



**TH7890M Evaluation test plan
(2001)**

**ESA / ESTEC
CNES
ATMEL Grenoble**

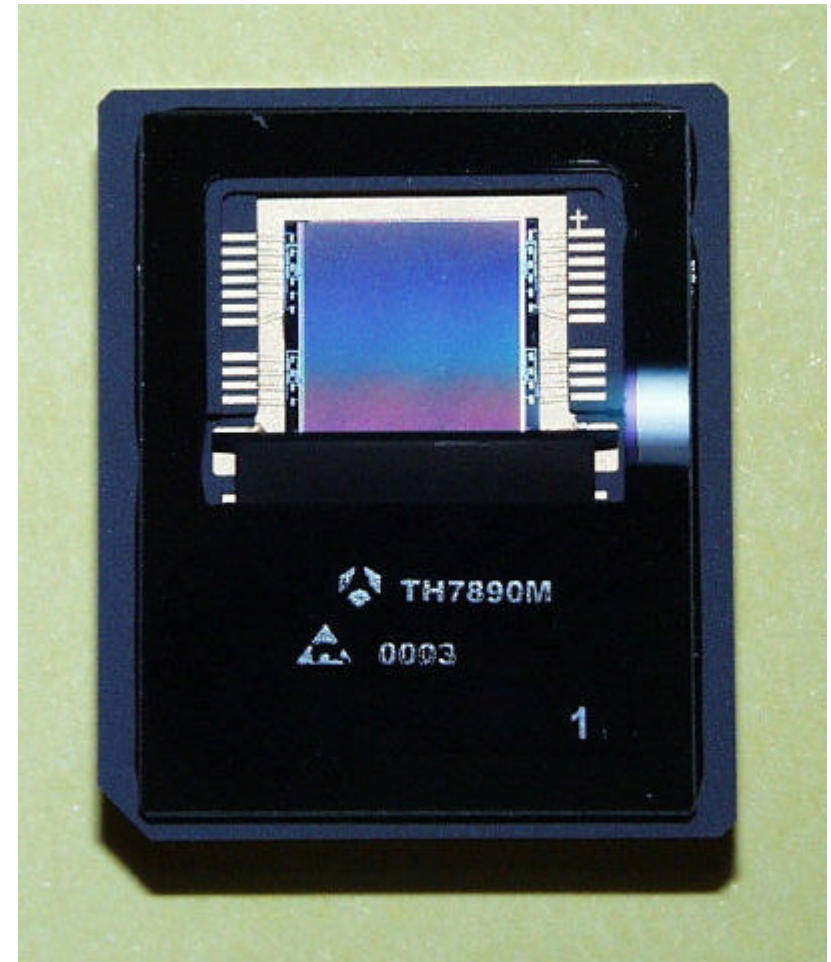
Introduction

- **The goal was to evaluate a new CCD device**
 - **Performances**
 - **Reliability**
 - **Irradiation tolerance**
 - **Production flow**

- **This presentation summarizes the work that has been performed in 2001 in the frame of the evaluation test plan**

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Device Presentation

- **Frame transfer CCD for star tracker applications**
- **512 x 512 pixels image zone**
- **17 x 17 μm^2 pixel**
- **100 % Aperture**
- **MPP mode operation**
- **4 phases clocking for image zone and memory zone**
- **2 phases clocking for output register**
- **Sapphire window with anti reflective coating**
- **Spectral range : 400 - 900 nm (AR)**
- **Saturation voltage : 900 mV**
- **Dark signal : $< 25 \text{ pA/cm}^2$ at room temperature**
- **Temporal noise : 220 μV rms**
- **Transfer inefficiency : 1×10^{-5} per stage (horizontal & vertical transfer)**
- **Responsivity (BG38) : $> 10 \text{ V}/\mu\text{J/cm}^2$**
- **Output amplifier consumption : 2.9 mA**

Audits / Documentation

- **During ETP, device PID has been successfully reviewed by CNES**
- **Production flow has been successfully audited by ESA & CNES. Comments were taken into account and correctives actions were implemented**
- **ESA / ESTEC has edited the TH7890M detail specification**

Evaluation Test Plan presentation

- **This plan consists of :**
 - **a device characterization :**
 - Construction analysis
 - operating area
 - irradiation tests (total dose & displacement damages)

