

HIREX ENGINEERING®



Radiation Pre-Screening of
High-Resolution High-Speed
ADC's

Final Presentation of ESTEC
Contract N° 13602/99/NL/GD

QCA Final Presentation Day, January 26th 2000

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Evaluation Content

- Parts Selection
- Total Ionizing Dose
- Single Event Effects



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Outline Presentation

- ▶ Tested Products
- ▶ Total Ionizing Dose
- ▶ Single Event Effects



Tested Products

- ➡ LTC1414 From Linear Technology
- ➡ AD9243 From Analog Devices
- ➡ ADC14161 From National Semiconductors



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Total Ionizing Dose Evaluation of 14-Bit ADC's



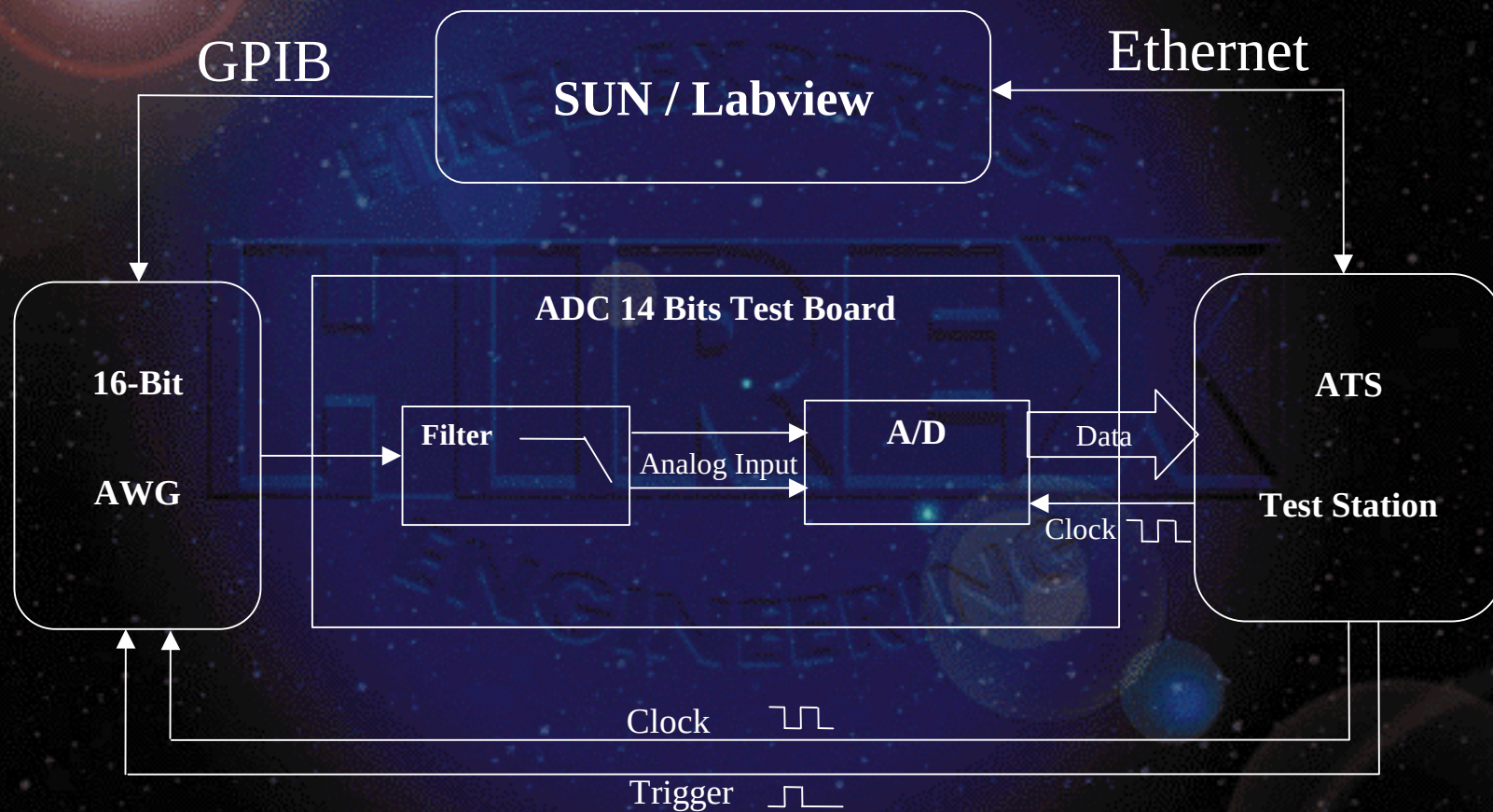
HIREX ENGINEERING - 117 rue de la Providence - 31500 TOULOUSE - Tél 33 (0) 5 62 47 56 90 - Fax 33 (0) 5 62 47 56 95 - e-mail : Hirex@HirexEngineering.com

TID Tested Electrical Parameters

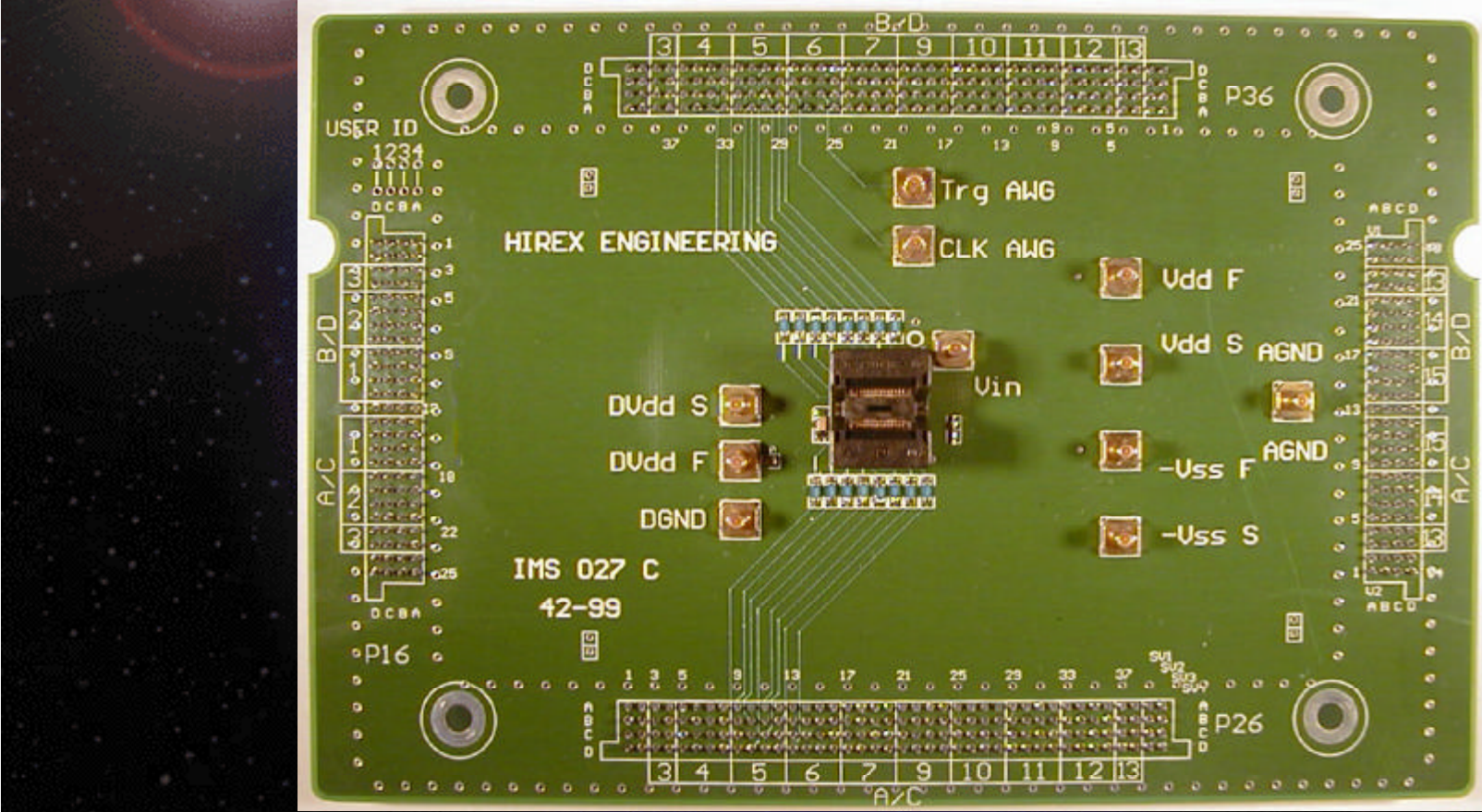
- ➡ Converter Characteristics (INL, DNL, Offset error, Gain Error)
- ➡ AC Electrical Parameters ($S/(N+D)$, THD, SNR, ENOB)
- ➡ DC Electrical Parameters (Inputs, Outputs, Supply Currents)



