# Ion Beam Center (IBC) @ HZDR
# From Basic Science to Industrial Applications

**Jürgen Fassbender**

MML FROM MATTER TO MATERIALS AND LIFE

HZDR

HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

DRESDEN concept

TECHNISCHE UNIVERSITÄT DRESDEN

# Ion Beam Facilities in Germany

Atomic Physics
Plasma Physics
Materials Research

GSI

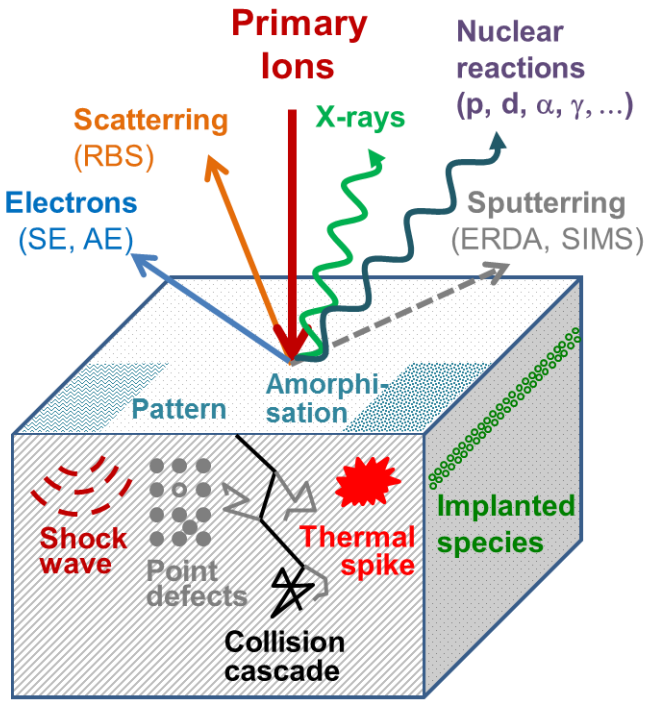
Kinetic Energy (MeV)

$10^{-3}$ $10^{-2}$ $10^{-1}$ $10^{0}$ $10^{1}$ $10^{2}$ $10^{3}$ $10^{4}$ $10^{5}$ $10^{6}$

IBC.

Materials Research
Resource Analytics
Industrial Applications

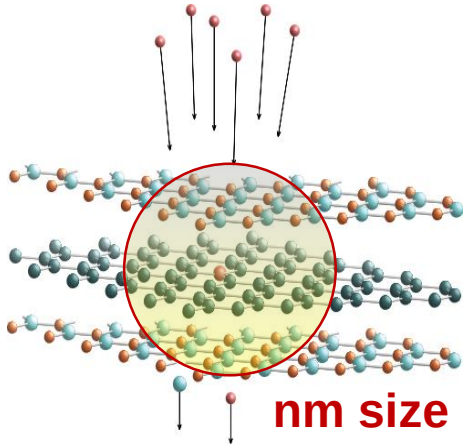
# Physics and Materials Science with Ion Beams



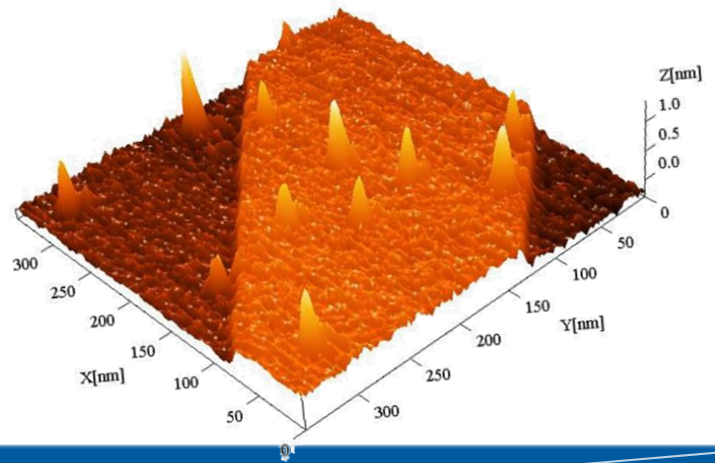

1. Energy release, doping, order/disorder
   → **Materials modification**
2. Secondary particle / radiation emission
   → **Materials analysis**

## Why ions?

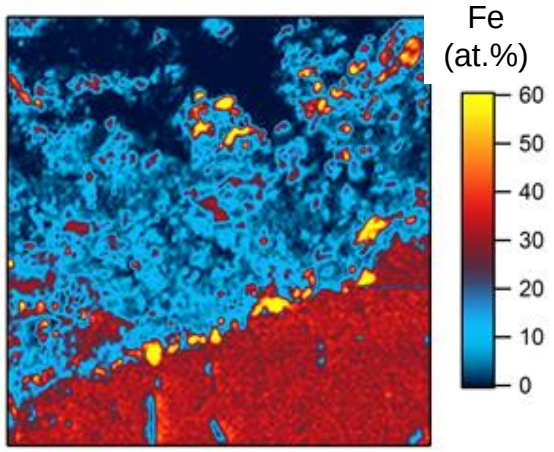
**Precision & control**
ion, position, amount



