

Task 4.2 Detector Characterization

WP4 session



*Institut
Ruđer
Bošković*

EUROLABS 2nd Annual Meeting
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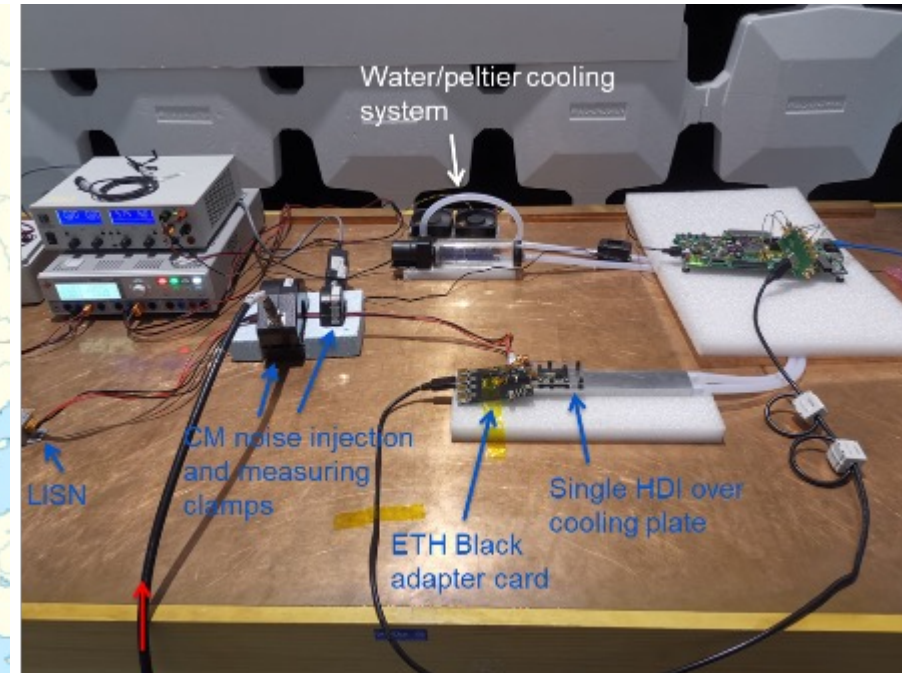
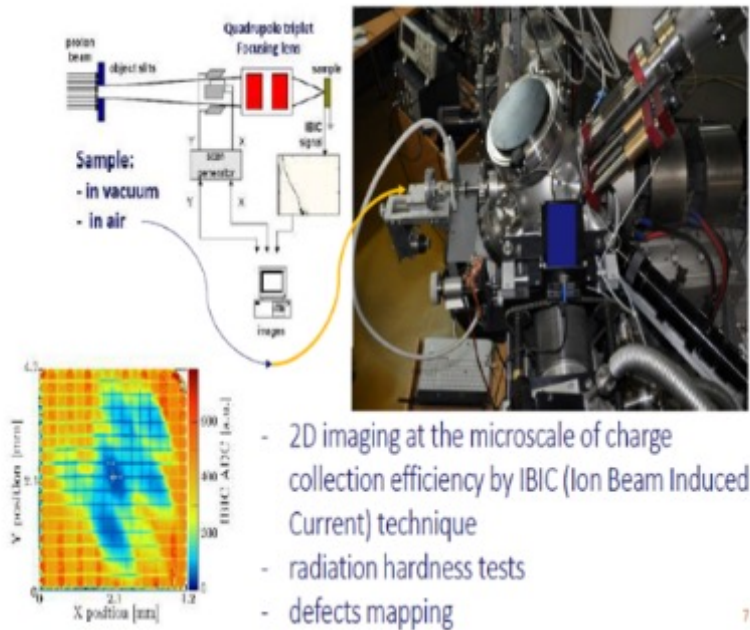


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- 1. Detector Characterization (T4.2)
- 2. Detector characterization at RBI-AF (T4.2.1)
- 3. Detector characterization at ITAINNOVA
EMCLab (T4.2.2)
- 4. Summary

