5th ISSE Training School

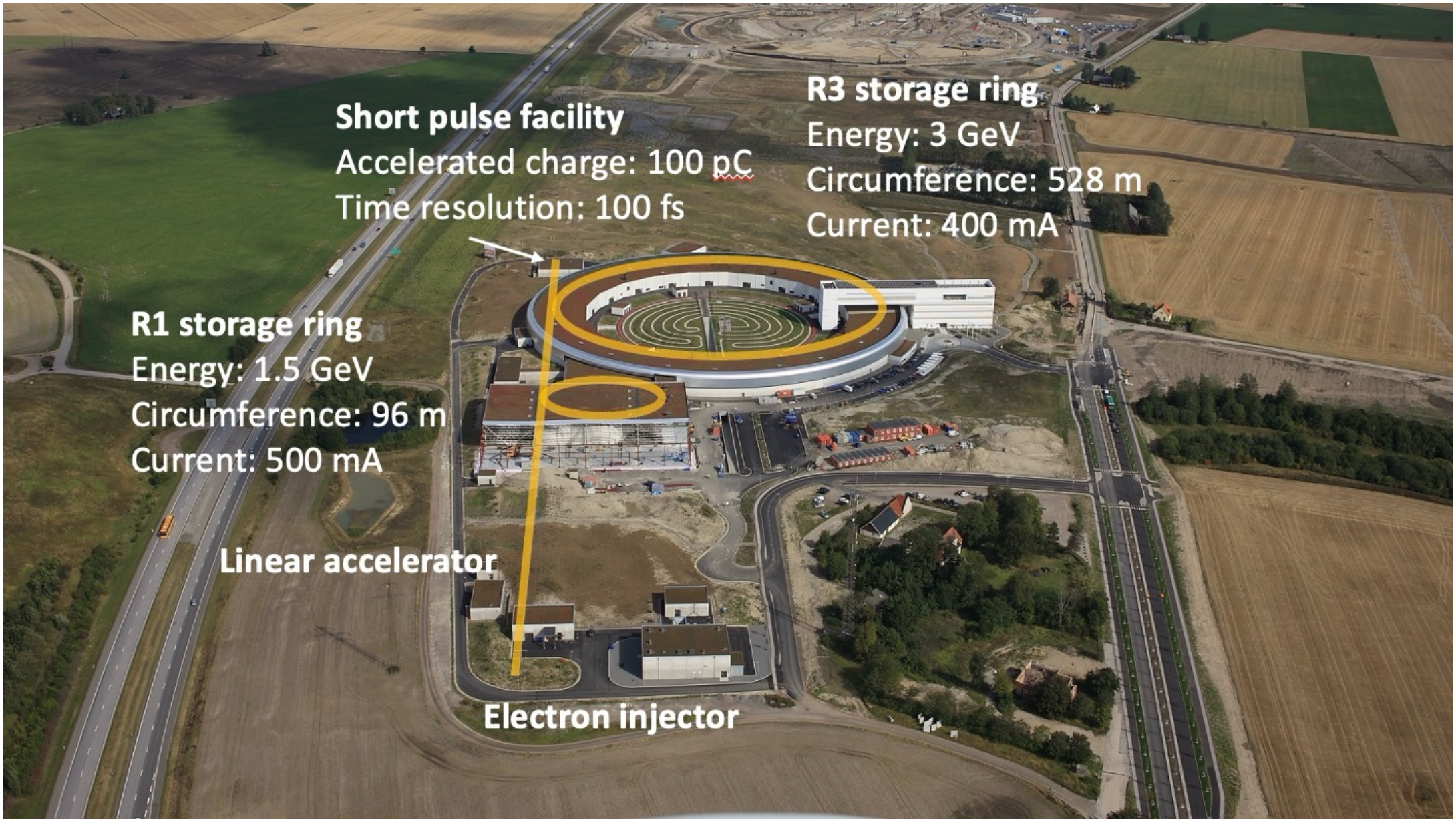
An introduction to the MAX IV Laboratory

