# FLIPPER
# ovvero come mandare in tilt un dispositivo

Monica Alderighi,
Astrosiesta 3 Maggio 2007

http://www.ipdb.org/glossary.php

# Tilt...

Pinball Glossary - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.ipdb.org/glossary.php#T

**Thumper Bumper —**
The name used by Bally and Williams to describe active **bumpers**. See *Bumpers* for a description.

**Thwacker —**
See **Knocker**.

**Tilt —**
A pinball machine will tilt, ending the current ball and discarding the **end-of-ball bonus** if the player moves the **cabinet** too violently or tries to lift it. Also see **Slam Tilt**.

There are three mechanisms that are used to detect machine abuse. The first is simply a conical pendulum suspended inside a metal ring. This is called a *tilt bob*. As the machine is nudged, the pendulum will swing, and if it ever touches the ring, a TILT occurs. Most new machines can be set to give one or more **tilt warnings** before actually tilting, and tilting in this fashion causes immediate loss of both the ball in play and your accumulated bonus for that ball.

The second tilt mechanism is the "ball roll" tilt; it's a pinball sitting in a metal track inside the cabinet. The track has a shallow slope in the same direction as the **playfield**, so the ball usually rests in the bottom of the track; at the top of the track is a sensor. If you physically lift the front of the machine, the ball rolls up the track and contacts the sensor. At the very least, this is an immediate tilt with no warnings. On most machines, it's a slam tilt.

Finally, there are usually one or more impact sensors, placed in places likely to be the subject of player abuse, such as the coin door and cabinet. Banging on one of these places hard enough to trigger one of these sensors will cause a slam tilt.

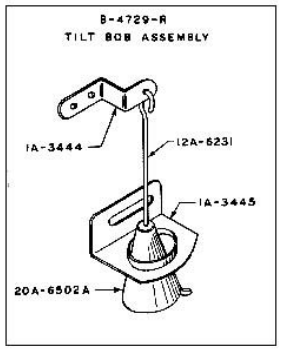



*Diagram of a Tilt Bob Assembly*

**Tilt Warning —**
Many **solid-state games** will issue one or more **tilt** warnings before actually tilting, so a player has a chance at one or two powerful shoves before losing the ball.

Done

Now: Sunny, 12° C | Mon: 23° C | Mon: 11° C | Tue: 23° C | Tue: 12° C

start | Gmail - Inbox - ... | F:\Documenti\p... | Microsoft Power... | Pinball Glossary ... | Image Analyzer | EN | 9.49

# FLIPPER

FLIPPER é una scheda basata su FPGA concepita come piattaforma configurabile per le seguenti applicazioni principali:

- Emulazione* di SEU mediante fault injection
- Test mediante irragiamento

e che può essere efficacemente impiegata per scopi diversi come:

- test equipment
- scheda I/O digitale
- scheda general purpose
- ...

* L'emulatore di SEU è stato sviluppato nel corso del Contratto ESA/ESTEC n. 8559 (brevetto depositato)

