

# A sample environment for in-situ X-ray studies on electron beam powder bed fusion (E-PBF)

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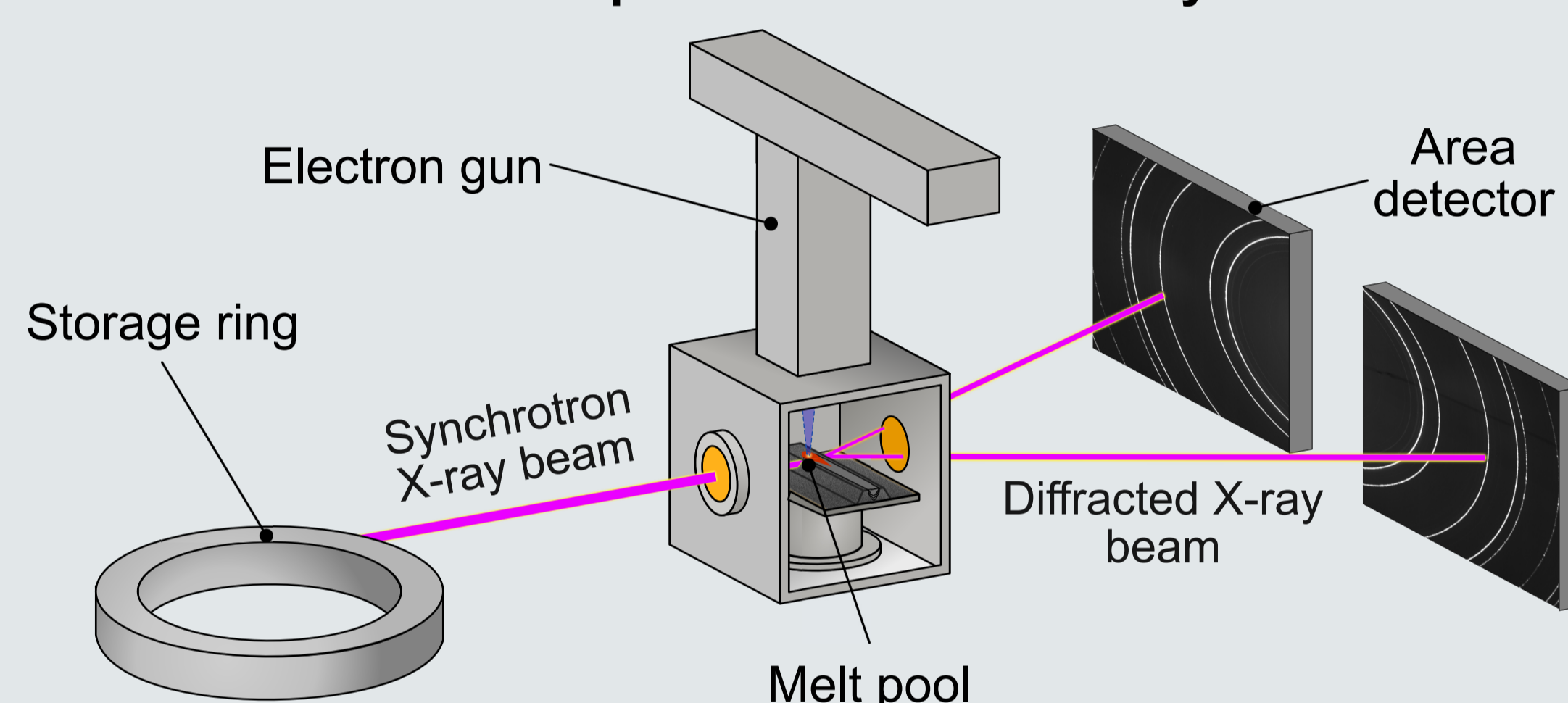
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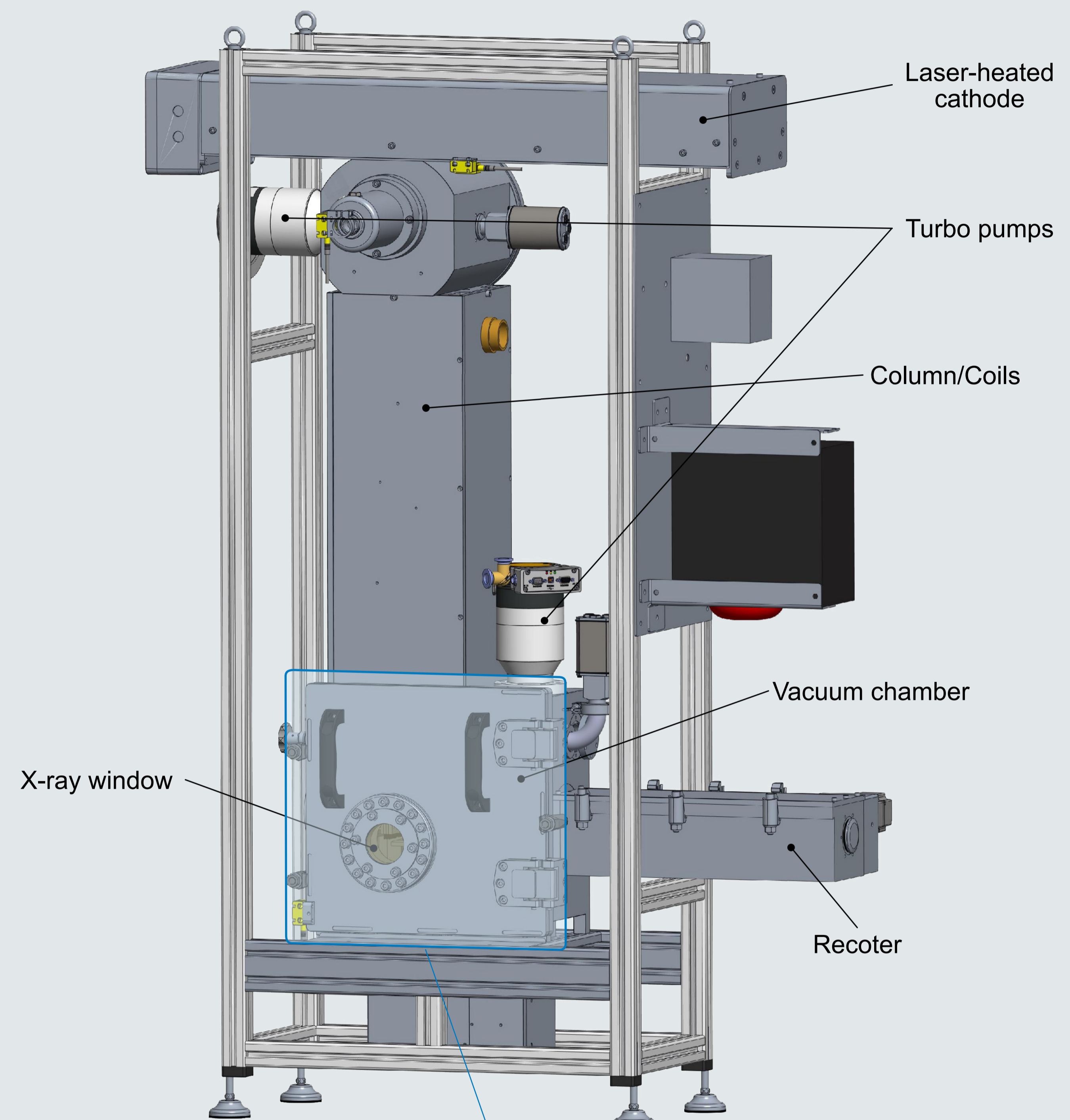
## Motivation & Background