Stefan Carlson

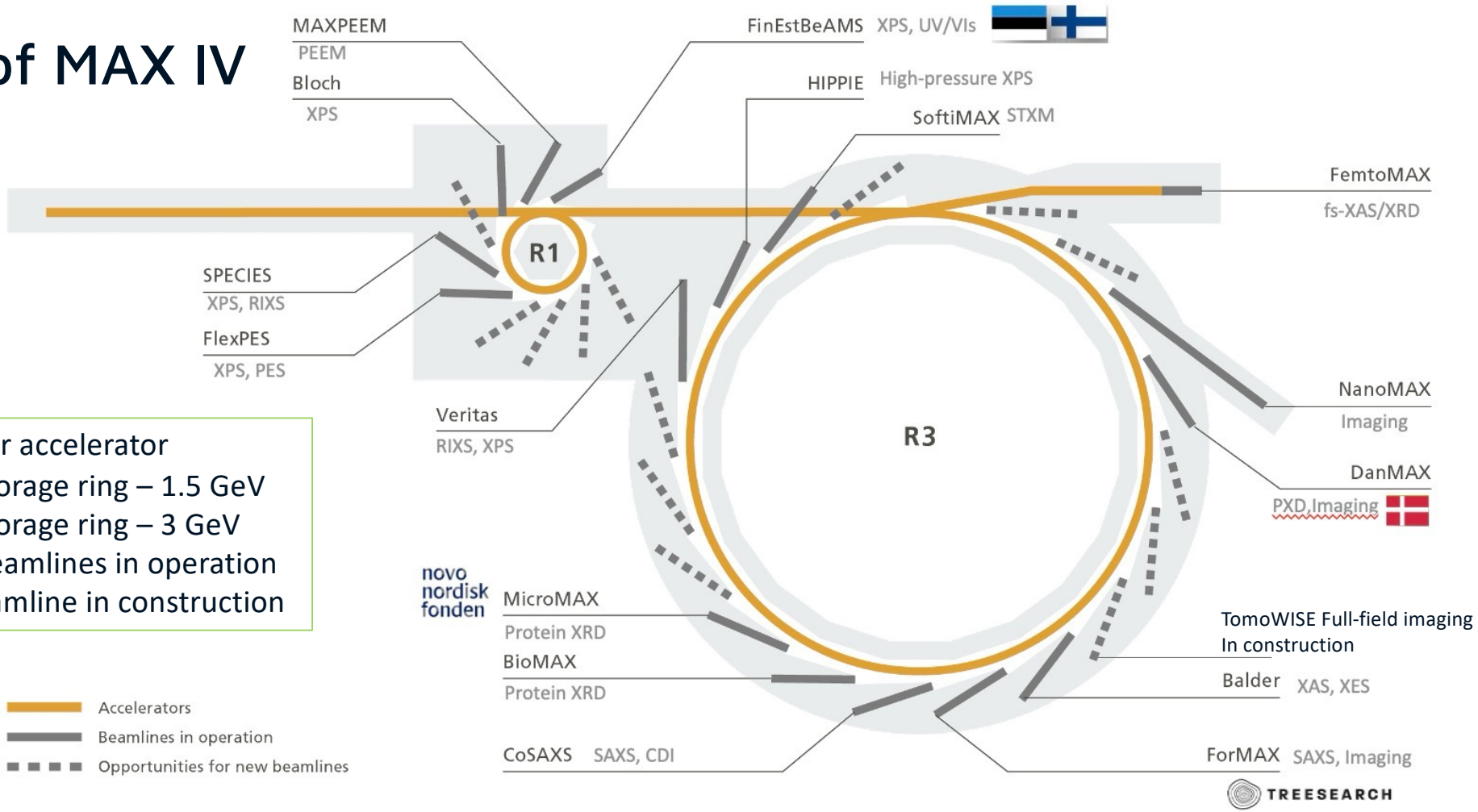
BEAMLINE OFFICE / SUPPORT LABS

This is MAX IV

- A Swedish, national laboratory for X-ray research with Lund University as host.
- A fourth-generation light source
- Available for academic and industrial users worldwide.
- This year we will celebrate 10 years in operation!


Short pulse facility
Accelerated charge: 100 pC
Time resolution: 100 fs
R3 storage ring
Energy: 3 GeV
Circumference: 528 m
Current: 400 mA
R1 storage ring
Energy: 1.5 GeV
Circumference: 96 m
Current: 500 mA
Linear accelerator
Electron injector

Map of MAX IV



Linear accelerator
R1 storage ring – 1.5 GeV
R3 storage ring – 3 GeV
16 beamlines in operation
1 beamline in construction

