

**Round Robin Studies  
of  
DFG Priority Programme  
“Materials for Additive Manufacturing”  
(SPP 2122)**



## Aim

- Address the scientific question “How does nano-additivation affect polymer & metal PBF-LB processability and final part properties?”
- Quantify the inter-laboratory variability in: densification, dimensional accuracy, microstructural and mechanical properties as well as virgin & used powder properties
- Peer-reviewed publication (of both, the pilot run and final run), seed data for AM materials database

## Background & Scope

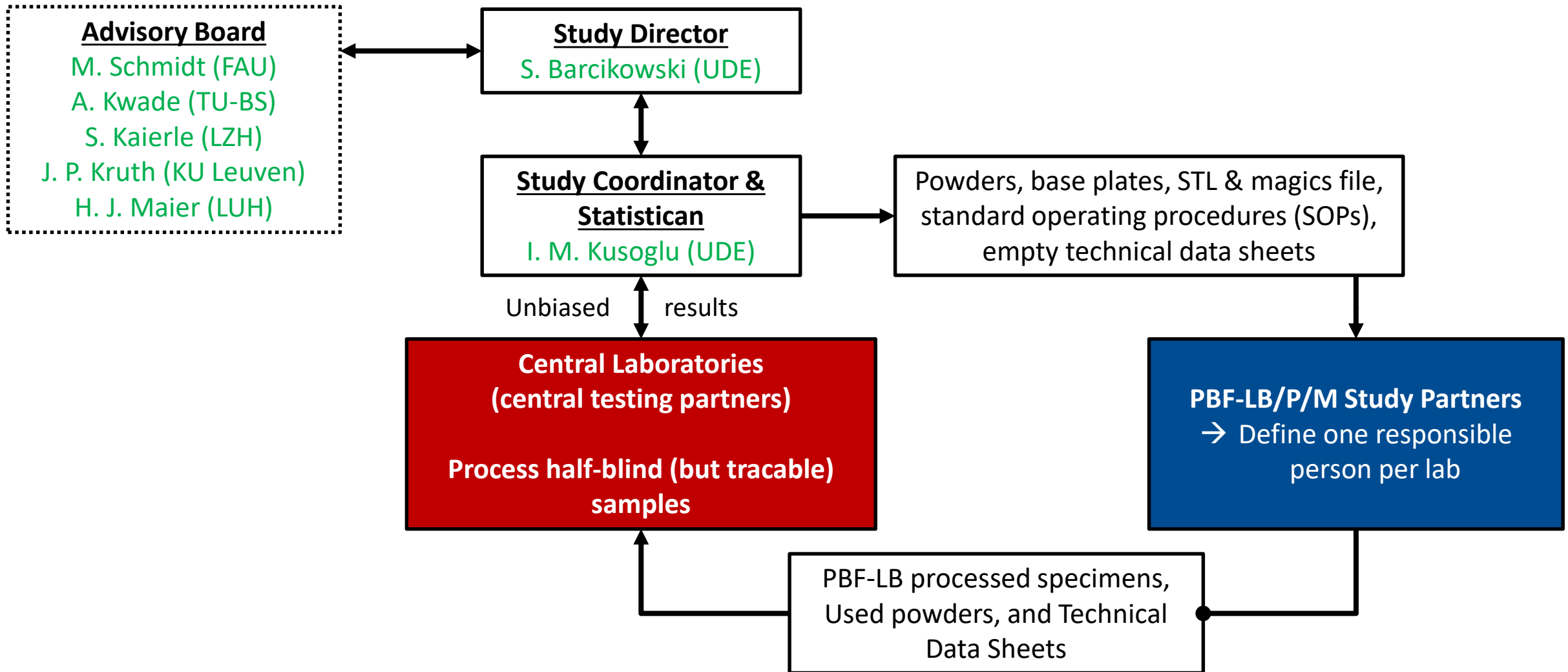
- Basis: priority program SPP2122 “materials for additive manufacturing” ([www.uni-due.de/matframe](http://www.uni-due.de/matframe))
- Participants: International institutions that run PBF-LB (at least 10 for polymer, 10 for metal)
- Coordination: 1 coordinator per laboratory, protocol needs to be signed by the coordinator
- Materials: PA12 and AlSi10Mg alloy (3 batch jobs: pure/nano-1/nano-2)
- In-depth analyzed powders will be provided to all participants
- Central analysis of as-built parts

To understand and document the influence of nano-additives on ...