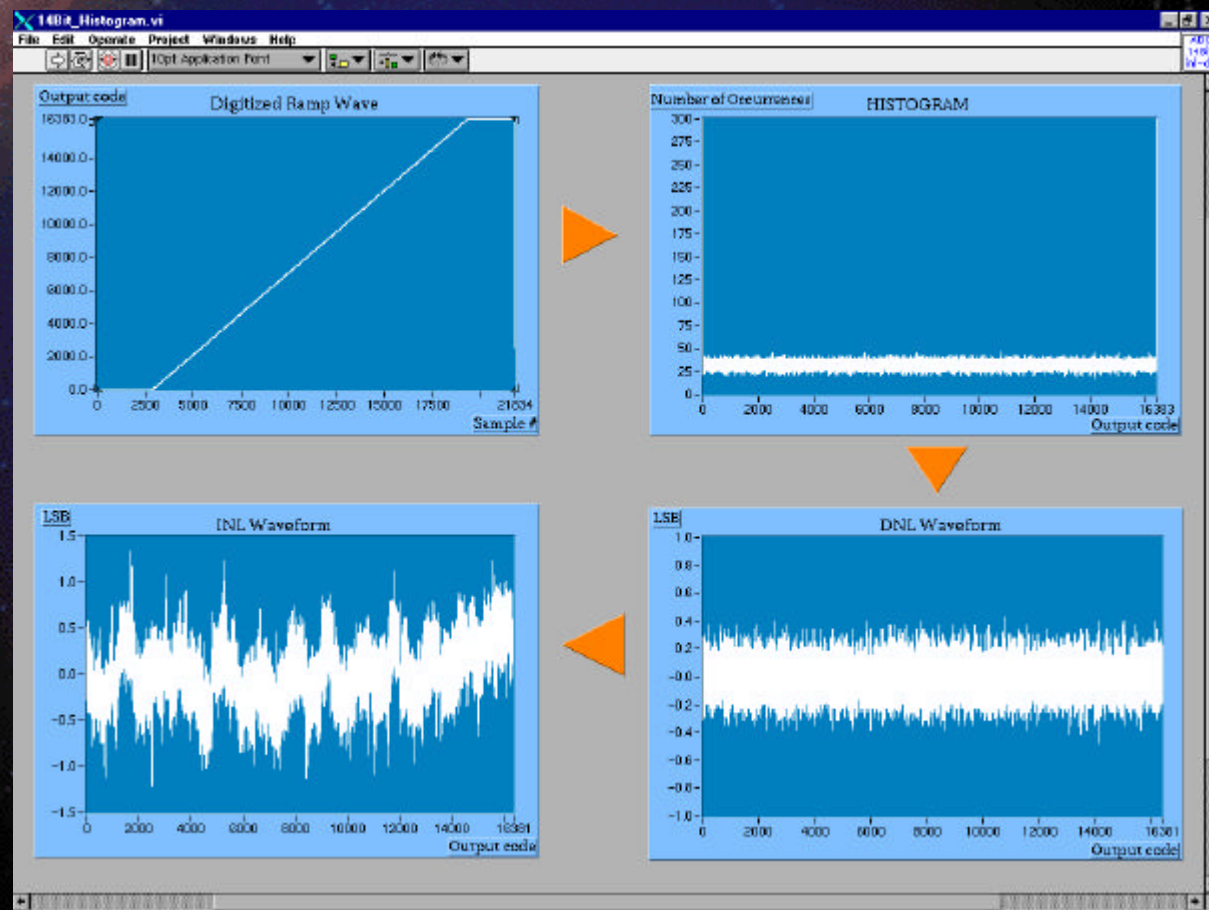
TID Test Programs Principle



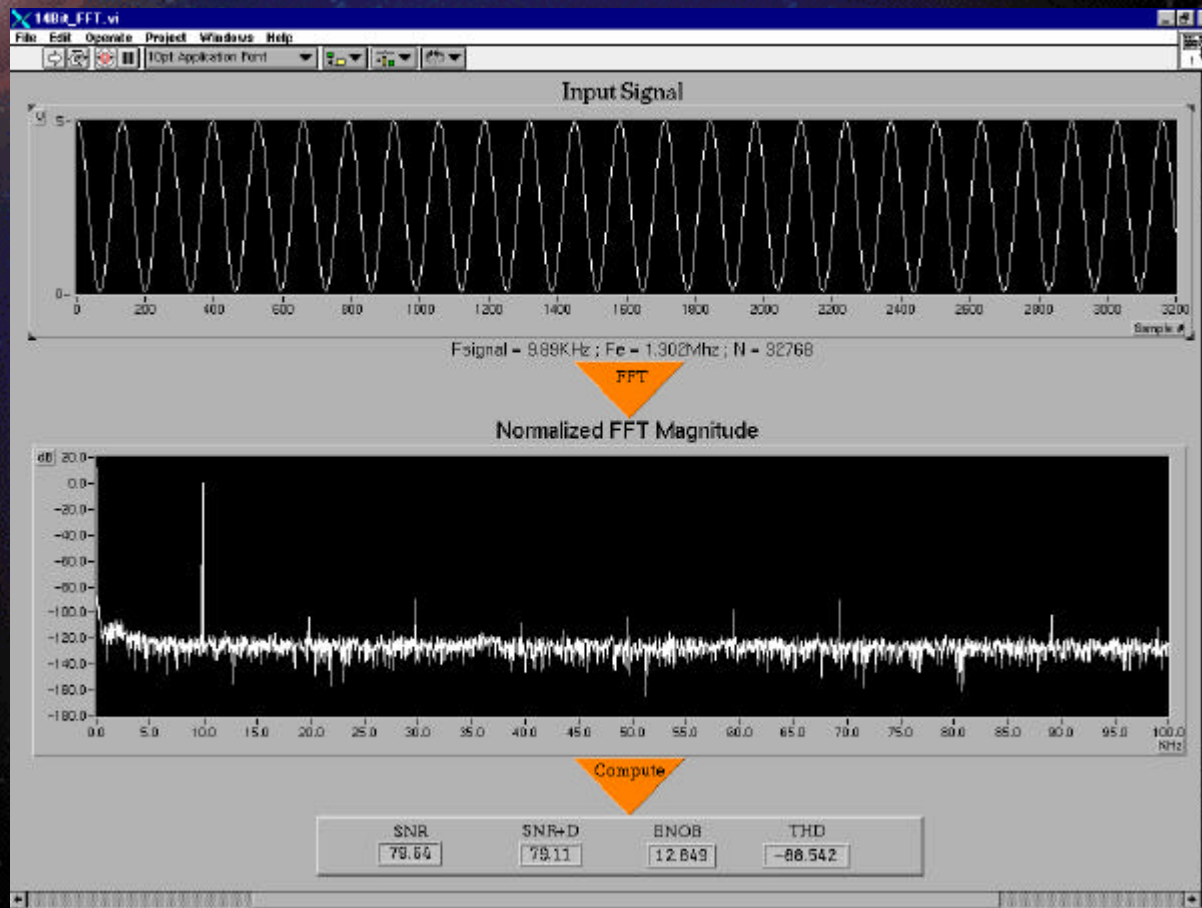
TID Test Fixture Board



Converter Characteristics



AC Characteristics



TID Tests Conditions

- ➡ 2 Groups of 3 samples tested
- ➡ One group at high dose rate: 1000 rad(Si)/hour
- ➡ One group at low dose rate: 300 rad(Si)/hour
- ➡ Irradiation and testing at room temperature
- ➡ CO_{60} Exposures at ONERA up to 50 Krad(Si) in 5 steps
- ➡ Annealing: 24H at 25°C & 168H at 100°C



