Course: Detectors and Electronics for High Energy Physics, Astrophysics and Space Applications
INFN-Laboratori Nazionali de Legnaro, Italy – April 4-8, 2005.

European SEE Irradiation Facilities and ESA Standards for Radiation Testing.

by

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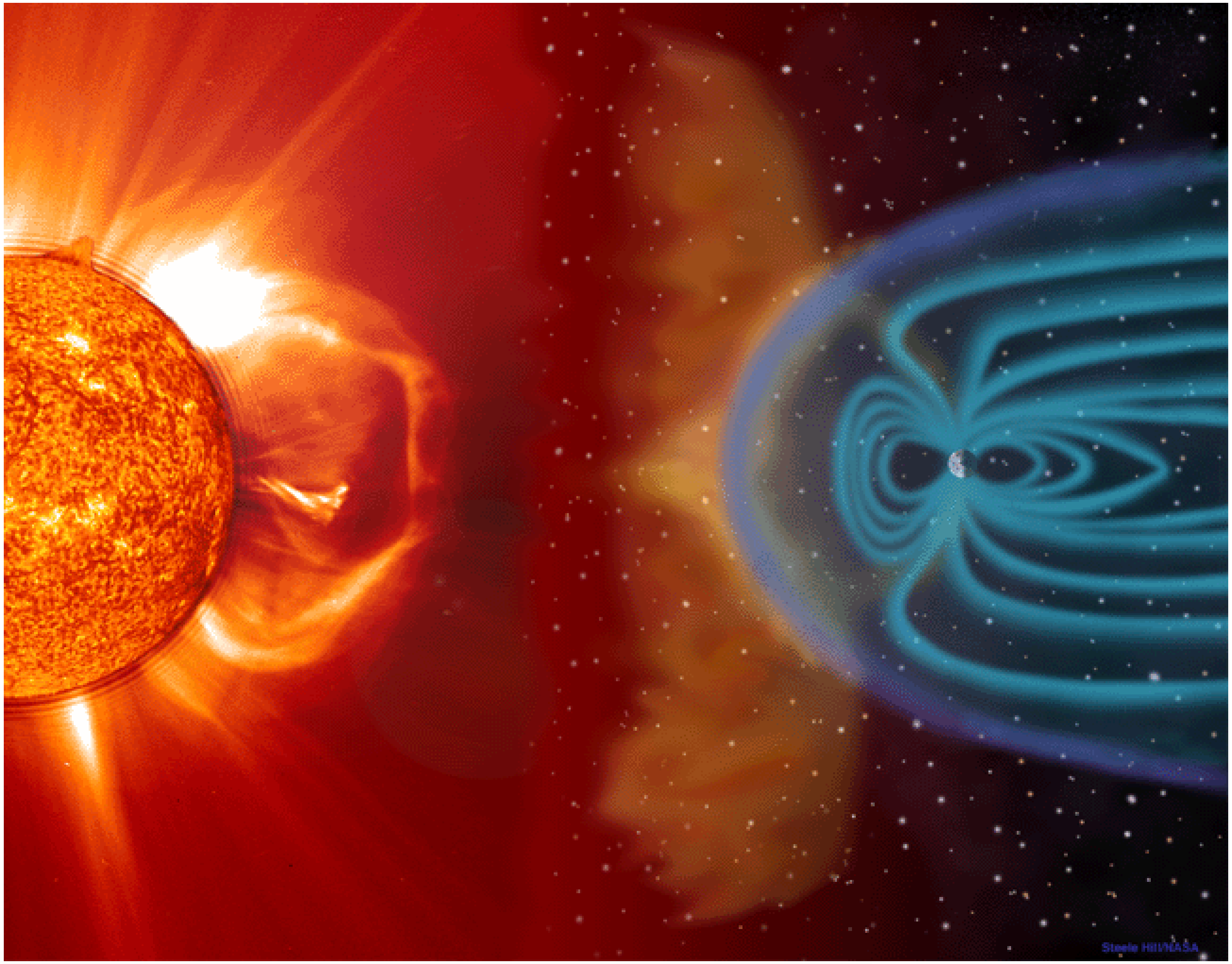
European Space Agency/ESTEC - The Netherlands

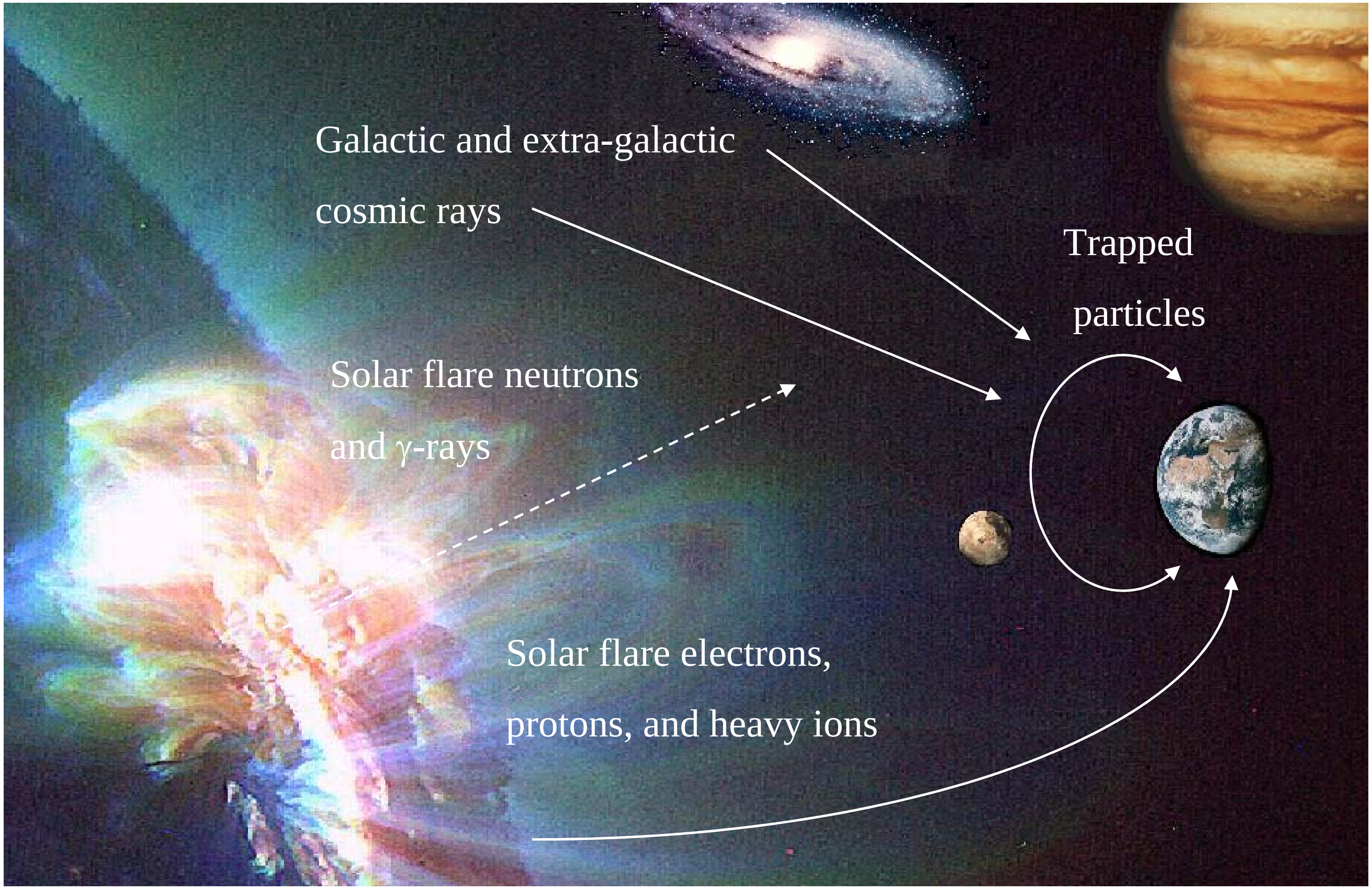
Abstract

Many European irradiation facilities have beam lines dedicated to component and material radiation characterisation and studies. Three of these facilities, under ESA contract, are routinely used during Single Event Effects (SEE) testing and detector calibration. These facilities provide ions and protons similar to those in space.
Following a short introduction on various space environments and a few spacecraft radiation anomalies, this lecture will focus on some of the more popular European accelerators. Their main characteristics will be highlighted before a series of recent radiation data will be presented.

Space Radiation Environments – I.



Space Radiation Environments – II.



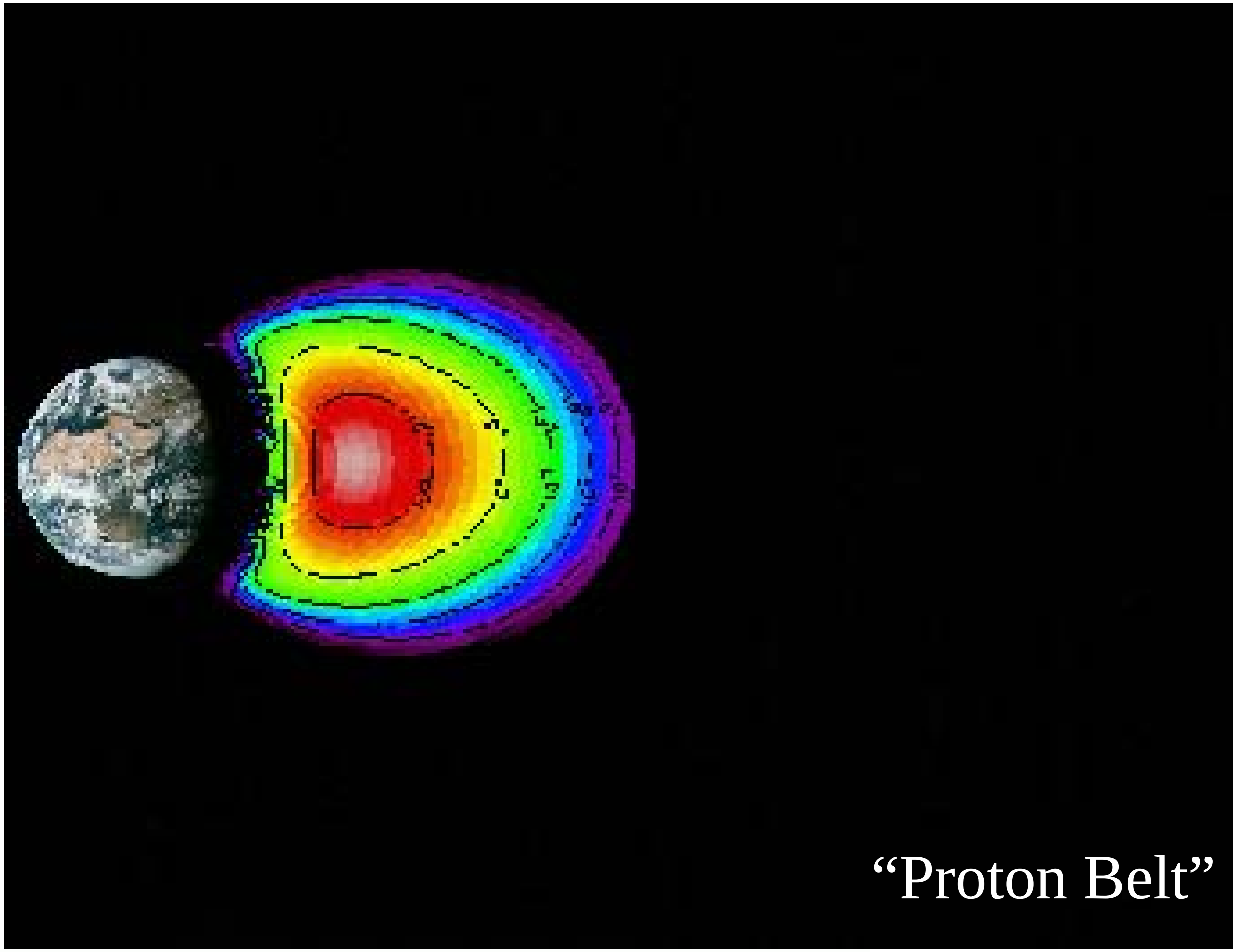
Galactic and extra-galactic cosmic rays

Trapped particles

Solar flare neutrons and γ-rays

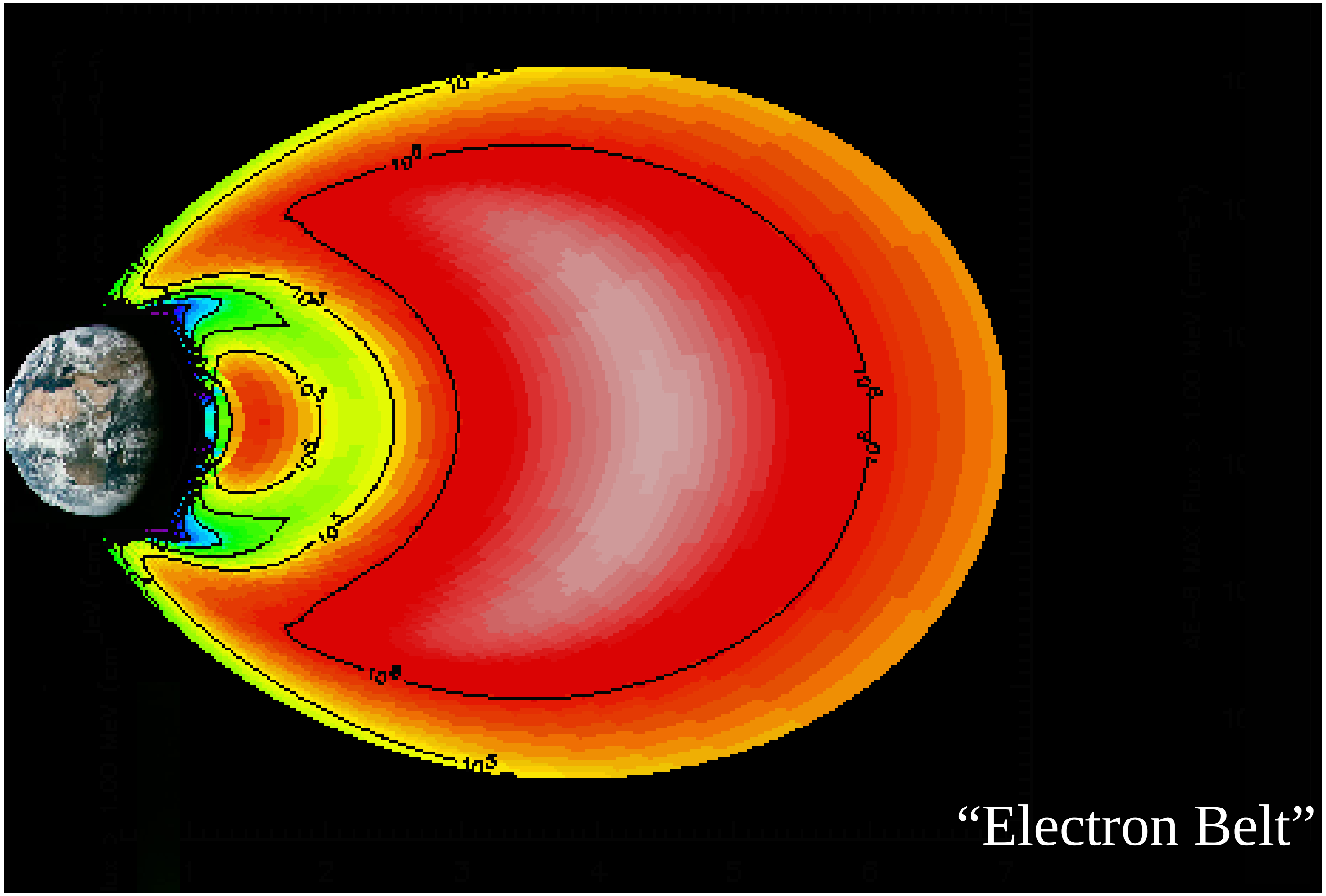
Solar flare electrons, protons, and heavy ions

Space Radiation Environments – III. Radiation Belts – I.



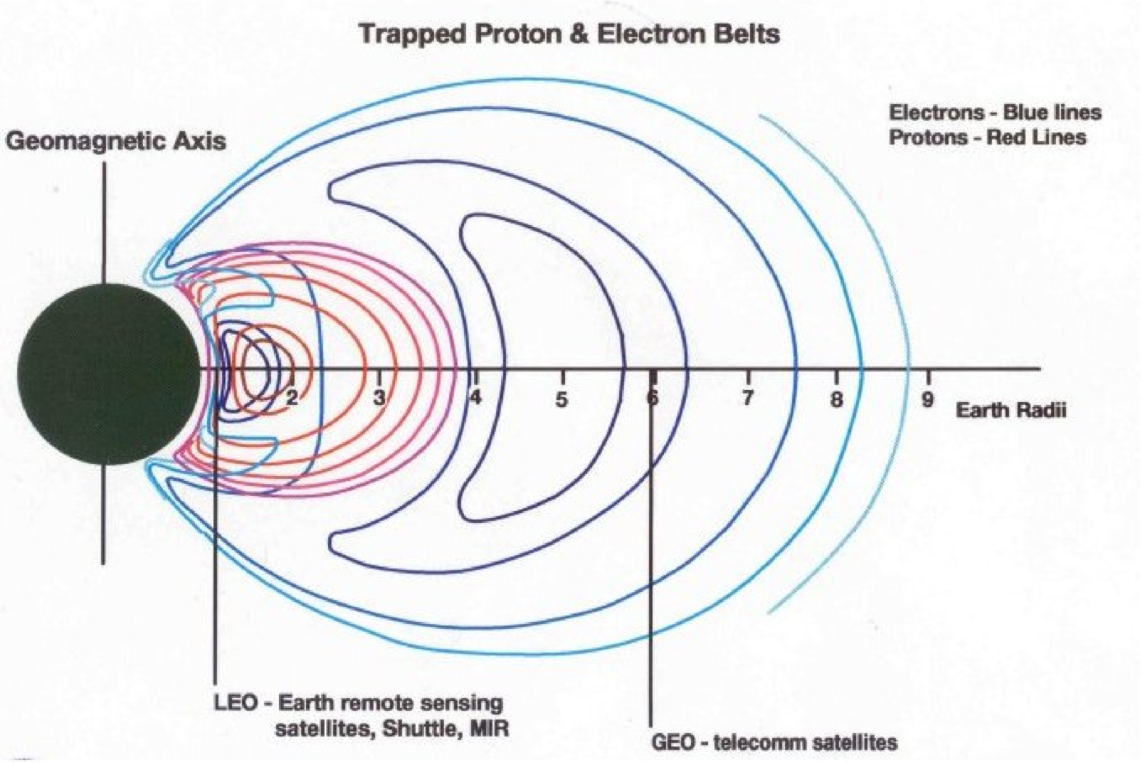
“Proton Belt”

Space Radiation Environments – III. Radiation Belts – II.

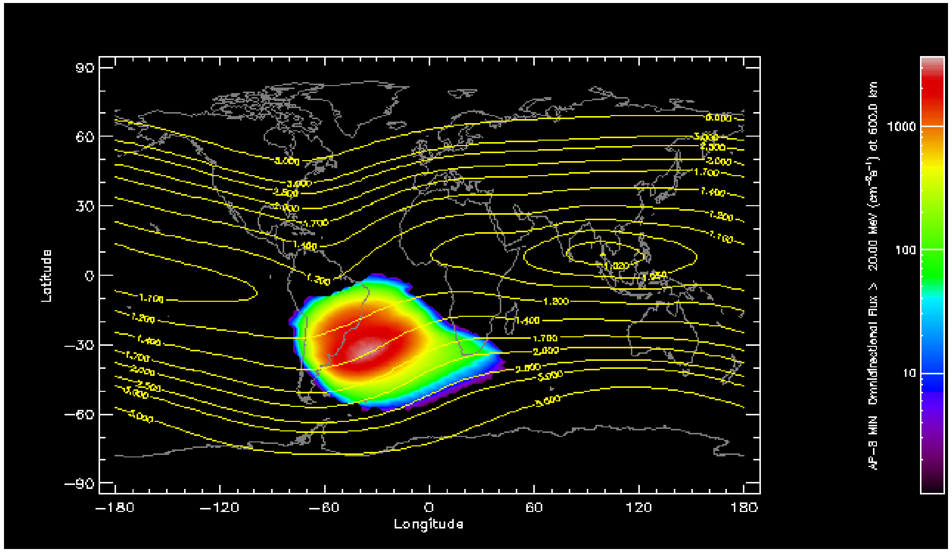


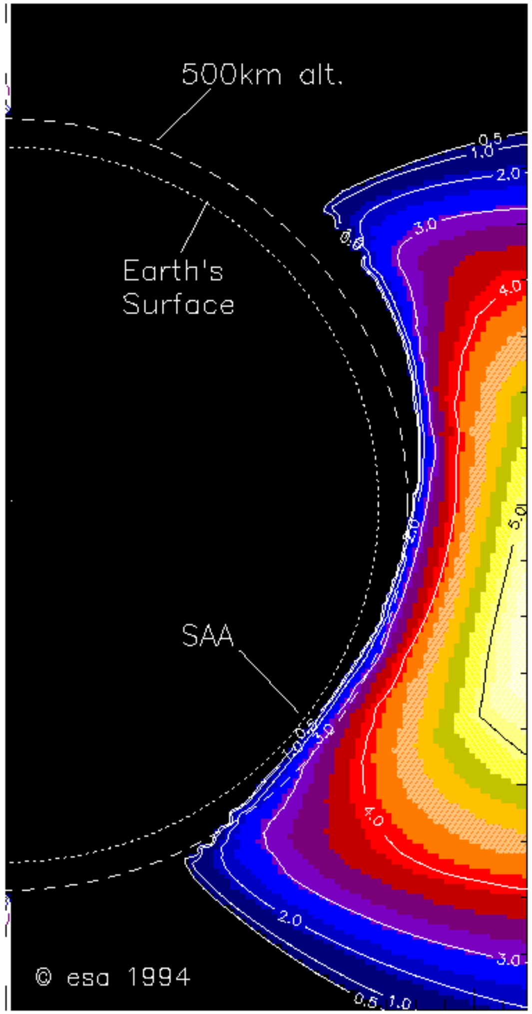
“Electron Belt”

Space Radiation Environments – III. Radiation Belts – III.

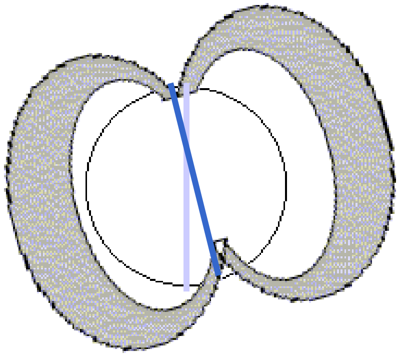


Space Radiation Environments – IV. South Atlantic Anomaly





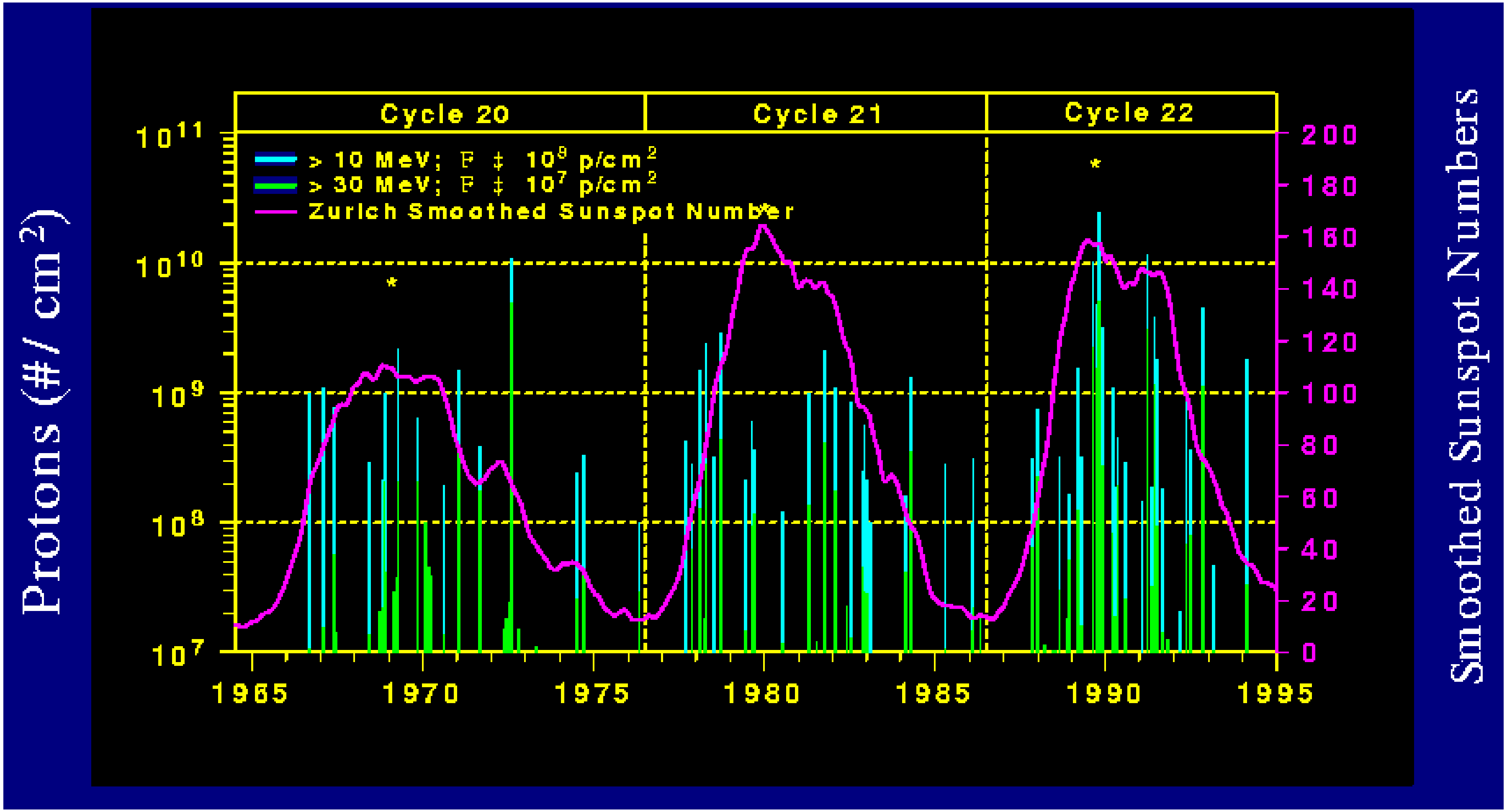
- The Earth's field is tilted by 11^{o} with respect to the rotation axis and offset by 500km towards the North Pacific



ESTEC - Radiation Effects and Analysis Techniques Section

Ref. : INFN Course, Italy, April 8, 2005.