- ... melting-resolidification (crystallization) kinetics
- ... processability
- ... microstructure
- ... mechanical properties
- ... densification
- ... Chemical composition

<u>Micropowder</u>	<u>Nano-additive</u>
PA12	Ag, Carbon Black
AlSi10Mg	SiC, TiC

# Organizational Chart

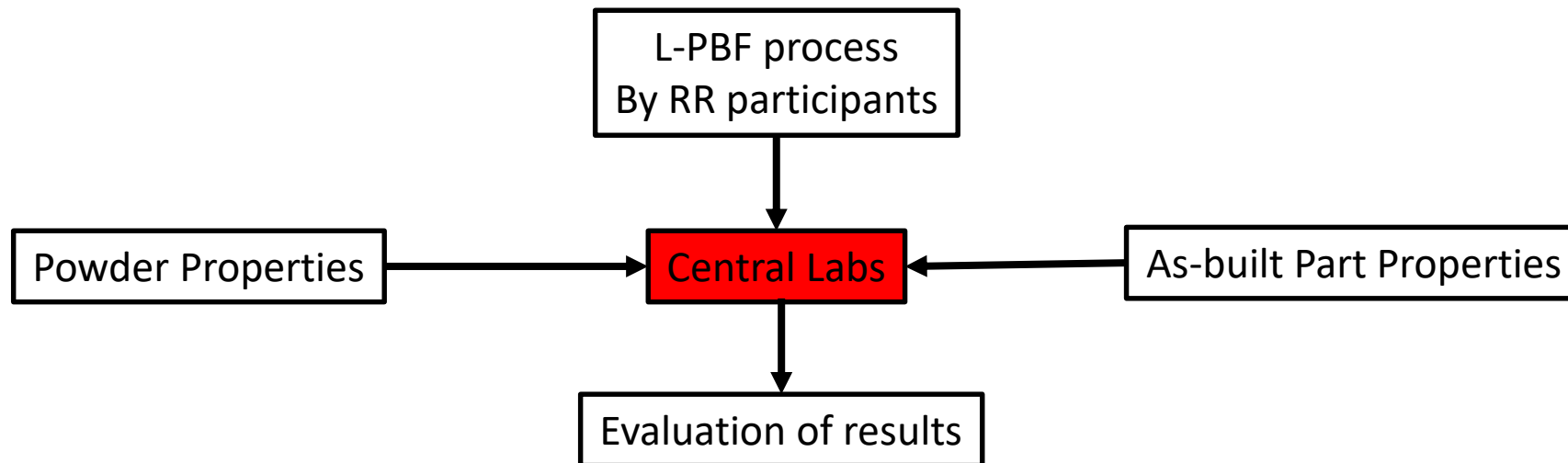


# Questions to be answered within the RR studies by evaluating the results of central laboratories

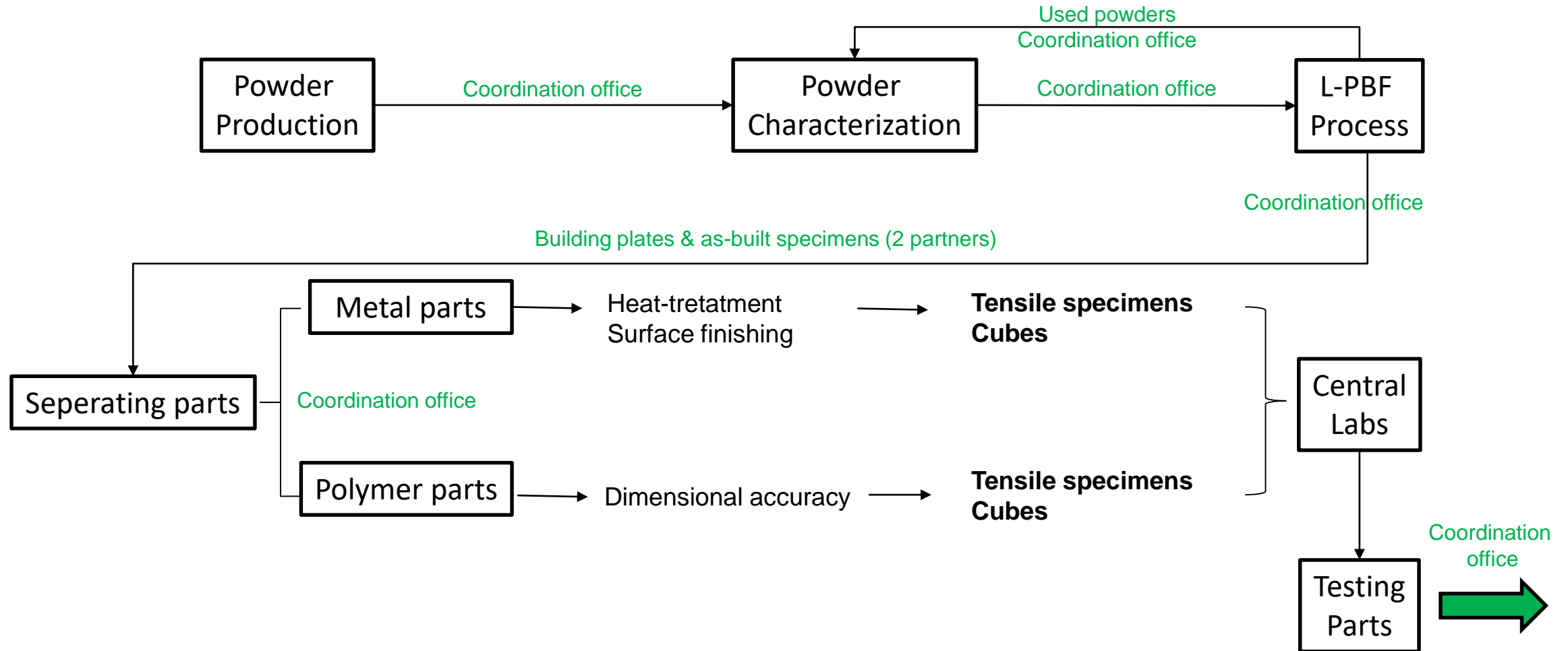
