HALO User Workshop 08.-09.10.2007
External Stores
Mirko Gläßer, Flight Facility Oberpfaffenhofen
Part I – General
- Overview
- Partners
- Project Schedule and Status

Part II - Belly Instrumentation Pod & Ventral Fin

Part III - Wing Stores
- Hanger Beam – Pylon
- PMS Carrier
- Wing Pod

- User Requirements / Provisions for
- Aerodynamic and Structural Design
- User Interfaces
- Particle Trajectories for PMS Carrier Design (K.Witte)
External Stores
Overview
External Stores Overview

- Provisions for Belly Pod
- Provisions for Ventral Fin
- Provisions for Wing Stores
- Provisions for Enlarged Tail Cone
- Shutter Door
External Stores
Partners

Deutsches Zentrum für Luft- und Raumfahrt e.V.
Entwicklungsbetrieb
LBA.NJA.005

aerostruktur
faserverbundtechnik gmbh

Gulfstream

RUAG

PC-Aero

VPLANE
External Stores
Project Schedule

30.03.2007 Contract Award
04/2007 Documentation Review
07/2007 1st LBA Meeting
08/2007 Preliminary Design Review
09/2007 Presentation of Certification Plan & MOC to LBA
11/2007 Critical Design Review

11/2007 Delivery of Prototypes for Adaptation on Aircraft
12/2007 Prototyping & Ground testing
   -Component GVT (CVT)
   -Loads

06/2008 Manufacturing and Assembly
08/2008 Delivery of Serial Parts
11/2008 Adaptation on Aircraft

12/2008 Ground Vibration Test on Aircraft
05/2009 Flight Tests with External Stores

07/2009 HALO Entry into Service – Demo-Missions
External Stores
Status

- Preliminary Design Review (PDR) performed
  - Belly Pod Pod & Ventral Fin
  - Hanger beam, pylon and Wing pod concept
  - PMS carrier concept

  Action Items defined and agreed

- Establishment of Means of Compliance (MOC) in work

- 1st molds in manufacturing progress
  - see example for Belly Pod
Belly Instrumentation Pod & Ventral Fin
Design Concept

- External Stores Part II -

Belly Instrumentation Pod & Ventral Fin
Ergebnisse – Grundkonfiguration mit belly-pod und hanger beams: AOA 3.7°
Darstellung der Fluidgeschwindigkeit in y-Richtung [m] 0.3 m unterhalb der Flügelunterseite
Neg. Wert: Strömung nach Außen

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Belly Instrumentation Pod & Ventral Fin User Requirements

- HAMP
- LIDAR
- GLORIA
- TELIS
- ALBEDOMETER

Nose section

Aft Section

Center sections A, B, C
Belly Instrumentation Pod & Ventral Fin
Structural Design Concept
Belly Instrumentation Pod & Ventral Fin
Structural Design Concept

Belly Pod Design

- 5 Belly Pod Sections
  - Nose
  - Section A (Gloria & others)
  - Section B (Lidar & others)
  - Section C (tailored to Cloud radar 35MHz)
  - Aft fairing (Decompression, gas exhaust & others)

- Carbon fiber sandwich except for Radome (glass fiber/Aramid)

- 3 Apertures have usable area of 10x7 inches as fuselage

- 2 Openings with diameter of 19 (20.5) inches as fuselage (Section C co-aligned)

- 3 Openings with diameter of 150mm (exhaust & venting)

- Openings accessible from outside (maintenance)

- Bird strike protection

- Rapid decompression

- Lightning strike protection (concept for Radome to be discussed)
Belly Pod Frames

- Nose, LIDAR and Aft fairing attached to frames and skate angle by screws
- Nose section is designed to withstand bird strike impact
- Section A (Gloria) and C (Radome) will be attached by quick release latches to skate angle and with some screws to frames
Belly Instrumentation Pod & Ventral Fin
Structural Design Concept

Belly Pod Section A (Gloria & others)
- Configuration for initial Flight Test phase and Certification
  - Gloria Opening required for instrument integration
  - Add. Flight Tests required

Belly Pod Section B (Lidar & others)
- Co-aligned with fwd view port
- Designed for 20.5” optical window (thickness = 30mm); 17kg
**Belly Instrumentation Pod & Ventral Fin**

**Structural Design Concept**

**Belly Pod Section C (Radome)**

- Quartz glass fiber or Aramid may be used for Radome design
- Material properties w.r.t. dielectric constants difficult to acquire (company proprietary data, sensitive)
- Ground testing necessary to proof concept
- Sample will be delivered when mold available (curvatures)
- Lightning strike protection necessary, concept need to be discussed with HALO user(s)
Belly Instrumentation Pod & Ventral Fin
Structural Design Concept
Belly Instrumentation Pod & Ventral Fin
Structural Design Concept

