SWITZERLAND INNOVATION PARK BIEL/BIENNE

Swiss Advanced Manufacturing Center

ADVANCED LASER POWDER BED FUSION RESEARCH WITH THE OPEN AM MACHINE

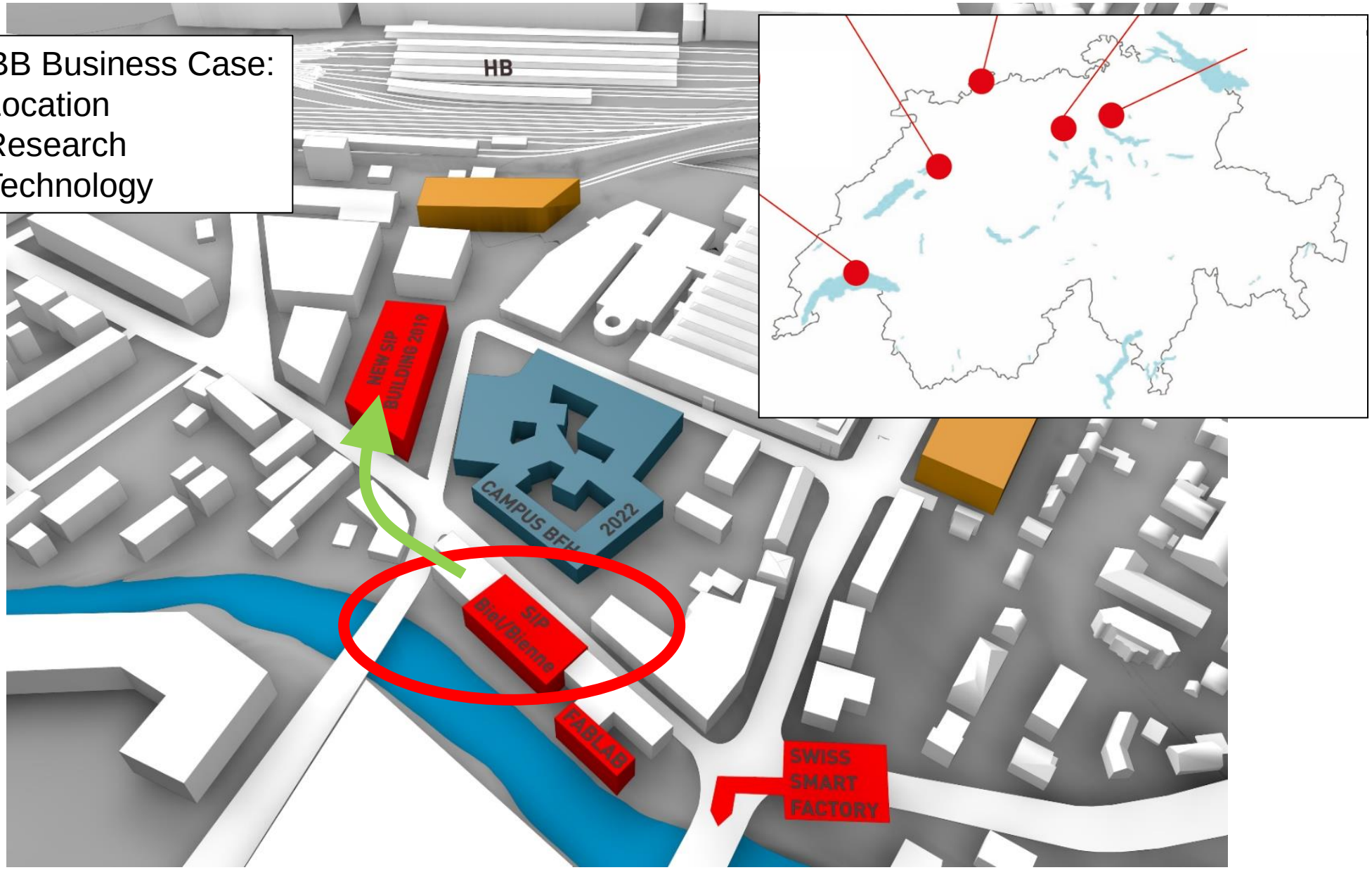
Capabilities and collaboration models

Dr. Felix Reinert

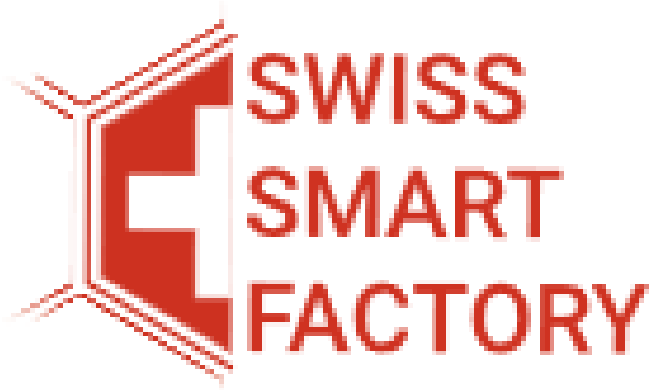
19.06.2019

Switzerland Innovation Park Biel/Bienne

SIPBB Business Case:
1) Location
2) Research
3) Technology



4 research groups, 1 engineering pool



