HIREX ENGINEERING®

Radiation Evaluation of Power MOSFET Devices From Different European Manufacturer

Final Presentation of ESTEC Contract N° 13413/98/NL/MV

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

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Tested Products

N-Channel Power MOSFET

Manufacturer	Type	Marking	VDS -Volt	Package
Philips	PHP50N06T	PHP50N06T m9814	55	TO-220
Philips	BUK456-200A	BUK456-200A m9616	200	TO-220
Motorola	MTP50N06VL	MTP50N06VL 9829	60	TO-220
Motorola	MTW32N20E	MTW32N20E DE9734	200	TO-247
Motorola	MTP50N06V	MTP50N06V 9534	60	TO-220
Siemens	BUZ100S	BUZ100S AC742	55	TO-220
Siemens	BUZ100SL	BUZ100SL B737	55	TO-220
Siemens	BUZ341	BUZ341 Z703	200	TO-218
SGS-Thomson	SP60	SP60 39822	60	TO-3
SGS-Thomson	SP100V	SP100V 9820	100	TO-3
SGS-Thomson	SP200V	SP200V 9820	200	TO-3
Siemens	SPP1N60S5	20N60N5 AQ910	600	TO-220
Philips	BUK7508-55	BUK7508-55 m9818	55	TO-220
Harris	HUF75639P3	75639P H819L	100	TO-262

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Tested Products

Different processes covered in this evaluation

- Double Diffused Power MosFET (DMOS)
- Trench MOS
- CoolMOS (Siemens)

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Total Ionizing Dose Evaluation of Power MOSFET Devices

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TID Tested Electrical Parameters

Symbol	Test Parameter	Test Conditions	Min limit	Max limit	Unit
BVDSS	Drain to Source breakdown voltage	VGS=0V, ID=xxmA	X		V
VGSTH	Gate to Source threshold voltage	VDS>=VGS, ID=xxmA	X	Y	V
+IGSS	Positive Gate Source leakage current	VGS=+xxV, VDS=0V		Y	nA
-IGSS	Negative Gate Source leakage current	VGS=-xxV, VDS=0V		Y	nA
IDSS	Drain current	VGS=0V, VDS=xxV		Y	µA
RDSON	Static drain to source on-state resistance	VGS=10V, ID=xxA		Y	Ohm

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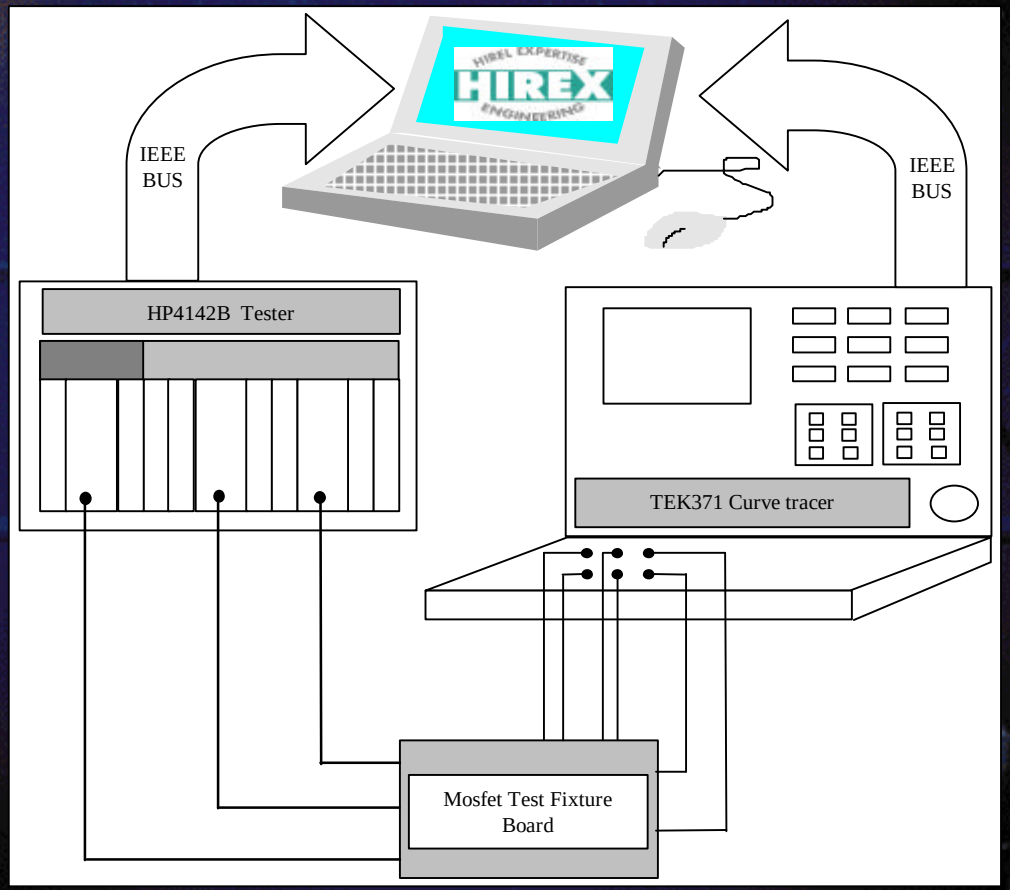
TID Test Programs Principle



