired trends

**Scope:** *small accelerators*: IBA, IBMM, AMS, ICNMTA...

5 – 15 year rolling timeframe

**Trends, Milestones, Outcomes**, ... Tools to try and identify
- where we are
- where we are going
- where we want to go
- whether we got there yet
How will the Roadmap be made? by whom? With what resources?

Who is it?

Proposed and co-ordinated by Aliz Simon, IAEA

Small Roadmap Steering Group initiated by the IAEA

Presently:
- N. Barradas  ITN Lisbon
- M. Chiari     INFN Florence
- D. Cohen     ANSTO Sydney
- I. Vickridge INSP Paris
- R. Webb      IBC Surrey

Possibility of two or three further members.

Rolling memberships? Some formalisation? Ensure representativity...

Please contact us if you have a new idea and/or wish to work with us.
How will the Roadmap be made? by whom? With what resources?

It is also all of us
The content and process are adaptive

Thematic Contributing Groups

Will need enthusiastic and available leaders, willing to work constructively and selflessly for the common good (!!!) e.g.

Stopping Powers, Cross sections, Databases
Accelerator technology, Detectors, Beamlines, specialisation of chambers
Application areas – improve in existing areas, new areas
Institutional organisation and trends
Software for simulation and fitting
Etc ...

Individual contributions

At Conferences
Via an online form (IAEA Accelerator Knowledge Portal)
Via online discussion forum
Written submissions
How will the Roadmap be made? by whom? With what resources?

IAEA support, plus contributed time and effort from us, plus any other institutional or company support

A Public Dynamic Document
http://nucleus.iaea.org/sites/accelerators/IBT_Roadmap/SitePages/Home.aspx

Community input
Presentation and solicitation at relevant conferences (IBA is the first – IBMM and others to follow)
Online discussion forum and questionnaire

Periodic updates after Technical Meetings
Hosted by the IAEA
IAEA Technical meeting October 2015: finalise first draft of the Roadmap for first semester 2016
First IBT Roadmap Review 2018, further annual or biannual reviews to follow

Held at appropriate conferences (keeping costs low!)
Working group meetings/sessions
Pilot Group Meetings
Some examples of strategic IAEA promoted work

**Nuclear reaction and elastic scattering cross sections**

IBANDL IBA Nuclear Data Library (since 2005)
Consultant engagement (A. Gurbich)
Consultant meetings
Two Coordinated Research Programs

IAEA Technical Meeting on Benchmarking Experiments for IBA (May 2015), Paraskevi (Vivian) Dimitriou IAEA
12 participants from 11 countries
Identify the most important nuclear and elastic cross-sections for benchmarking experiments
Establish common working methods and reference materials
Set a work plan 2-3 year timeframe

**MeV SIMS**

IAEA Coordinated Research Program on MeV SIMS (Aliz Simon, IAEA)
Development of Molecular Concentration Mapping Techniques Using MeV Focussed Ion Beams
9 countries, 2014-2018
Coming up …

N. Barradas  Working together: the software example

J. Demarche  The Accelerator Portal: a resource for the Roadmap

I. Bogdanovic-Radovich  
IBA2015 Statistics

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Driving forces in IBA software

- NDF: initially throughput, then capability and accuracy
- SIMNRA: limitations in existing codes: non-Rutherford cross sections, DS, MS, straggling…
- PIXE integrated in NDF: first, proximity effect; then, Total IBA was an old wish, and it opens new fields and opportunities
- 2D/3D structure: Problem driven
- Improved calculation of many effects: Problem driven + developer interest
- Monte Carlo simulation: HI-ERDA
- ANNs: first, proximity effect; then, real time IBA

- SRIM/SigmaCalc + SIMNRA/NDF/Corteo: all problems solved!
- Is there much left to be done that can be done and is really relevant?
- Are we just adding one more significant digit to the answer?
Users are the key

- Software developers merely provide a service!
- IBA community, and scientific community at large, bring us problems to solve and challenges to face.
- Nevertheless, very often what drives us is not the needs of the community but our own needs and interests, and those of our friends and collaborators.
- Can we go on as before – business as usual?
### A SWOT analysis for IBA software

#### HELPFUL (for your objective)

- **Strengths**
  - Well-established and mature
  - Strong (if small!) community
  - Diverse: analytic, MC, specialised
  - On-going active development

#### HARMFUL (for your objective)

- **Weaknesses**
  - Limited cooperation
  - Plenty of closed source code
  - Small and ageing work-force
  - Basic data (stopping, cross sections: who will measure them?)