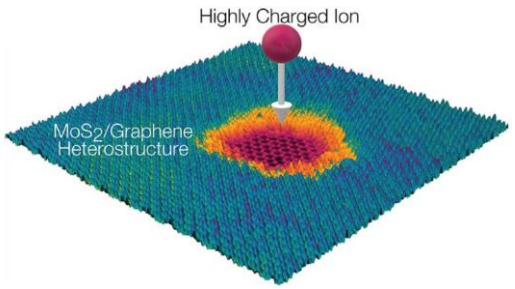

**Material states**
far from equilibrium




**Chemical analysis**
quant., non-destructive

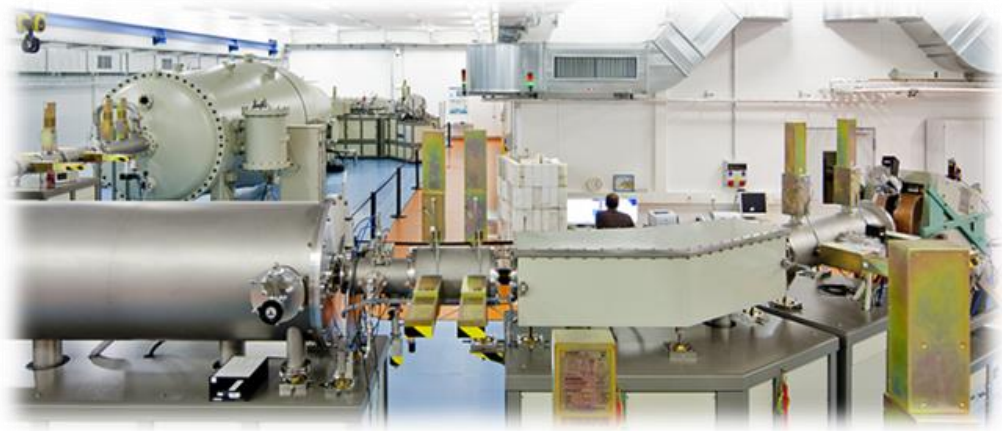


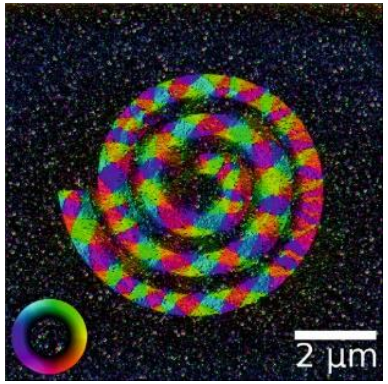
# IBC – Ion Beam Center




Precise carving of nanostructures in 2D heterostructures by highly charged ions

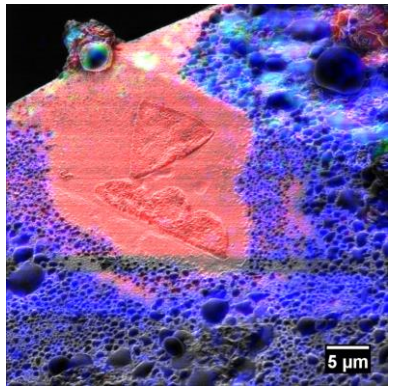
ACS Nano. **14**, 10536 (2020)



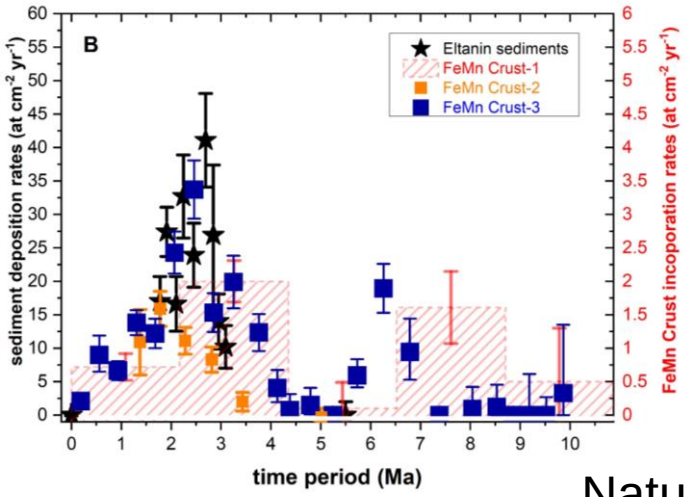



Magnetic nanostructures induced by HIM irradiation

Small **15**, 1904738 (2019)