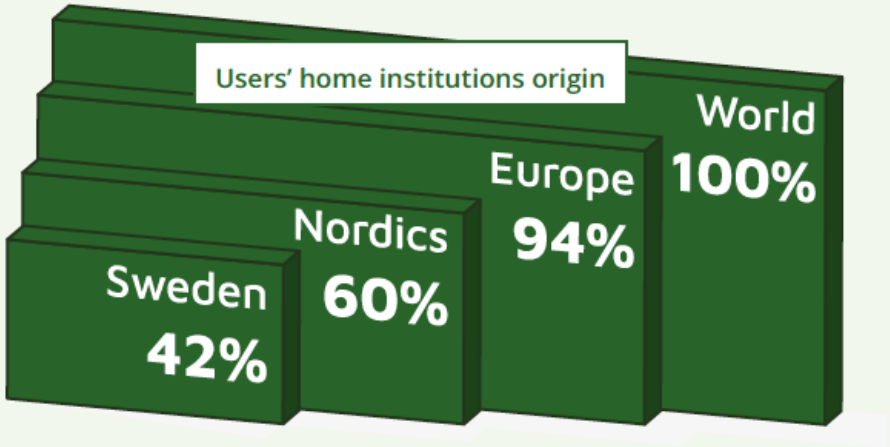
Funders

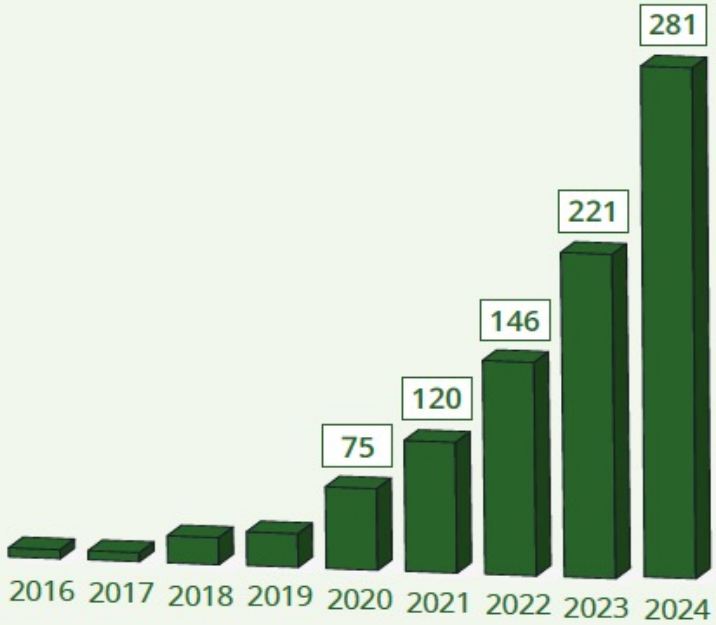
Annual operations budget is about 640 MSEK

