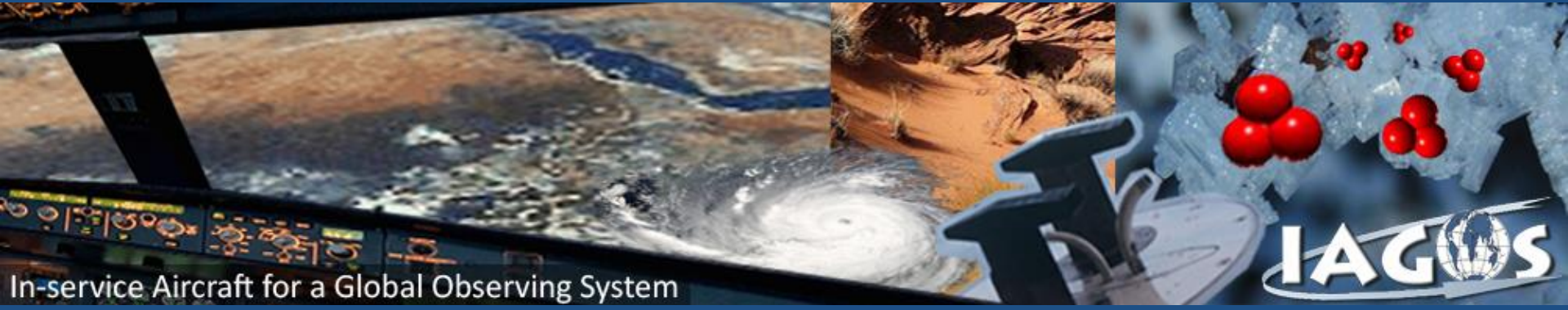


http://www.iagos.org

IAGOS TECHNICAL BASIS AND DEVELOPMENTS

1- TECHNICAL CONCEPT

2- SYSTEM DESCRIPTION

3- SYSTEM CERTIFICATION

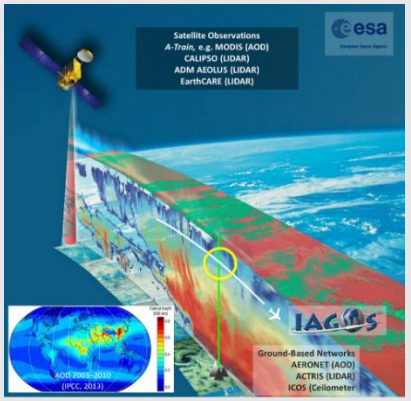
4- AIRCRAFT INSTALLATION AND OPS.

5- TECHNICAL PERSPECTIVES

1 - IAGOS - Technical Concept

www.iagos.org

IAGOS objective is to provide scientific instrumentation for atmospheric monitoring, to be operated on commercial aircraft on a routine basis over decades



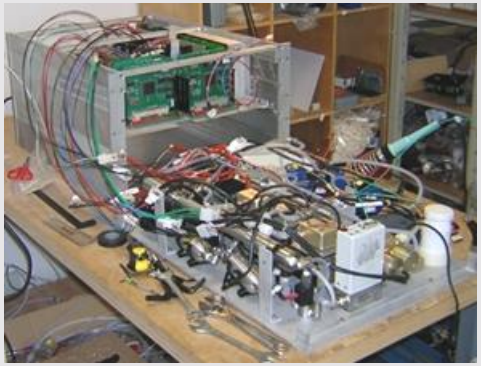
Technical development is a balance between :

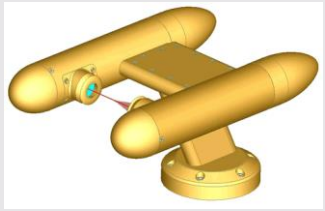
Scientific needs

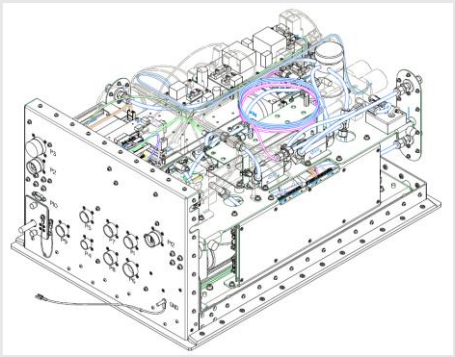
- Relevant measurements
- Existing research/industrial technologies
- High level performances (precision …)
- Long periods operation, stable calibration

Aeronautic requirement

- Aircraft environment
- Fully automatic, low maintenance
- Certification on commercial aircraft





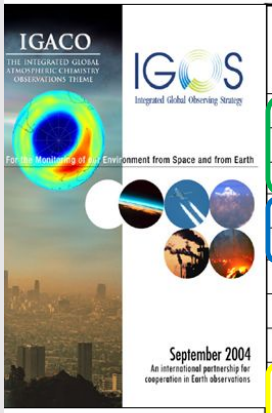


1 - IAGOS - Technical Concept

www.iagos.org

- In the last 10-20 years, IAGOS developed airborne instrumentation which matches the requirements for atmosphere observation in the different domains
- We propose different configurations for IAGOS equipped aircraft
- This technical effort from the IAGOS partners is to be continued in the coming years
- The limitations are the aeronautic certification and airlines operations