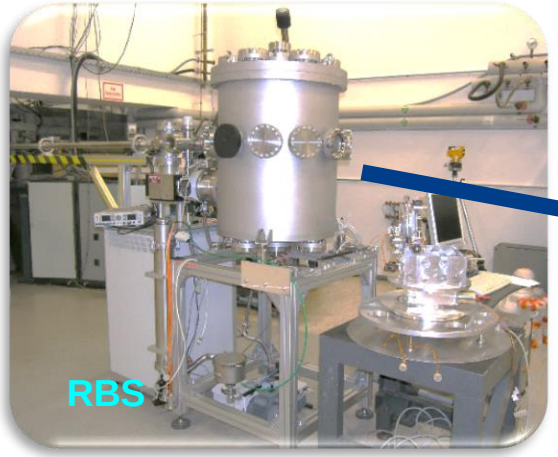

Ion beam Analysis with a lateral resolution of 8 nm



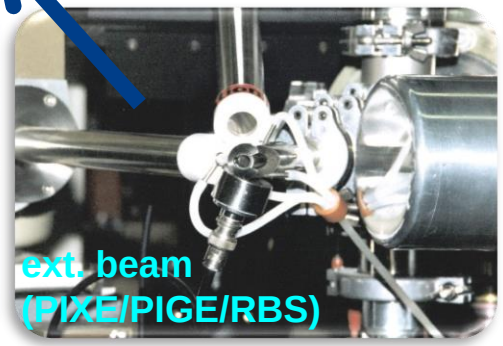

AMS dating of nearby supernova signatures

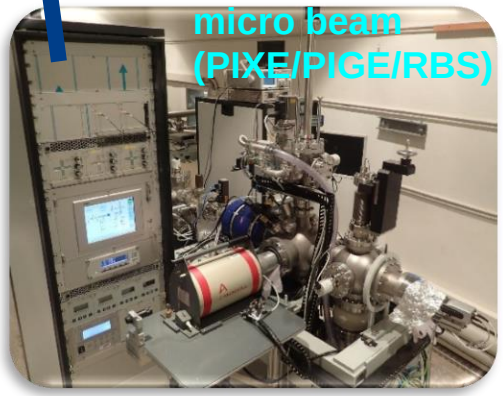
Nature **532**, 69 (2016)