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TID Test Conditions

Irradiation Steps	Dose rate	Annealing steps	Temperature
krads	krads/h	hours	°C
0			
3.85	0,075		25
7.35	0,075		25
13.95	0,075		25
19.65	0,075		25
24.65	0,075		25
29.85	0,075		25
36.85	0,075	0	25
		24	25
		192	100

Source CO_{60} ONERA-CERT

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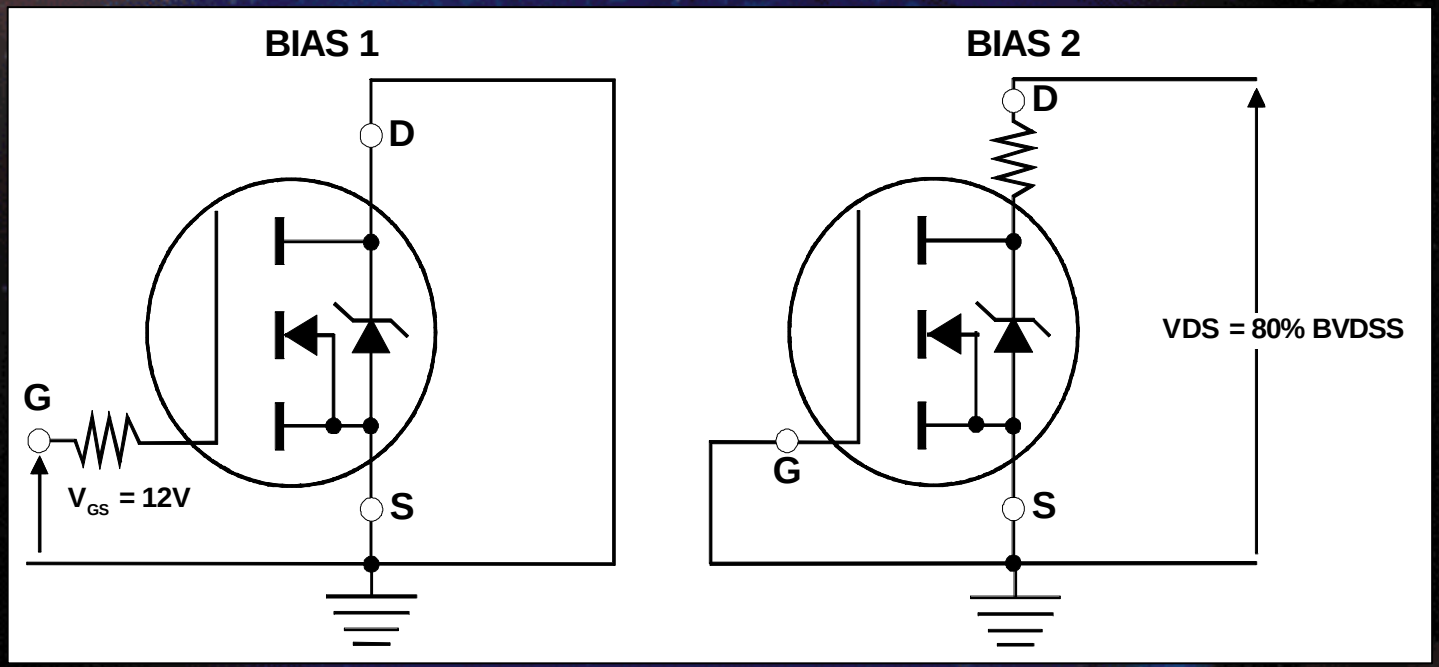
TID Bias Conditions



5 parts/type for each bias conditions + 1 control/type

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TID Test Results

CO_{60} TID Results		Failing Parameters		Tolerant Level Krad(Si)	
Manufacturer	Type	Bias 1	Bias 2	Bias 1	Bias 2
Philips	PHP50N06T	-	VGSTH	36.85	19.65
Philips	BUK456-200A	VGSTH	BVDSS	29.85	7.35
Motorola	MTP50N06VL	VGSTH	VGSTH	29.85	29.85
Motorola	MTW32N20E	VGSTH	VGSTH	13.95	3.85
Motorola	MTP50N06V	VGSTH	VGSTH	36.85	24.65
Siemens	BUZ100S	VGSTH	VGSTH	13.95	7.35
Siemens	BUZ100SL	VGSTH	BVDSS	24.65	3.85
Siemens	BUZ341	BVDSS	BVDSS	19.65	3.85
SGS-Thomson	SP60	-	BVDSS	36.85	13.95
SGS-Thomson	SP100V	-IGSS	BVDSS	7.35	13.95
SGS-Thomson	SP200V	BVDSS	BVDSS	7.35	3.85
Siemens	SPP1N60S5	VGSTH	VGSTH	7.35	7.35
Philips	BUK7508-55	VGSTH	VGSTH	13.95	7.35
Harris	HUF75639P3	-	-	36.85	36.85