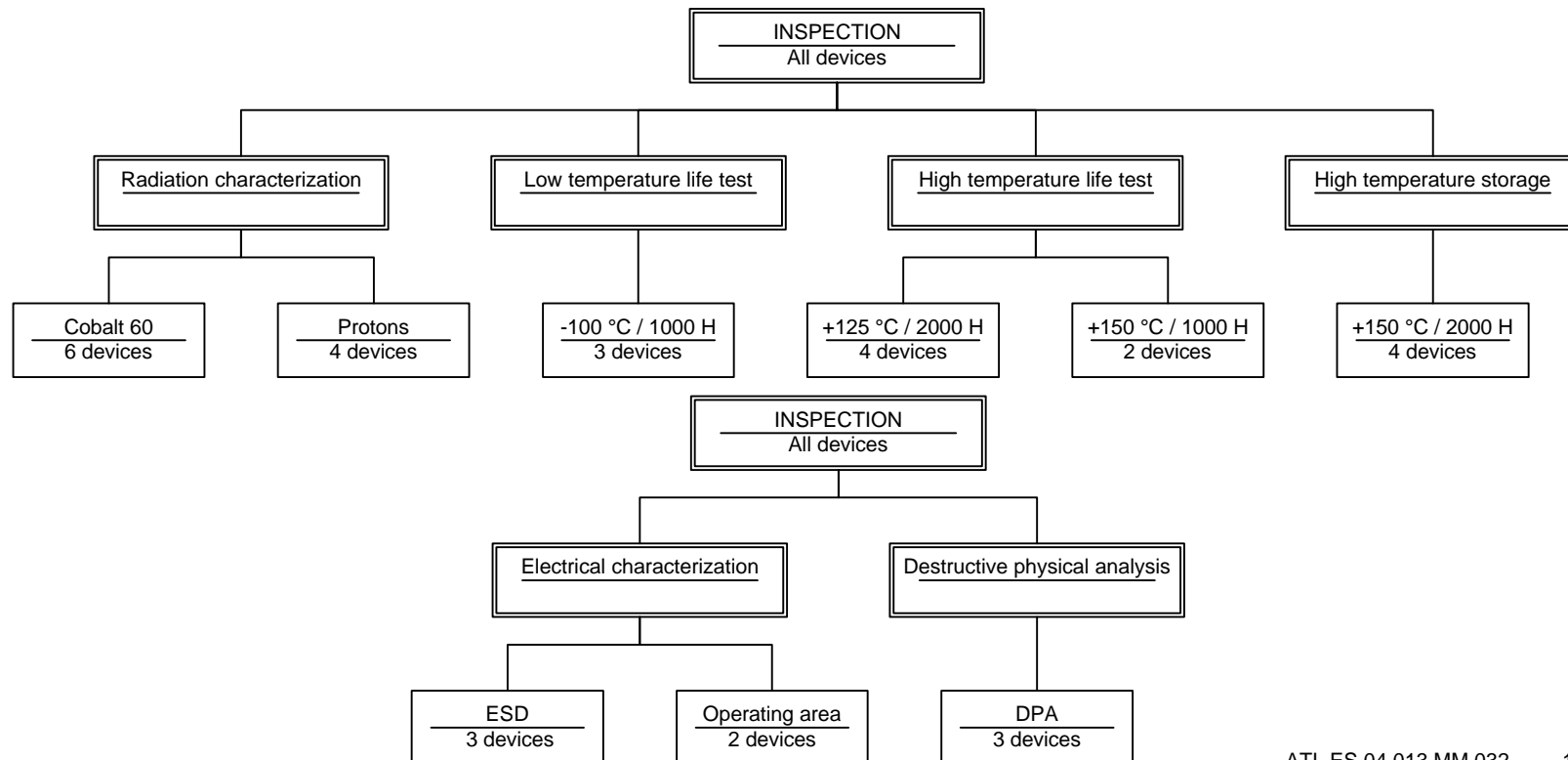
 - **a device reliability evaluation :**
 - operating life tests and storage life tests
 - Environmental tests

Construction analysis (ESTEC)

