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## **3DMC 2016 Conference**

### **A350 Bracket Measurement Assisted Rigging**

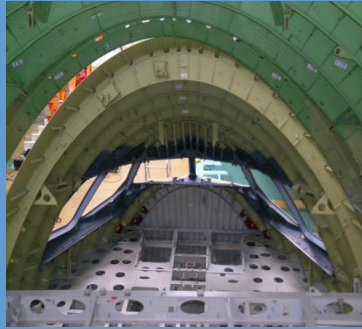
3 November 2016

# Airbus Pre Assembly Line Plant of Saint-Nazaire



# Airbus Saint-Nazaire: three centers of excellence

## Structural assembly



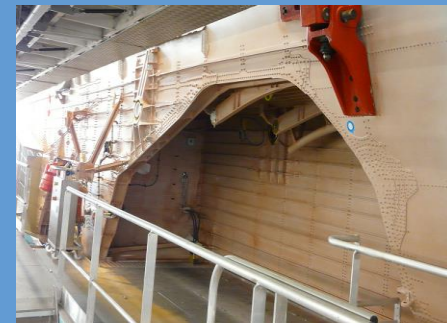
## Painting



## Equipping & Testing



Forward fuselages all families



Center / Nose Fuselages

## OBJECTIVES

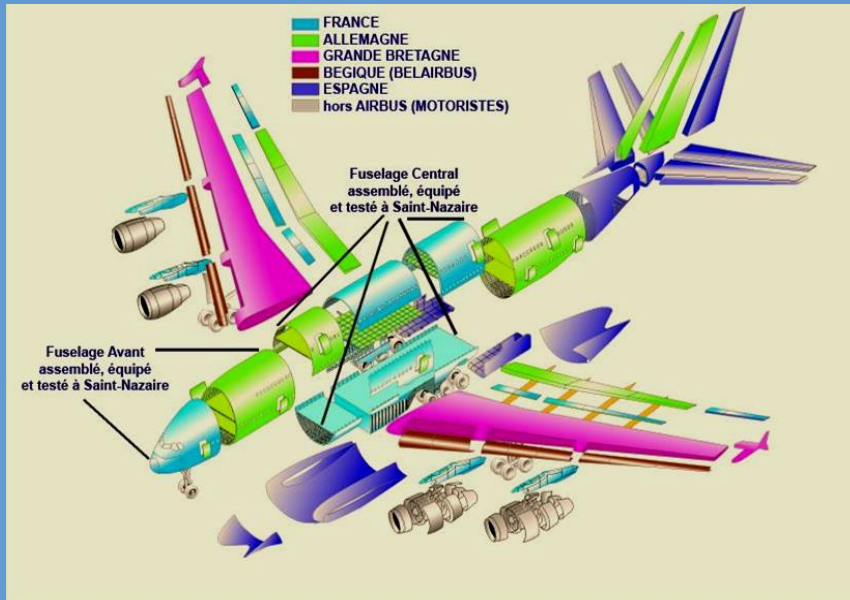
Delivery of Airbus sections to final assembly lines (FAL), according to

- quality requirements
- time limit
- costs.

# Airbus Saint-Nazaire: the example of the A380 program

## Work packages assembly in Saint-Nazaire

1.



### Central fuselage :

Suppliers: Nantes, STELIA, Germany, Spain, Belgium(Sabca), Italy (Alenia), Airbus Helicopters & Sogerma