Space Radiation Environments – V. Solar Energetic Particle Events



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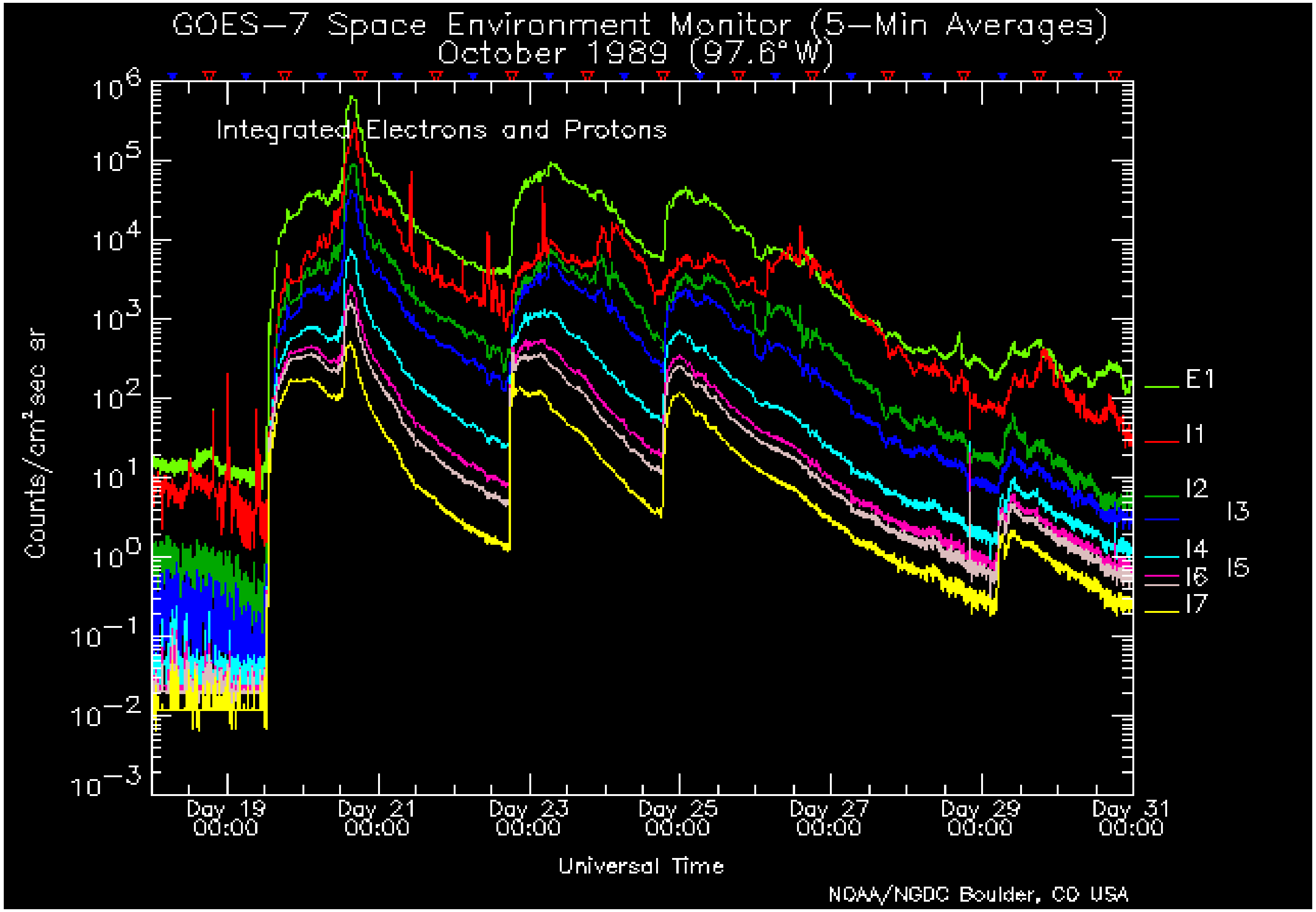
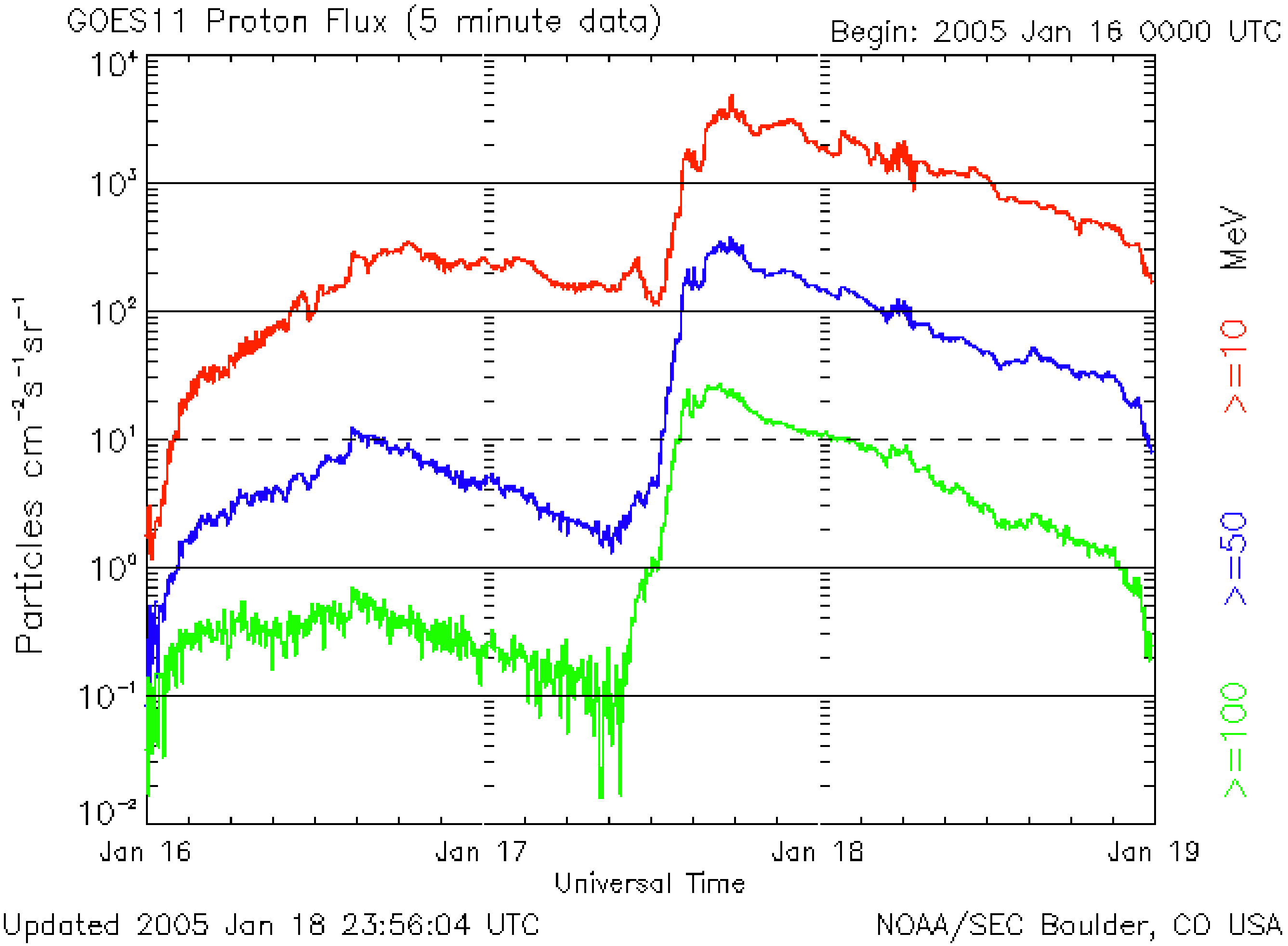
Space Radiation Environments – VIa. Solar Flare October 1989



Space Radiation Environments – VIb. Solar Flare January 2005.



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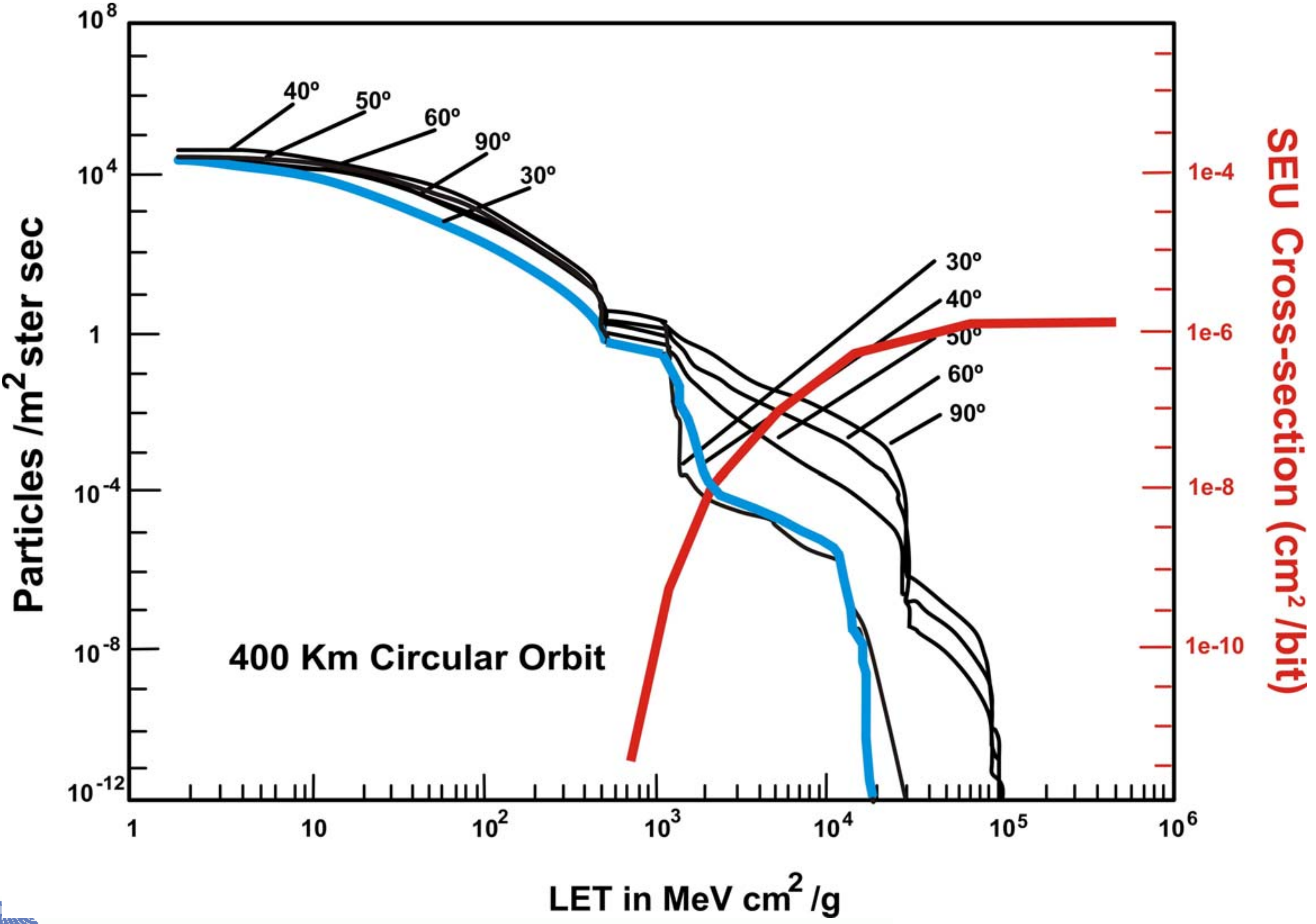
Space Radiation Environments – VII. Low Earth Orbit



Radiation Effects in Components – I.

The Space Radiation Environments

Contains energetic particles –
capable of causing significant damage to spacecraft components

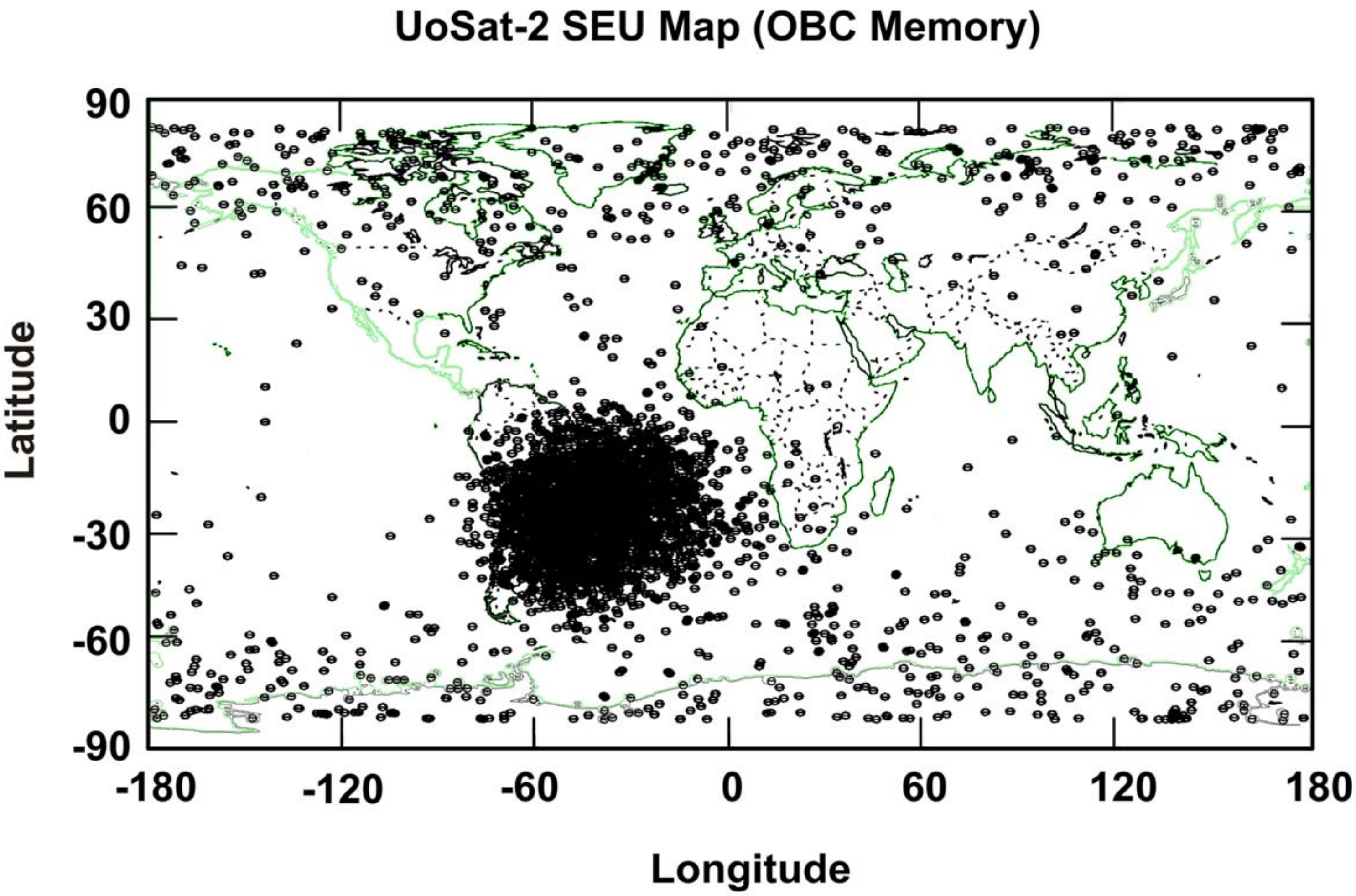
With the result of:

Total Ionization Dose (TID) damage
Displacement Damage
Single Event Effects

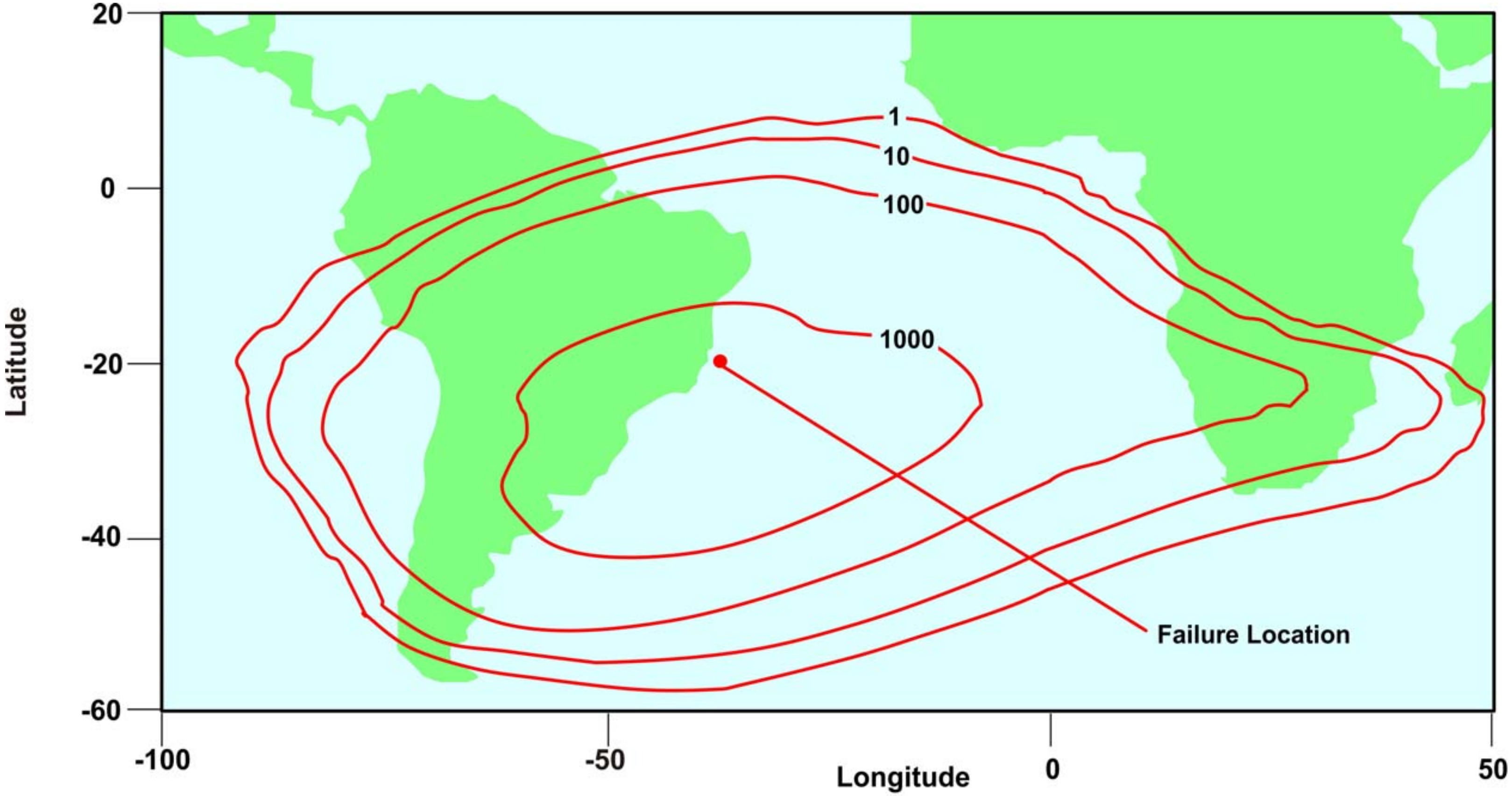
Causing:

- **Degraded performance**
- **Temporary loss of performance**
- **Catastrophic failures**

Spacecraft Radiation Anomalies Ia – SAA SEU.

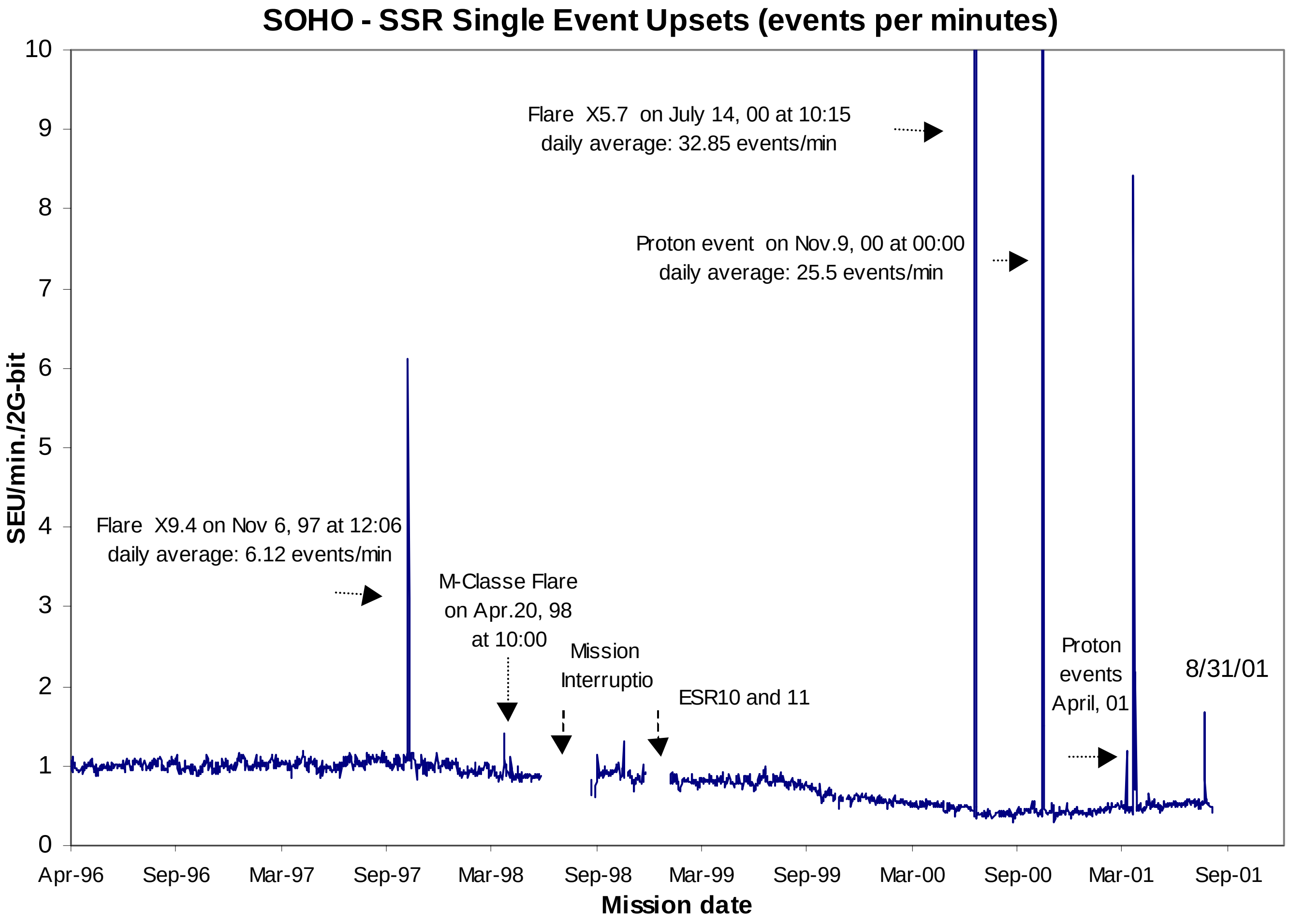


Spacecraft Radiation Anomalies II – ERS-1/PRARE Latch-up.



