Fugro commence new Airborne Lidar Bathymetry trials

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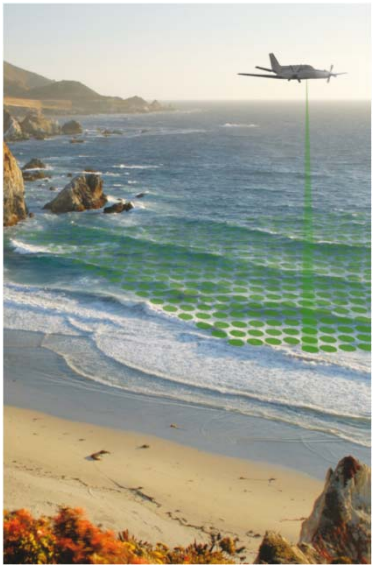
20 May 2011

FIG Working Week 2011
Bridging the Gap between Cultures
Marrakech, Morocco, 18-22 May 2011

Contents Menu

LADS Technology

- **LADS - Laser Airborne Depth Sounder**
- Hydrographic Survey / Shallow Water Mapping tool based on Lidar technology
- or “Airborne Lidar Bathymetry” (ALB) technology
- System mounted inside an aircraft
- Pulses of laser light are used to measure the depth of water and height of features (ie rocks, islands, beach gradients)
- Technology designed principally for Nautical Charting applications, ALB technology is used now in other applications such as:
  - Coastal Zone Management
  - Marine and Coastal Engineering
  - Pre-Seismic surveys for O&G Industry
  - Delineation of Baselines for EEZ/UNCLOS



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Fugro LADS Technical Philosophy

- **Applications**

  Nautical Charting

  From the commencement of operations in 1992, the focus of the hardware and software has been to collect data for nautical charting. This requires:
  - appropriate data quality, and
  - robust algorithms based on signal to noise ratio, to detect the seabed and small objects from noise

  Coastal Zone Management and Habitat Mapping

  Due to the continuous development process the Fugro LADS systems has developed from it roots of nautical charting to coastal zone management and habitat mapping applications. Development of capabilities for:
  - digital imagery
  - hyperspectral data
  - seabed reflectivity and seabed classification

  have enabled the Fugro LADS system to used for coastal zone management, habitat mapping and tsunami inundation modelling applications

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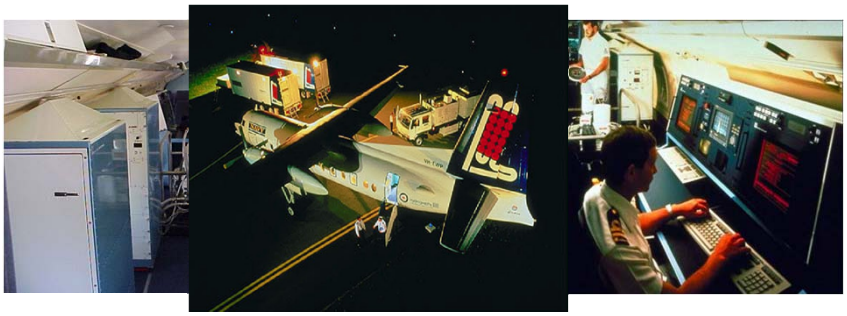
FIRST : LADS Mk I (RAN LADS I)

- The original LADS technology was developed for the Royal Australian Navy (RAN) in the 1970s and early 1980s by the Defence Research Centre Salisbury, South Australia
- The experimental WRELADS system built in the 1980s proved the concept and demonstrated the advantages of the technology in coastal waters
- In 1989 industry was invited to turn experimental concepts into an operational hydrographic survey tool
- This culminated in the building of the original LADS Mk I system by a consortium lead by BHP Engineering and Vision Systems
- LADS Mk I entered service with the RAN in October 1992 operating from a Fokker F27-500 Aircraft.
- The system operated extensively around the Australian coastline including the Great Barrier Reef and was decommissioned in 2008, after operating continuously a period of 15.5 years