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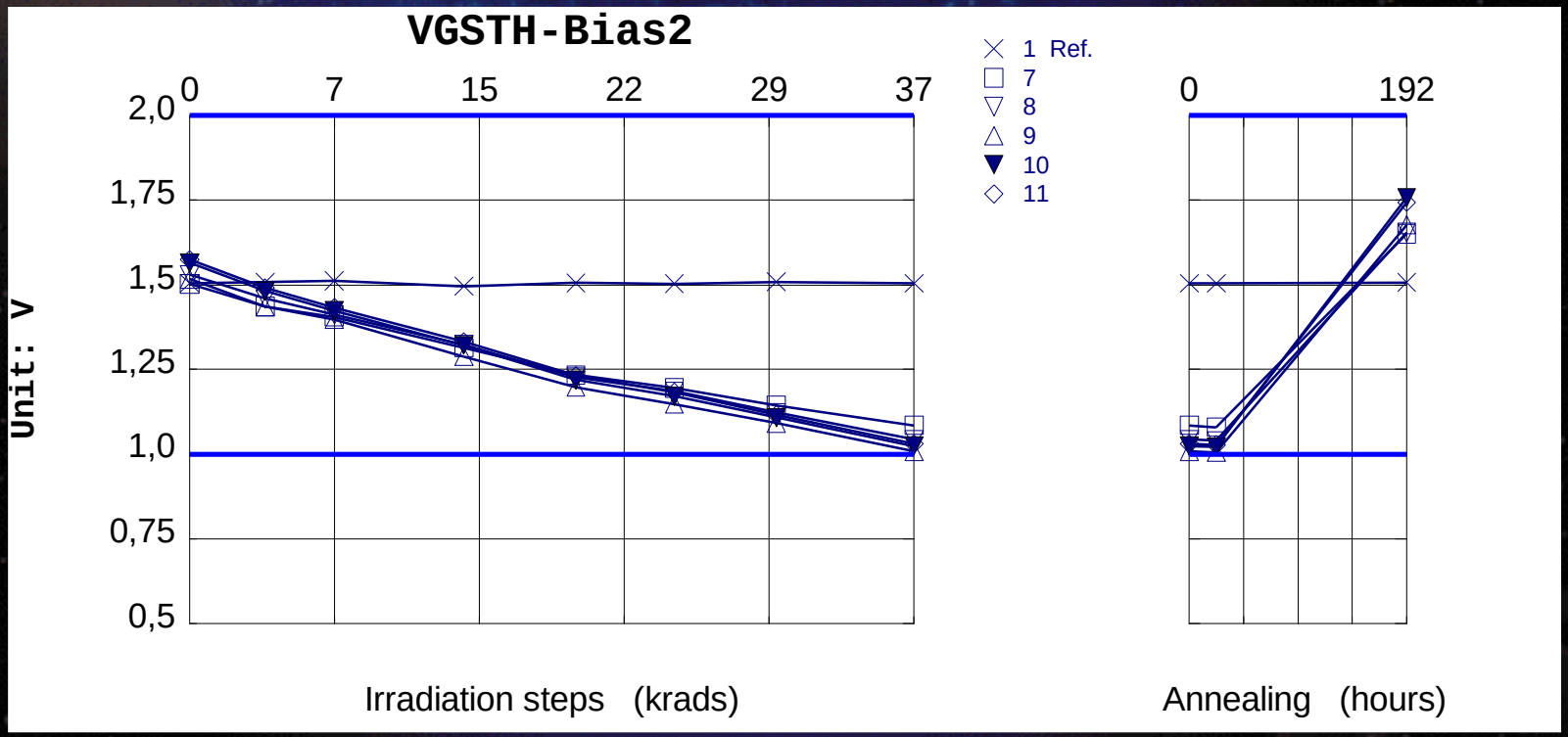
TID Test Results : MTP50N06VL