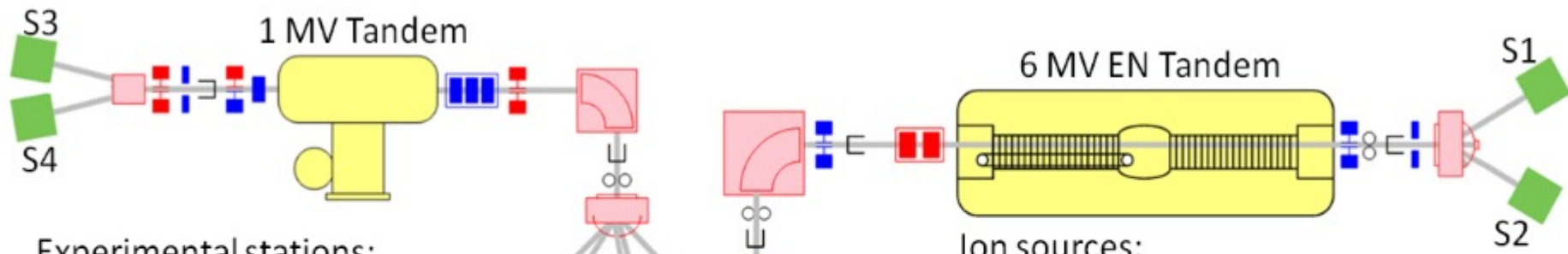
1. Detector Characterization

- The T4.2 TA facilities are focused on special detector and system characterization
- Two facilities are involved in this task to cover two different type of characterization.
 - Tandem Accelerator Facility at Rudjer Boskovic Institute (RBI) in Croatia for radiation characterization of detectors (sensors and ASICs)
 - EMC Laboratory at Instituto Tecnológico de Aragón (ITAINNOVA) in Spain for electromagnetic noise characterization of detectors.



2. Detector characterization at RBI-AF (T4.2.1)

Ruđer Bošković Institute Tandem Accelerator Facility (Zagreb, Croatia)



Experimental stations:

- E1 – RBS/PIXE/PIGE
- E2 – In air
- E3 – Dual with μ -beam
- E4 – Dual beam irradiation
- E5 – TOF-ERDA
- E6 – Capillary MeV TOF-SIMS
- E7 – Channeling RBS/PIXE
- E8 – Nuclear reactions
- E9 – Ion μ -beam

- Simultaneous ion beams possible
- Ion beam only from 1MV Tandem
- Ion beam from 1MV or EN Tandem

Ion sources:

- S1 – RF (for α particles)
- S2 – Sputtering
- S3 – Duoplasmatron (for α particles)
- S4 – Sputtering

- Two accelerators
- 9 end stations

Main applications:

- Materials' analysis
- Materials' modification studies

In EURO Labs:

- **Characterization of detectors and related materials**
- **Radiation hardness studies**