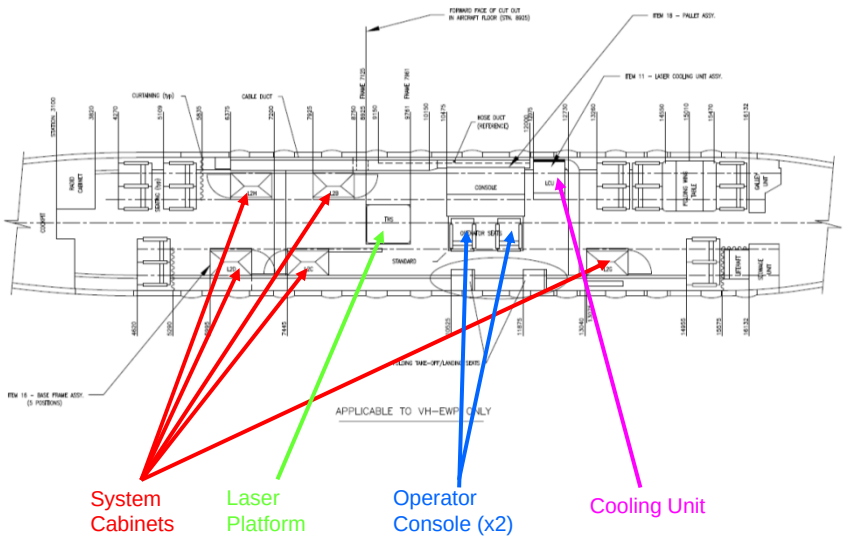
FIRST : LADS Mk I (RAN LADS I)

- Data was logged on 9-track tapes and processed on a MIPS computers in an air-conditioned container on a semi-trailer. As technology developed, and in light of operational experience, the RAN LADS system was continually upgraded to meet emerging requirements.
- The airborne system incorporated a flash tube laser operating at 168 Hz



LADS Mk I installed in the Fokker F27
RANLADS Fokker F27-500
System and cabinets (left) operators console (right)

FIRST : LADS Mk I (RAN LADS I)



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SECOND : LADS Mk II

- In 1998 the LADS Mk II system was launched for the commercial survey market
- This system incorporated a diode pumped laser operating at 990 Hz and was operated from a Dash 8 aircraft until October 2009, before being transferred to a Fokker F-27 (the previous RAN aircraft)
- This system was also continuously upgraded throughout its life to take advantage of technological advances, operational experience and changing requirements
- The LADS Mk II system operated for government and commercial customers around the world including Australia, New Zealand, the Middle East, Europe and Northern America and was decommissioned in March 2011, after operating continuously for a period of 14.5 years

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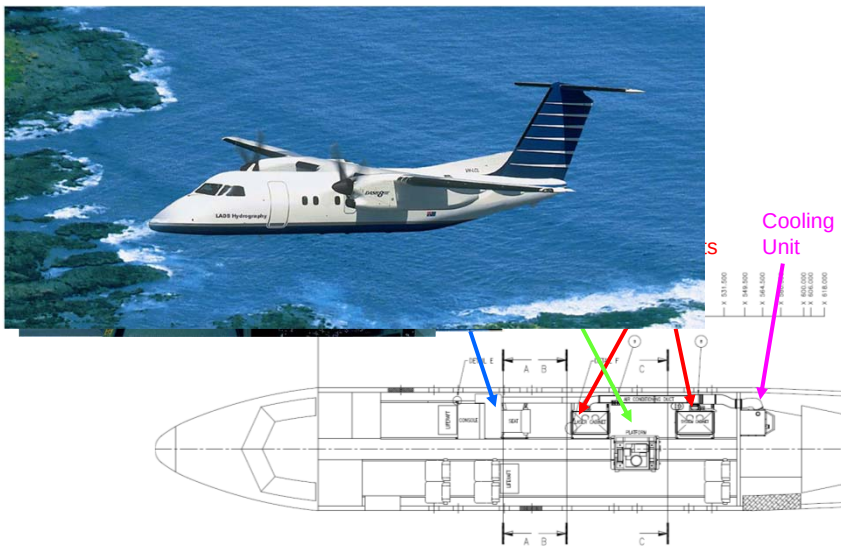
SECOND : LADS Mk II



