



Capacitec

Best Practices in the use of “Smart” Displacement, Gap and Hole Mapping Sensors for Aircraft and Aircraft Engine test and overhaul.

Presented by

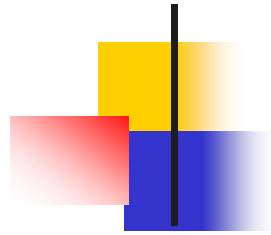
Bryan Manning/ Commercial Director

&

Jean-François Doussin/ Technical Director

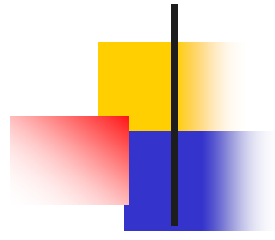
Capacitec Europe

April 6, 2005



Capacitec Background

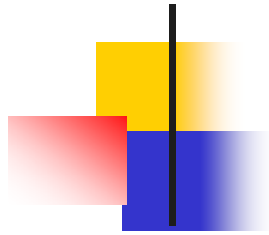
- ◆ Over 25 years of Aerospace Market Experience in Europe, the US and Japan
- ◆ Customers include: Snecma, MTU, Airbus, Rolls Royce, GE, P&W, Boeing, Lufthansa, Air France...
- ◆ Unique leading technology in non-contact capacitive displacement, gap and hole "mapping" sensors and systems
- ◆ "Best-of-breed" small sensor size vs. large range, extreme temperature (Cryogenic (-272°C) to 1000°C, high magnetic fields (> 2 Tesla), radiation (10^{12} Rads)



Aircraft Engine Applications

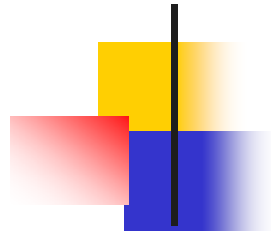
- ◆ Engine rebuild concentricity
- ◆ Fan blade clearance
- ◆ Engine maintenance assessment
- ◆ High temperature thermal expansion
- ◆ Blade tip gap measurement
- ◆ Measurement of bore diameters





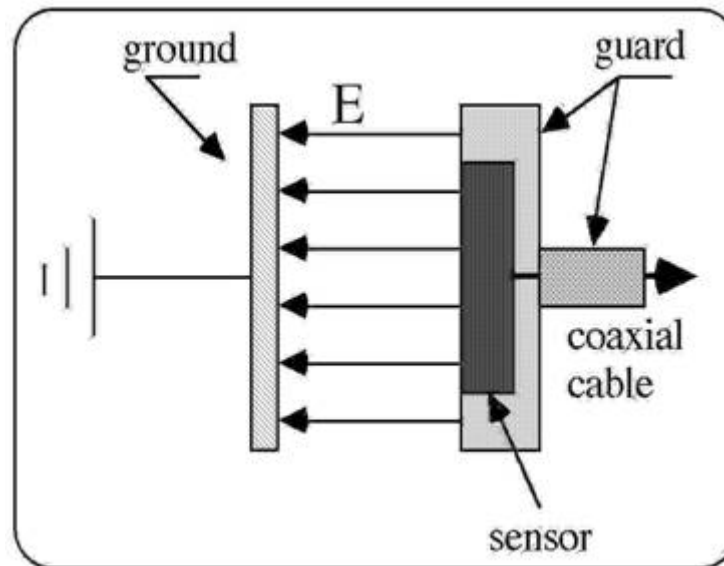
Aircraft Applications

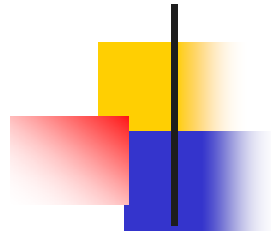




Principle of non contact capacitive measurement

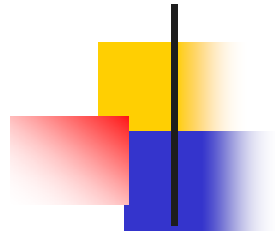
- ◆ Capacitive reactance is proportional to the distance between the sensor and the target