Engineering

Applied research very close to industrial application

SIPBB -> SAMC infrastructure

Infrastructure:

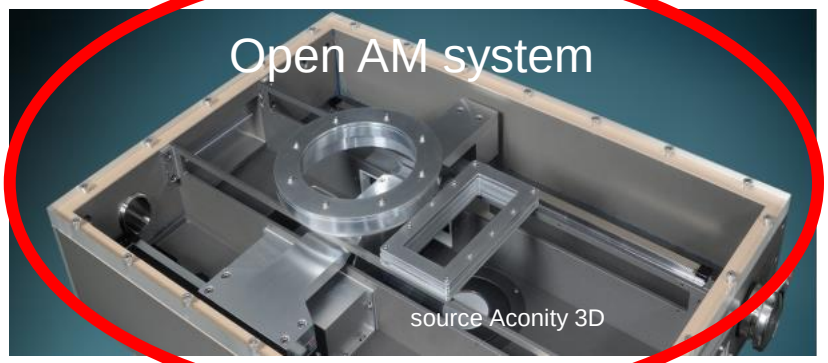
- State-of-the-art SLM machine
- Metallography-Lab with microscope
- Post-machining (flow-grind, blasting)
- High-accuracy 3D Scanner
- Laser-Lab
- CT scanning system
- Design for AM software
- Open AM System (4. July 2019)

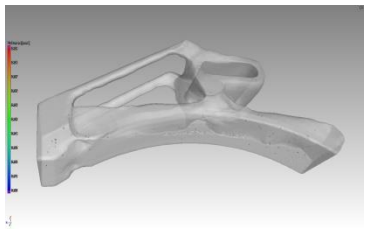
Personal and skills:

