Airborne Integrated Systems for Safety Improvement,
Flight Hazard Protection and All Weather Operations

FLYSAFE
Final Forum

What has FLYSAFE to add to existing TAWS?

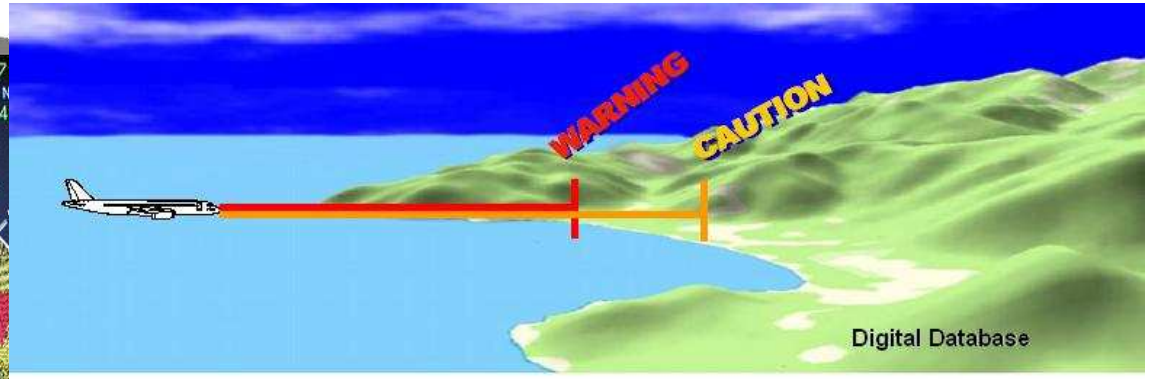
25 – 26 March 2009, NLR, Amsterdam

Outline

- State-of-the-art TAWS features
- Enhancements brought by FLYSAFE
- Beyond FLYSAFE

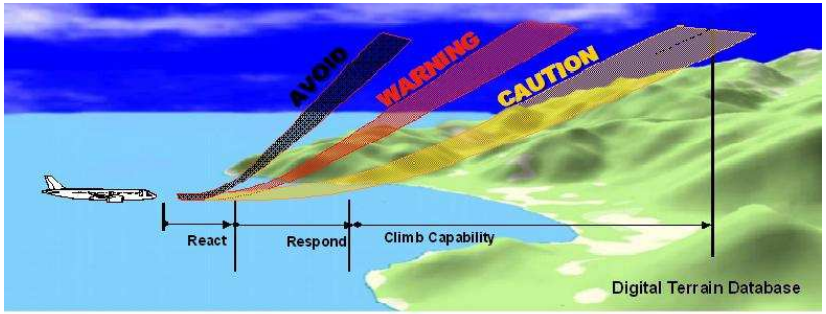
TAWS basic features

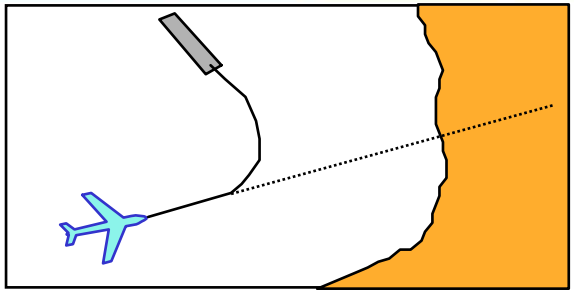
- **TSO-C151a Class A Terrain Awareness and Warning System (TAWS) equipment includes**
  - **DO-161a reactive modes 1-5 (a.k.a GPWS modes)**
  - **Terrain hazard Display**
  - **Terrain Collision Predictive caution and warning modes**