2024 – statistics

USERS

1921 visiting users from **292** institutions across **35** countries





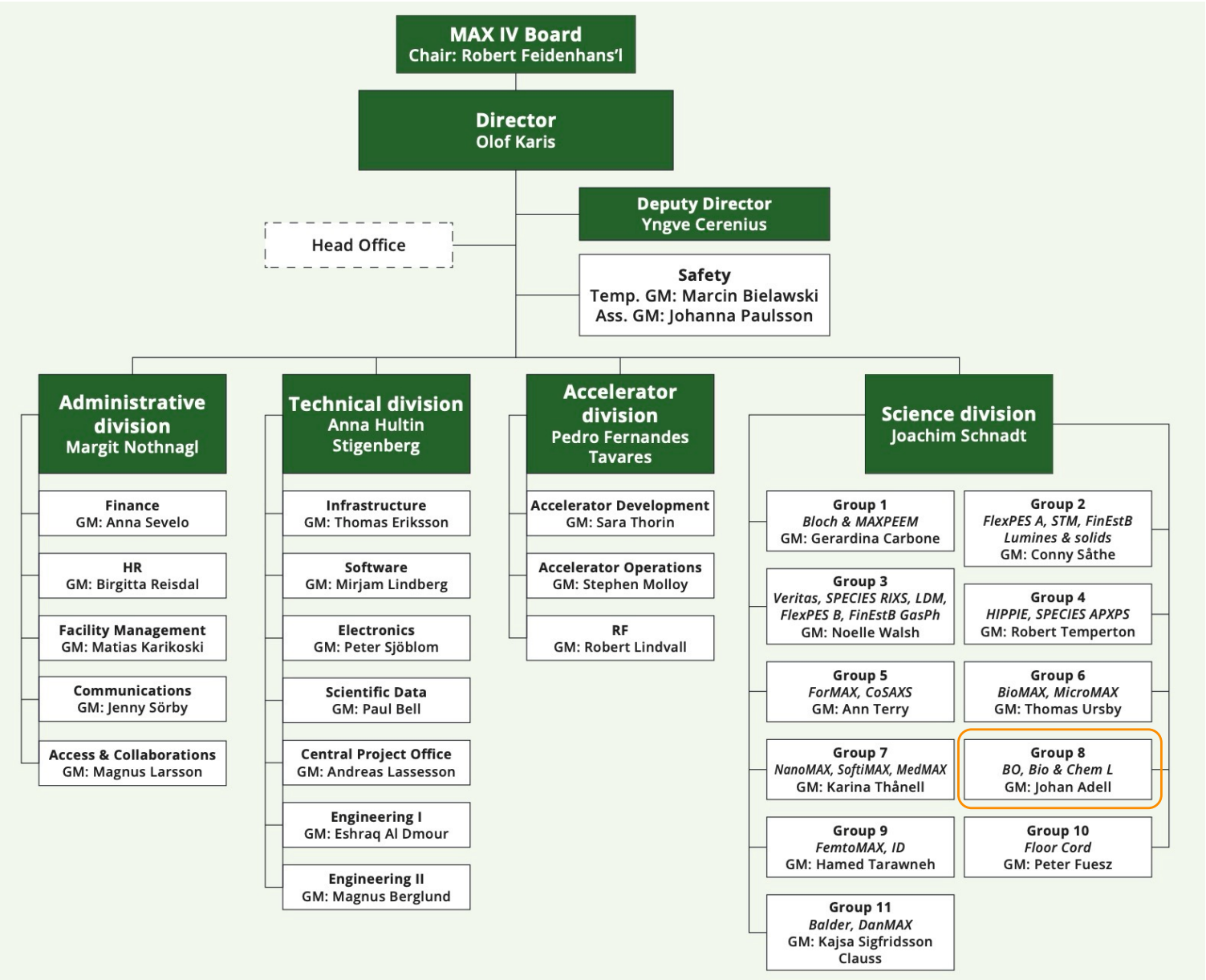
Publications per year*

*As of March 2025, correction rights reserved

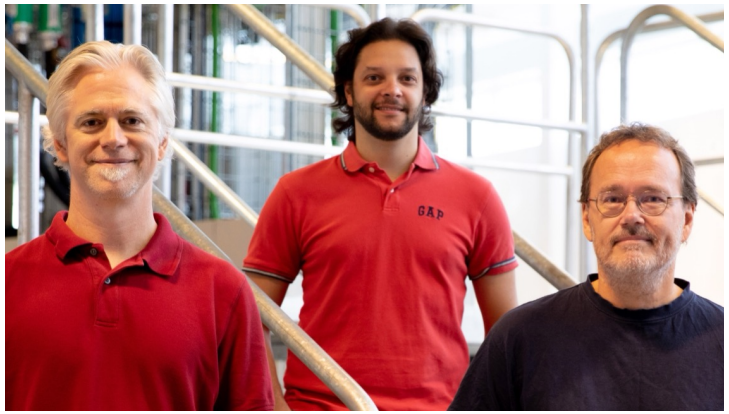
Sample environments in the MAX IV organization

Development of sample environments are mainly done by beamlines and users.

Dedicated sample environment support is available within the Beamline Office group.



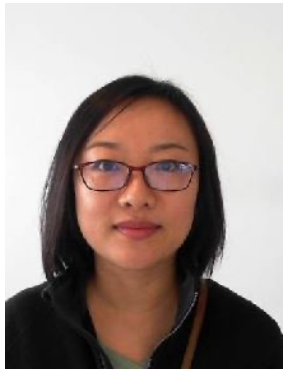
Beamline Office - Support Labs team



Chris Ward
Detectors
Electronics

Artur Domingues
Sample environments
Fast prototyping

Stefan Carlson
Sample environments



Yang Chen
Team leader
Chemistry labs

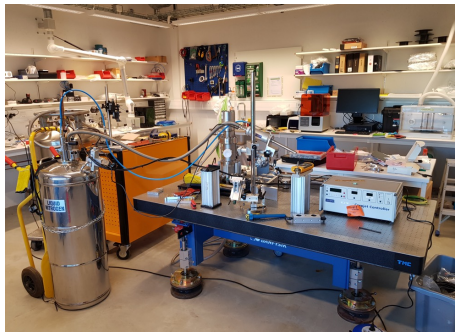
Anicée Guglielmi
Chemistry labs

Some of our responsibilities

- 5 Sample environment labs
- 5 Chemistry labs
- Instrumentation loan pool
- Consumables for labs and beamlines
- Project assistance at beamlines
- Sample environment development