IGACO TARGET VARIABLE LIST



Chemical species	Air Quality	Oxidation Capacity	Climate	Stratospheric Ozone Depletion
O_3	✓	✓	✓	✓
H_2O (water vapour)	✓	✓	✓	✓
CO	✓	✓		
CO_2			✓	
CH_4		✓	✓	✓
HCHO	✓	✓		
VOCs	✓	✓		
N_2O			✓	✓
$NO_x = NO+NO_2$	✓	✓	✓	✓
HNO_3	✓	✓		✓
SO_2	✓	✓	✓	✓
BrO, ClO, OClO HCl, $ClONO_2$ CH_3Br, CF_3Br, CFC-11, CFC-12, HCFC-22				✓ ✓ ✓ ✓
aerosol optical properties	✓		✓	✓
actinic flux	✓	✓		

Configuration a

Package 1 (CNRS)
O_3, CO (CNRS)
H_2O (FZJ)
BCP (Uni MAN)
RTTU (MF)

Package 2a (FZJ)	
NOy	O_2
	Air

Configuration b

Package 1 (CNRS)
O_3, CO (CNRS)
H_2O (FZJ)
BCP (Uni MAN)
RTTU (MF)

Package 2b (FZJ)	
NOx	O_2
	Air

Configuration c

Package 1 (CNRS)
O_3, CO (CNRS)
H_2O (FZJ)
BCP (Uni MAN)
RTTU (MF)

Package 2c (FZJ)	
Aerosol number density total, non-vol, acc	Buta-nol
	Buta-nol

Configuration d

Package 1 (CNRS)
O_3, CO (CNRS)
H_2O (FZJ)
BCP (Uni MAN)
RTTU (MF)

Package 2d (MPG)	
Greenhouse Gases CO_2, CH_4, H_2O, CO	Cal Gas
	Cal Gas

Configuration e

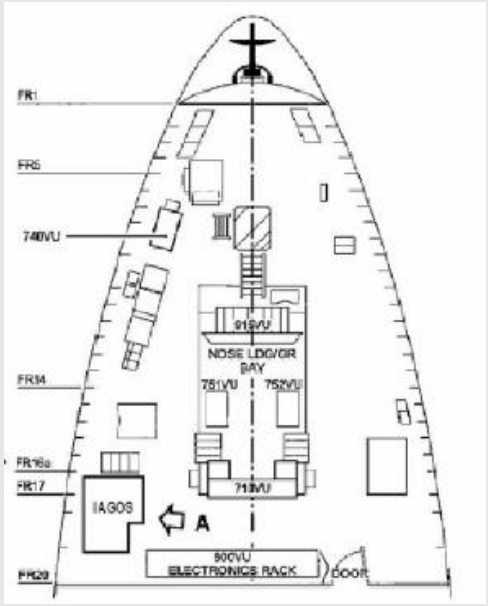
Package 1 (CNRS)
O_3, CO (CNRS)
H_2O (FZJ)
BCP (Uni MAN)
RTTU (MF)

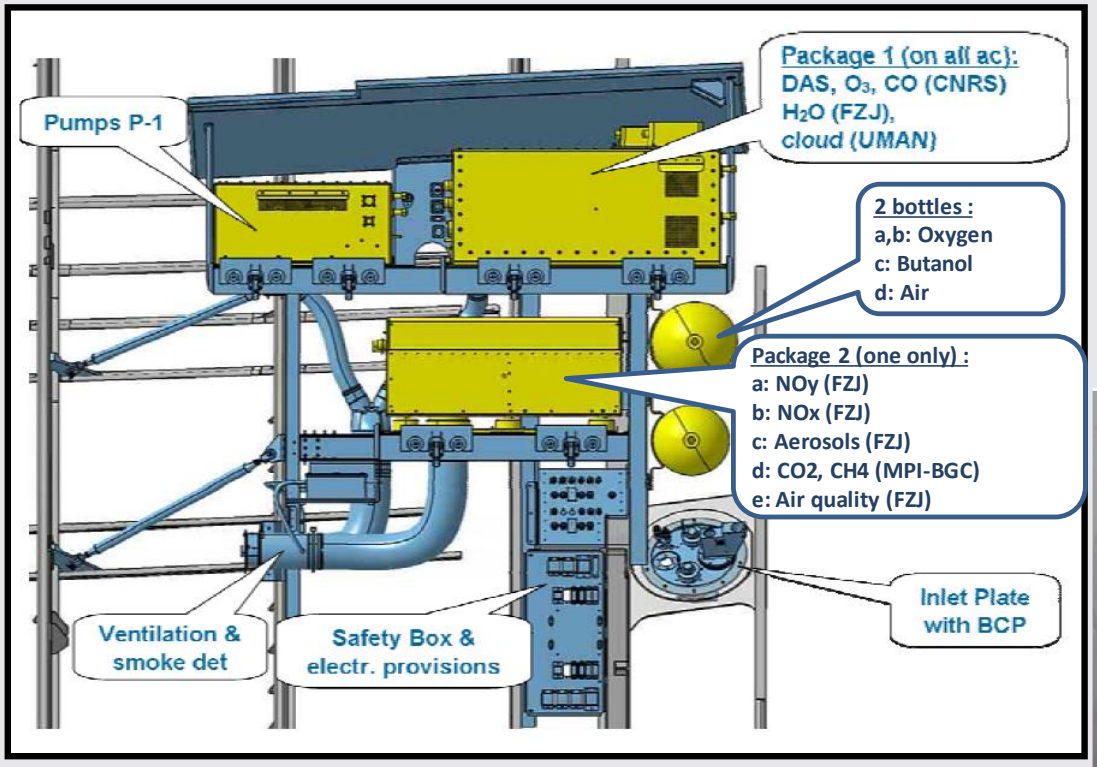
Package 2e (FZJ)
Aerosol Extinction NO_2