### Nose fuselage :

Suppliers: Nantes, STELIA, Germany, Socata, & Latécoère



## Junction of the front part



## Equipment installation and testing

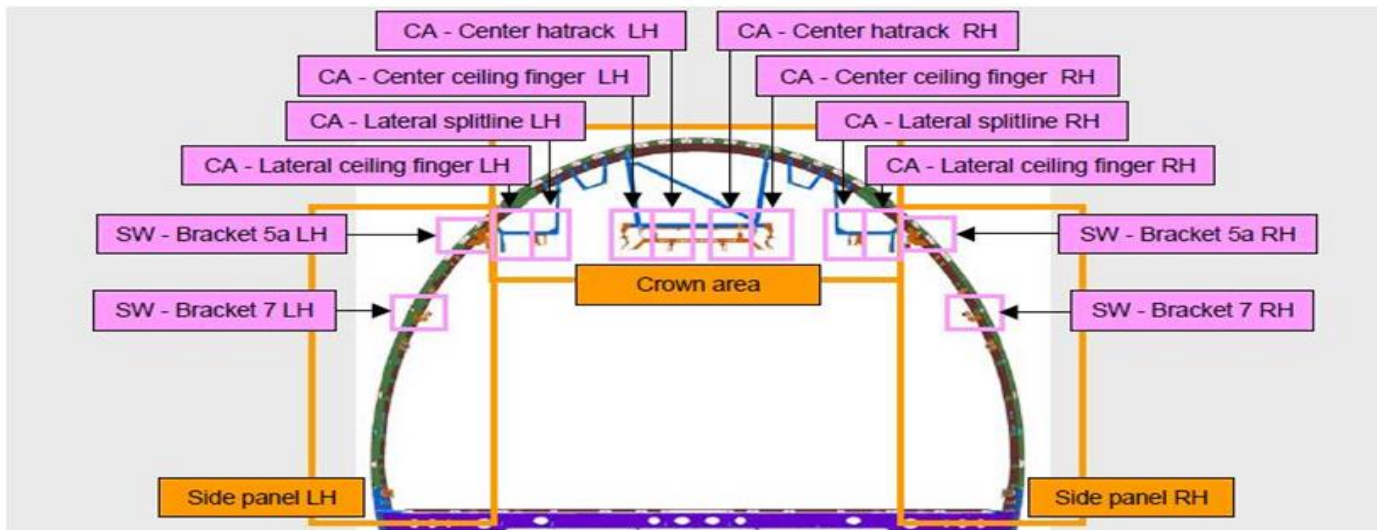


# Manufacturing context / AS IS

## As Is Description : A350 Flow Line station – Cabin Brackets alignment / Adjustment

- All cabin bracket required an adjustment from practical position to theoretical position during the assembly processes to ensure the good alignment and position of these brackets that support the luggage panel of the cabin.
- As Is process is performed by Laser Tracker technology (*Watch mode : measure & riggings*) in **14 Hours with the section freeze for others operations.**

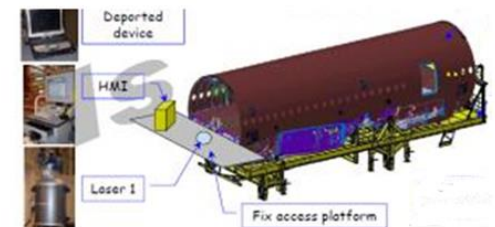
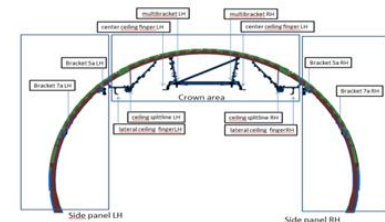
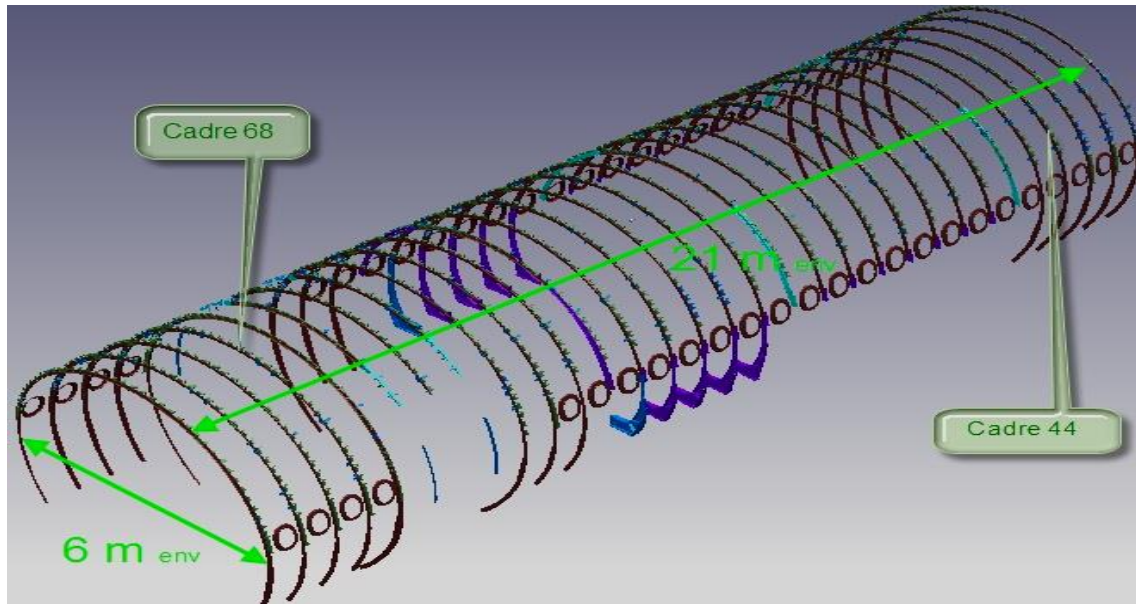
**B-Bracket** required to geometric identification for the rigging operation