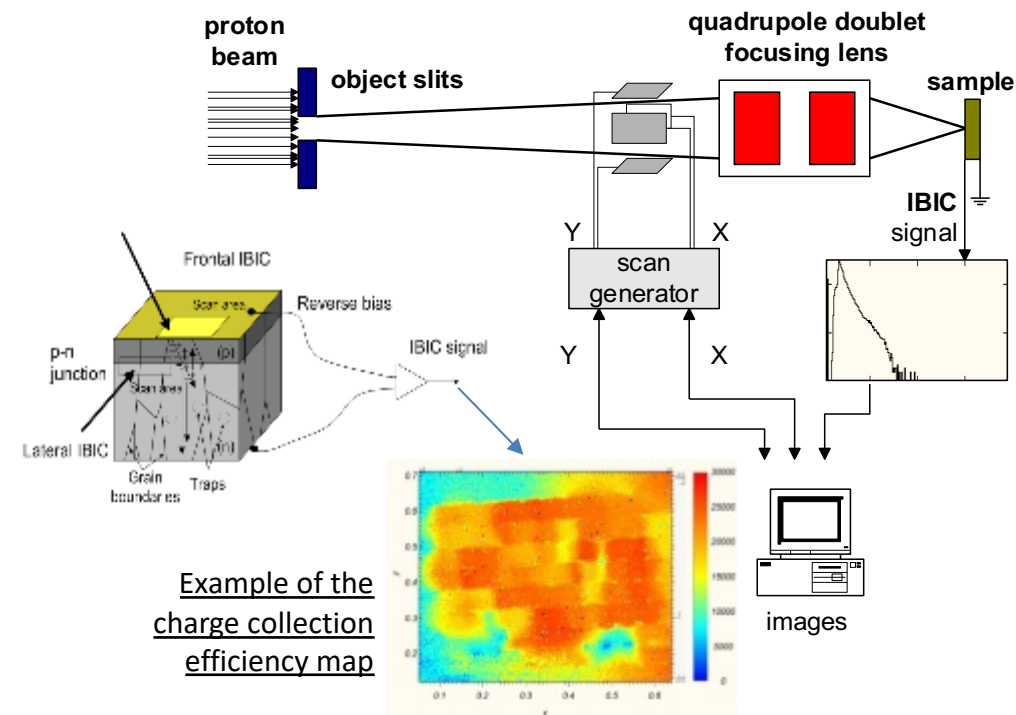
2. Detector characterization at RBI-AF (T4.2.1)

Transnational Access to RBI-AF: Characterization of detectors and related materials

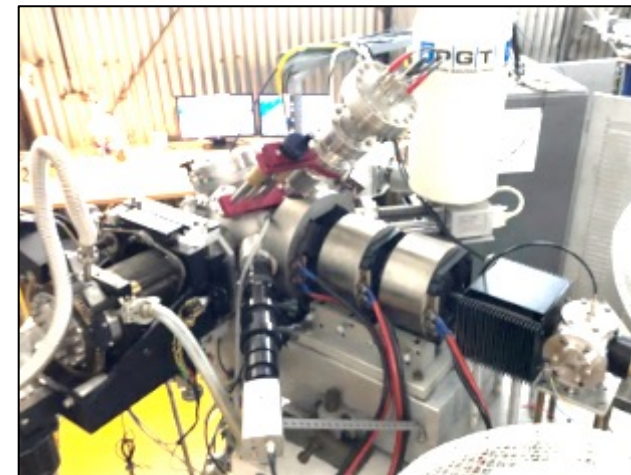
(i) in vacuum and in-air IBIC (Ion Beam Induced Charge) imaging of charge collection properties using protons of up to 10 MeV with 1 μm resolution and **heavy ions** on demand and/or time resolved IBIC (**TIBIC**);

Users will have on disposal two ion microprobe end-stations:

“New” dual beam ion microprobe (DuMi); second micro beam line under development



- Lateral and frontal modes (<1 μm spatial resolution)
- Measures charge collection efficiency maps
- Probing different depths (1 to 700 μm)



“Old” ion microprobe

- In vacuum IBIC
- In-air IBIC
- Time resolved IBIC
- About 1 μm resolution for CCE maps