What is the effect of nanoparticles additivation on the powder properties of AlSi10Mg and PA12 powder feedstocks?

What is the effect of nanoparticles on chemical composition, relative density, volumetric pore size and distribution, microstructure, thermal properties, and mechanical properties of as-built parts?

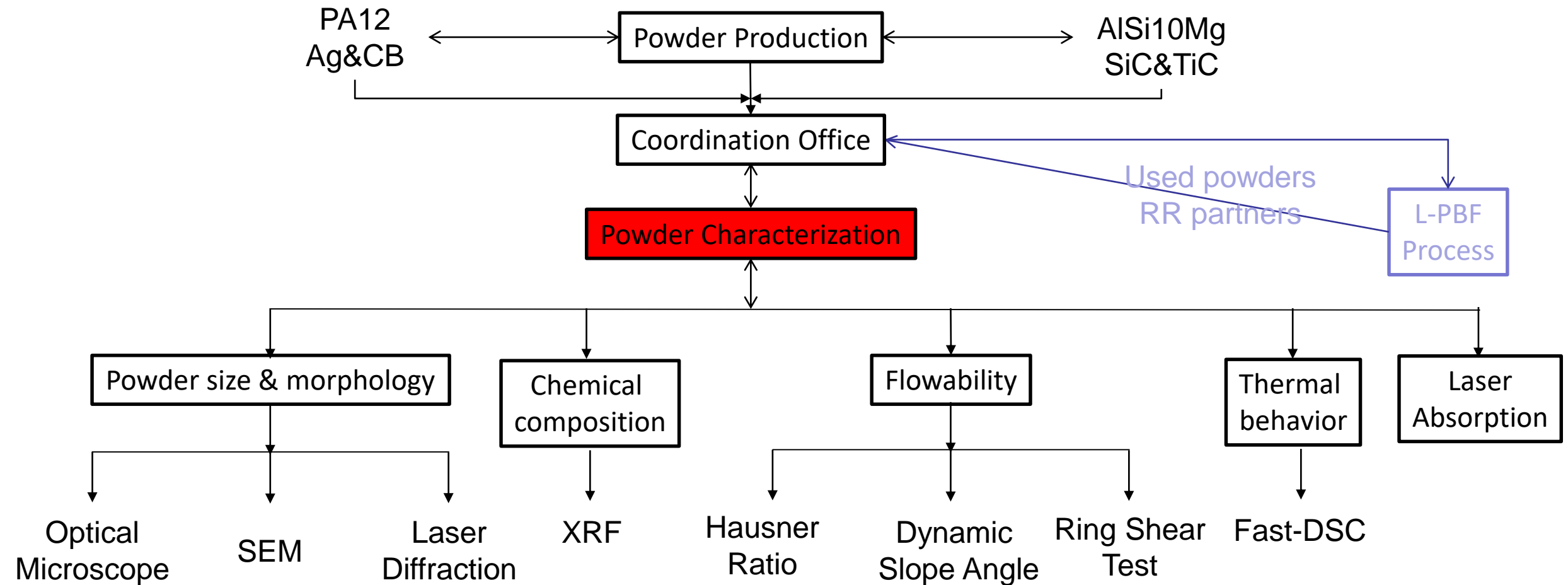
How is the statistical deviation of the results between the Round Robin participants?



