

In-service Aircraft for a Global Observing System

## WP-4 Preparation of operational basis

H. Franke (enviscope), WP4

F. Karcher (MF), Task 4.1

C. Gerbig (MPG), Task 4.2

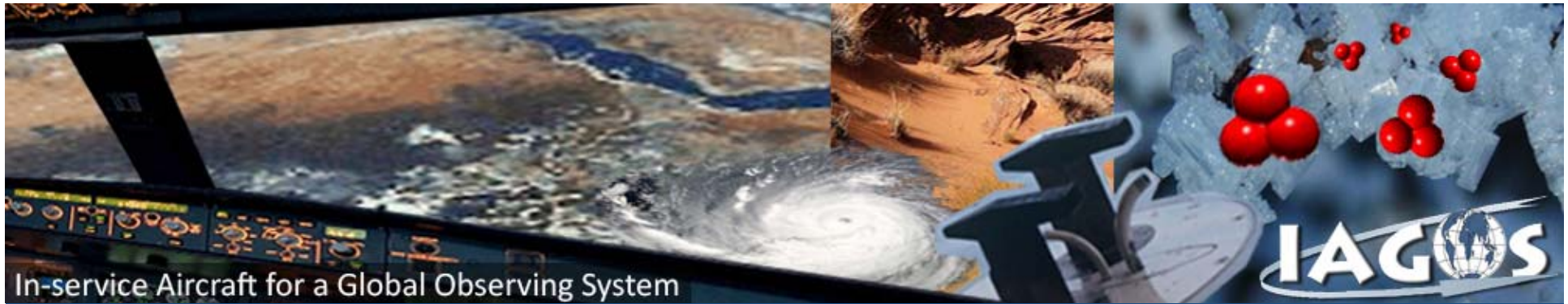
A. Petzold (DLR), Task 4.3

K. Dahmann (enviscope), Task 4.4

P. Nedelec (CNRS), Task 4.5

## WP-4 : Preparation of operational basis

No	Objective/Deliverable	Partner	due
D4.1	Certification documents of RTTU and software on the 1st equipped IAGOS aircraft	MF	36
D4.2	Certification documents for CO <sub>2</sub> instrument inclusive prototype testing	MPG	36
D4.3	Certification documents for Aerosol instrument and air-intake inclusive prototype testing	DLR	36
D4.4	Flow chart comprising all maintenance and QA/QC procedures	enviscope	36
D4.5	STC for IAGOS Instrument onboard A330	CNRS	48



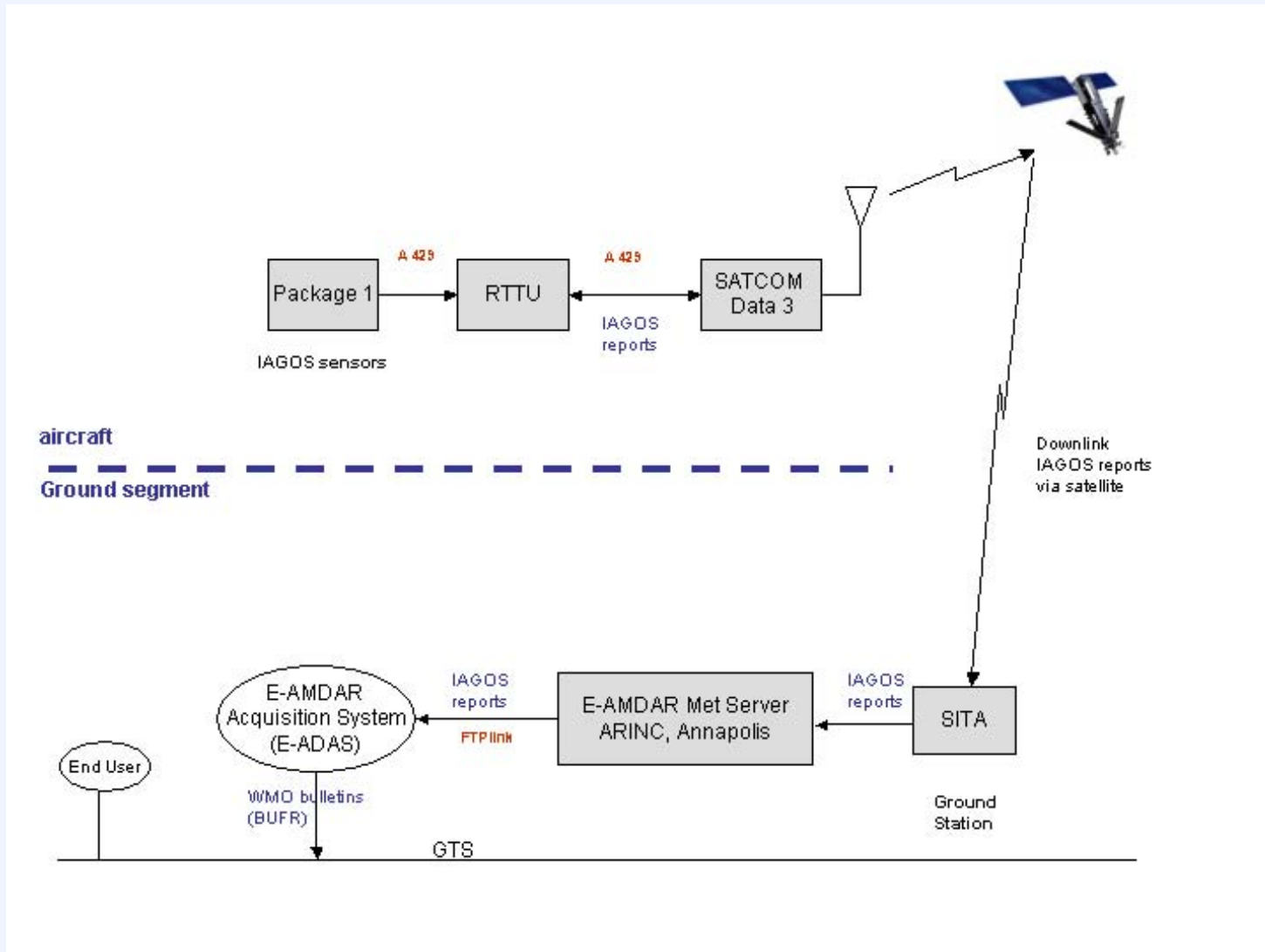
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# T4.1 Certification of RTTU and software

F. Karcher (MF)

IAGOS-ERI Annual Meeting 2009, Toulouse, 7.-9.10.2009

# Specifications of Real-Time Transmissions



Task 4.1

# Progress

- *Summary of progress towards objectives*
  - *RTTU specifications (IAGOS-DS, sub-contract with Aéroconseil)*
  - *Development and Tests Plan (IAGOS-DS, sub-contract with Aéroconseil)*
  - *Study installation of RTTU inside P1*

Task 4.1



Harald Franke, WP-4

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# Progress

- *Summary of progress towards objectives*
  - *RTTU specifications (IAGOS-DS, sub-contract with Aéroconseil)*
  - *Development and Tests Plan (IAGOS-DS, sub-contract with Aéroconseil)*
  - *Study installation of RTTU inside P1*
- *Milestone*
  - M4.1.1: Decision on subcontractor for RTTU (MF/M5)**
  - M4.1.2: Preliminary design review (PDR) of RTTU (MF/M12)**

Task 4.1



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# Deviations from Annex I

- *Reasons*
  - *Task 4.1 dependent on Design work in IAGOS-DS (end : April 2009)*
  - *Additional study on the possibility to install RTTU inside P1*
  - *Action towards Real-Time data users (operational costs)*
- *Impact*
  - *Delay 12 months*
- *corrective actions*
  - *End of Task 4.1 not critical (Month 36)*
  - *Development of RTTU can be reduced with re-use of existing LRU*
- *Use of Resources*
  - *person.month used instead of 3 (planned in Year 1 for task 4.1 corrective actions)*

Task 4.1



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# Objectives and milestones for year 2

## **Objectives**

- *Revision of user requirements (data products)*
- *Design of the RTTU based upon the Development and Test Plan*
- *Completion of the Preliminary Design*
- *Review process (PDR)*
- *Preparation of detailed layout and presentation of the CDR*

## **Milestones**

- *M4.1.1 Subcontracting*      => *Month 18 (planned for M5)*
- *M4.1.2 PDR of RTTU*      => *Month 24 (planned for M12)*
- *M4.1.3 CDR of RTTU*      => *Month 30 (planned for M18)*

Task 4.1



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## Summary Task 4.1 : Certification of RTTU and software