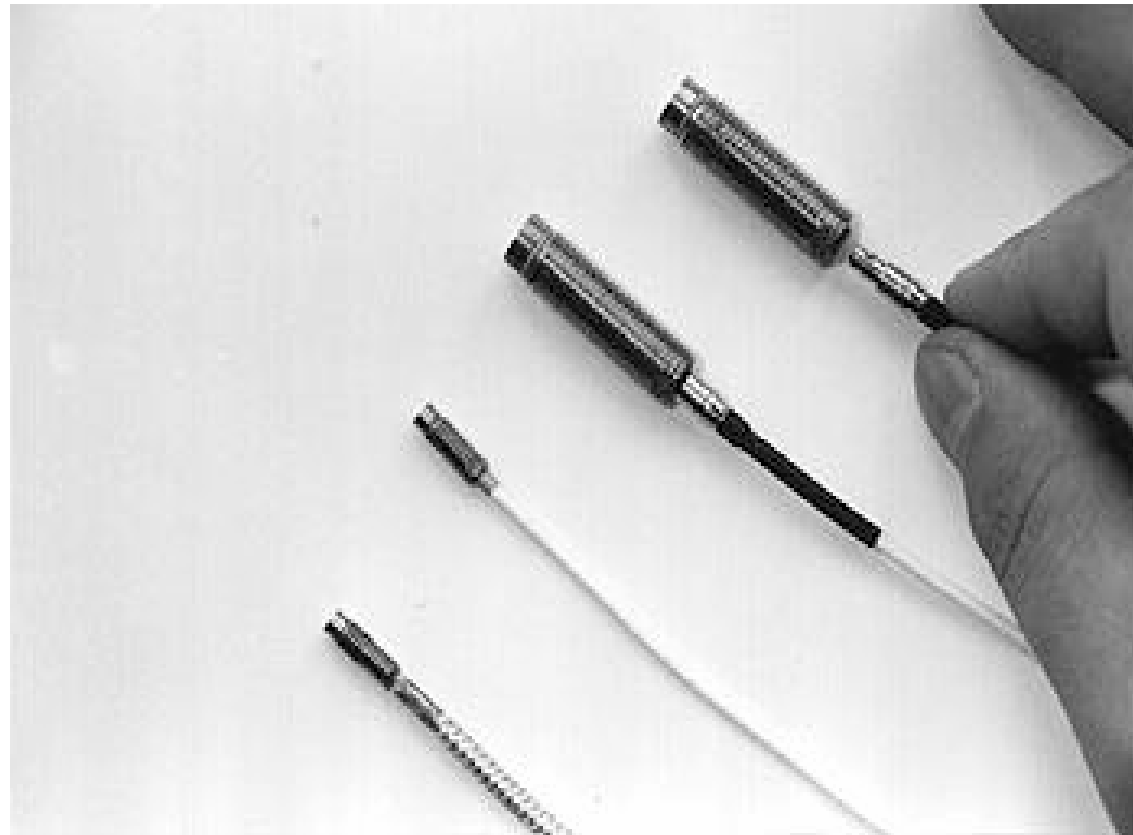


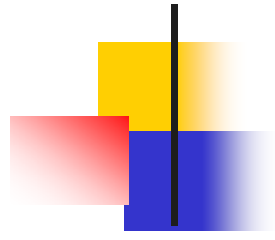
Displacement measurement

- ◆ High resolution combined with very small probe sizes (2 mm OD)
- ◆ High precision with linearity to 0.1% FS and repeatability to 0.01% FS
- ◆ Extreme temperature: Cryogenic (-272°C) to 1000°C
- ◆ High frequency response for high temperature and fatigue testing
- ◆ Blade length balance testing



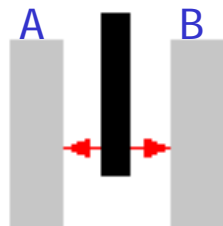
Typical displacement sensors





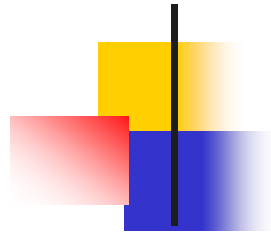
Gap measurement

- ◆ Gap measurement range from 0.23 mm to 6 mm
- ◆ Handheld portable instrumentation: Gapman/Gapmaster
- ◆ Complete line of standard and custom wand sizes
- ◆ Complete solutions: sensor wand, electronics, data acquisition and display software



A, B = metal or composite





Hole/Bore/Taper measurement

Easy to use in all aircraft environments.