Support labs for sample environments

Sample environment lab

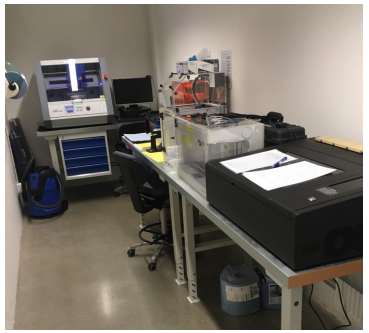


Furnace, cryo, assembly

Test and detector lab

Detector test, X-ray test station

Fast prototyping lab



3D printers, milling, laser cutter

Beamline workshop

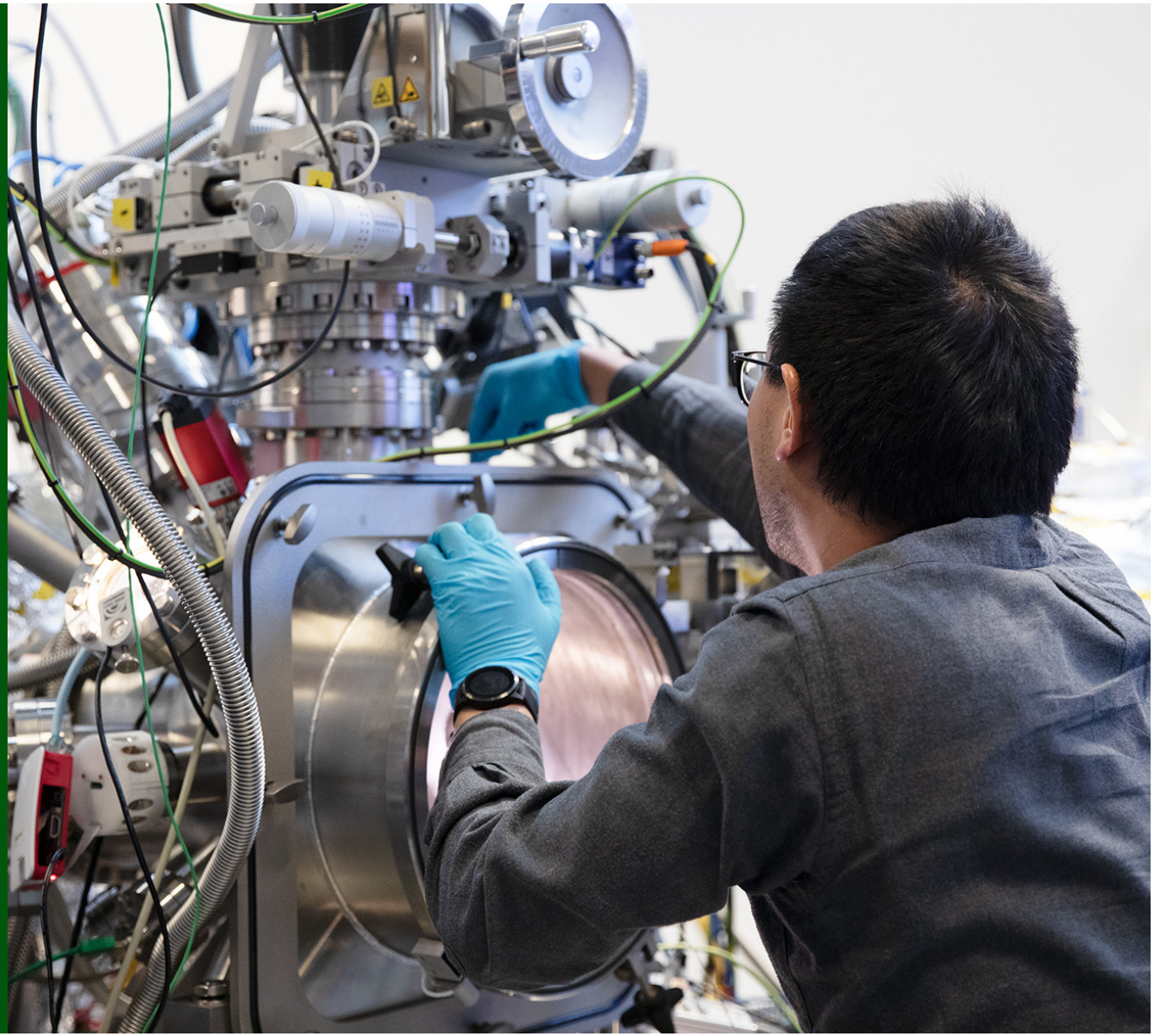
Open 24/7, Drilling machine, Tools

Sample Preplab

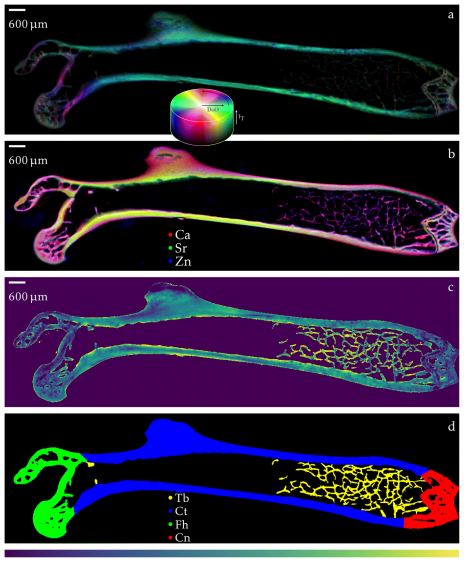
LAF tent, furnaces, DSC, polishing, coating

Experiments at MAX IV

- MAX IV users study material properties – structure, chemistry, electronics, magnetic etc.
- The equipment is specialised for different techniques and/or sample types at different beamlines.
- We always strive to facilitate experiments under dynamic and realistic conditions: In situ and operando.

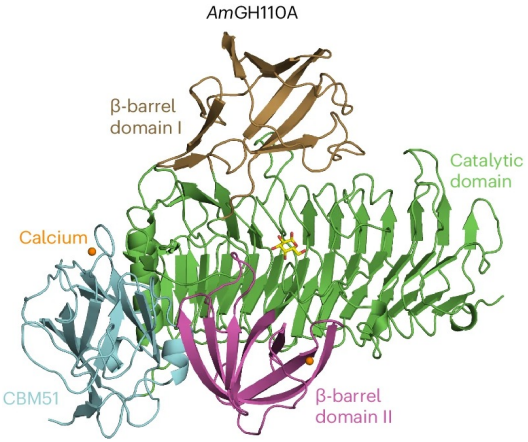


Experiments – Three main methods



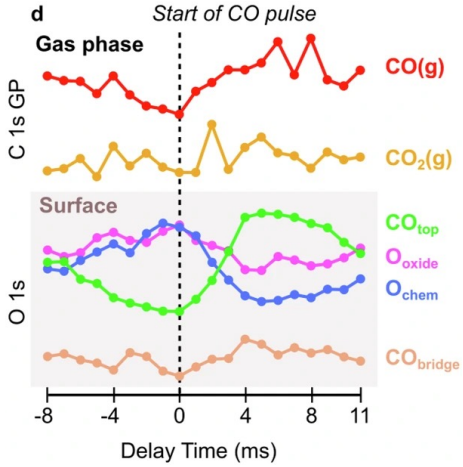
Imaging

Displaying structural and electronic details with nanometric resolutions in 2 and 3 dimensions.



Scattering and diffraction

Understanding the 3D structure of materials with resolutions down to atomic details.