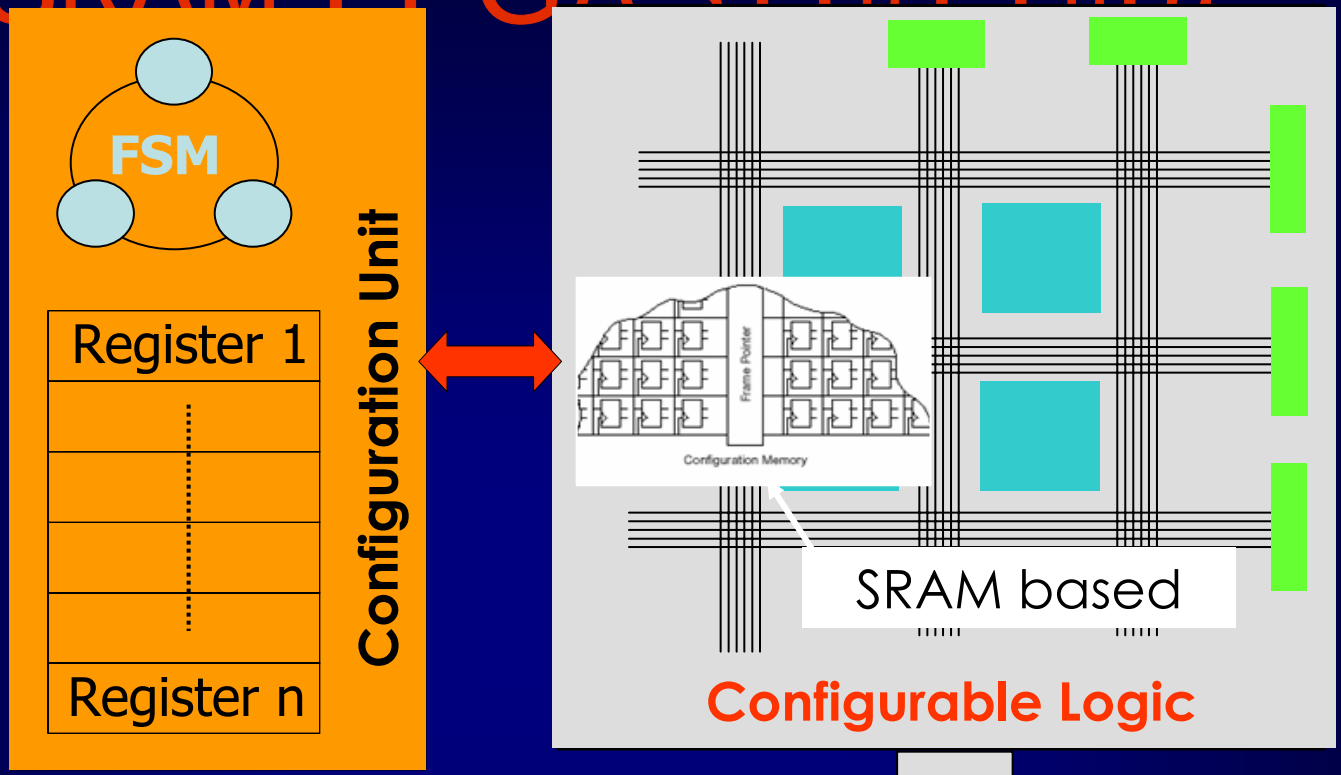
# Il dispositivo in questione…

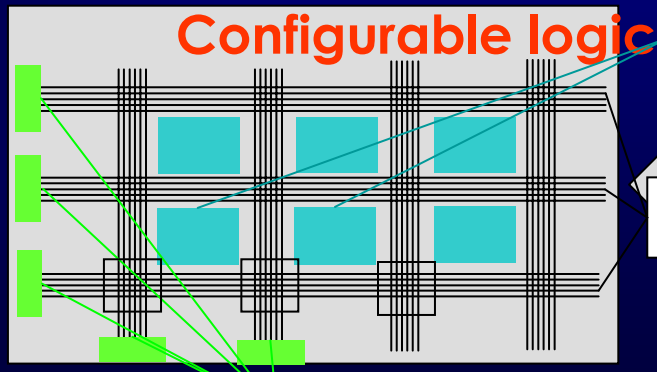
- Field Programmable Gate Array → FPGA
  - Programmabilità
  - Elevata densità di integrazione
  - Elevate prestazioni
  - Ridotti costi di sviluppo
- Applicazioni
  - Telecom, Avionica, spazio, Elettronica consumo, Auto….
- Tecnologie realizzative diverse
  - Antifuse (ACTEL)
    - One time programmable
  - Memorie SRAM (XILINX, Altera)

# SRAM FPGA

- Caratteristiche
  - Pressoché illimitata programmabilità!!!!
  - Flessibilità elevata
    - Modifica funzionalità circuito a posteriori
    - Riparazione di guasti
- R&D @IASF Milano
  - Sviluppo prototipi
  - Def. Tecniche “dedicate” di tolleranza di guasti
  - Irraggiamento in acceleratore
  - Finanziamenti
    - ASI per la ricerca di base ’99
    - ESA