Future option under development

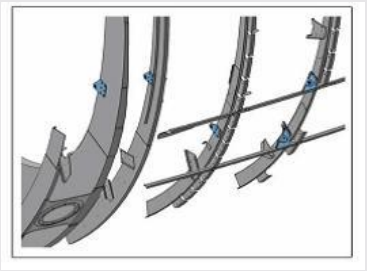
2 – IAGOS - System Description

www.iagos.org





- Basic system is 107 kg (with 1 Package2 : + 60 kg)
- Inlets on existing removable plate (no specific holes on fuselage)
- After IAGOS removal, only 5 brackets remain on aircraft frames ⇨



2 – IAGOS - System Description

www.iagos.org

IAGOS System

Figure 20: IAGOS inlet on the Lufthansa aircraft D-AIGT (Viersen).

Inlet Plate from inside

IAGOS Control Panel

Cockpit Pushbutton

2 - IAGOS - System Description

www.iagos.org

- System works fully automatically (no action required on ground or in flight)
- System automatically starts when the aircraft is powered
- Data are recorded from Take-Off to Landing (Air Speed > 50 knots)
- Position and Meteo parameters are recorded every 4 sec via Arinc-429 reception.
- Data are transmitted to CNRS after landing via GSM included in the Package1 (activated WoW and fwd Cargo Door opened)

4.13.2. Electronic Flight Instrument System (EFIS)

EFIS3 provides to Package 1 via ARINC 429 bus following information:
- time,
- date,
- radio altitude,
- longitude,
- latitude,
- ground speed,
- wind direction,
- wind speed.

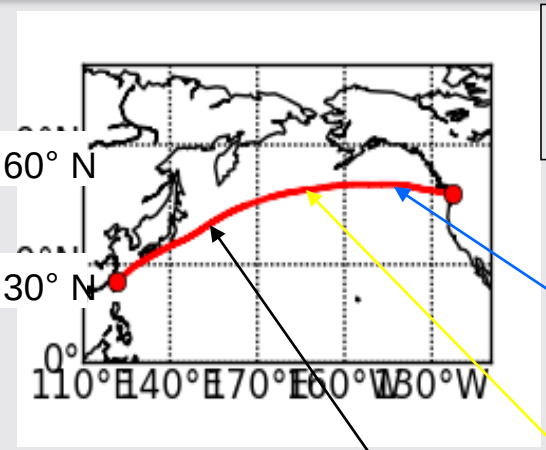
4.13.3. Air Data Inertial Reference Unit (ADIRU)

ADR3 provides to Package 1 via ARINC 429 bus following information:
- barometer altitude,
- calculated speed,
- airspeed,
- external pressure,
- air temperature,
- static temperature.

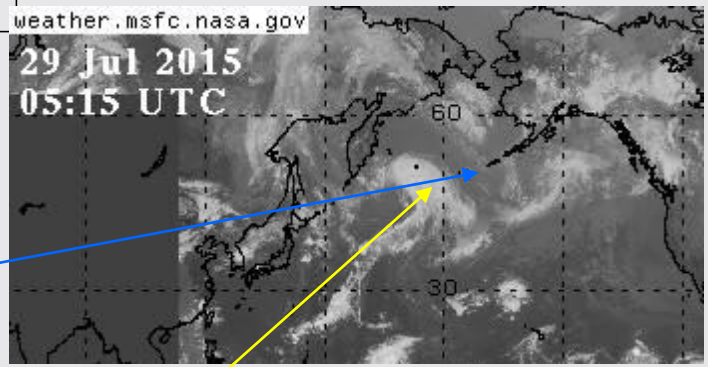
2 - IAGOS - System Description

www.iagos.org

IAGOS – Flight Taipei – Vancouver
Depart : 28.07.2015 16:58 UTC
Arrival : 29.07.2015 03:53 UTC