# Manufacturing context / AS IS

## As Is Description : A350 Flow Line station – Cabin Brackets alignment / Adjustment

- The ramp up of A350 S15-21 Cabin Bracket installation is not possible with current technology.
- **160 interfaces** to rig between frame 44 and 68 with **28 possible configurations**.  
(Airlines cabin configuration link)
- **Volume** of the section **21 meters X 6 meters** diameter.



# Manufacturing context / TO BE

**Holistic Approach and Gemba in Multi-Functional Team context → Change Process & Innovation**

## CONCEPT: SEPARATE MEASUREMENT AND RIGGING PROCESS

- Laser Tracker technology is replaced by Photogrammetry technology to perform the measurement of practical position of cabin bracket
- Laser Tracker is maintained to perform and measure :
  - The adjustment of the twist levelling of the section.
  - Some reference points for photogrammetry alignment and Scaling.
- The riggings adjustment is performed after the initial photogrammetry measurement with Smart rigging tools embedded Laser sensor devices connected to **Personal Digital Assistant**.

## ADVANTAGES :

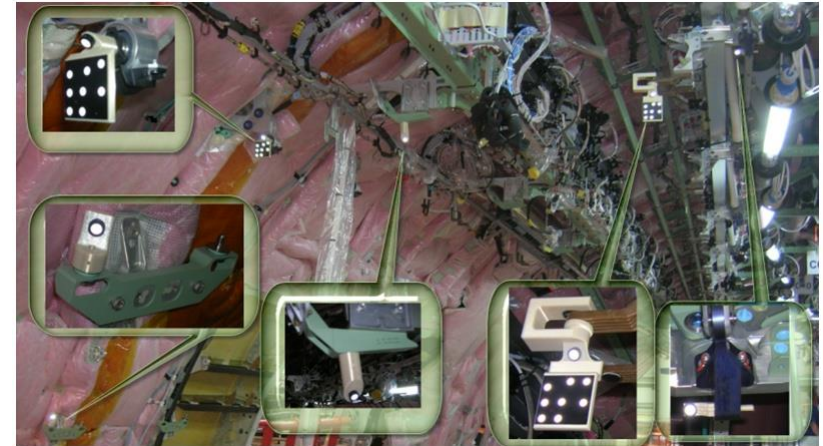
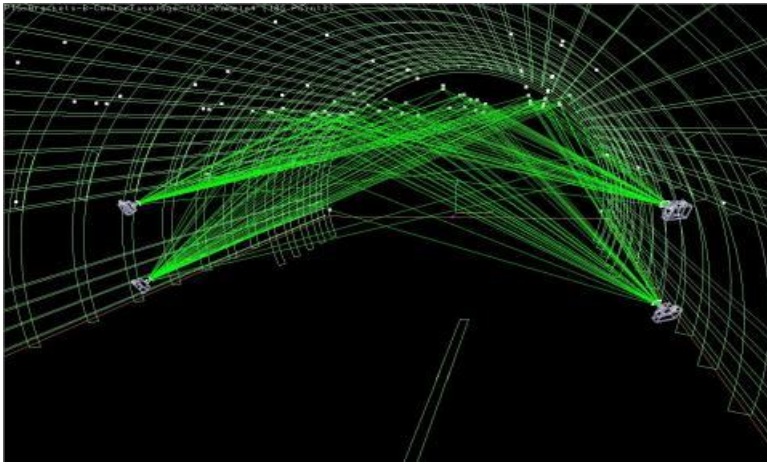
- |   |  |   |
|---|--|---|
| • <b>Instable mode measurement capable</b>                            | → Do not freeze the section for others operations  | → <b>Lead Time Reduction, Agility</b>   |
| • <b>Measurement in One Shot</b>                                      | → Versions configuration process capability without workload impact (Numbers of parts need to capture) | → <b>Lead Time Reduction, Stability</b> |
| • <b>Parallelization of rigging operation Assisted by Smart Tools</b> | → New line balancing thanks to concurrent working allowed while rigging                                | → <b>Lead Time Reduction, Agility</b>   |

