Recent Advances and Future Electrical Landing Gear Systems

ICAS Workshop – Cape town

02 / 09 / 2013

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AGENDA

1. **Historic Hydraulic Landing Gear Systems and move toward more electric**

2. **Recent advances on EHA technology for Steering and Extension/Retraction Systems (example of the nose landing gear)**

3. **Recent advances on EMA technology for Landing Gear Systems:**
   - Braking System
   - Extension/Retraction System
   - Steering System

4. **The future of Electrical Landing Gears**

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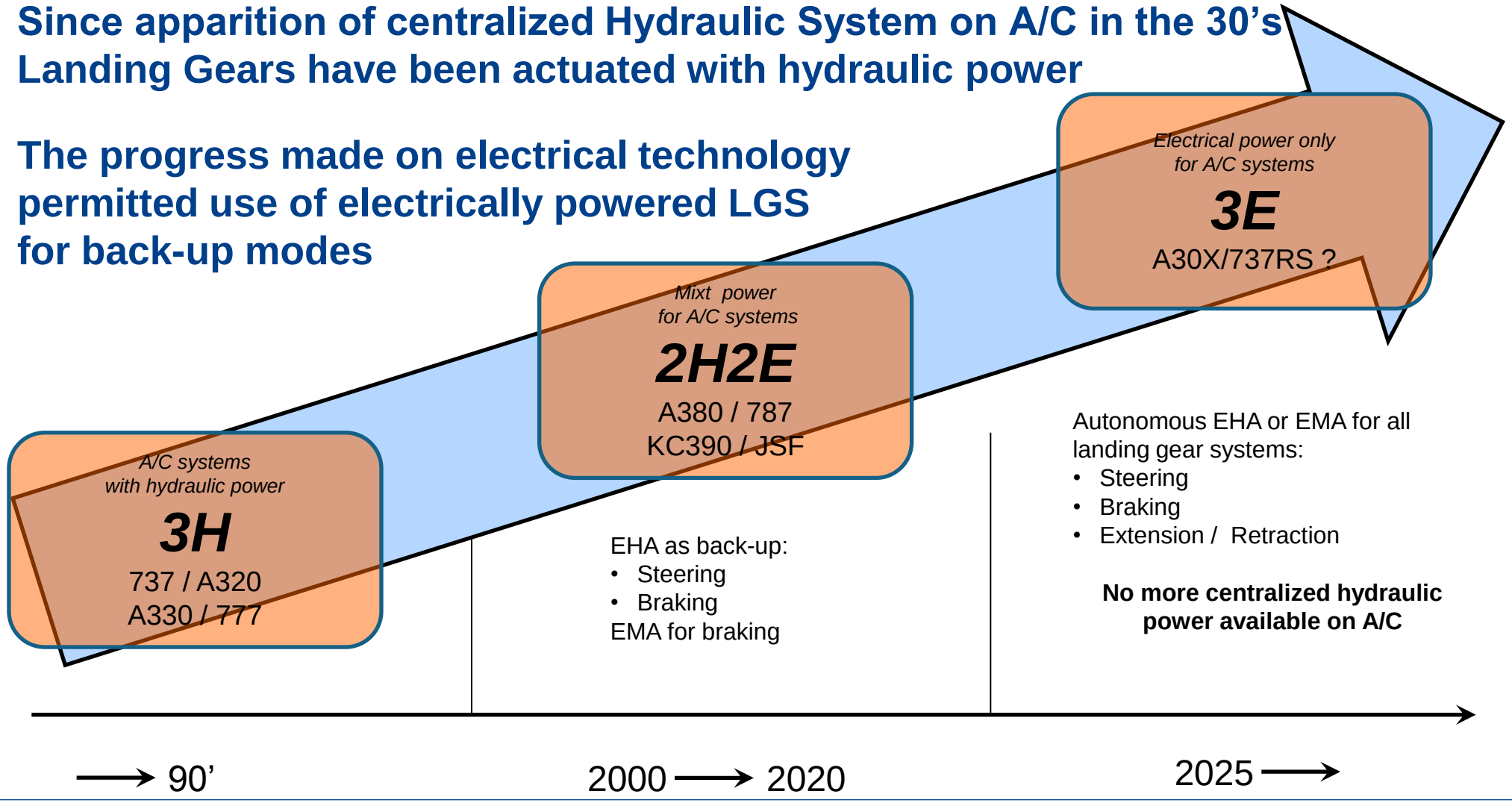
Historic Landing Gear Systems