# SRAM-FPGA struttura



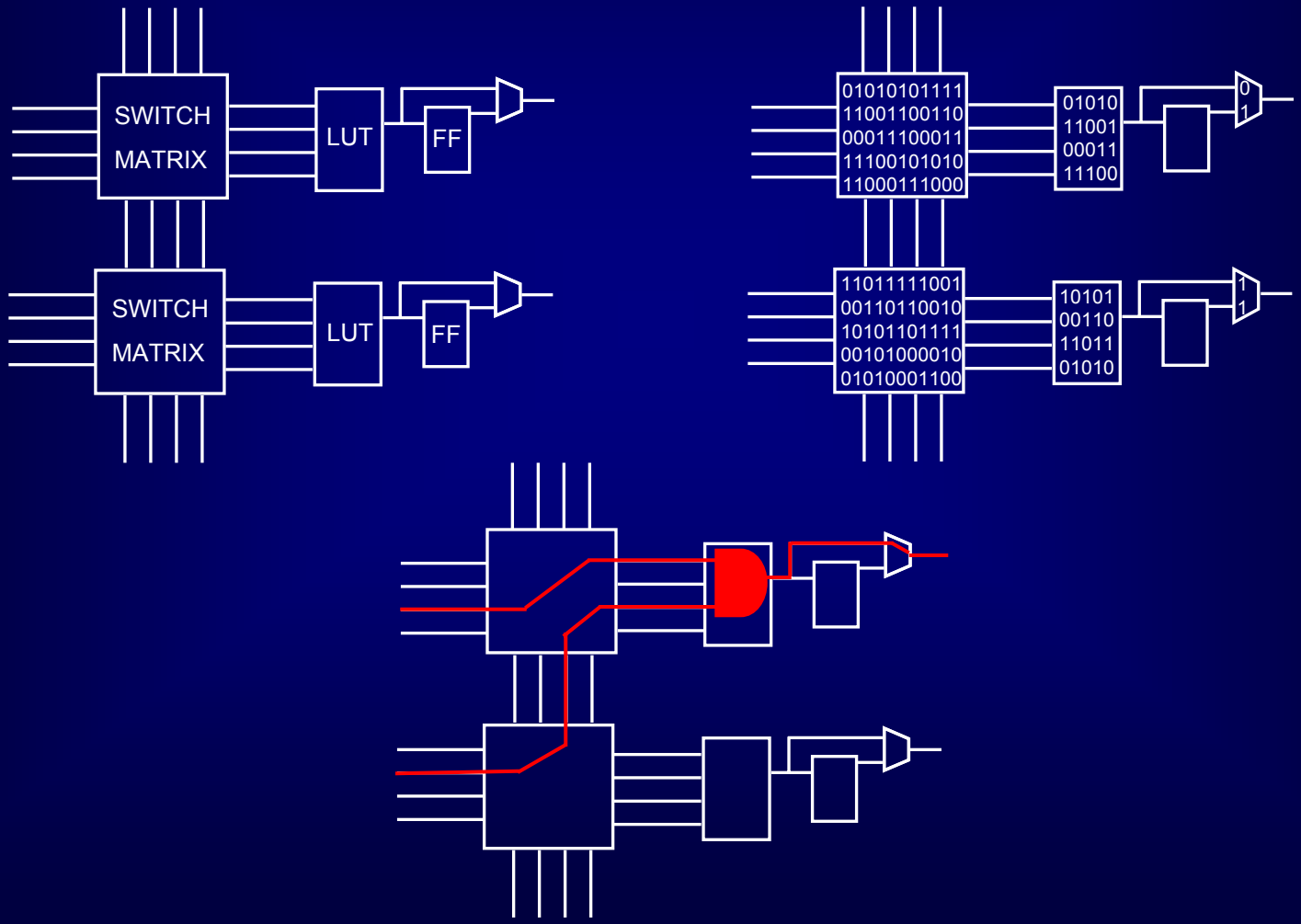




CLB logical resources

Interconnection resources

I/O resources

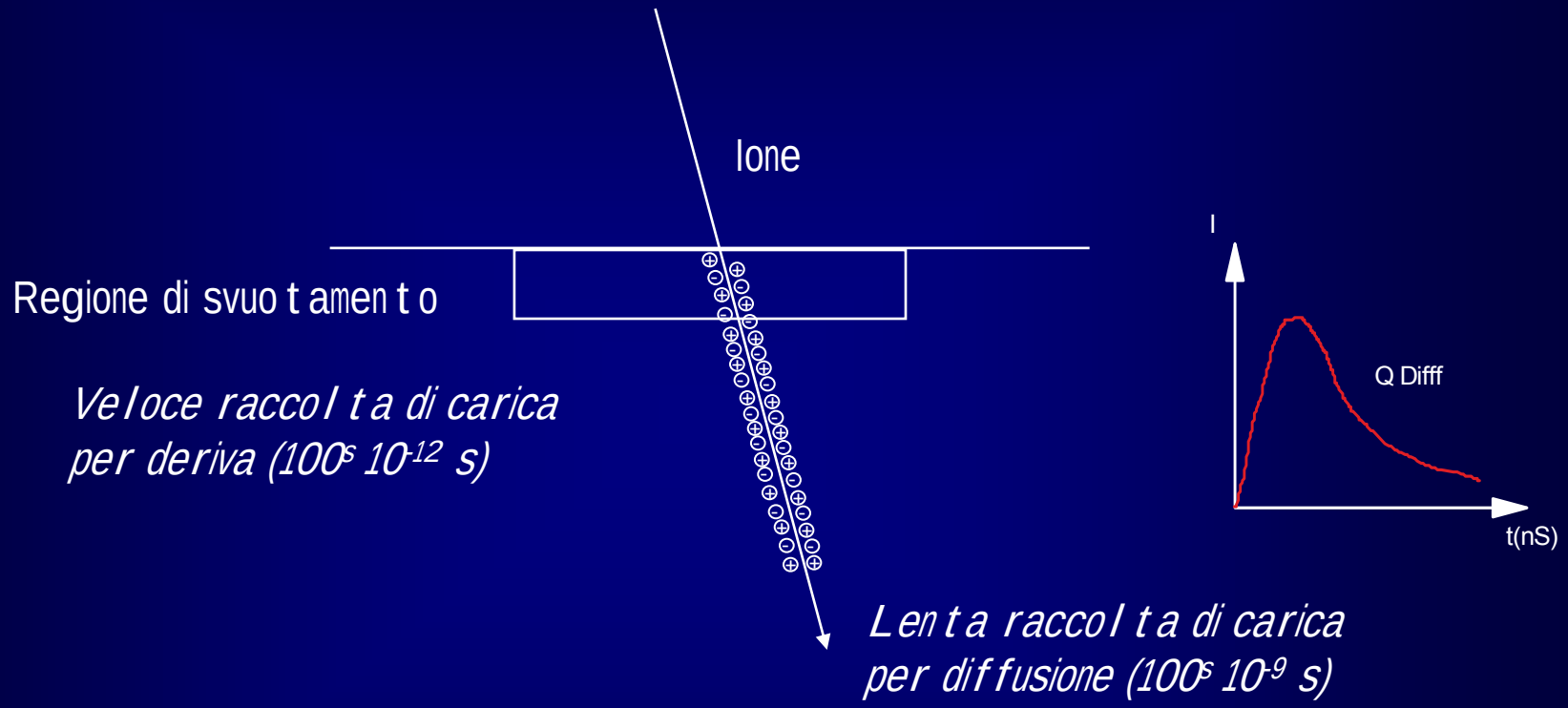
# Esempio


SWITCH
MATRIX
LUT
FF
SWITCH
MATRIX
LUT
FF
01010101111
11001100110
00011100011
11100101010
11000111000
01010
11001
00011
11100
0
1
11011111001
00110110010
10101101111
00101000010
01010001100
10101
00110
11011
01010
1
1

# Interessante, ma....

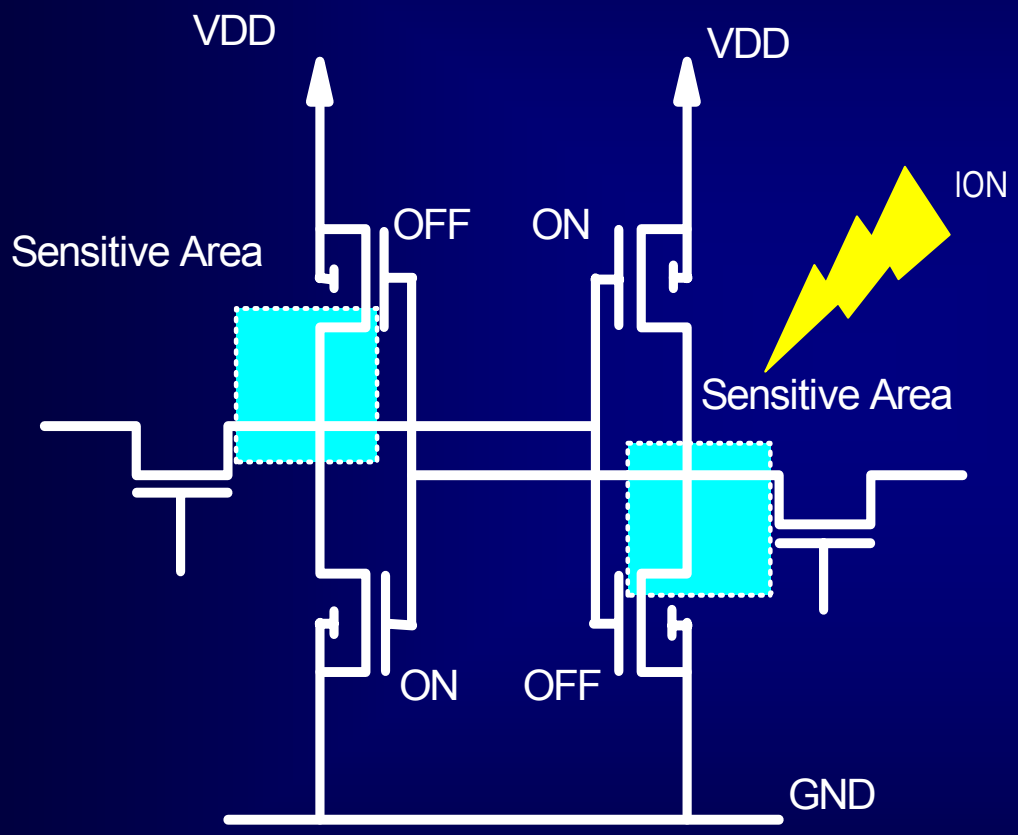
- Sensibilità a radiazione ionizzante (protoni, ioni pesanti)
- Effetti
  - TID (Total Ionizing dose)
  - SEE (Single Event Effect)
    - SEU (Single Event Upset)
- Mitigazione
  - Tecnologia realizzativa (TID)
  - Design Hardness
    - TMR tool, scrubbing