- Felix Reinert, AM expert, laser welding
- Andreas Burn, Laser expert, optics

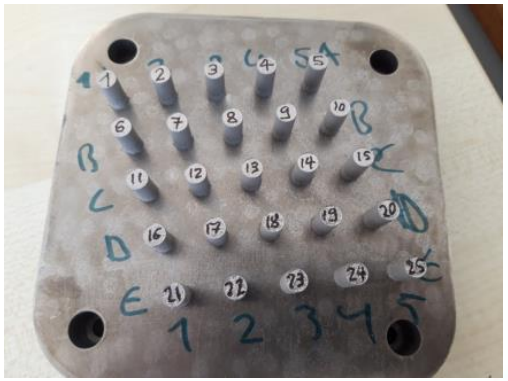
Dr. phil.-nat. Andreas Burn

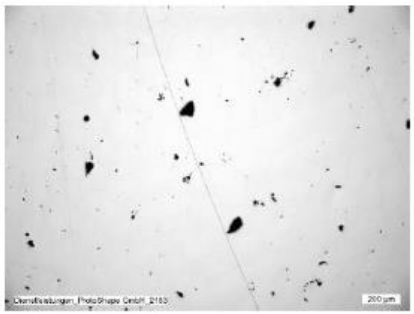
Dr. phil.-nat. Felix Reinert

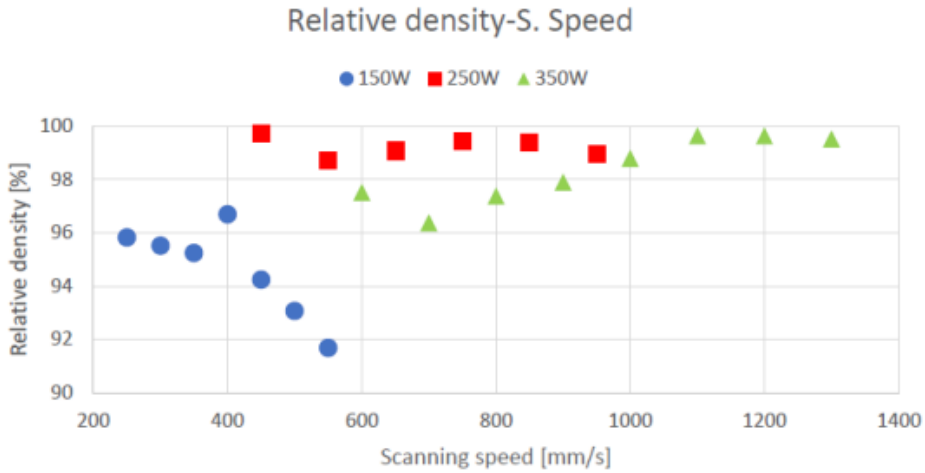




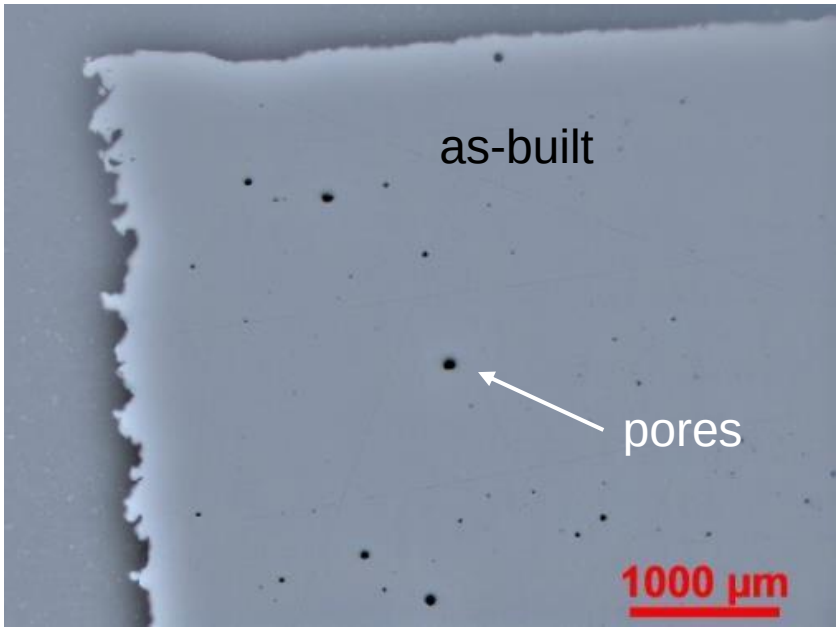
Laser Tracks: VED

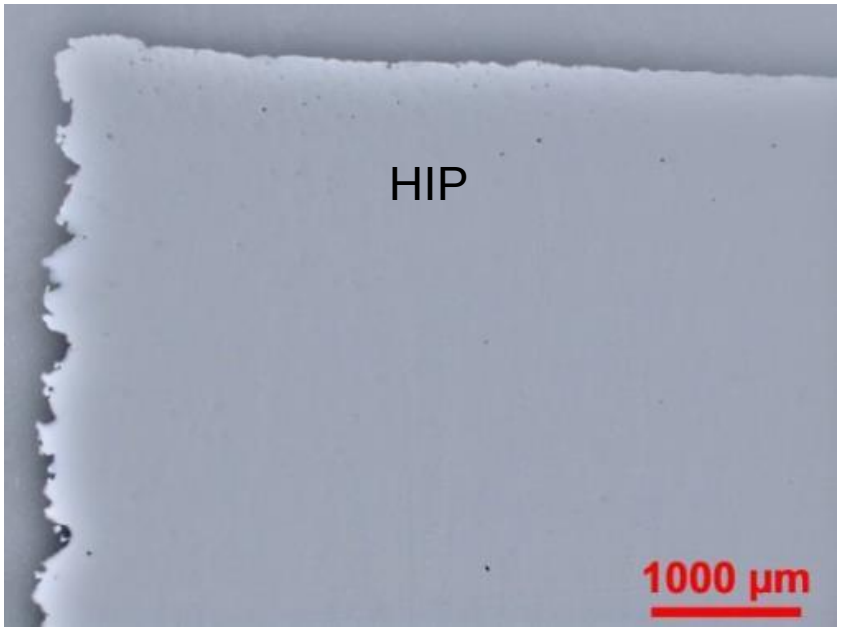


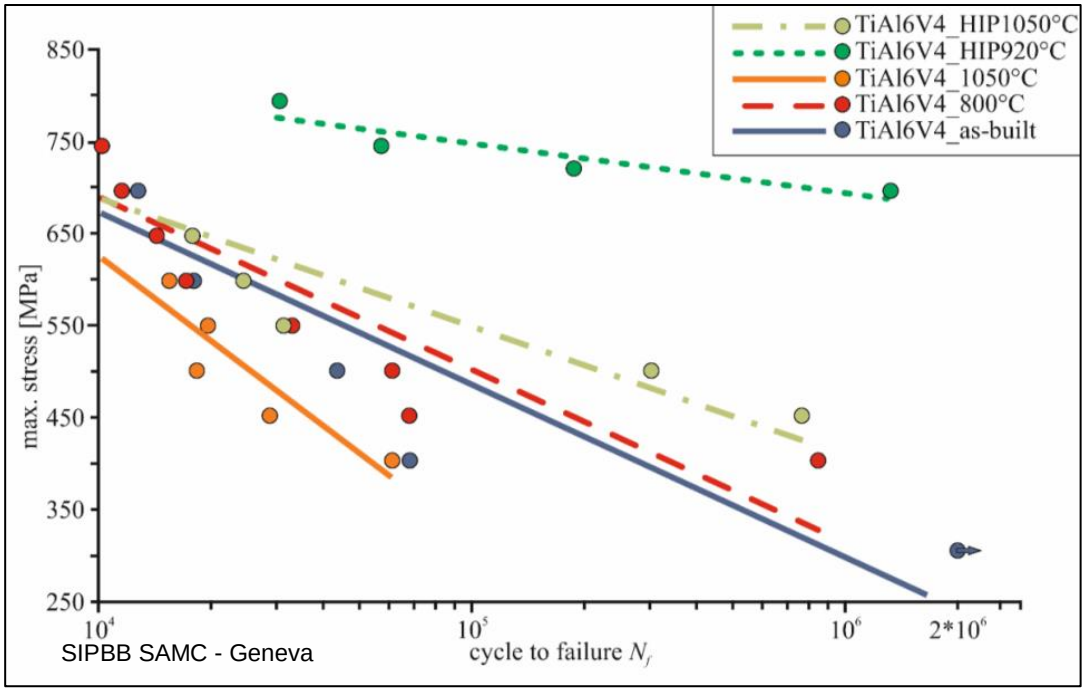


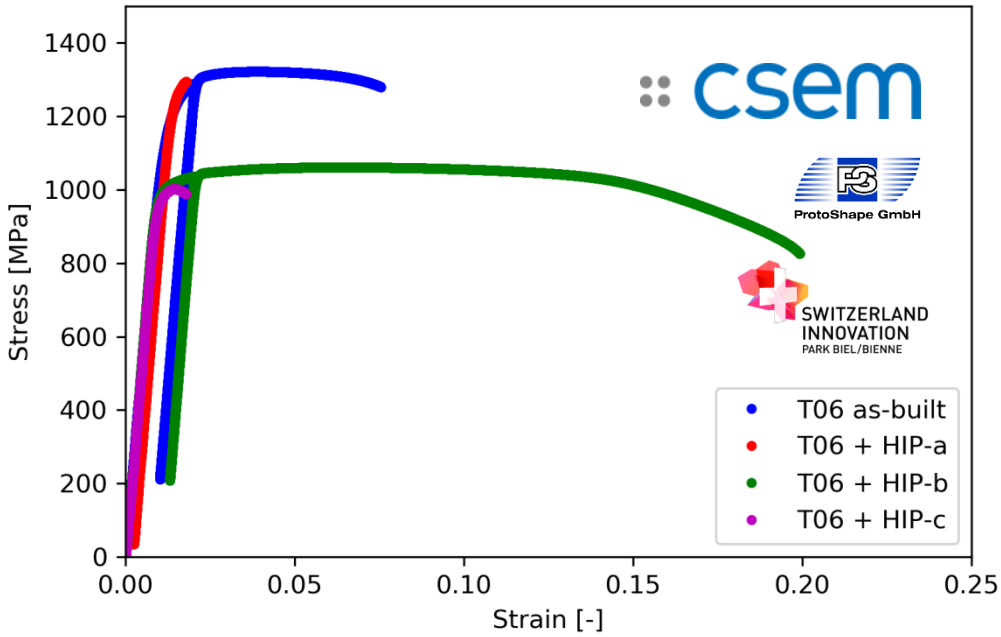


HIP process for metal AM: AMTI project