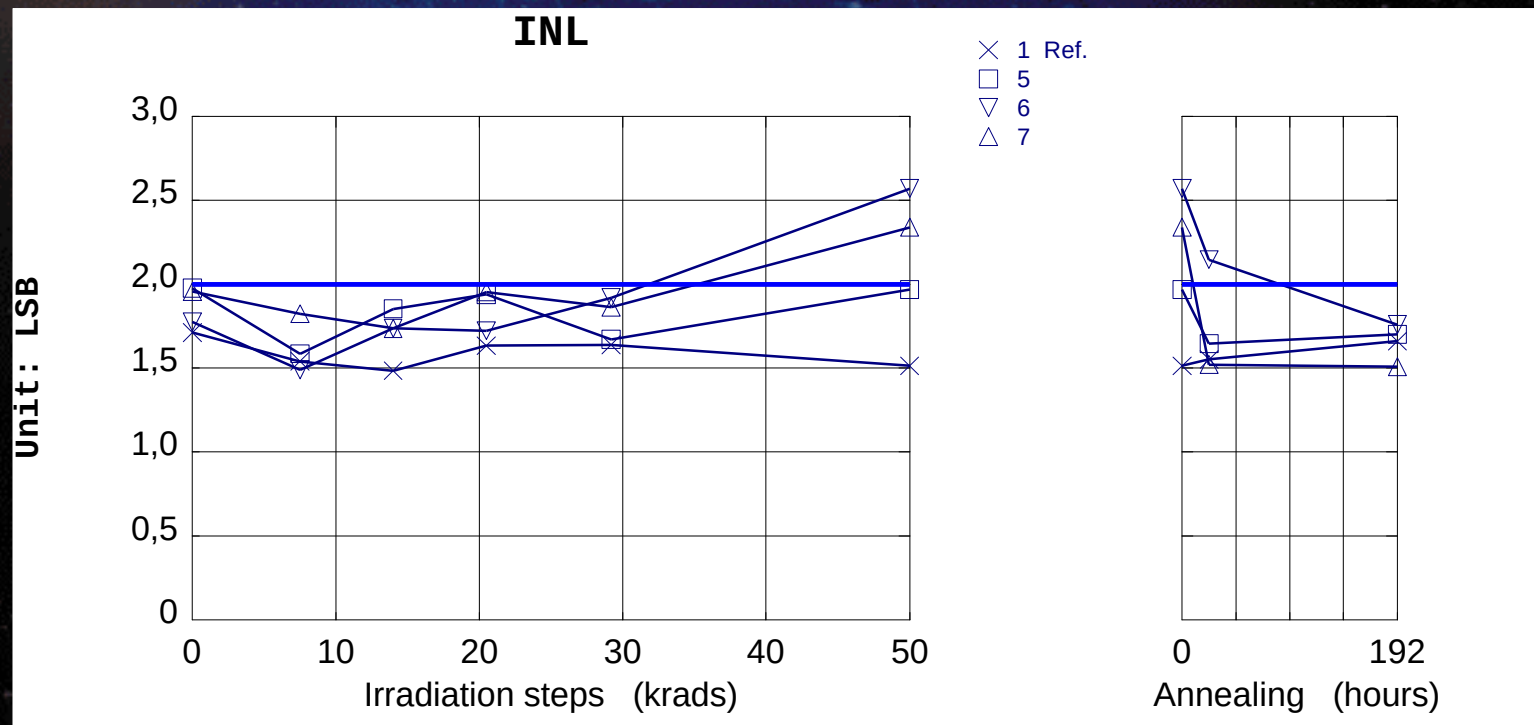
TID Test Results : LTC1414

- ➡ At High Dose Rate:
 - INL exceeded spec limit at 22 Krad(Si)
 - Recovery for most samples after annealing
 - All other parameters remained within spec limits
- ➡ At Low Dose Rate:
 - INL exceeded spec limit at 50 Krad(Si)
 - Recovery for of all samples after annealing
 - All other parameters remained within spec limits



TID Test Results : LTC1414

INL Evolution at Low Dose Rate



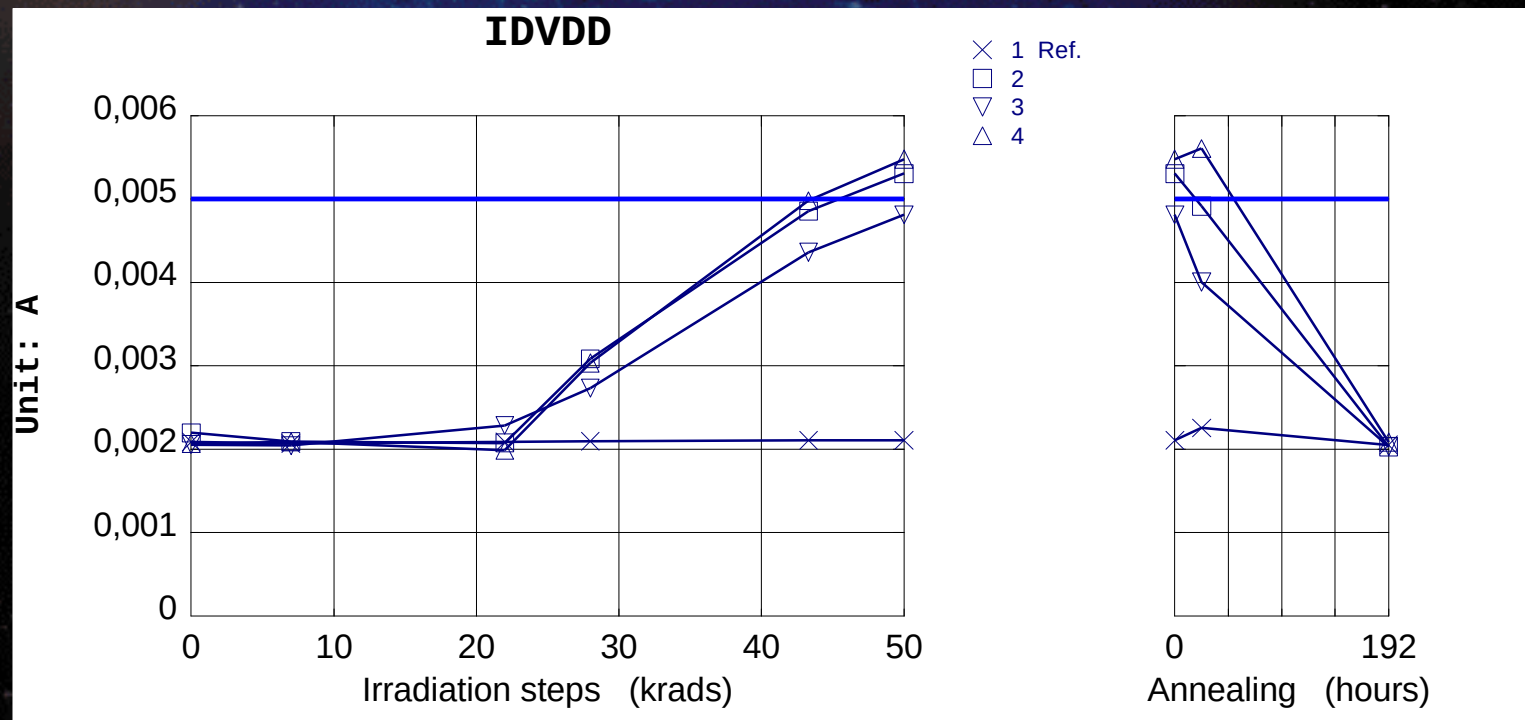
TID Test Results : AD9243

- ➡ At High Dose Rate:
 - IDVDD exceeded spec limit at 43 Krad(Si)
 - Recovery for all samples after annealing
 - All other parameters remained within spec limits
- ➡ At Low Dose Rate:
 - INL exceeded spec limit at 29 Krad(Si)
 - IDVDD exceeded spec limit at 50 Krad(Si)
 - All other parameters remained within spec limits



TID Test Results : AD9243

IDVDD Evolution at High Dose Rate



TID Test Results : ADC14161

➡ At High Dose Rate:

- ID exceeded spec limit at 22 Krad(Si), IDI/O at 43
- Continuous degradation & recovery after annealing
- All other parameters remained within spec limits