- A sample environment to study **electron beam powder bed fusion (E-PBF) in-situ with synchrotron X-ray radiation** was designed and constructed.
- The sample environment is designed for **X-ray imaging, wide-angle X-ray scattering (WAXS)** and **small-angle X-ray scattering (SAXS)**.
- The sample environment allows for measurements of the electron beam-matter interaction, melt pool dynamics, defect formation, solid-state phase transformations, stress and texture evolution and facilitated in-situ results for E-PBF specific materials design.

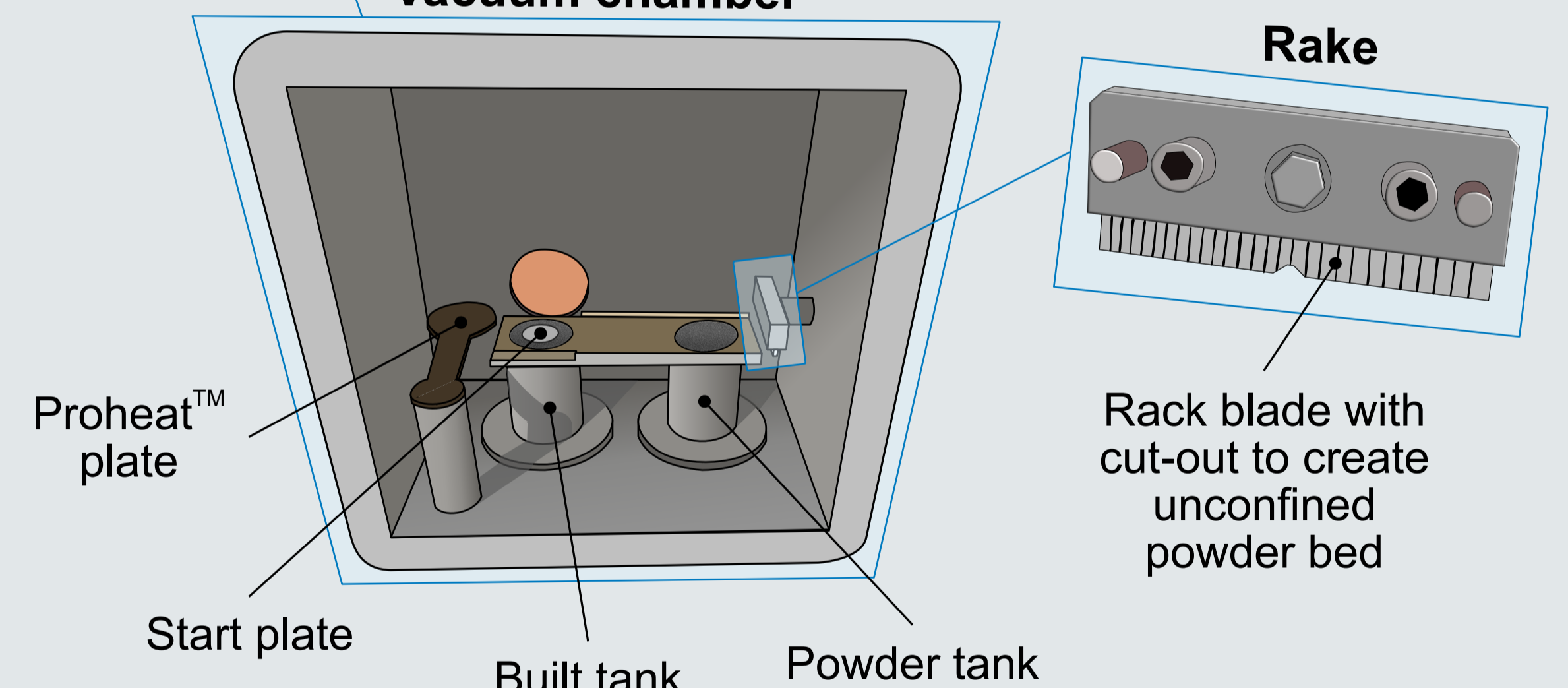
### The E-PBF sample environment at a synchrotron



