1		Introduction	1
2	2.1 2.1.1 2.2 2.2 2.2.1 2.2.2 2.2.3 2.3	State of the Art Process Fundamentals Laser-induced Metal Melt Pools Melting Track Formation and Stability in Metal AM Laser-based Metal AM Systems (powder bed) Beam Sources and Optical Systems Shielding Gas Flow Novel Approaches for Metal AM Interim Conclusion	5 5 18 24 25 29 30 32
3	3.1 3.2	3DLP Process Principle Energy Input into Powder Bed Exposure Sequence and Process Parameters	33 33 35
4	4.1 4.2 4.2.1 4.2.2 4.2.3 4.3 4.4 4.5 4.5.1 4.5.2 4.5.3 4.6 4.7 4.7.1 4.7.2 4.7.3 4.8 4.9	Laboratory Machine Development Requirements Profile Mechanical Subsystem Working Head Positioning System Build Platform and Powder Reservoir Powder Application Unit Beam Sources and Optical Unit Software and Control Shielding Gas System (SGS) and Shielding Gas Nozzle Global SGS: General Layout Local SGS: Nozzle Design Spatter Deflection and Processing Atmosphere 3DLP Laboratory Machine Machine Characterization Time Response of Beam Sources Thermal Shift, Spot Size and Intensity Distribution Dynamics of Positioning System Applied Material Interim Conclusion	39 40 41 41 42 42 43 44 46 46 48 49 51 52 52 52 57 59 59 62
5	5.1 5.2	Theoretical Modelling Energy Input within Melting Track Energy Input on Leading and Exit Edges	63 63 64



12	2	Annex	167
1	1	Abbreviations and symbols	159
10		Bibliography	151
9		Summary and Outlook	147
8	8.1 8.2 8.2.1 8.2.2 8.2.3 8.2.3 8.2.4	Processing Time Evaluation Approach Process Comparison Total Exposure Time Exposure Time Composition Conventional Process Exposure Time Composition 3DLP Influence of Process Parameters	137 137 138 138 139 141 143
7	7.1 7.2 7.3 7.4 7.5	Part Quality Experimental Approach Density Surface Roughness Dimensional Accuracy and Detail Resolution Mechanical properties	113 113 119 122 130 136
6	$\begin{array}{c} 6.1 \\ 6.2 \\ 6.3 \\ 6.3.1 \\ 6.3.2 \\ 6.3.3 \\ 6.3.4 \\ 6.3.5 \\ 6.3.6 \\ 6.4 \\ 6.4.1 \\ 6.4.2 \\ 6.4.3 \\ 6.4.4 \end{array}$	Process Development Experimental Approach Single Spot Melting Tracks Multi-spot Melting Tracks Influence of Spot Distance Δy_S Influence of Spot Number n_S and Exposure Speed v_B Influence of Spot Arrangement Influence of Spot Arrangement Influence of APD Interim conclusion Single Melting Layers Influence of Spot Arrangement Influence of APD Influence of APD Influence of APD Influence of APD Interim conclusion	73 73 82 82 84 88 90 98 101 103 103 104 109 112
	5.3 5.4 5.4.1 5.4.2	Simulation of Temperature Fields Calculation of Processing Times Conventional L-PBF Exposure Sequence 3DLP Exposure Sequence	66 67 69 71