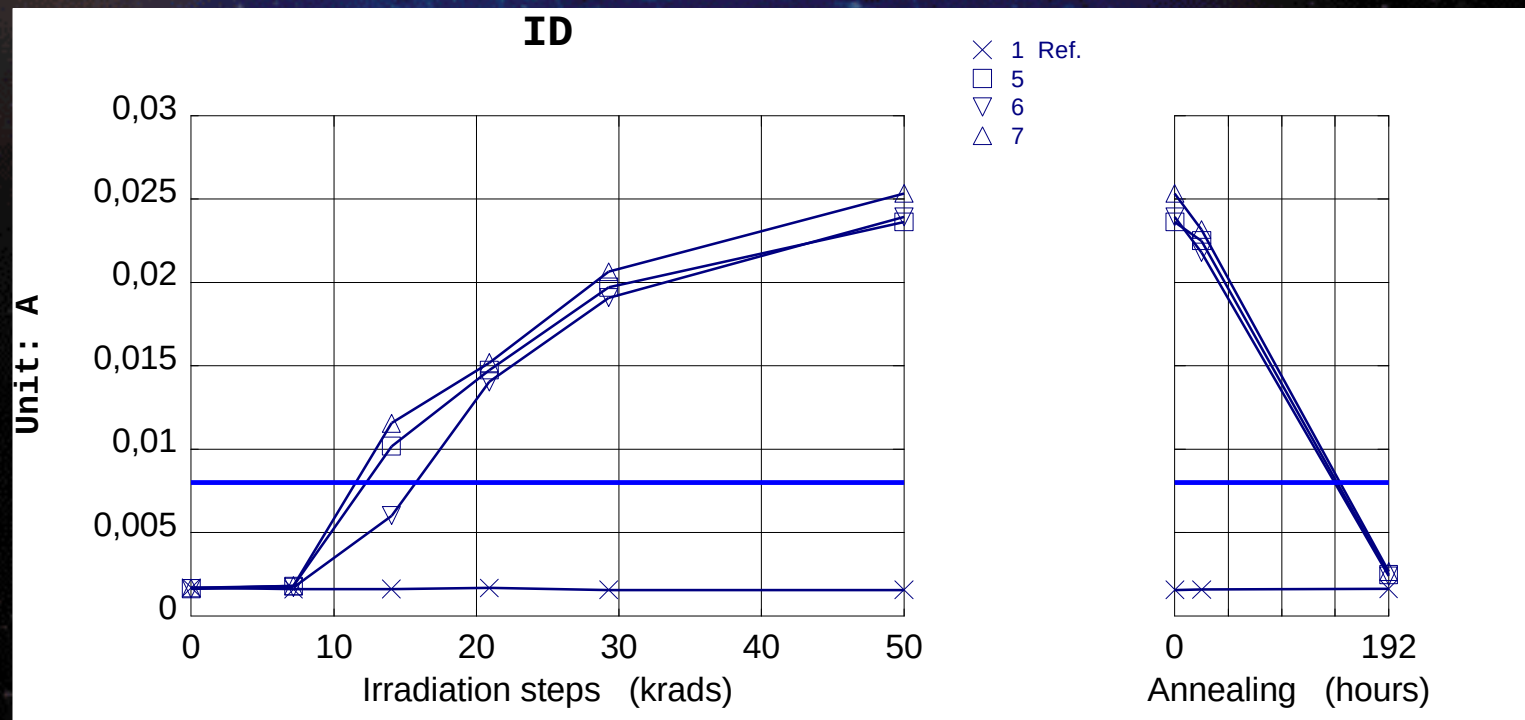
➡ At Low Dose Rate:

- Lost of functionality at 50 Krad(Si) with recovery during annealing
- ID exceeded spec limit at 21 Krad(Si)
- All other parameters remained within spec limits



TID Test Results : ADC14161

ID Evolution at High Dose Rate



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Single Event Effect
Evaluation of 14-Bit ADC's



Test performed in June 99,
at the European Heavy Ion Facility (HIF),
Université Catholique de Louvain,
(Belgium)



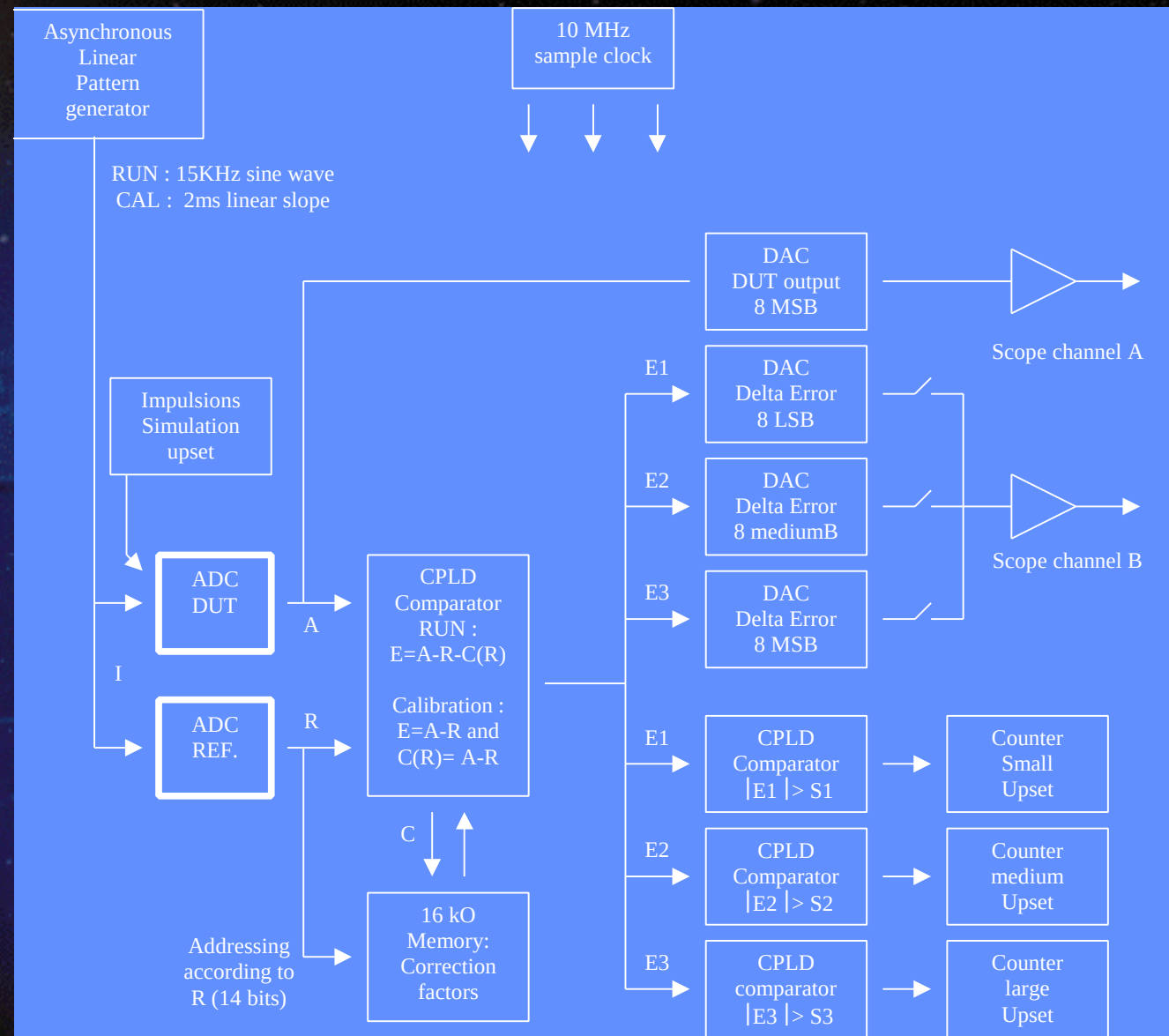
SEE Test Principle

- ➡ Direct observation of ADC output
- ➡ Based on Golden Chip Method
- ➡ Differential calibration
- ➡ Operated at Nominal Sampling Frequency
- ➡ Possibility to detect permanent errors