# IBC – Ion Beam Center

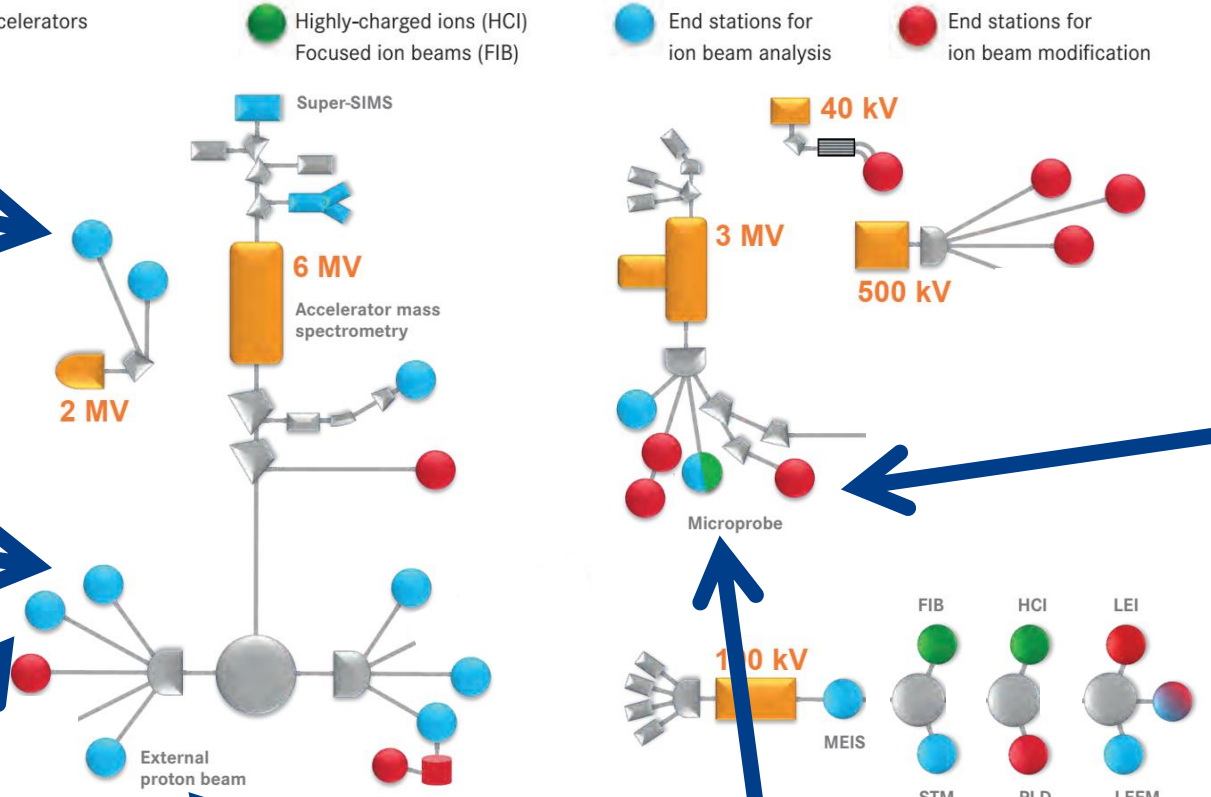






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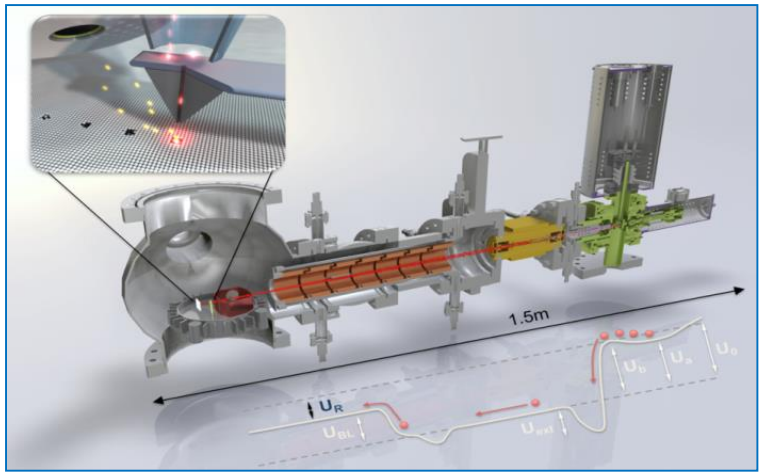
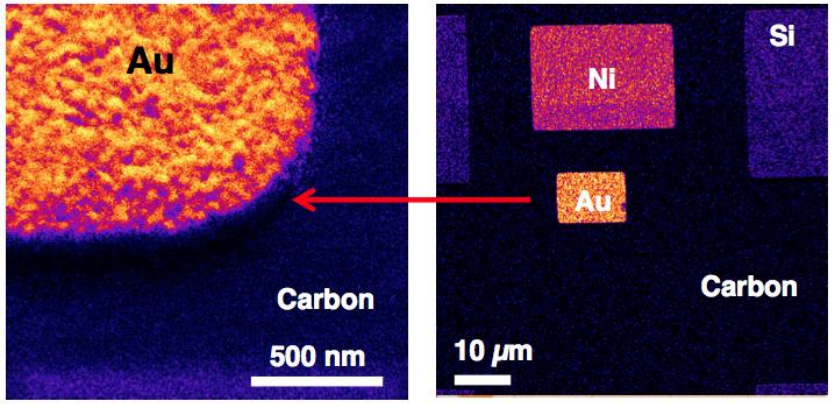
# Innovative Instrumentation at IBC

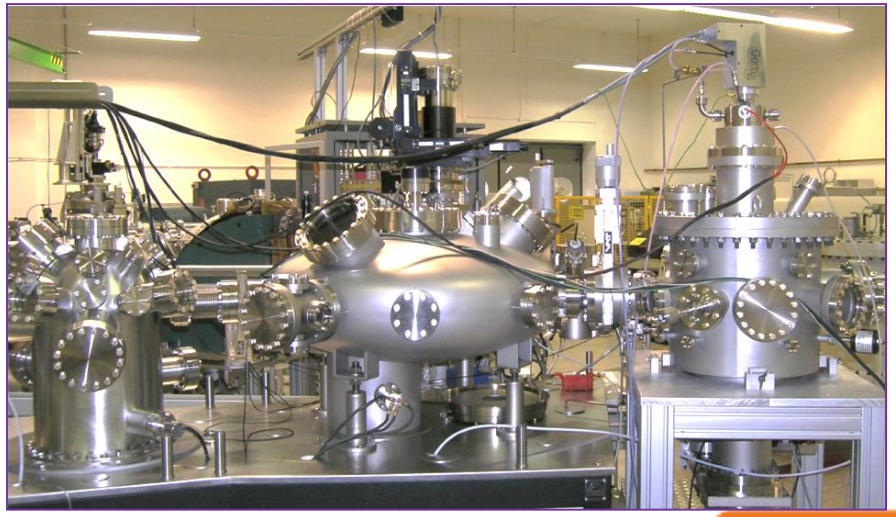
**Modification** | **Modification / Analysis** | **Analysis**




**Ion doping with atomic precision**




**Ion Beam Analysis on the nanometer scale**



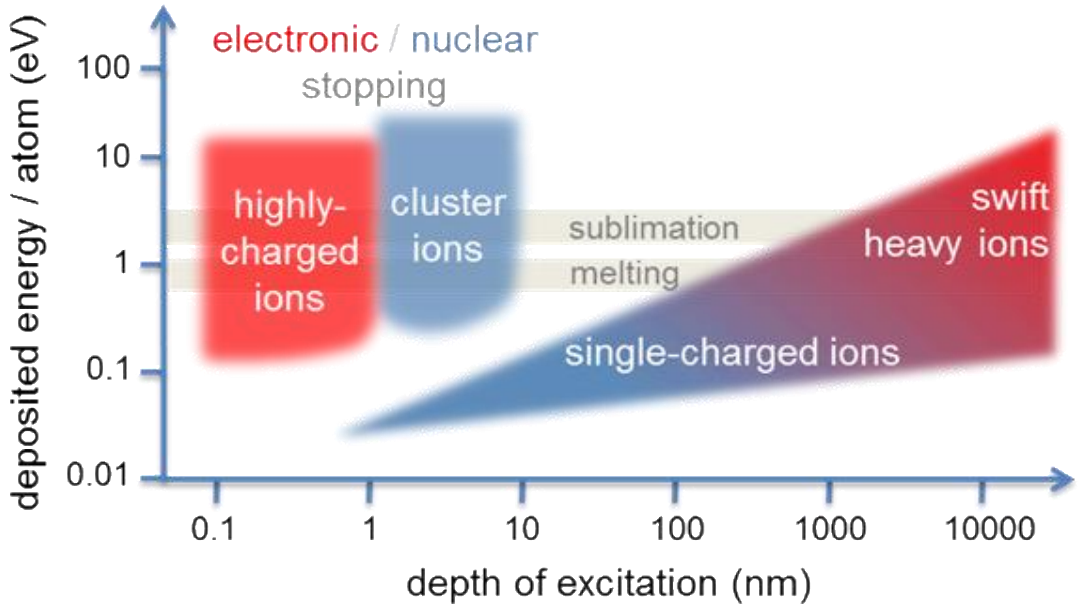
**Combining ion beam modification & analysis**

