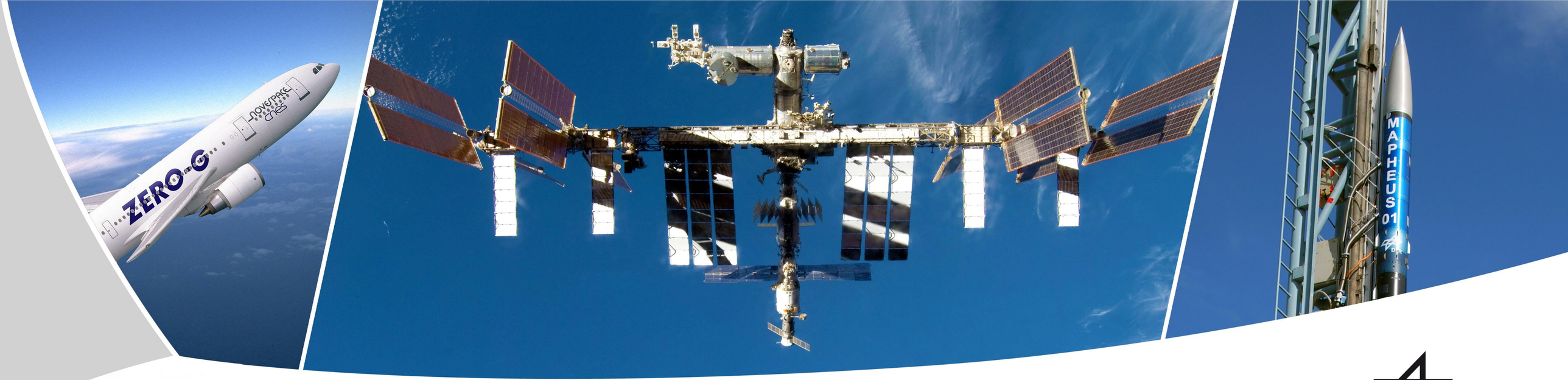

Institut für Materialphysik im Weltraum

In-situ X-ray investigations of the growth orientations of metal alloys and the role of interface anisotropy

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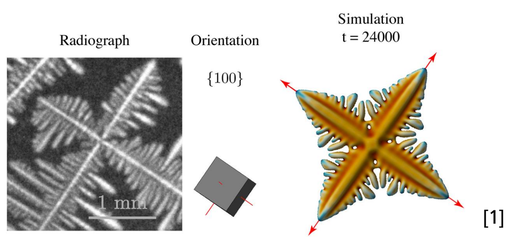
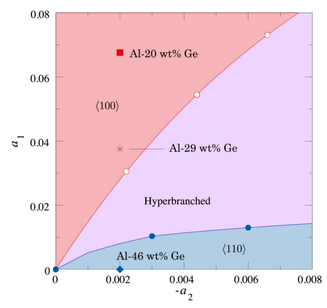
Motivation

- Investigation of AlGe alloys by Becker et al. using in-situ X-radiography imaging, phase field simulation and post-mortem electron backscatter diffraction
- In situ tomoscopy enables examination of the dendrite in all directions



[1]

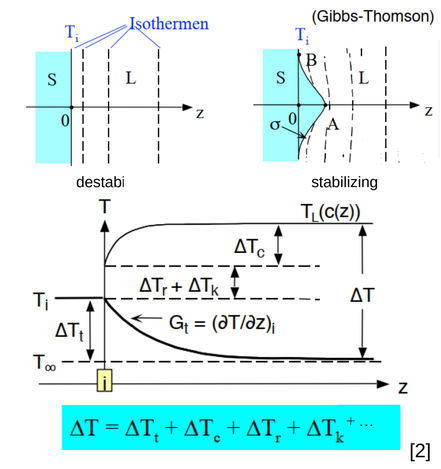


[1]

Dendrites

Influence on dendritic growth:

- Diffusion of heat and material
- Atomic kinetics at the interface
- Shape and curvature of the interface
- Interface energy
- Anisotropy
- Alloy composition
- Growth of the side arms
- …



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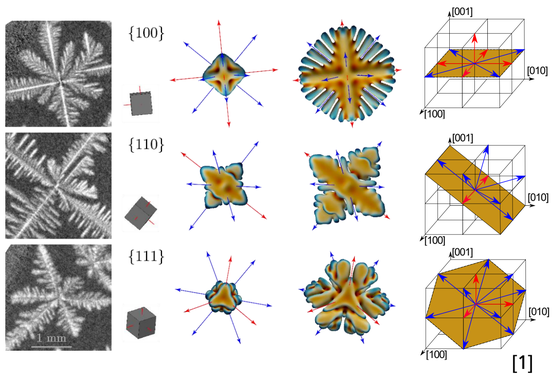


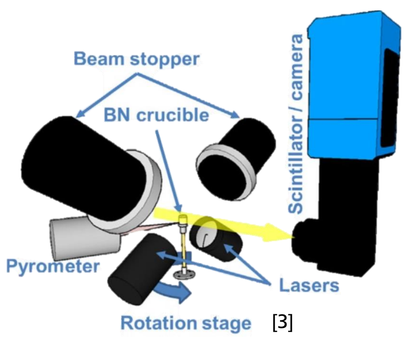
[1]

Dendrite descriptive parameters:

- DAS (**d**endrite **a**rm **s**pacing)
- Curvature
- Shape
- Peclet – number
- Solidification velocity
- Alloy composition
- Crystallographic direction
- Angle of the dendritic arms
- Temperature
- …..