# SEU




- Se o meno si genera un SEU dipende dalla qaun tità di carica raccolta (≥ critical charge)

# Memorie SRAM



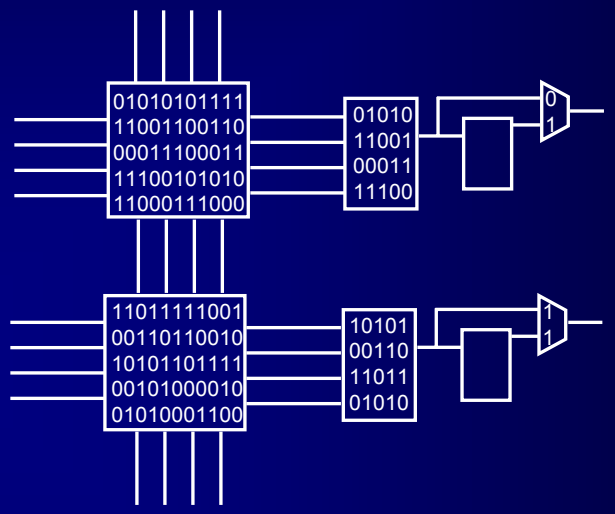

Se la quantità di carica raccolta è elevata, un voltaggio adeguato puó causare un bit-flip o soft error

0 → 1

1 → 0

# SEU in SRAM-FPGA

- Può influenzare
  - Funzioni
  - Dati
  - Interconnessioni
  - Memoria di configurazione
  - Logica di configurazione

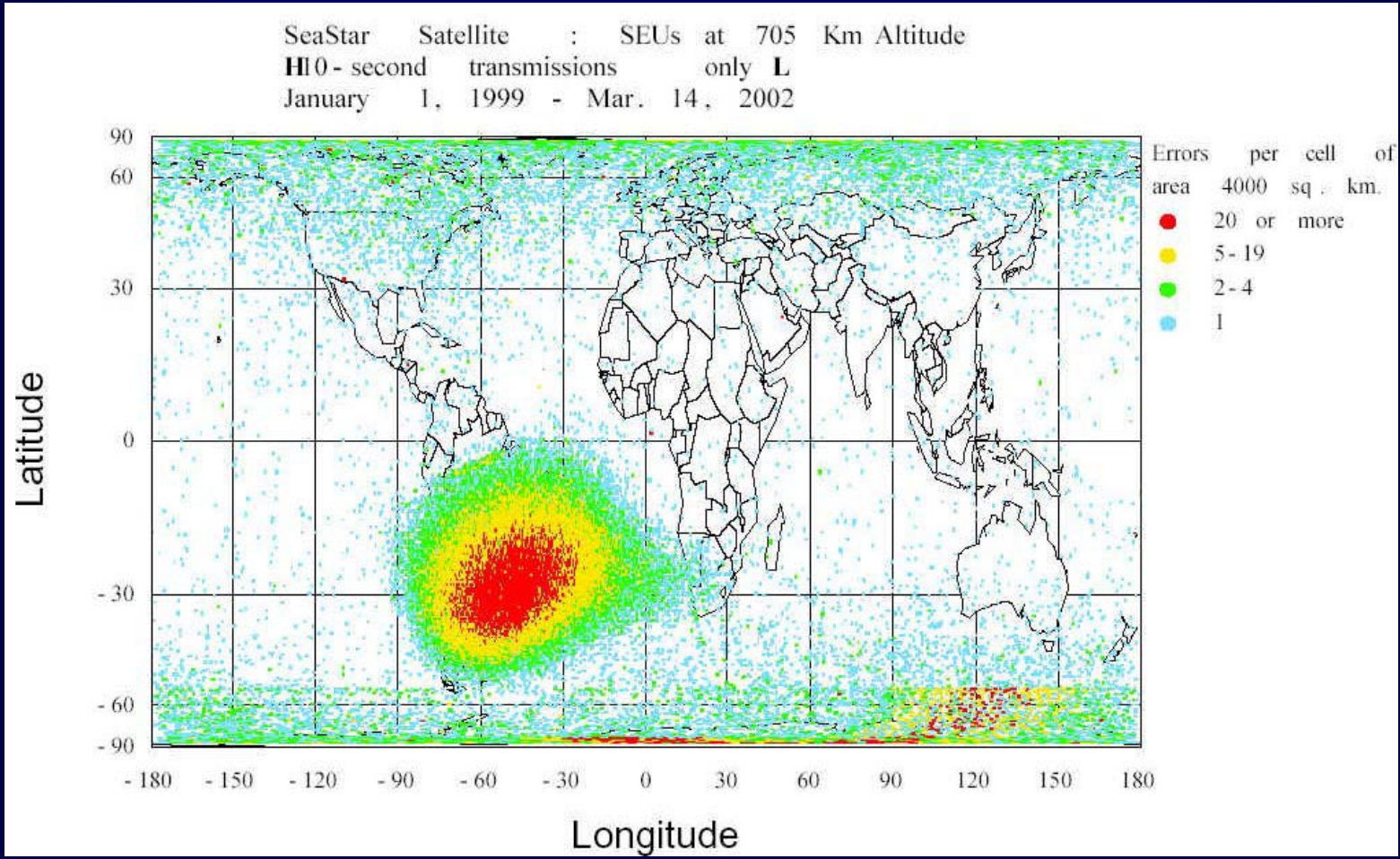



- Strumenti adeguati per il loro impiego in ambito spaziale/avionico
  - Studio e analisi degli effetti
  - Tecniche di protezione/mitigazione