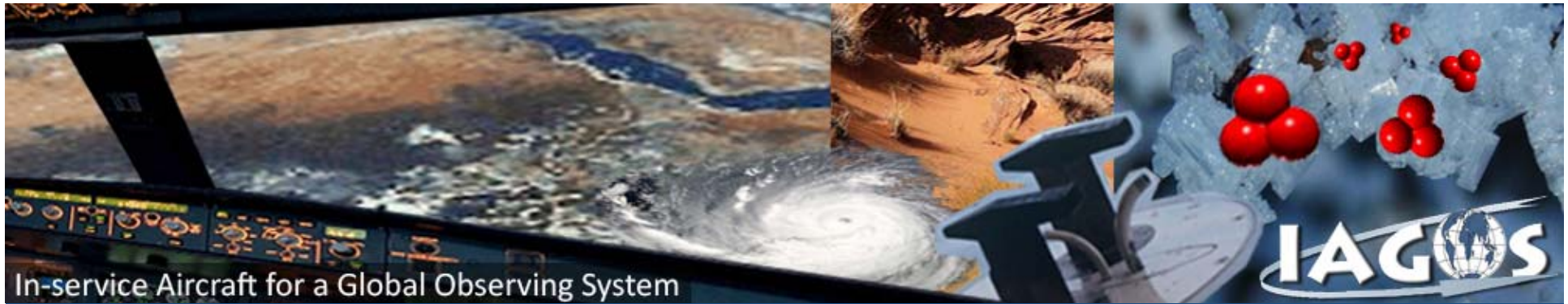
Deliverable(s)	D4.1: Certification documents of RTTU and software on the 1st equipped IAGOS aircraft (MF/M36)
Milestone(s)	M4.1.1: Decision on subcontractor for RTTU (MF/M5) M4.1.2: Preliminary design review (PDR) of RTTU (MF/M12)
Status	Call for tender for development & certification of RTTU delayed Study of installation of RTTU inside P1 =>identified, started, to be completed by Month18 (new schedule) Info on real-time products sent to users
Achievements	RTTU Interface, System and Equipment Specification RTTU Development and Tests Plan
Deviations from Contract	Delay 12 months =>M4.1.1 (M18) M4.1.2 (M24) M4.1.3 (M30)

Task 4.1



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# T4.2 Certification of CO<sub>2</sub> Package

C. Gerbig (MPG)

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# Progress

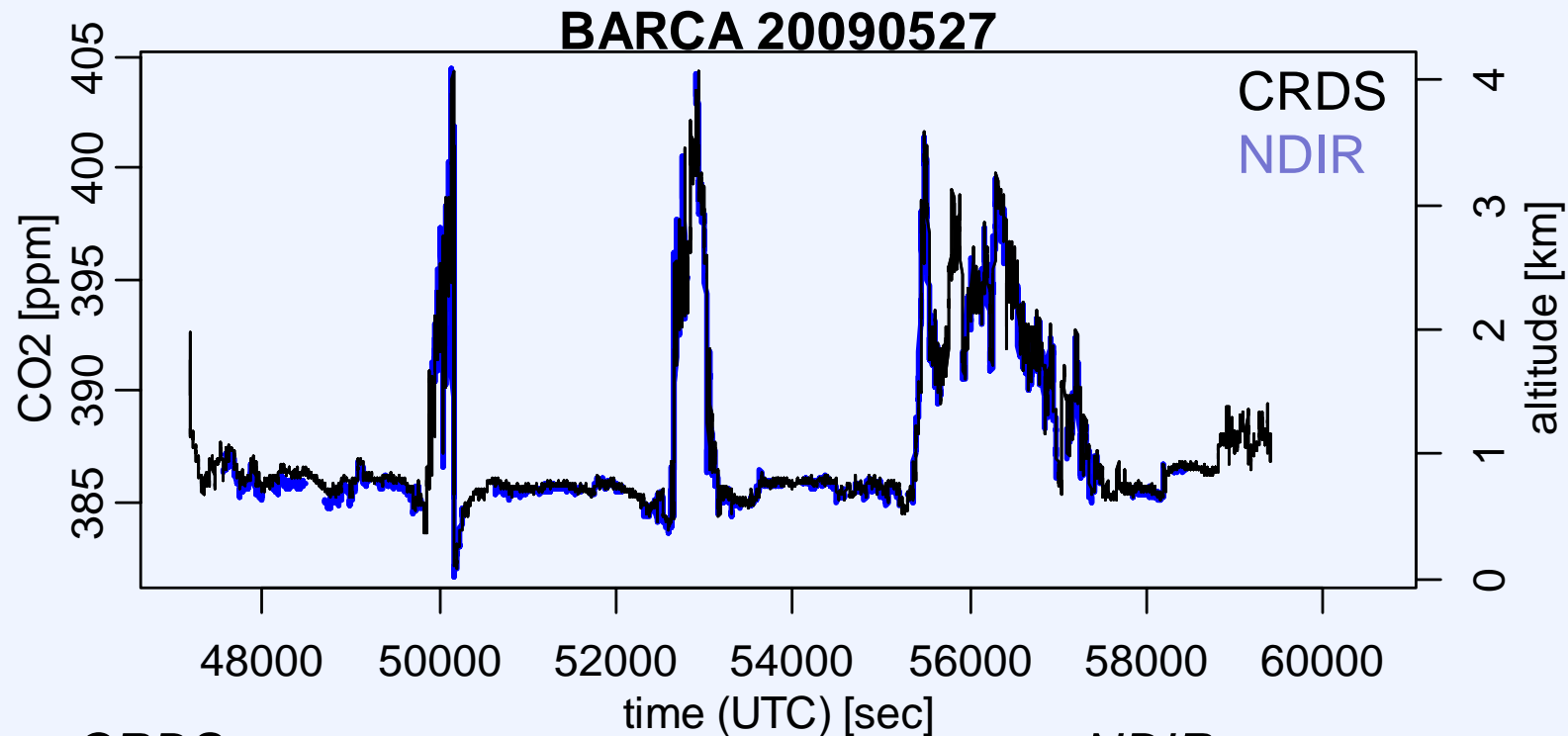
- Approach: Cavity Ring-Down System (CRDS) by Picarro Inc. for CO<sub>2</sub>, CH<sub>4</sub> and H<sub>2</sub>O
- Targeted specifications:

CO <sub>2</sub> Precision@1 s	0.1 ppm
CO <sub>2</sub> accuracy	0.1 ppm
CH <sub>4</sub> Precision@1 s	1 ppb
CH <sub>4</sub> accuracy	2 ppb
H <sub>2</sub> O Precision@1 s	100 ppm
Dimensions + Weights	IAGOS Package II

- IAGOS-DS Prototype CRDS flown onboard Bandeirante (Brazil) and onboard Learjet (Europe)



# In-flight comparison => targeted specifications met



*CRDS*

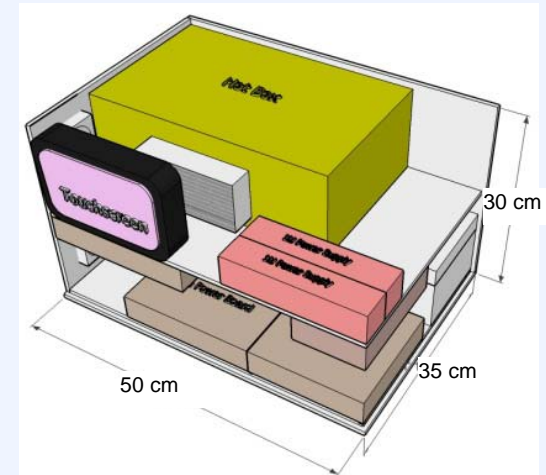
- *No calibration during flights*
- *No drying of sample gas*
- *Using measured H<sub>2</sub>O to correct for sample dilution and pressure broadening*

*NDIR*

- *Frequent calibration during flights*
- *Drying of sample gas*

## Progress 2:

- *Joint activity with Picarro for manufacturing CRDS components*
- *Strong communication link established between enviscope and Picarro*
- *DOE funding for SBIR phase II was not granted*
- *But: Picarro has redesigned all components (synergy with development of eddy flux CRDS)*
  - *fully modular*
  - *4 lasers => additional species possible, e.g. CO*
- *Schedule will be met*