HISTORIC LANDING GEAR SYSTEMS

Since apparition of centralized Hydraulic System on A/C in the 30's Landing Gears have been actuated with hydraulic power

The progress made on electrical technology permitted use of electrically powered LGS for back-up modes



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Recent advances on EHA technology for steering and Extension/Retraction Systems

EHA TECHNOLOGY ALREADY IN SERVICE

➔ Technology certified on A380 for back-up modes

- Braking/Steering : LEHGS (Local Electro-Hydraulic Generation System)

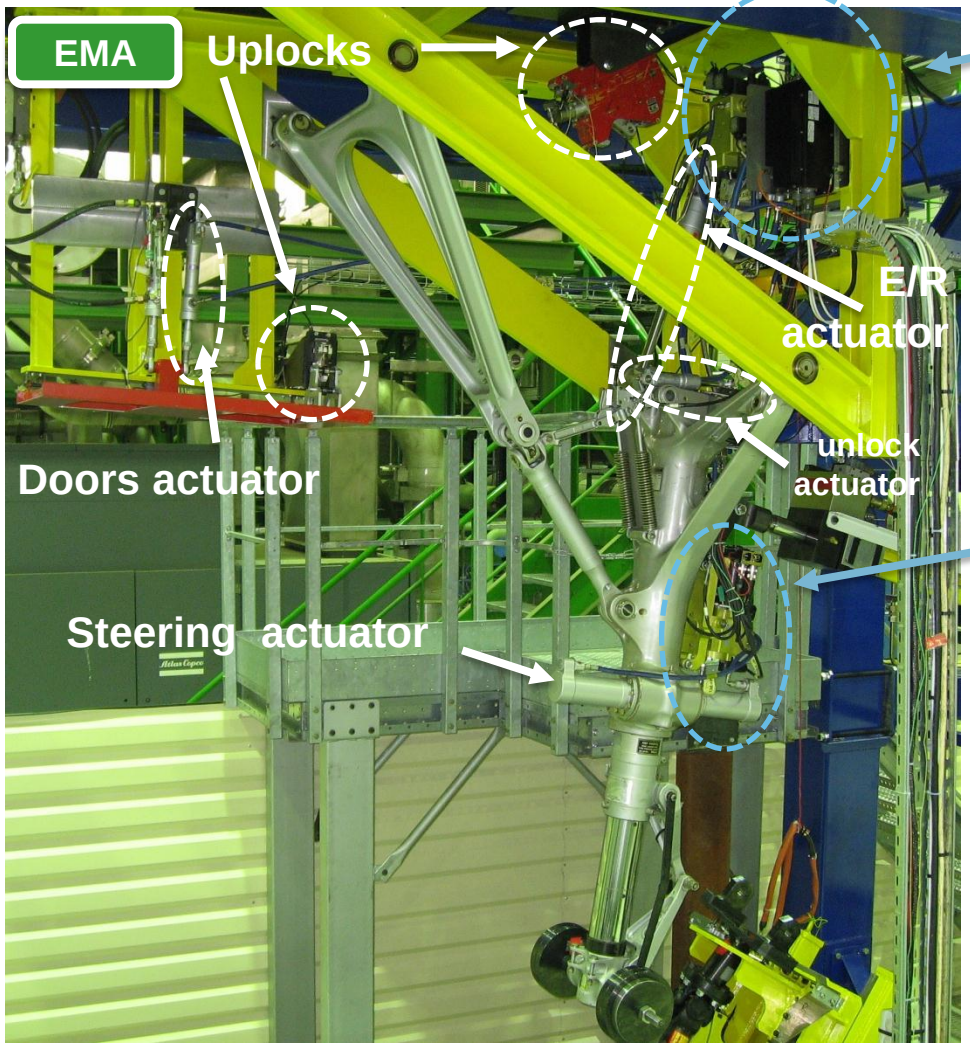
⇒ MBD responsible for the whole system

  - The Motor Pump is pressure controlled, filling a reservoir (constant speed / sense of rotation)
  - The reservoir provides the hydraulic supply to braking or steering control valves (DDV, EHSV) in case of failure of the normal mode