Spectroscopy

Understanding the electronic structure and chemical state of materials.

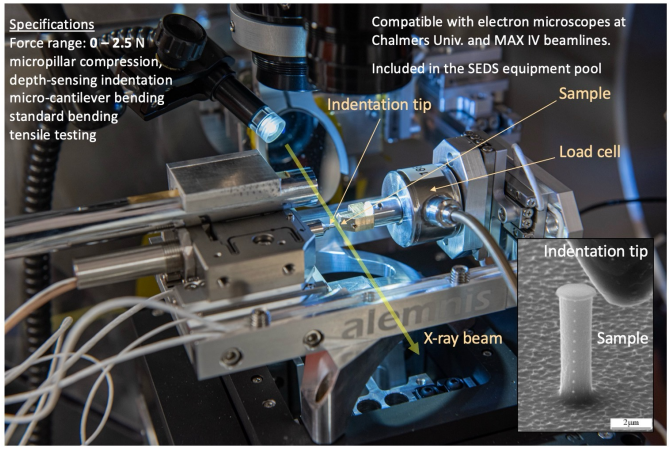
Figures

T. E. K. Christensen et al., Faraday Discuss., 2025, Advance Article

M. Jensen et al., Nat Microbiol 9, 1176 (2025)

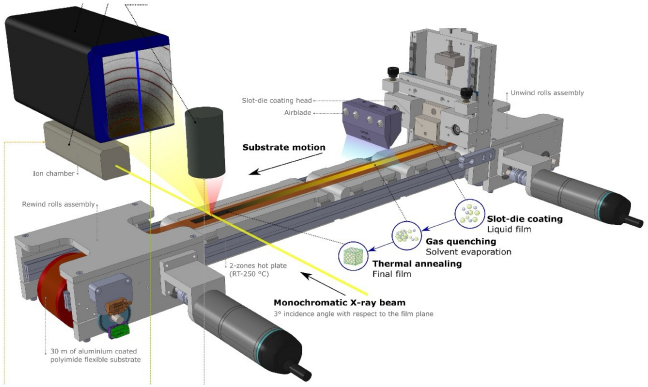
C. N. Eads et al., Nat Commun 16, 1216 (2025)

Some sample-environment examples



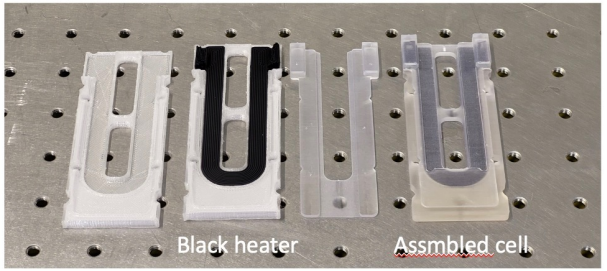
Slot-die coating

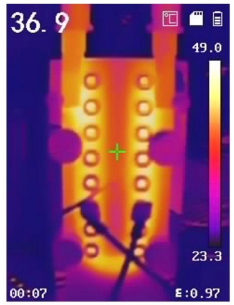
In-situ formation of metal-halide perovskite thin films
Project at Balder by M. Ciambezi, J. Liu, J. Li, M. Ramakrishnan, E. L. Unger and J. Just



Fast prototyping for CoSAXS

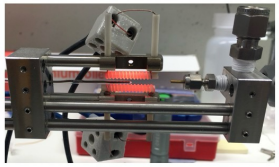
SAXS measurements on human-tissue material
Temperature at the sample must be controlled at 37°C





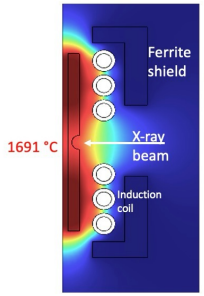
Thermally stabilized cell printed out with electrically conducting plastic heater

Capillary cell

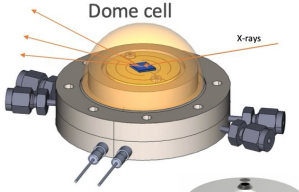


Linkam furnace

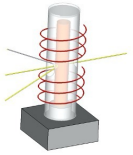
Induction furnace



Dome cell



MAX IV catalysis cell



Diamond-anvil cells

HP Practical, Wednesday 13:30 – 17:45. Lecturers: Dörthe Haase and Damian Paliwoda