VGSTH Evolution : Bias 2 conditions



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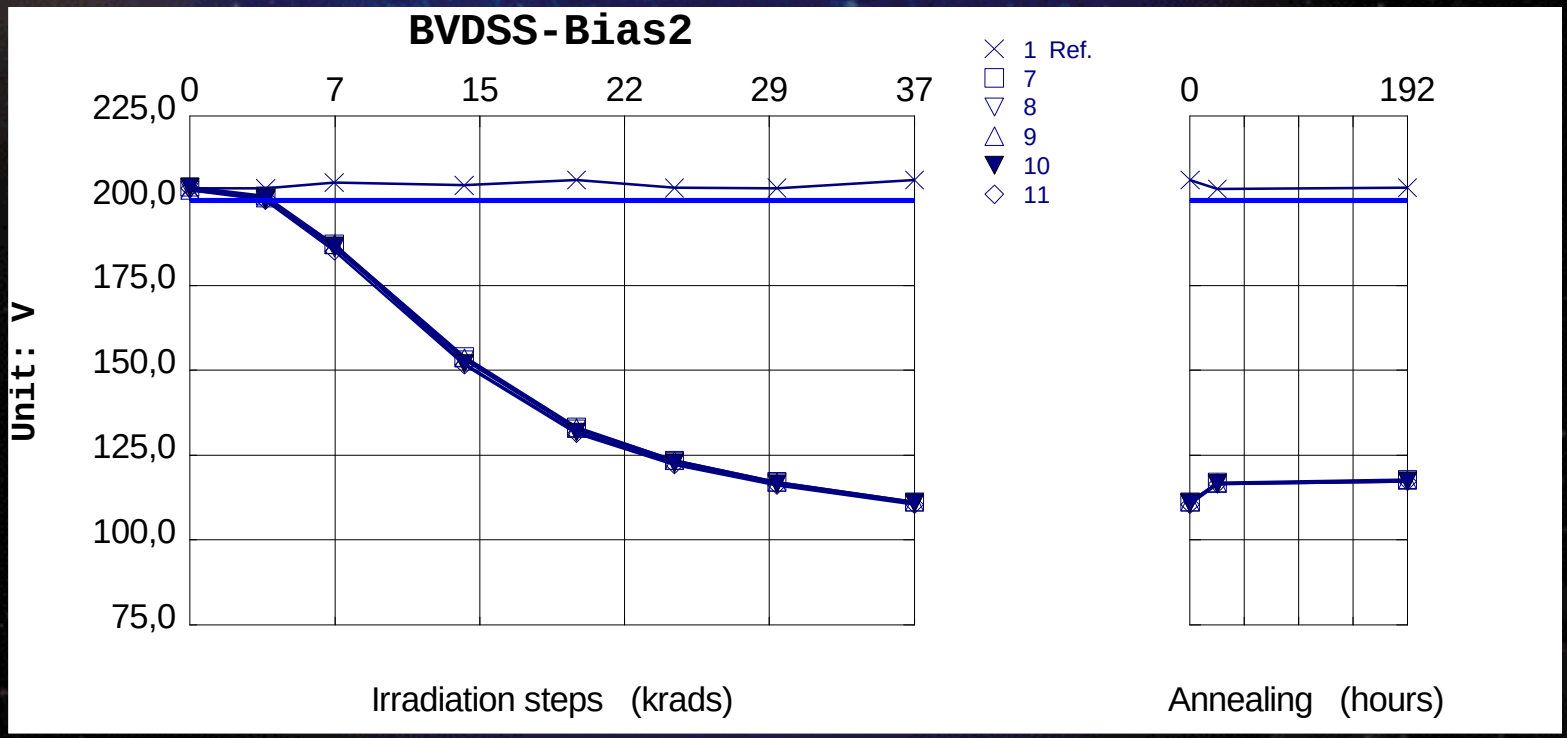
TID Test Results : SP200V