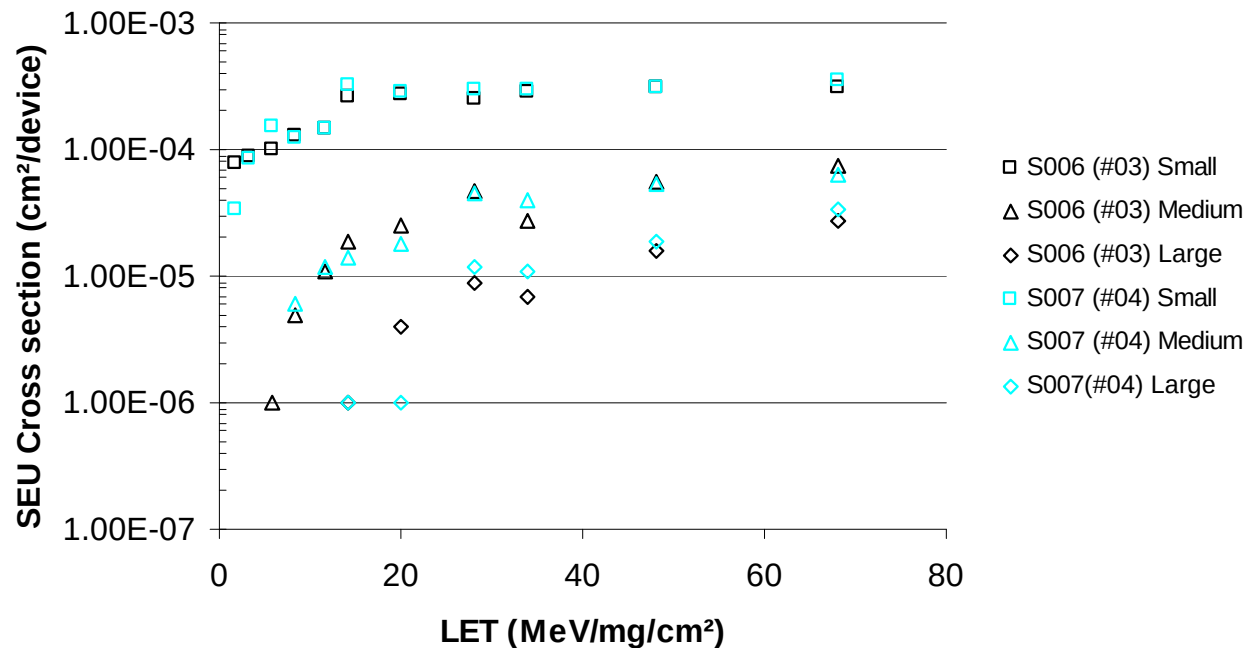


ADC Test Principle

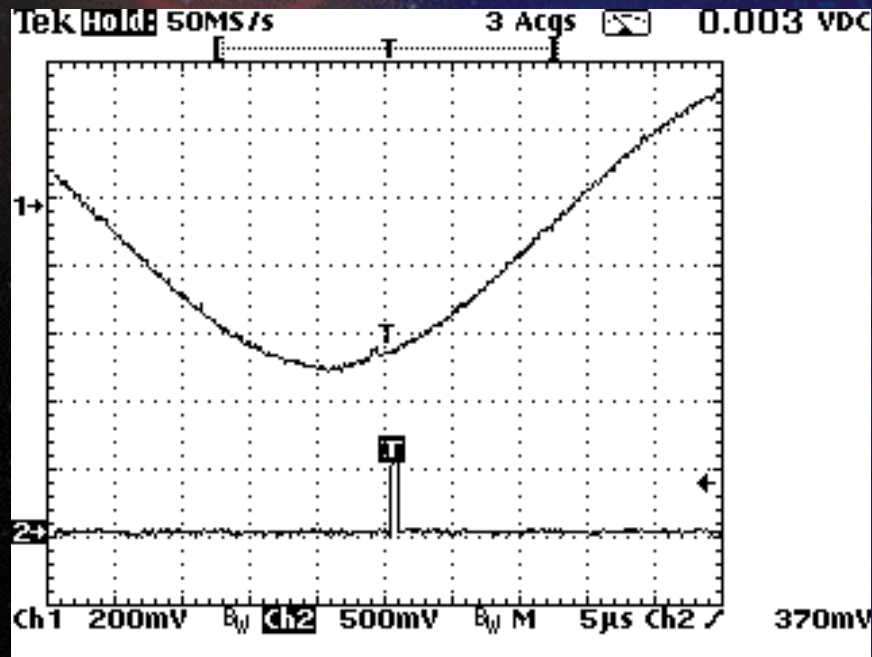
Test board was designed for up to 16 bits ADCs and sampling frequency up to 20MHz