# In letteratura...

- "Anomalie" nell'elettronica di satelliti (report by Binder et al., Hughes Aircraft - 1975)
  - 4 su 17 satellite-years of operation
  - Vagamente imputate a ioni ferro da 100 MeV del vento solare
- SEU da contaminazione radioattiva dei chip (report Intel – 1978)
- Dipendenza dell'effetto neutroni dall'altitudine (report IBM su terrestrial cosmic rays effects 1981 - 1984)
  - Analisi di computer repair log

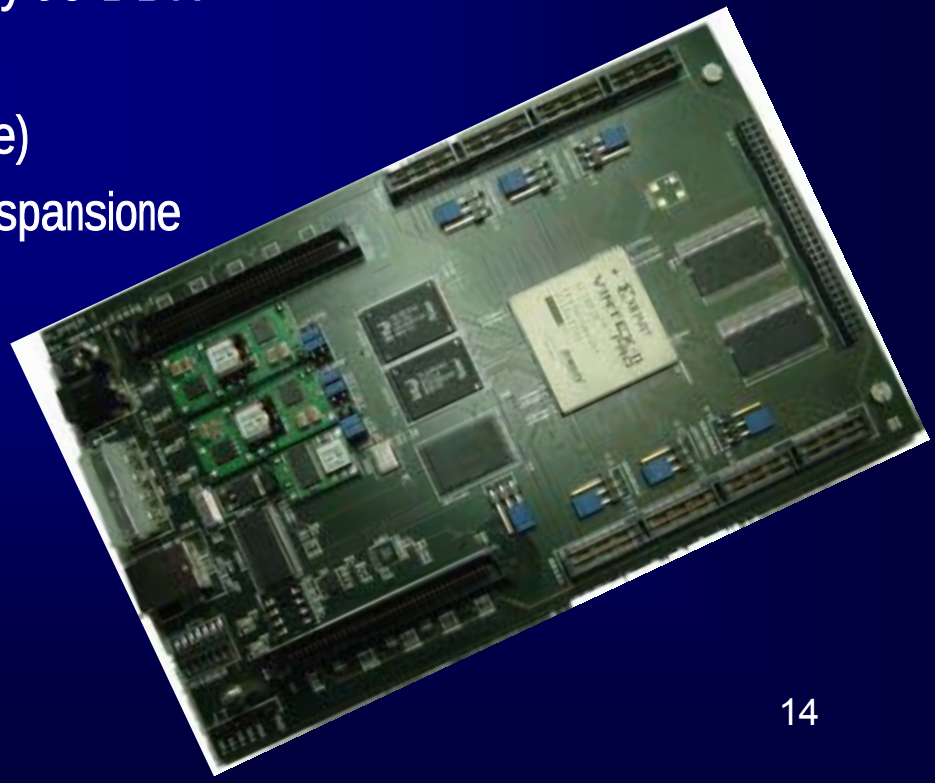
# Proton SEUs




*Credits: NASA/GSFC*

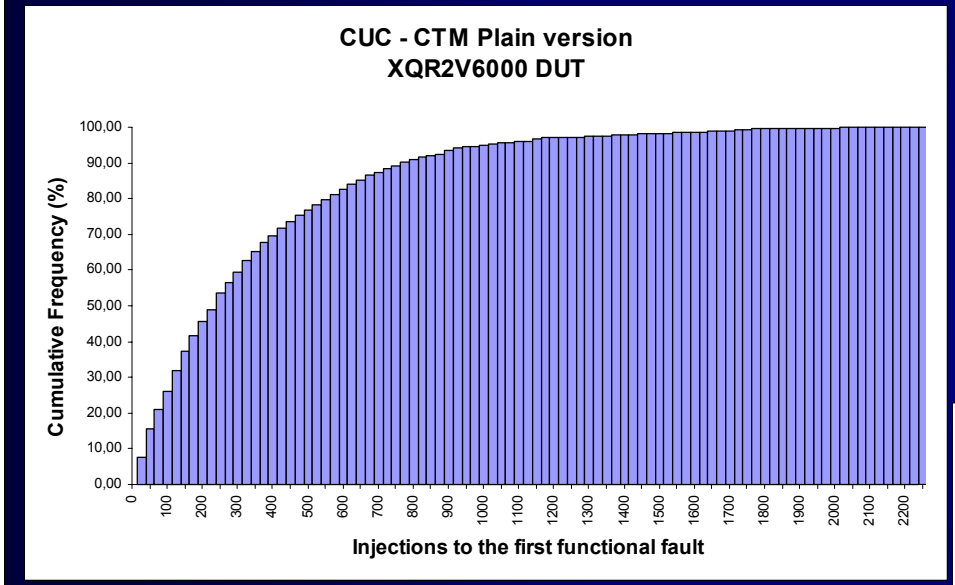
# FLIPPER
## Caratteristiche Principali

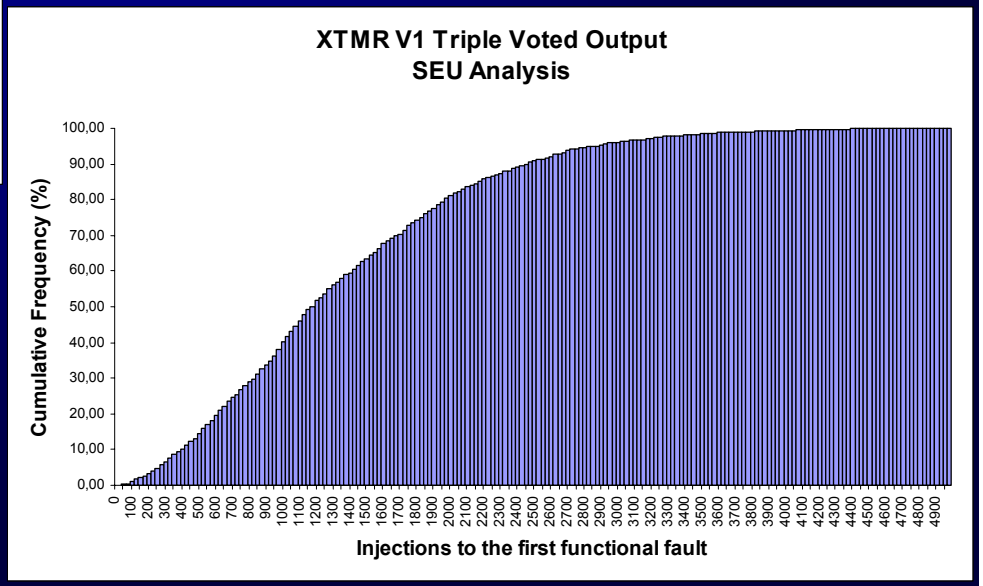
- Xilinx XC2VP20-5 FF896 (2 PowerPC on-chip)
- Porta USB 2.0
- Link Gigabit Ethernet
- Fino a 128 MByte SDRAM o 256 MByte DDR
- 16 MByte Flash
- Slot per schede di test (rivelatore)
- Slot P160 standard per schede di espansione
- Piu' di 400 segnali I/O