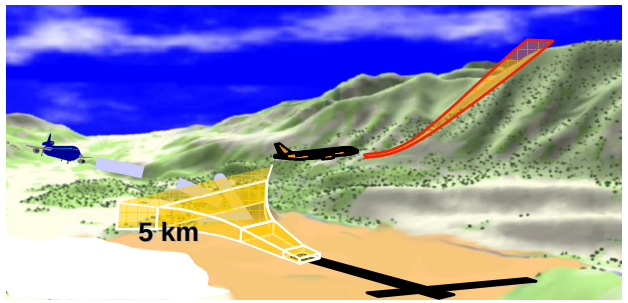


THALES TAWS advanced design

- **Exceeds TSO-C151a by unique "flight proven" innovative features to:**
  - **Provide appropriate alerts to clear terrain**
    - **Time-to react-based alerts (by use of current climb gradient)**
    - **Specific warning alert "avoid" when pull-up is not enough**
  - **Cover more CFIT situations**
    - **Approaches / takeoff in mountainous environment**
    - **Landing tunnel to provide protection up to correct landing**
    - **Anticipation in turns**
  - **Reduce drastically nuisance alerts**







THALES TAWS Predictive Collision Avoidance Principle

- **Principle**
  - **Terrain avoidance procedure: wing levelled and pull-up**
- **3 “Clearance Sensors” search database**
  - **Caution Clearance Sensor issues caution alert when DB penetrated**
  - **Warning Clearance Sensor issues warning alert when DB penetrated**
  - **Avoid Clearance Sensor issues avoid alert when DB penetrated and pull-up is not enough to clear hazard**
- **Look Ahead protection Surface**
  - **Goals**
    - **Ensure protection of achievable escape manoeuvre by aircraft**
    - **Clear the hazardous terrain with margins**
  - **Design**
    - **Climb angle trade-off between « early justified alerts » while avoiding « nuisance alerts »**
    - **Modulated by current aircraft climb capabilities**

FLYSAFE Objectives and derived functional additions

- **"To develop innovative presentations of traffic, terrain and obstacle to enhance the crew situation awareness"**
  - ✓ **Obstacle display function**
  - ✓ **Safety altitude display function**
  - ✓ **Vertical situation display function**

- **"To develop an anticipation function providing adequate display for each phase of flight and view of the threats in protected areas"**
  - ✓ **Terrain / Obstacle / safety altitude flight path check function**

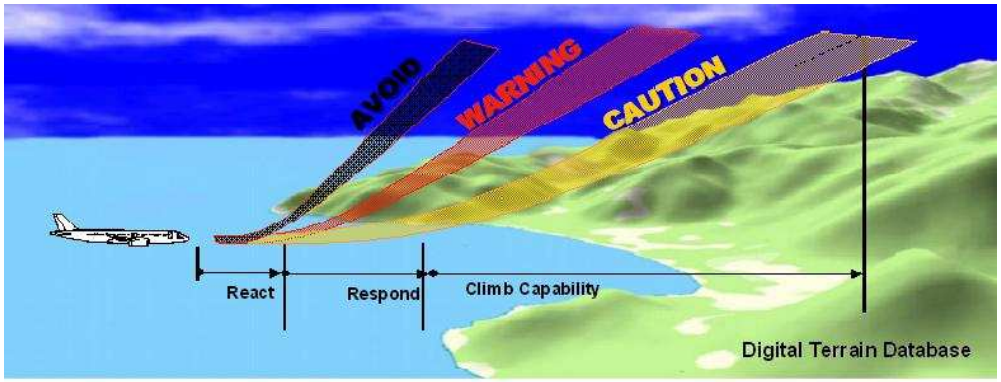
- **"To develop a prioritization function coping with any kind of alarm"**
  - ✓ **Obstacle Collision Prediction Alert function**