BVDSS Evolution : Bias 2 conditions



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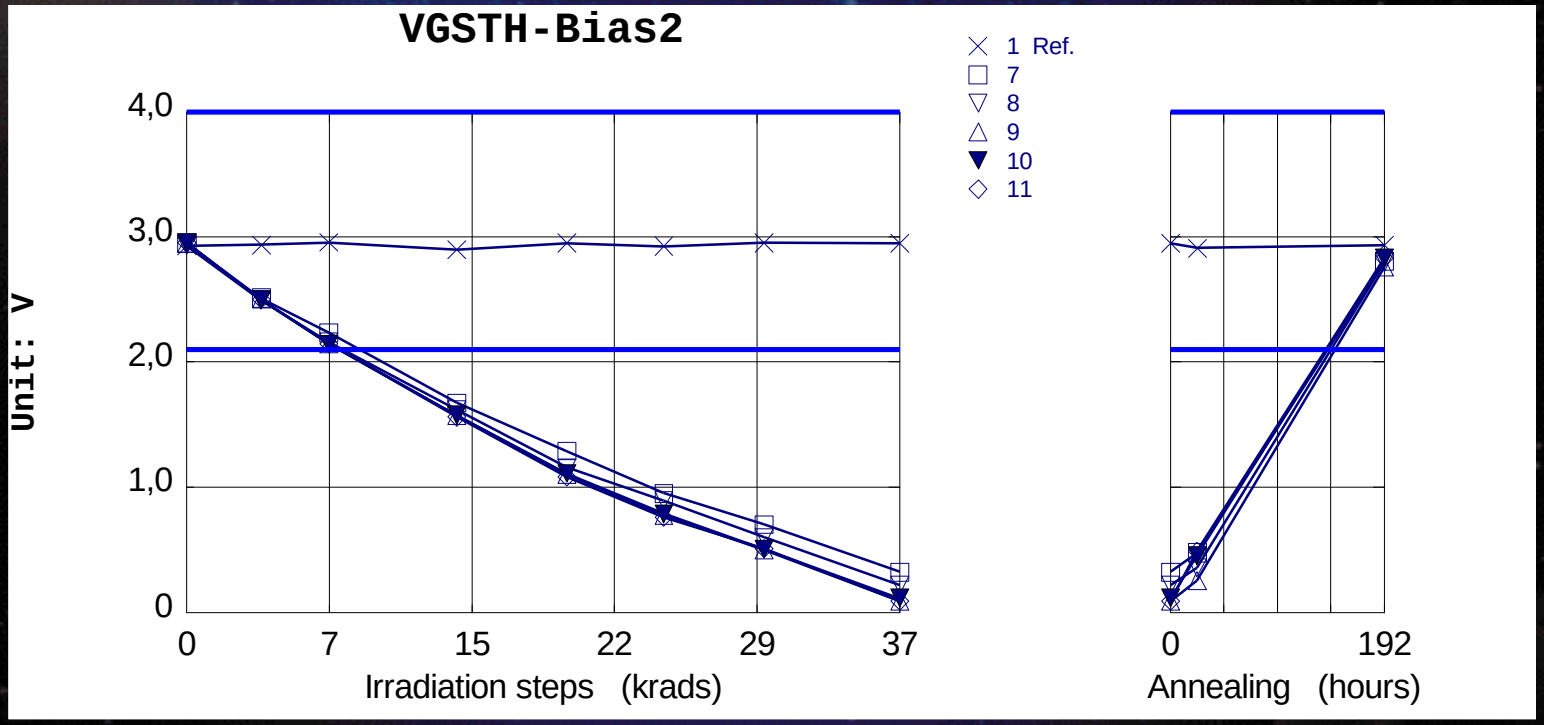
TID Test Results : BUZ100S

VGSTH Evolution : Bias 2 conditions



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Single Event Effect
Evaluation of Power MosFET Devices

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

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Tested Products

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Philips	BUK456-200A	BUK456-200A m9616	200	TO-220
Siemens	BUZ100S	BUZ100S AC742	55	TO-220
Siemens	BUZ100SL	BUZ100SL B737	55	TO-220
Siemens	BUZ341	BUZ341 Z703	200	TO-218
SGS-Thomson	SP60	SP60 39822	60	TO-3
SGS-Thomson	SP100V	SP100V 9820	100	TO-3
SGS-Thomson	SP200V	SP200V 9820	200	TO-3
Siemens	SPP1N60S5	20N60N5 AQ910	600	TO-220
Philips	BUK7508-55	BUK7508-55 m9818	55	TO-220
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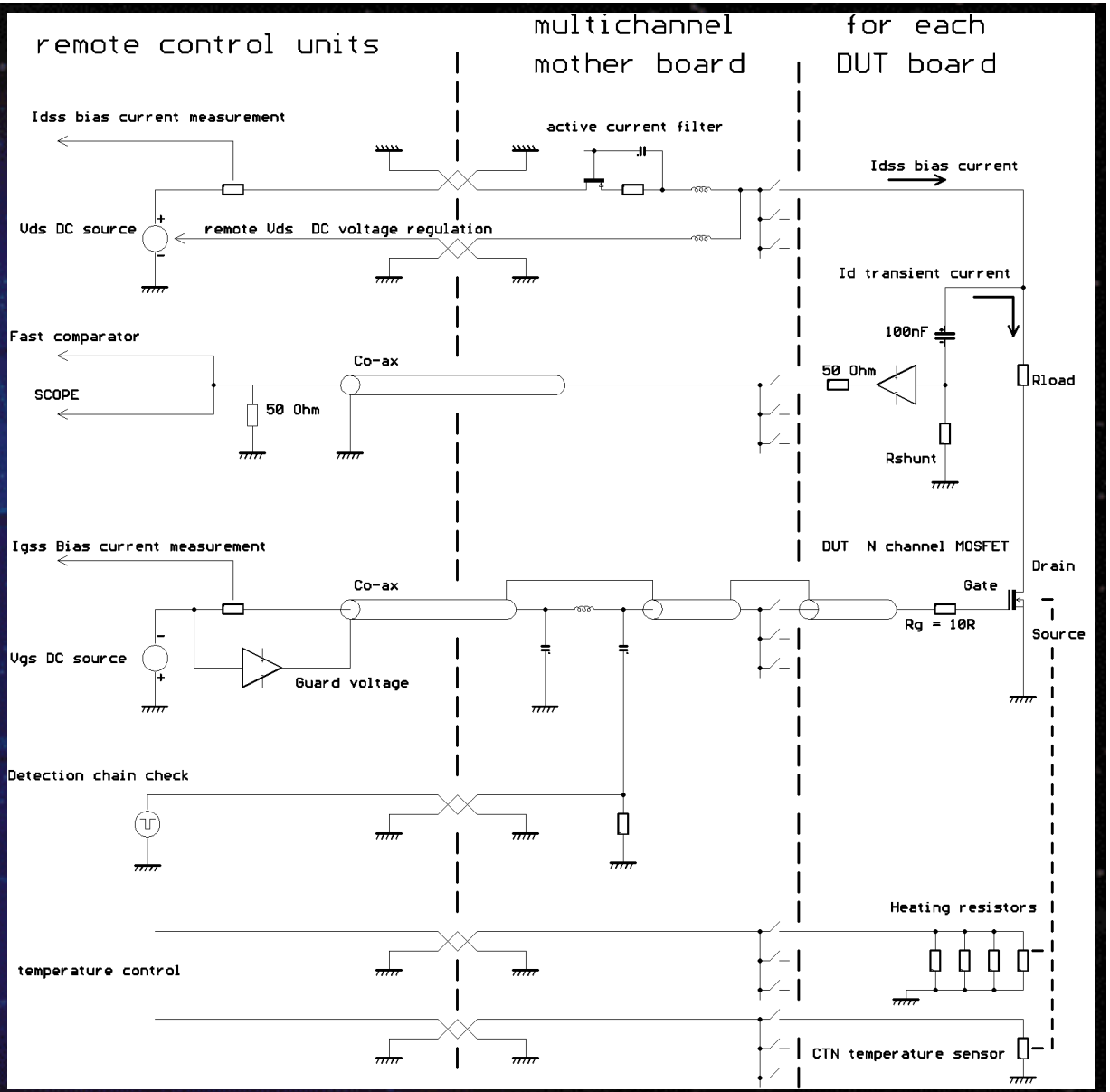
SEE Mosfet Test Principle