CHINA AIRLINES



Stratospheric Ozone O3 > 200 ppb

Very High Pollution from Asia CO > 300 ppb

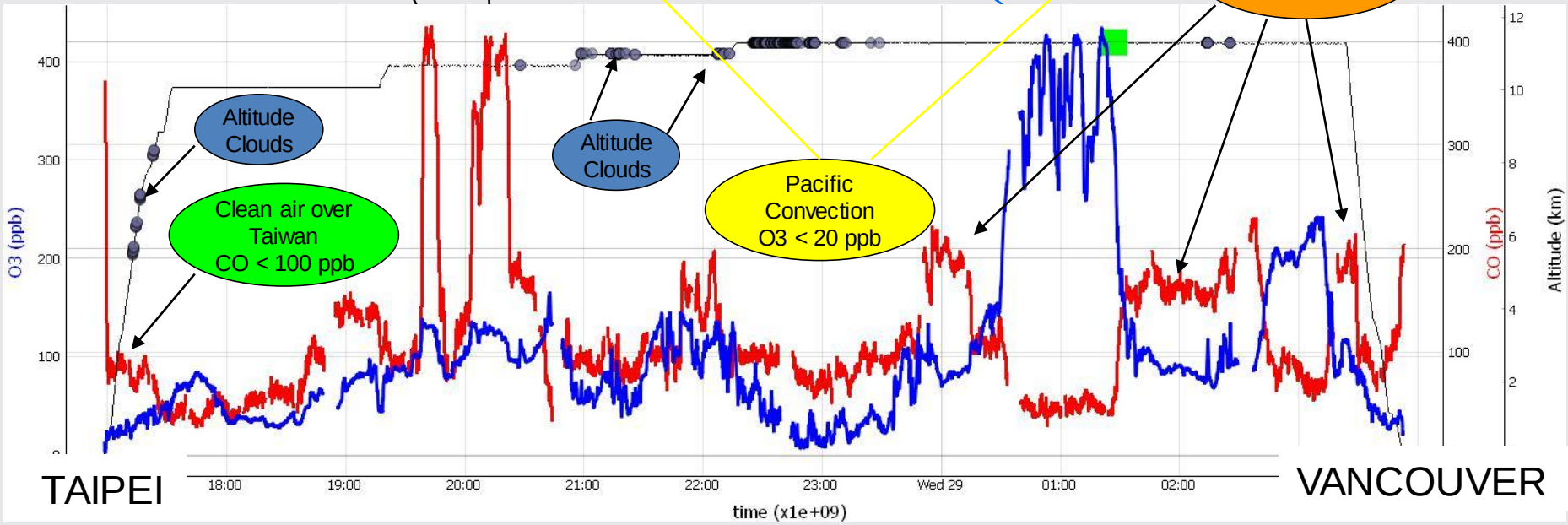
Pollution from Asia CO > 150 ppb

Altitude Clouds

Altitude Clouds

Clean air over Taiwan CO < 100 ppb

Pacific Convection O3 < 20 ppb



TAIPEI

VANCOUVER

3 - IAGOS - Certification

www.iagos.org

Certification had to follow EASA CS25 rules “Large Aeroplanes”

- **Structure justification**
  - Airbus load factors (up to 9g in x)
- **Electrical justification**
  - Protections
  - Aircraft electrical load Analysis
- **Safety analysis**
  - Laser : only in flight
  - GSM transmission : only on ground
- **Instruction for Continued Airworthiness**
- **No impact on aircraft operations (incl. ETOPS)**

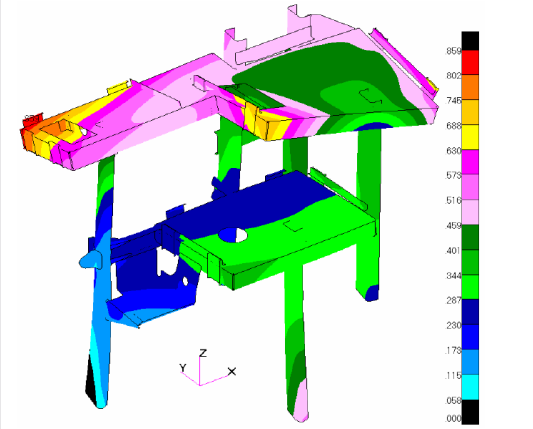


Figure 35 : Deformed shape of the IAGOS secondary structure under +1gX[mm]

3 - IAGOS - Certification

www.iagos.org

EASA
European Aviation Safety Agency

SUPPLEMENTAL TYPE CERTIFICATE

10045974 REV. 8

This Supplemental Type Certificate is issued by EASA, acting in accordance with Regulation (EC) No. 216/2008 on behalf of the European Community, its Member States and of the European third countries that participate in the activities of EASA under Article 66 of that Regulation and in accordance with Commission Regulation (EU) No. 748/2012 to:

SABENA TECHNICS BOD

19 RUE MARCEL ISSARTIER
33700 MERIGNAC CEDEX
FRANCE

and certifies that the change in the type design for the product listed below with the limitations and conditions specified meets the applicable Type Certification Basis and environmental protection requirements when operated within the conditions and limitations specified below:

Original Type Certificate Number: EASA.A.004
Type Certificate Holder: AIRBUS S.A.S.
Type: A330
Model: A330-201, A330-202, A330-203
A330-223, A330-243
A330-301, A330-302, A330-303
A330-321, A330-322, A330-323
A330-341, A330-342, A330-343

Description of Design Change:
IAGOS MODIFICATION
This STC installs the Integration of routine Aircraft measurements into a Global Observing System on A330 Series.
The Revision 1 extended the applicability of the modification, by adding a new MSN.

See Continuation Sheet(s)

For the European Aviation Safety Agency

Date of Issue: 31 July 2017

David SOLAR
Deputy Head of
Large Aeroplanes Department

10019144
SUPPLEMENTAL TYPE CERTIFICATE - 10045974 - REV. 8 - SABENA TECHNICS BOD - 303415

An Agency of the European Union

EASA
European Aviation Safety Agency

The Revision 2 extended the applicability of the modification, by adding a new MSN.
The Revision 3 extended the applicability of the modification, by adding a new MSN.
The Revision 4 corrected the applicability of the modification.
The Revision 5 removed limitations applicable to MSN 1259.
The Revision 6 extends the applicability of the modification, by adding a new MSN.
This Revision 7 extends the applicability of the modification, by adding a new MSN.

EASA Certification Basis:
The Certification Basis (CB) for the original product remains applicable to this certificate/ approval.
The requirements for environmental protection and the associated certified noise and/ or emissions levels of the original product are unchanged and remain applicable to this certificate/ approval.