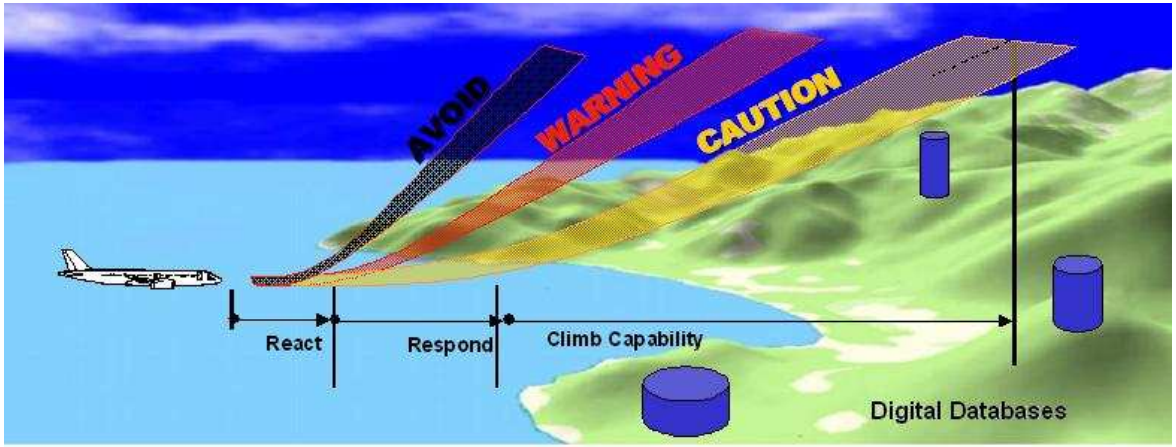
GCAM-OBSTACLE: overview

- **The obstacle alerting is defined on the same basis as the CPA mode**
- **The obstacle function is composed of**
  - **Obstacle Collision Prediction and Alerting clearance sensors (OCPA)**
    - **Caution OCPA for “obstacle ahead” alert**
    - **Warning OCPA for “obstacle pull-up” alert**
    - **Avoid OCPA for “avoid obstacle” alert**
    - **Obstacle alerting information included in GCAM radial information**
  - **Obstacle database**
    - **Consolidation of Digital Object File (FAA) & Jeppesen database**

Software development was performed
• from THALES certified TAWS product line,
• following whenever possible industrial standards,
• to de-risk algorithms & to be easily (re-)integrated within product

GCAM-Obstacle enhancement



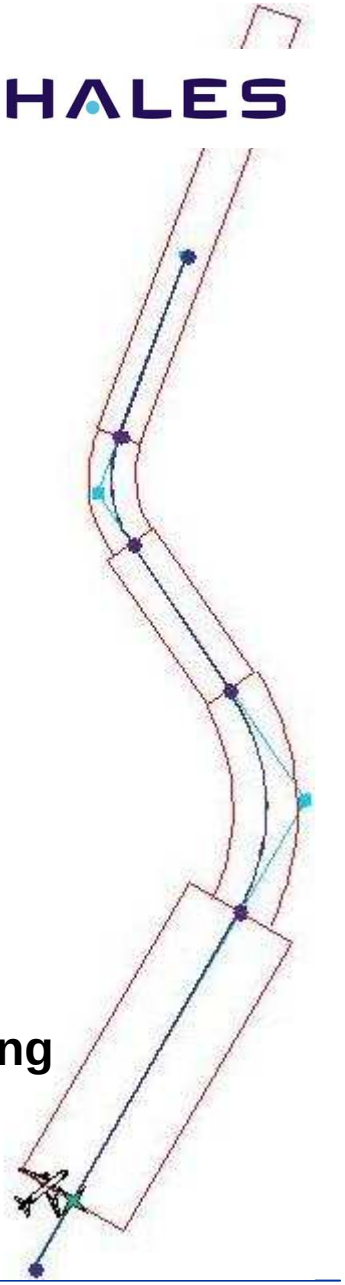


- Same sensors shared between CPA and OCPA
- Sensor clearance evaluated on two independent databases (terrain and obstacle)
- Two dedicated sets of alerts (terrain and obstacle)
- At same level of alert, priority is given to the terrain alert