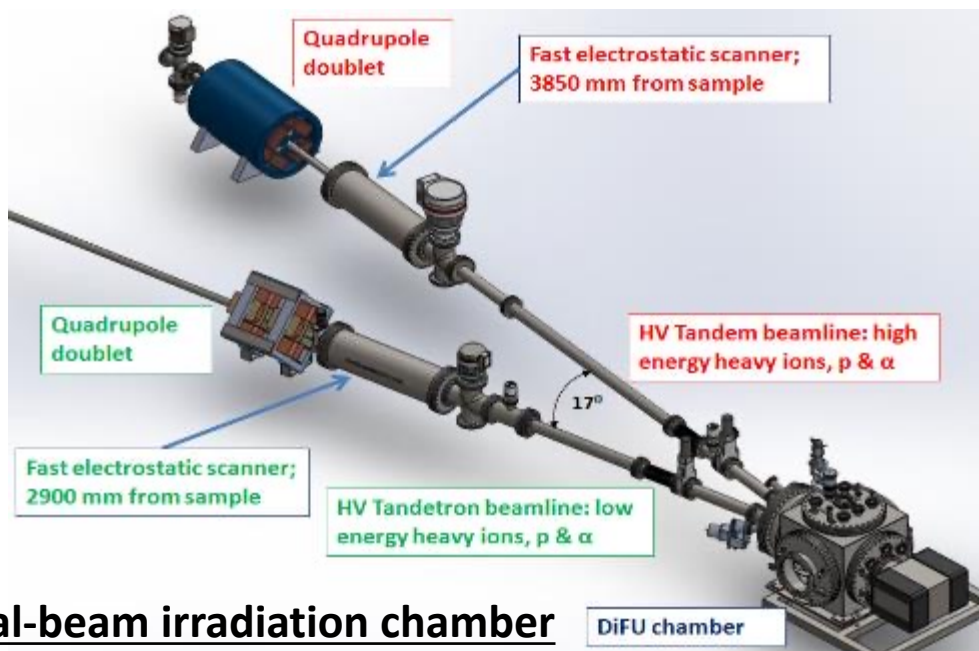
2. Detector characterization at RBI-AF

Transnational Access to RBI-AF: Radiation hardness studies

(ii) **Radiation hardness studies:** real-time controlled damaging of small detector areas using protons or heavier ions, including ion beam analysis

For such studies users will have on disposal both ion microprobe end-stations and other end stations depending on the actual objectives of the proposed work.

Ion Channeling
Irradiation and analysis of crystalline materials

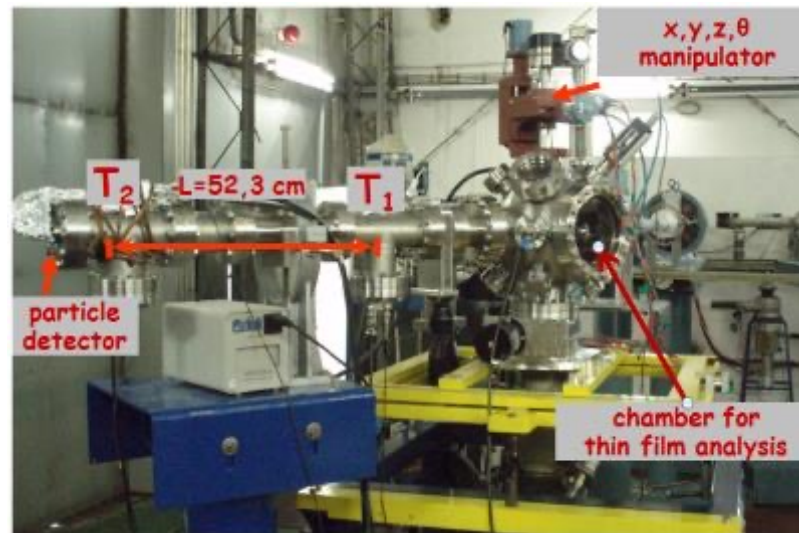
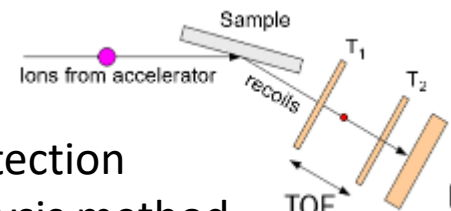


Dual-beam irradiation chamber

- Irradiation of areas up to 2x2 cm²
- Samples on room temperatures or up to 600 C

TOF-ERDA

Time-of-flight elastic recoil detection
- Thin films analysis method



TA Activities

- *We were approached by 4 potential users.*
- *After discussions and careful pre-examination, it was realized that two could be feasible.*
- *Therefore two formal applications were submitted and later accepted.*
- *Technical and logistic support before, during and after their experiments, including some help for post-experiment analysis of data, has been provided.*

