ESRF	**Experiment title:** Exploration of residual stress distribution in additive manufactured titanium Alloys for high performing applications	**Experiment number**: MA/3395
Beamline: ID15A	**Date of experiment**: from: 28th of June/2017 to:1st of July/2017	**Date of report**: 2017-07-11
Shifts: 6	**Local contact(s)**: Thomas Buslaps	*Received at ESRF:*

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Report:

During the six shifts allocated in the ID15A beamline we managed to do over 1000 measurements on in total 4 different additive manufactured Titanium alloy samples. Two of the additive manufactured sampels where first measured in as-manufactured condition in the beamline on different selected positions, thereafter both samples were stress relieve heat treated at 704C/2hours in an Nabertherm ambient air furnace located at ESRF, followed by re-measured in the ID15A beamline on the same positions as before the stress relieve heat tretament. It is anticipated that this specifically chosen stress relieve heat treatment (704C/2hours), which is conventionally used for this particular titanium alloys for cast and wrought material forms, fully relieves any existing residual stress that exist after the additive manufacturing process. This has however not been shown before, and therefor the novel results from these measurements will reveal if any, and in such case how large and where in the sample geometries, residual stresses remains in the two different additive manufactured samples after the conventional stress relive heat treatment. One of these two samples is manufactured using Laser Metal Deposition with wire (LMDw) and the other sample was produced using Electron Beam Free Form Fabrication (EBF3).

In addition, two more samples manufactured with LMDw but in different sequences as compared with eachother and compared with the stress relieve heat treated samples, where also investigated with regard to residul stresses in the material in as-built condition. The results from these measurements will reveal how large residual stresses that forms dependant on in what sequence the material has been deposited. Once analysed, the data will be

important for validation of stresses predicted in a simulation model that is beeing developed within the present group of researchers. In addition, these results will eventually also be highly valuable for companies applying the different additive manufacturing processes for building real components, especially with regard to optimise the building routes for part geometries to minimise residual stresses and thus detrimental distorsion of whole structures.

Parts of the results from these residual stress measurements are planned to be presented at the 1st Acian Pacific International Conference on Additive Manufacturing (APICAM2017), Melbourna, Australia, 4-6 December 2017, and at the TMS 2018 symposium: Advances in Additive Manufacturing of Titanium and Titanium Based Alloys, Phoenix, Arizona, USA, March 11-15, 2018. The abstract of the presentation to be held at the APICAM2017 conference is copied in below. It is intended that at least one more scientific journal paper will follow within near future on the results gathered from the measurements performed at ESRF within this project.

ABSTRACT for the presentation (Invited talk) planned to be held at the APICAM2017 conference in Melbourne, 4-6 December, 2017:
In recent years, global interest in additive manufacturing (AM) of metals has gained considerable momentum, both in academia and in industry. Development of new AM methods, maturity of existing methods based on enhanced process understanding and recognition of new areas for potential use of AM have all contributed to the above. In Sweden, the interest in AM has also followed this trend, with growing emphasis on both pre-competitive research and industrial implementation. The purpose of this talk is to provide an overview of the prominent activities associated with AM of metals in Sweden, starting with early users that explored this technology already some ~15 years ago, covering recent examples of state-of-the-art efforts in the country, and finally discussing some emerging trends. Selected examples of AM methods, materials and applications will be discussed, and some of the key challenges encounterd in realizing certain industrial applications when developing AM routes for specific components will be highlighted. The talk will focus on both direct energy deposition (DED processes involving use of wire and powder) and powder bed processes (EBM and SLM) for building of titanium alloy, Ni-based superalloy and steel components.