## KEY OUTCOMES :

- Photogrammetry combines with smart rigging tool replaces conventional physical rigging template or sequential and rigging measurement.
- Bracket Rigging becomes a digital process with quick tasks execution and none dependent to Engineering changes.

# Photogrammetry : Methods' and Simulation

Simulation to validate the feasibility and performance



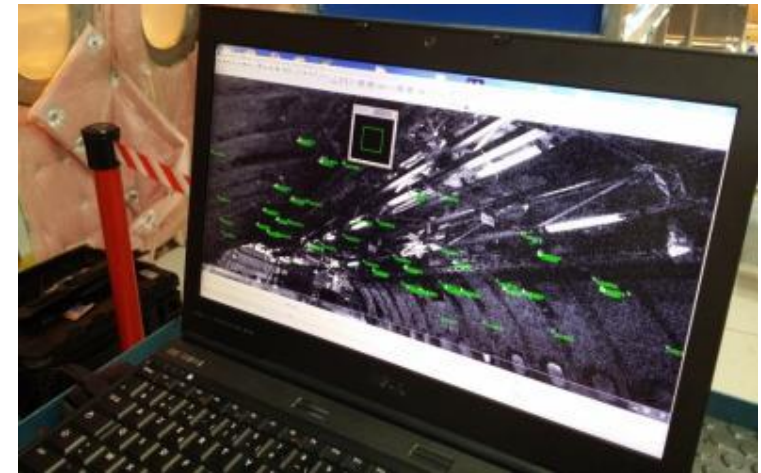
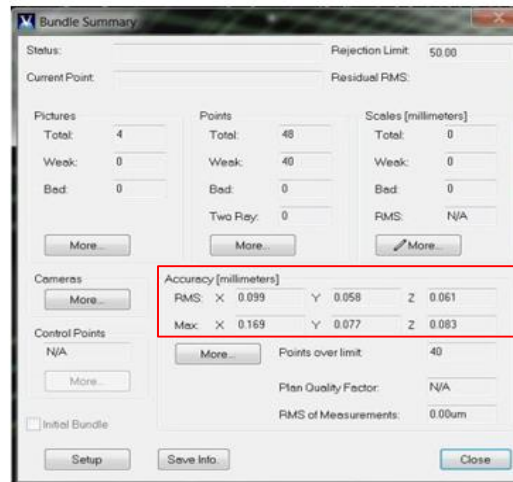
3D Print prototype target

The simulation with four cameras gives a one sigma RMS result of:

- X : 0.099 mm
- Y : 0.058 mm
- Z : 0.061 mm

Max

- X : 0.169 mm
- Y : 0.077 mm
- Z : 0.083 mm





# Photogrammetry : Hardware integration

Pre orientation camera  
ensure by integrated base  
**Very easy to set-up**

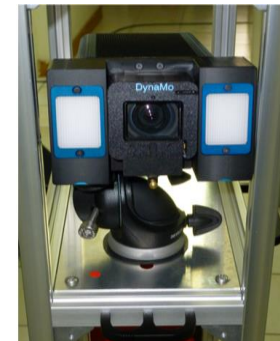
Zone 1  
44-50

Zone 2  
52-56

Zone 3  
58-62

Zone 4  
64-68

**Installation des colonnes**



**Movable Photogrammetry  
station**

***20 minutes for complete  
section measurement***

# Photogrammetry : HMI allow an High level of integration

User experience has validated HMI to hide complexity to Mechanics (operator centered)