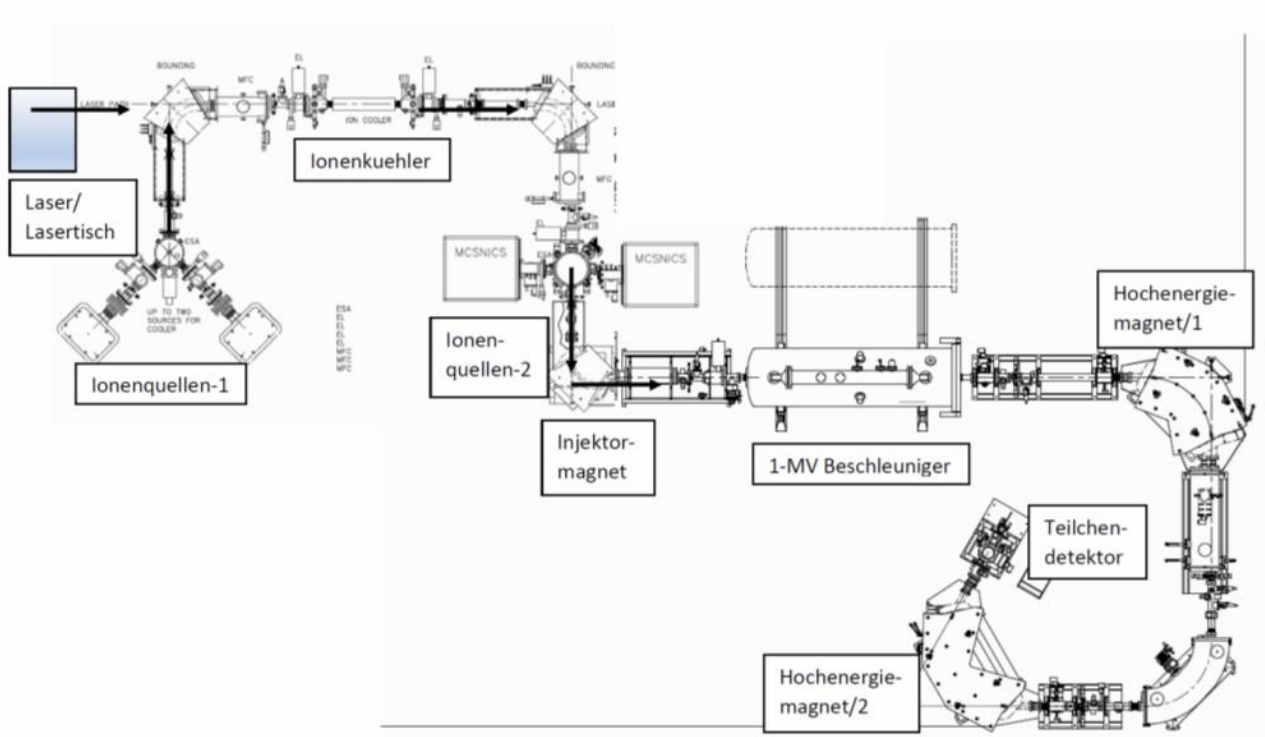
real-time, in-situ and in-operation experiments