Motor Pump Sub-Assembly

System EHA demonstration completed on real NLG

(Steering + Extension / Retraction of LG & doors)



E/R Manifold + Power Electronics

Motor-Pump + Steering Manifold + Fluid reservoir

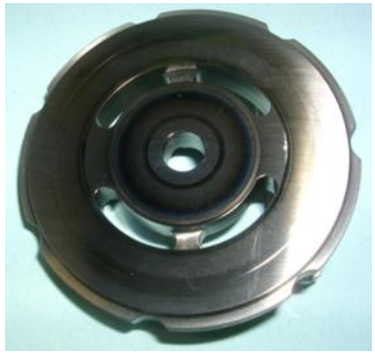
IMPROVEMENT OF LIFE POTENTIAL FOR MAIN COMPONENTS

EHA (Electro-Hydrostatic Actuation) : already certified technology on back-up modes.

Objective is to make EHA technology reliable enough for normal mode application during A/C full life

➔ **Extensive studies have been made on Pumps Geometry, Material, Treatments:**

- Life potential of pumps already doubled, final goal is to meet 150 000 FH endurance
- Robustness to fluid pollution will be demonstrated



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Recent advances on EMA technology for Braking System

ELECTRICAL BRAKING SYSTEM
DEMONSTRATION ON A/C

➔ EABS A340 ELECTRIC BRAKE

- Braking System Qualification (EMA, EBC, adapted BSCU)
- Economical assessment : weight, maintenance
- Flight tests in 2008: Performance Validation

➔ BOEING 787 DREAMLINER

- Large project management for Electric Technology
- Technical optimization (incl. Power consumption)
- Maturity and Robustness demonstration
- Specification, conception & qualification tests
- DO160 / DO254 / DO178 Certification
- EIS on 787-8 since August 2012

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➔ Technology Assessment

- System weight to be slightly higher in Electric than in Hydraulic (depending on the A/C size)
- Reliability will remain lower at equipment level
- Better availability is reached at system level
  - LRU health monitoring
  - Very high dispatch based on architecture design and reconfiguration capability
- Eased installation and maintenance (plug & play system)
  - Decrease of the A/C assembly cost and of the maintenance costs
- Braking performances are comparable in Electric and in Hydraulic