Microfluidics at Balder, CoSAXS, and MicroMAX

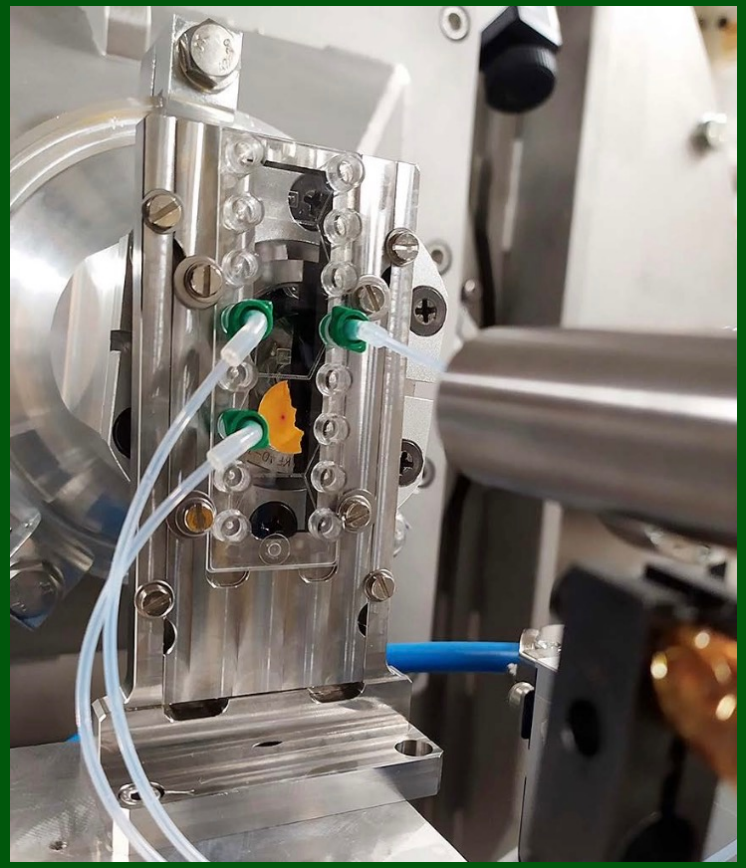
Sample delivery and mixing.

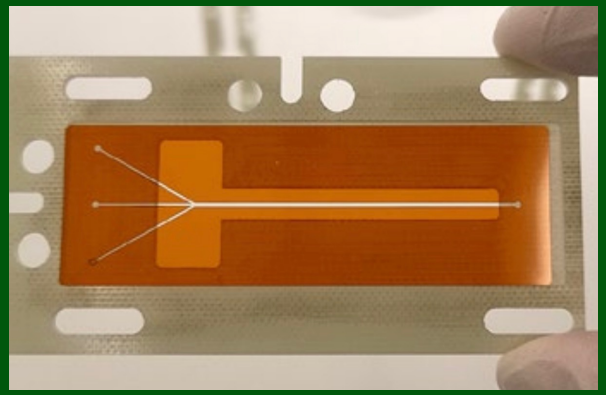
20 – 300 µm channel diameters

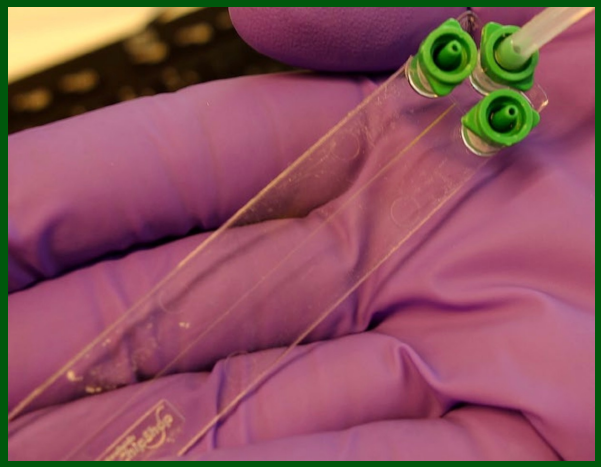
<u>Practical training session at MAX IV !</u>

Wednesday 13:30 – 17:45.

Lecturers: Yang Chen and Hira Qazilbash.





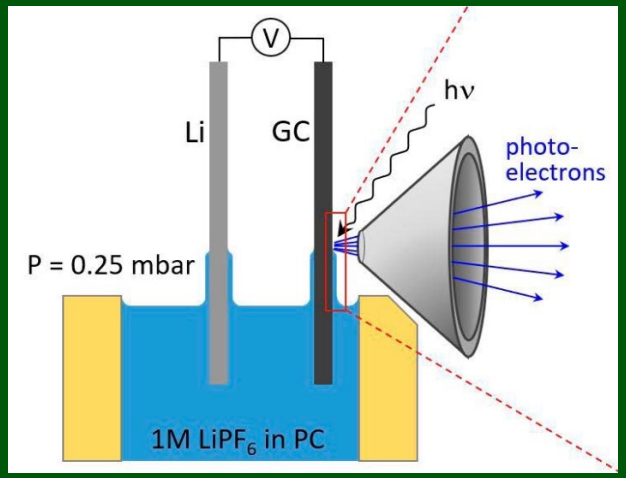


MAX IV

Electrochemistry with XPS

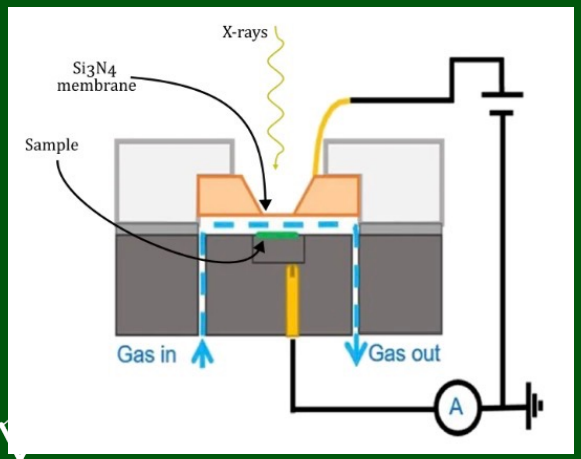
Dip-and-pull electrochemical experiments