# Objectives and Milestones for Year 2

## **Objectives**

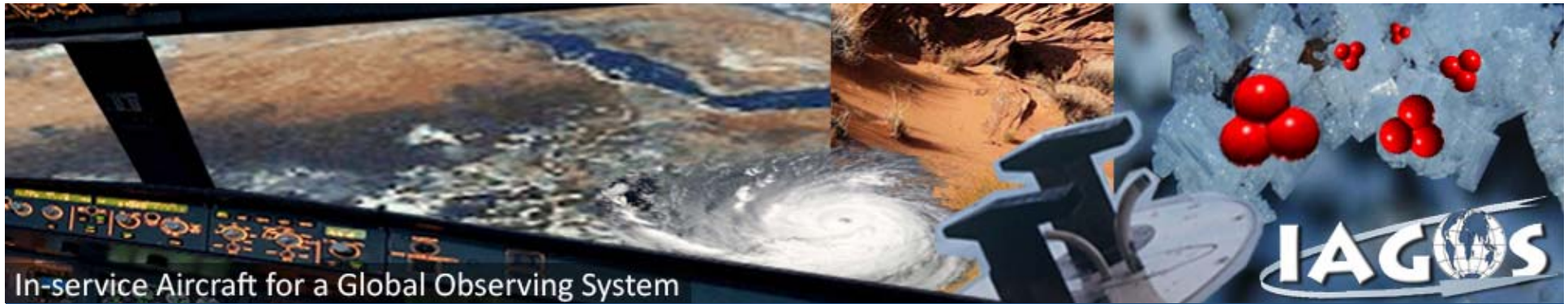
- *Preparation of Preliminary Design*
- *Preparation of Critical Design*

## **Milestones**

- *M4.2.1 PDR of CO2 Package in M18*
- *M4.2.2 CDR of CO2 Package in M24*

## Summary Task 4.2 : Certification of CO<sub>2</sub> Package 2d (including testing on ac)

Deliverable(s)	D4.2: Certification documents for CO <sub>2</sub> instrument inclusive prototype testing (MPG/M36)
Milestone(s)	M4.2.1: PDR of CO <sub>2</sub> Package (MPG/M18) M4.2.2: CDR of CO <sub>2</sub> Package (MPG/M24)
Status	Work will start now
Achievements	Collaboration with Picarro established Plans for 4 laser system
Deviations from Contract	no



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# T4.3 Certification of Aerosol Package

A. Petzold (DLR)

IAGOS-ERI Annual Meeting 2009, Toulouse, 7.-9.10.2009

# Progress

## **Summary of progress towards objectives**

- *Preliminary design of the Aerosol Package 2c was developed by partner 6 based on the output from the delayed IAGOS-DS WP 4.*
- *Draft aerosol inlet system design was developed by partners 11 and 12.*
- *Computational fluid dynamics calculations were conducted in order to develop an optimal design from the particle trajectory point of view.*
- *Potential solutions for the technical realisation are:*
  - *adaptation of standard avionic part (pitot tube), or*
  - *new development aligned with the scientific requirements of aerosol probing from an aircraft.*
- *Aerosol inlet design undergoes an iterative discussion process with aviation companies to derive the best solution.*
- *Preliminary design review of the entire Aerosol Package 2 c including the inlet will be performed after the acceptance of the aerosol package design.*

Task 4.3



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# Progress

## ***Significant Results***

- *Aerosol Package 2c preliminary design finished*
- *Draft aerosol inlet design finished*
- *Milestone Report M 4.3.1 submitted*

Task 4.3



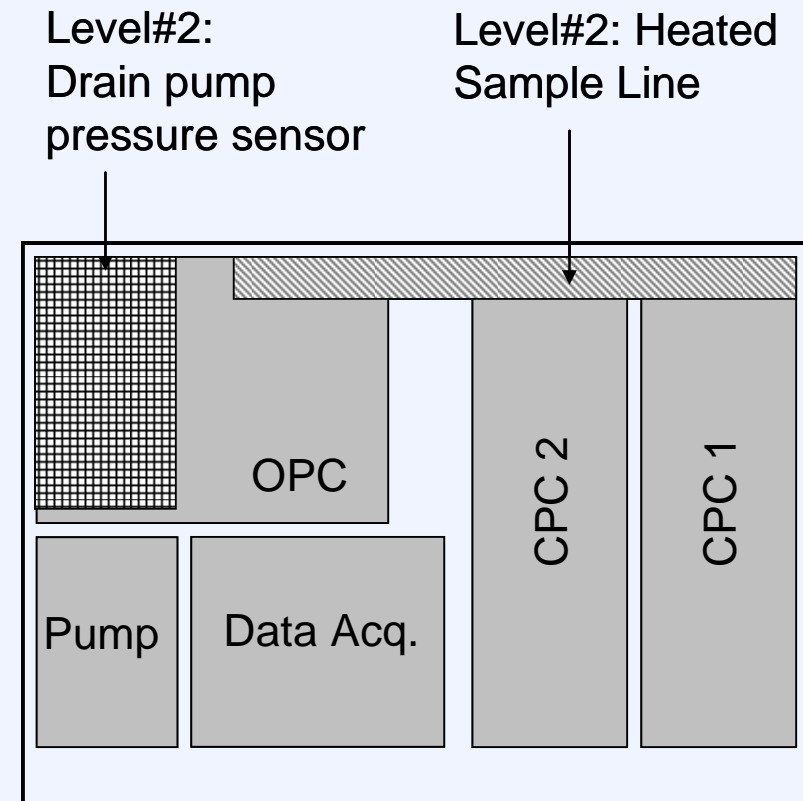
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# Details of Aerosol Package 2c

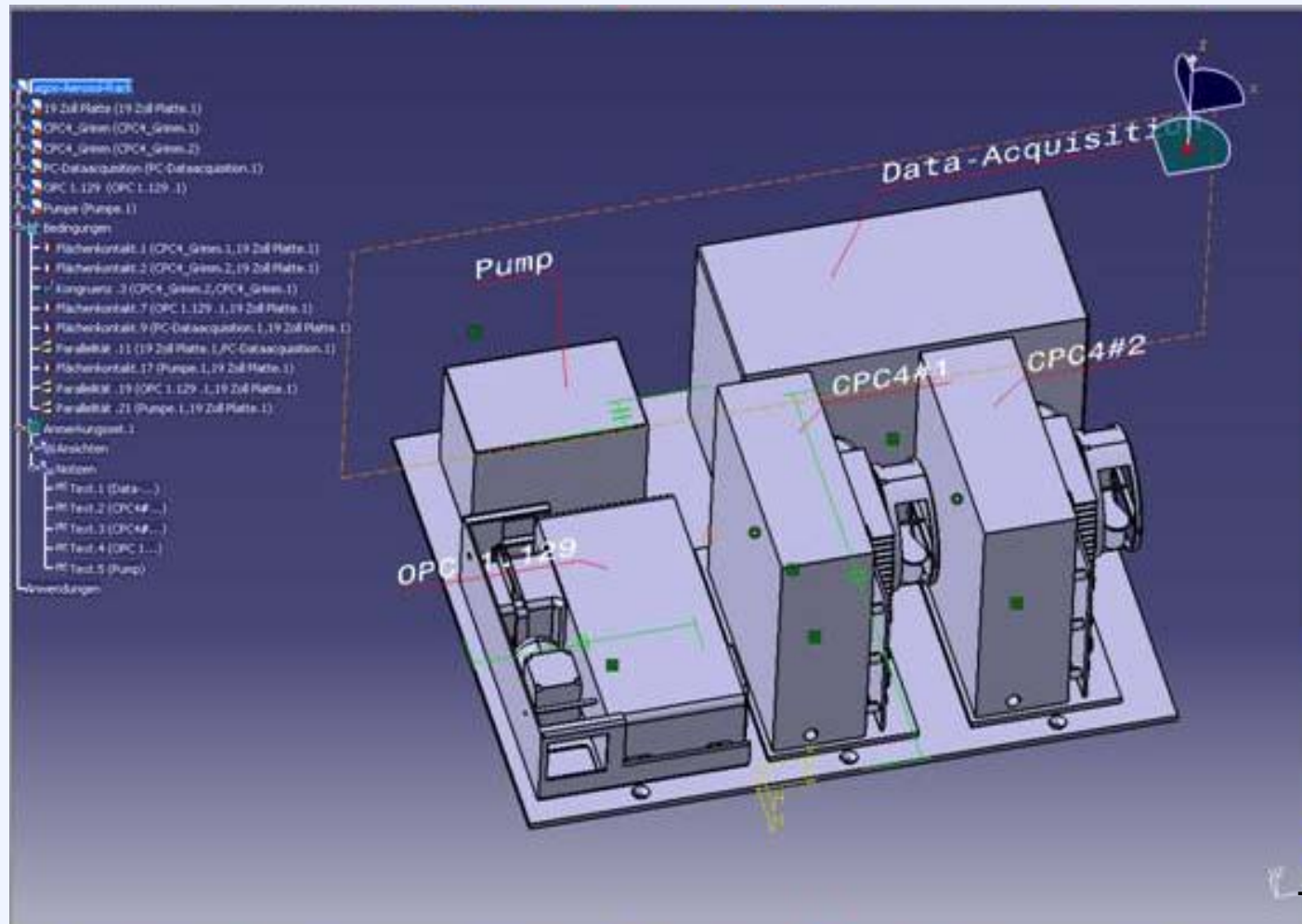
## Parts of Aerosol Package 2c

- Two condensation particle counters (CPC) based on the commercial CPC kernel GRIMM 5.410;
- optical particle counter (OPC) of type GRIMM SkyOPC 1.129 (from IAGOS-DS);
- membrane pump KNF 813.3 (0,25 m<sup>3</sup>/h = 4,16 l/min at 50 mbar);
- mini thermal denuder (developed in cooperation with FH Aargau, CH);
- data acquisition system.