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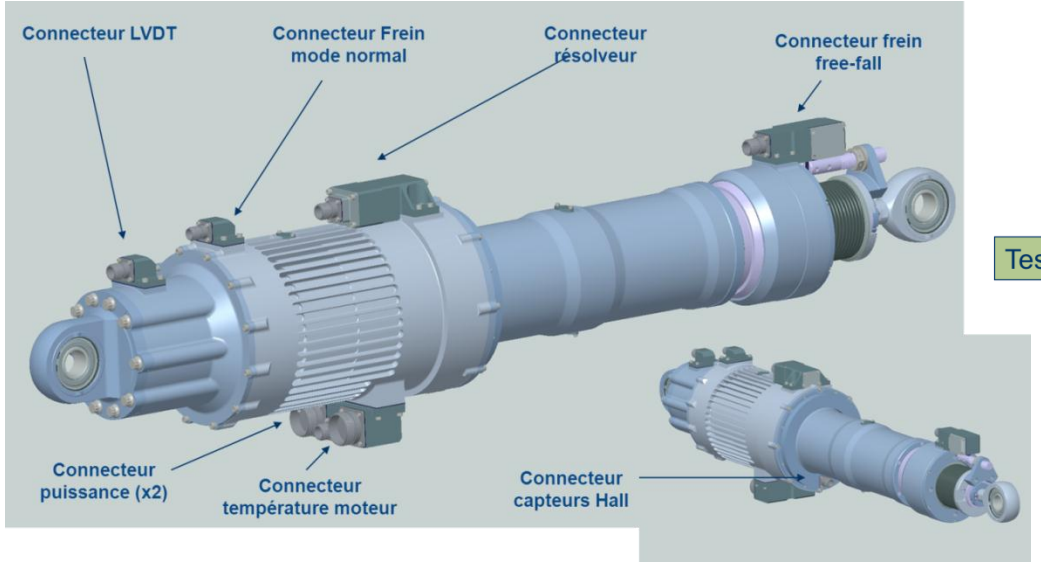
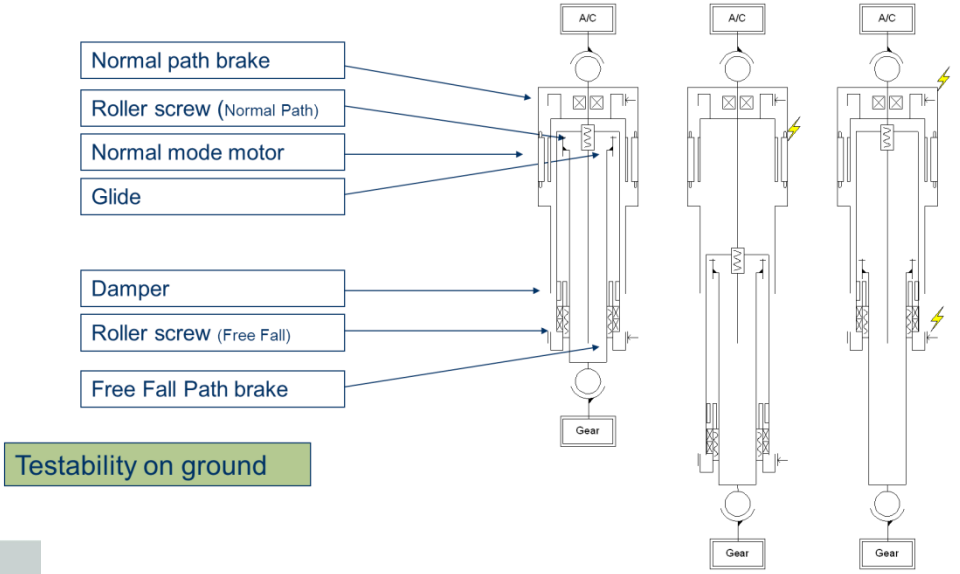
Recent advances on EMA technology for Extension/Retraction System

Direct Drive Duplex Actuator for E/R

➔ Mains characteristics / Schematics

- Dual screw → jam tolerant
- Direct Drive on normal path
- High torque / Low speed motor
- Electromagnetic damping in emergency



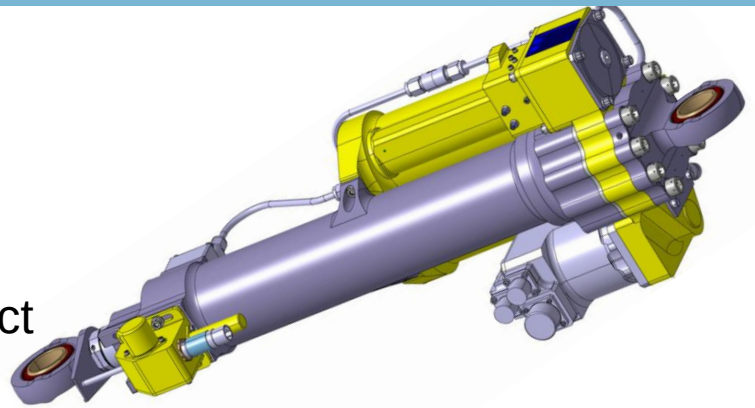


➔ Fully duplex configuration lead to overweight actuators – need to find alternative solution