Failure Location in South Atlantic Anomaly showing
Proton contours (p/cm2/sec)

Spacecraft Radiation Anomalies III – SOHO/SSR SEU SMJ44100



SOHO - SSR Single Event Upsets (events per minutes)

Flare X5.7 on July 14, 00 at 10:15
daily average: 32.85 events/min

Proton event on Nov.9, 00 at 00:00
daily average: 25.5 events/min

Flare X9.4 on Nov 6, 97 at 12:06
daily average: 6.12 events/min

M-Classe Flare
on Apr.20, 98
at 10:00

Mission
Interruptio

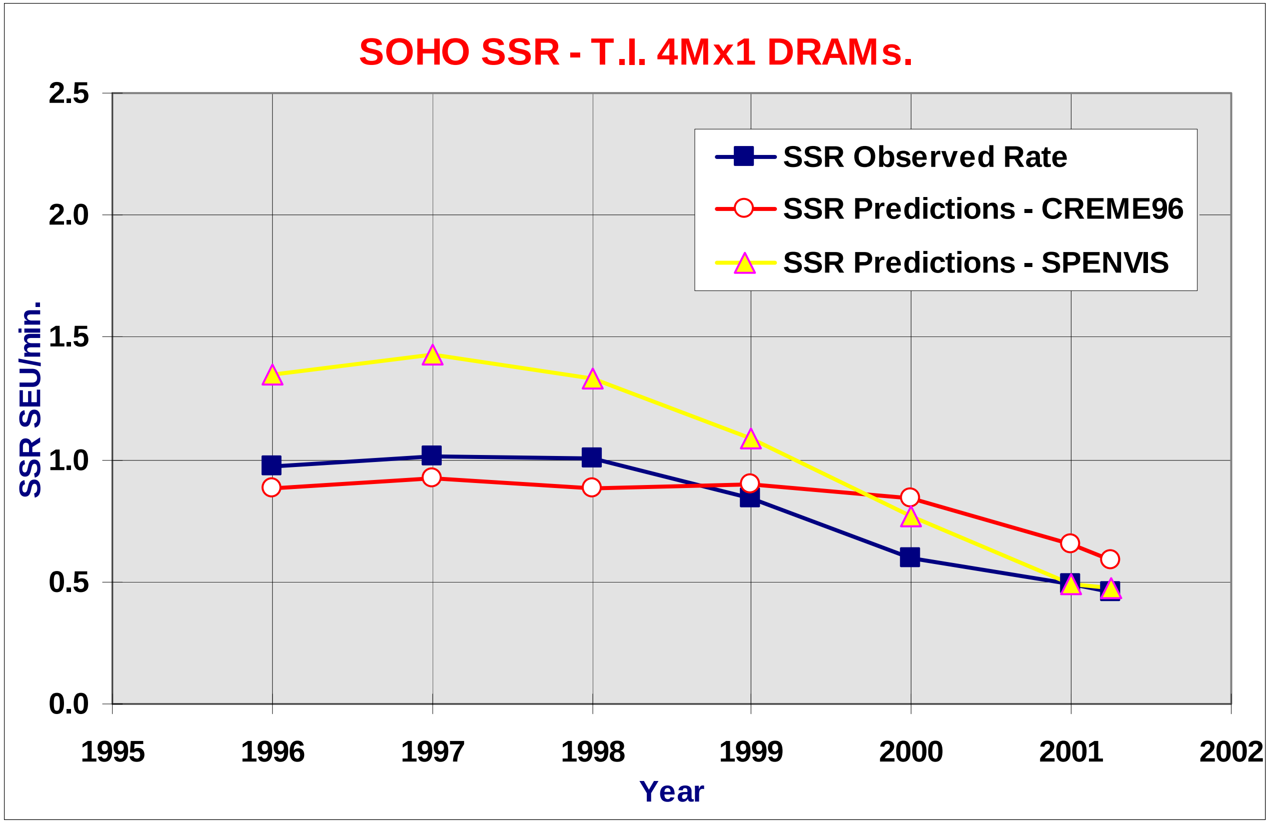
ESR10 and 11

Proton
events
April, 01

8/31/01

Monitored 1562 days – 1.0 to 0.5 SEU/min.

SOHO - CREME96/SPENVIS SEU PREDICTIONS



SSR - Observations versus predictions

Radiation Evaluation of Components – I.

- A large number of ground simulation testing is carried out –
    - Total Ionization Dose – Co-60 gamma
    - Displacement Damage – Accelerators (Protons)
    - Single Event Effects – Accelerators (Heavy ions & Protons)

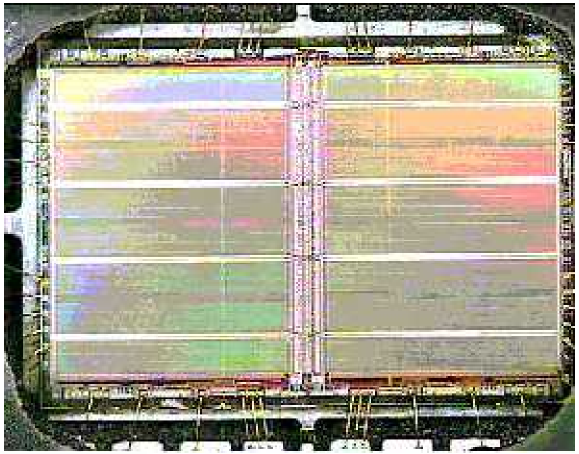
- Several European Accelerator Facilities have Ions and Proton Energies suitable for SEE testing – 3 under ESA contract:
    - Proton Irradiation Facility (PIF) at the Paul Scherrer Institut (PSI), Villigen, Switzerland – (used since 1992).
    - Heavy ion Irradiation Facility (HIF) at the University Catholique de Louvain (UCL), Louvain-la-Neuve, Belgium – (used since 1996).
    - RADiation Effects Facility (RADEF) at the University of Jyväskylä, Jyväskylä, Finland – (used since now).

Radiation Evaluation of Components for Space Aapplications I.

TID Co-60 Testing
- No device preparation required

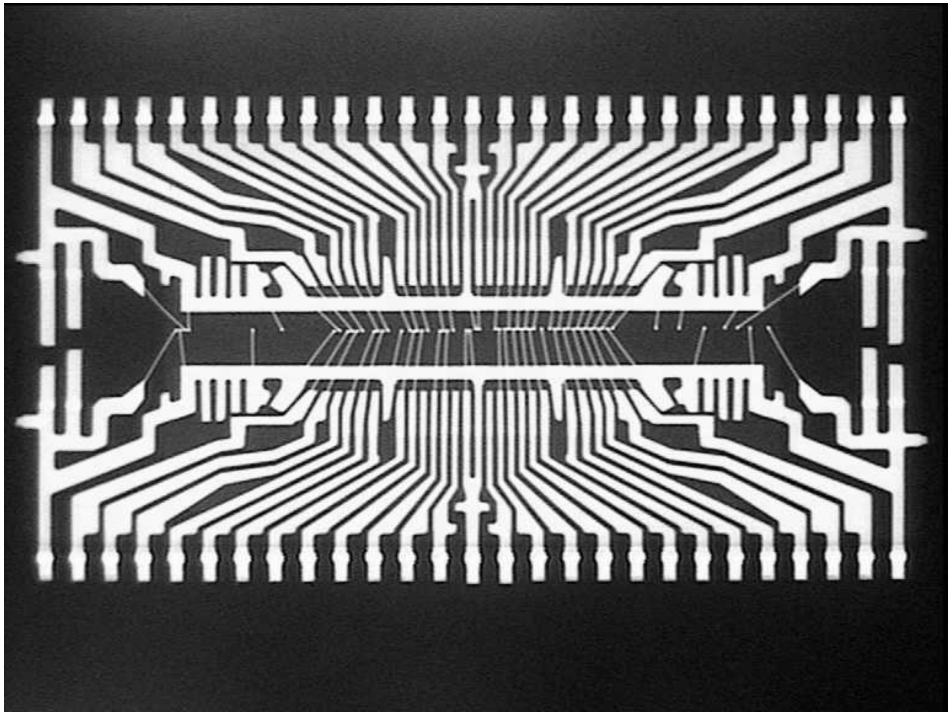
SEE Proton Testing
- No device preparation required

SEE Heavy ion Testing
- Device preparation required



Radiation Evaluation of Components for Space Applications – II.

- Today, nearly all memories are assembled with centre bond pads and a lead frame on top of the die.

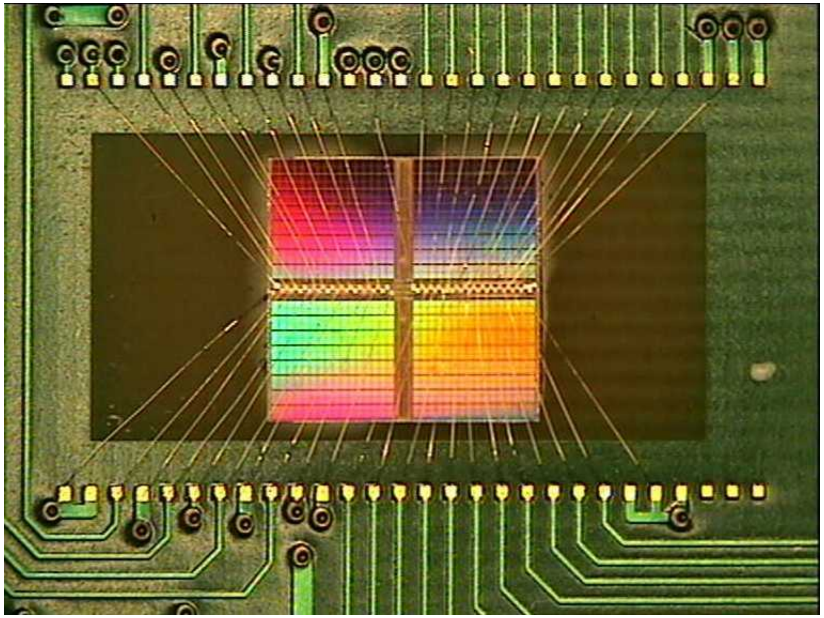


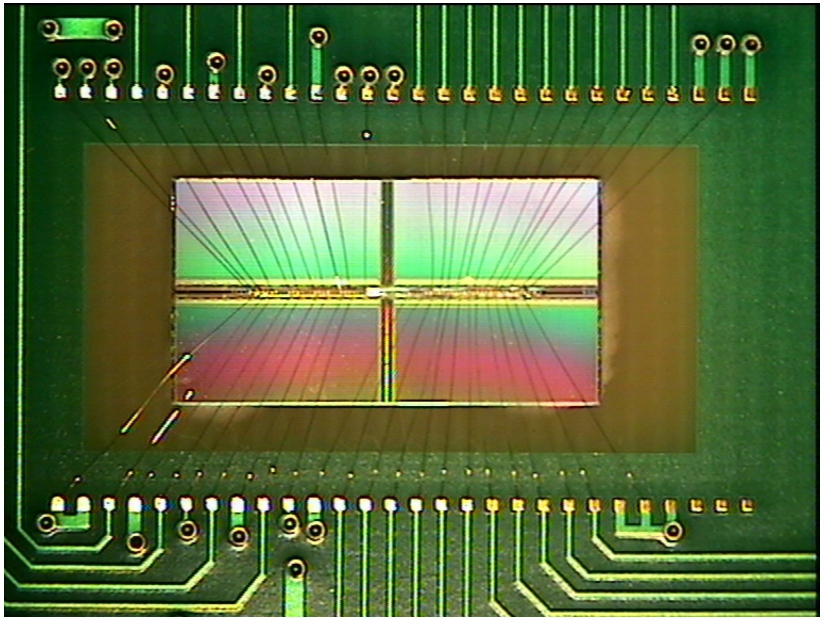
X-ray of Hitachi 256-Mbit SDRAM in 54-pin TSOP (plastic package).

Etched/re-bonded Preparation Method

Etched/re-bonded (Micron 128-Mbit and Hyundai 256-Mbit)

- To Chemical etch the package
- Remove the lead frame
- Re-bond the bare die to a test board
- Irradiation from the front

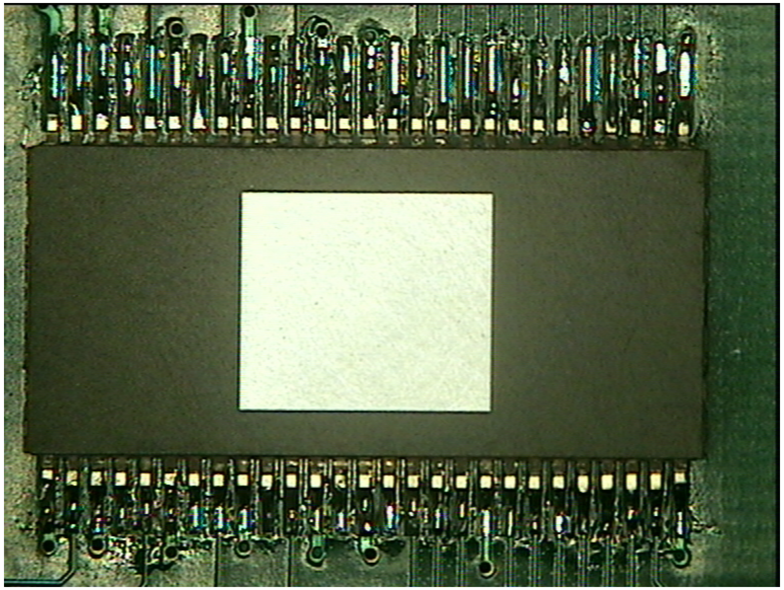


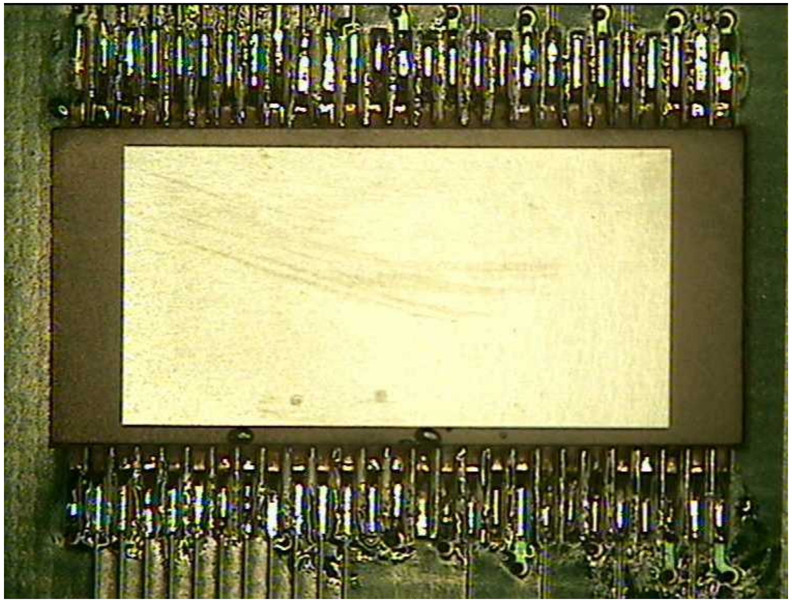


Back Thinning Preparation Method

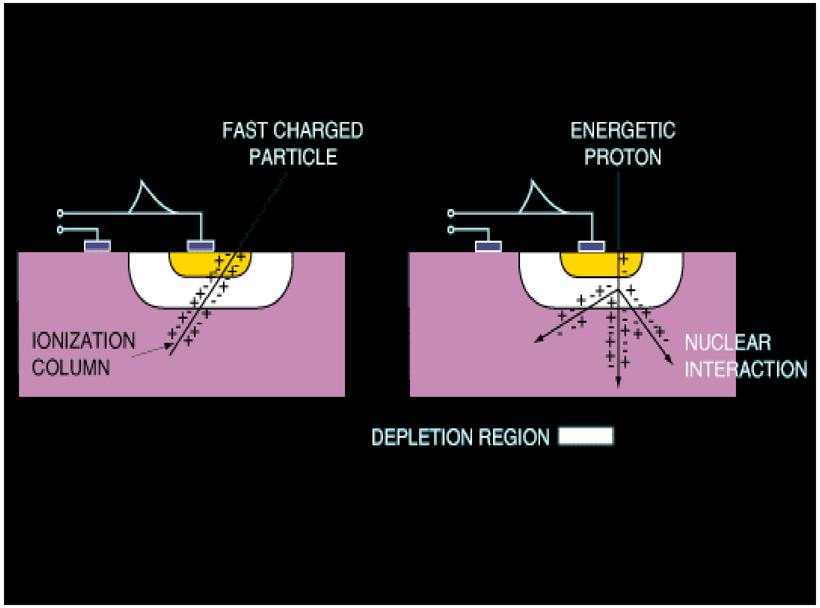
Back thinned (Micron 128-Mbit and Hyundai 256-Mbit)

- To thin the back of the package/die to about 50 µm
- Main assembly remains untouched
- Requires irradiation from the back
- Accelerator Ion penetration problem





Radiation Effects in Components – II. Single Event Effects



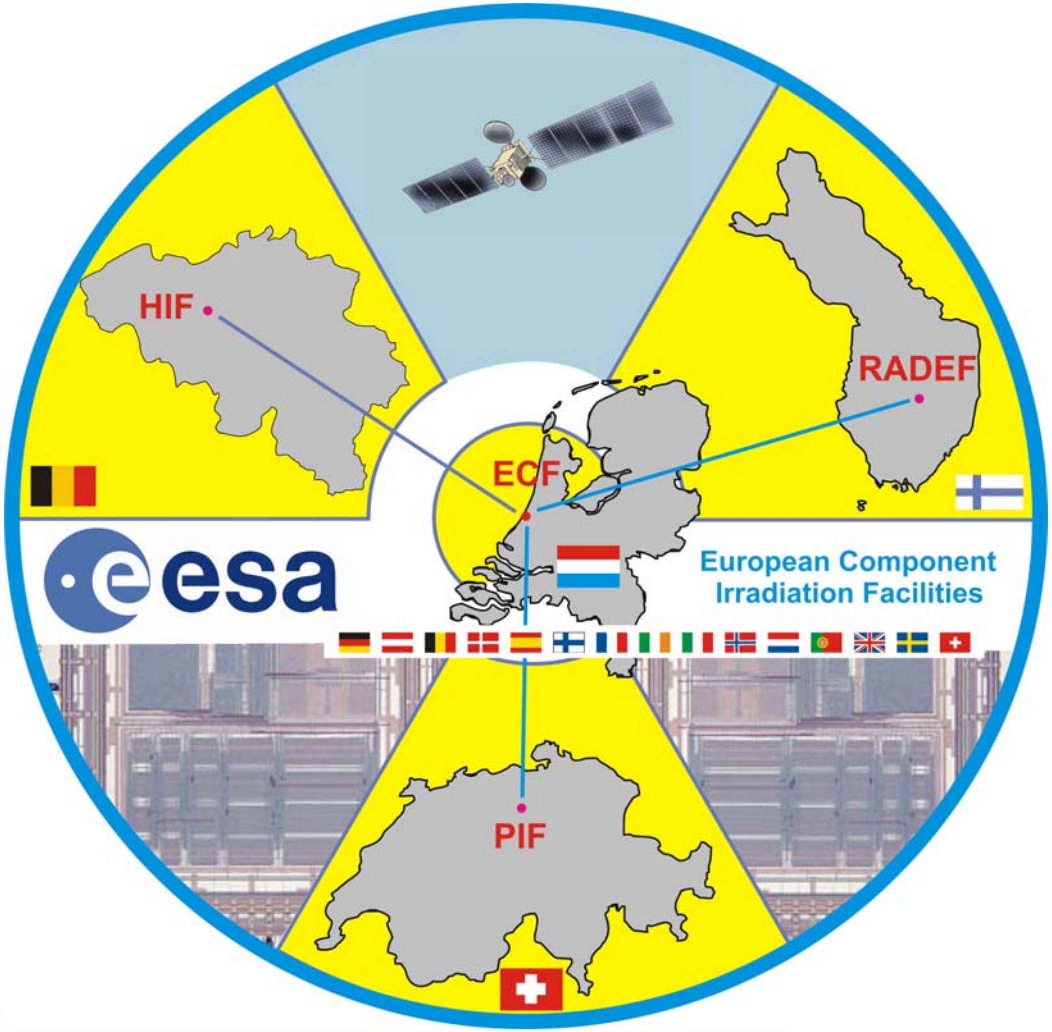
Non Destructive SEE

- Single Event Upset (SEU)
- Multiple Bit Upset (MBU)
- Single Event Transient (SET)
- Single Event functional Interrupt (SEFI)

Destructive SEE

- Single Event Latch-up (SEL)
- Single Event Gate Rupture (SEGR)
- Single Event Burn-out (SEB)

European Component Irradiation Facilities - I.



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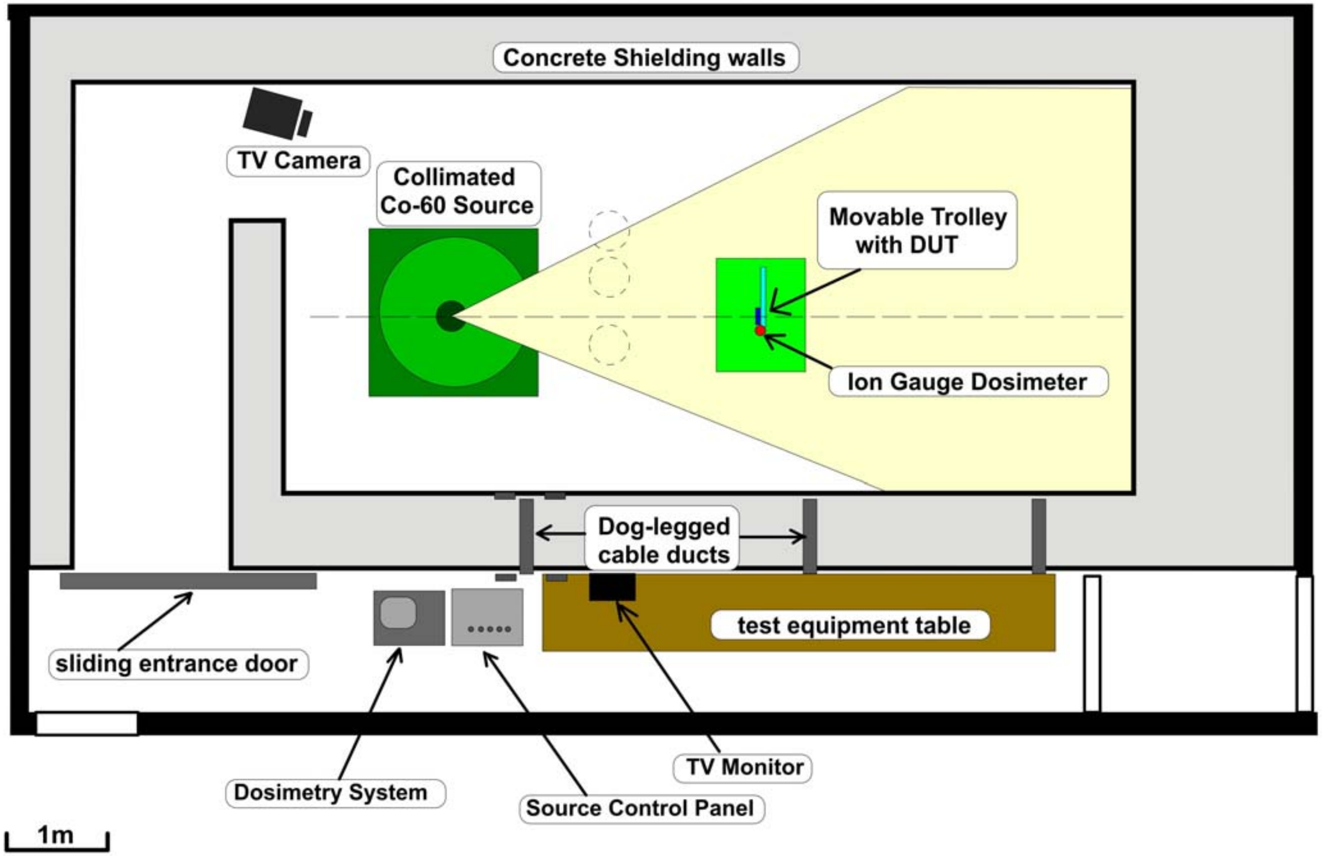
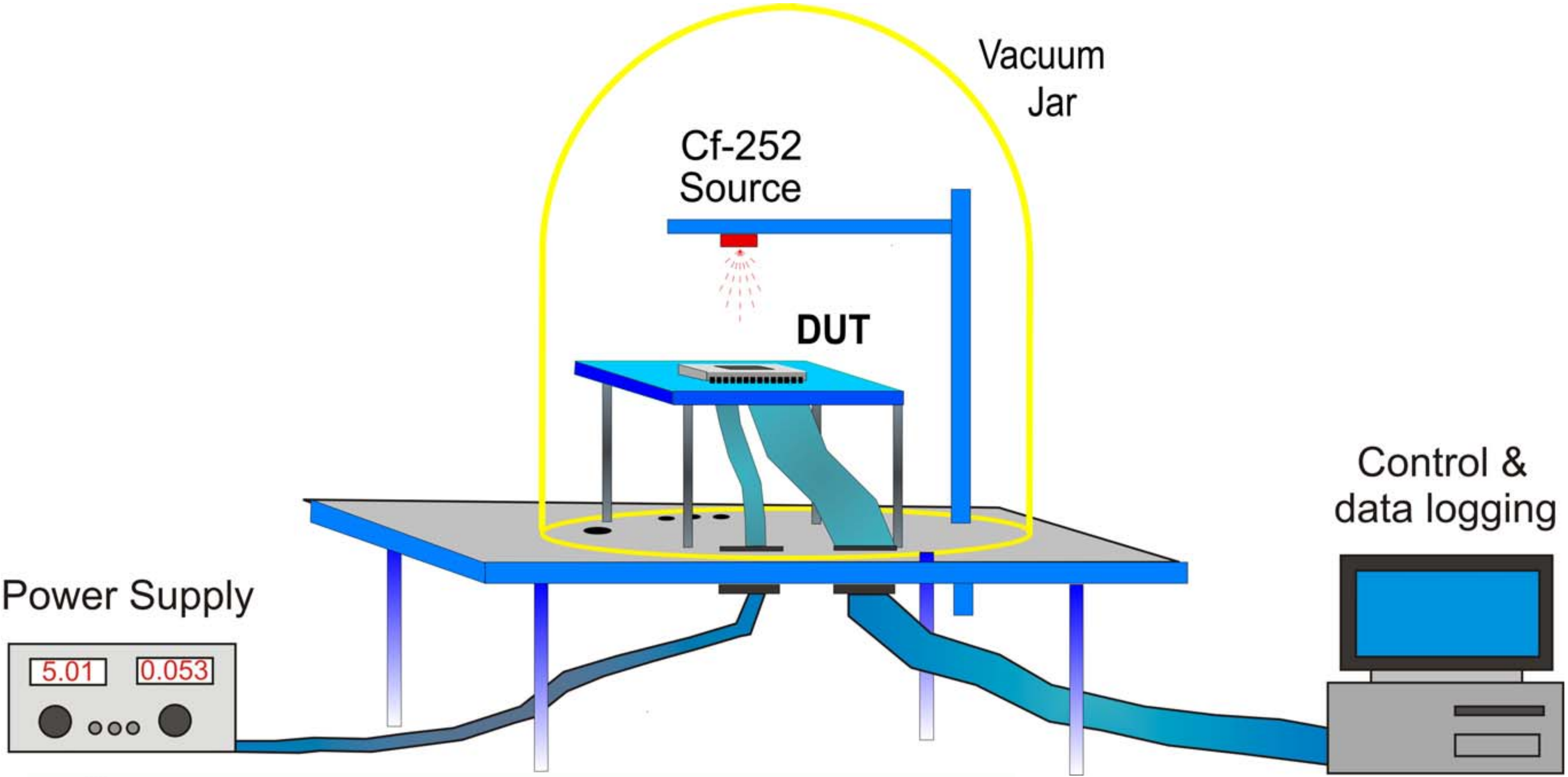
European Component Irradiation Facilities – ESTEC TID (Co-60).