#### INTERNAL (within organisation)

- **Opportunities**
  - New IBA techniques requiring analysis
  - New detection systems
  - Massively parallel computers
  - EU, IAEA fostering development
  - Total IBA

- **Threats**
  - Specialised IBA techniques (with no need for software or with own software)
  - Decreasing relevance of IBA
  - No funding for software
  - No funding for computers for IBA
Coming up ...

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The Accelerator Knowledge Portal: a resource for the roadmap

nucleus.iaea.org/sites/accelerators

- IAEA’s portal to bring together the MV accelerator community
- Information
- Interaction
- Intercollaboration
The Accelerator Knowledge Portal: a resource for the roadmap

nucleus.iaea.org/sites/accelerators
The Accelerator Knowledge Portal: a resource for the roadmap

- The IBT roadmap page

A resource for discussion, brainstorming
A focus point for the elaboration of the roadmap

nucleus.iaea.org/sites/accelerators
We would like to get your input before 10 October 2015 both on status and trends in IBA and technical topics of the IBT Roadmap.

These 2 independent questionnaires are available on-line in the IAEA Accelerator Knowledge Portal/Roadmap.
Coming up ...

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IBA and Accelerators

David Cohen, ANSTO, Australia
Value of MeV Accelerator Systems

Create opportunities to participate in competitive research programs, grants and industrial contracts both nationally and internationally.

Increase organisations nuclear and atomic scientific reputation through establishment of major national and international collaborations and networks and by publishing leading edge research.

Provides the ability for a research organisation to interact cross a broad range of disciplines from archaeology to zoology and to meet research requirements for universities, research institutes and industry.

Training of national and international researchers, postdocs, postgrads and students in leading edge accelerator based techniques and their applications.
Accelerator Science Technology Platform

**Facilities** - 1-10 MeV accelerators
- Ion sources, 20-100keV implanters,
- Most ions in the periodic table.

**Capabilities** - Ion Beam Analysis (IBA)
- Accelerator Mass Spectrometry (AMS)
- Photon, particle, radiation detection
- Ion-atom interactions with matter
- High voltage, vacuum, electronic.

**Platforms**

- Environmental tracing, Hyper-accumulating plants systems, salinity, erosion environmental sensors
- Microspectroscopy 2D, 3D mapping, characterisation, Bio-imaging
- Fine particle air pollution
- Geology Exploration Fluid inclusions in minerals
- Radiation dosimetry Radiation damage micro-dosimetry micro-detectors IBIC mechanisms
- Hardware & software control, High speed data acquisition, High voltage systems, Vacuum systems.

**Users** - universities, IAEA, collaborators, commercial, training

**External revenue** - grants, contracts

**Earth sciences**, Geomorphology, landscape change, Climate change

**Materials modification**, Interface engineering, Thin films coatings, Multi-layers Fission-fusion surfaces

**Archaeology**
- Archaeometry
- Fundamental physics, K,L,M, X-ray cross sections, Coster Kronig transitions, Subshell fluorescence yields, Heavy ion stopping Nuclear reactions
- Nuclear security and defence, safeguards