Associated Technical Documentation:
- Modification Approval Sheet, ref.: S-00-2275, Issue 9, dated 21 June 2017;
- Aircraft Flight Manual Supplement, ref: AFM-S-F3034-00-01Issue 7, dated 21 July 2017;
- Instruction for Continued Airworthiness, ref: ICA-F3034-00-05 issue D, dated 28 February 2017
or later revisions of the above listed documents approved by EASA.

Limitations/Conditions:
The modification is applicable to the following aircraft Serial Numbers: MSN 421, 861, 989, 1259, 657, and 838.

Prior to installation of this design change it must be determined that the interrelationship between this design change and any other previously installed design change and/ or repair will introduce no adverse effect upon the airworthiness of the product.

- End -

- **Additional aircraft : Revision of the STC**
- **STC Extension to local authorities for non European aircraft :**

民航處 CIVIL AVIATION DEPARTMENT

3 - IAGOS - Certification

www.iagos.org

- EASA STC Package 2d is available for all aircraft – To be extended to Taiwan and FAA
- Other Package2 STC are under process

SUPPLEMENTAL TYPE CERTIFICATE

10060508

This Supplemental Type Certificate is issued by EASA, acting in accordance with Regulation (EC) No. 216/2008 on behalf of the European Community, its Member States and of the European third countries that participate in the activities of EASA under Article 66 of that Regulation and in accordance with Commission Regulation (EU) No. 748/2012 to:

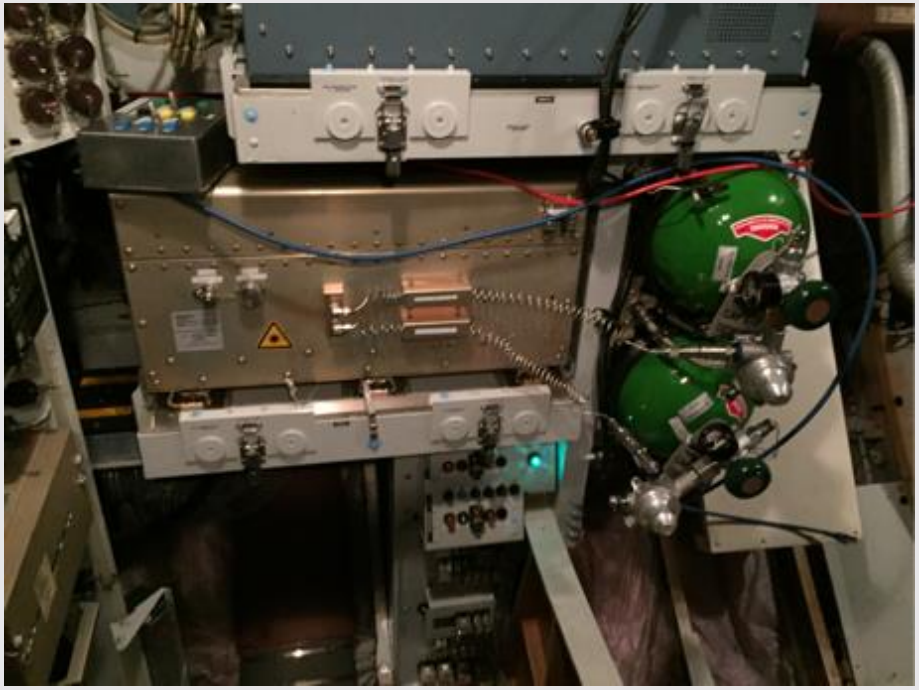
GOMOLZIG FLUGZEUG- UND MASCHINENBAU GmbH

EISENWERKSTRASSE 9
58332 SCHWELM
GERMANY

and certifies that the change in the type design for the product listed below with the limitations and conditions specified meets the applicable Type Certification Basis and environmental protection requirements when operated within the conditions and limitations specified below:

Original Type Certificate Number: EASA.A.004 and EASA.A.015
Type Certificate Holder: AIRBUS S.A.S.
Type: A330 and A340
Model: A330-301, A330-302, A330-303
A330-321, A330-322, A330-323
A330-341, A330-342, A330-343
A340-311, A340-312, A340-313
A340-341, A340-342, A340-343

Description of Design Change:
A330, A340 Installation of IAGOS P2
The design change related to this STC deals with the Installation of the Package P2d, of IAGOS-P2.



- Package 2d has been integrated and tested on Lufthansa A330
- Package 2d will start operations this month

4 - IAGOS - System Installation

www.iagos.org

- Iagos system is designed and produced by Sabena Technics (Part 21)
- Installation can be performed by any Part 145 MRO
- CNRS and Sabena Technics provide on-site support

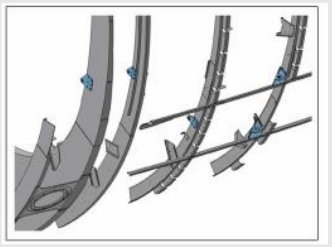
MRO FACILITIES WHERE 10 IAGOS SYTEMS WERE INSTALLED (2009 – 2017)