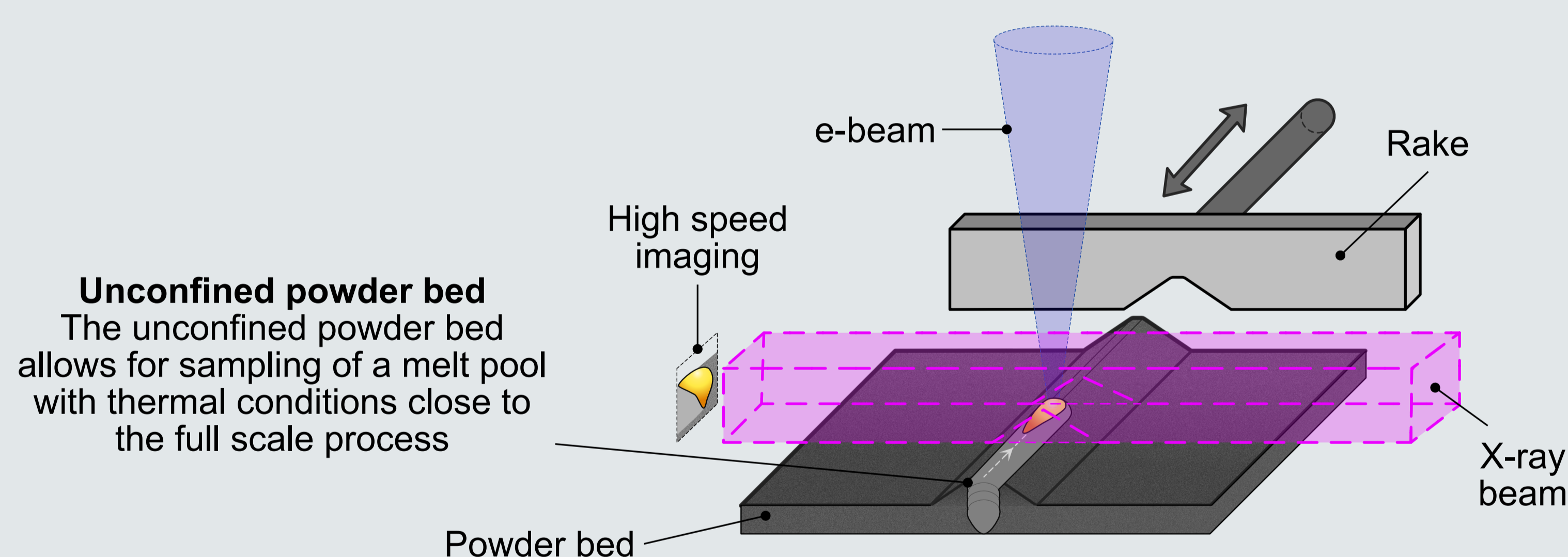
### The E-PBF sample environment



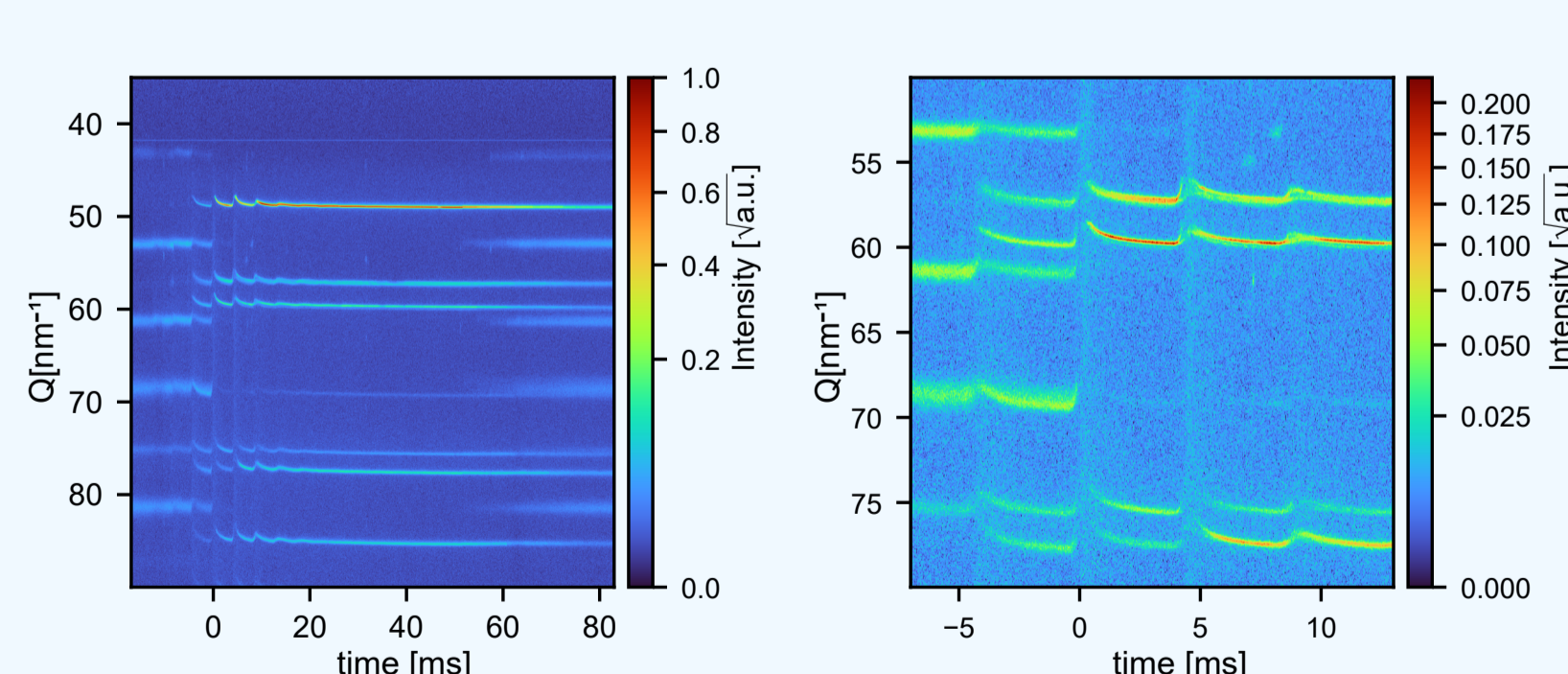
### Vacuum chamber



### The in-situ measurement

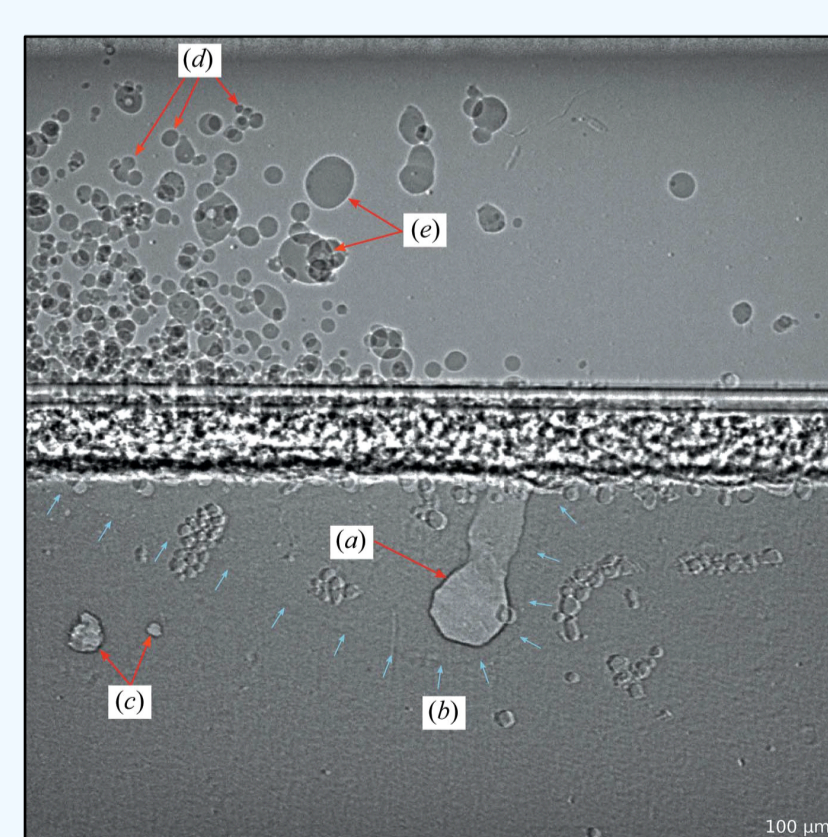


## WAXS



*In-situ* wide-angle X-ray scattering (WAXS) of powder bed fusion which allows to track the phase transformation, stress and texture evolution in metallic materials with high spatial (beam sizes of hundreds of  $\mu\text{m}^2$  [1]) and temporal (up to 20 kHz [2]) resolution.

## Imaging



*In-situ* imaging of powder bed fusion with synchrotron radiation allows to track the melt pool and powder dynamics, as well as pore and crack evolution with high spatial (few  $\mu\text{m}$  [1]) and temporal (up to 1 MHz [3]) resolution.

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## SAXS

*In-situ* small-angle X-ray scattering (SAXS) enables tracking of the precipitate size (particle sizes of tens of nm [1]).

## Conclusion

An electron beam powder bed fusion (E-PBF) sample environment for in-situ synchrotron studies is presented. This sample environment will provide measurements with high spatial and temporal resolution. Thereby, the sample environment will **foster the process and alloy development for the E-PBF process**.

[1] C. Ioannidou et al., "In-situ synchrotron X-ray analysis of metal Additive Manufacturing: Current state, opportunities and challenges", doi:10.1016/j.matdes.2022.110790.  
[2] S. Hocine et al., "Operando X-ray diffraction during laser 3D printing", doi: 10.1016/j.mattod.2019.10.001.  
[3] N. D. Parab et al., "Ultrafast X-ray imaging of laser-metal additive manufacturing processes", doi: 10.1107/S1600577518009554.