Simplex Jam Tolerant Actuator for E/R

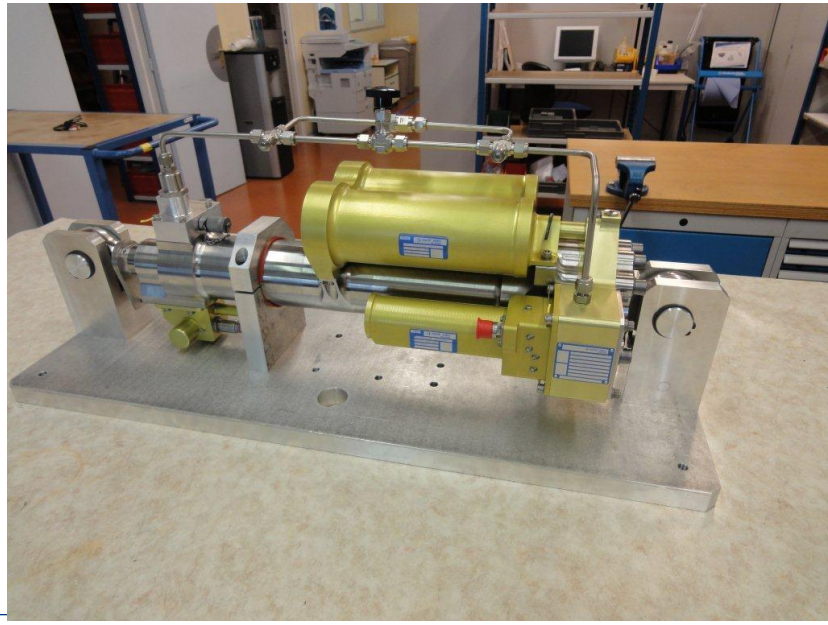
➔ Mains characteristics:

- Simplex mechanical transmission
- Jam tolerant in extension
- Hydraulic passive damping / Wet actuator
- LG architecture optimized to permit unlock and retract from single EMA



➔ Achievements:

- Low weight EMA Prototype available
- Component level tests:
  - Rollerscrew/axial bearing over temperature
  - Electric motor
- Actuator level test:
  - Normal and Emergency mode
- System level tests on real LG expected end-2013



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Recent advances on EMA technology for Steering System