In-situ X-ray investigations using synchrotron

- Energy range: 8-45 keV
- 20, 10, 1 Tomograms per second (Tps)
- Laser-based heating
- Boron nitride crucible
- Different Alloys
  - AlGe 5%-45% in 5% steps and 53%
  - AlCu 7%, 25%, 33%
  - AlCe 4%, 12%, 20%
  - AlSi18%Cu10%
- Voxel size of 2.75 µm



[3]

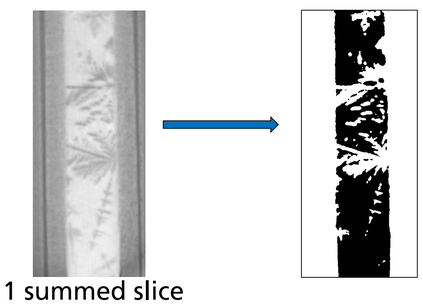
Analysis of the data

First aim: Extraction of the dendrites

- 1 Tomography≙553 Slices
- 20 Tomograms per second

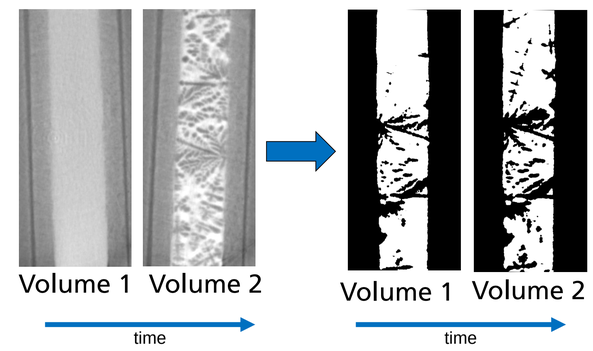
→ Automation needed

1.Step: Increasing the contrast
→ **Summation of three time steps**



1 summed slice

2. Step: Correct the angle - automated
Problem:

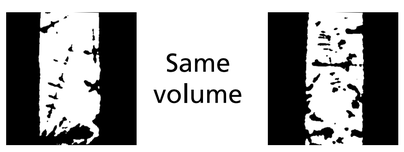


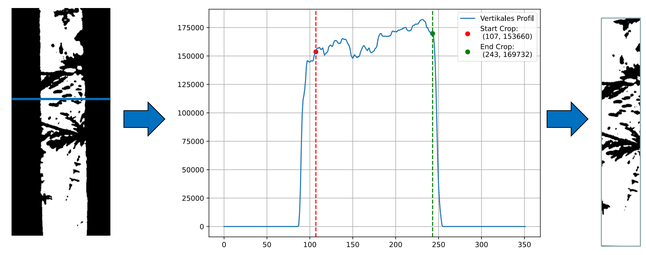
→ Rotation over time:
- Different image processing steps:
  e.g. Gauß-Filter;
  Histogram equalization; ….

3. Step: Removal edges

- Unequal edges in the same volume
- Universal mask not possible

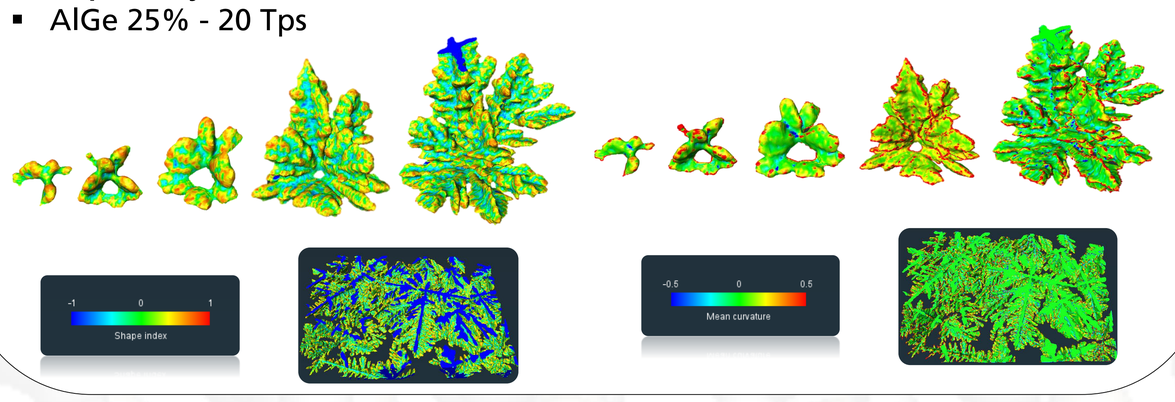
Solution:
→ Automated crop of the sample needed





4. Step: Analysis of the dendrites

- AlGe 25% - 20 Tps

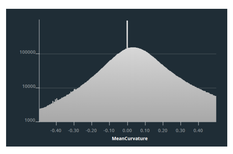


Outlook

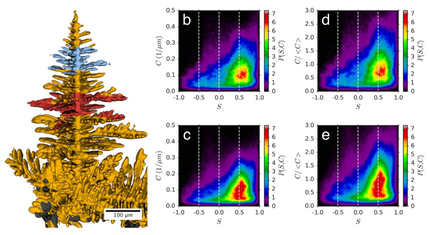
Sample Analysis:
- Chemical analysis
- Comparison between different alloys
- Velocity

Statistical analysis of the Data:
- DAS
- Crystallographic direction
- Curvature
- Shape
- …

Analysis of the data extracted from the 3D-dendrites:



Interface shape distribution (ISD):



[1] Becker et al., Acta Materialia, 165, 2019
[2] D. M. Herlach & D. Holland Moritz, “Einführung in die Metallphysik”, Skript, 2003/2004
[3] Kamm, García-Moreno, Neu, et al. Adv Eng Mater (2016)
[4] Gibbs et al., Scientific Reports,11824, 2015