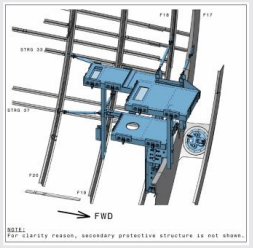
4 - IAGOS - System Installation

www.iagos.org

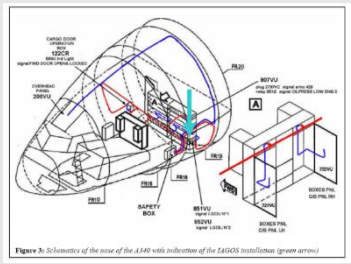
- Aircraft selection 6 months before inst.
- Installation kit and SBs production
- Installation during scheduled layover (3 weeks)

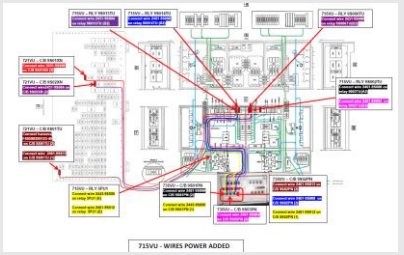
Step 1 : Structure installation



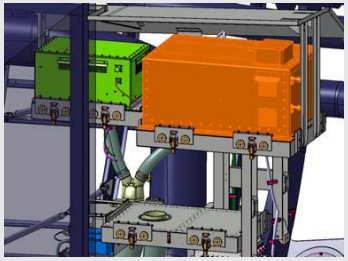


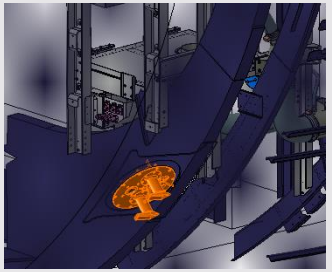
Step 2 : Electrical installation





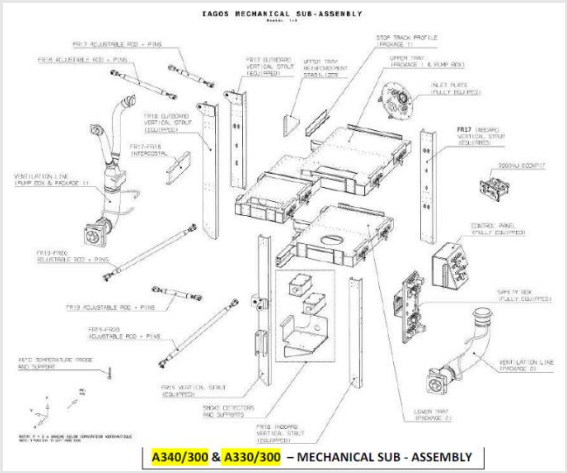
Step 3 : IAGOS Package1 system installation



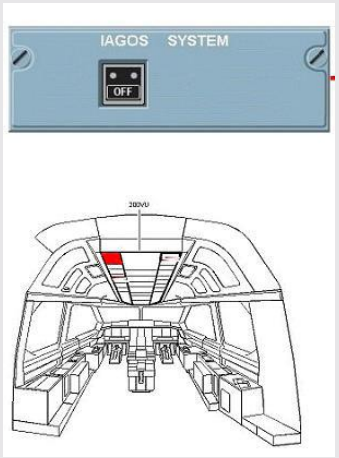


Step 4 : Ground Test Procedures (GTP)

No Flight Test requested



Mechanical installation kit



4 - IAGOS - System Installation

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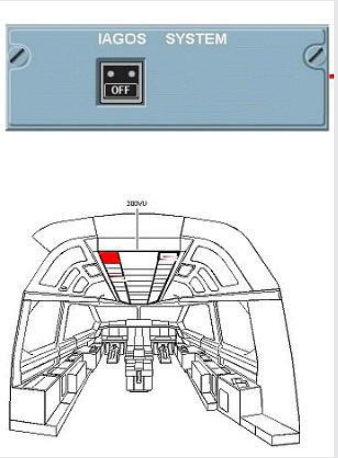
4 - IAGOS - System Operations

www.iagos.org

IAGOS system maintenance is minimum for the airlines :

4 Airworthiness tasks (< 10 M/H per year) :

- Inlet Plate inspection (4 months)
- Safety Relays checks (8 years)
- Smoke detection check (2 years)
- Cockpit P/B check (2 years)



Recommended tasks (< 20 M/H per year) :