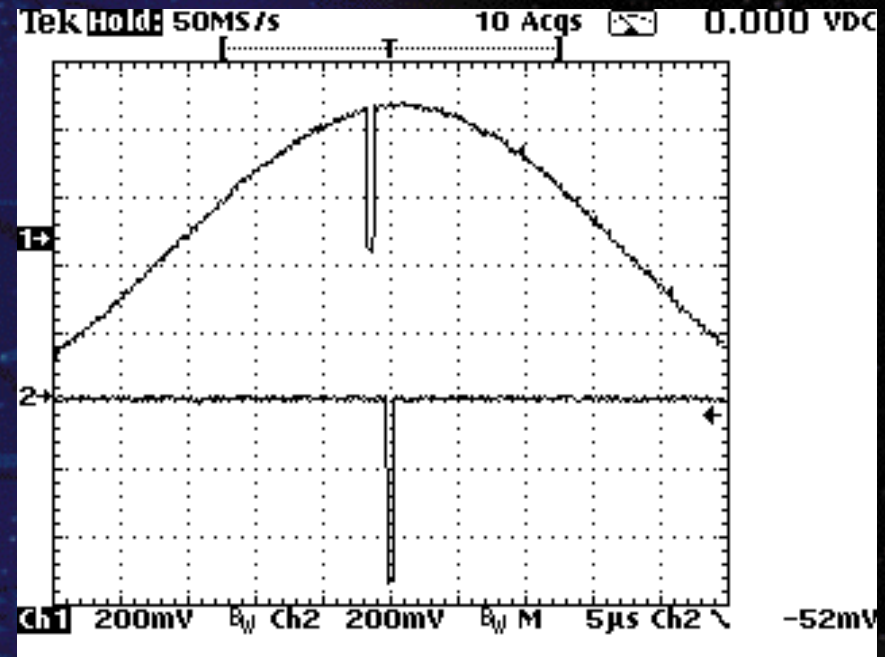
SEE Test Results : LTC1414



SEE Test Results : LT1414



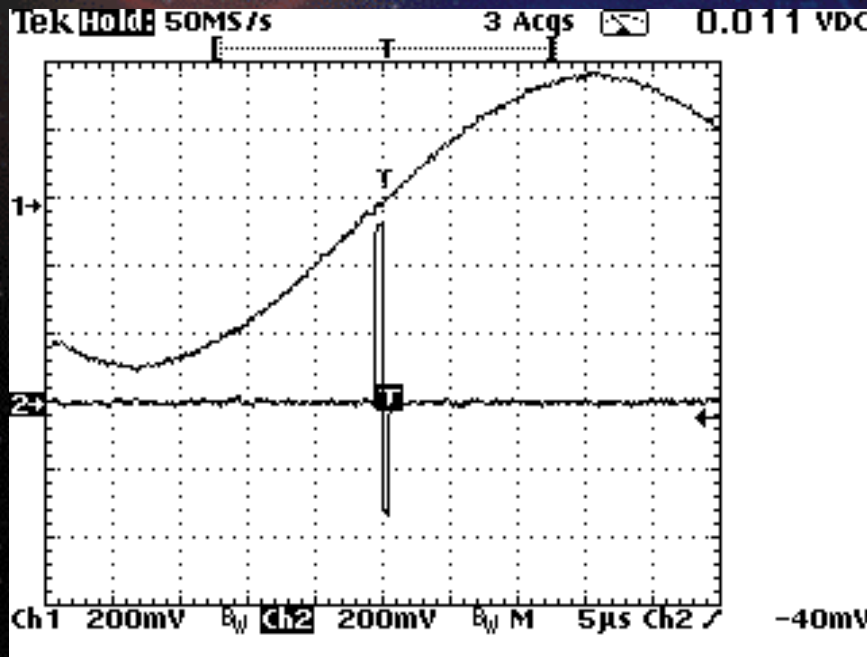
Small error



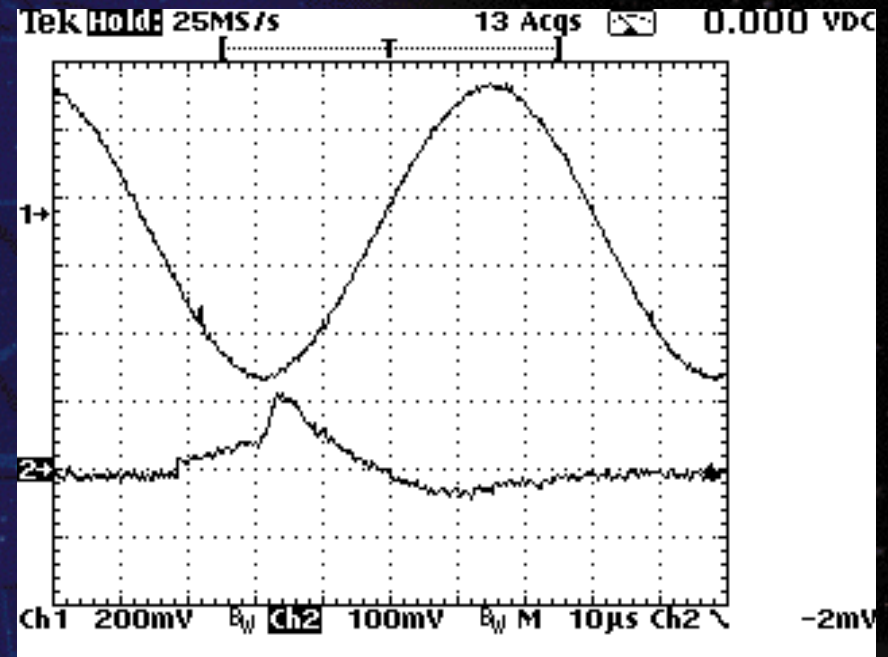
Large error



SEE Test Results : LT1414



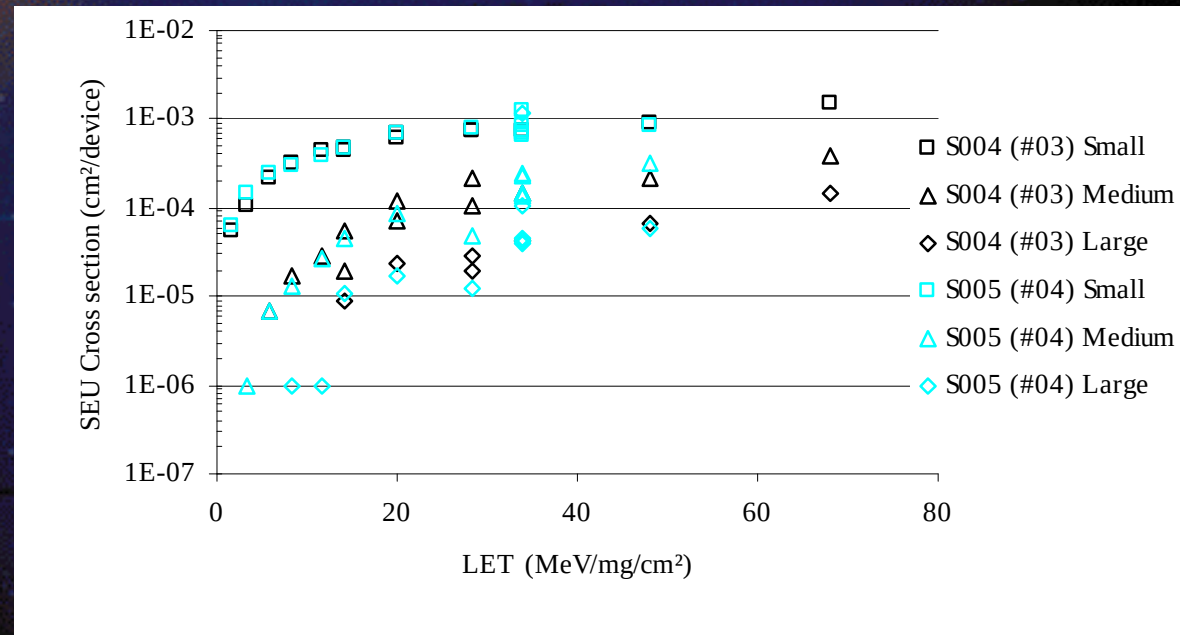
small channel,
two consecutive small events