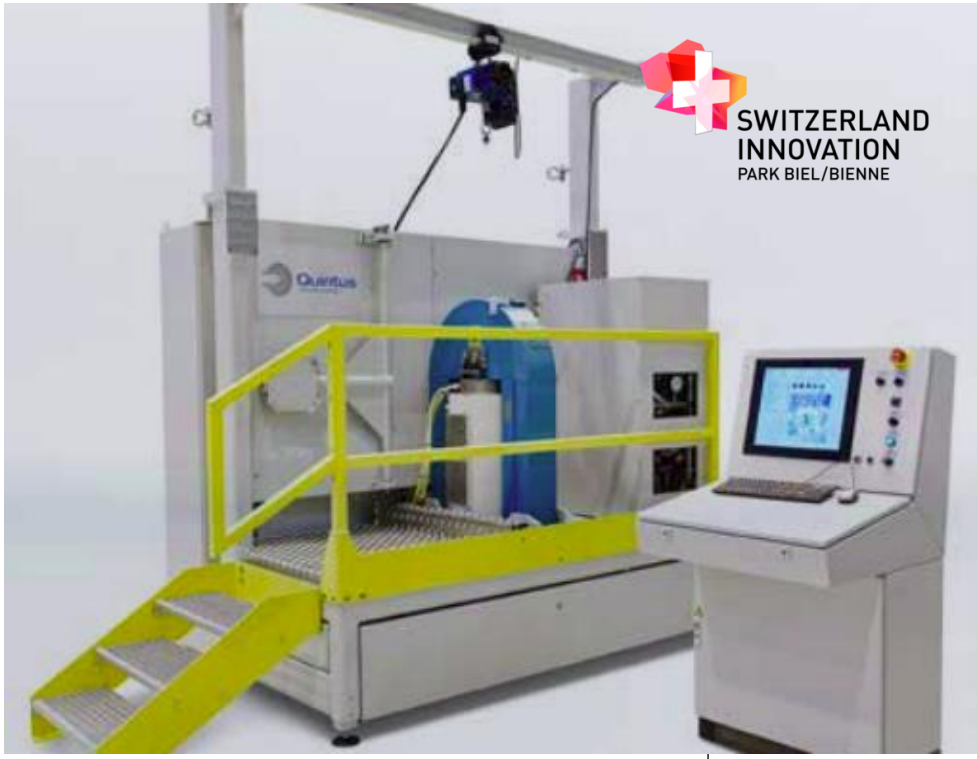


hipC – consortium for a TTC-AM

Why HIP: high cycle fatigue, combination with heat treatment, tune microstructure

Out of 9 applications, 1 passed, 4 conditionally
hipC is at place 2 overall and therefore conditionally passed

Cornerstones of hipC services:
- State-of-the-art HIP machine, 2000 bar, 1400°C, uniform rapid cooling, uniform rapid quenching
- Professional operation guaranteed by a skilled operator
- Guidance, consulting and engineering by scientific process engineer
- Fast and efficient custom tailored HIP cycles
- Facility that allows combination of HIP and HT cycles
- Yearly hipC user conference
- Metallographic analysis
- Lab scale HIP cycles on very small machine
- Connection to the international HIP community



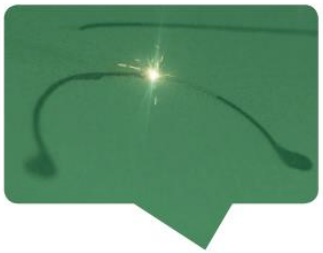
Advisory Board:

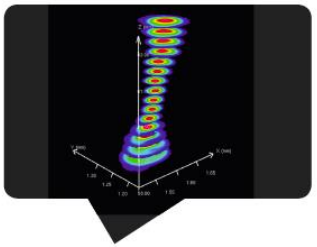
SIPBB	Felix Kunz
PS	Felix Reinert
Deloro	Rolf Schmidt
Gerster	Patrick Margraf
Sauber	Christian Streit
EPFL	Roland Loge

Consortium list:

1. SIPBB
2. BFH
3. CSEM
4. EMPA
5. EPFL
6. ProtoShape
7. Deloro
8. Quintus
9. GF Precicast
10. ETA
11. Sulzer
12. HES-SO
13. SUPSI
14. FHNW
15. Inspire
16. TTC-AM M4M
17. Turbocoating
18. Sauber
19. Gerster

Open AM system at SIPBB





ADVANCING THE POWDER BED FUSION TECHONOLOGY OF THE FUTURE

ADVANCED LASER SOURCES
BEAM DELIVERY
OPTIMIZED ENERGY DEPOSITION

Focus:

- **Advanced optics, High Power Laser beam delivery & characterization for AM**
- **Selective Laser Melting process for metals**
- **Process performance monitoring**

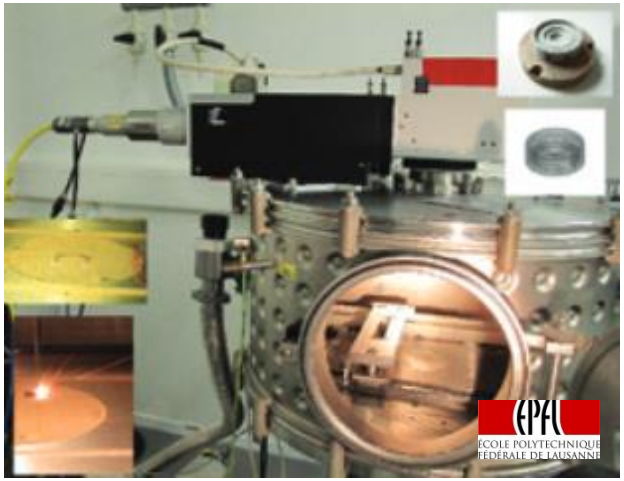
Positioning of open AM machine

Industrial AM machines
- Production
- Automation

Applied research
Modular & open architecture
Industrial level coating & airflow
CE certification

Interchange of components like Laser, optics and monitoring systems while guaranteeing a buildup like production machines.

Lab-AM machines
- Basic research
- Purpose built



Cornerstones of the open AM system

500W Single Mode (SM) Fiber-Laser, QBH compatible

Modulation of laser power for optimized energy input

Interchangeable collimators for broad range of spot size 35 to 500um

Build volume: ∅ 140 x 200mm

High temperature heating up to 800°C -> Build volume: Ø 100mm

Vibration supported coating system for small size powders < 10 µm

Argon / Nitrogen capable

Open control software to access all process parameters and systems

Process gas system of the open AM system

Integrated volumetric flow rate sensor

Software control of flow rate for optimized fume extraction (up to 70 m^3/h)

External filter with integrated cyclone

Oxygen sensor 210000 to 1 ppm range

Interchangeable flow ducts

Optics: Scanner and online monitoring

3D scanner:
on-the-fly focus variation
AxialScan 30 High Power

3D Scanner interchangeable to F-Theta

Free programmable machine control of all axis and systems
Process parameters open
Integration of sensor with configurable API

Pyrometer:
- 2 separate high-speed pyrometers
- Coaxial position
- Measurement of thermal emission
- 100kHz frame rate
- -> lateral position of each sensor adjustable
- Temporal and spatial mapping

New monitoring systems can be easily integrated

Camera:
- 7 kHz at 320x320 pixels
- Bright illumination system
- Coaxial at 3x3mm

Collaboration models

Machine capabilities are unique in Switzerland, but:
-> human skills necessary: experienced engineer for this AM machine

Research to be conducted always together with engineer

Efficiently use capabilities in Switzerland

Companies:
- Direct funded research
- Innosuisse projects
- Consortial-projects

Partner Research Organizations (ETHs, Unis, Fachhochschulen, CSEMs):
- Own application for research projects: rent with cash or as subcontractor
- Common application for research projects: SIPBB junior or senior partner

Ideas

- BYO: (bring your own) Laser
- Test fine particle powders
- Test your optics
- Generate parts with graded layer thicknesses
- Correlate online monitoring with mechanical data (temporally & spatially mapped)
- Validate your production system for medtech or aerospace
- Integrate your monitoring technology
- Modify the control software
- High temperature materials processing
- Test new airflow ducts based on CFD optimized designs

As of last week

Open AM machine at SIBBB

Thank you for your attention

Want to collaborate?

Contact:

felix.reinert@sipbb.ch