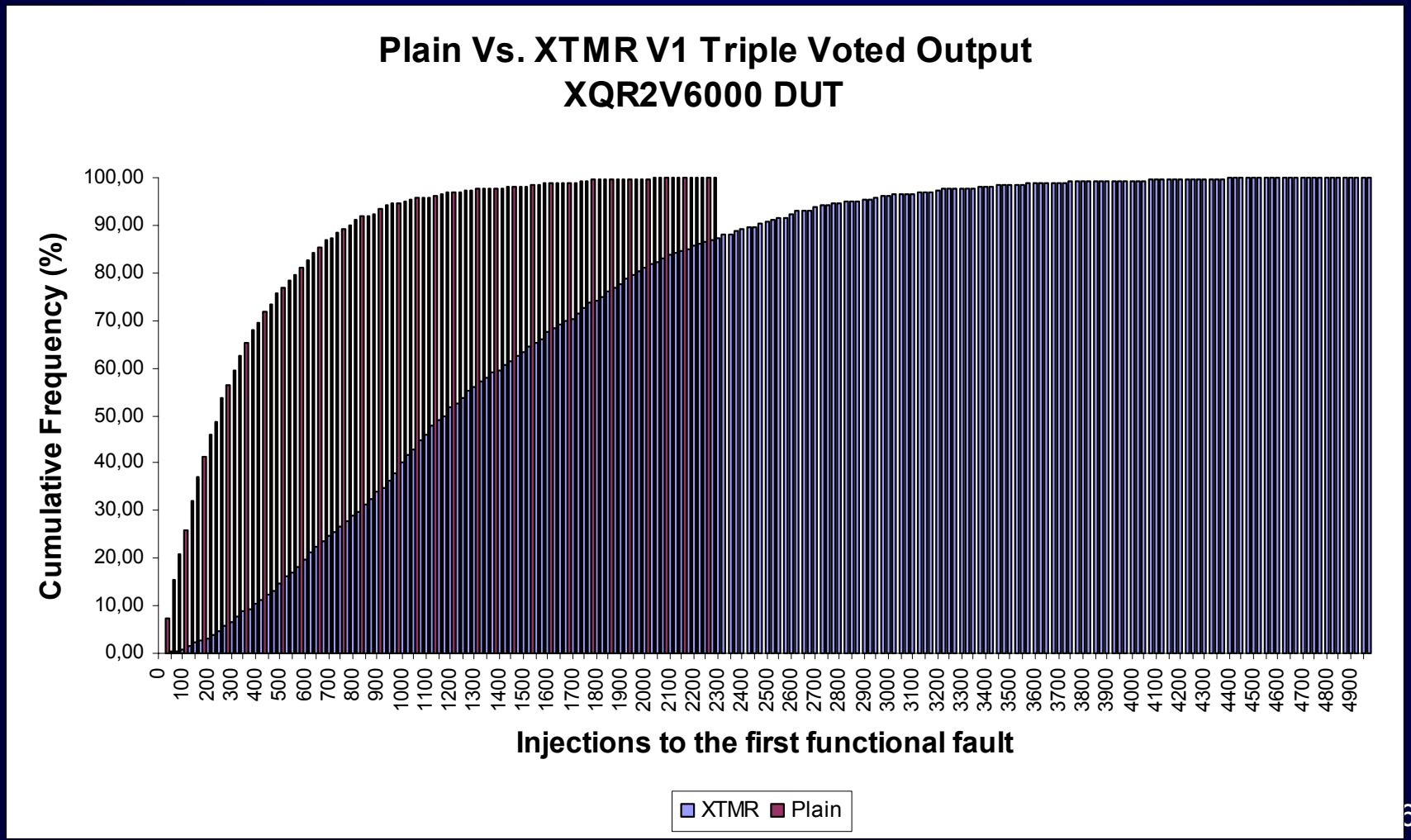
# FLIPPER results 1 (ESA)