Estec 2000 Ci Co-60 Facility

European Component Irradiation Facilities – ESTEC CASE (Cf-252).



Ref. : INFN Course, Italy, April 8, 2005.

European Component Irradiation Facilities – PIF
Proton Irradiation Facility, Paul Scherrer Institut (PSI).

The PIF, constructed in cooperation between PSI and ESA, has been used extensively by the space community as well as by research teams since – May 1992.

Initially, irradiation experiments were performed in the large Nucleon Area (NA2) using protons of energies between 35 and 300 MeV.

European Component Irradiation Facilities – PIF Proton Irradiation Facility, Paul Scherrer Institut (PSI).

PIF Main Features

A) General

- Irradiation take place in air
- Fux/Dosimetry ~5 % absolute accuracy
- HIF compatible sample frame is fixed on XY table

B) High Energy PIF

- Initial Energies: 254, 100 and 60 MeV.
- Energy range: 30 to 254 MeV
- Maximum Proton flux (254 MeV): 2.5E8 p/cm2/sec
- Beam spot ~90 mm diameter
- Beam uniformity > 90 %

European Component Irradiation Facilities – PIF
Proton Irradiation Facility, Paul Scherrer Institut (PSI).

PIF Main Features

A) General

- Irradiation take place in air
- Fux/Dosimetry ~5 % absolute accuracy
- HIF compatible sample frame is fixed on XY table

C) Low Energy PIF

- Energy range: 6 to 71 MeV
- Maximum Proton flux : 5E8 p/cm2/sec
- Beam spot ~50 mm diameter
- Beam uniformity > 90 %

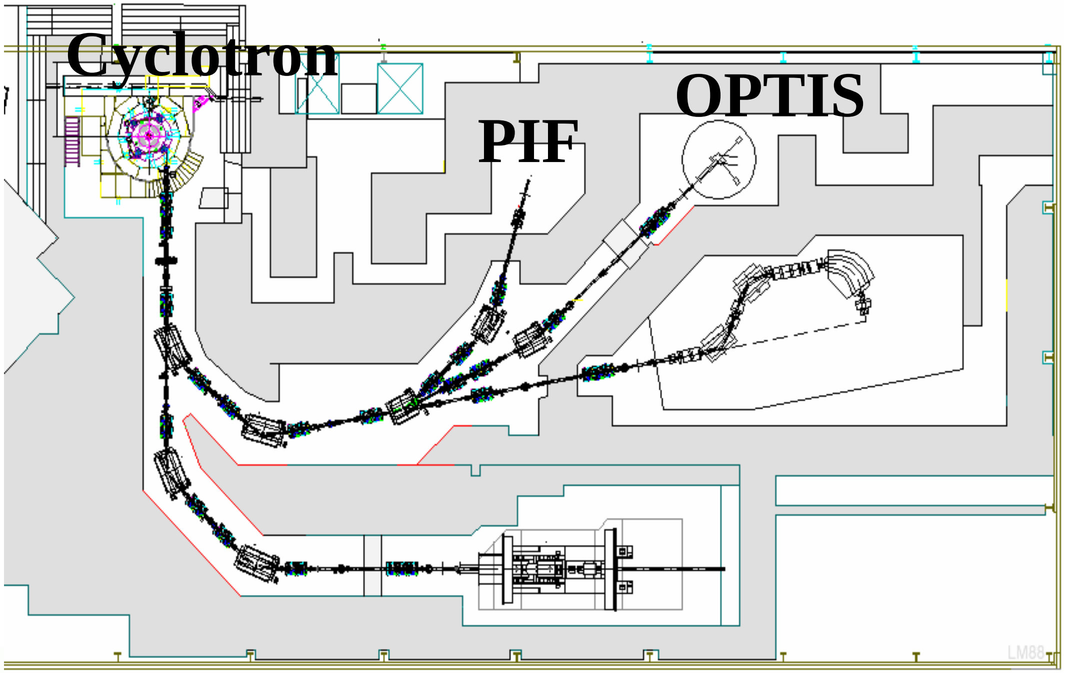
European Component Irradiation Facilities – PIF
Proton Irradiation Facility, Paul Scherrer Institut (PSI).

Proscan Project

This new PIF will merge the low and high energy facilities into one and provide a wide range of proton energies from 5 up to 255 MeV.

The construction works for the Proscan project started back in 2002.

The new cyclotron together with the new PIF will be commissioned at the end of 2006.



European Component Irradiation Facilities – PIF
Proton Irradiation Facility, Paul Scherrer Institut (PSI).

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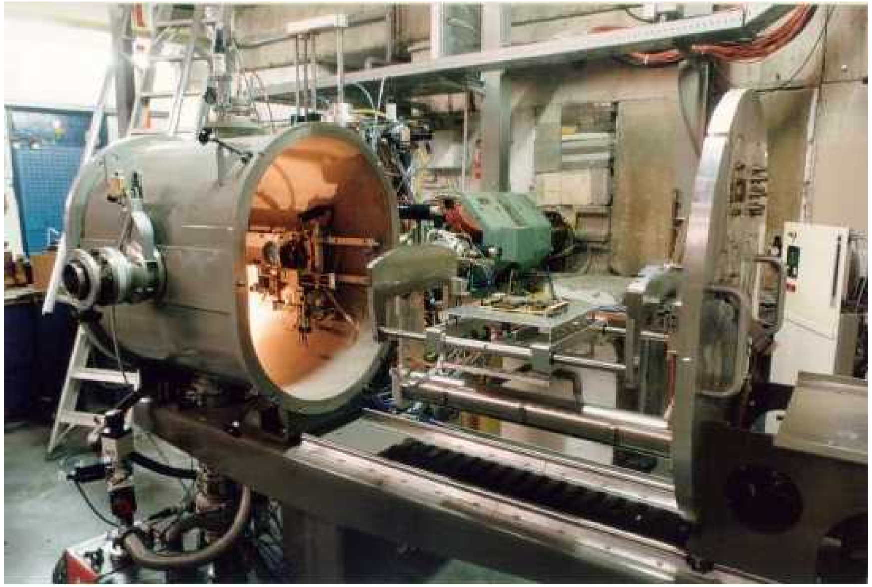
Future PIF area

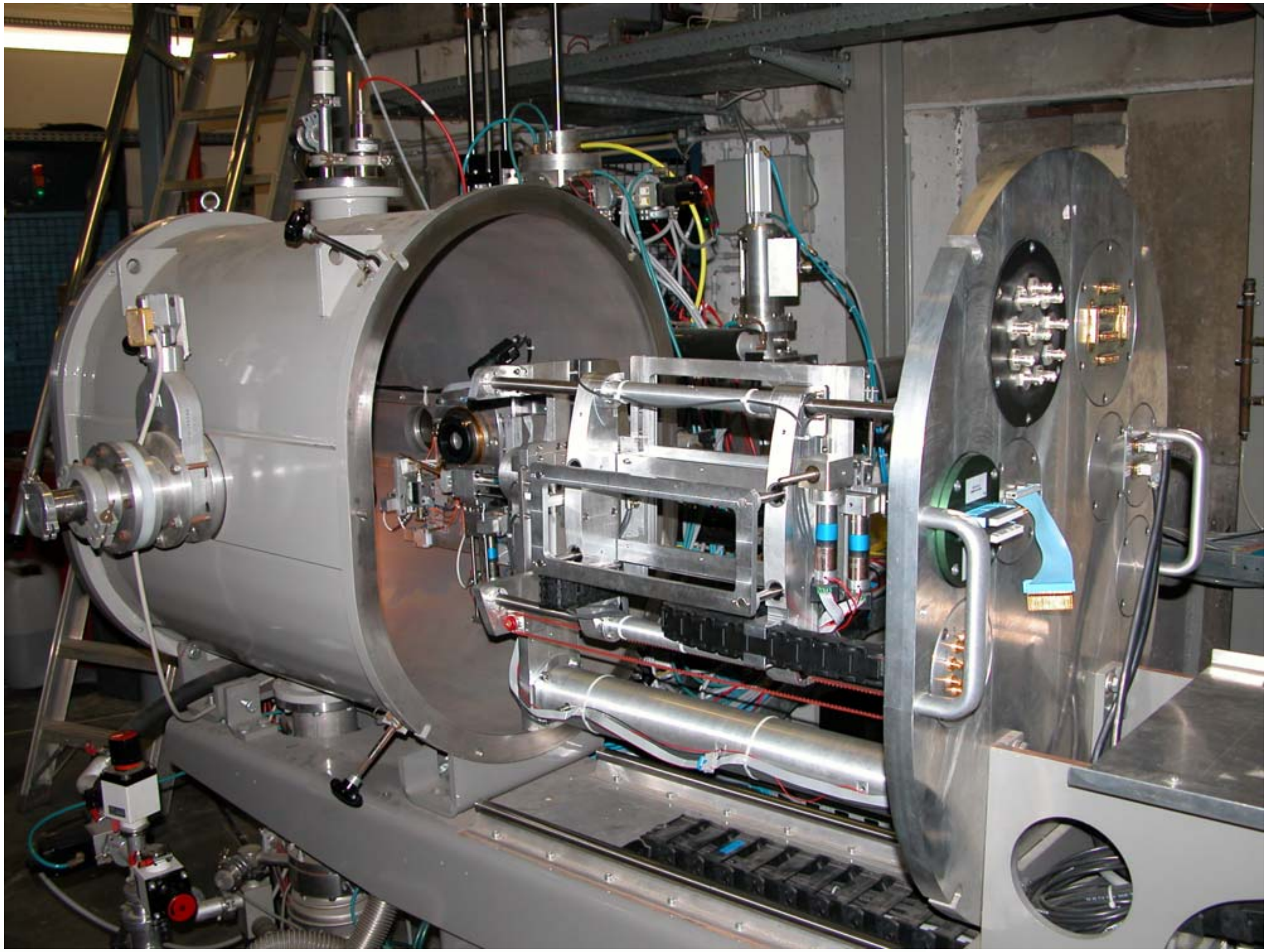
European Component Irradiation Facilities – HIF
Heavy-ion Irradiation Facility – UCL, Belgium.

After an evaluation and assessment period in the mid-1990s, ESA initiated the setup of a permanent heavy ion beam line at the CYClotron of LOuvain la NEuve (CYCLONE) at UCL.

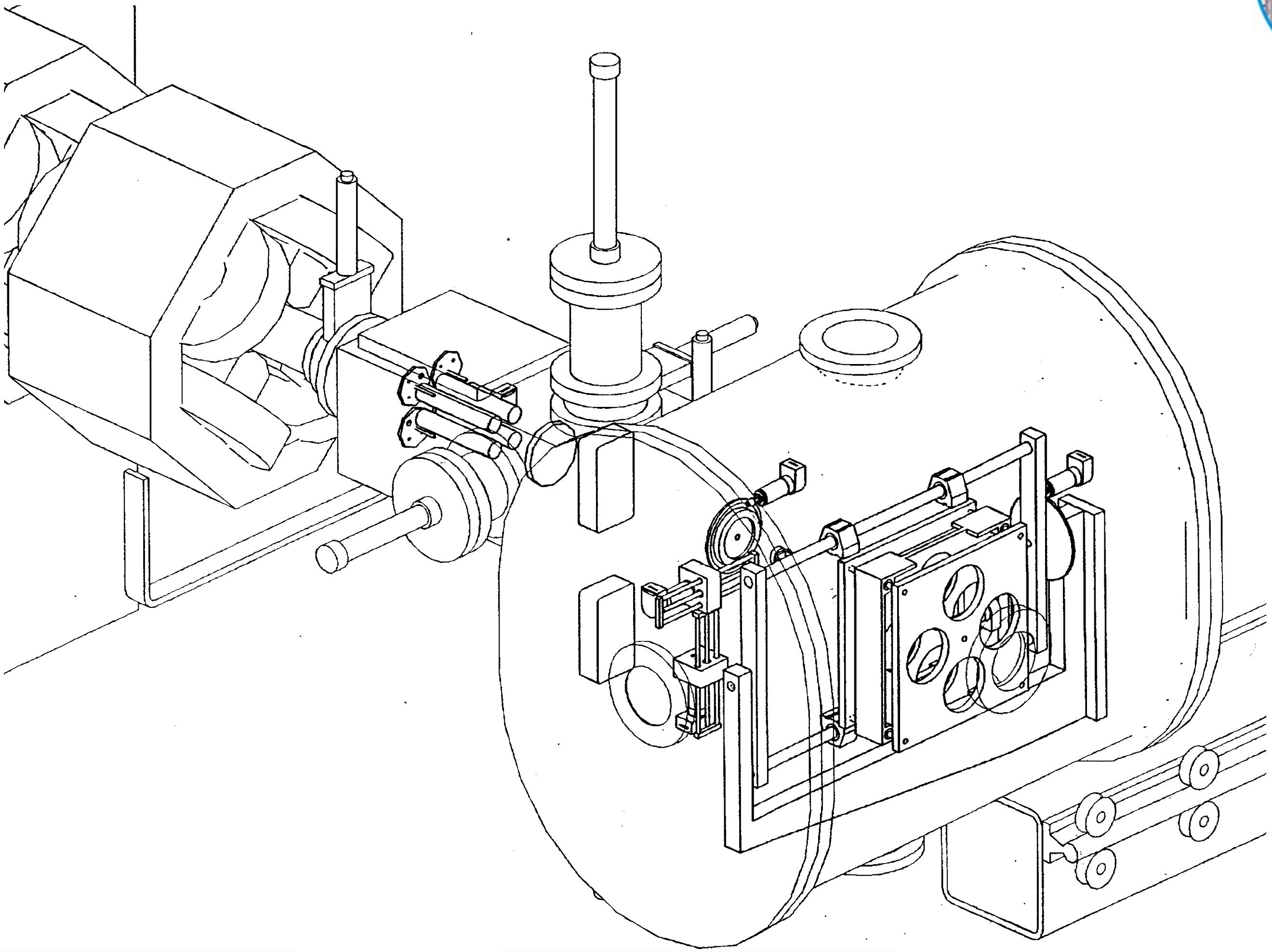
ESA and the space community have used this beam line HIF, dedicated for SEE testing, since 1996.



European Component Irradiation Facilities – HIF Heavy-ion Irradiation Facility – UCL, Belgium.

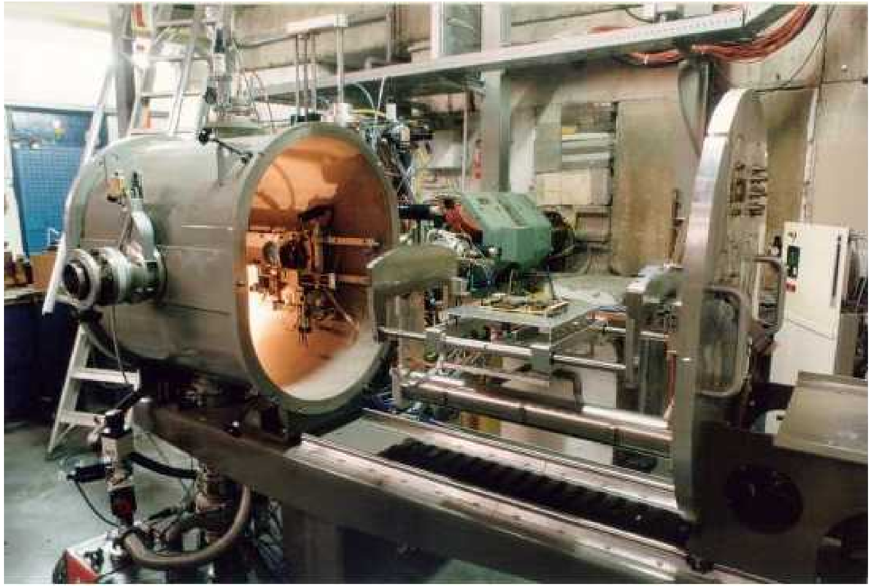


European Component Irradiation Facilities – HIF
Heavy-ion Irradiation Facility – UCL, Belgium.



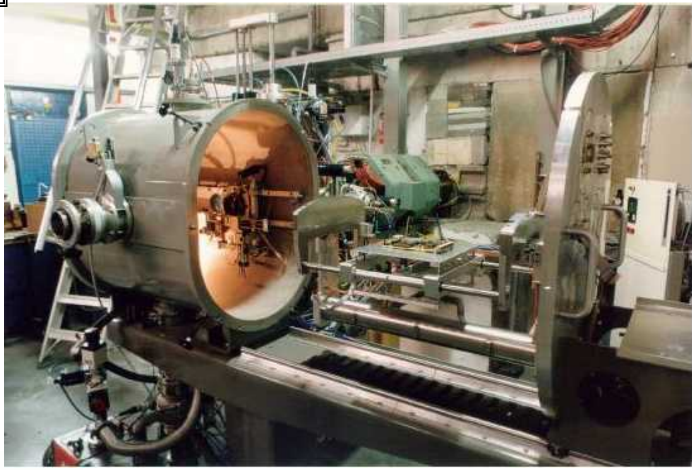
European Component Irradiation Facilities – HIF
Heavy-ion Irradiation Facility – UCL, Belgium.

The HIF uses the multiparticle, variable-energy cyclotron CYCLONE. It is capable of accelerating protons up to 75 MeV, light and heavy ions up to Xenon (from 0.6 to 27.5 MeV/amu) and has an external Electron Cyclotron Resonance (ECR) ion sours and beam transport systems to provide heavy ion beams.



European Component Irradiation Facilities – HIF
Heavy-ion Irradiation Facility – UCL, Belgium.

Ion Cocktail M/Q=4.94	Energy MeV	Range µm Si	LET MeV(mg/cm²)
$^{10}B^{2+}$	41	80	1.7
$^{15}N^{3+}$	62	64	2.97
$^{20}Ne^{4+}$	78	45	5.85
$^{40}Ar^{8+}$	150	42	14.1
$^{84}Kr^{17+}$	316	43	34.0
$^{132}Xe^{26+}$	459	43	55.9
UCL – Ion Cocktail #1 produced for ESA			



European Component Irradiation Facilities – HIF
Heavy-ion Irradiation Facility – UCL, Belgium.

High Penetration Heavy Ions – Available at the HIF.

Ion	E_{cyclo}	$LET(Si)_{cyclo}$	$Range_{cyclo}$	E_{DUT}	$LET(Si)_{DUT}$	$Range_{DUT}$
$^{13}C^{4+}$	133	1.2	276	131	1.2	266
$^{22}Ne^{6+}$	177	4	129	170	4.1	122
$^{28}Si^{8+}$	248	6.6	115	236	6.8	106
$^{40}Ar^{12+}$	390	9.9	125	372	10.1	119
$^{58}Ni^{17+}$	538	21.2	92	500	21.9	85
$^{83}Kr^{25+}$	813	31	100	756	32.4	92

Expected additional Xe beam for higher LET

European Component Irradiation Facilities – HIF
Heavy-ion Irradiation Facility – UCL, Belgium.

•In addition to the HIF beam line, CYCLONE has other beam lines, which can be used for radiation testing.

•The proton radiotherapy beam line, now modified for SEE testing, can provide proton energies of 10 to 75 MeV with a +/- 10 % homogeneity over an area of 10 cm in diameter.

•The neutron research beam line, capable of producing quasi monoenergetic neutron beams in the energy range of 25 to 70 MeV, have been used and assessed by several experimenter groups for SEE works.

European Component Irradiation Facilities – HIF
Heavy-ion Irradiation Facility – UCL, Belgium.

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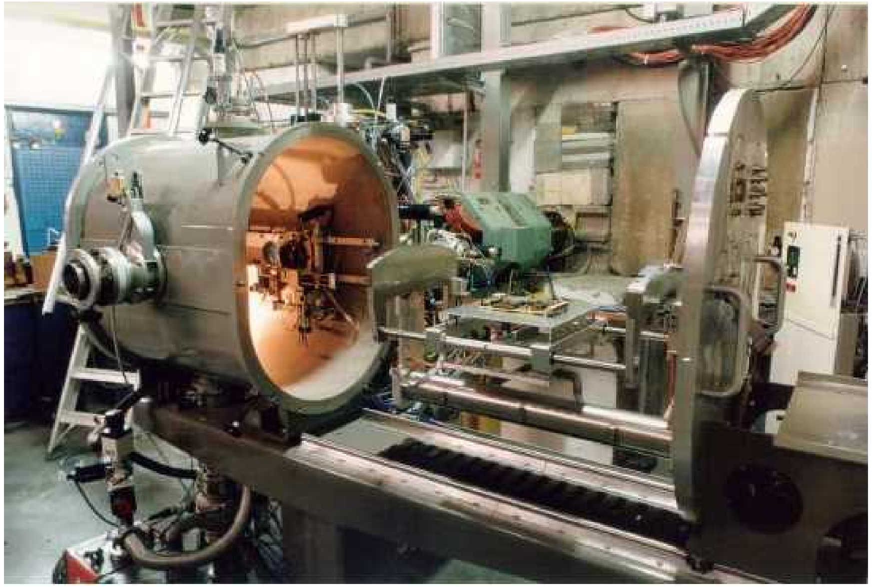
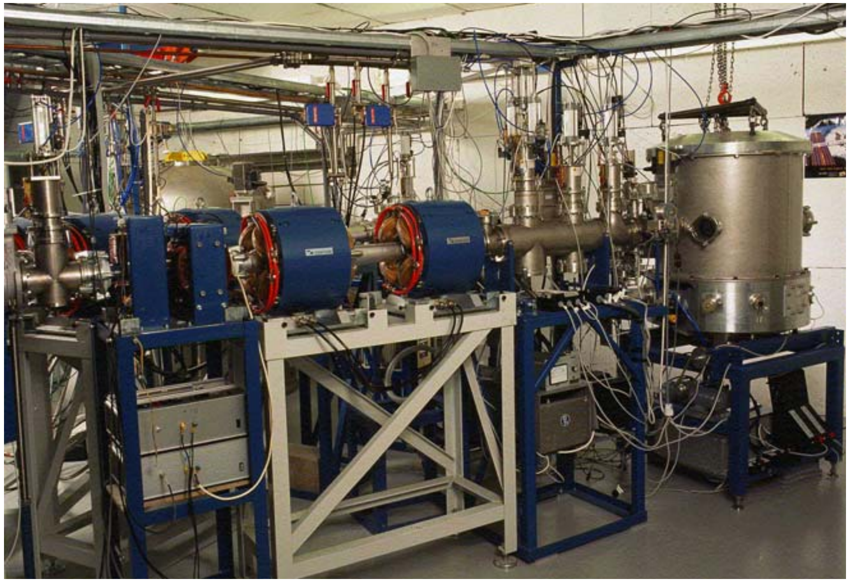


European Component Irradiation Facilities – RADEF RADiation Effects Facility – Jyväskylä, Finland.