**Isotopic ultra-tracing**, nuclear forensics, bomb pulse, actinides, bio uptake, diet, toxicology

**Ion source enhancement**, ECR ion source development
Positive Ion Accelerator Trends

• Multiple/ simultaneous techniques – PIXE with PIGE, RBS, ERDA, STIM
• Multiple isotopes for AMS, $^{14}\text{C}$, $^{10}\text{Be}$, $^{26}\text{Al}$, $^{36}\text{Cl}$, $^{129}\text{I}$, actinides
• Complementarities with synchrotrons, SEM’s – what are they?
• High resolution 2D, 3D elemental mapping, tomography
• Improved dataset requirements for all IBA techniques, cross sections...
• Broad range of applications – material science, environmental science, life science, geological exploration, nuclear safeguards ......
• Moving towards more ‘industrial engagement’ implying ‘real’ financial returns for days run as well as timely turnaround, reproducible, accurate and precise results.
• Formation of interdisciplinary teams to address larger problems.
• How do MeV accelerators in Europe, North America, Asia, ... compare?
Ion beam analysis (IBA) using MeV positive ion accelerators took off in the mid 1970’s and continues to expand today, 40 years later. Accelerator mass spectrometry started in 1980’s and continues to increase. Application of ion beams using positive ion accelerators still an expanding phase.
<table>
<thead>
<tr>
<th>Do we ask ourselves, ‘what are the key questions IBA/accelerators can answer’?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IBA</strong></td>
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<tr>
<td>Fine particle air pollution</td>
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<tr>
<td>Can the different source contributions to fine particle air pollution in megacities in Asia be identified and quantified?</td>
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<tr>
<td>Microdosimetry</td>
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<tr>
<td>Can microdetectors be constructed to quantitatively determine doses at the cellular level?</td>
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<tr>
<td>Nuclear materials</td>
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<tr>
<td>Which materials have the best radiation hardness properties for future fusion and fusion reactor systems?</td>
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<tr>
<td>For other areas have we considered what big questions we will address?</td>
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<tr>
<td><strong>AMS</strong></td>
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<tr>
<td>Glacial chronologies – Antarctica</td>
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<tr>
<td>What is the timing and extent of the east Antarctic ice sheet during the last 14,000 years, did it contribute to 20m rise in global sea levels then?</td>
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<tr>
<td>Nuclear forensics</td>
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<tr>
<td>Can we track and identify where U and Pu have come from through isotopic signatures?</td>
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<tr>
<td>Landscape change</td>
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<tr>
<td>At what rate is the Australia continent eroding?</td>
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<tr>
<td>Are mega-boulders on the Australian cliff margins the result of past tsunami events or are they the remnants of bedrock denudation?</td>
</tr>
</tbody>
</table>
Numbers of Accelerators?

- How does this look globally?
- Do we interact vertically or just horizontally, why?
- Accelerators are well connected worldwide,
- Interact regularly, technically and research through conferences, workshops, SNEAP etc.
- IAEA Knowledge Portal for Accelerators
Coming up ...

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Where might it lead?
The development of **smaller transportable accelerators** would open new fields, in particular in those applications, as cultural heritage, where the vast majority of the world cultural heritage is immovable. The impact of laboratory based analytical techniques could diminish in the future with the advent of more and more performing ED-XRF systems for elemental analysis of cultural heritage objects.
Laser plasma acceleration ("wakefield" acceleration), with accelerating gradient up to 6 order of magnitude greater, could develop in a transportable system for **in-situ external beam PIXE** (where the proton beam nonmonochromaticity - 10% at least - could not be an issue) or eventually **PIGE** analysis of cultural heritage objects?
Could it lead to proton backpacks?
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Two ways to add opinions:
Fill in questionnaire: paper copy here; electronic copy on IAEA portal
or www.ionbeamcentre.co.uk/IBAroadmap.php
Join the IAEA Technical Meeting

Why the questionnaire?

• We have made a start in defining the purpose and goals of the roadmap.