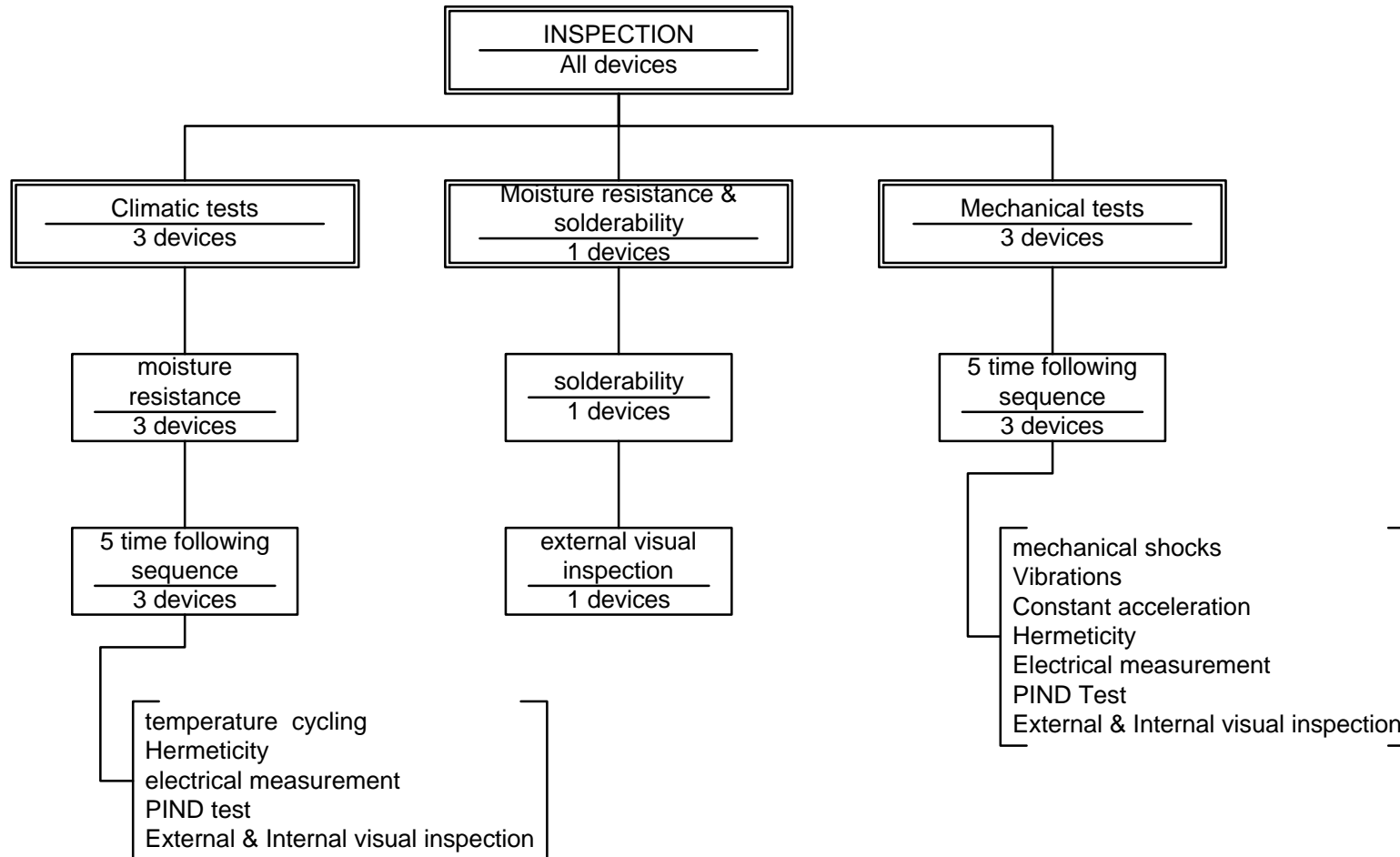
- **Construction analysis has been carried out by ESTEC**
 - **Device meets the general ESA/SCC construction analysis requirements**
 - **Waiver on one glue which has high outgassing values is accepted by ESA/ESTEC**

Evaluation plan presentation (1/2)

- more than 270 elementary tests
- more than 100 electrical and electro-optical measurement steps



Evaluation plan presentation (2/2)



Operating area conclusions

- **Nominal values used for biasing and supplying the device have large margins to prevent drivers drifts**
- **Bias voltages are optimized to improve radiation tolerance**

ESD

- **Non protected inputs (MPP mode)**
- **Results obtained in ESD tests correlate previous data obtained on same technology devices**
- **2 ESD damages during the 270 handling steps**
- **Stress level during ESD tests : no failure up to 200 V**

Cobalt 60 irradiation

- **Total dose applied up to 80 krad (Si)**
- **Source : Cobalt 60 - 420 rad/h**
- **Results :**
 - **Dark signal at 80 krad equivalent to dark signal at 3 krad for a TH7863D**
 - **No significant Responsivity evolution after irradiation**
 - **No significant Transfer efficiency evolution after irradiation**
- **Main impact of irradiation is threshold voltage drift**

Proton irradiation

- **Applied irradiation dose : 10 MeV & 50 MeV**
- **Applied fluence : 3×10^9 p/cm² & 3×10^{10} p/cm²**
- **Results :**
 - **Average dark signal and DSNU increase due to displacement effect**
 - **No significant other characteristics evolution after irradiation**
- **Main impact of proton irradiation is DSNU and average dark signal increase**

Operating life tests and storage life tests

- **2000 H/125 °C operating life tests**
 - **1000 H/150 °C operating life tests**
 - **1000 H/-100 °C operating life tests**
 - **1000 H/150 °C storage tests**
-
- **Devices passed successfully these different tests without significant drift**

Environmental tests

- **Moisture resistance / solderability**
- **Climatic tests**
- **Mechanical tests**

- **Devices passed successfully these different tests without significant drift**

Conclusion

- **Devices succeeded to the different tests of the ETP**
- **These results shows that there is a good margin between stress levels (electrical & environmental) and screening levels**
- **All these results show that TH7890M device is a good candidate for space applications with improved radiation behavior, high reliability and high performances**