- Confronto bontà tecniche di mitigazione selezionate

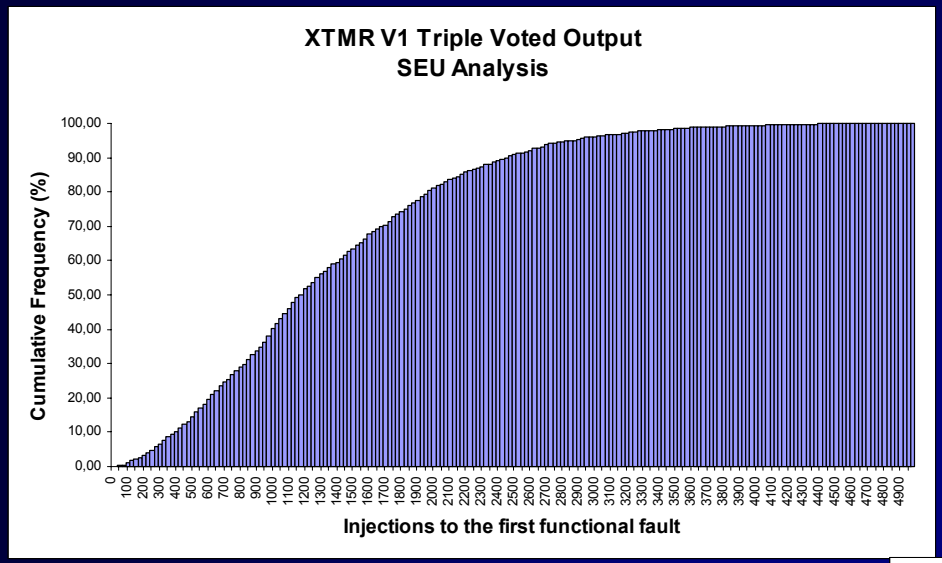


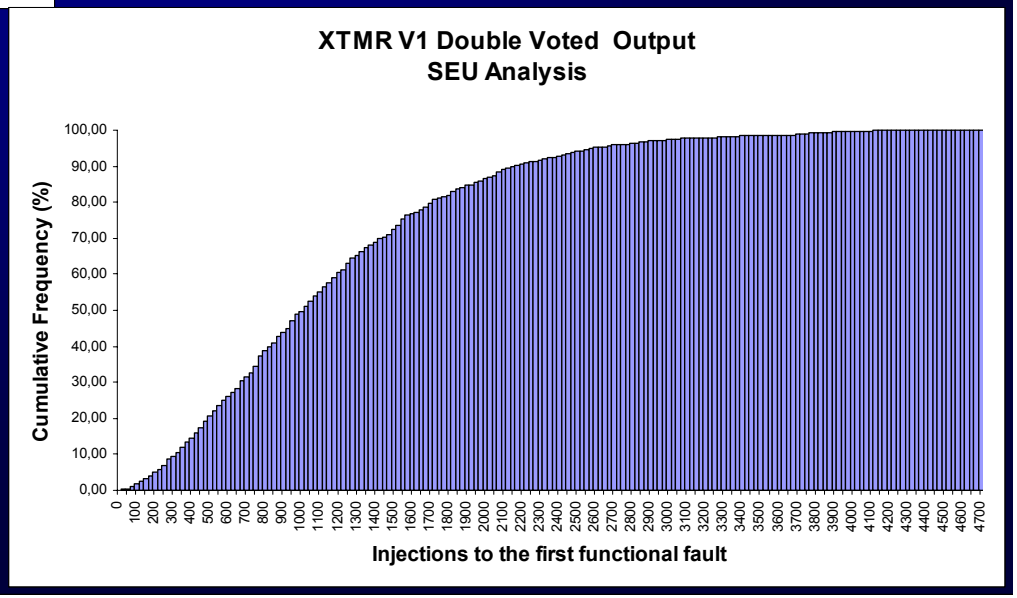



# FLIPPER results 1 (ESA)

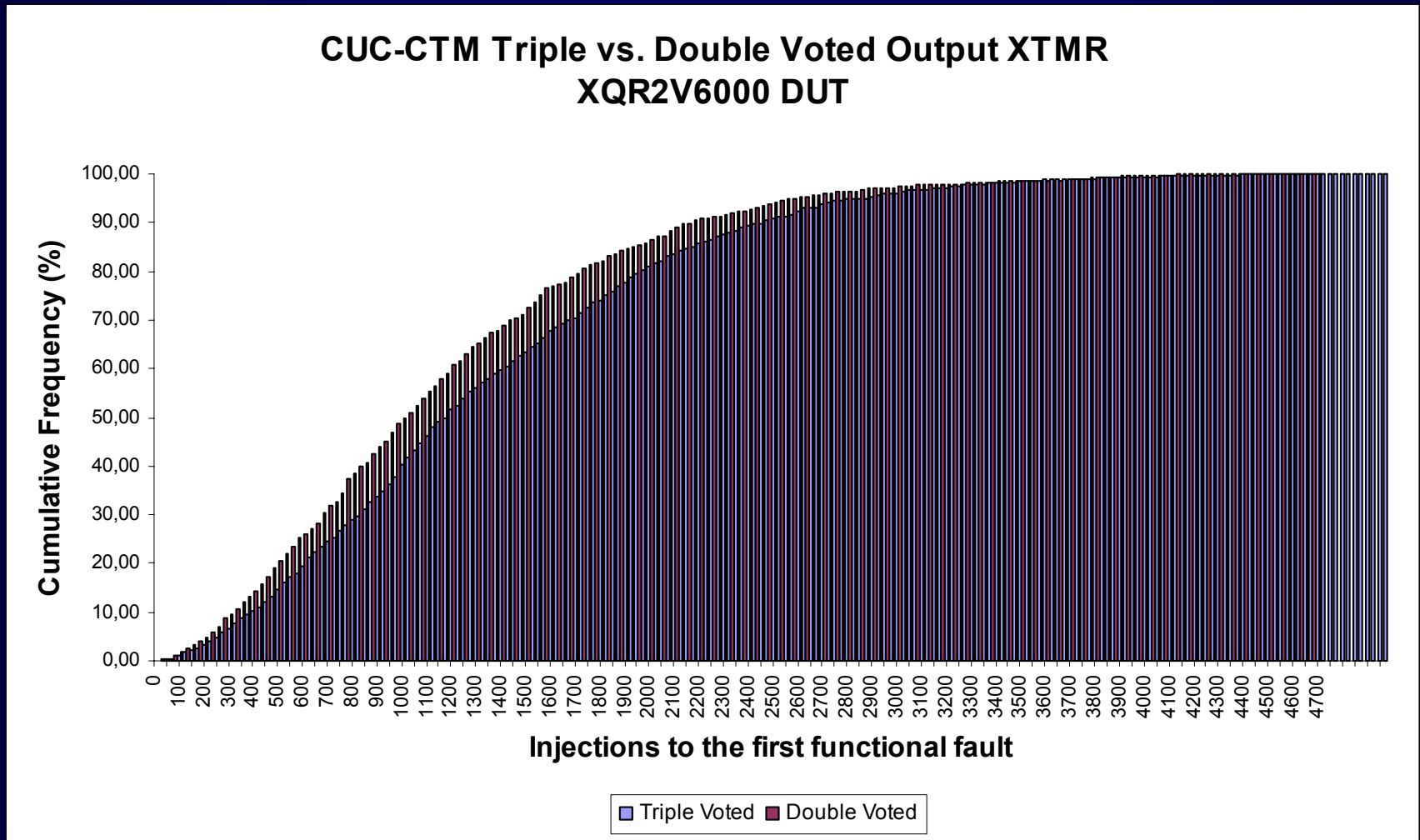


# FLIPPER results 2 (ESA)



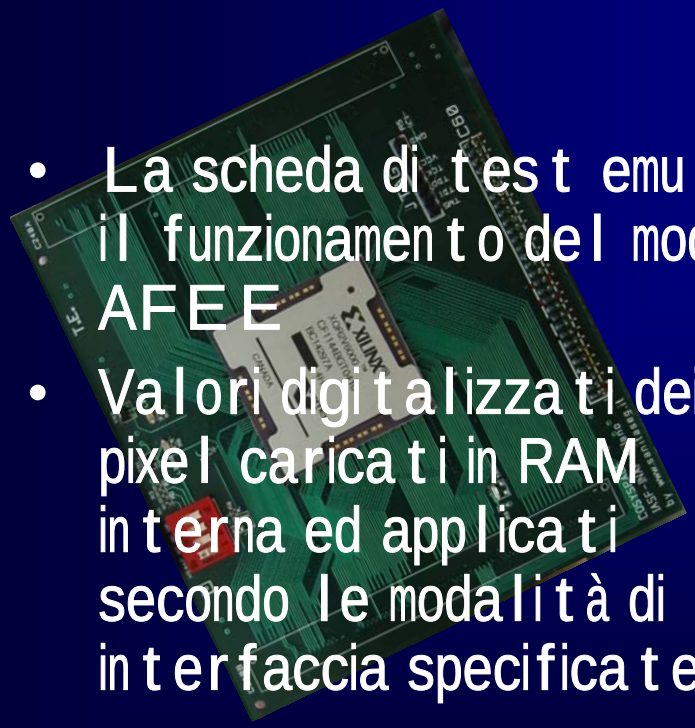



# FLIPPER results 2 (ESA)

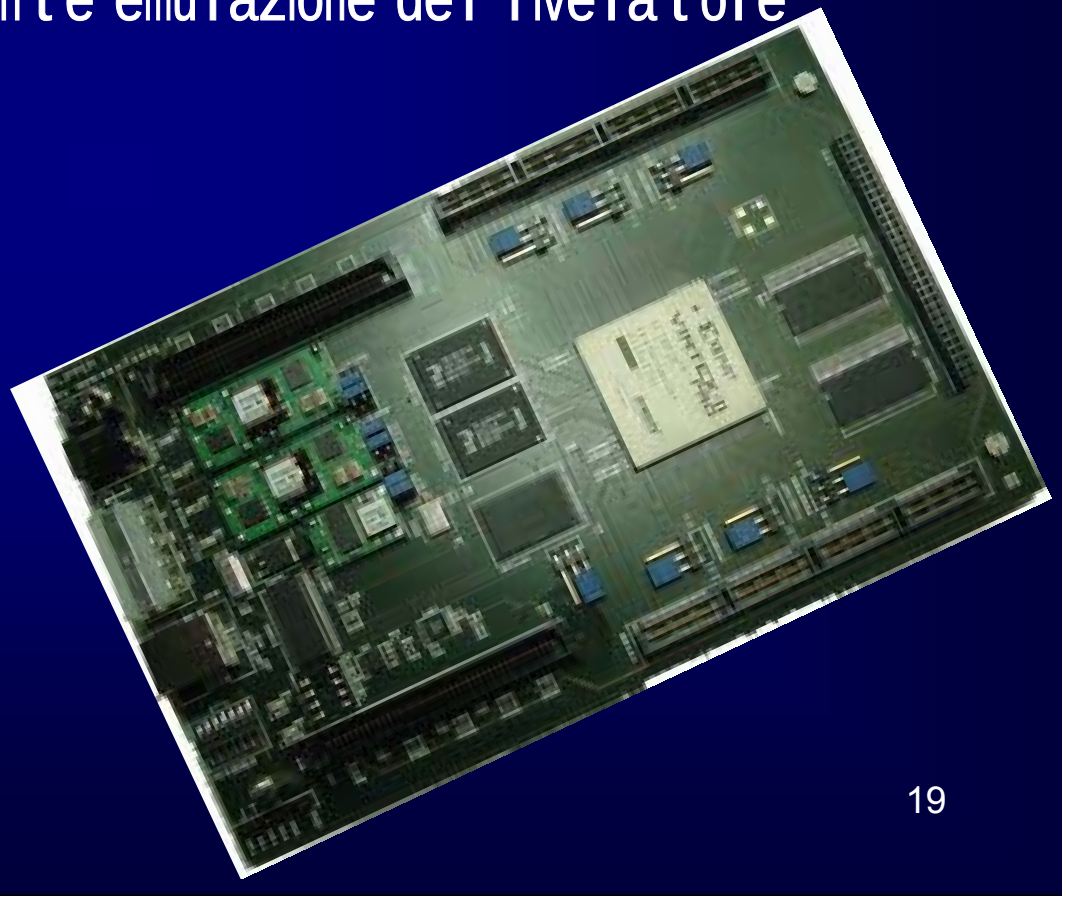


# FLIPPER & CZT

- Implementazione algoritmi filtering digitale
- Implementazione algoritmi di analisi della forma e calcolo dell'energia
- Verifica del sistema mediante emulazione del rivelatore



- La scheda di test emula il funzionamento del modulo AFEE
- Valori digitalizzati dei pixel caricati in RAM interna ed applicati secondo le modalità di interfaccia specificate



# SRAM-FPGA nello spazio

- GRACE (NASA, LDR)
- FedSat (Univ. Southern Australia)
- OPTUS (Raytheon)
- MARS2003 Lander &Rover (JPL)
- Venus Express (TU Braunschweig)
- KompSat-2 (Korea Aerospace Research Institute)
- SAR-Lupe-1 (OHB-System GmbH)