Both Idss and Igss current measurement

Up to 10 Test positions

Temperature control

Chain check test



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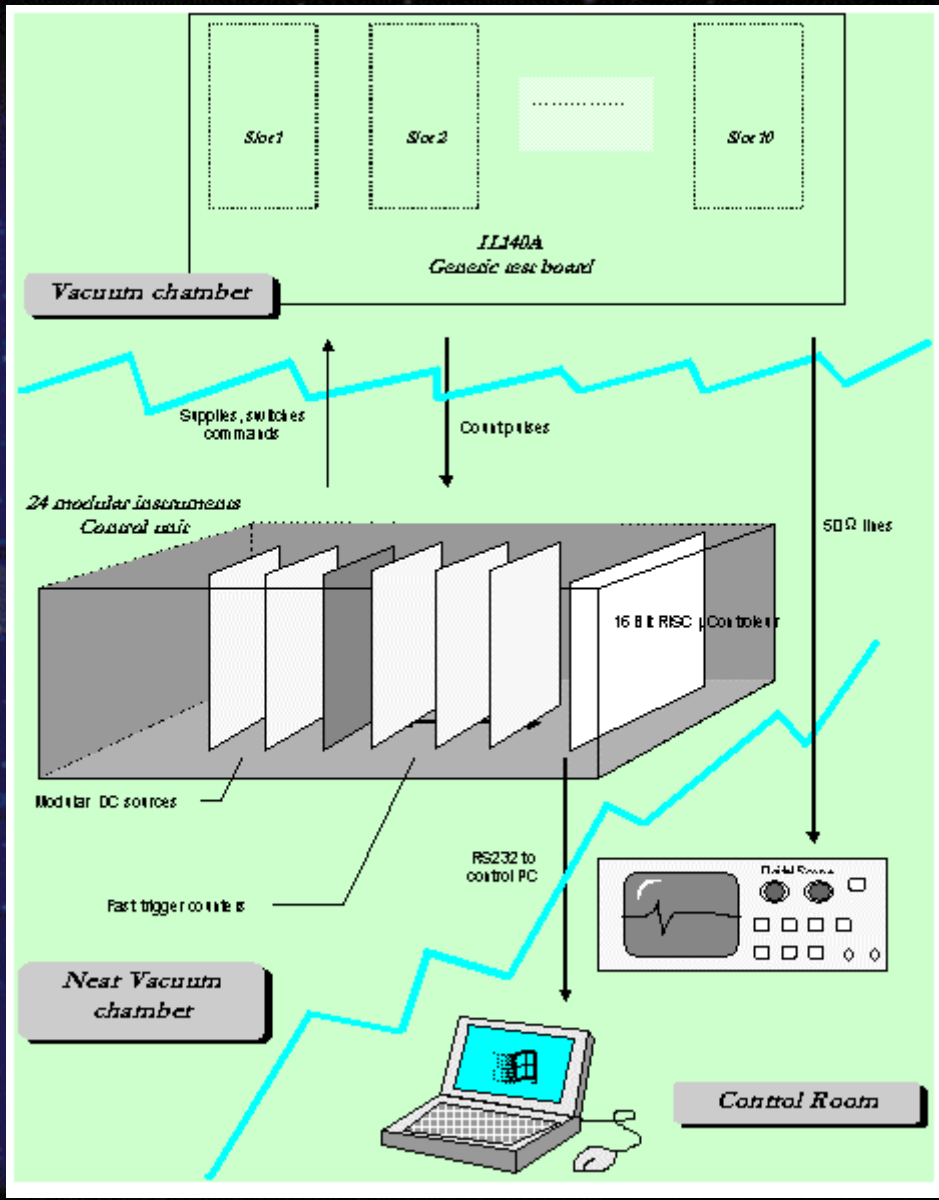
Test Set-up