# IBC – Ion Beam Center

## Low Energy Ions / Focused Ion Beams

Controlled ion beam mediated doping of 2D materials



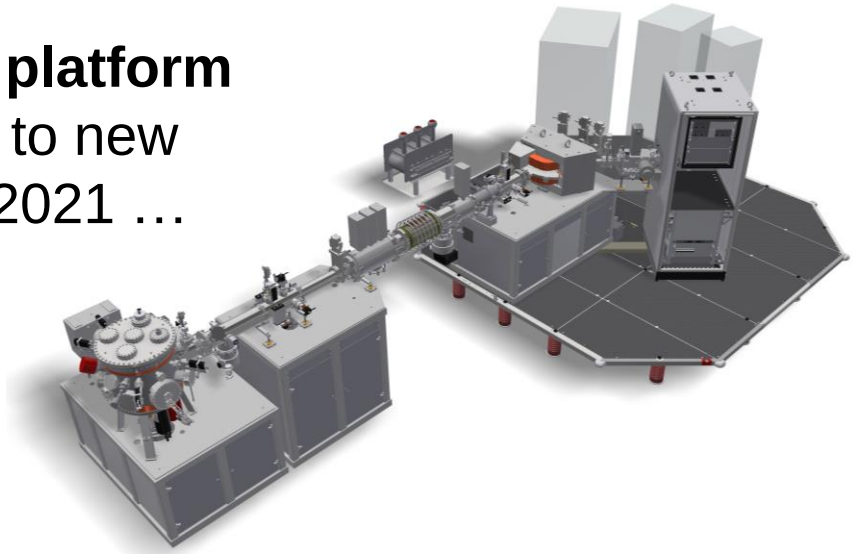

## AMS extension

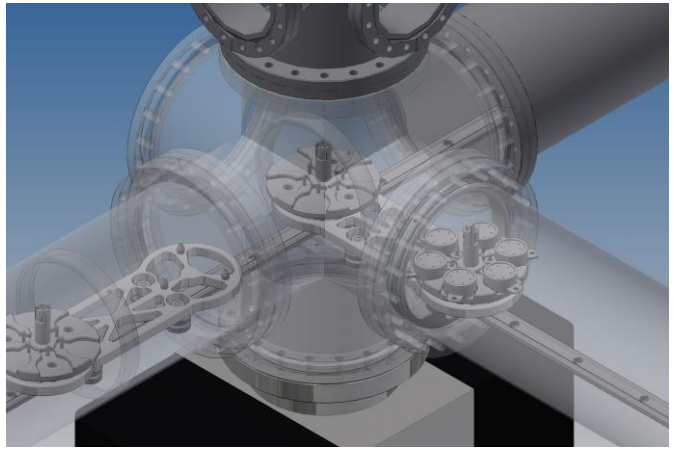
More beamtime for users and development of non-routine nuclides

Laser ionization

# IBC – Ion Beam Center
# LEINEF

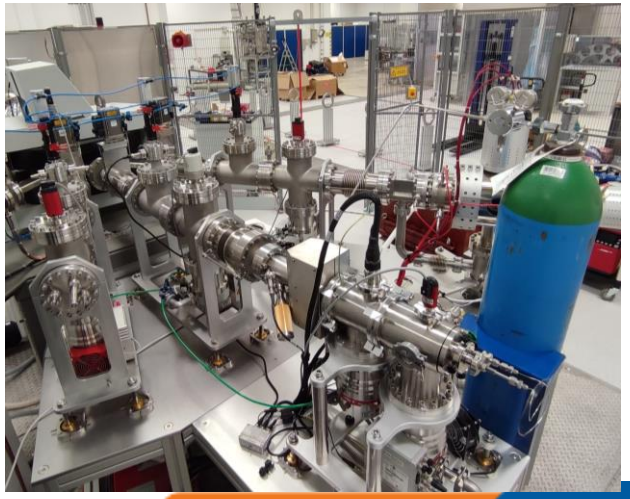
**100kV platform** moved to new site in 2021 …





Installation of **transfer** tunnel in **2022**

Attachment of **end stations** in **2022-2023**



**…** and was equipped with 3 more **ion/cluster sources**

# IBC – Ion Beam Center as User Facility

### IBC Statistics:

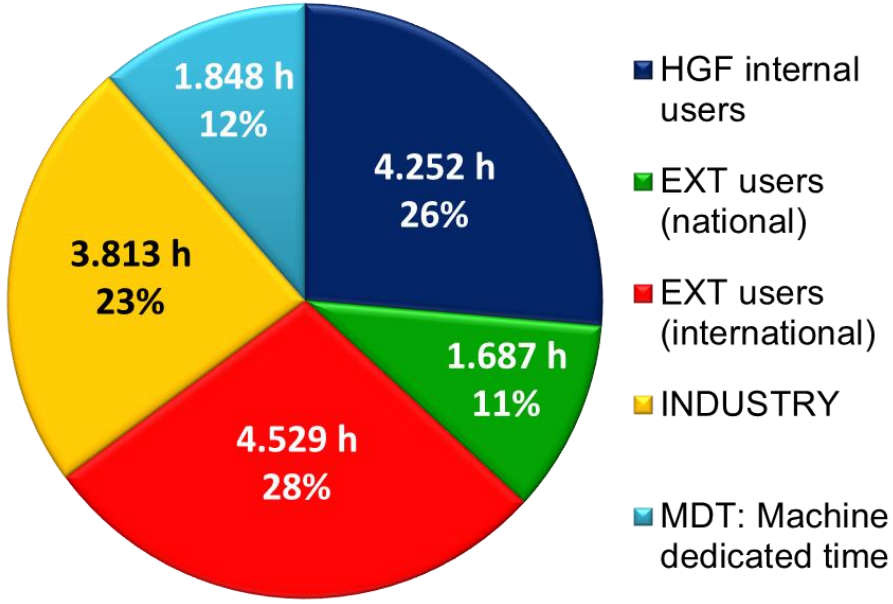
Operation Time: 16.200 h (total)

User Beam Time: **14.200 h** (88%)