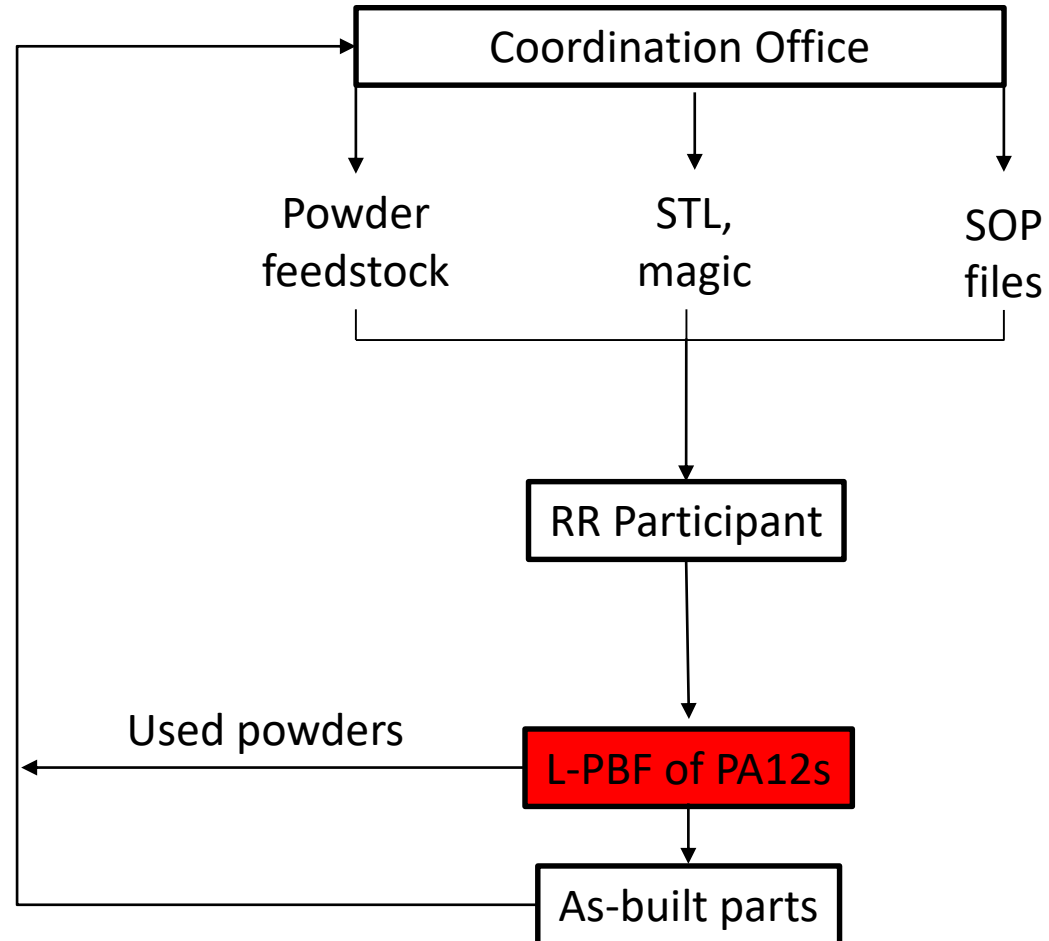
# Work flow of Round-robin studies