Enhanced safety, coverage in obstacle-dense areas

GCAM Vertical Situation Display: overview

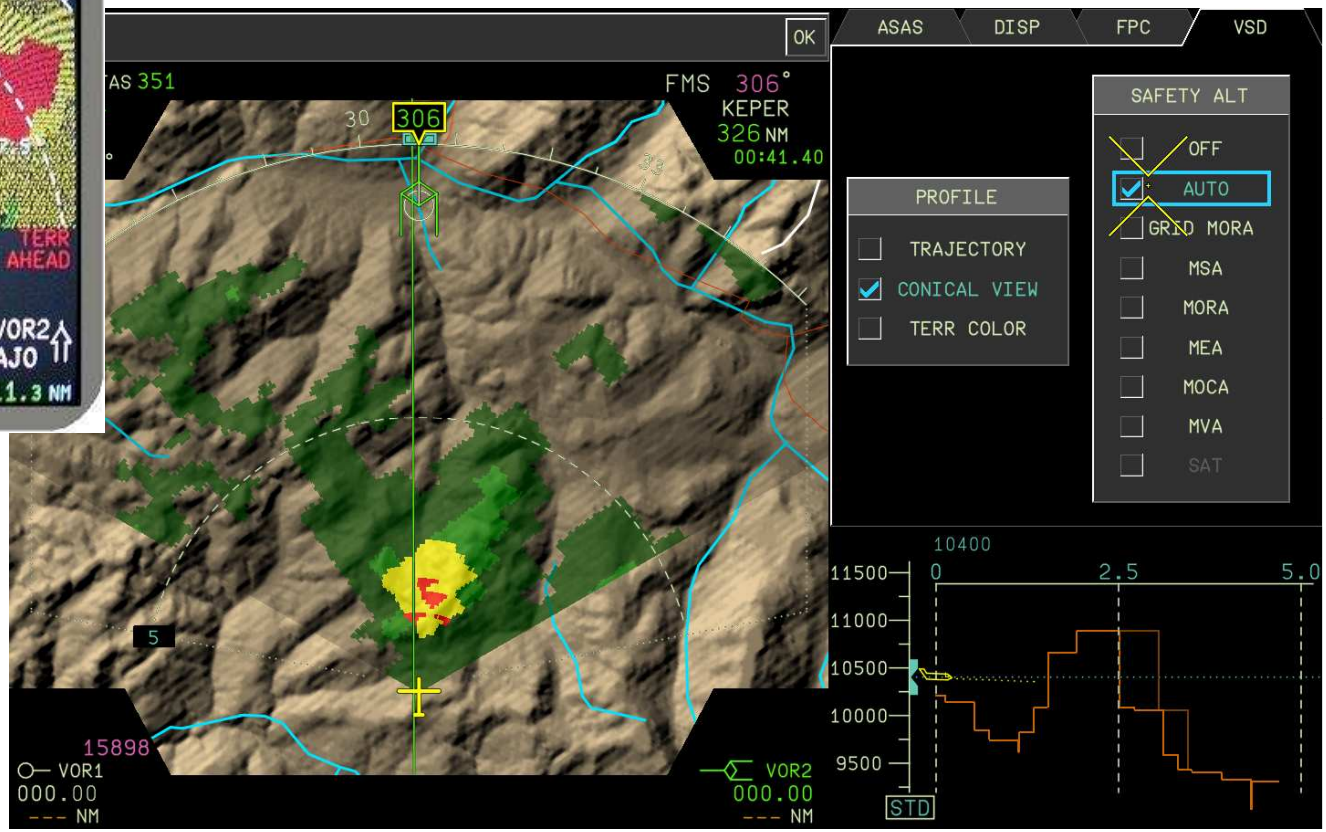
- Vertical profile “slicing options”
  - 2 independent vertical profiles for captain and first-officer
  - References available:
    - Profile under track (manual flight)
    - Profile under FMS trajectory (managed flight)
    - Profile under ILS
    - Profile under selected azimuth (pilot option)
  - Vertical corridor dimensioned according to RNP
- Features
  - Long range capability: correction for Earth rotundity
  - Enhanced awareness: consolidation with TAWS CPA alerting
  - Low nuisance alerts on landing: correction about runways
  - Display modes: configurable number of samples