- The RADEF at the University of Jyväskylä (JYFL), Jyväskylä, Finland, has been under ESA development since April 2004.
- Initial test campaigns showed capabilities at RADEF that were not present at the HIF.
- Higher ion energies resulting in much deeper ion penetration ranges allowed successful reverse side irradiation of thinned Integrated Circuits (IC’s).



European Component Irradiation Facilities – RADEF RADiation Effects Facility – Jyväskylä, Finland.

Earlier ion cocktails covered a LET range of 2.0 to 64.0 MeV/(mg/cm^2) with penetration ranges in Si of 108 to 68 µm respectively.

Ion Cocktail M/Q=4.7	Energy MeV	Range µm Si	LET MeV(mg/cm^2)
$^{14}N^{3+}$	86	108	2.0
$^{28}Si^{6+}$	172	74	8.0
$^{56}Fe^{12+}$	345	64	22.0
$^{84}Kr^{18+}$	517	66	35.0
$^{136}Xe^{29+}$	830	68	64.0
JYFL – Ion Cocktail produced for ESA June 2001.			

European Component Irradiation Facilities – RADEF
RADiation Effects Facility – Jyväskylä, Finland.

•New ion cocktails covered a LET range of 2.0 to 29.0 MeV/(mg/cm^2) with penetration ranges in Si of 2118 to 93 µm respectively.

Ion Cocktail M/Q=3.8	Energy MeV	Range µm Si	LET MeV(mg/cm²)
$^{15}N^{4+}$	140	211	2.0
$^{30}Si^{8+}$	280	127	7.0
$^{56}Fe^{15+}$	523	95	18.0
$^{82}Kr^{22+}$	766	93	29.0
JYFL – Ion Cocktail produced for ESA October 2001.			

European Component Irradiation Facilities – RADEF RADiation Effects Facility – Jyväskylä, Finland.

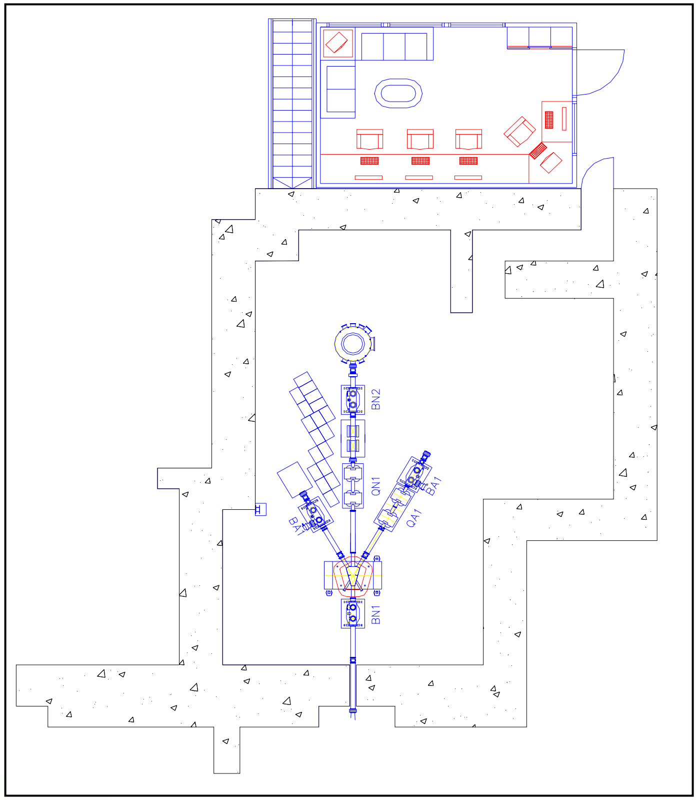
- New development goals will be to produce even higher penetration ion cocktails – the April 2005 cocktail will cover a LET range of 1.7 to 53.0 MeV/(mg/cm^2) with penetration ranges in Si of 218 to 97 µm respectively.

Ion Cocktail M/Q=3.7	Energy MeV	Range µm Si	LET MeV(mg/cm²)
$^{15}N^{4+}$	139	218	1.7
$^{30}Si^{8+}$	278	132	6.0
$^{56}Fe^{15+}$	523	99	18.0
$^{82}Kr^{22+}$	768	96	30.0
$^{131}Xe^{35+}$	1217	97	53.0

JYFL – Ion Cocktail to be produced for ESA April 2005.

European Component Irradiation Facilities – RADEF
RADiation Effects Facility – Jyväskylä, Finland.

- A new proton beam line will also be installed within the new RADEF cave.
- This offers an extra option for users to perform proton SEE tests during the same test campaign.
- The same test setup and test equipment as used for the heavy ion test just needs to be moved to the proton beam line.
- The maximum proton energy available will be 65 MeV.



European Component Irradiation Facilities – RADEF
RADiation Effects Facility – Jyväskylä, Finland.

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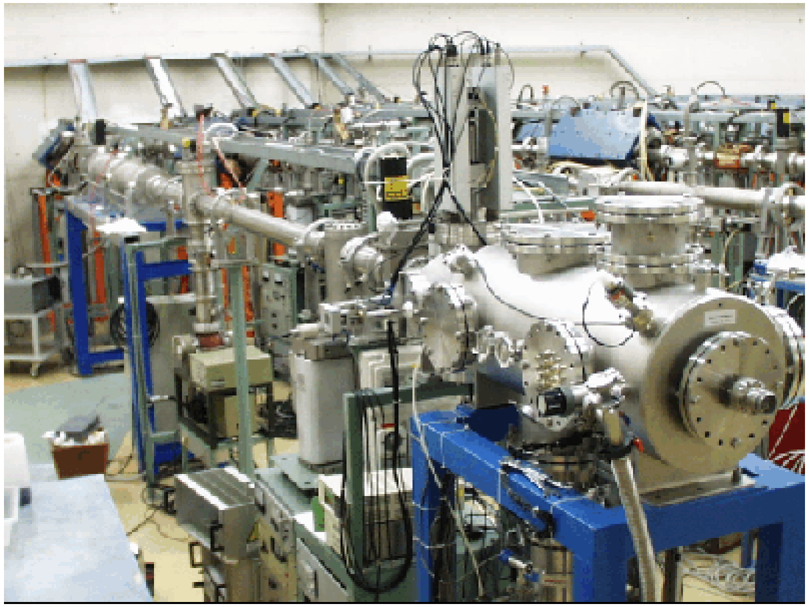
The SIRAD Irradiation Facilities – INFN National Laboratory of Legnaro, Padova, Italy.

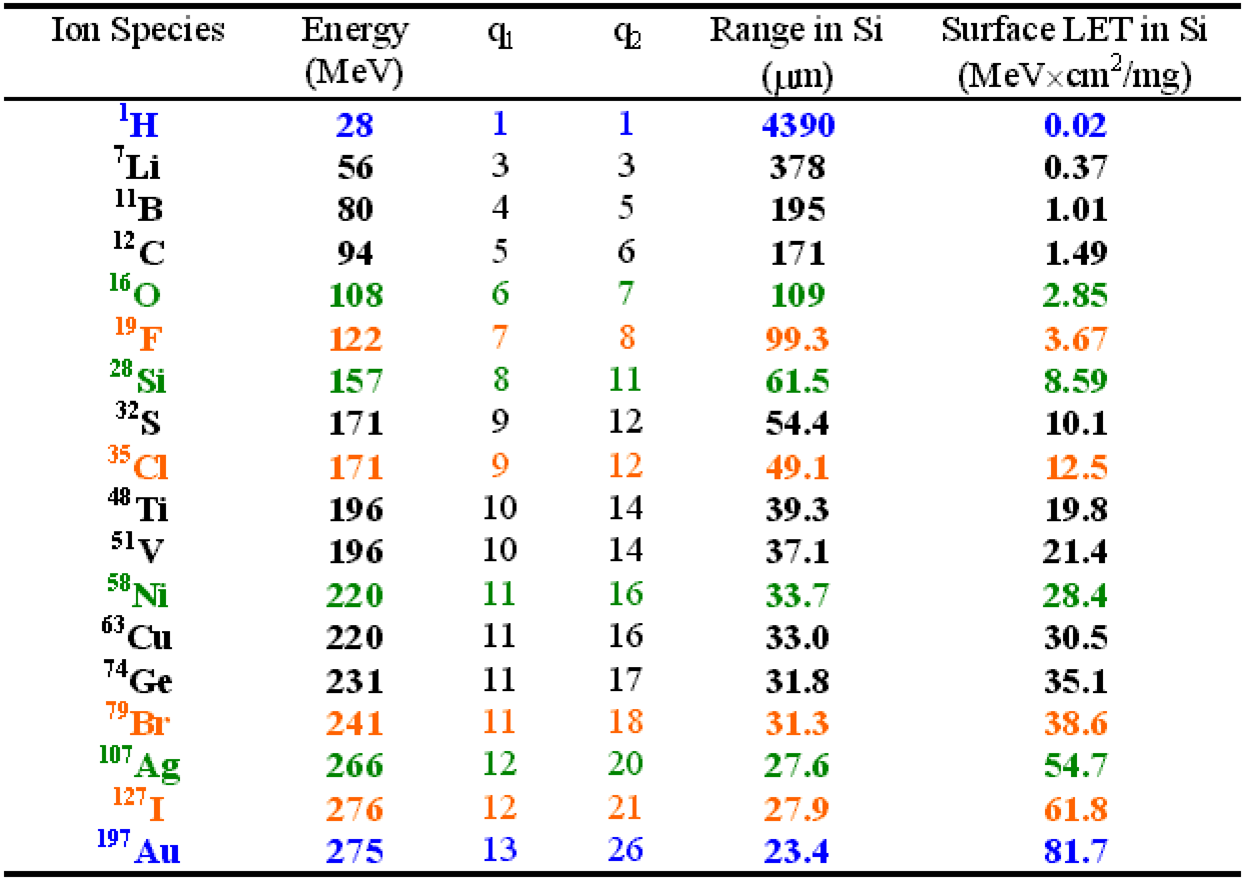
Dedicated beam line for bulk damage and Single Event Effects studies in semiconductor devices and electronic systems for high energy physics and space applications.

The facility is upgraded with an Ion Electron Emission Microscope (IEEM) for mapping the sensitivity of electronic devices and systems to single ion impacts.



The SIRAD Irradiation Facilities –
INFN National Laboratory of Legnaro, Padova, Italy.

Typical ion beams available at SIRAD.



Ion Species	Energy (MeV)	q_1	q_2	Range in Si (μm)	Surface LET in Si (MeV×cm^2/mg)
^{1}H	28	1	1	4390	0.02
^{7}Li	56	3	3	378	0.37
^{11}B	80	4	5	195	1.01
^{12}C	94	5	6	171	1.49
^{16}O	108	6	7	109	2.85
^{19}F	122	7	8	99.3	3.67
^{28}Si	157	8	11	61.5	8.59
^{32}S	171	9	12	54.4	10.1
^{35}Cl	171	9	12	49.1	12.5
^{48}Ti	196	10	14	39.3	19.8
^{51}V	196	10	14	37.1	21.4
^{58}Ni	220	11	16	33.7	28.4
^{63}Cu	220	11	16	33.0	30.5
^{74}Ge	231	11	17	31.8	35.1
^{79}Br	241	11	18	31.3	38.6
^{107}Ag	266	12	20	27.6	54.7
^{127}I	276	12	21	27.9	61.8
^{197}Au	275	13	26	23.4	81.7

The SIRAD Irradiation Facilities – INFN National Laboratory of Legnaro, Padova, Italy.

For more information, contact:
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University di Padova
Via Marzolo 8,
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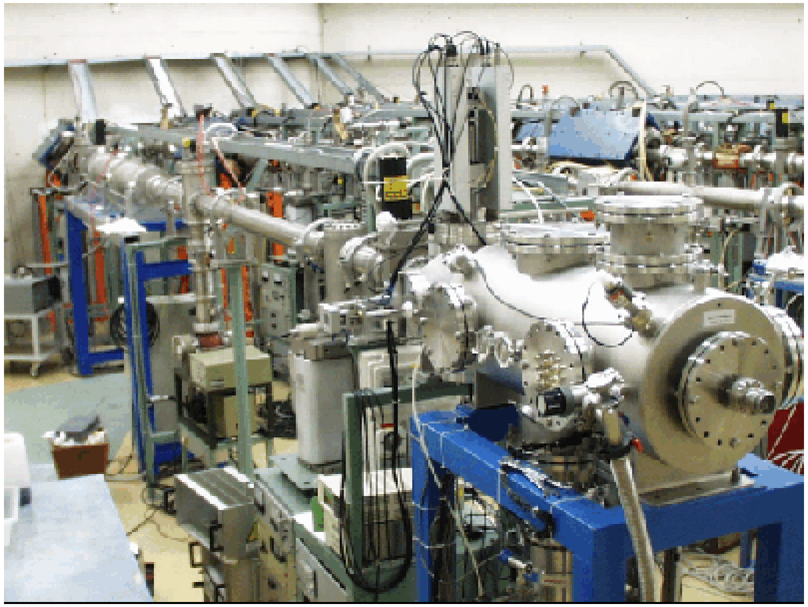
Italy
Tel. 39-(0)49-8277215
Candelori@pd.infn.it
http://sirad.pd.infn.it/sirad/



European SEE Accelerators – RADECS Workshop I.

RADECS Thematic Workshop on European SEE Accelerators, May 26th 2005.

University of Jyväskylä, Department of Physics, Jyväskylä, Finland

Organising Committee:

Reno Harboe Sørensen	ESA/ESTEC, NL
Françoise Bezerra	CNES, F
Philippe Calvel	ALCATEL Space, F
Sophie Duzellier	ONERA, F
Renaud Mangeret	EADS Astrium, F
Ari Virtanen	JYFL, FIN

European SEE Accelerators – RADECS Workshop II.

Tentative Programme

European SEE Accelerators – I.

09:00	Opening	Welcome and Scope of Workshop	Reno Harboe Sørensen
09:15	Facility F1	RADEF, Jyväskylä, Finland	Ari Virtanen
09:30	Facility F2	BIBER, Berlin, Germany	Jörg Opitz-Coutureau
09:45	Facility F3	CPO, d'Orsay, France	Sophie Duzellier
10:00	Facility F4	GANIL, Caen, France	Bruno Piquet
10:15	Facility F5	PIF, PSI, Villigen, Switzerland	Wojtek Hajdas
10:45	Facility F6	IPN, d'Orsay, France	Sophie Duzellier
11:00	Facility F7	SIRAD, Padova, Italy	Andrea Candelori
11:15	Facility F8	TSL, Uppsala, Sweden	Alexander Prokofiev
11:30	Facility F9	HIF, UCL, Louvain-la-Neuve, Belgium	Guy Berger
11:45	Facility F10	Other facilities/Complimentary facilities	Philippe Calvel
12:00	Study S1	Micro-beam Study by CNES/UCL	Françoise Bezerra
12:15	Study S2	Design and Test of a Reference SEU Monitor	Reno Harboe Sørensen
14:00	User U1	CERN – Test Experiences and Needs	Thijs Wijnands
14:15	User U2	EADS Astrium – Test Experiences and Needs	Renaud Mangeret
14:30	User U3	Saab Ericsson Space – Test Experiences and Needs	Stanley Mattsson
14:45	Round Table 1	Introduction –	Renaud Mangeret
15:00	RT-1	European Needs	
15:45	Round Table 2	Introduction –	Françoise Bezerra & Sophie Duzellier
16:00	RT-2	LET Calculations/Ion Penetrations	
16:30	Round Table 3	Introduction –	Sophie Duzellier
16:45	RT-3	Preliminary: Open (Proton Testing)	
17:15	Conclusions	RT 1)2)3)-Overall	Reno Harboe Sørensen/Committee

European SEE Accelerators – RADECS Workshop III.

The 1st RADECS Thematic Workshop on European SEE Accelerators will take place at the Department of Physics, University of Jyväskylä, Jyväskylä, Finland on May 26th 2005.

This event has been combined this year with the ESA/ESTEC Final Presentation Day on May 25th 2005 and

RADEF inauguration on May 27th 2005.

Participation is open and free of charge – but requires pre-registration:

http://www.phys.jyu.fi/research/applications/RADEF/QCA_WORKSHOP/index.html

**D/TOS-QCA Final Presentation Day, ESA/ESTEC, Noordwijk, The Netherlands –
April 09, 2002.**

60 MeV Proton Testing of 4N49 Optocouplers from Isolink, Micropac and Optek, Summary Results.

by

[1]R. Harboe-Sørensen, [2]J.-F. Pascal & [2]F.-X. Guerre

**[1]European Space Agency/ESTEC - The Netherlands
[2]HIREX Engineering, Toulouse - France**

Abstract

At the same time as the 3C91C proton testing was carried out for ENVISAT-1, a few 4N49 Optocoupler parts from Isolink, Micropac and Optek were also irradiated. Summary results covering the same biasing conditions and addressing the Current Transfer Ratio (CTR) degradation will be presented and compared with results obtained on the 3C91C.

Why Proton Testing ?

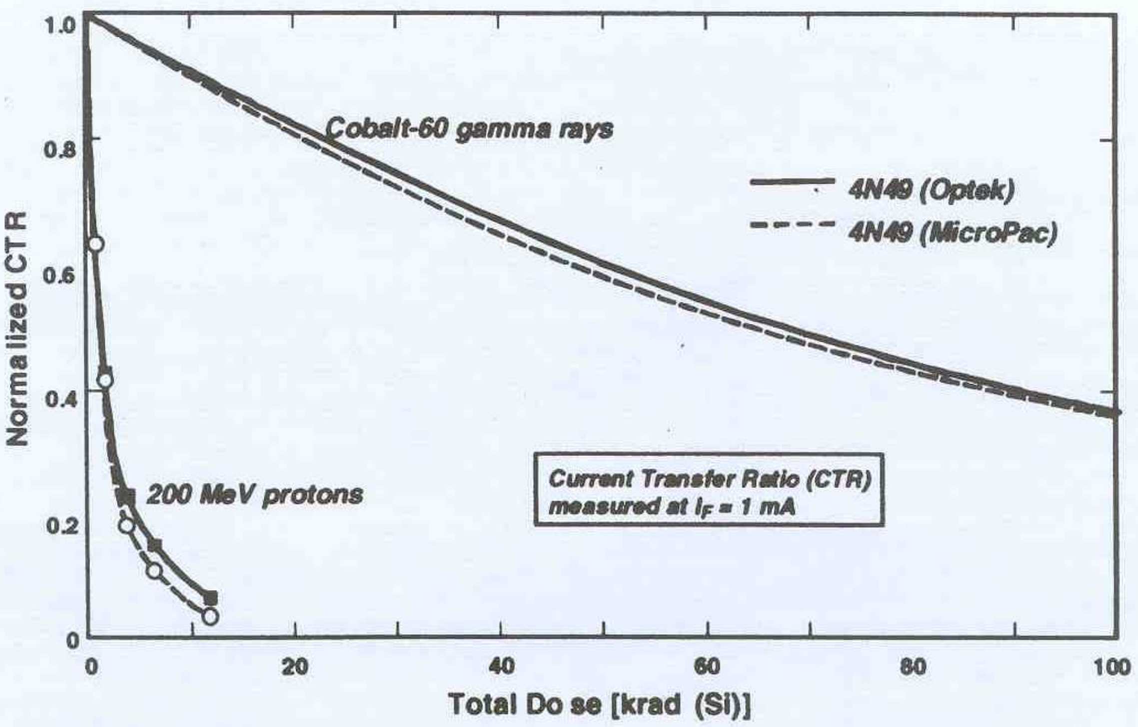
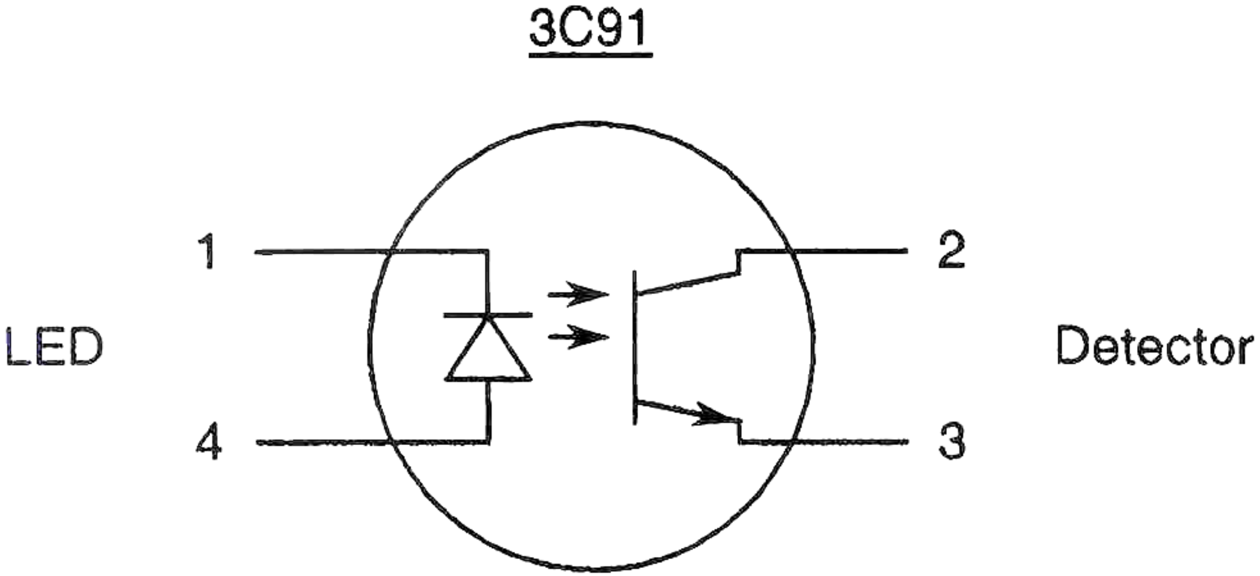


Figure 1. An optocoupler's response to Co-60 compared to proton irradiations.

Ref.: K. A. LaBe et al, IEEE Trans. On Nucl. Sci. vol 46, No. 6, Dec. 1998.

Current Transfer Ratio (CTR)



CTR is defined as the Collector Current (I_C) in the Detector Divided by the LED Forward Current (I_F).