Ext User Quote: **71%**

Experiments: ~ 160/a

Publications: ~ 120/a

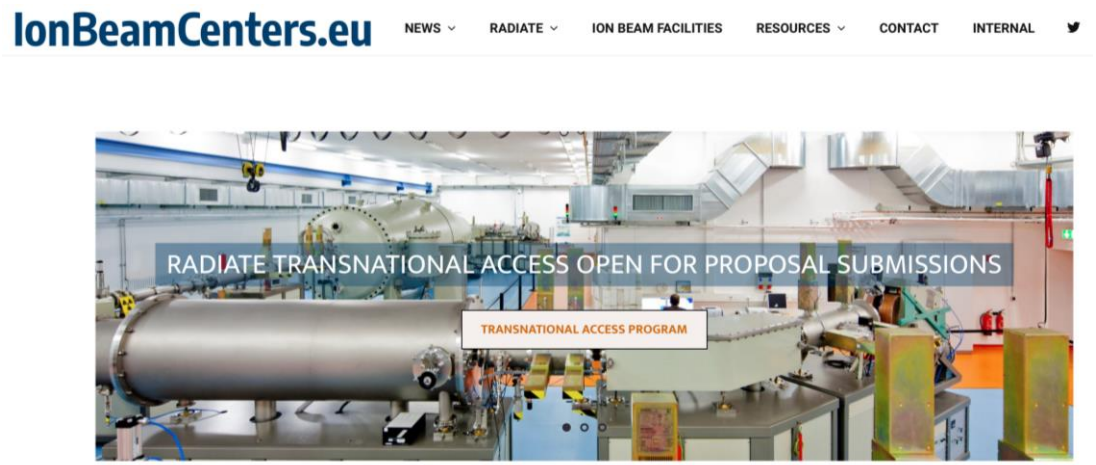


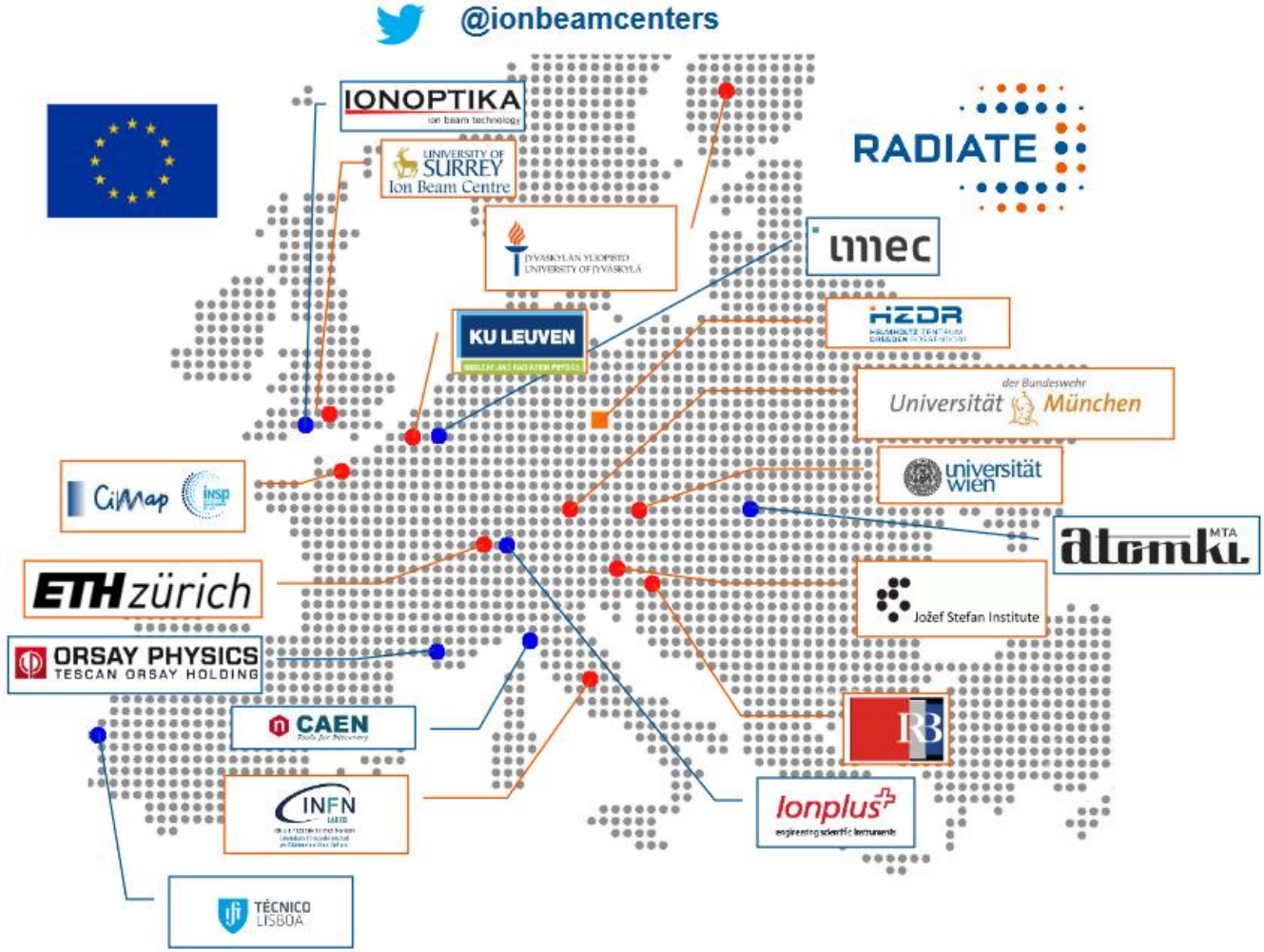

## Collaborations:

- Joint research & networking across Europe


- Education, training measures & infrastructure development for ion beam facilities in emerging countries
- Collaboration with industrial partners leading to product innovation