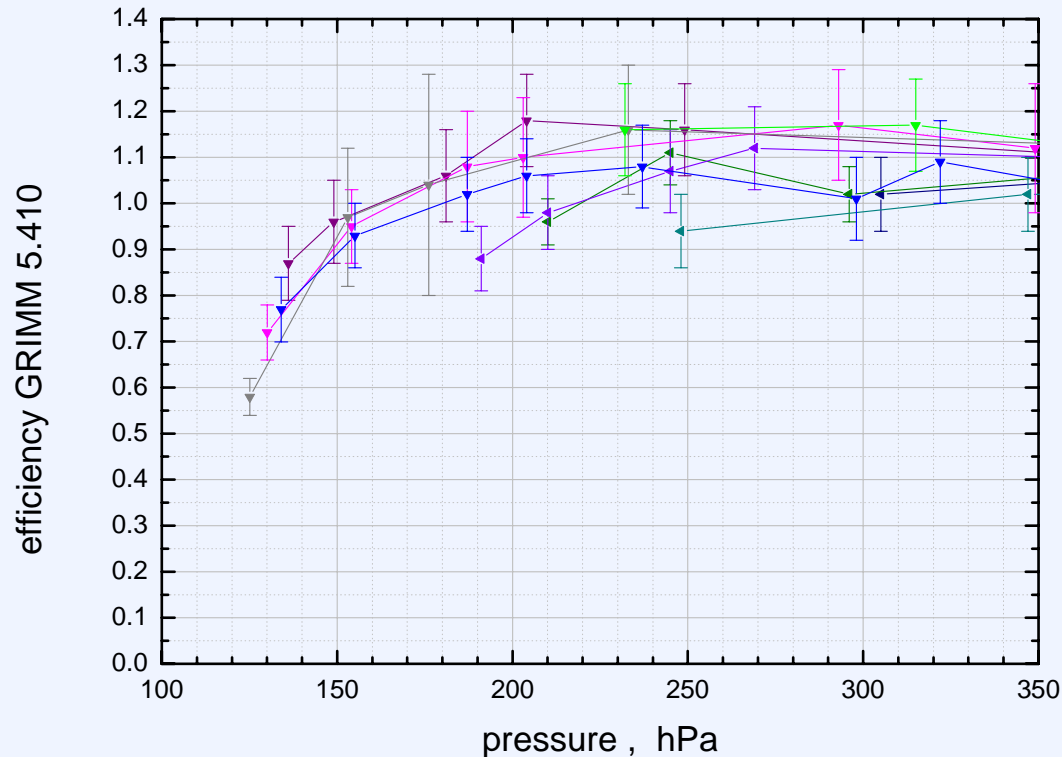
Task 4.3

# Details of Aerosol Package 2c



Task 4.3

# Details of Aerosol Package 2c



Colorized lines represent repetitive measurement at different days under otherwise similar conditions.

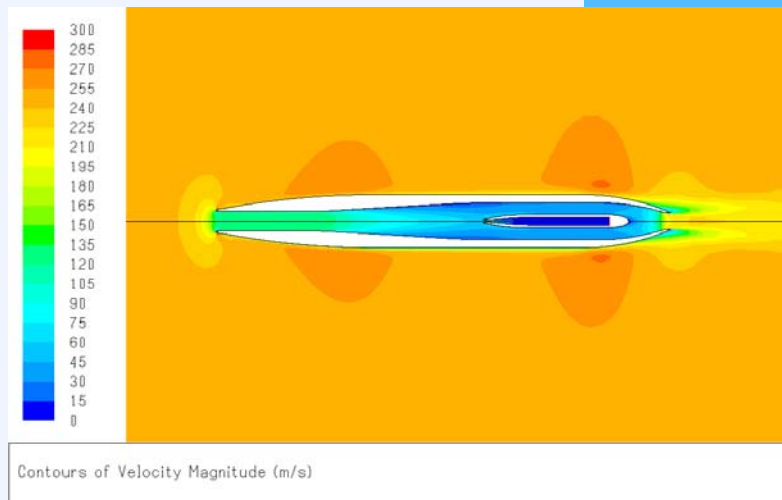
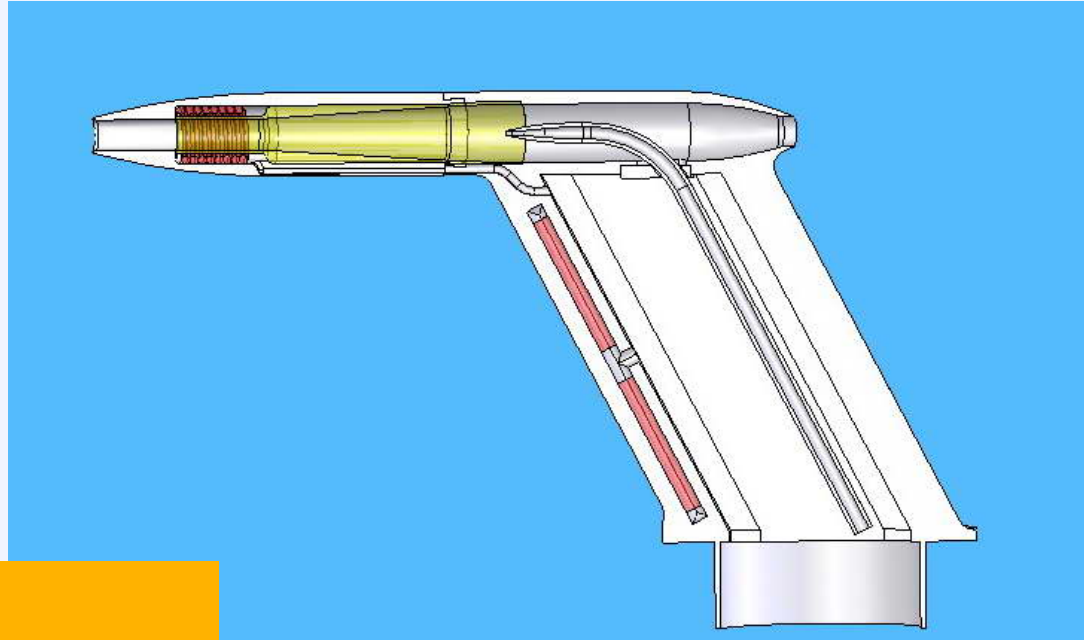
## *Conclusion from IAGOS-DS tests*

Detection efficiency of GRIMM CPC 5.410 kernel at reduced pressure: reduction in detection efficiency is reproducible, effect can be corrected during data reduction.