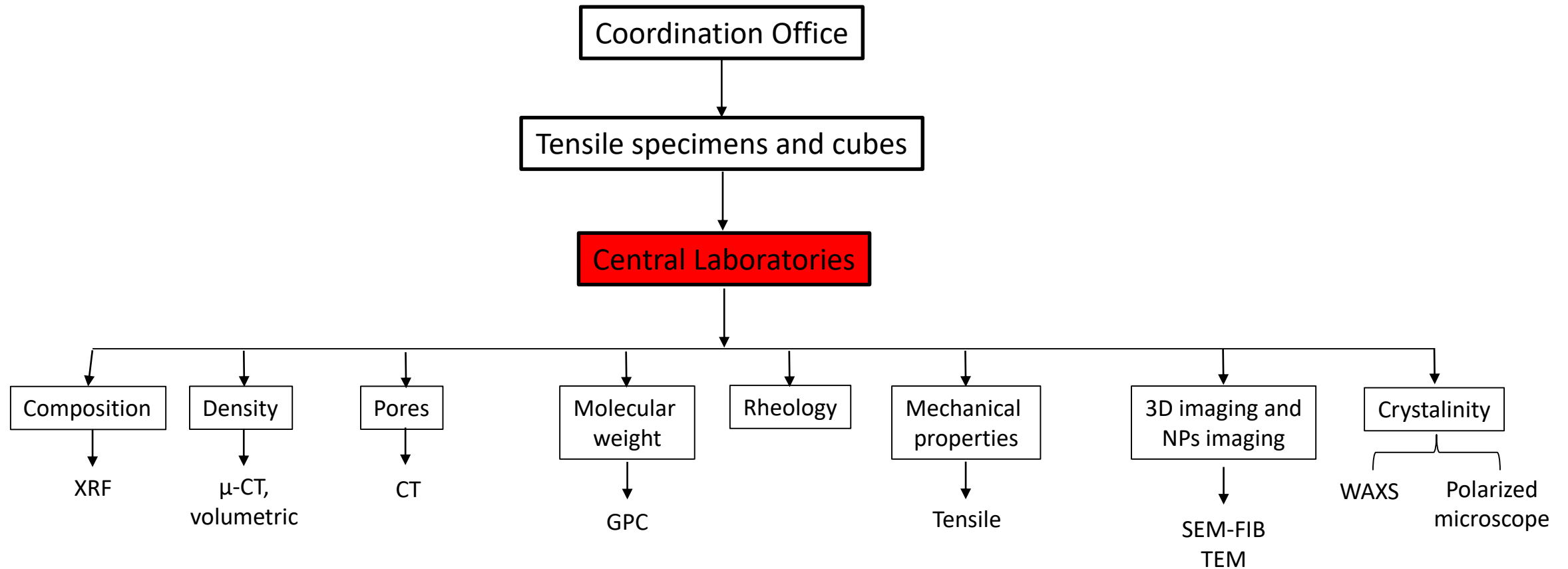
# Workflow for powder production & characterization in RR