GCAM-VSD enhancement

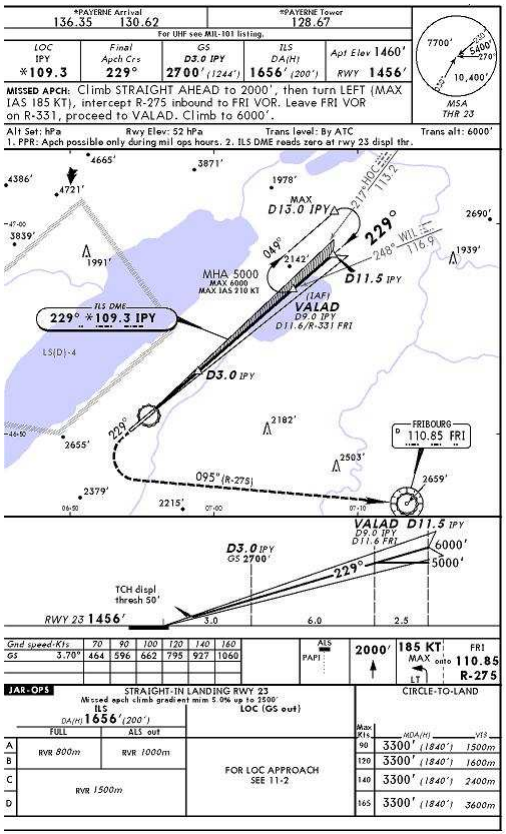
THALES

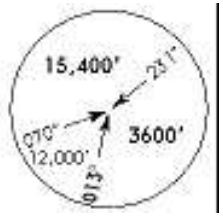
Enhanced situation awareness



GCAM-Safety Altitudes: overview

- Safety altitudes database provided by Jeppesen
- Safety altitudes covered
  - related to Airways
    - MORA: Minimum Off-Route Altitude
    - MEA: Minimum En-route Altitude
    - MOCA: Minimum Obstacle Clearance Altitude
  - Safety altitudes related to airports
    - MSA: Minimum Sector Altitude
- 3 pilot-selectable modes: off, auto, selection