# Details of Aerosol Inlet

## Preliminary Specification:

- Height above fuselage 120 mm
- Tube diam. 20 mm
- Pylon width 12 mm
- Mass < 500 gr.
- Anti – Ice provisions



Principle: Shrouded diffuser type

Fluid dynamic analysis by IfT

Flow-field: velocity in m/s

Task 4.3

# Deviations from Annex I

## ***No deviations from Annex I***

- *Aerosol Package 2c preliminary design finished*
- *Draft aerosol inlet design finished*
- *Milestone Report M 4.3.1 submitted*

## Use of resources

*Partner 6 has finalised the design of the aerosol package based on the work performed in IAGOS-DS. After the acceptance of the aerosol package design, partner 6 will conduct ongoing work on the basis of IAGOS-ERI resources.*

Task 4.3



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# Objectives and milestones for year 2

## **Objectives**

- *Start detailed design of analyser, preparation of drawings and design specification according to the certification requirements*
- *Revise inlet design according to the results from the iterative discussion process with aviation companies. Start preparation of drawings, examination of special manufacturing methods (ant-ice provisions), preparation of a qualification plan.*
- *Prepare the Aerosol Package 2c Critical Design Review.*

## **Milestones**

- *M4.3.2 CDR of Aerosol Package incl. Aerosol Inlet in M24*

Task 4.3



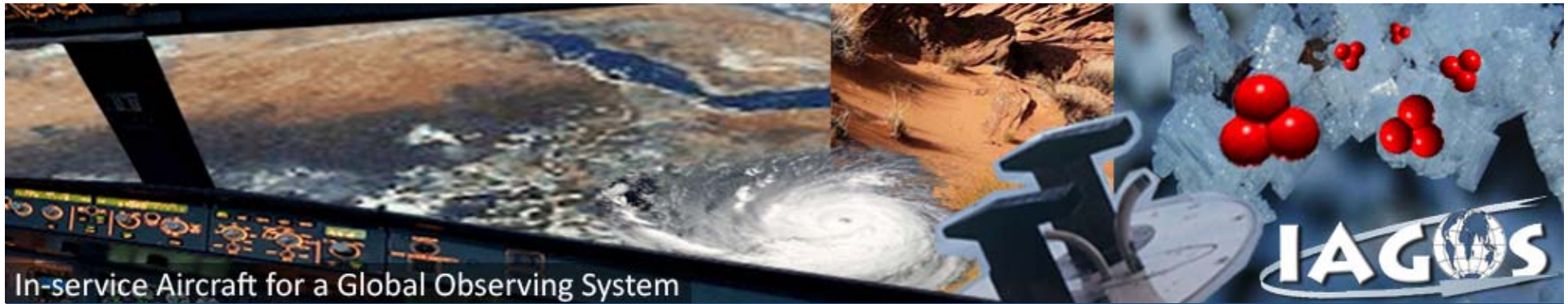
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## Summary Task 4.3 : Certification of Aerosol Package 2c (including testing on ac)

Deliverable(s)	D4.3: Certification documents for Aerosol instrument and air-intake inclusive prototype testing (DLR/M36)
Milestone(s)	M4.3.1: PDR of Aerosol Package incl. Probe (DLR/M12)
Status	Eligibility test completed, components definition completed, feasibility of an adequate instrument layout according to P1 provisions proved. Preliminary design of the intake completed.
Achievements	PDR Documents
Deviations from Contract	No deviations

Task 4.3



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# T4.4 Maintenance and QA / QC procedures

K. Dahlmann (enviscope)

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## **T4.4 Maintenance and QA / QC procedures**

In last months the enviscope colleagues had a brainstorming about the following questions:

- **How is the definition of A340 maintenance**
- **Could maintenance of IAGOS-ERI STC 1 / “STC 2” follow the A340 maintenance chart**
- **How should be the IAGOS-ERI structure to organise the maintenance procedures with the necessary quality requests from airlines and EASA**

Task 4.4



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# Airbus A340 maintenance chart

- Flight hour inspection:
  - A-Check every 800 hours
- Calendar time inspection:
  - daily, service check weekly
  - C-Check: 22 (25) month
  - IL (intermediate layover): 72(96) month
  - D-Check: 144 month
- Unscheduled inspections:
  - aircraft or a system defect during operation

Task 4.4

# IAGOS-ERI Package - maintenance

- Information from WP partners about necessary maintenance for STC 1 / package 1 and STC 2 / package 2 including all different sensor systems
- Every design organisation (DO) must define, which maintenance-task should be necessary for the designed parts
- Every production organisation (PO) should decide which “internal” repairs will be done by PO or airline mechanics
- enviscope compose a questionnaire list for all partners
- Please answering this until end of 2009

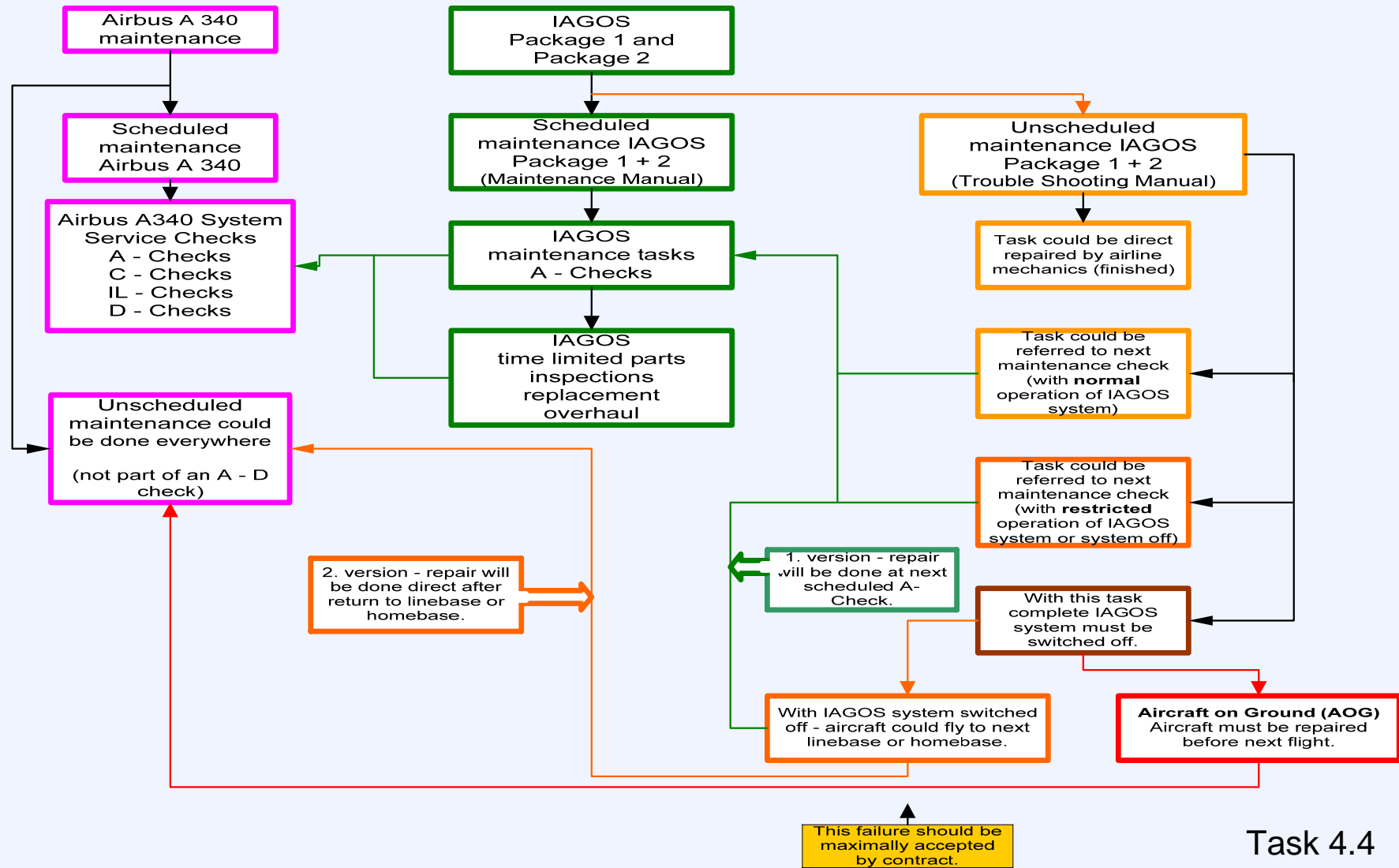
Task 4.4



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# System maintenance chart



Task 4.4



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# IAGOS-ERI maintenance structure

With MOZIAC System we have good experience in the last 15 years to organise maintenance for a few instruments in a de-central organization. The involved institutes organised everything with her one structure.

In future IAGOS-ERI will operate up to 20 systems with different sensor options.