Hole/Bore/Taper measurement

- ◆ System conforms to Aerospace precision and quality control requirements
- ◆ Specialized in “mapping” complex tapered holes
- ◆ Qualified tool at Airbus: Hamburg, Nantes, Toulouse, Bristol etc. , as well as at Boeing and Lockheed.

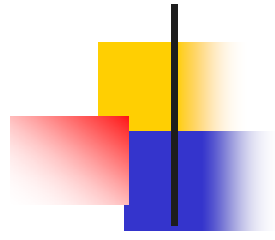




Aircraft Engine Applications

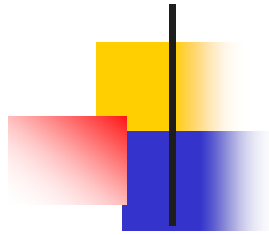
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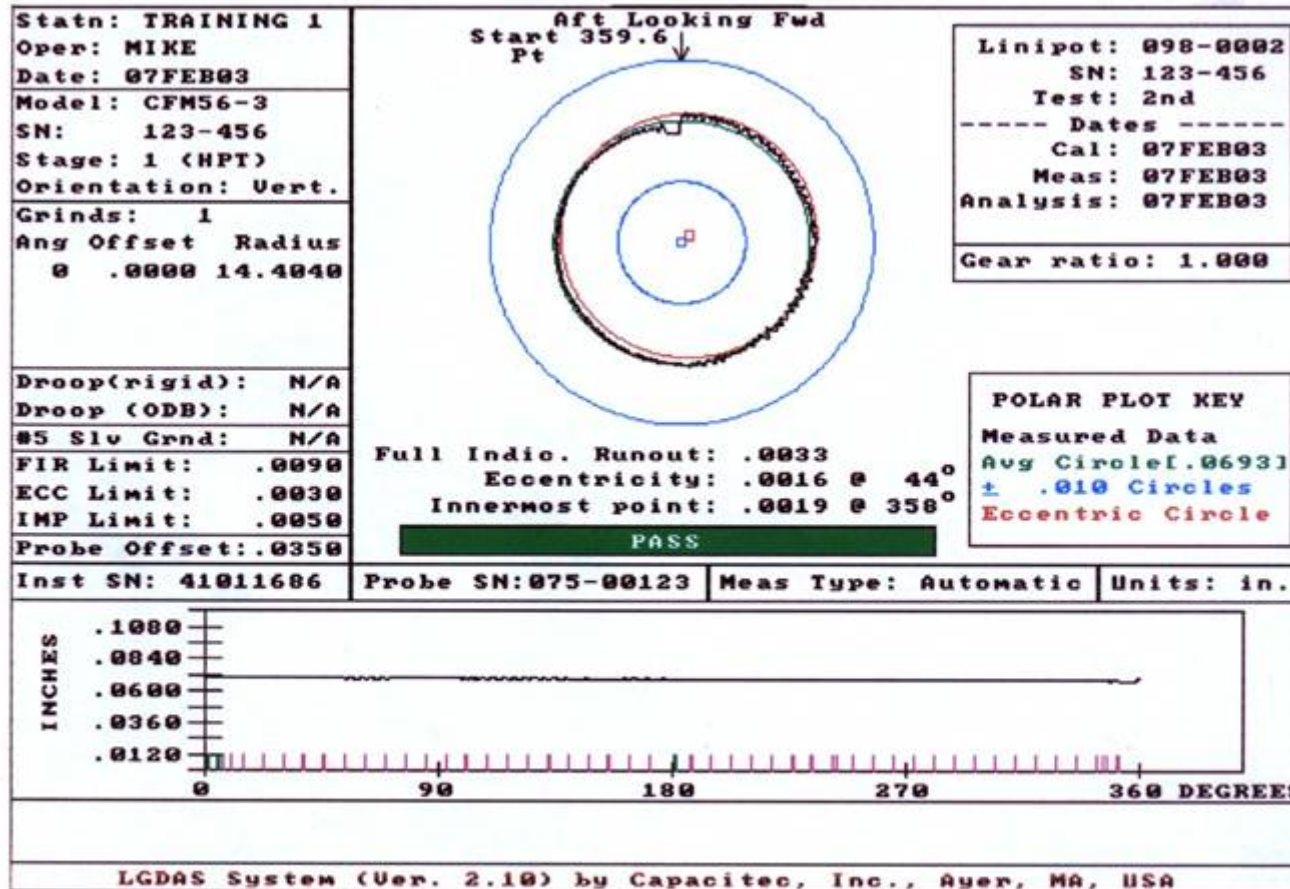
Engine Rebuild Concentricity