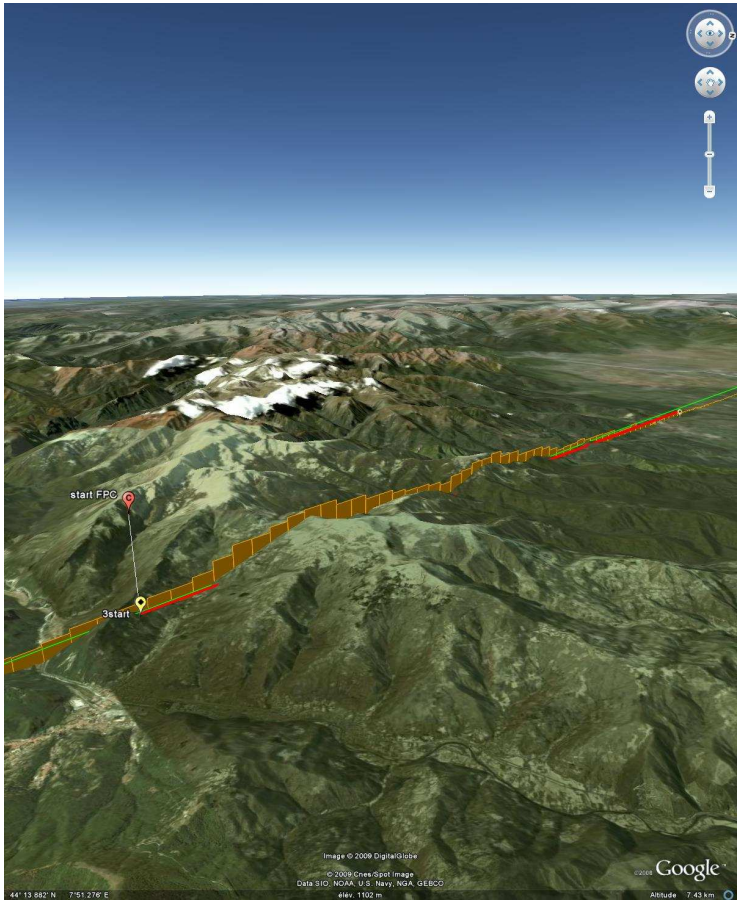
GCAM-Safety Altitudes: enhancements

Enhanced situation awareness

Example of displayed MEA

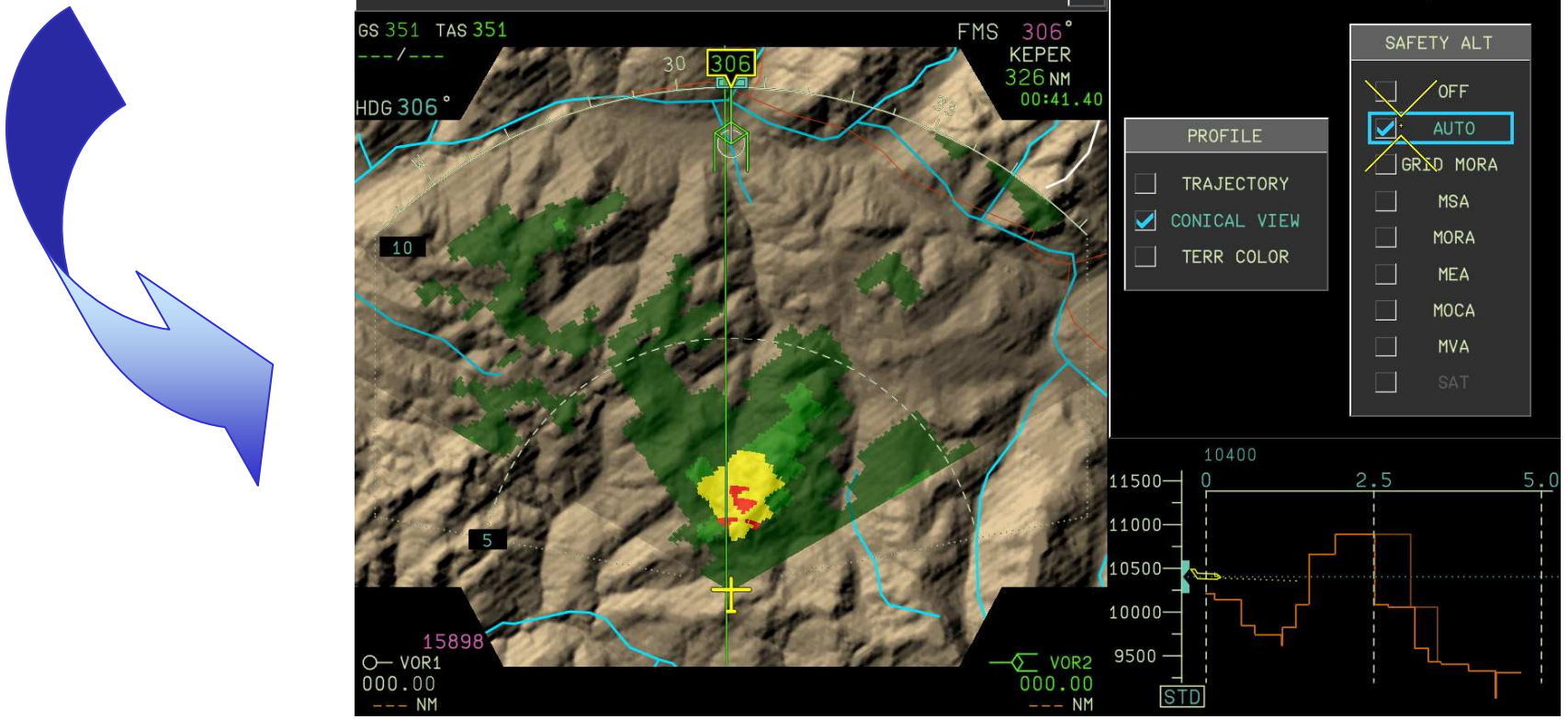
GCAM-Flight Path Check: overview

- **Conflicts detected**
  - **Terrain / Obstacle / Safety Altitude / other (spare)**
  - **Up to 30 conflicts detectable**
- **Trajectories surveyed**
  - **Type of flight plan : active, secondary, temporary**
  - **Information : existing start point, end point**
  - **Conflicts localised**
    - **Position of start and end conflict points**
    - **Horizontal and vertical margins**
    - **Localisation on flight plan in time-to-go (sec)**
    - **Localisation on flight plan in distance-to-go (NM)**



GCAM-Flight Path Check: enhancements

Enhanced situation awareness, increased safety



Beyond FLYSAFE

- **FLYSAFE prototype developments of the enhanced TAWS will be transferred from the R&D department to the product department**
  - **Introduction in product line per maturity order**
    - **Obstacle function (integrating real aircraft escape performance)**
    - **Vertical Situation Display function**
    - **Flight Path Check function**
  - **Some developments are of interest for other THALES products than the TAWS**
    - **Safety altitude function for the Flight Management System**

FLYSAFE developments on the TAWS has achieved the objectives to
✓Enhance state of the art
✓ Support competitiveness of European know-how
✓ Prototype innovative features