**Task 4.4 should develop adequate maintenance structures.**

Different organisation concepts are possible:

- De – central
- Central – start / November 2009
- Central - future
- Central - future operation
- Central - future 2

**We need your competence to find the correct structure!**

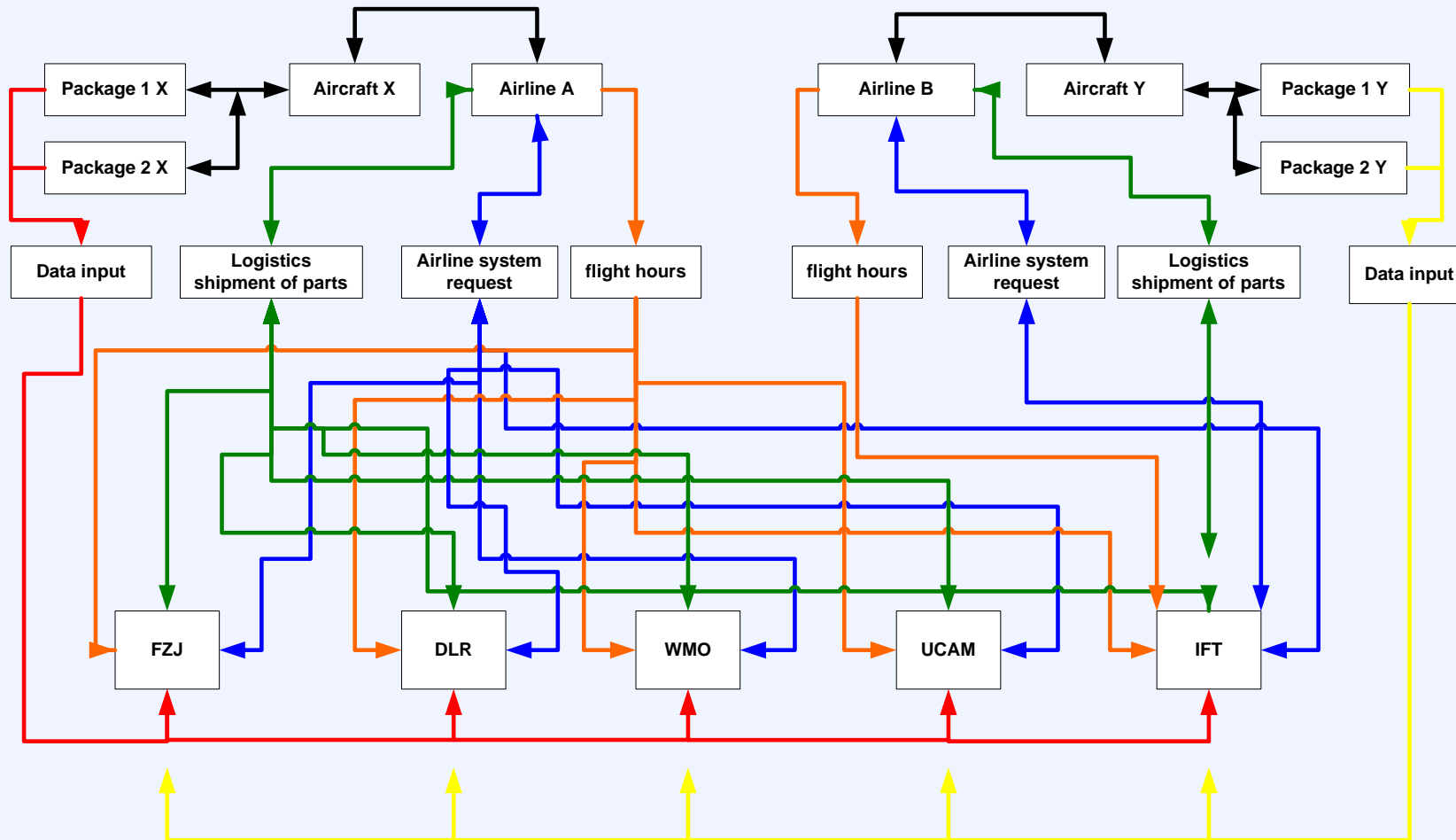
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# D4.4 Maintenance „de – central“



Every WP partner is responsible for complete organization with airlines. It could be necessary as business organization and possibly with EASA certificates.  
They must organise it like the central organization.

Quality Management in acc. to EASA requirements should be established to be sure that all partners using the necessary aviation law.

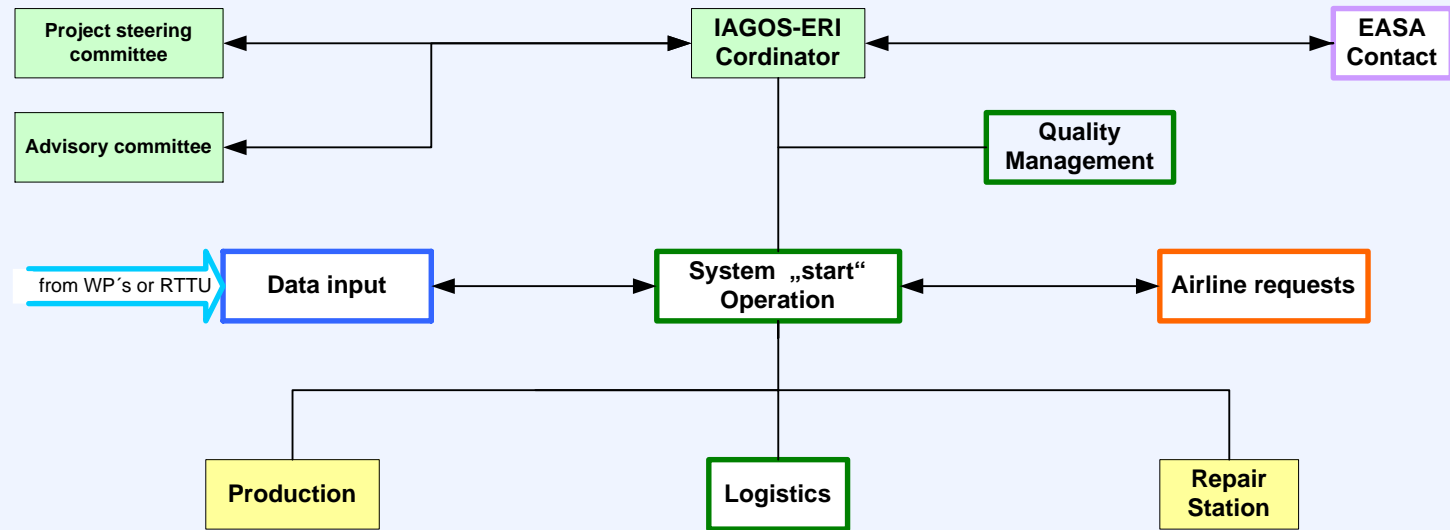
Task 4.4



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# Maintenance „central start“



During start of operation the responsibility could be at the IAGOS-ERI coordinator.  
 In future (2010) there should be a legal business organization („IAGOS-ERI Body“ SA, GmbH, AG, Ltd. etc.).

It should be checked, if EASA certifications are necessary:  
 Design Part 21 J  
 Production Part 21 G  
 Repair Part 145  
 Logistics in acc. to ISO 9120

All WP - partners are partners of „IAGOS-ERI „start“ organization“ with the same rules they have now.

Enviscope should organise IAGOS-ERI Operation at „start“ of operation in November 2009.