Centre de Protontherapie d’Orsay: 200 MeV proton beam

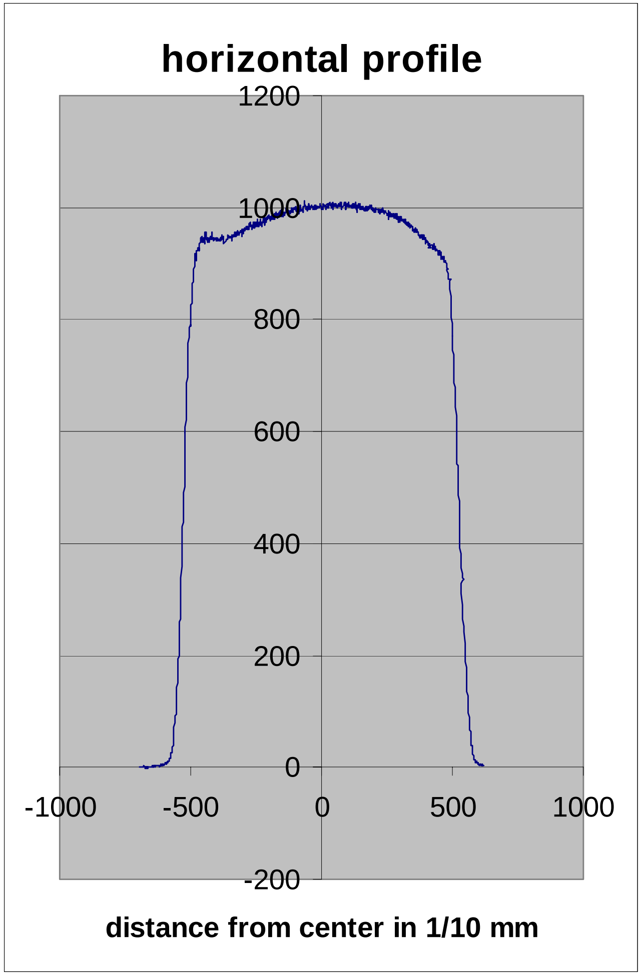
Synchro- cyclotron SC200 installed in Orsay in 1957

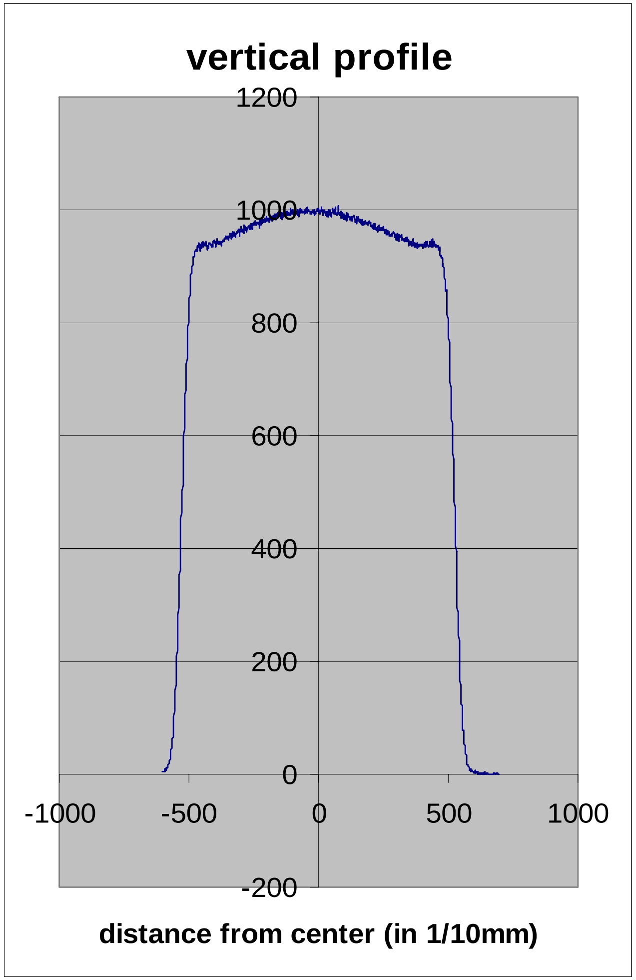
- Used for physics research until 1990
- Devoted to Medical Treatment since 1991
- However, open for other applications during night and weekend hours.

Used Test Conditions

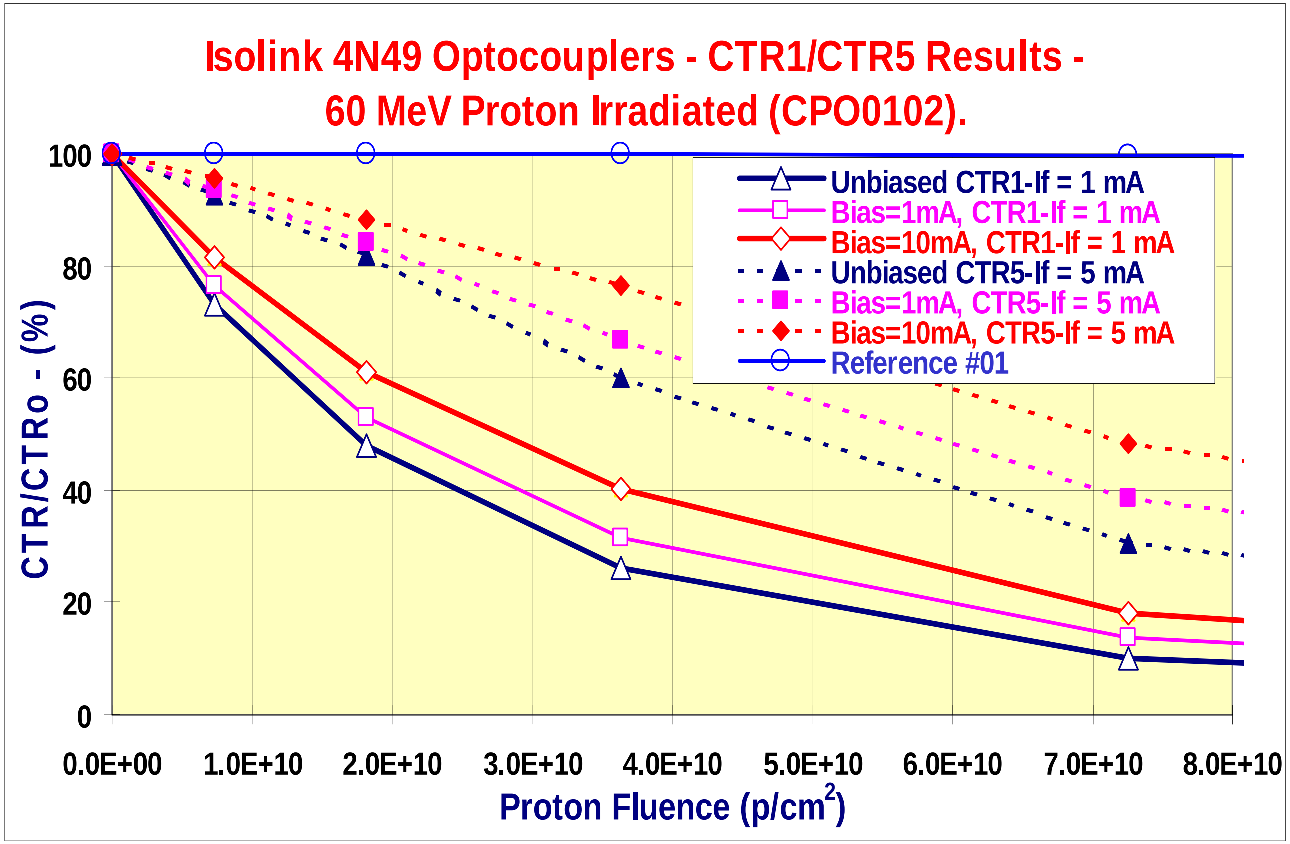
- Energy: 60 MeV
- Beam size Ø: 10 cm
- Flux: 2.7E07 p/cm^2/sec.
- Calibration: On-line ionization chambers
- Beam Profile: horizontal/vertical

CPO: Beam Profile

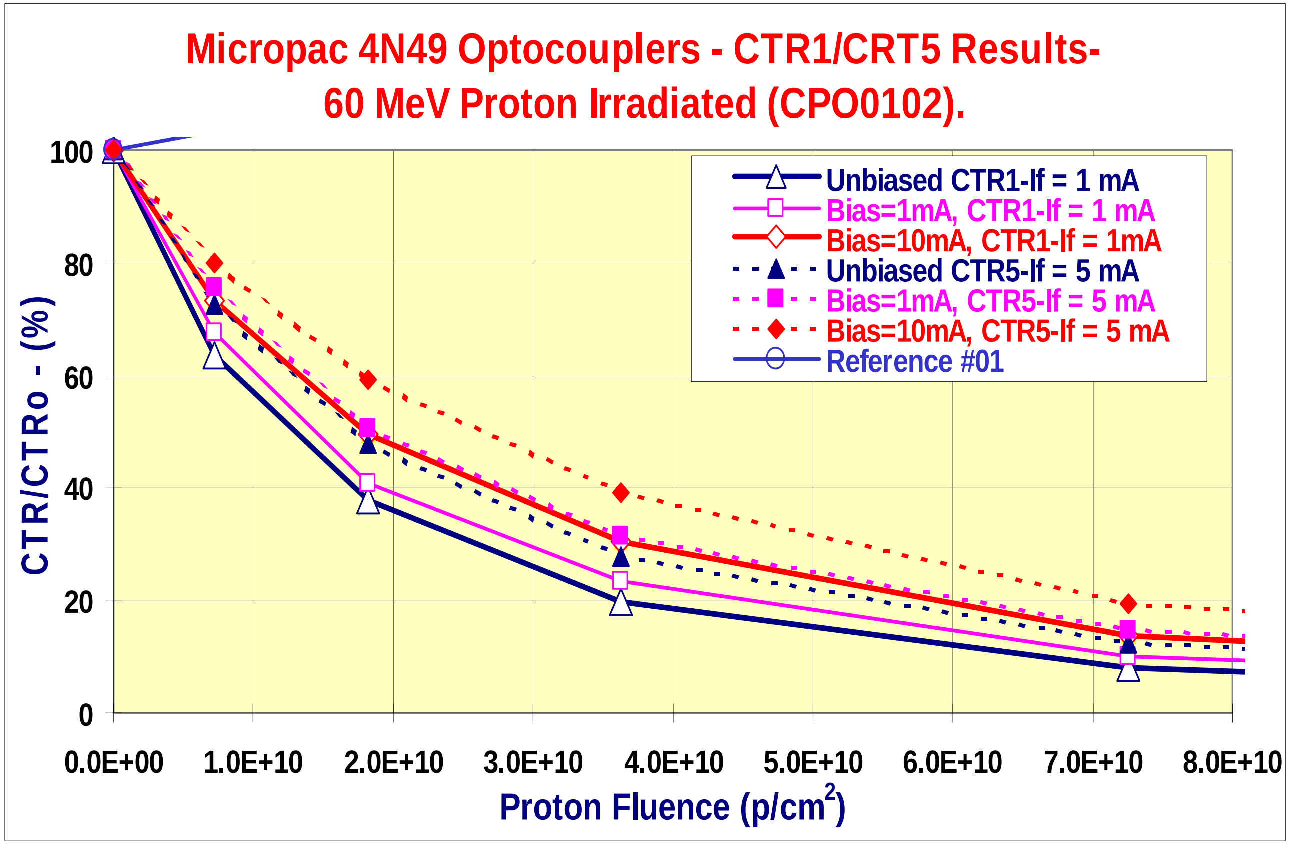




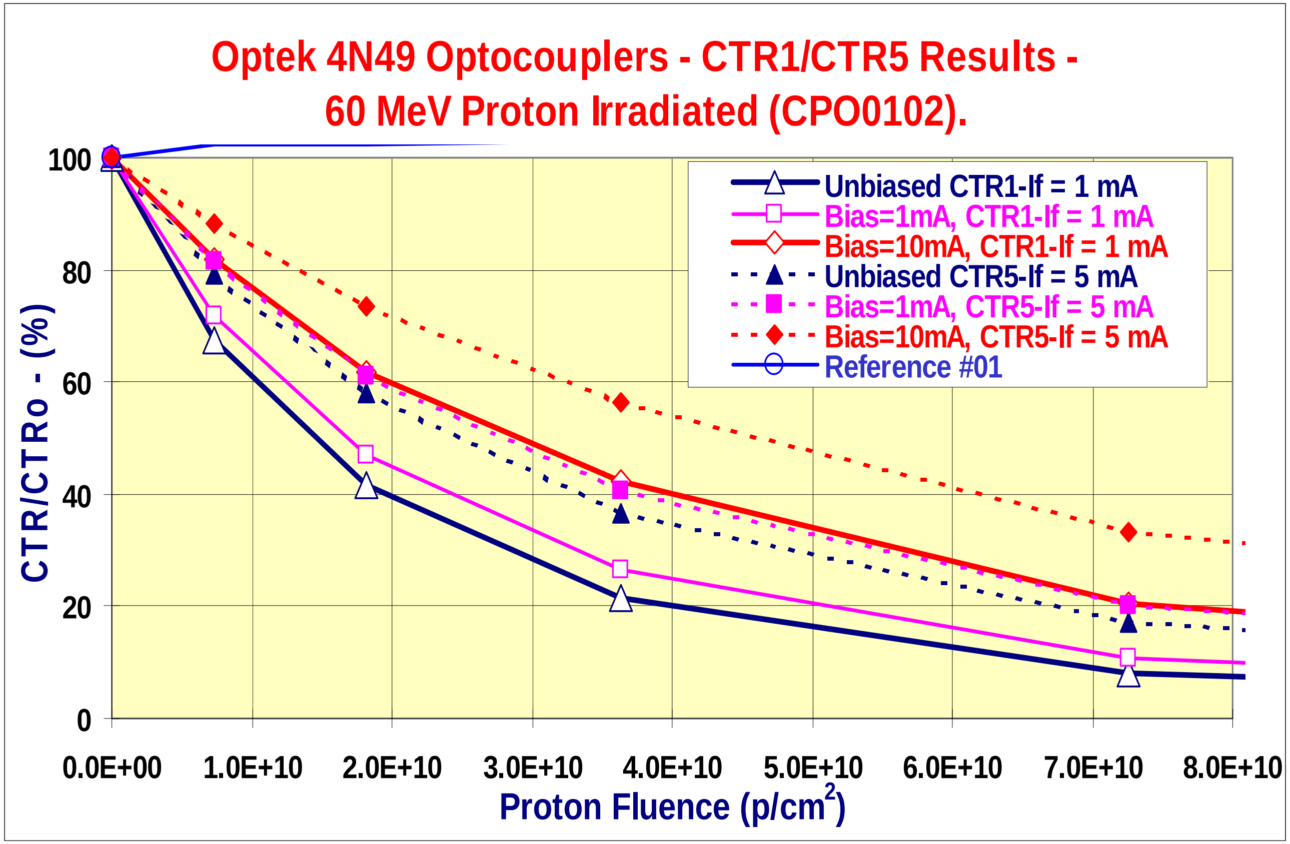
Isolink 4N49 CTR Results:
Unbiased, Biased 1 mA and 10 mA - CTR = 1 mA and 5 mA



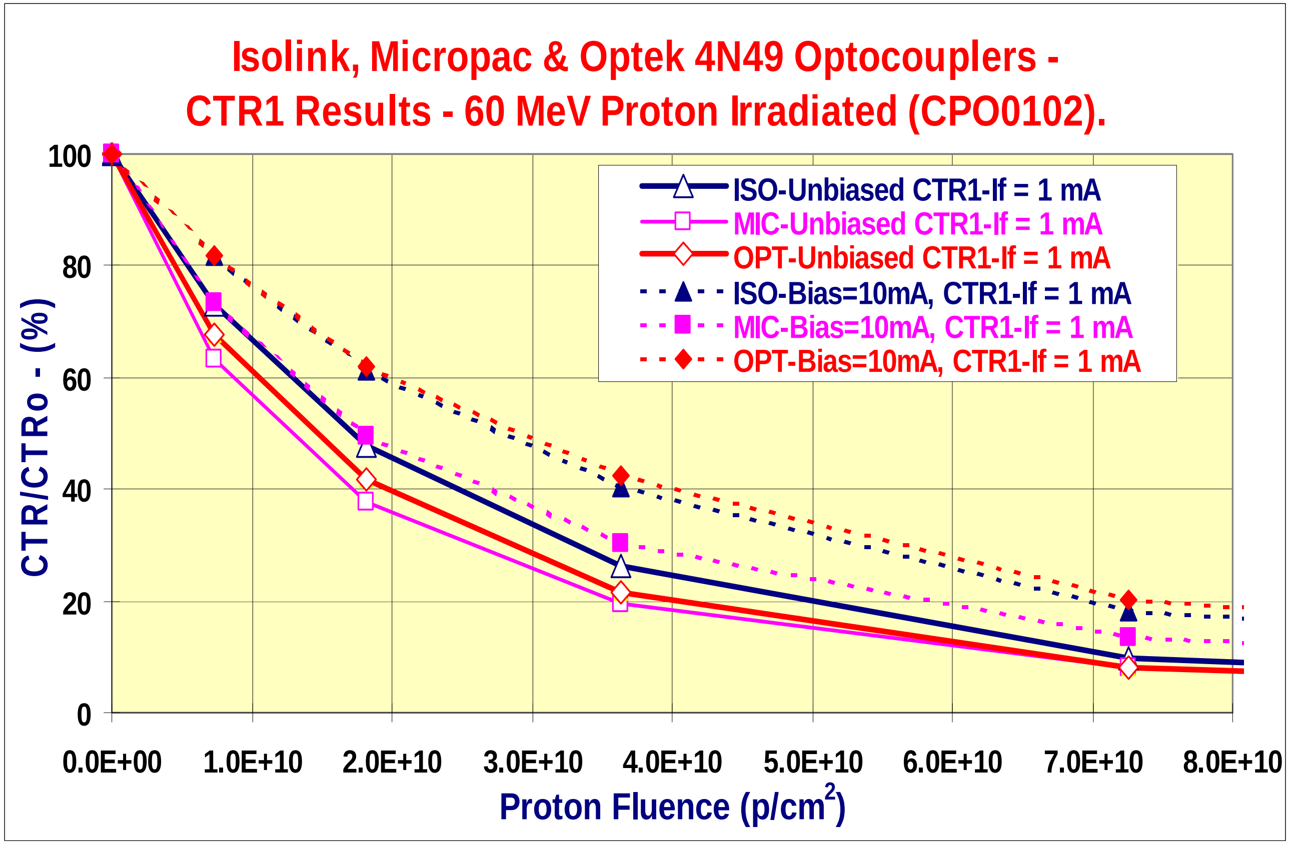
Micropac 4N49 CTR Results:
Unbiased, Biased 1 mA and 10 mA - CTR = 1 mA and 5 mA



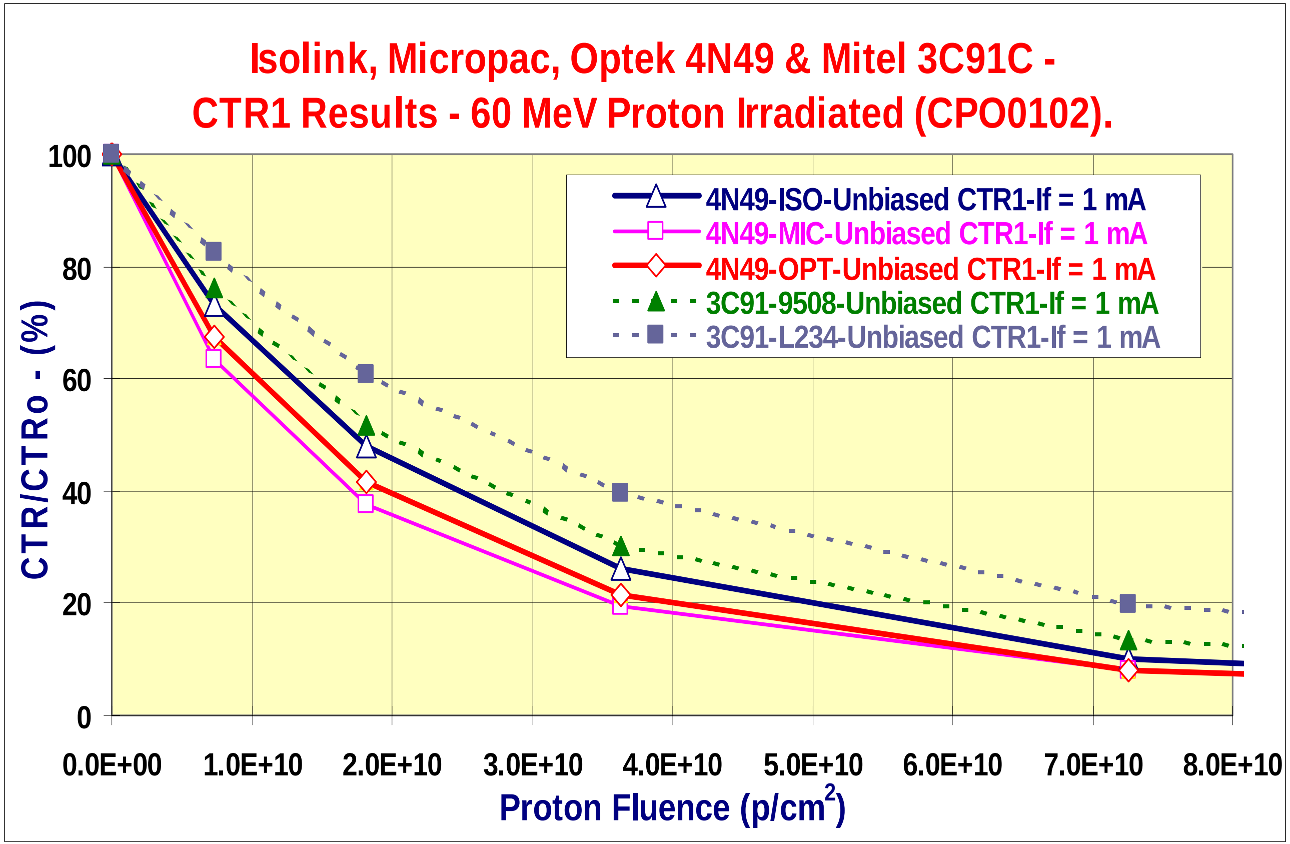
Optek 4N49 CTR Results:
Unbiased, Biased 1 mA and 10 mA - CTR = 1 mA and 5 mA



Isolink, Micropac and Optek 4N49 CTR Results: Unbiased and Bias = 10 mA - CTR = 1 mA



Isolink, Micropac, Optek 4N49 and Mitel 3C91 CTR Results: Unbiased - CTR = 1 mA



Isolink, Micropac, Optek 4N49 Optocoupler Testing: Conclusion

4N49 Preliminary radiation CTR data presented here

Tested types show increased degradation of CTR when compared to the ENVISAT-1 3C91C lots.

At a 60 MeV proton fluence of 3.63E10 p/cm^2 – 4N49 Unbiased and I_F = 1 mA – the CTR was reduced to;

- **Isolink : 26 %**
- **Micropac : 20 %**
- **Optek : 21 %**

Test report not available, however, presentation material to be found under –

5th QCA Presentation Day
https://escies.org/public/radiation/

European Space Components Conference, Toulouse, France – September 24-27, 2002.