General Belly Pod Load Carrying Capability

Belly pod designed as fairing/radome
Fuselage support structure (belly pod attachment hardpoints) designed to carry aerodynamic loads only

Belly pod has a limited load carrying capability for inertia loads
- Optical view port: 17kg of optical glass with thickness of 30mm
- Aperture 10x7 in: 10kg with C.G. moment arm of 150mm (inside)
- Opening Diameter of 150mm: 3kg with C.G. moment arm 100mm (inside)
- Gloria Opening: Airloads up to max speed (tbd)

External aero and inertia loads (e.g. < inlets) must be carried by belly pod instrument HP!
Belly Pod Instrument Attachment Hardpoints

- GVFS 196.0
- 231.6
- 261.3
- 296.3
- 331.3
- 358.5

Fwd

Load Capability
- Twelve (12) belly pod instruments hardpoints
- Acceptable mass: 350kg
  supported by 4 hardpoints in a square
- C.G. moment arm: 380mm from surface
- Allowable fuselage panel loads to be considered
Belly Instrumentation Pod & Ventral Fin User Interfaces

Belly Pod Instrument Attachment Hardpoints

Domed Nut Plates
Belly Pod Instrument Hardpoint

P/N CA 21285-2 Panel Fastener / Mark IV
(Tridair Mini Mark)

Alcoa Fastening Sys Torrance
3000 W Comita BLVD
Torrance CA 90505

View Looking Down & Otbd- LH Side
Belly Instrumentation Pod & Ventral Fin
User Interfaces

Belly Pod Instrument Attachment Rigg

Fuselage skin

Shock mount attachment

Perforated instrument tray

3D-Schnitt A-A
Maßstab: 1:10

3D-Schnitt B-B
Maßstab: 1:10

3D-Schnitt C-C
Maßstab: 1:10

Fuselage section

Seitenansicht
Maßstab: 1:30
Belly Instrumentation Pod & Ventral Fin User Interfaces

View Port Adapter & Aperture Instrument Plates
Belly Instrumentation Pod & Ventral Fin
User Interfaces

Available Power and Signal Sources

Power
115V AC 400Hz 3-Phase Experiment
115V AC 400Hz 3-Phase Mission Anti-Ice
28 V DC (according to SPDP)

No 220V 50 Hz!

Signal/Data
Provisions for Ethernet

… or as required by HALO user

…
Wiring for analog signals
Optical fiber
Satcom (Inmarsat)
Belly Instrumentation Pod & **Ventral Fin**
Design Concept

- Ventral Fin -
**Belly Instrumentation Pod & Ventral Fin**

**Structural Design Concept**

**Ventral Fin**
- Metal brackets attached to the fuselage attachment hardpoints
- Carbon fiber spars bolted to brackets
- Separated carbon fiber sandwich sections reinforced with spars and ribs including removable fairings
  - Leading edge will withstand bird strike
  - Trailing edge can be adapted to shape of enlarged tail cone
- Extension of hydr drain from FCS vertical tail
- Electro-static discharger
- No electrical provisions

**Spars & Brackets**

**Removable Fairings**
External Stores
Discussion

Questions?
Belly Pod & Ventral Fin

GULFSTREAM Proprietary & Confidential Data
For DLR-EB internal use only!
- External Stores Part III -

Wing Stores
Wing Stores
User Requirements

HALO should be capable to carry existing under wing instruments
- PMS … (OAP – CAPS)
- Pods …

Future Application
- Sensor integration … (AMSSP)
- Radar application … (Dipol)
- Aerosol Pods … (?)
Wing Stores
Provisions for

Assumption during Development
- Attachment system using hanger beam concept
- Store weights of 500, 1000 and 1500lbs
- Store C.G. between front beam and local 40% wing chord
- Symmetric store installation only
- Single store configurations use center hardpoint
- Multiple store configurations always locate heavier stores outside
- No electrical components in fuel tank
- No provisions for store ejection
- Lightning strike: attachments need to be qualified to transfer zone 1A (ARP 5414)
PMS Carrier
Design Concept

- PMS Carrier -
Ma 0.80 / 40kft / 2° alfa
Clean Wing
Flaps up

No Instrument / Pod installed

Sampling Inlet Locations
PMS Carrier
Aerodynamic Design

AoA=0°, Yaw=0°

AoA=5°, Yaw=0°

Shock induced flow separation

Flow separation at high AoA
PMS Carrier
Aerodynamic Design

Drag comparison:

> For isolated PMS shows the swept design the best aerodynamic performance

> Design can be improved by changing of planform and adjustment of profile geometry

> Aerodynamic benefits of the swept design need to be checked / confirmed using the integrated aircraft configuration
Wing Stores
Structural Design Concept
Hanger Beam

➤ Plan view derived from the NACA series 65

➤ Carbon fiber structure

➤ Fixed attachment at the forward hard points (see example)