• We want everyone to feel they have a part in this

• We want your views on the purpose and goals

• We want to capture your experiences and beliefs in IBA and its competition and how you see the future
### Purpose

<table>
<thead>
<tr>
<th>Comments</th>
<th>Enhance reputation and relevance of accelerator-based techniques for addressing evolving societal and technological challenges by:</th>
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<tbody>
<tr>
<td></td>
<td>a. Extending application of Energetic Ion Beams in answering key questions that will</td>
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<tr>
<td></td>
<td>• Improve materials properties</td>
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<tr>
<td></td>
<td>• Lead to increased sustainability of natural resources</td>
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<td></td>
<td>• Extend understanding of the natural and cultural environments</td>
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<td></td>
<td>• Improve human health</td>
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<td>• Ensure security of people and societies</td>
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<td></td>
<td>b. Contributing to the Knowledge Society through education and training.</td>
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<td></td>
<td>c. Guiding accelerator technology and the associated infrastructure to capture future developments proactively – to lead rather than to follow</td>
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### Primary Goals

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“Ask not what IBA can do for you ask what you can do for IBA.”
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2. What are the major techniques which compete with IBA?

3. Which IBA Techniques do you have access to?

- RBS/EBS
- Channelling
- Real Time RBS
- Hi Res RBS
- NRA
- PIXE
- PIGE
- Hi Res PIXE
- IBIC
- IBIL
- ERD
- HI-ERD
- MeV-SIMS
- AMS
- Other:

4. Currently which areas of research is IBA making a forefront contribution?
Two ways to add opinions:
Fill in questionnaire: paper copy here; electronic copy on IAEA portal or www.ionbeamcentre.co.uk/IBAroadmap.php
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5 How Do You See The Future?
Over the next 10 years will the role of IBA in the following areas:

<table>
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<th>Area</th>
<th>“decrease”</th>
<th>“stay the same”</th>
<th>“increase”</th>
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<td>Biomedical</td>
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<tr>
<td>Materials Science</td>
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<td>Surface Science</td>
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<tr>
<td>Environment</td>
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<td>Health</td>
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<td>Energy</td>
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<tr>
<td>Astrophysics</td>
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<tr>
<td>Art &amp; Archaeology</td>
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<tr>
<td>Forensics</td>
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<tr>
<td>Semiconductor/photonic Devices</td>
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<tr>
<td>Other (please specify)</td>
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Over the next 10 years will the following Ion Beam Technologies:

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<th>“increase”</th>
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<td>Ion Implantation</td>
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<td>Ion Beam Analysis</td>
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<tr>
<td>Accelerator Mass Spectrometry</td>
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<tr>
<td>Other (please specify)</td>
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How many papers do you expect to publish using IBA

<table>
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<th>Time Frame</th>
<th>Expected Papers</th>
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<tr>
<td>next year</td>
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<tr>
<td>5 years</td>
<td></td>
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<tr>
<td>10 years</td>
<td></td>
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6. Quality Assurance
   Are You Aware of any Written Protocols for IBA in your Lab? yes [ ] no [ ]
   Should IBA be Quality Assured (eg ISO accredited/certified)? yes [ ] no [ ]
   What Percentage of your work engages with industry? [ %]
   What Percentage of your work is with external collaborators? [ %]

7. Is your Lab planning any substantially new initiatives? yes [ ] no [ ]

8. What is the single most significant development that you would like to see to improve your work?

9. What is the most exciting new area?

10. A little about you
    Are you An Early Stage Researcher [ ] A “Mid Range” Researcher [ ] An Old Warrior [ ] Or Ancient History [ ]
    Are you a regular user of IBA techniques?
    Do you use other Ion Beam Techniques such as Ion Implantation? If so what?
Coming up ...

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Twelfth International Topical Meeting on Nuclear Applications of Accelerators

November 10-13, 2015
Washington, DC-USA

Abstract submission deadline:
26 June 2015
http://accapp15.org/
Joint ICTP-IAEA Advanced Workshop on High sensitivity 2D & 3D Characterisation and Imaging with Ion Beams

26-30 September 2016 ICTP, Trieste, Italy
Technical Meeting on

Formulating strategies for keeping accelerator based technologies at the forefront of scientific endeavours

19-23 October 2015

Location to be announced, subject to host government acceptance.

For more info visit the IAEA AKP.

You need to be nominated by your Government in order to participate.
Thank you for your attention
Aliz.Simon@iaea.org