RBI-AF	User Projects	Total users	Beam hour
M1-M48	12	24	504
M1-M12	2	4	92

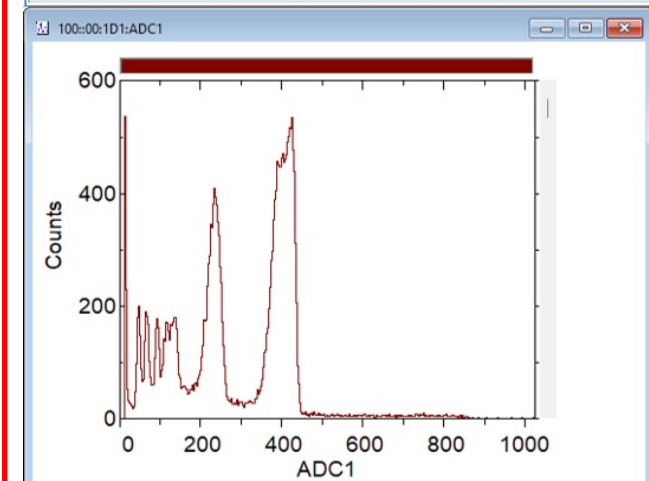
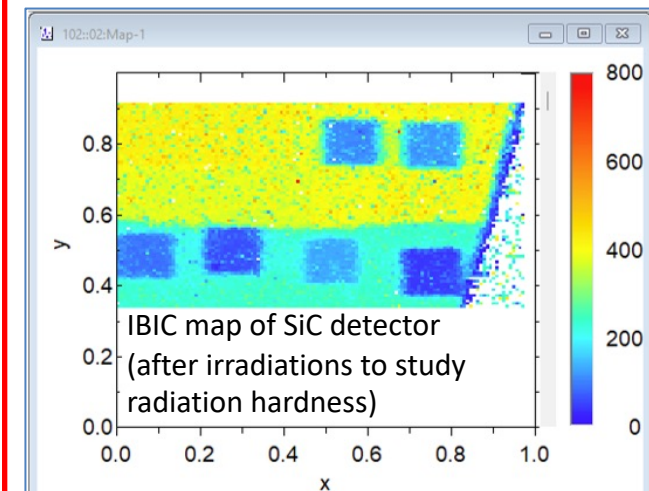
- *Important notice: Due to our transfer to new accelerator building, we will be closed for users for about 6 months during the first half of 2025. Also, 6 MV EN tandem will be closed in December 2024. New 5 MV Tandetron will be in operation at late 2025 or during Q1 2026.*

2. Detector characterization at RBI-AF

Performed TA User projects

- *EURO-LABS-RBI-2003-001 (6-10.3.23.): Charge transport response of SiC sensors for harsh environment and single ion implantation projects have been studied. In the experiment unique capabilities for deterministic heavy ion counting capabilities of the novel ultra-thin SiC radiation detectors realized by STLab srl were investigated by users from Swizerland and Italy.*
- *EURO-LABS-RBI-2003-002 (8-12.5.23.): Detailed 3D charge detection efficiency (CCE) characterization of large area single pad SiC detectors dedicated to the use for the particle identification were investigated by users from Italy.*