➤ Simply supported at the rear hard points (not shown)
Pylon

- Forward swept leading edge to create a direct load path

- Plan view derived from the NACA series 65 (thickness top section 12%, bottom section 10.4%)

- Carbon fiber sandwich

- Ribs on top and bottom, removable nose and trailing edges

- Release mechanism to prevent hazardous conditions during minor crash landing
Hanger Beam, Pylon and Wing Pod

Structural Design Concept

- Release mechanism to prevent hazardous conditions during minor crash landing

- Wing store unit is designed to carry aero loads according to standard Mach/Alt envelope and store inertia loads (weights of structure of HB, pylon, wing pod with payload)

- Scientific payload assumed to be at least 400kg

- High Stiffness requirements (>17Hz) for proper aeroelastic behaviour

- Integrated but removable store rack
PMS Carrier
Structural Design Concept
PMS Carrier
Structural Design Concept
PMS Carrier
Structural Design Concept

Cross-sectional View: PMS on Wing Mid Station

PMS canisters turned 3° Nose down
designed for Ma 0.7 (recommended speed for mission data gathering)
compromise because of
- variations in AOA vs. weight, speed and altitude
- different inclination angles at each wing station due to wing twist
- geometric model used for CFD analysis is based on jig-shape data
- further inclination produces negative lift force … means more drag
## PMS Carrier
### Structural Design Concept

<table>
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<th>Design Condition - MCR: 40,000ft / 0.692Ma / AOA 3.7° / dCD 0.0020</th>
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<td><strong>Outboard wing station</strong></td>
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Note: AOA = AOA + inclination profile + inclination store.
PMS Carrier
Structural Design Concept

Projected Allowable Aero Loads

“FSSP“
Canister
“CAPS-PHIPS“
“FSSP“

1423
904
1803
2273

Flight
Projected Allowable Instrument Payload (Inertia)

- 60kg
- 34kg
- 34kg

Flight
Wing stores
User Interfaces

Available Power and Signal Sources

**Power**
115V AC 400Hz 3Phase Mission Anti-Ice

115V AC 400Hz 3 Phase Experiment
will be splitted into
-3x single phase 115V AC
-power supply for 28 VDC TRU
-3x 28V DC

No 220V 50 Hz!

**Signal/Data**
Ethernet Cat 5
switch required: 2 ports per canister

Optical fiber @ Wing SPDP

Conduits

Disconnect Panel
Wing stores
User Interfaces

Wire routing in pylon and removable trailing edge

28V DC TRU
Ethernet Switch

1423
904
1803
2273
Wing Stores

Electrical System

MS 3452W22-23S

MS 3452W24-2S

MS 3452W16-11S

Ethernet

RJ-45

TBD

RJ-45/mil tbd

RJ-45/mil tbd

RJ-45/mil tbd

MS 3452W16-10S
External Stores
Discussion

Questions?
PMS Carrier
- Wing Pod -
Wing Pod
Aerodynamic Design

M = 0.80, C_A = 0.494
Wing Pod
Structural Design Concept

**Nose Section**
- Removable cap
- Bird strike zone
- 2 Apertures sized ~ 10 x 7 inches
  - 2 Openings diameter 150mm

**Center Section**
- Instrument tray

**Tail Section**
- 2 Openings for instruments
- 2 Openings for venting & exhaust
Wing Pod
Structural Design Concept

- Torsion box
- Access doors with quick release latches
- Frames (removable)
- Lower shell for sensor installation with 2 apertures 10x7 inches
- Hardpoints on both sides (4 each) to support equipment
Wing Pod
Structural Design Concept
Wing Pod
Structural Design Concept

X-sectional View on Mid Wing Station
Wing Pod
Structural Design Concept

Side view
Wing Pod
Structural Design Concept
Wing Pod
Structural Design Concept

External instrument loads for wing pod

Note: Preliminary data only - load analysis not yet completed!

General Assumption of External Instrument
Outer Instrument Diameter 150mm, side area 3x frontal area (L=110mm)
Variations Da/L highly desired; lift, drag and force coefficients on requests

A: PMS sensor head: 5kg, C.G. 150 mm from surface
B: Aperture 10x7 inches: 10kg, C.G. 150 mm from surface
C: Opening Dia 150mm: 3kg, C.G. 150 mm from surface
External Stores
Addtitional Components

Delivery

1 Belly Pod (sections and instrument rigg as presented)
1 Ventral Fin
Tbd - Belly pod nose radome optional

6 Hanger beams (inboard, mid, outboard station; lh & rh)
4 Pylons
2 Wing pods
2 Instrument trays
2 PMS carrier
Tbd - Wing pod nose radome optional

Fixed price proposals available until 12/2008 for additional equipment if required!
External Stores
Discussion

Questions?
Wing Pod