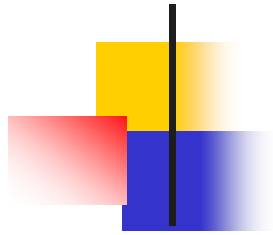
- ◆ ~8 mm sensor attached to end of blade in HPC or HPT stage of CFM56 engine with lead exiting through inspection bore scope hole.
- ◆ The rotor is rotated 360° to measure the gap between the blade tip and housing circumference
- ◆ Displacement values sent to custom software program which polar plots deviation of the blade assembly's concentricity
- ◆ Out of spec concentricity requires technician adjustment by re-torqueing case segments
- ◆ 100 plus systems in operation



Engine Rebuild Concentricity

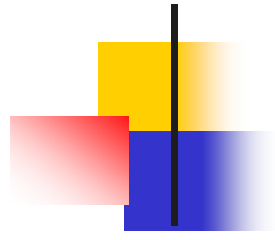
* Plot courtesy of CFM International





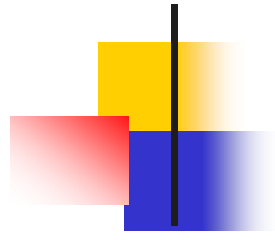
Fan blade clearance

- ◆ Current mechanical gap measurement methods, step gages and shims, are very limited and fail Gage R & R.
- ◆ Capacitec has developed a special “electronic gap gage” that meets Gage R & R goals and allows quality control improvements such as Six Sigma to be attained.



Fan blade gap tool

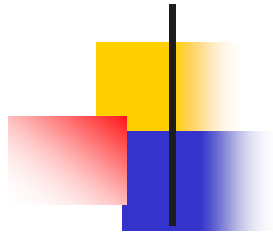




Fan blade gap tool



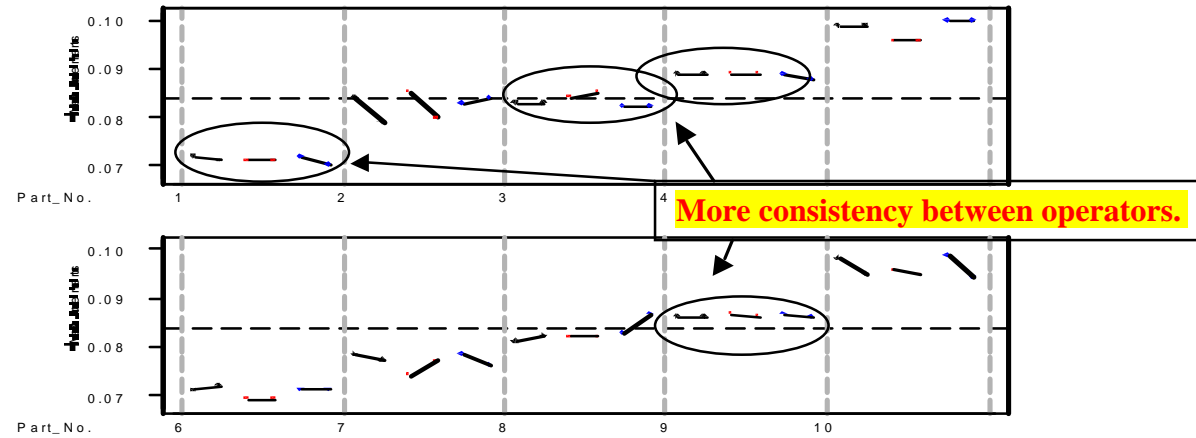
Maintenance Tool
range 0.9 to 5 mm



Fan blade clearance

Clearance_Gapman_Run_Chart

R & R Study





Fan blade portable gap tool





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