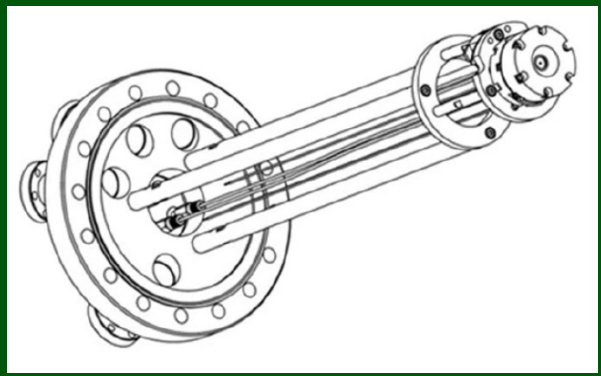
F. G. Capone, et al., Operando observation of the dynamic SEI formation on a carbonaceous electrode by near-ambient pressure XPS. Energy Environ. Sci. 17, 1509 (2024). DOI: 10.1039/D3EE03228K



Electrochemical cell

APXAS, The cell is used at SPECIES together in collaboration with Dr. Piero Torelli, IOM-CNR, Italy.





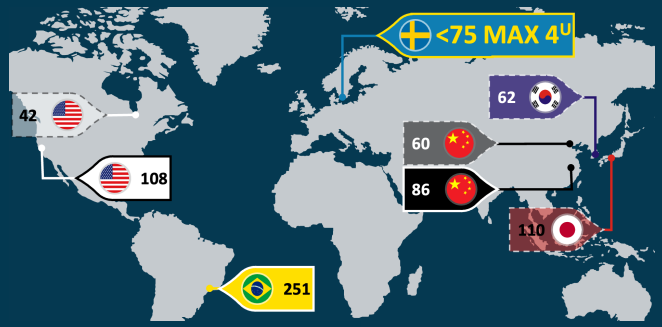
Electrochemical practical on Wednesday, 13:30 – 17:45 !

Lecturers: Anicée Guglielmi, Alice Corani, Hari Narayanan Vasavan, and Agathe Bougeard.

MAX 4U

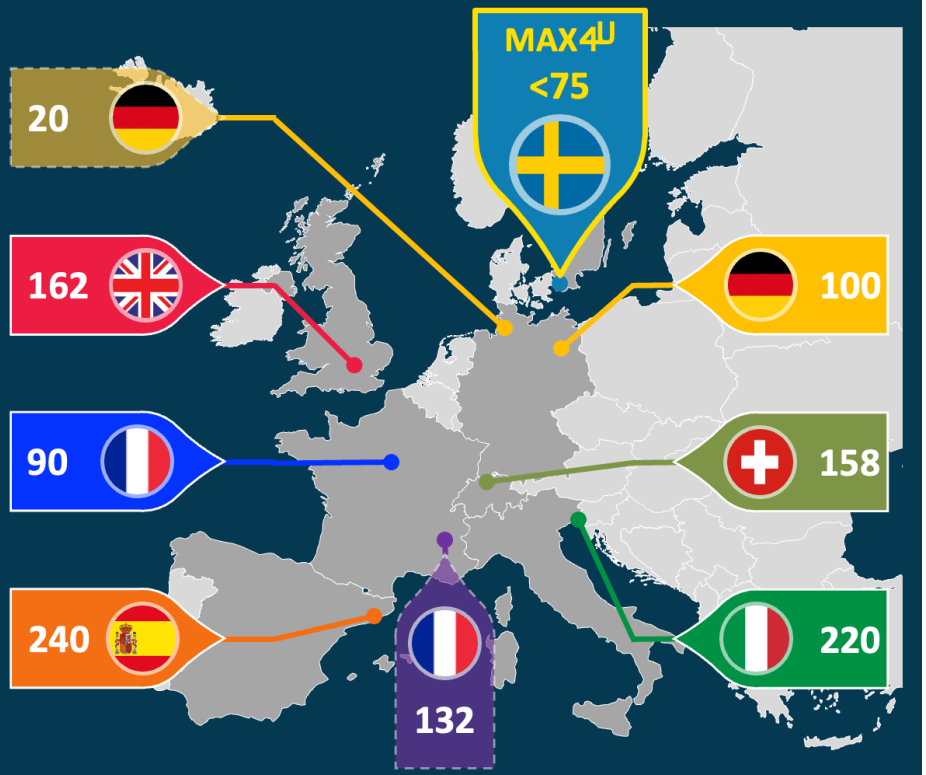
Securing leadership, excellence, resilience, and relevance of Swedish research an innovation with X-rays for the next decades

MAX 4U website



A ***"surgical"*** upgrade of our 3GeV ring from 328 to below 75 pm·rad

Horizontal Emittance [pm·rad]



c/o A.ROBERT

V9.0126

Thank you for your kind attention!