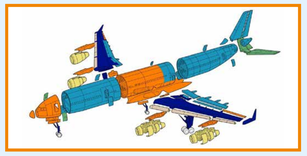
Large Volume Metrology in Industry

EURAMET
European Association of National Metrology Institutes

	AEROSPACE		ADVANCED MANUFACTURING		BIG SCIENCE
END USER NEED					
	International traceability 100 laser trackers in 5 countries Need: calibrate/verify ADM SOA: requires intrinsic interferometer	**Clean Skies: Laminar flow wing, weight loss** Improved jig and manufacture accuracy Need: 100 µm full wing accuracy SOA: 400 µm	**Factory of the future, Energy production** Metrology networks, error map large tools Need: < 100 µm SOA: 200 µm	**High value engineering** Compensate thermal errors, measure fast Need: 100 µm in 15 °C to 30 °C factory SOA: 200 µm, slow photogrammetry	**LHC replacement at CERN** 25 km tunnel, 10x better beam accuracy Need: 10 µm accuracy in 200 m SOA: 100 µm to 300 µm
IMPACT MATRIX	Frequency Scanning Interferumetry (FSI): intrinsically traceable measuring system	FSI: 50 µm accuracy	FSI: 4x better accuracy than indoor GPS (iGPS) – reference network and mapping tool	FSI: faster, 50 µm accuracy	
	2 new traceable Absolute Distance Meters (ADMs)		In situ error mapping with reference laser tracker	Portable ADM as local scale for photogrammetry	Portable ADM and reference laser tracker to counteract stratification
	3D network: reduction in 3D refractive index enabling all optical tools to achieve required accuracy; turbulence mitigation; portable refractive index compensated ADM and tracking interferometer				
	Advanced hybrid modelling with dimensional and thermal data fusion enables thermal compensation (currently missing) – reduced energy costs for air conditioning, shorter thermalisation times				
	FSI, new laser tracker, portable ADM, hybrid model, 3D refractive index: demonstrated in live end-user environment		New laser tracker, ADM design, FSI licensed to instrumentation manufacturers; new metrology capability: verification service at partner MG		New metrology capability: new tools available at NMIs

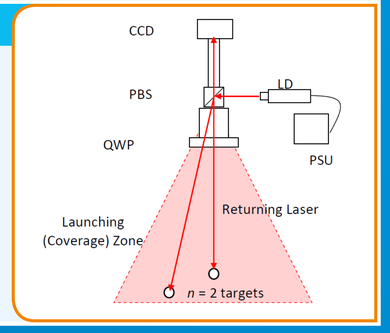
DISSEMINATION		IMPACT		
Exploitation	**Knowledge transfer**	**Financial**	**Social**	**Environmental**
NMI services IP licensing to Collaborators Contacts: Etalon AG Hexagon Metrology Renishaw Leica, API	Stakeholder steering committee JRP open website 4 Major international conferences 8+ Journal papers Trade magazine articles Good Practice Guide (compensation) NPL Dimensional Training Framework Standards committees: ISO, BS, VDI/VDE, UNI, ASME Metrology committees: EURAMET, CCL	JRP critical to laminar flow manufacturing: Safeguards €2.3 trillion 2030 orders whilst complying with 2020 regulations Saves money for high value components: €10k per day depreciation per aero engine Inspection time reduced Reduced thermal control required	Enables LHC successor (science jobs) Enables improved beam therapies for oncology Maintains European advanced manufacturing advantage Wider uptake of Large Volume Metrology tools, leading to new applications at SMEs	Estimated aviation weight benefits: Per plane: 100 kg from JRP science ==> 1600 tonnes less CO_2 emitted p.a. ==> 1.4 M litres of fuel saved p.a. Inspection of moulds and blades for 100 m rotors on wind turbines Improved metrology for fusion systems

WP1 – Innovative measuring systems

3 new systems:

1. Wide beam FSI & **2.** Self-illuminated photogrammetry
- Better uncertainty than photogrammetry
- Faster than laser trackers
- Multiple targets
- Innovative applications

3. Intersecting planes technique
- Useable in poor environments



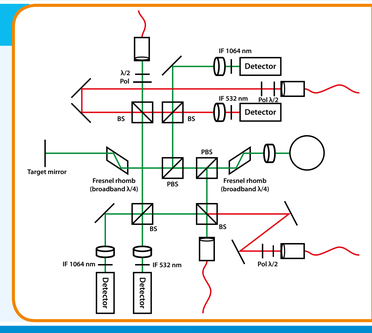
WP2 – New traceable ADMs

3 new approaches/devices:

1. Wide beam FSI from WP1 (traceable gas cell)

2. Absolute tracking interferometer (traceable iodine cell & frequency measurements)

3. Portable Laser diode ADM (traceable frequency measurements)



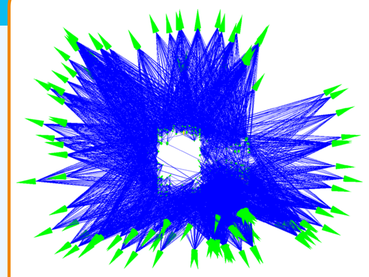
WP3 – 3D refractive index

3 solutions:

1. Line of sight compensation in tracking interferometer by utilising unused Nd:YAG wavelength

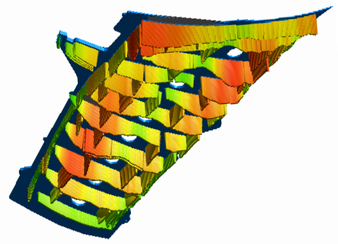
2. Second diode laser compensation in portable ADM

3. 3D camera network:
- Dense network
- Dual wavelength illumination



WP4 - Multi-component modelling

- Digital model of a real-world aerospace assembly
- Model extended to include tolerance stack-up
- Hybridisation to accept live dimensional and thermal data
- Optimisation for sensor placement
- Best practice



WP5 – Verification and demonstration

- New test facility construction & operation
- Intercomparison of new tools and techniques across NMIs
- Real-world measurements on site at end-user

"…we see the work here leading to a step change of the state of the art for large volume metrology … when working with these systems in non-ideal environment … we see ourselves benefiting from this project through the various programmes of activity within the production, test and R&T domain within Airbus…"

Mark Summers, Head of Manufacturing Research Wing
Richard Burguete, Product Domain Authority – R&T, Airbus