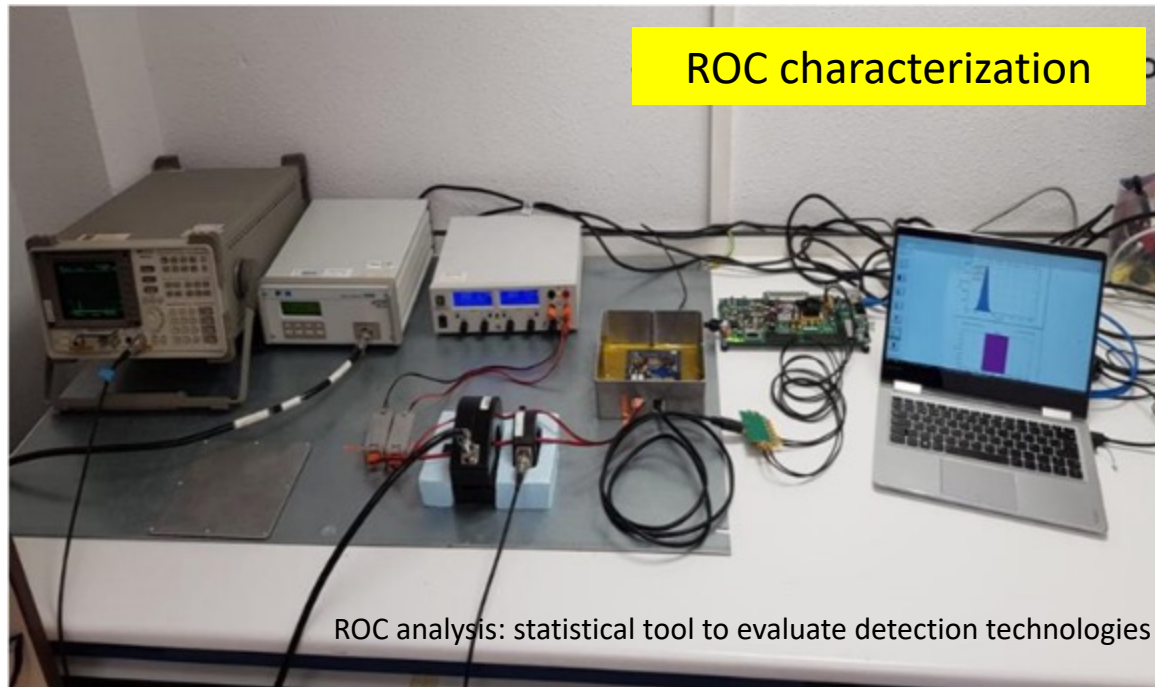
EURO-LABS-RBI-2003-001 (M. Camarda) March 23
Damaging & probing beam: Carbon 5 MeV



Corresponding pulse-height spectrum

3. Detector characterization at ITAINNOVA EMCLab

- EMCLab performs Electromagnetic Compatibility (EMC) test (standard and non-standard) to identify the EM noise emissions and susceptibility of detector electronics
- This was a very useful activity during the AIDA 2020 project.
 - Many different systems were tested



3. Detector characterization at ITAINNOVA EMCLab

- No access requests were made to ITAINNOVA EMC during this period.
- The primary focus in the project's first year was concluding key upgrades for the EMCLab.
 - Automatic EMC test bench to measure the noise transfer functions (TF) of physics detectors were developed within the AIDAINNOVA project.
 - GUI System was developed within EUROLABS Task 4.4.5.
- This strategic approach positions EMCLab to benefit from these enhancements throughout the project.
- Nevertheless, several activities were conducted to promote and contact future users.
 - "EUROLABS Project: A Valuable Tool for Electromagnetic Characterization of LSC Experiments.y, "Scientific Annual Meeting of LSC in May 2023

- Actual status

EMCLab	User Projects	Total users	Tests hours
M1-M48	14	56	800
M1-M12	0	0	0

- Contact with 5 groups of electronics designers has been established to secure access to the lab
- Currently, three access requests are in preparation:
 - CMS-ETL (USA group - FNAL) – ETROC2 Test
 - CMS-ITK Upgrade (CERN group) – CMS-ITK Power Group Test
 - RB53 (INFN group) – RB53C Test

4. Summary

- In WP4 two facilities have been used to characterize detectors
 - Radiation response characterization – RBI
 - Electromagnetic characterization – ITAINNOVA
- 1304 UA (hours) for testing are offered in two facilities – 92 hours have been performed
- Two TA projects were approved and implemented at the RBI accelerator facility.
- No access requests were made to ITAINNOVA EMC during this period, but 3 TA projects are in preparation.
- Some dissemination activities have been also performed.
- Improvements activities are in good progress at RBI & ITAINNOVA (to be reported WP4-T4.4.).