# IBC – Projects: RADIATE



# ANALYTICAL RESEARCH INFRASTRUCTURES IN EUROPE

ARIE is a network of high-level facilities that provide instruments and services to enable European researchers to address the Missions of Horizon Europe

# Use of IBC Facility for Innovations in Industry

## Ion Beam Services

### Power Electronics

(Diodes, IGBT, GTO)

**Less power loss**

Higher switching speed

### Opto-Electronics

CMOS image chips

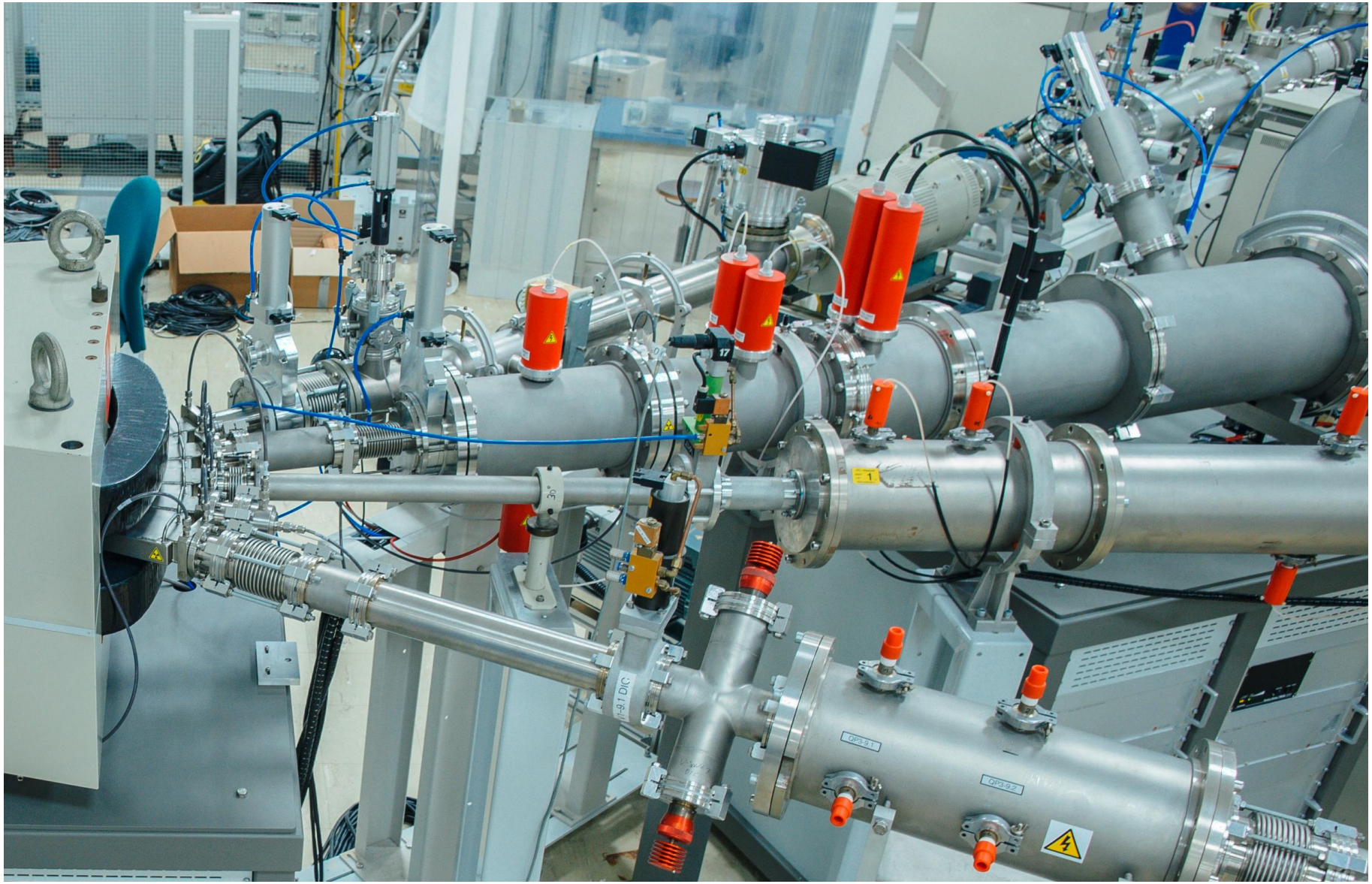
Improved lasers

Detectors (APDs, SiPM)

### Selected partners:

IXYS Corporation, ABB, Infineon, Jenoptik, ON Semiconductor, Zeiss, Bosch Technik fürs Leben, SEMIKRON innovation+service, First Sensor, mi2-factory, KETEK, www.PETER-BREHM.de Die Präzision in Titan für den Menschen, Bosch Mahle TurboSystems

# Thank you for your attention



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