**Résultat de la mesure**

Résultat Mesure	
RMS Total:	100.00
Résultat Transformation	
RMS ΔX:	0.06
RMS ΔY:	0.05
RMS ΔZ:	0.04
RMS Total:	0.09

Plus d'infos

**OK**

Configuration of measurement



13 frames measured in four zones



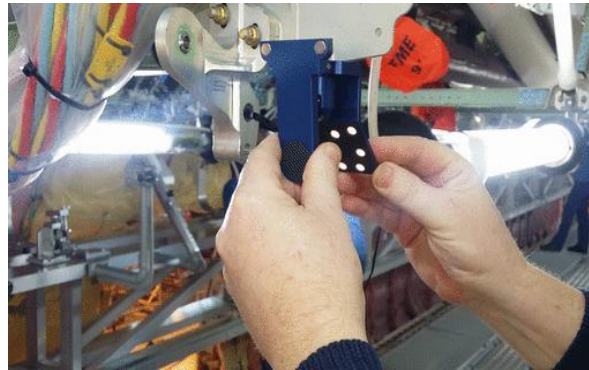
Duration of measurement 10 s by Zones



20 minutes to capture the complete area of the section aircraft

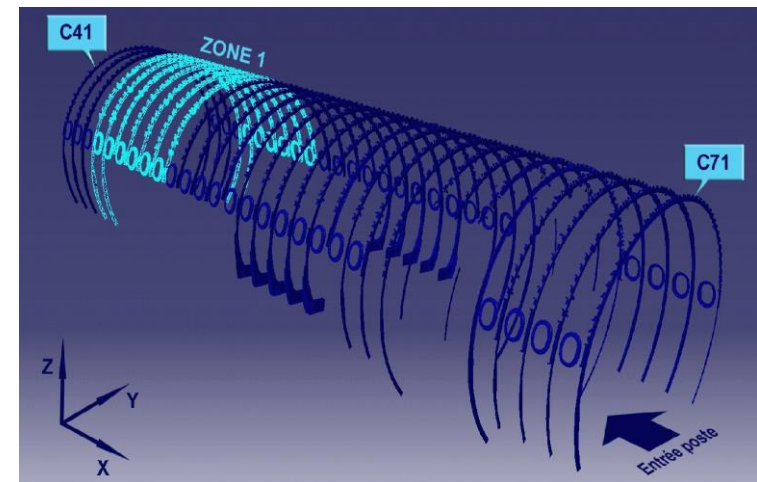
# Technical Innovation : New Concept of Metrology Target Holder

Quick install/removal and self-positioning magnetic target holder  
(reduce the As Is workload installation target holder )




# Photogrammetry : Measurement procedure

- Six reference targets in each of four zones measured by Laser Tracker during levelling process (24 total).
- Alignment and scaling via common points on feature targets.
- Coded targets installed to assist with automation of the measurement within the required volume.
- Coded targets with tooling to measure required points. (red arrows)

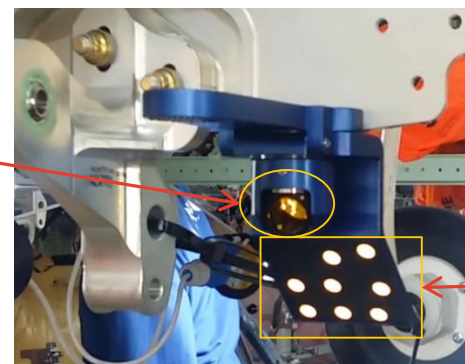
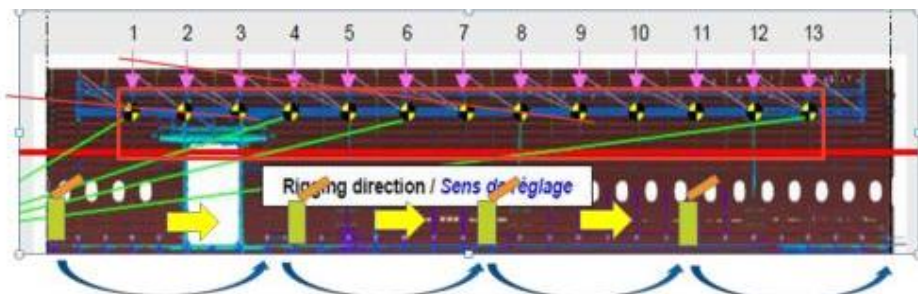