An Overview of Radiation Single Event Effects Testing of Advanced Memory Components.

by

R. Harboe-Sørensen

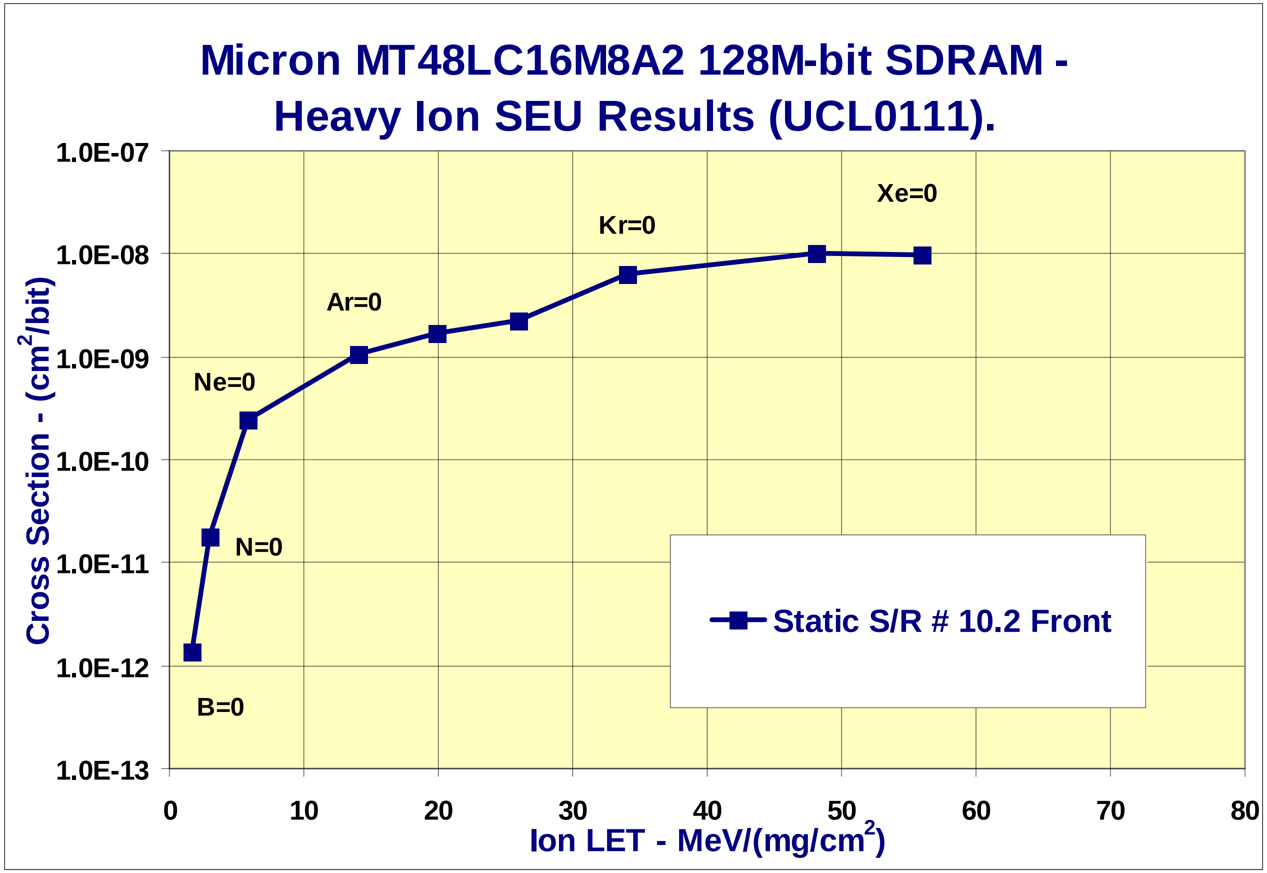
European Space Agency/ESTEC - The Netherlands

Abstract

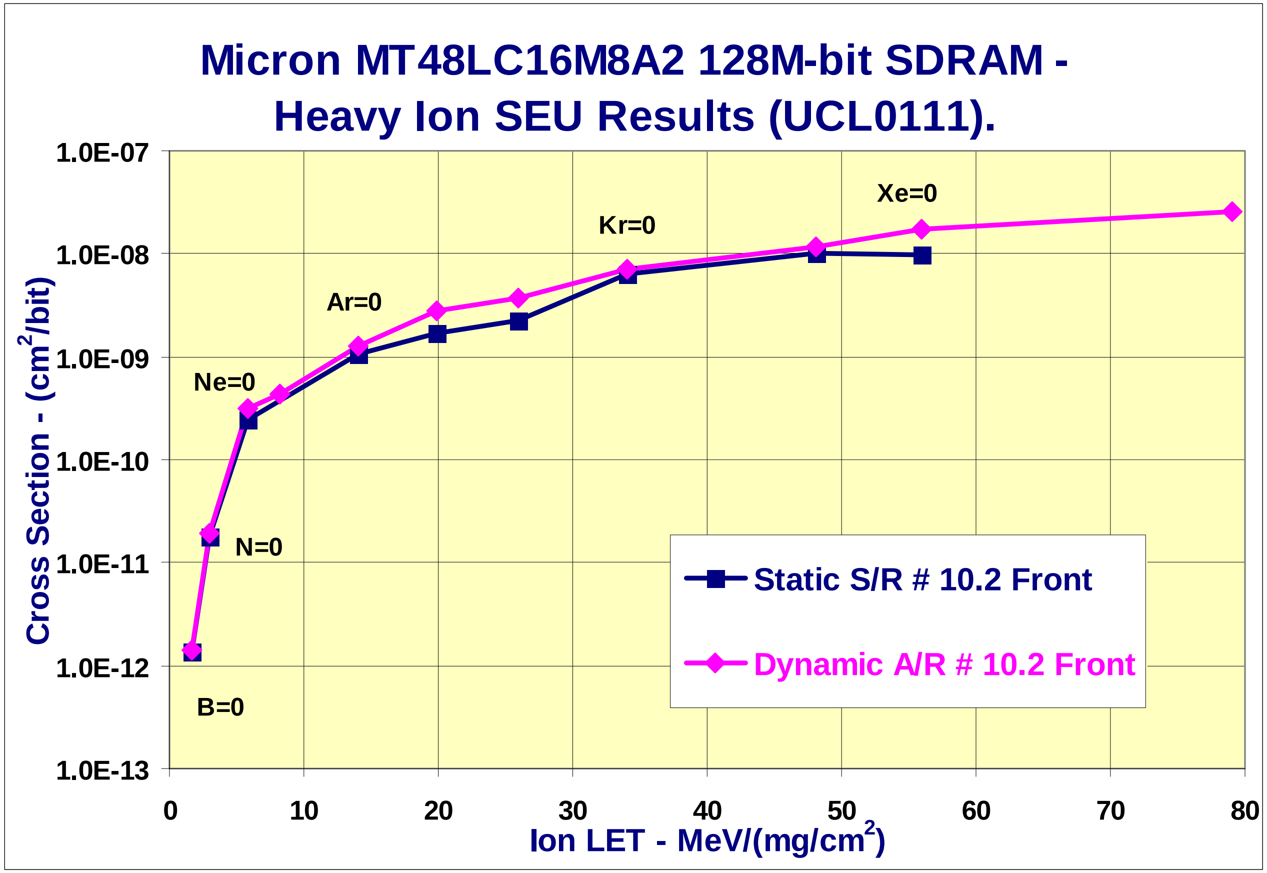
For space applications, current available high-density memories have to be radiation tested as they come. This presents a particularly difficult challenge for heavy ion Single Event Effects testing since modern memories are using dense assemblies and plastic packages. This presentation aims to provide an overview of where we are today and what can be done.

Ref. : INFN Course, Italy, April 8, 2005.

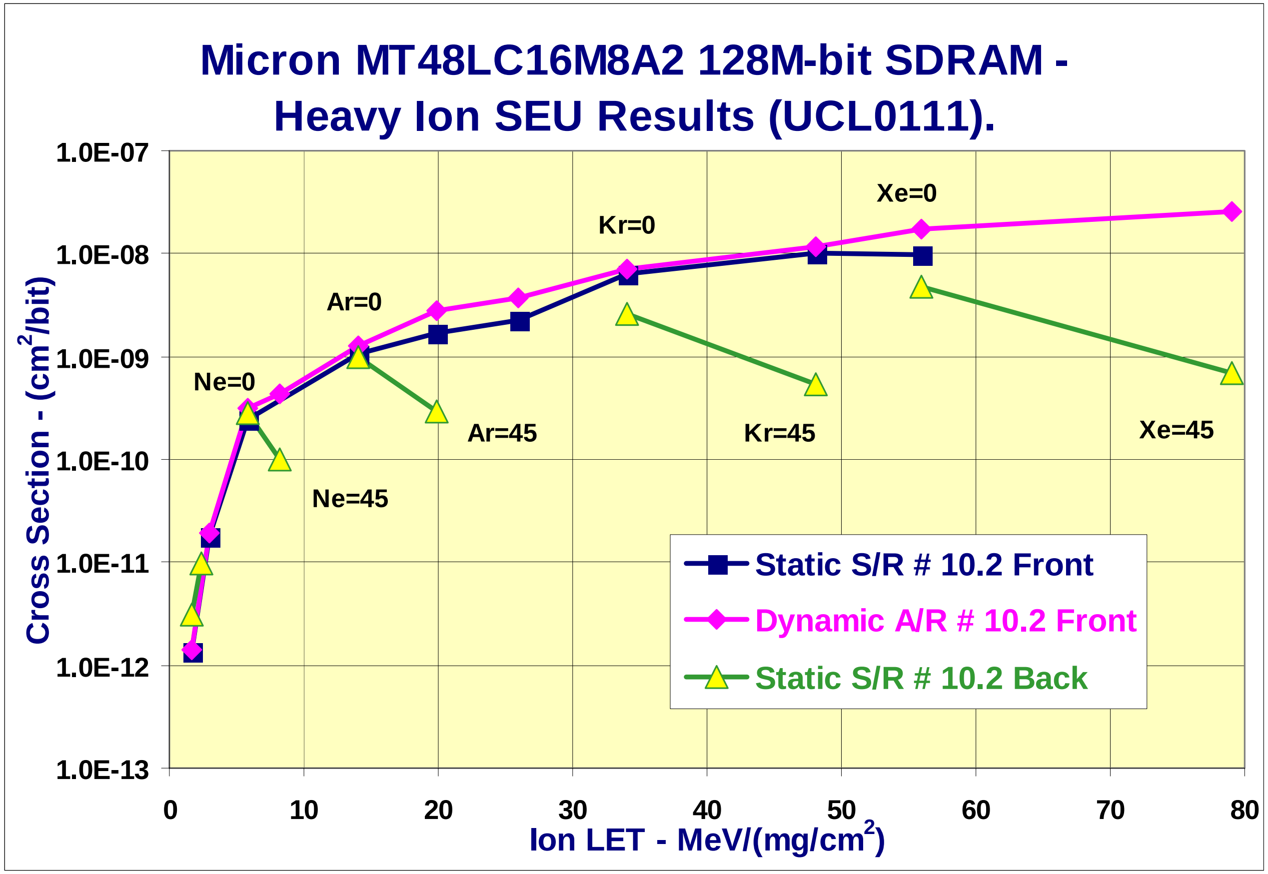
Heavy Ion Results - HIF, UCL, B.



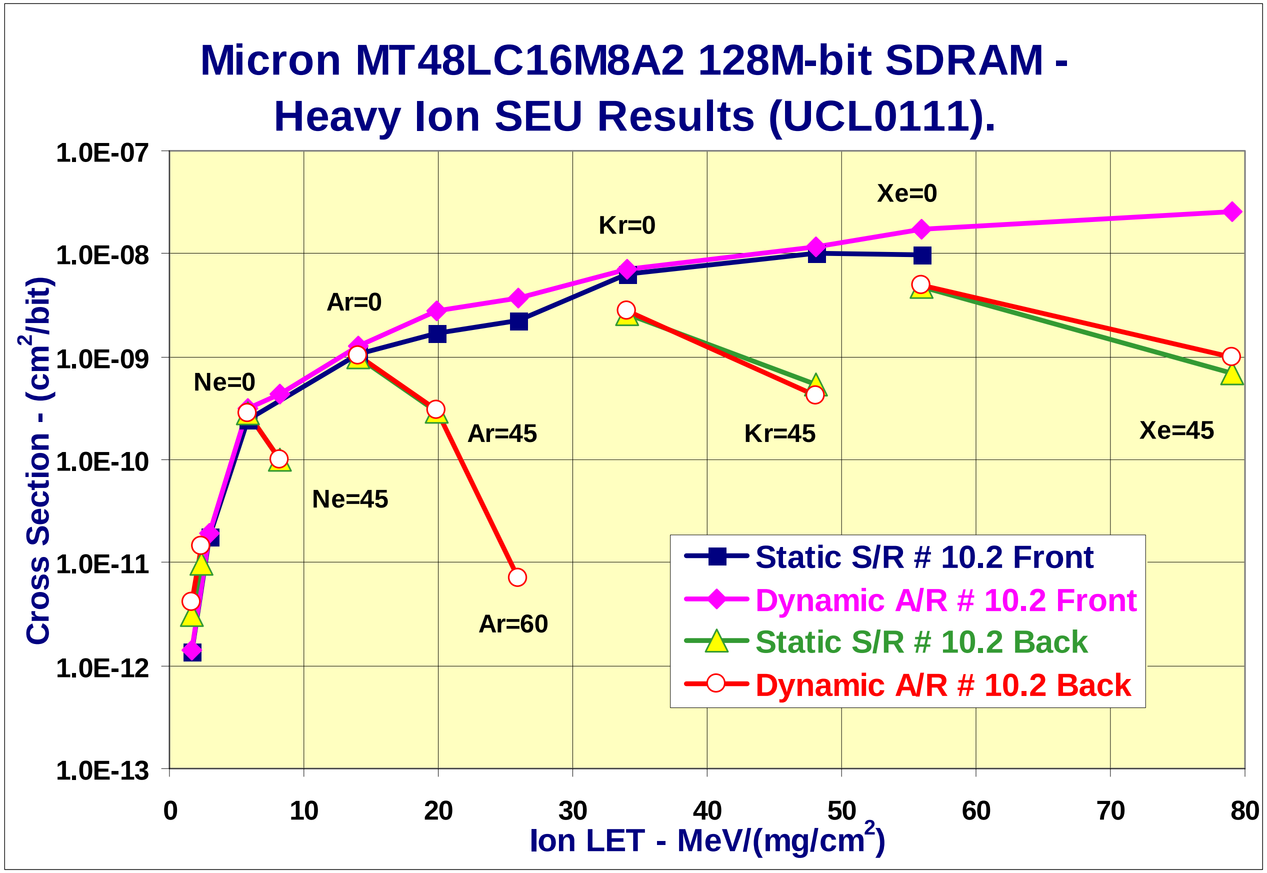
Heavy Ion Results - HIF, UCL, B.



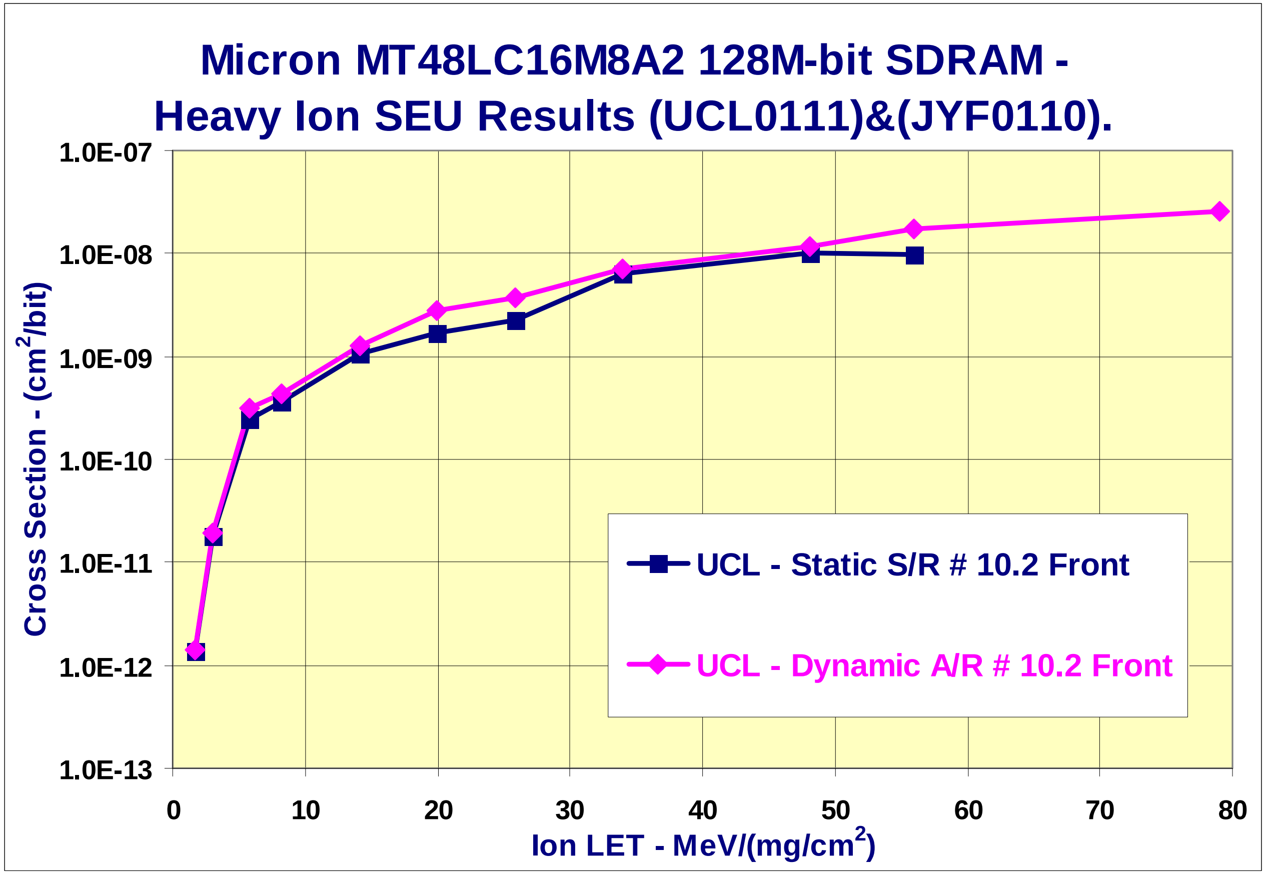
Heavy Ion Results - HIF, UCL, B.



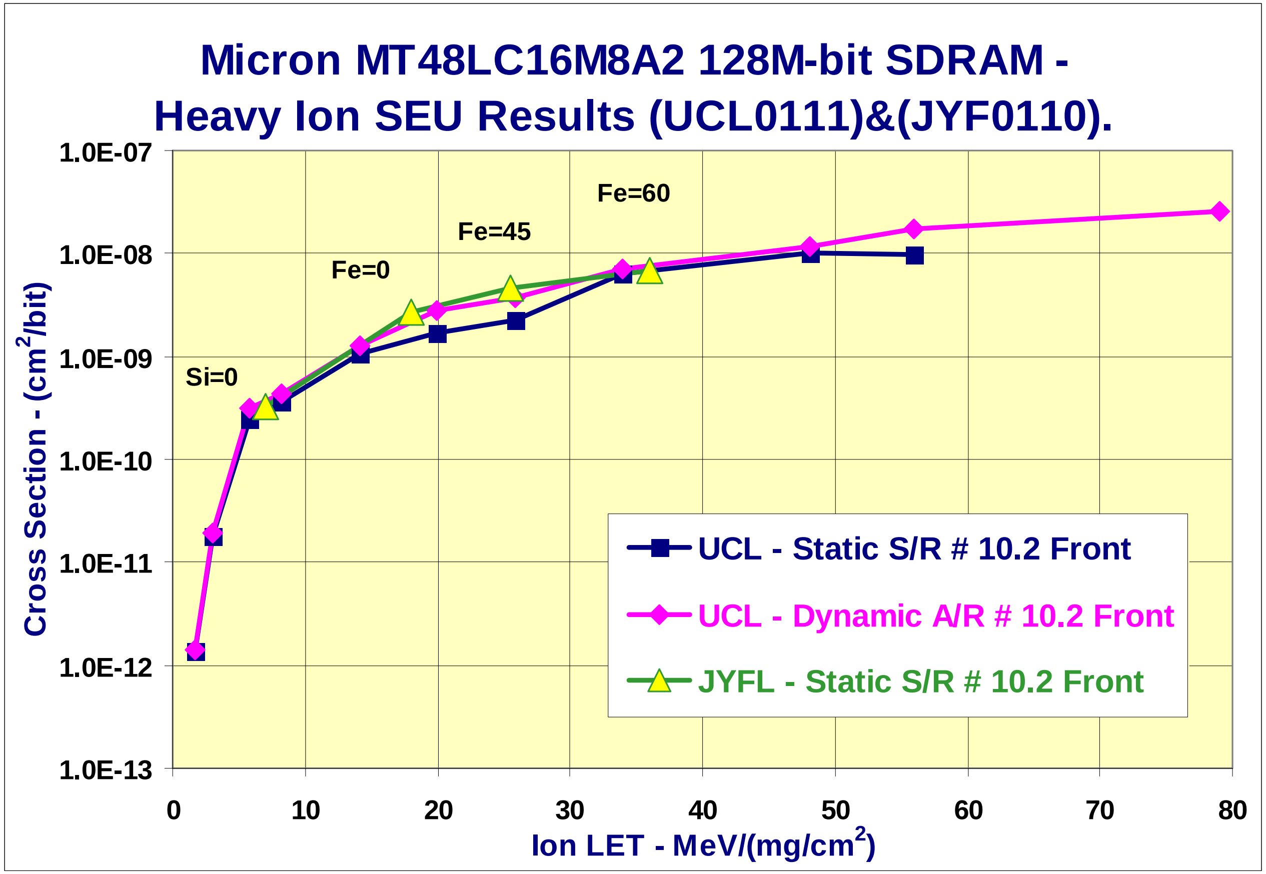
Heavy Ion Results - HIF, UCL, B.



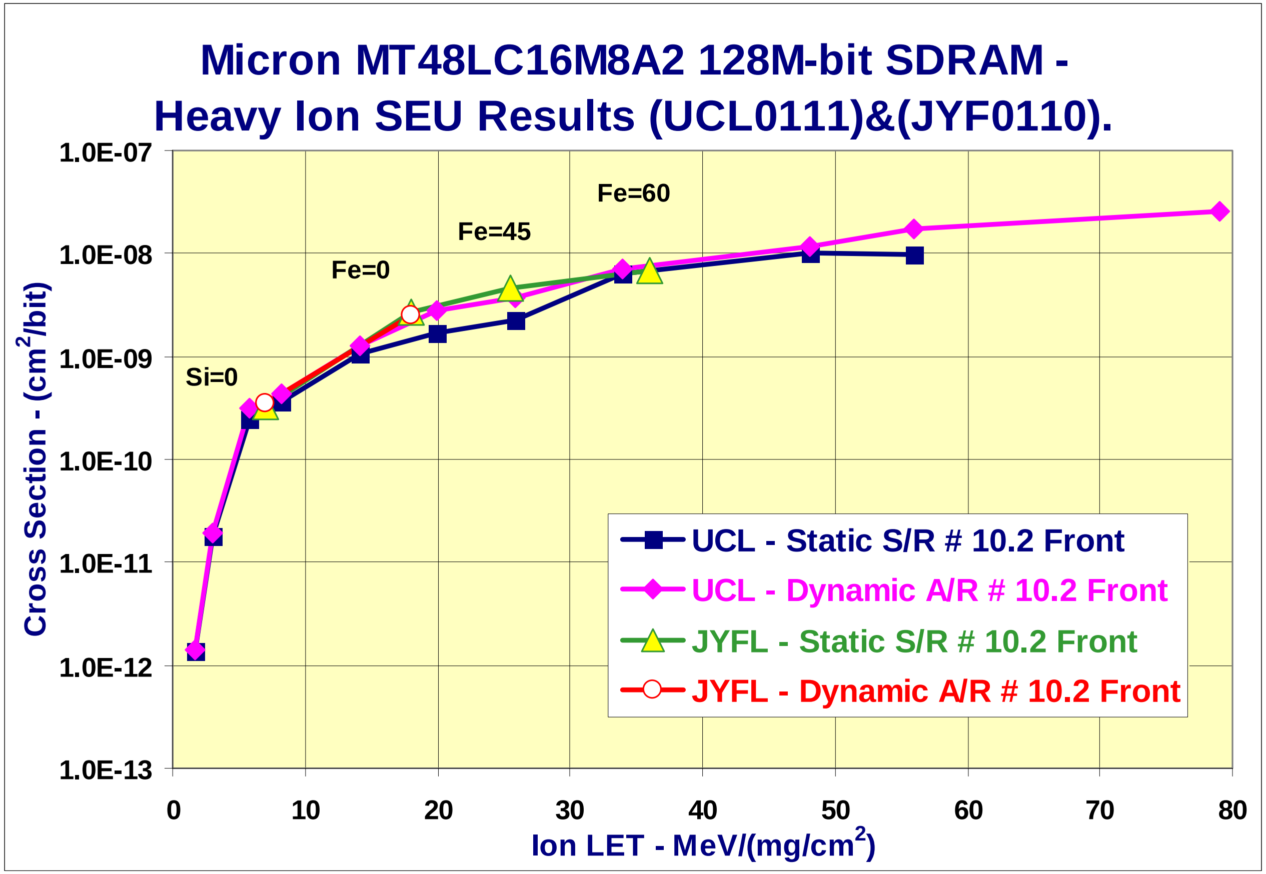
Heavy Ion Results - HIF, Belgium & JYFL, Finland.



Heavy Ion Results - HIF, Belgium & JYFL, Finland.



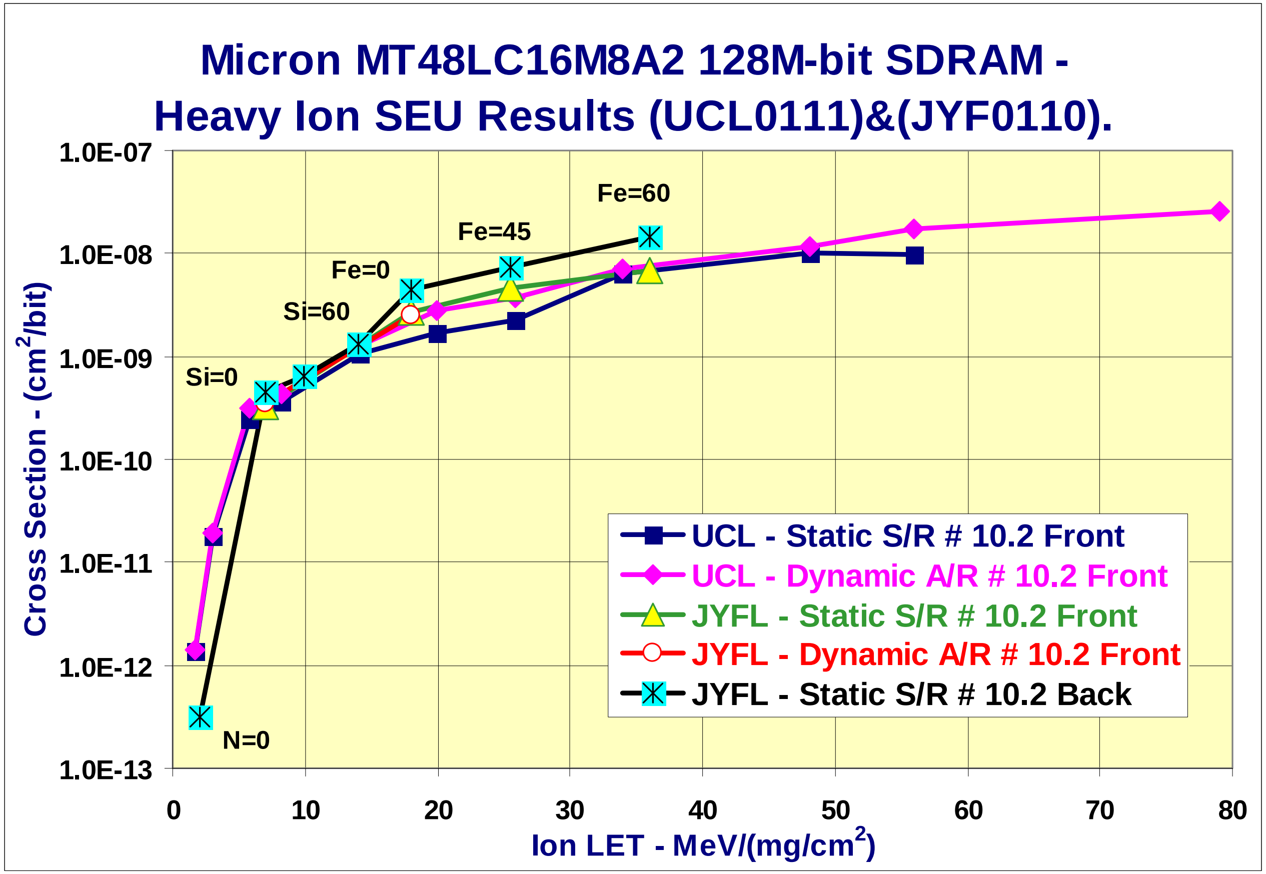
Heavy Ion Results - HIF, Belgium & JYFL, Finland.