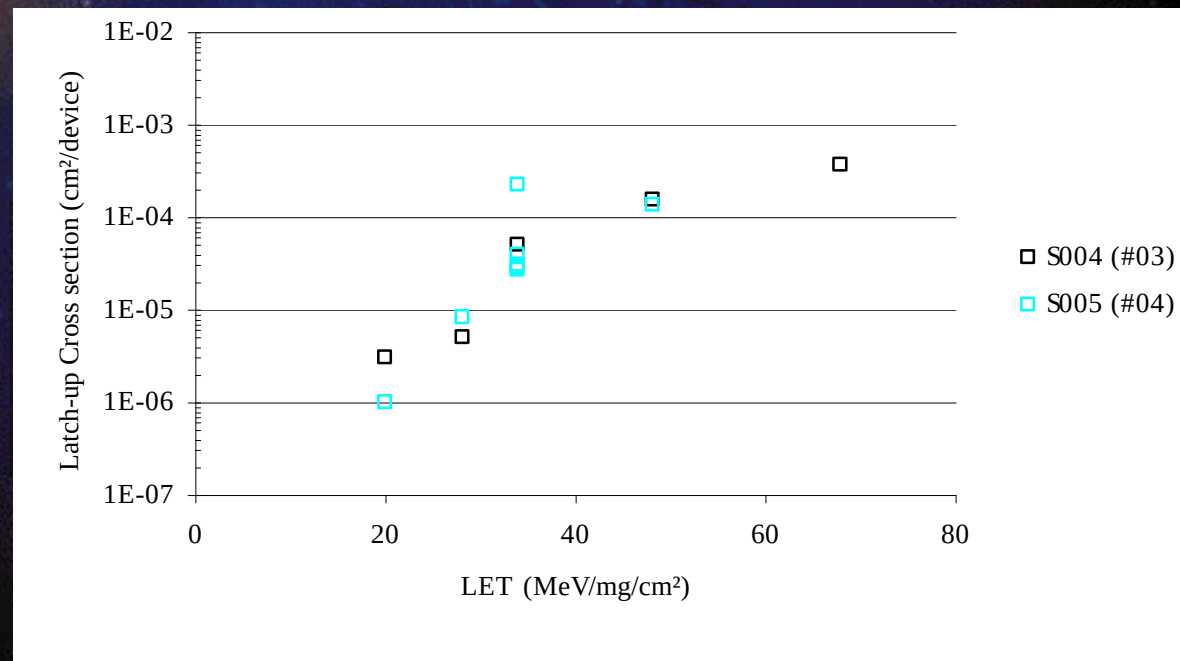
small channel,
analog event



SEE Test Results : AD9243



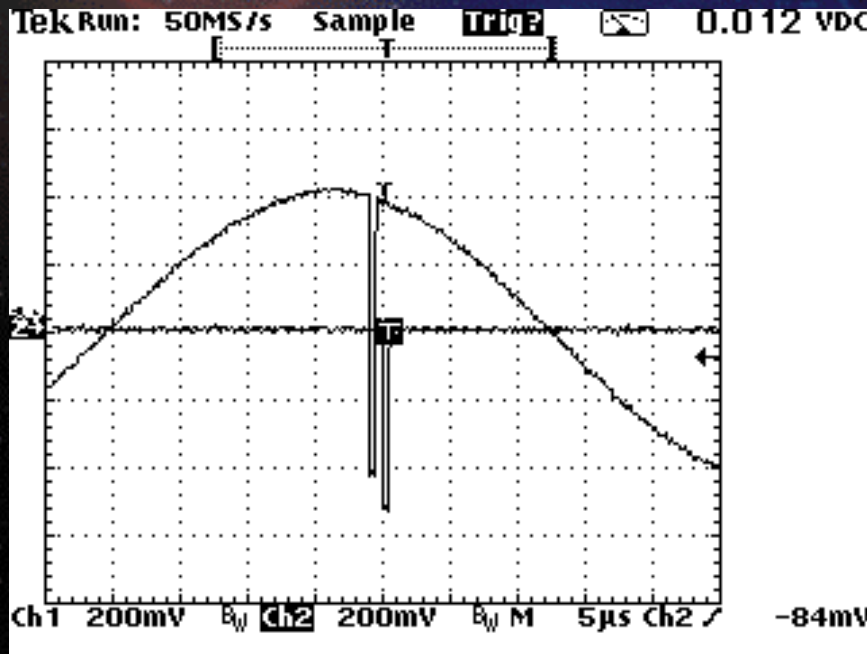
SEE Test Results : AD9243



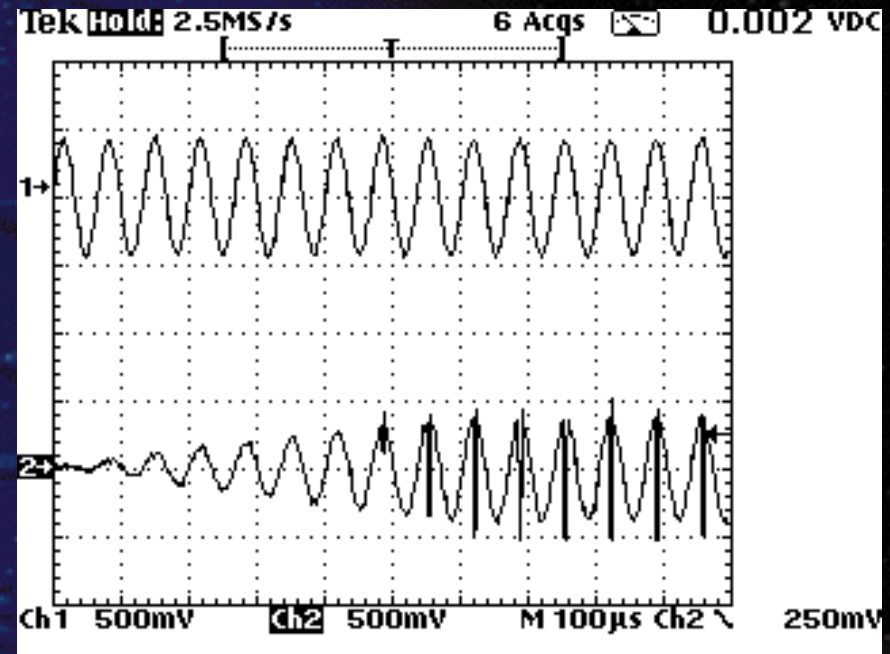
SEL cross-section



SEE Test Results : AD9243



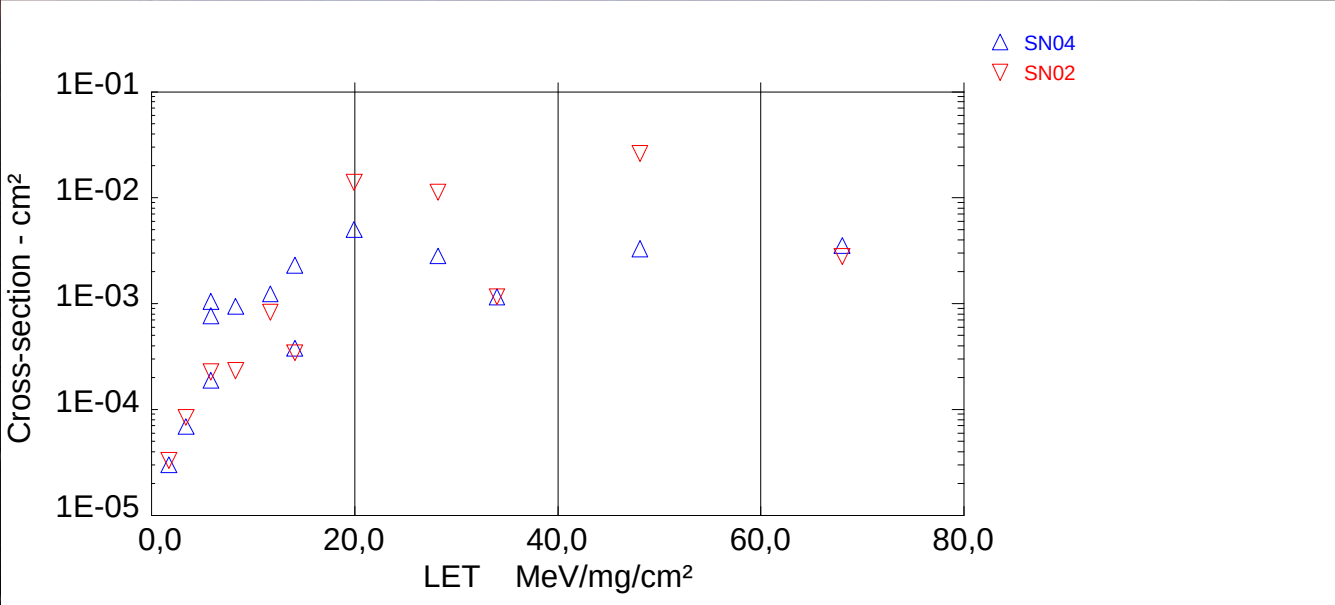
Large channel



Small channel: Sustained latch-up
(below the threshold detection value)



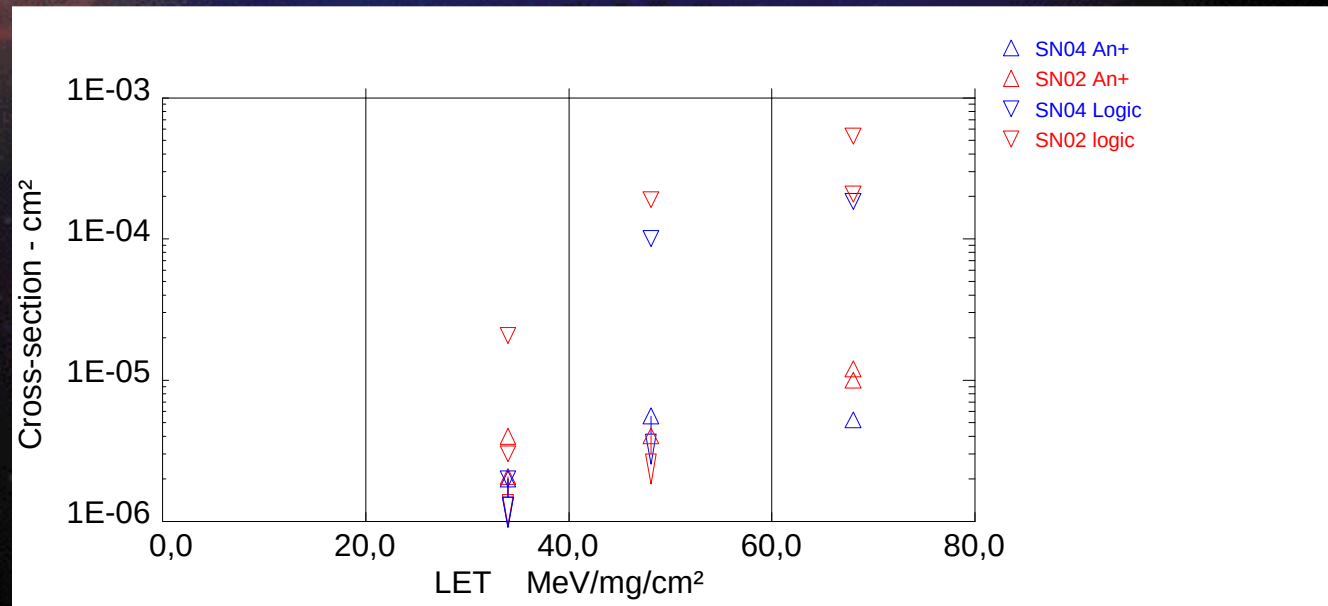
SEE Test Results : ADC14161



Small errors (threshold = +/- 6 LSBs)



