Stage 1: Four Labs
This Stage 1 interlaboratory comparison investigated the extraction of areal surface texture data per ISO 25178-2 from X-ray computed tomography (CT) reconstructions of a titanium additively manufactured (AM) part. Four laboratories were included, using similar machines: one Nikon XT H 225 industrial CT and three Nikon MCT225 metrology CTs. This low number of labs with similar machines were chosen for the purpose of providing knowledge and experience useful for the design and configuration of an expanded Stage 2.

Artefact Design
The CT measurement fixture included two artefacts, both manufactured from Ti6Al4V ELI, a material commonly used in medical and aerospace applications.
- One AM cube, 10 mm per side, manufactured using Electron Beam Melting, for surface texture measurement and analysis. The AM surface was measured five times using an Alicona G4 focus variation (FV) instrument prior to the XCT measurements.
- One machined dimensional artefact, for analysis of scaling and surface determination (results not reported here).

CT Machine Setup
Parameter settings for the CT machines were kept as similar as possible. Five consecutive measurements were performed on each CT machine.

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<th>XCT machine</th>
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<td>Nikon XT H 225</td>
<td>XCTHUD</td>
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<td>Nikon MCT225</td>
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<td>National Physical Laboratory, UK</td>
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Data Processing
CT reconstruction was performed using Nikon CTPro 3D. Surface determination and extraction were performed using VGStudio MAX 3.0. Local iterative surface determination was performed with a search distance of 4 voxels. The AM surface was converted to PLY format using VGStudio MAX “Super Precise” setting. Aligning and cropping of the extracted surface areas was performed per Townsend et al. [1]. The surface evaluation area was 8 mm x 8 mm, with an L-filter nesting index 8 mm and S-filter nesting index 0.025 mm per ISO 25178-3. Areal surface parameter values per ISO 25178-2 were generated.

Results
False colour height maps for one Alicona G4 and one NPL CT measurement are shown, together with the results table for selected parameters per ISO 25178-2, including sample standard deviation figures (SD). Plots of mean roughness, Sa and maximum peak-to-valley distance, Sz, for the Alicona G4 measurements and all CT machine measurements are shown. There was a 0.5% or less difference between the mean Sa and mean Sz from the extracted surface from all MCT225 machines and the Alicona G4. The non-metrology XT H 225 machine figures were -5.2% for Sa and -3.4% for Sz.

Conclusions
- The results confirm the validity of using CT for the extraction of surface texture data from additively manufactured components.
- The surface extraction methodology and data analysis appears robust.
- These measurements were taken over a period of five months. There appears to have been negligible change of the fixture and artefacts over that time period.
- There is good repeatability and reproducibility of results, providing a good baseline for an expanded, Stage 2 interlaboratory comparison.

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References