- Four zones over aircraft length approx. 21 m long
- Measure coded targets and six reference points per zone

# Photogrammetry : Measurement procedure

- The close coordinates of the Brackets-B-Rigging points for automatic labelling in the theoretical file replacement are also measured (Auto Relabeling)
  - The D12 system is set up at the level of the 57 framework.
  - Script used to measure points.
  - Delta X, Y and Z computed to assist the bracket adjustment feature and verification.
- 
- The cameras are positioned on the hole of floor working panels, height of 400 mm for the lower camera,
  - All targets are visible from these two columns camera stations positions.
  - The measurement is controlled by a script. This script fires the cameras and the completes the bundle.
  - The acquisition of images lasts six seconds and the calculation is ten seconds.
  - The D12 system required no stability. V - STARS directly calculates the differences between the theoretical and measured points. These differences are expressed on axes X, Y and Z of the sign corresponding to the six points of reference.

# Photogrammetry : Measurement procedure reallocation



Laser Tracker reflector

PHOTO Target

Specific target Holder with double reflector (LT /Photogrammetry)

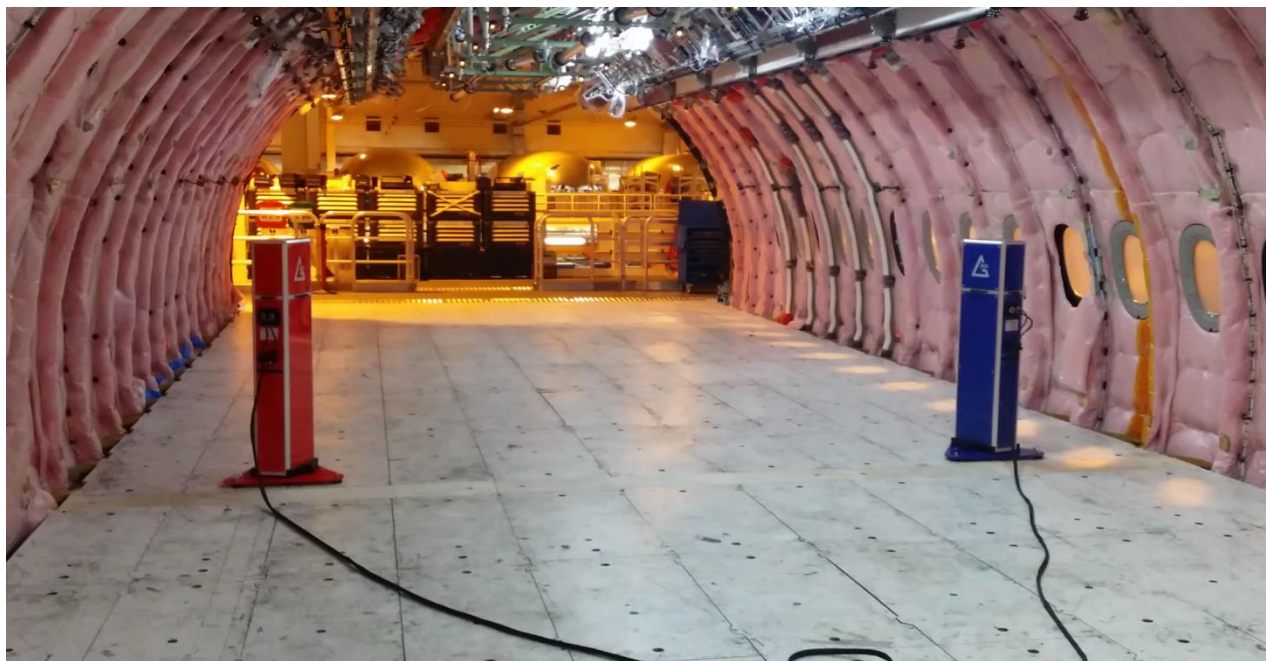
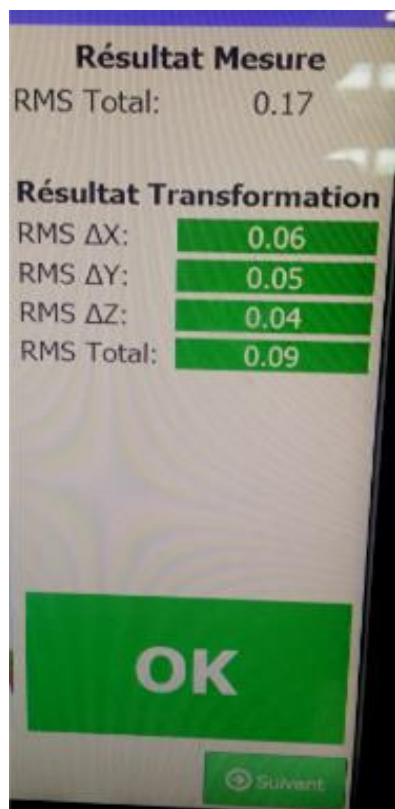
The reallocation on the 4 areas measured by Photogrammetry to create one measurement data's collection