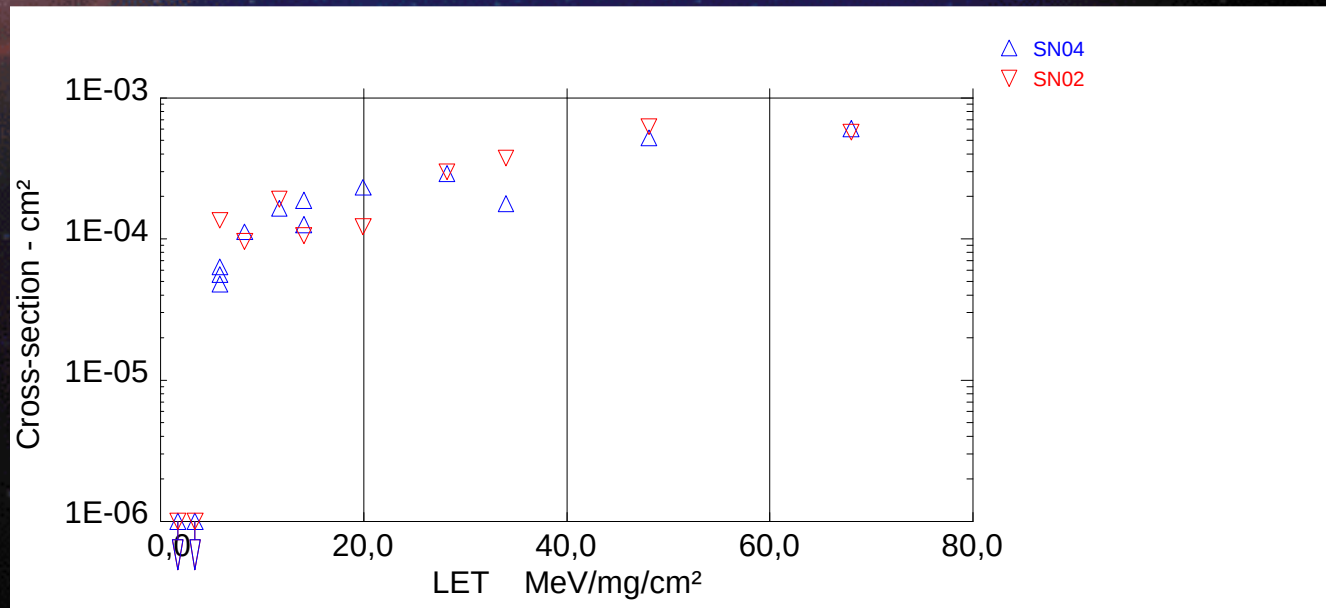
SEE Test Results : ADC14161



SEL cross-section for the two DUT power supplies



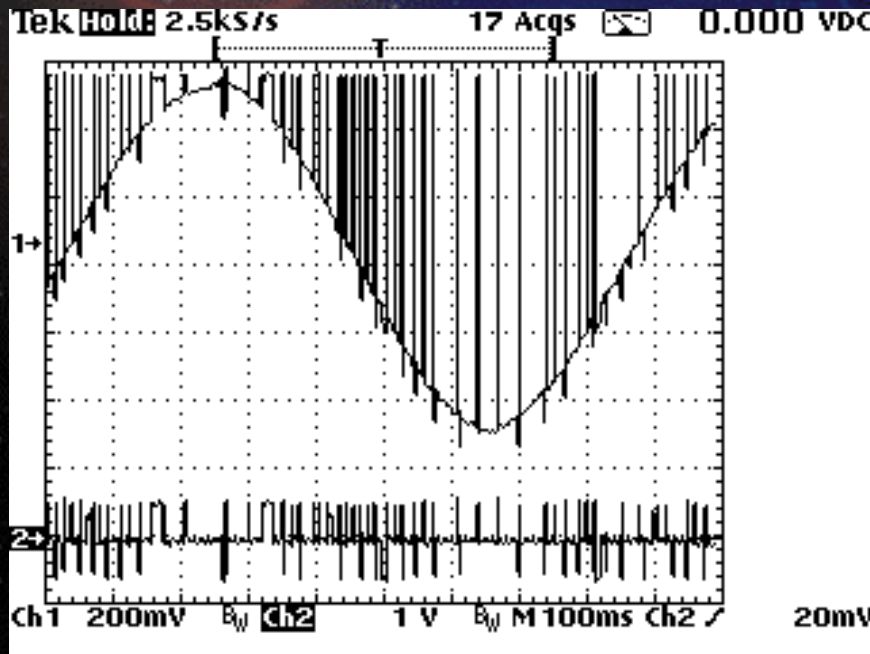
SEE Test Results : ADC14161



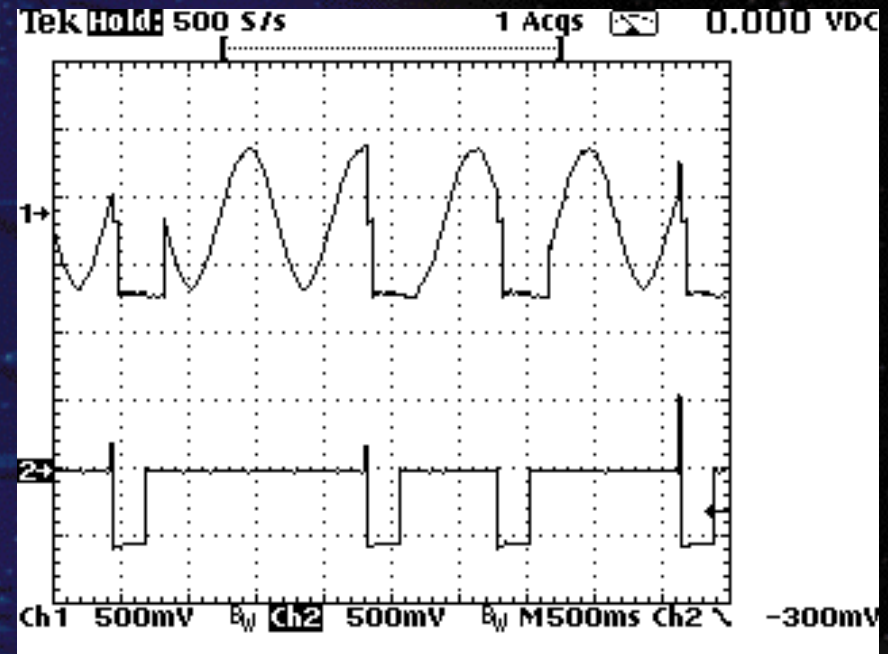
Permanent errors (calibration), SEU device cross-section



SEE Test Results : AD14161



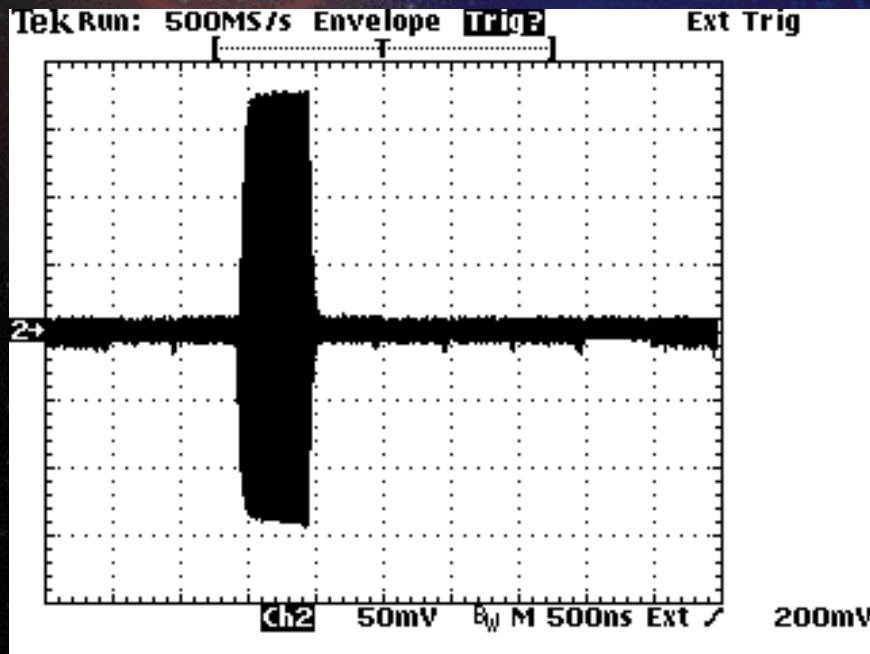
Large channel, permanent error in the calibration memory without DUT reset



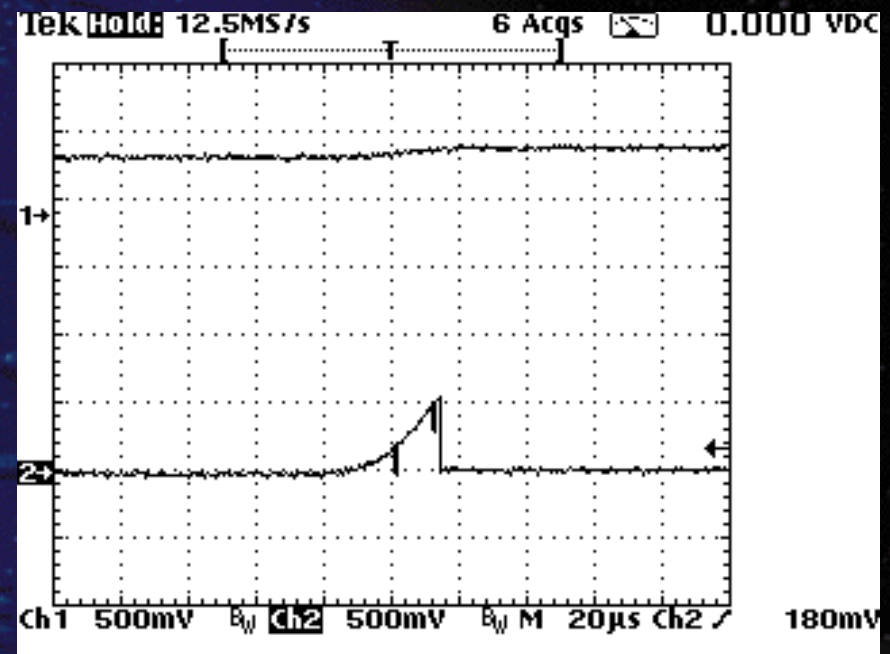
Medium channel, permanent errors detection and DUT reset



SEE Test Results : AD14161



Small channel, error envelop



Medium channel, analog event

