OPTO-PYROTECHNICAL TECHNOLOGY FOR SPACE APPLICATIONS

Problem Statement for Launch Vehicles
October 5 & 6th, 2005
Pyrotechnical Subsystem on Ariane 5 (1/3)
Current status

- The current A5 ECA configuration includes:
  - 369 pyrotechnical devices (including 515 meters of pyro-transmission line) – this number would noticeably decrease thanks to opto-pyro technology
  - 79 final functions to be activated which shall remain unchanged

- The safeguard rules require two independent subsystems:
  - One dedicated to neutralisation
  - One for functional and operational needs

⚠️ Compliance with current safeguard requirements is still to be achieved through dedicated studies, which could direct the architecture selection
Pyrotechnical Subsystem on Ariane 5 (2/3)
Current status (cont’d)

- 515 meters of pyro transmission cords over 189 lines
- 34 detonators
- 17 Arming & Safety Devices
- 36 IFOC
- 30 RMV

BSA: Boîtier de Sécurité et d’Armement (Safe & Arm Box)
RMV: Relais MultiVoies (MultiPath Relays)
IFOC: Inflammateur à Fonctionnement par Onde de Choc (Detonation to Deflagration Initiator)
Main objectives associated with Optopyrotechnics

- Recurring Cost reduction (at both system and pyro-subsystem levels)
  - Only a *technological breakthrough* can bring about new cost savings (removal of pyrocords, multipath relays, ...)

- RAMS:
  - Removal of primary explosives from the system
    - should lead to decrease the dangerousness at system level (after demonstration of security requirements)
    - should simplify the last operations (*additional cost saving*)
  - Immunity to Electro-Magnetic Interference (EMI) and Electrical Static Discharge (ESD)
    - increase the safety

- Mass reduction
Optopyrotechnical Subsystem (1/3)

Principle

- The optopyrotechnics project consists in replacing the current electro-pyrotechnical chains by electro-opto-pyrotechnical chains.

**Electro-pyrotechnical elementary chain**

- Electrical Detonator (AD)
- BSA
- LT
- RMV
- Pyrotechnical Transmission Line
- FT

**Optical Interception Barrier**

**Relais Multi-Voies**

**Final function (Fonction Terminale)**

**Electro-pyrotechnical chain**

- Electrical Detonator (Electro-detonator)
- Laser diode (DL)
- Optical Interception Barrier
- Switch
- Optical Fiber

**Optical Detonator/Initiator**

**Detonator – DOP**

**Initiator - IOP**

**FT**
The major concern of the opto-pyro technology is **Optical Power Transmission** through FiberOptic, which is somewhat different from the well-known **Optical Data Transmission**.

- Optical Data Transmission has been mastered for years in aeronautics:
  - Basic rules such as routing, …remain valid for Power application
  - Space environment may be more severe (in particular launch vehicles)
- Optical Power Transmission raises new problems still to be solved

More over, compliance of components, specially optical ones, with harsh environment is not assessed
Moving from electro-pyrotechnics to opto-pyrotechnics has several impacts:

- « visible » at Stages level:
  - Layout
  - Pyrotechnics sub-system simplification,…
- less « visible », at System level:
  - Transient phases studies for control of Stages separation (and ignition): simultaneity of commands
  - Fulfilling Safeguard requirements
  - Impacts on On-Board Flight S/W which manages Ordnance commands

Switching toward optopyrotechnic is not only a technological step, but also impacts system aspects:

- overall design, manufacturing, testability and AIT (Assembly Integration Test) process from the early beginning