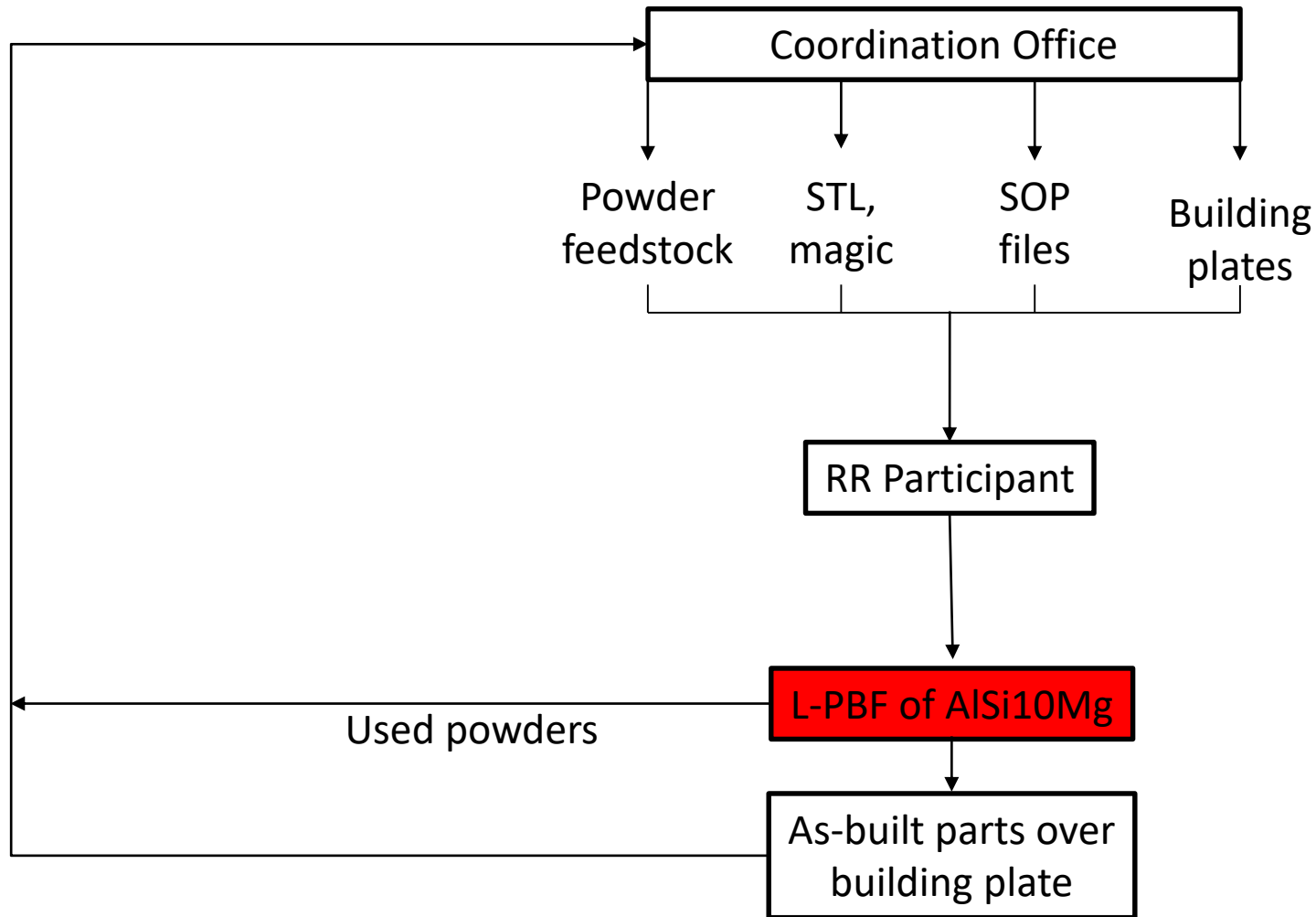
# Workflow for L-PBF processing of PA12, Ag/PA12, and CB/PA12 powder feedstocks