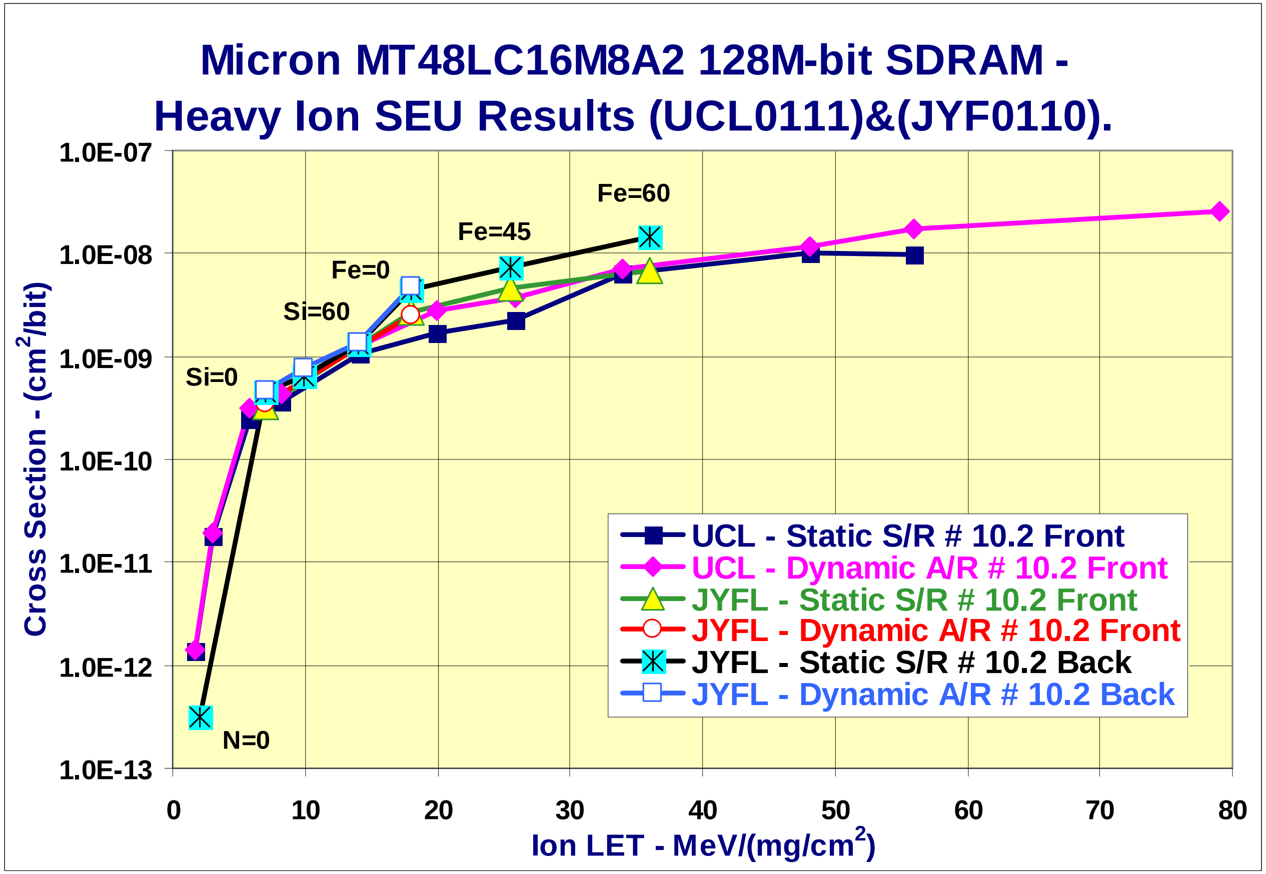
ESTEC - Radiation Effects and Analysis Techniques Section

Ref. : INFN Course, Italy, April 8, 2005.

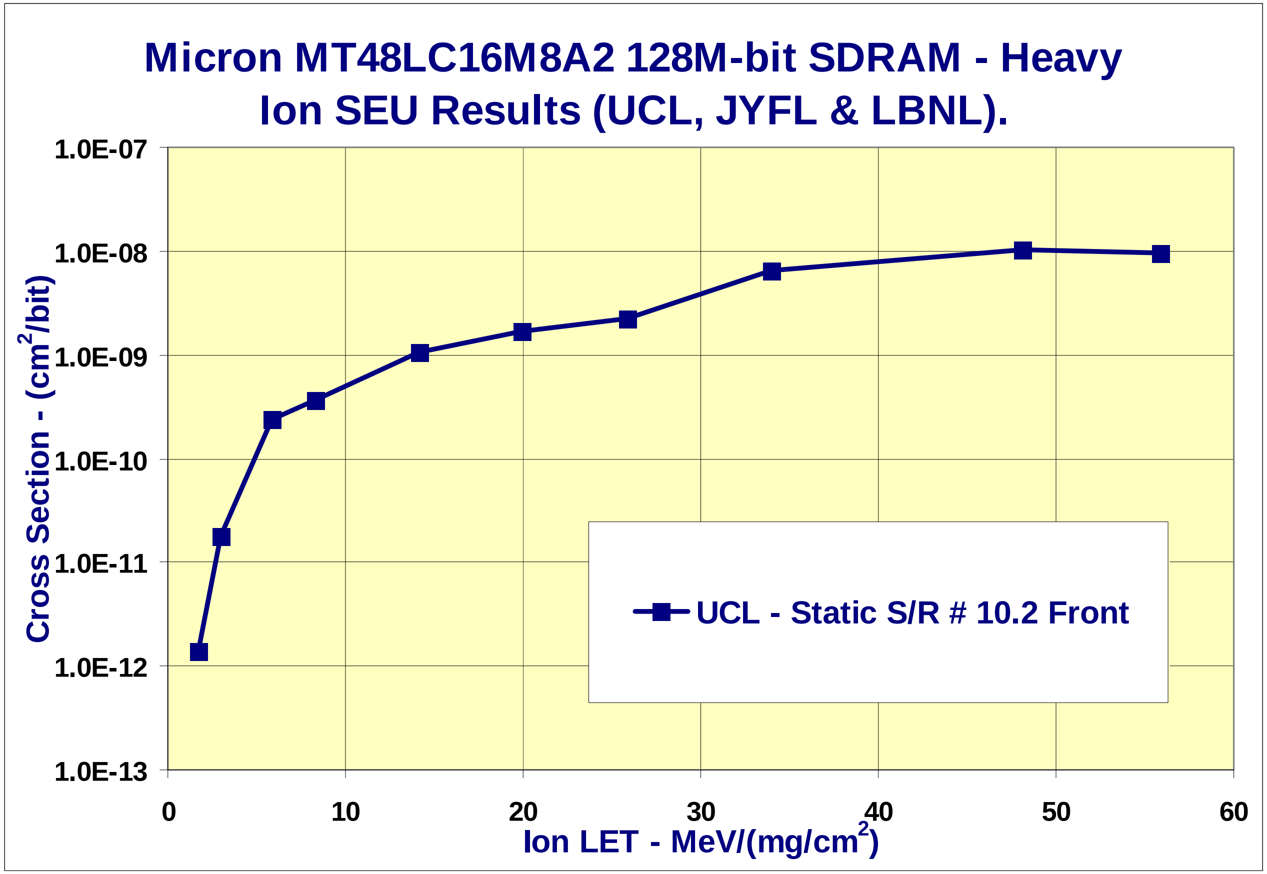
Heavy Ion Results - HIF, Belgium & JYFL, Finland.



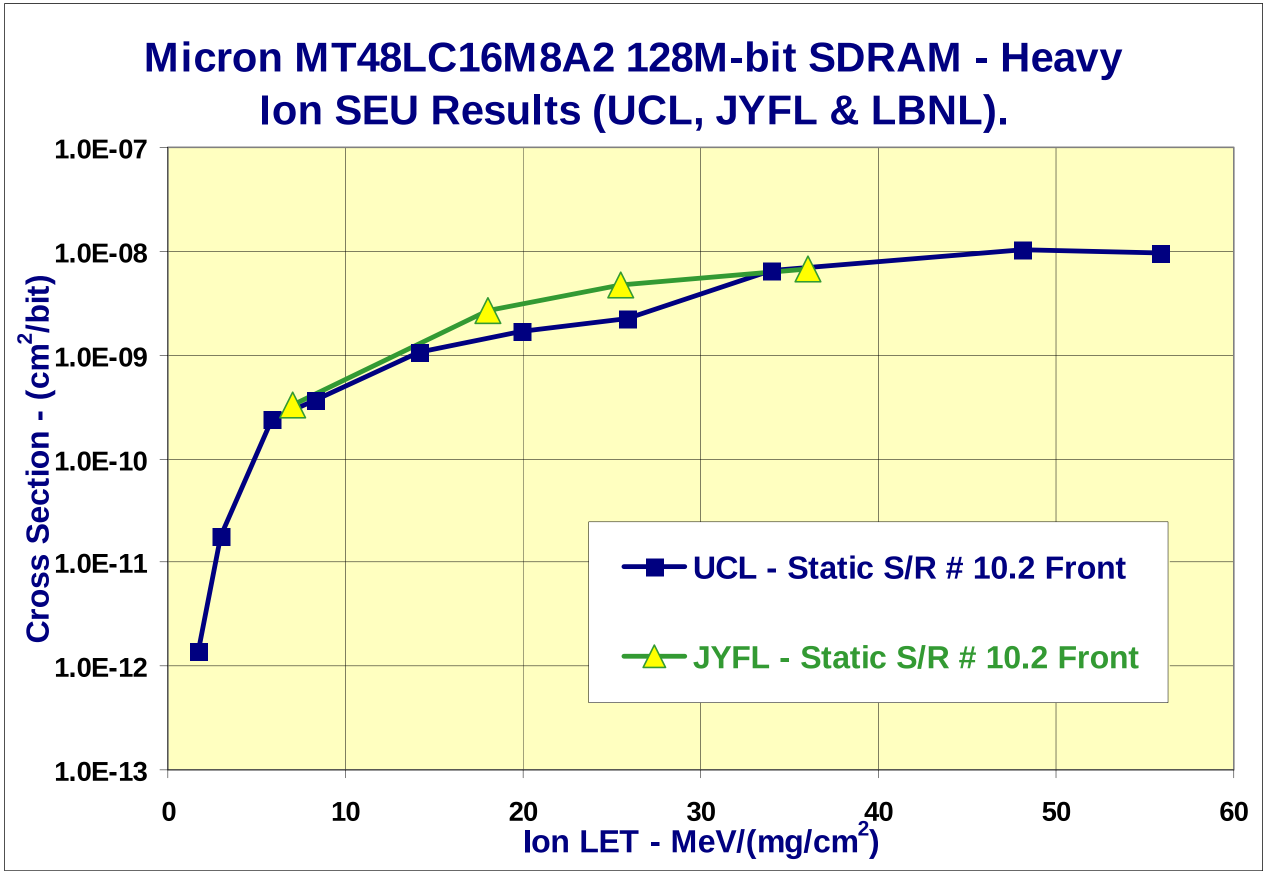
Heavy Ion Results - HIF, Belgium & JYFL, Finland.



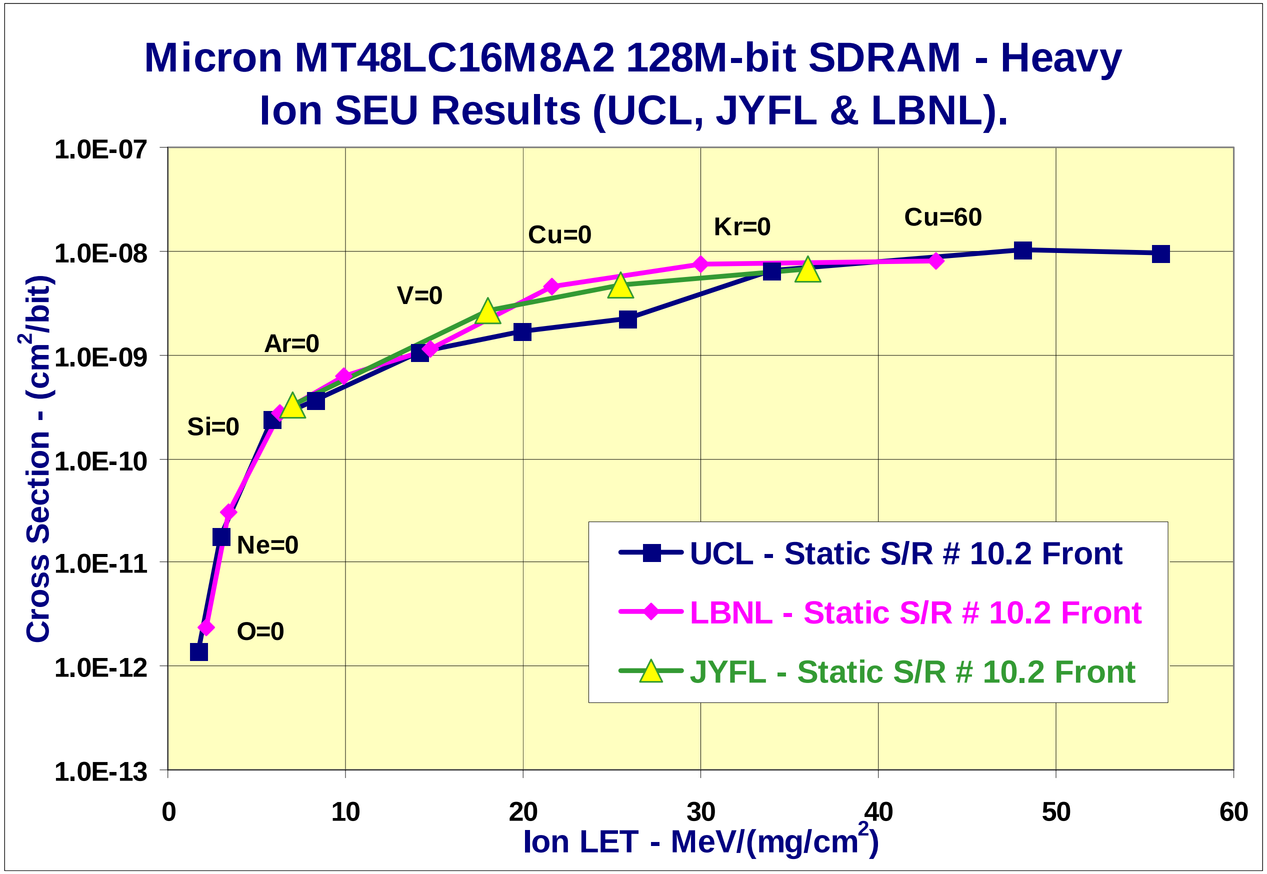
Heavy Ion Results - HIF, Belgium, JYFL, Finland & LBNL, USA.



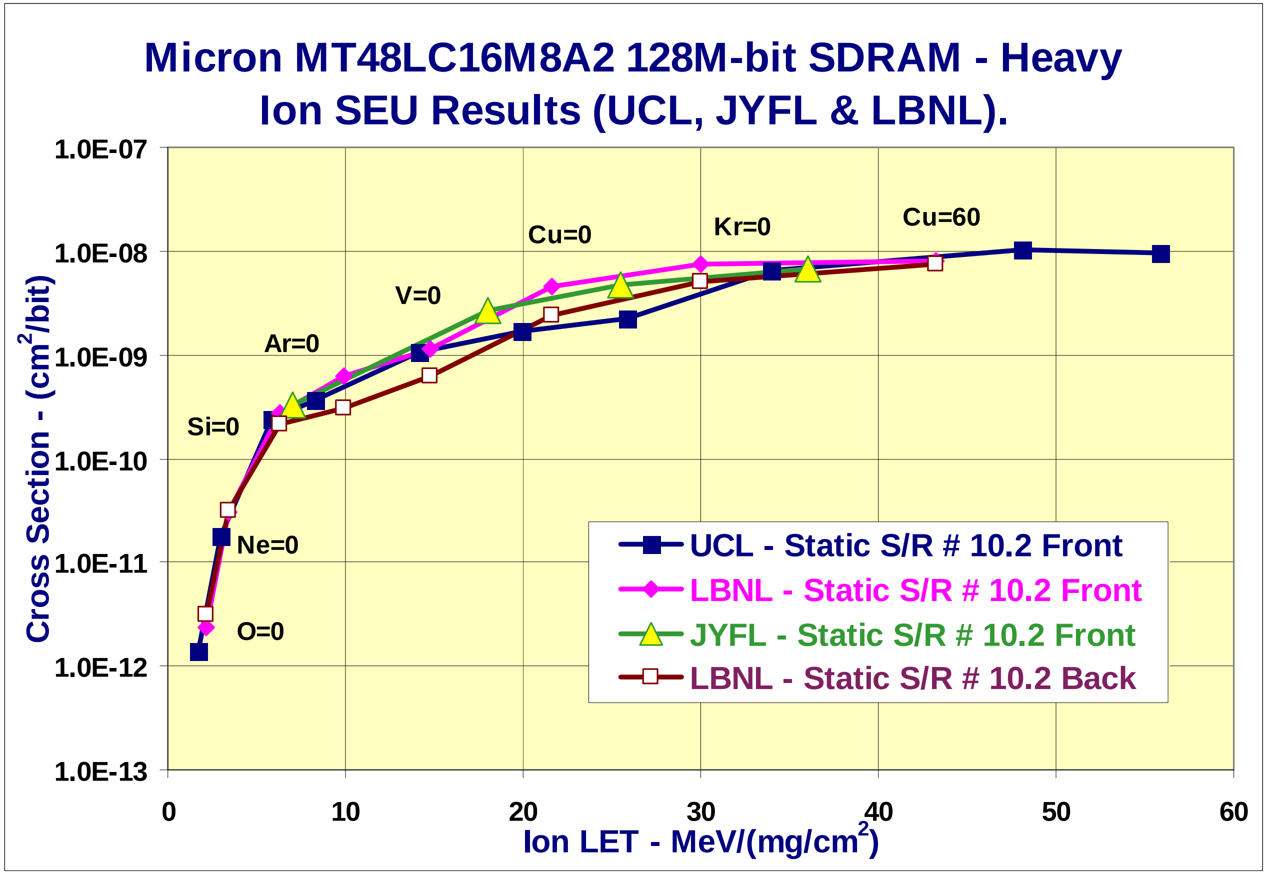
Heavy Ion Results - HIF, Belgium, JYFL, Finland & LBNL, USA.



Heavy Ion Results - HIF, Belgium, JYFL, Finland & LBNL, USA.



Heavy Ion Results - HIF, Belgium, JYFL, Finland & LBNL, USA.



Micron MT48LC16M8A2 128M-bit SDRAM - Heavy Ion SEU Results (UCL, JYFL & LBNL).

Conclusions

- Advanced memories, assembled with center bonds and lead frames, can be heavy ion SEE tested today provided:
  - Samples can be prepared via etching/re-bonding or back thinning and
  - Using accelerators with high penetration ions.

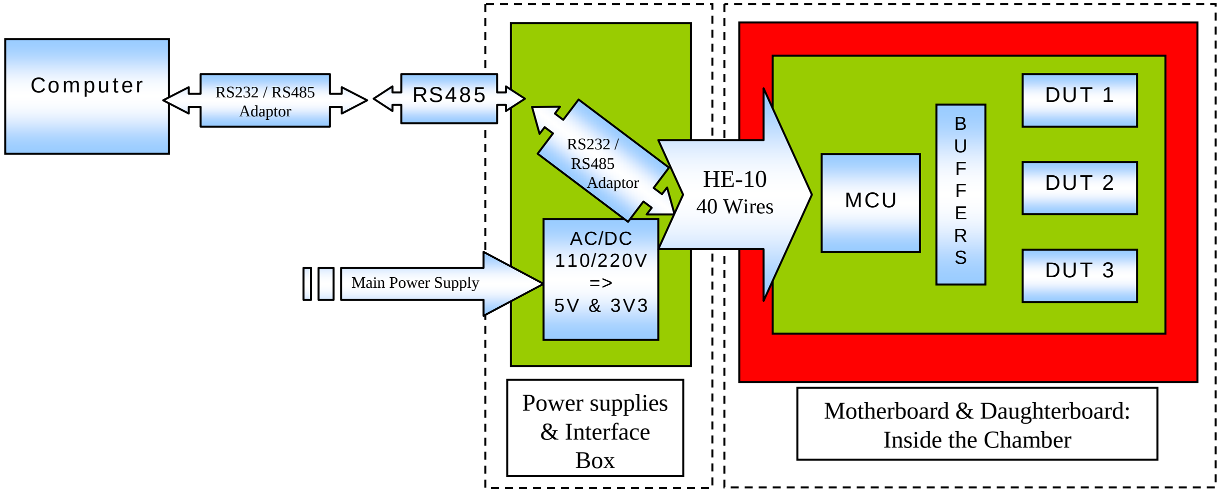
- Here, heavy ion Front and Back irradiation of SDRAMs showed the same SEE response, but testing has to be optimized in respect to the test sample and available ions. The LBNL facility provided sufficient number of ion species and range, whereas the HIF and JYFL, need developments in areas of:

  - Number of available ion species and

  - Ion range in Si (about 100 µm)

Reference SEU Monitor – I.

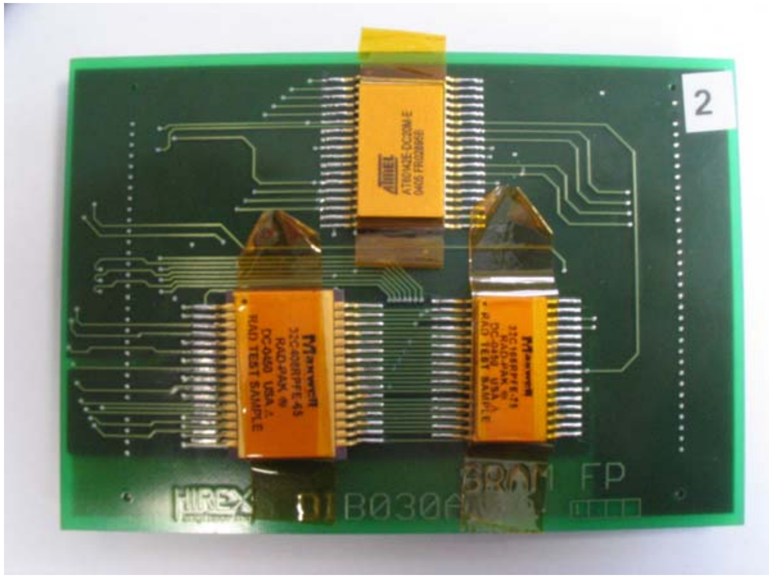
ESA will construct and calibrate a 'Reference SEU Monitor' system intended for use as a reference system at accelerators.



Basic design.

Reference SEU Monitor – II.

Beam characteristics can be verified by experimenters via this simple system, which uses an SRAM as the detecting element and a laptop as the controller.



Daughter-board lay-out.

15 'Reference SEU Monitor' systems will be produced and distributed – free of charge – to interested European SEE test sites.

escies.org
european space components information exchange system

European Space Components Information Exchange System

See:

https://escies.org

Radiation

ECSS – I.

http://www.ecss.nl/

ECSS and PSS Standards – Radiation

ECSS – Space Engineering

#ECSS-E-10-04 – Space Environment

#ECSS-E-10-12 – Methods for Calculating of Radiation Received and its Effects, and a Policy for Design Margins

ESCC Radiation Test Methods and Guidelines

#ESA PSS-01-609 – Radiation Design Handbook

#ESCC – Basic Specification 22900 - Total Dose Steady-State Irradiation Test Method

#ESCC – Basic Specification 25100 - Single Event Effects Test Method and Guidelines

Summary –

Hope this presentation has provided answers to questions you may have! – if not or if I can be of further help – don't hesitate to contact me.

THANK YOU FOR YOUR ATTENTION !

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e-mail: Reno.Harboe.Sorensen@esa.int

https://escies.org/public/radiation/esa/