is performed

by post treatment with the practical coordinates measured by Laser Tracker during the levelling phase before this process

# Photogrammetry : Deployment since May 2016

## 4 Camera Performances Results post deployment



Display quick camera orientation function

(Simultaneous acquisition of four images for each camera follow by the bundle adjustment)

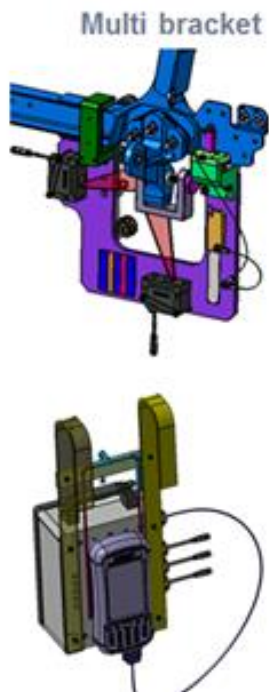
Transformations results  
Laser tracker reference point and  
photogrammetry measurement

# Photogrammetry : Provide input data to perform the adjustment with smart tools connected

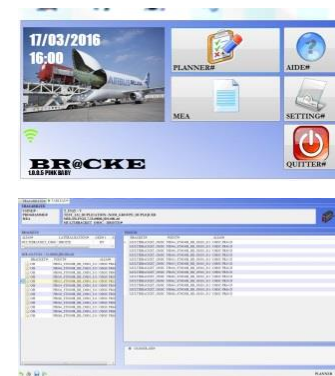
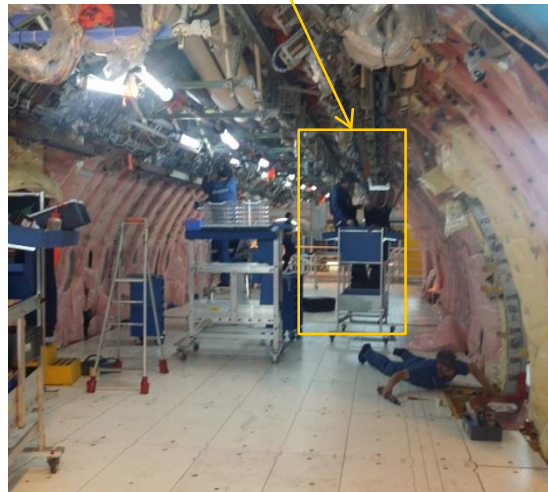
## Example of Smart tools rigging for Multi Bracket family of cabin brackets

→ Photogrammetry provide input data through MAA Airbus software suite database to perform adjustment with smart tools connected to Airbus Operational System.