Include particle fluence counting

(TTL signal)

to compute an SEGR Cross-section



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SEE Test Conditions

HIF & Test Parameters SEB/SEGR

- UCL CYCLONE- Heavy Ion Facility (HIF)
  - $^{84}Kr^{17+}$ at 316 MeV - LET = 34.0 MeV/(mg/cm²)
  - $^{40}Ar^{8+}$ at 150 MeV - LET = 14.1 MeV/(mg/cm²)
- Single Event Burn-out (SEB)
  - Fixed Gate Source voltage (VGS) = -2V
  - Variable Drain Source Voltage (VDS) given in % of VDS Max
- Single Event Gate Rupture (SEGR)
  - Variable Gate Source voltage (VGS) = -2V/-15V
  - Variable Drain Source Voltage (VDS) given in % of VDS Max

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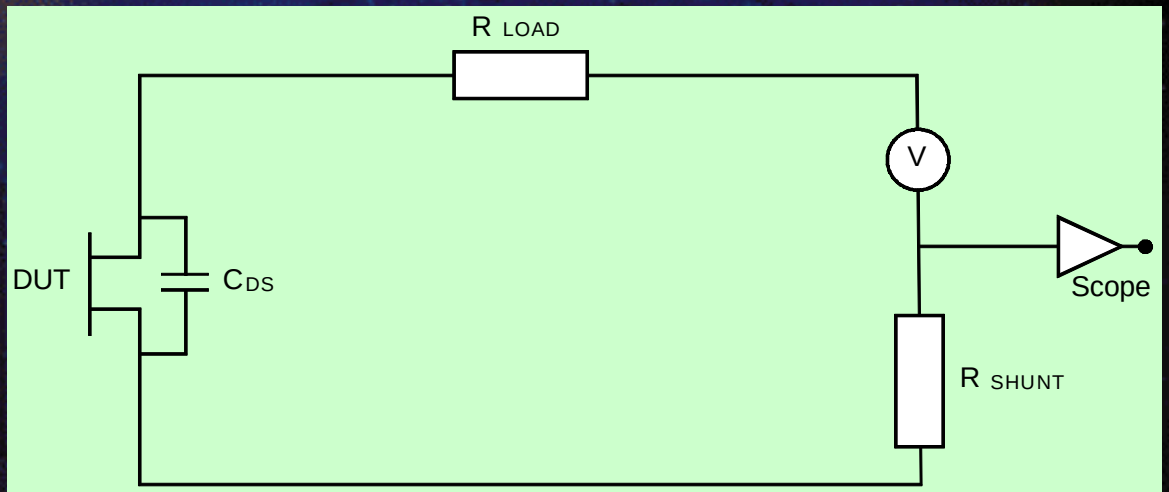
SEE Test Results



Symbol	Value
Rload	1.6 kohms
RShunt	25 ohms

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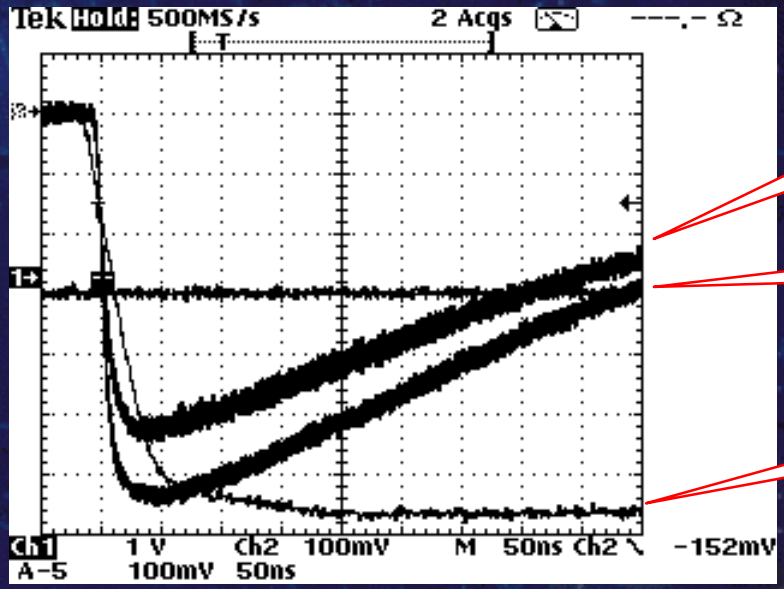
SEE Test Results