THIRD : RAN LADS II

- On 10 November 2008 a new RAN LADS II system commenced operations for the RAN
- The system specification was similar to the upgraded LADS Mk II system at that time with upgraded hardware and software, and also included some specific developments for the RAN
- The system commenced operations in the Fokker F27, however 12 months later was transferred to the Dash 8 aircraft in November 2009.
- The system continues to operate around the Australian coastline for the RAN.

THIRD : : RAN LADS II

RAN LADS II System initial layout in the F27

RAN LADS II System layout in the Dash 8

(similar layout to LADS Mk II)

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Fugro LADS Technical Philosophy

- **Design Philosophy**
  The cornerstones of Fugro LADS technical design philosophy are based on maximising the quality of the data collected, a focus on hydrographic survey for nautical charting and refreshing the technology through a continual upgrade process

- **Data Quality**
  The Fugro LADS systems have been designed with an emphasis on data quality. This is based on collecting signals with the highest quality signal to noise ratio by:
  - 7 mJ laser Power
  - Wide aperture receiver
  - Automatic gain control

  We have conducted experiments using lower laser powers and witnessed the deterioration in the signal quality and coverage under these circumstances, therefore maintaining laser power was an important factor when designing the Fugro LADS Mk 3 system

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Fugro LADS Technical Philosophy

- **Continual Upgrades**
  The LADS systems have been continually upgraded in the light of operational experience, to solve problems, to provide new capability and to mitigate obsolescence or to take advantage of new technical developments.
  Previous upgrades have included:
  - Extending depth capability
  - Introducing Faster laser developments
  - Introduction of a topographic capability
  - Digital imagery including georeferenced mosaicing
  - hyperspectral data collection and processing
  - seabed reflectivity and classification
  - collecting data relative to the ellipsoid
  - extending operational heights for low cloud and high ground

  Having a technical team directly supporting surveyors conducting RAN and contract surveys has provided continuous feedback which has facilitated development of the systems to keep them current

  This has provided system longevity, and is the reason the LADS Mk I & II systems were able to operate and remain competitive each for a period of approximately 15 years

FOURTH : Fugro LADS Mk 3

- **System Design and Requirements**
  The requirements behind the Fugro LADS Mk 3 system were to maintain the positive performance discriminators of the previous Fugro LADS systems without the requirement for a large dedicated aircraft .

  The challenge was to build a system that has the capability of the previous systems, and without compromise, could be deployed in an aircraft of opportunity

  The requirements of the Fugro LADS Mk 3 system were to:

  1. Reduce: Mass
     Dimensions
     Power consumption
  2. Improve: Laser rate
     Depth performance
     accuracy and target detection

Fugro LADS Mk 3

- **Major Components**

  The Fugro LADS Mk 3 system has been redesigned as two main units:

  1. an equipment cabinet, and
  2. a sensor head unit

  With ancillary units:

  3. an operator's laptop, and
  4. a pilot's display

  The equipment cabinet weight 97 kg and the sensor head 135 kg

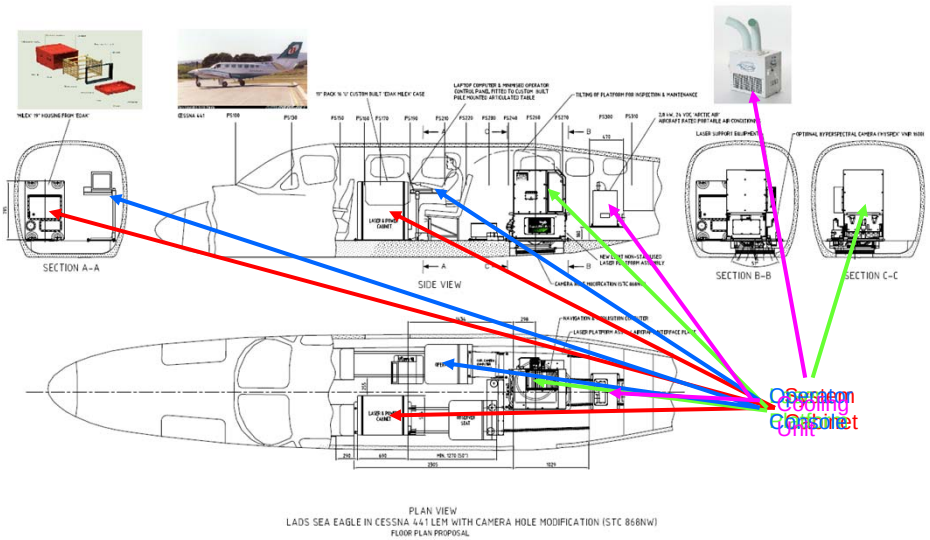
  The current draw is 70 Amps at 28Vdc, with an additional 35 Amps for the cooling unit.

Sensor Head & Equipment Cabinet

Fugro LADS Mk 3

- **Aircraft Considerations**
  - The airborne system has been designed for robustness, reliability, ease of maintenance, ease of installation and modularity to facilitate operation in a wide range of aircraft
  - A Cessna 441 was selected as the trials platform for the new system because of the local availability of a suitable aircraft that is owned and operated by Fugro
  - The system is also considered suitable for other aircraft of similar size, such as the King Air 200 or A90

Fugro LADS Mk 3 – Schematic in Cessna 441



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Fugro LADS Mk 3 – Installed in Aircraft

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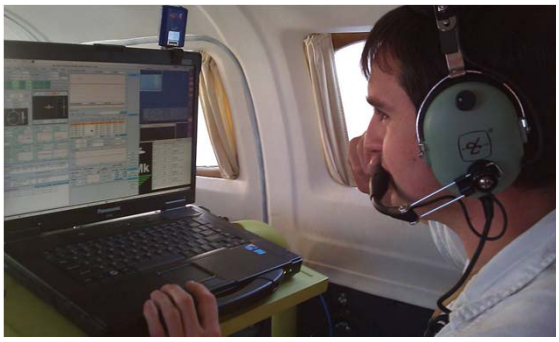
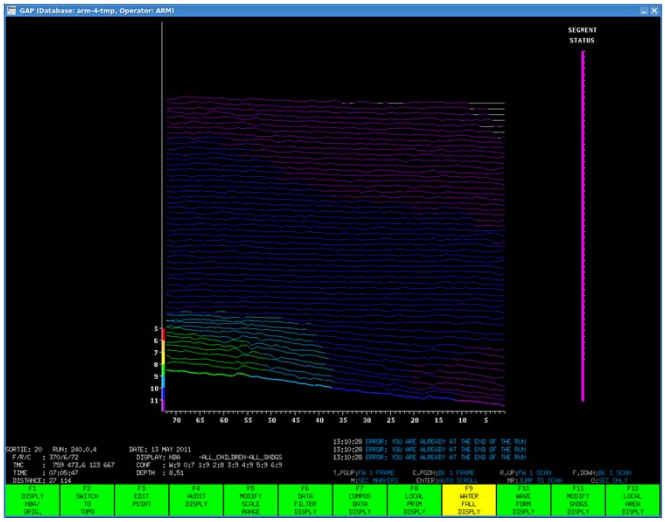
Fugro LADS Mk 3

- **Set to work and acceptance trials**
  - Set to Work trials flights are currently underway in Adelaide, South Australia
  - Accurate benchmark areas and deployed targets that have been accurately surveyed are being used to verify the system performance