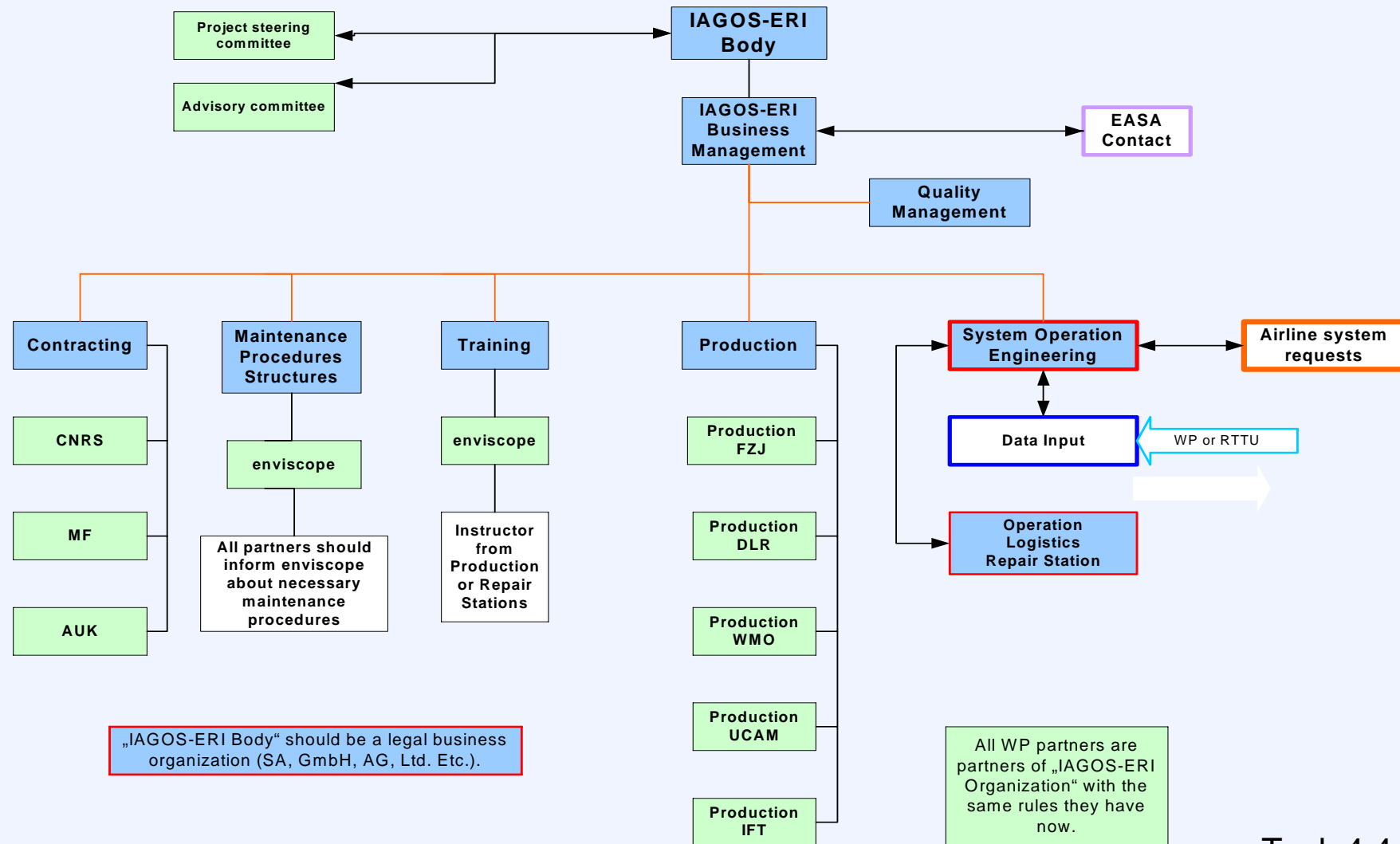
Task 4.4



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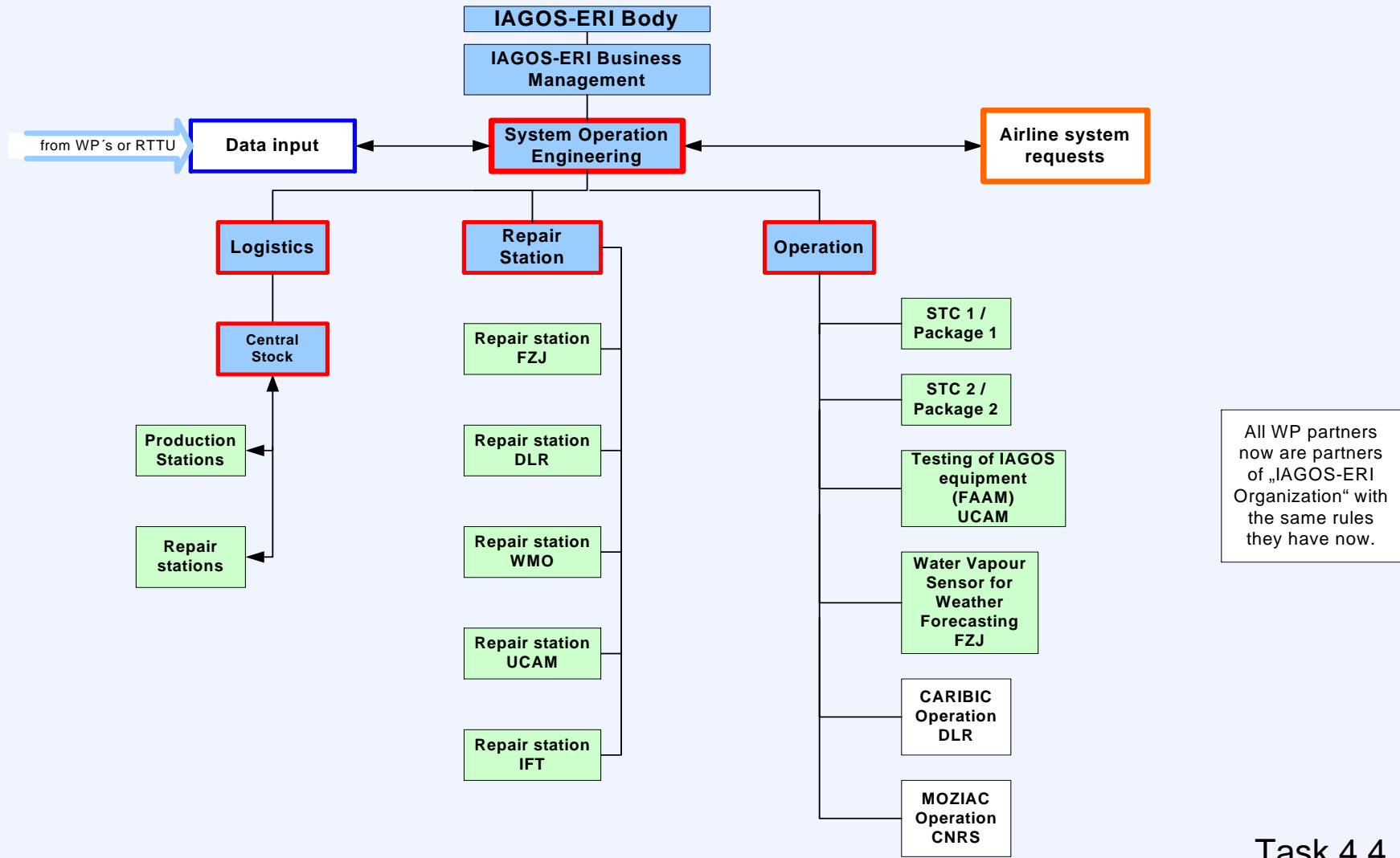
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# Maintenance „central future“