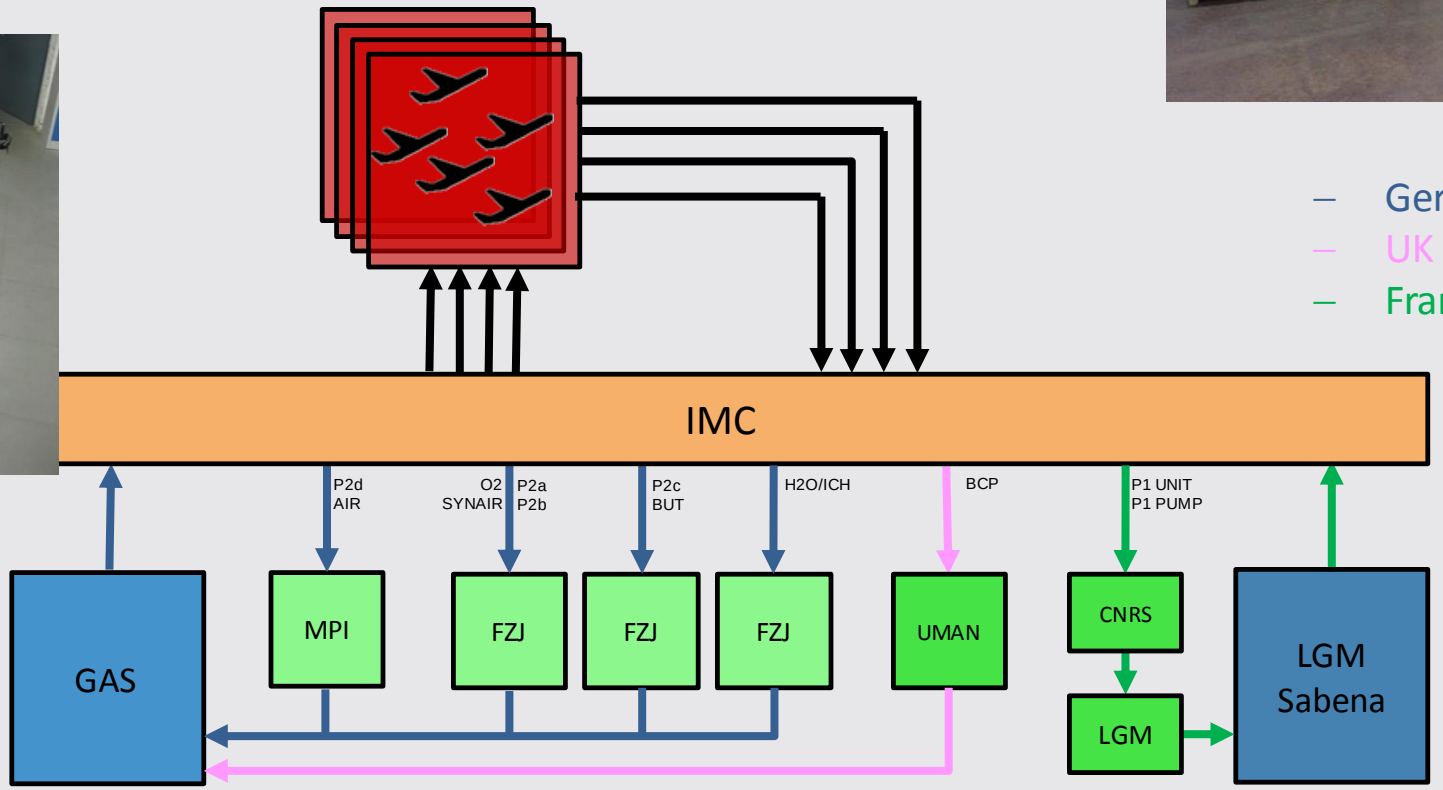
Replacement of scientific equipments every 2 to 6 months :

- Package1
- BCP
- H2O
- Package2

4 - IAGOS - System Operations

IAGOS Logistics Flowchart

- Shipping of serviceable LRU to airlines
- Shipping of unserviceable LRU to research institutes
- Conformity check by MO to issue EASA Form1
- Serviceable LRU on stock at IMC



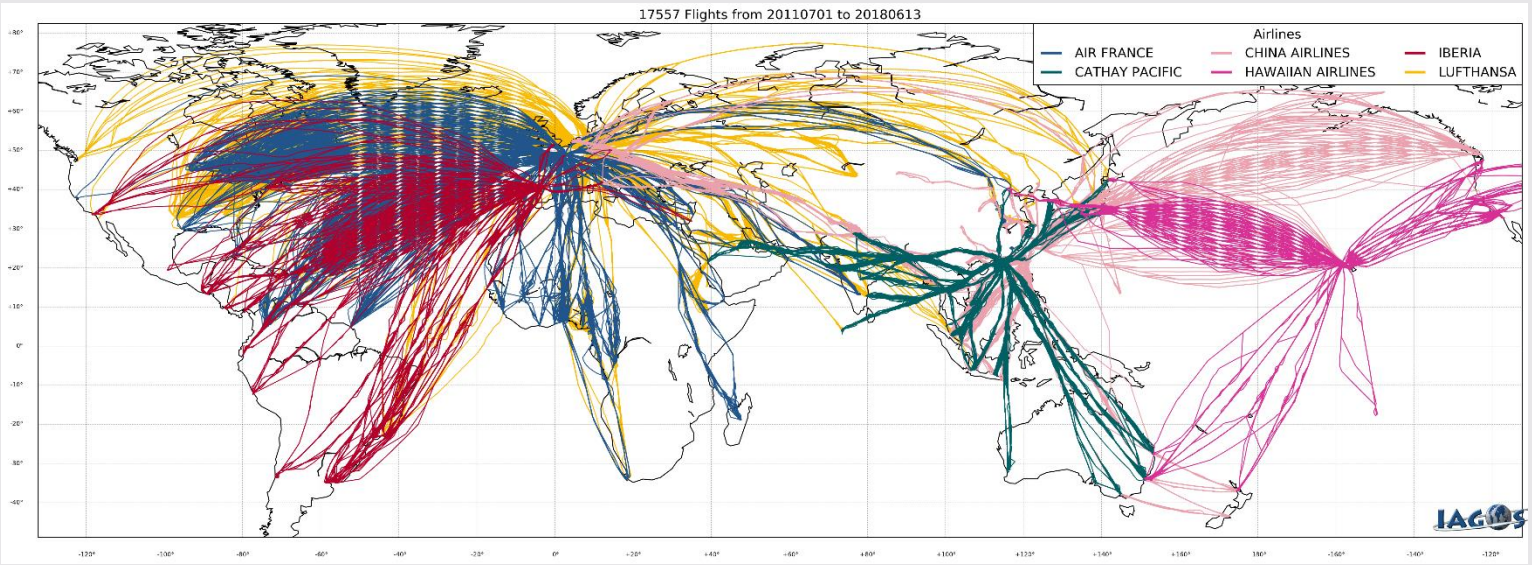
- Germany
- UK
- France

4 - IAGOS - System Operations

www.iagos.org

8 IAGOS aircraft are now in operation (2 A340 are retired) :

- Lufthansa: A340 (2011), A330 (2015)
- China Airlines: ~~A340 (2012)~~, A330 (2016, 2017)
- Air France: A340 (2013), A330 (2017)
- Cathay Pacific: A330 (2013)
- Iberia: ~~A340 (2014)~~
- Hawaiian Airlines: A330 (2017)