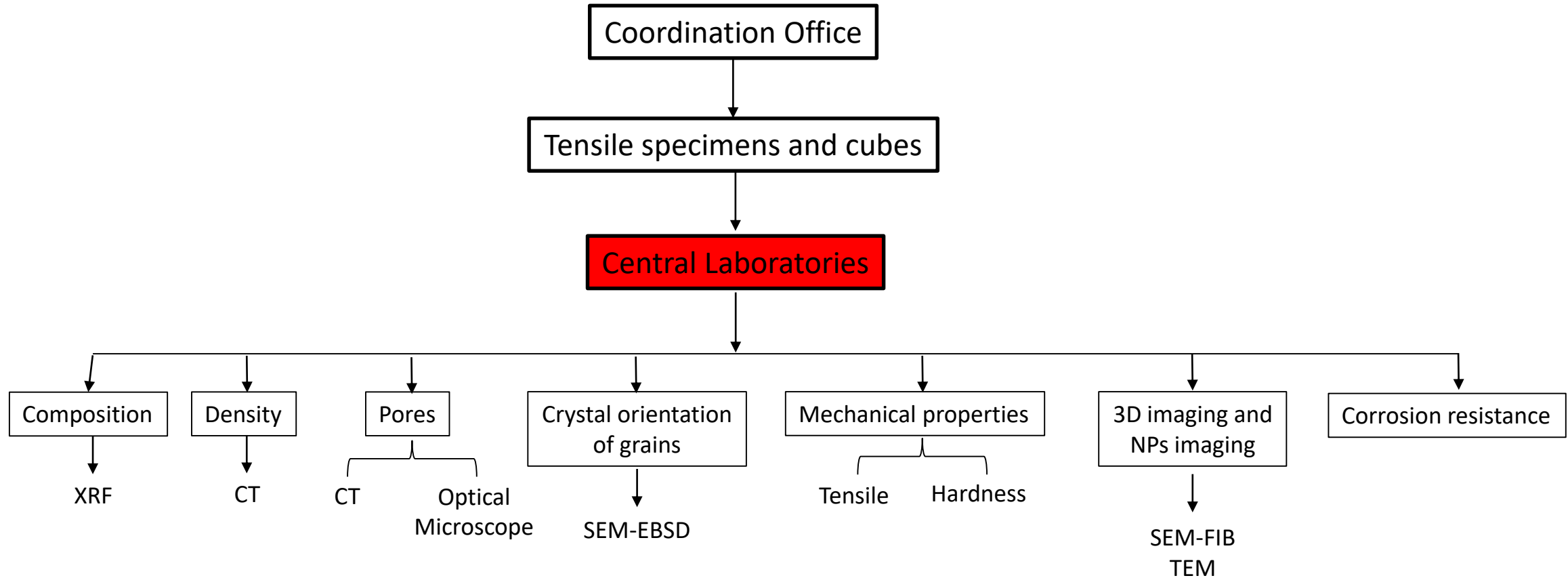






# Workflow for L-PBF processing of AlSi10Mg, SiC/AlSi10Mg, and TiC/AlSi10Mg powder feedstocks





# Time planning for Round Robin

First funding period of SPP2122

Second funding period of SPP2122

2020						2021						2022																		
June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec



- ✓ Developing new powder feedstocks for L-PBF
- ✓ Producing high amounts of NPs modified powder feedstocks for L-PBF
- ✓ Determine the quality of produced powders
- ✓ Define standard process parameters for round-robin studies
- ✓ SOPs for higher reproducibility and repeatability of the round-robin

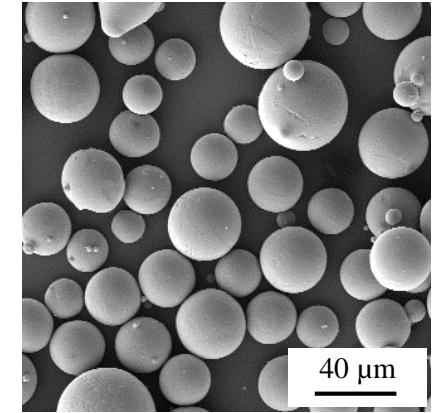
- ✓ Check workflow and sampleflow of round-robin chain
- ✓ Check central laboratories for testing as-built specimens
- ✓ Check processability of powders in different L-PBF machines
- ✓ Check SOPs for processing and testing parts
- ✓ Peer-reviewed publication from the results

- ✓ Produce 100 kg of NPs additivated powder feedstocks for Round Robin
- ✓ At least 10 participants for L-PBF of metal powders
- ✓ At least 10 participants for L-PBF of polymer powders
- ✓ Quantify the inter-laboratory variability in: densification, geometric tolerance, microstructure and mechanical properties as well as virgin & used powder properties
- ✓ Peer-reviewed publication, seed data for AM materials database

Final team of the Full-Run RR will be determined from participants of the second funding period

## Detailed powder properties:

- Particle shape distribution (size dependent aspect ratio)
- Particle size distribution ( $Q_x$ , d10, d50, d90)
- Hausner Ratio
- Avalanche Angle
- Ring shear test and/or Freeman Powder Rehometer
- Chemical Composition incl. Oxygen, Humidity