E.g. MAA Measurement Assisted Assembly Airbus software Suite



Coactivity is possible during rigging phase



Simply HMI to use by operator



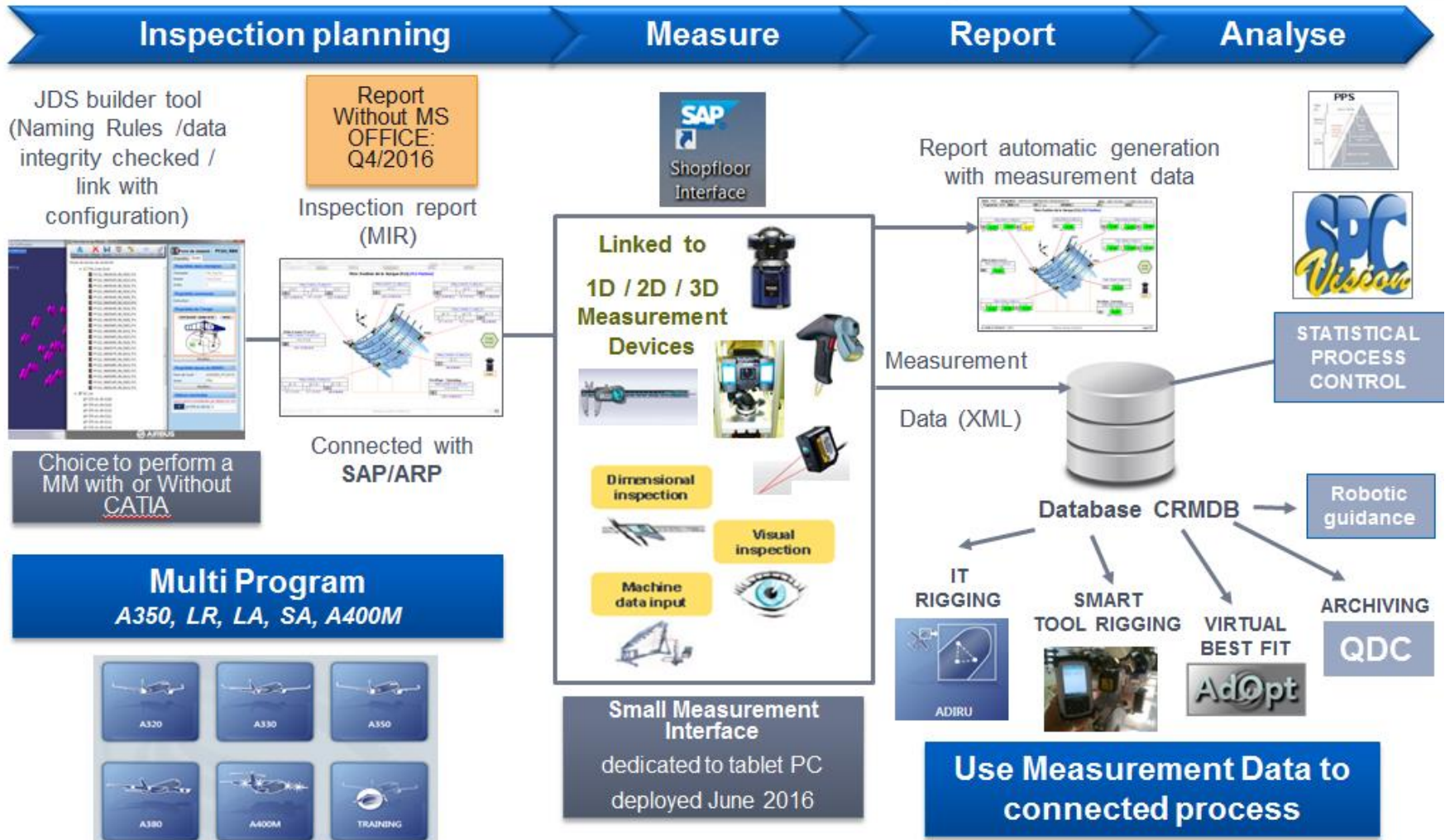
# Smart tool assisted rigging process

## Example of rigging process with B-Bracket ajustable in Y and Z in two step



# Management Measurement End to End Process Overview

E.g. MAA Measurement Assisted Assembly Airbus software Suite



## Questions & Answer

# Thank you for your attention



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