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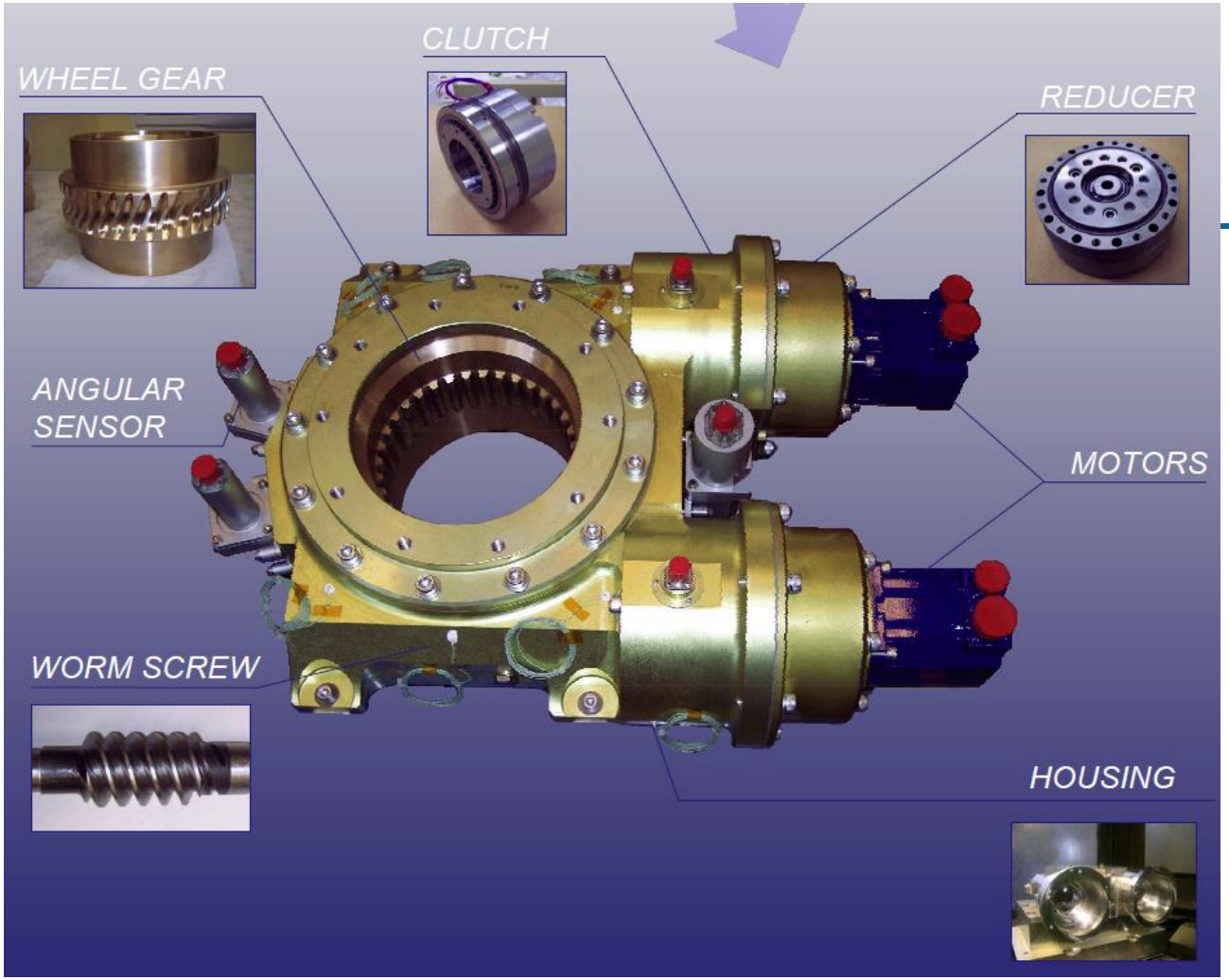
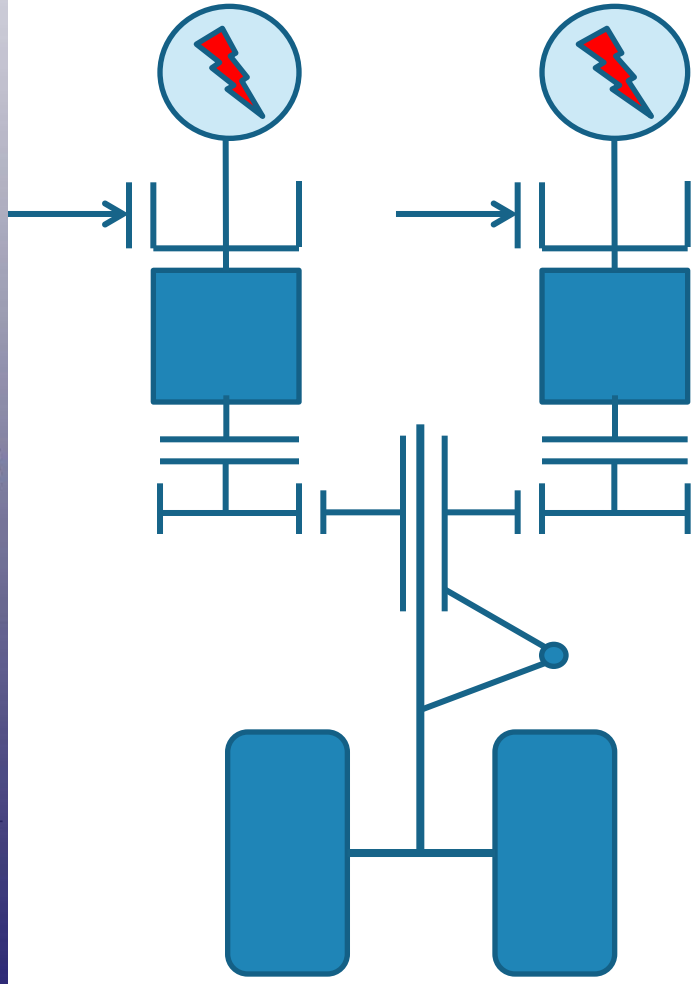
FIRST TRIAL – FULLY REDUDANT STEERING EMA