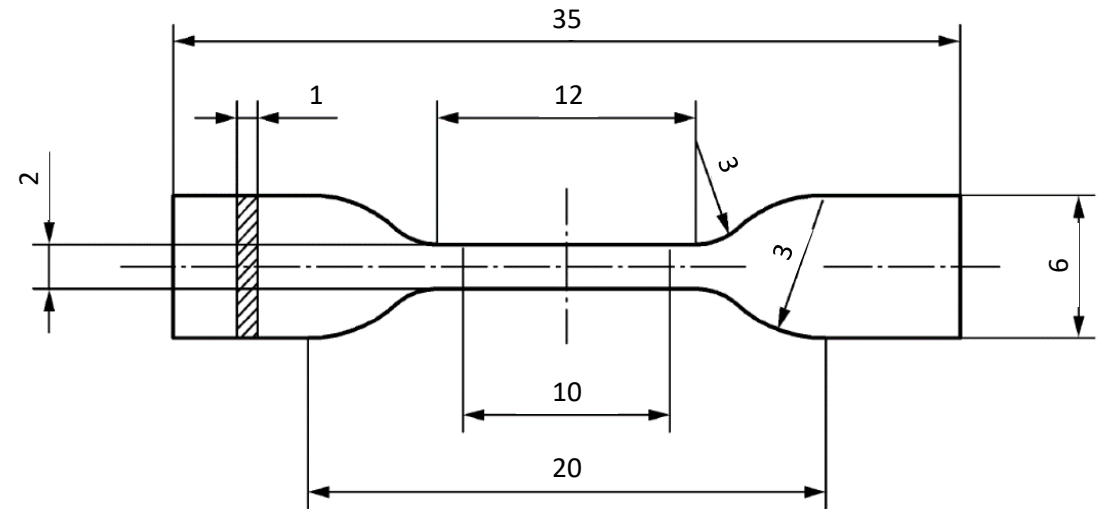


- Two samples per powder material: Used (powder bed) and virgin (stored) powder; aliquots of every laboratory
- Standard operating procedure (SOP) for handling, sampling, and storage provided
- Powders in sufficient quantity provided

- **Each partner defines one responsible contact person**
- **Magics-files (.stl respectively) provide by Coordinator / LPT**
- **One buildjob per powder material; tensile bars (3 orientations) and cubes**
  - Required powder bed dimension PBF-LB/M: min 200 x 200 x 68 mm<sup>3</sup>
  - Required powder bed dimension PBF-LB/P: min 200 x 200 x 40 mm<sup>3</sup>
- **Each participant will follow SPP2122-provided standard operating procedures (SOP)**
- **3 materials (blend, 2 types nanocomp.) for each metal & polymer feedstocks**

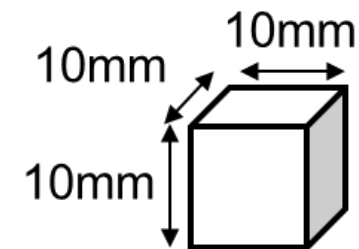
## Each build job yields:

- 20 tensile specimens (0°)
- 20 tensile specimens (45°)
- 20 tensile specimens (90°)
- 15 cubes



Tensile specimen, DIN EN ISO 527-2 Type 5B

Minimum build area : 200 mm x 200 mm  
Total height of build volume: 45 mm  
(35 mm height of tensile bars, 10 mm base powder layer)



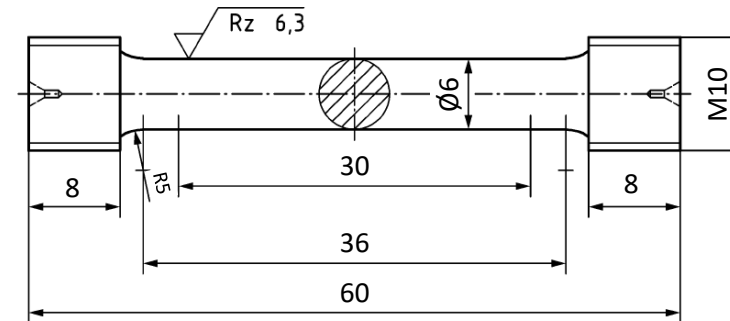
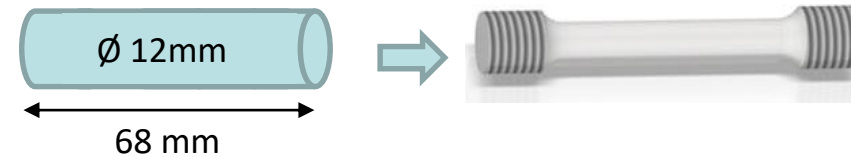
Cubes

## Each build job yields:

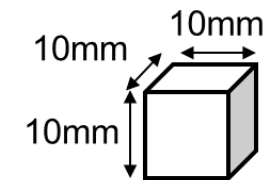
- 9 bars (0°)
- 9 bars (45°)
- 9 bars (90°)
- 15 cubes

Minimum build area : 200 mm x 200 mm  
Total height of build volume: 73 mm  
68 mm height of tensile specimen  
5 mm support structures

As-built bars will be machined to tensile specimens



Tensile specimen, DIN 50125:2016-12 Form B



Cubes



Thank you for your interest in SPP2122`s Round-robin

Contact : [ihsan.kusoglu@uni-due.de](mailto:ihsan.kusoglu@uni-due.de)

Website: <https://www.uni-due.de/matframe/>