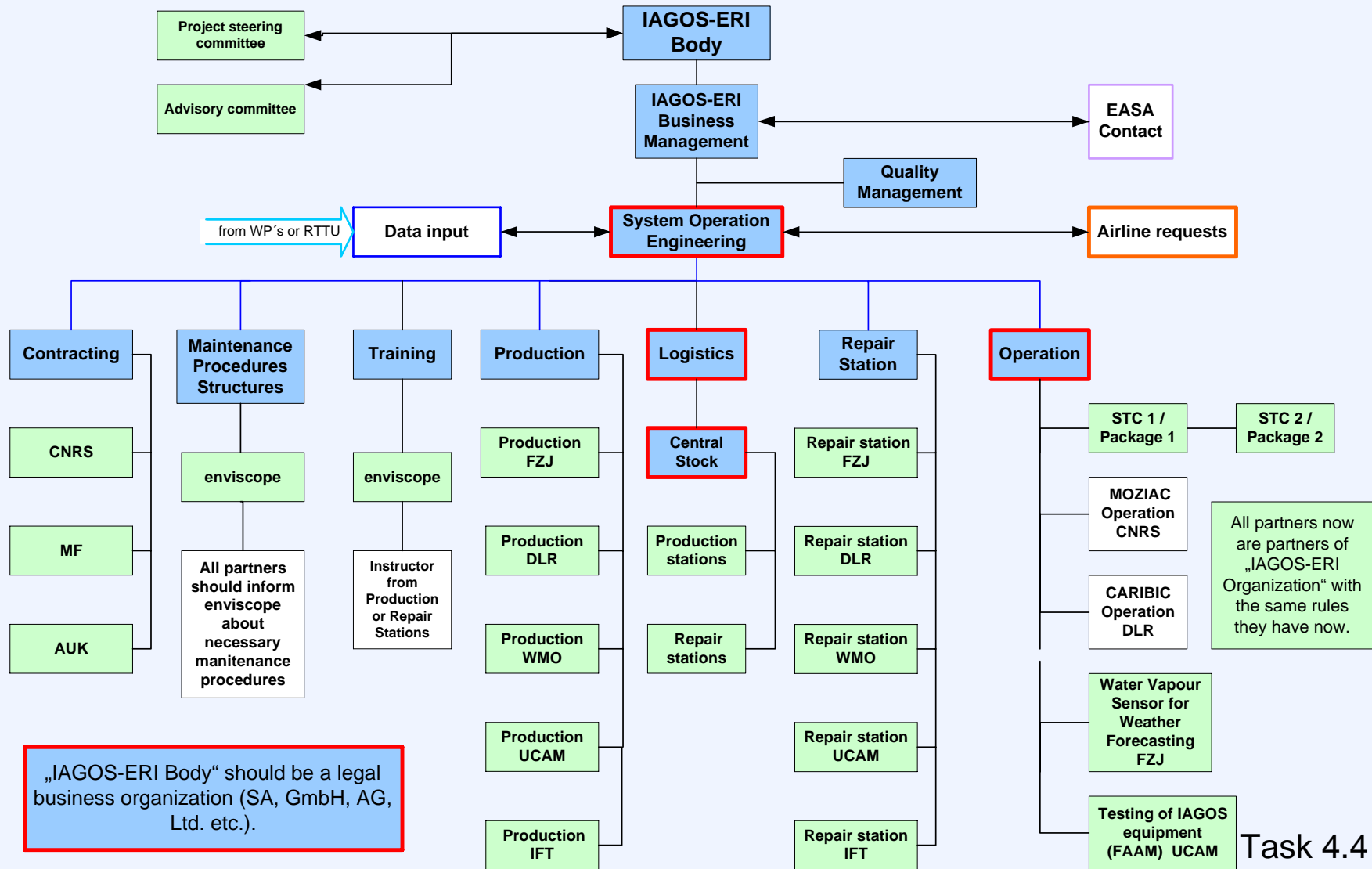
Task 4.4

# Maintenance „central future - operation“



Task 4.4

# Maintenance „central future 2“



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# IAGOS-ERI Organisation structure

- Within the next year the concepts will be discussed in order to gain a decision of the IAGOS-ERI maintenance structure and its organisation.
- The first system should fly in November 2009
- Without an IAGOS-ERI organisation – we could have a lot of problems with the airlines, EASA and EU.

Task 4.4



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# IAGOS-ERI Organisation structure

- enviscope suggest that we organise the operation of the IAGOS-ERI system with at least package 2 instruments as an example, starting with the first instrument in November 2009. The “future” IAGOS-ERI organisation structure will be developed according to the growing number of instruments.

Task 4.4



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# Objectives and milestones for year 2

## **Objectives**

- *Implementation of “central start” procedure for first IAGOS equipment*
- *Preparation of maintenance charts for the next stage*
- *Questionnaire to involved IAGOS parties (Operators, Contract issues)*
- *Definition of maintenance chart structure*
- *Organization of rotational calibration*

## **Milestones**

- *M4.4.1 Review of scheduled maintenance operation chart in M30*
- *M4.4.2 Review of contingency maintenance operation chart in M30*
- *M4.4.3 Review of rotational calibration QA/QC plan in M30*

Task 4.4



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## Summary Task 4.4 : Sustainability of operation

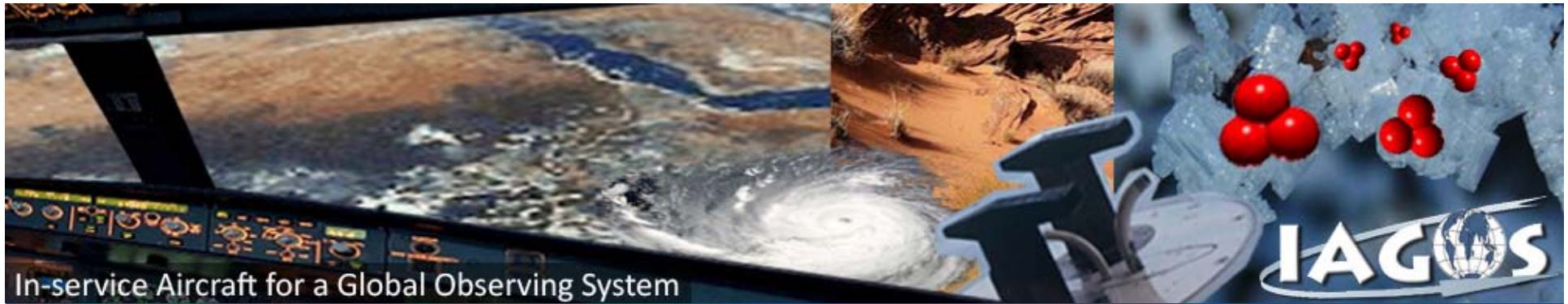
Deliverable(s)	D4.4: Flow chart comprising all maintenance and QA/QC procedures (enviscope/M36)
Milestone(s)	M4.4.1: Review of scheduled maintenance operation chart (enviscope/M30)
Status	Work has started, evaluation of scientific requirements, evaluation of aircraft maintenance procedures, development of a “Start procedure” for the first IAGOS implementation (Nov. 2009)
Achievements	Draft organization charts comprising different conceptions (central / de-central) and different grade of complexness.
Deviations from Contract	No deviations

Task 4.4



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# T4.5 Extension of STC to A330 aircraft

P. Nedelec (CNRS)

IAGOS-ERI Annual Meeting 2009, Toulouse, 7.-9.10.2009

# Progress

- *IAGOS-DS final objective is to obtain STC on A340-300*
- *Lufthansa aircraft will be equipped of IAGOS system (Package1 + Package2) in November 2009*
- *STC on A330 will be started when the complete STC will be obtained for A340*

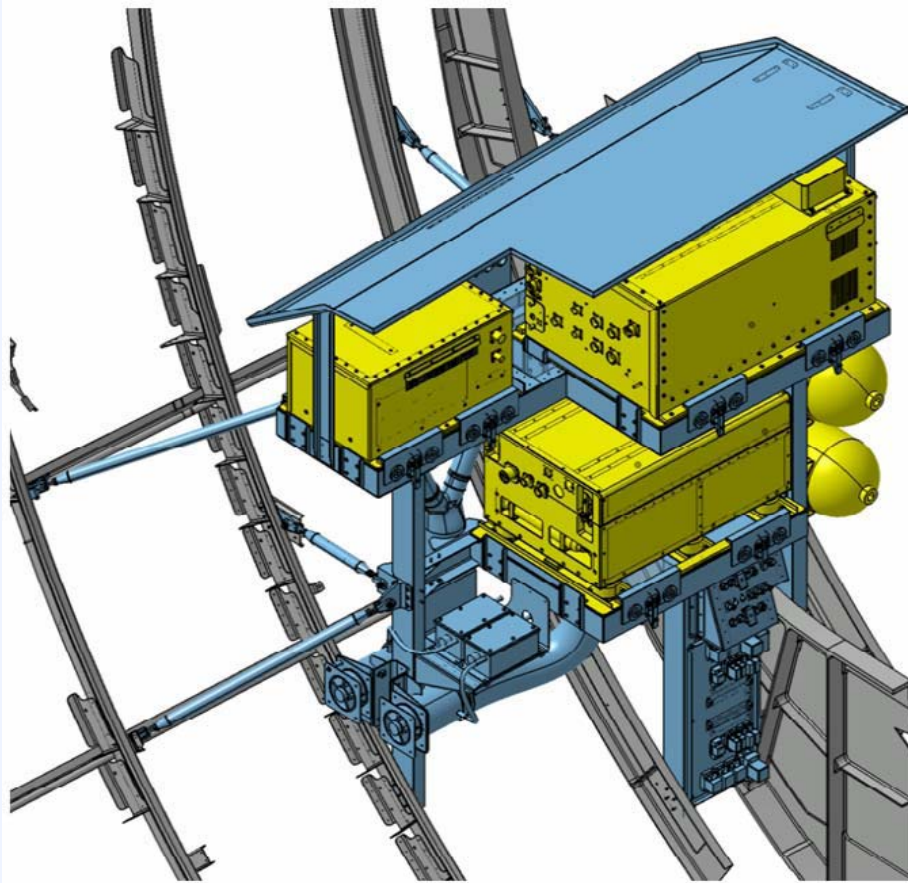
Task 4.5



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IAGOS – STC on A330 will be very similar to STC on A340



**SB divided into 3 parts :**

- Permanent structural/electrical provisions
- Removable structural/electrical provisions
- IAGOS System installation

**-Ground tests will include :**

- Electrical bonding
- Safety tests
- Power ON
- Functional test
- EMI test (first aircraft only)

**Nominal weight : 125 kg (max 140 kg for options)**

Task 4.5

## Task 4.5 : Extension of STC to A330 aircraft

Deliverable(s)	D4.5: STC for IAGOS Instrument onboard A330 (CNRS/M48)
Milestone(s)	M4.5.1: Engineering study for extension of STC to A330 (CNRS/M18)
Status	Not started, waiting for IAGOS-DS STC on A340
Achievements	EASA contact established
Deviations from Contract	Engineering study will start in month 15 (beginning of 2010).

Task 4.5



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