Fugro LADS Mk 3 – Set to work trials



Fugro LADS Mk 3

- The LADS systems have been designed and built with an emphasis on quality and performance.
- With the ability to upgrade systems as technology advances or customer requirements change, Fugro has demonstrated that LADS systems are able to operate and remain competitive over an extended period of time.
- It is these engineering philosophies that Fugro has held onto and used when designing the new Fugro LADS Mk 3 system, that will avoid obsolescence, provide enhancements based on customer requirements and increase longevity of the Fugro LADS Mk 3 system and any future systems designed by the Fugro team

Fugro LADS Mk 3 - System Specifications

FEATURE	SPECIFICATION
Aircraft Type	Cessna 441
Survey Configuration	Altitude 1200 to 3000 feet, speed 125 to 175 knots.
Operational Capability	Full day or night operation, all weather (VFR, IFR)
Airborne Survey Crew	1 operator (plus observer optional)
Laser Rate	1.5 kHz
Depth Range	0 to 80 m (dependent on water clarity)
Topographic Range	to 50 m above sea level.
Sounding Density	Nominal patterns 2x2 m, 2.5x2.5m, 3x3 m, 4x4 m , 5x5 m and 6x5 m.
Swath Width	Independent of operating height and water depth. • 430 m at 6x5 m, 175 kts • 360 m at 5x5 m, 175 kts • 288 m at 4x4 m, 140kts • 150 m at 3x3 m, 148 kts • 126 m at 2.5x2.5 m, 125 kts • 79 m at 2x2 m, 122kts
Scan Pattern	Rectilinear
Position Systems	WADGPS, DGPS and KGPS.
GPS Receiver/IMU	Applanix POS AV 610 V5 (embedded Trimble BD960 receiver L1, L2, Glonass, DGPS)
Horizontal Accuracy	IHO Order 1 (5 m + 5% of water depth at 95% confidence)
Vertical Accuracy	IHO Order 1 (refer to table 4.3 in following section)
Object Detection	2m cube (IHO Order 1a), dependant on water clarity, sounding density and depth.
Laser Power	Nominal 7 mJ Green, 5mJ beneath aircraft.
Digital Images	Redlake Mega plus II ES2020 high speed digital camera with ultra wide angle lens.
Digital Mosaic Imagery	Images collected at 1 Hz merged to mosaic with resolution nominally 40cm per pixel, accuracy 5m 95% CEP.
Relative Reflectivity	0 – 255 value for per pulse seabed reflectivity at 532nm. Values are relative and scaled across entire survey to maximise dynamic range.

Fugro LADS Mk 3

- **System Enhancements**
  1. Improved physical and optical design of the transmit and receive sides of the system, through improvements to the optical coatings on mirrors, lenses and windows to improve the reflectivity and transmission
  2. Faster laser, The system has been launched initially with a 1.5 KHz laser with room for expansion
  3. Higher altitude of operations to 3000 ft (enable wider swath width)
  4. Improvements in shallow water performance
  5. 7 degrees of cross-track and roll compensation
  6. Improved positioning vie interface with new Applanix POS AV 610 inertial system.
  7. Airborne system operator console/software on laptop
  8. The system has been tested with a depth performance of **80 metres** (Such performance was realised with clear water conditions)

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Fugro LADS Mk 3

- **Future Improvement Plan**

  The system design has been considered to facilitate ongoing system upgrades in function and performance. These include improvements in:

  – laser speed
  – **swath width**
  – seabed reflectance
  – very shallow water operations
  – operations on the ellipsoid
  – **operations in swell**
  – inclusion of statistical analysis tools

  This continual upgrade philosophy is the same as the previous Fugro LADS systems, which avoid obsolescence and increases longevity

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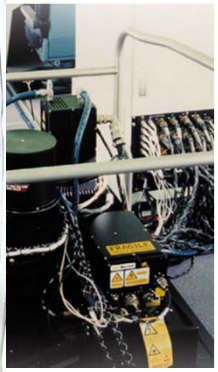
LADS Systems

WRELADS

1980s

LADS Mk I
Fugro LADS Mk 3

1992-2008



LADS Mk II

1998-2011

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Thank You

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