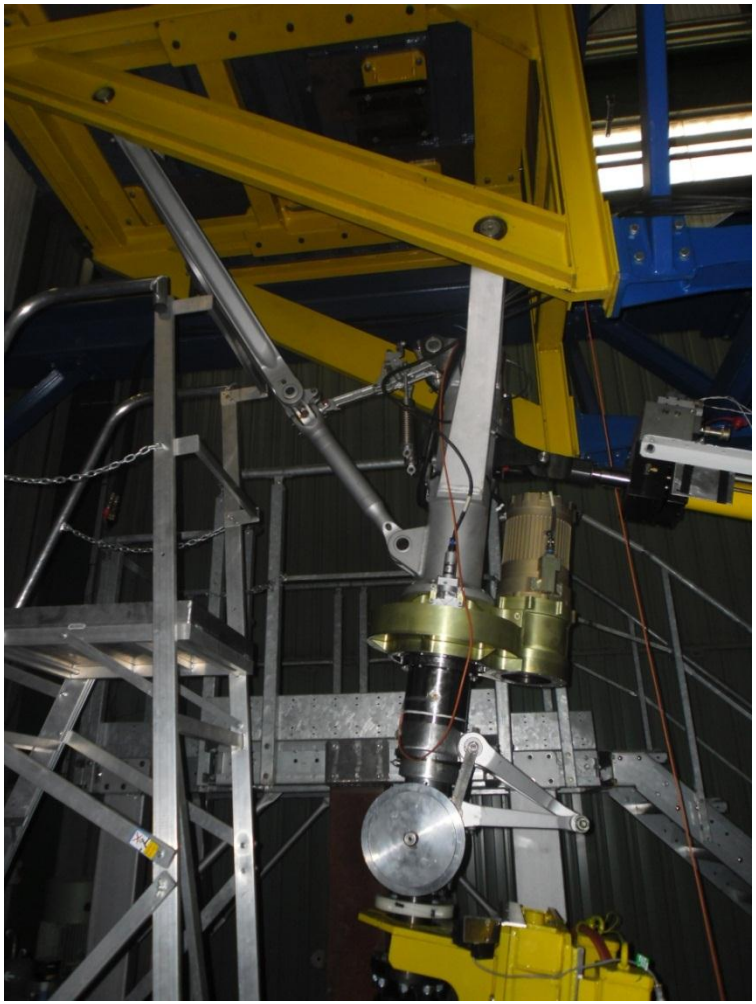




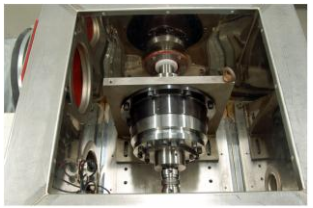
SECOND TRIAL - PROMISING CONCEPT TESTS FROM COMPONENT TO REAL LANDING GEAR

➔ Tests successfully completed:

- Components tested separately:
  - Motor (dedicate loading rig)
  - Harmonic Drive (over Temperature)
  - Torque limiter (Static / Dynamic tests)
- Actuator tested on real landing gear:
  - Full load / speed spectrum
  - Full actuator characterisation and good model correlation
  - Cold Temperature test campaign



➔ Next step is to address weight optimisation and realistic test for shimmy and flat tire landing



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The future of Electrical Landing Gears

THE FUTURE OF ELECTRICAL LANDING GEARS

1. **Completion of robustness demonstration of EHA technology & Entry Into Service for LG Systems in normal mode**

2. **Cumulate experience in service for Electrical Braking System & Optimize next generation architecture**

3. **Qualify/Certify the new Electrical Green Taxiing function for Short Range aircraft application**

4. **Mature Simplex Extension / Retraction EMA to compete with EHA weight for all electric aircraft application**

5. **Demonstrate weight effective steering EMA solution compliant with Shimmy and Flat tire landing requirements**

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