5 – Technical Perspectives

www.iagos.org

- NEW INSTRUMENTS :
  - Smaller instruments
  - New measurements
  - System reconfiguration
  - RRT time transmission of the data

- ADDITIONAL AIRCRAFT/AIRLINES
  - Increase the global coverage (Africa, South America, Polar Routes)
  - IAGOS objective is to equip 15-20 aircraft

- NEW AIRCRAFT
  - A330neo : Short term
    - Equivalent to A330
    - First commercial by TAP
    - Fly over the next 20-30 years
  - A350 : Investigation with Lufthansa for Caribic
    - Complex aircraft : composite structure, computer controlled electrics
    - Definition belongs only to Airbus at the moment
  - A320 : Long term, for Air Quality

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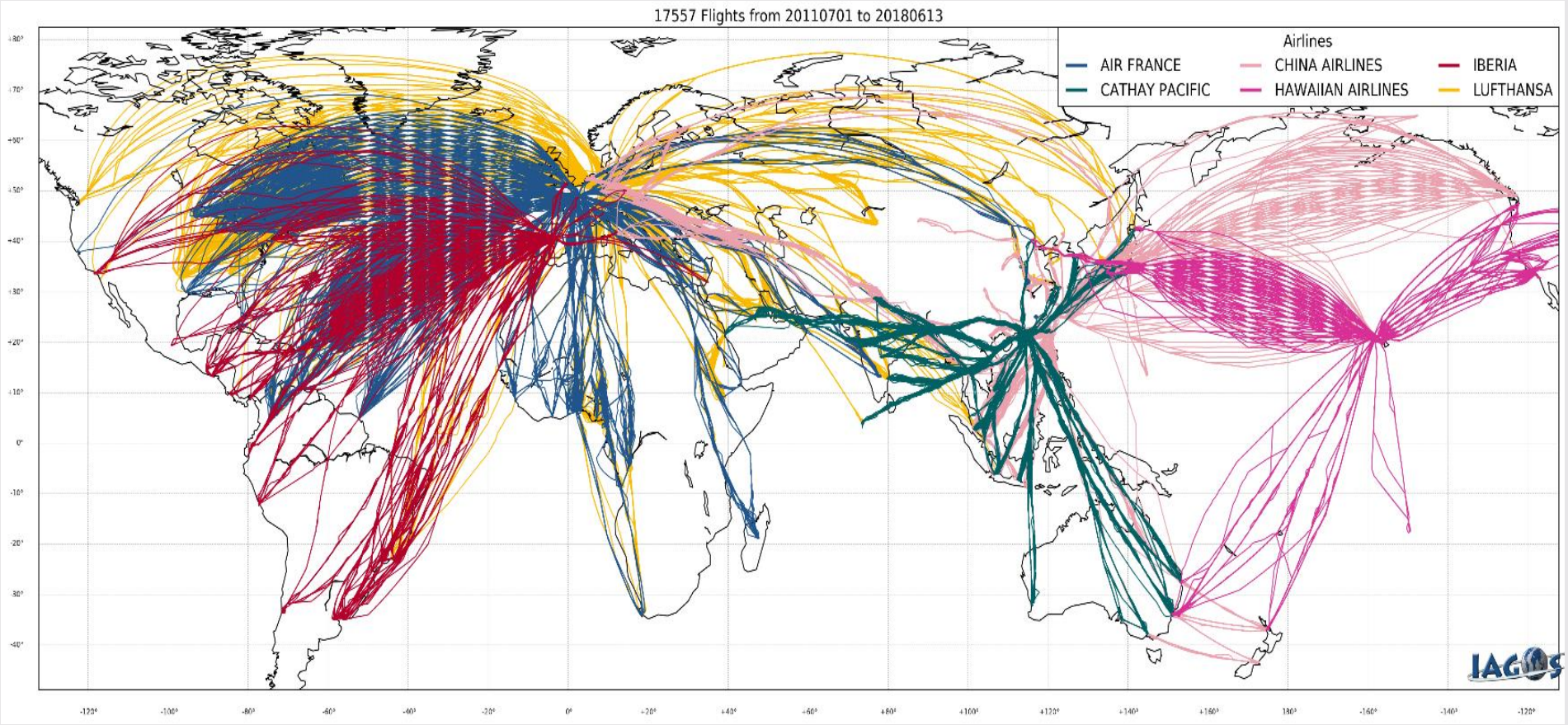

THANKS TO 6 AIRLINES SUPPORTING IAGOS

Lufthansa AIRFRANCE CHINA AIRLINES CATHAY PACIFIC IBERIA HAWAIIAN AIRLINES