60V Vds rating

70V Vds rating

Simulation pulse

Example of non destructive SEBs observed
on a 100V transistor at 60V and 70V Vds ratings

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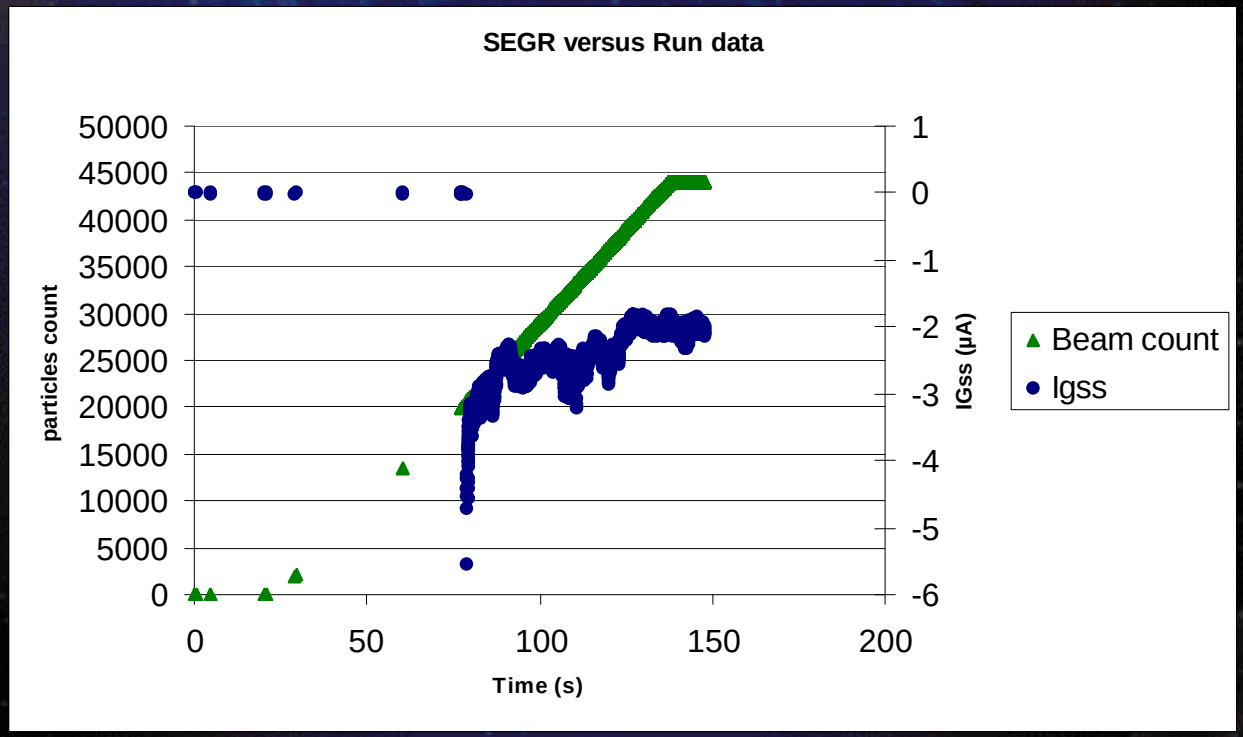
SEE Test Results

Run analysis for SEGR cross-section determination



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SEE Test Results

SEB results

Max. VDS without SEB		Parameters		Max. VDS in%	
Mfr.	Type	VGS	VDS	LET = 14,1	LET=34,0
Philips	PHP50N06T	-2 V	55 V	60%	45%
Philips	BUK456-200A	-2 V	200 V	55%	25%
Siemens	BUZ100S	-2 V	55 V	65%	50%
Siemens	BUZ100SL	-2 V	55 V	60%	50%
Siemens	BUZ341	-2 V	200 V	<35%	25%
SGS-Thomson	SP60	-2 V	60 V	65%	40%
SGS-Thomson	SP100V	-2 V	100 V	100%	55%
SGS-Thomson	SP200V	-2 V	200 V	80%	35%
Siemens	SPP1N60S5	-2 V	600 V	40%	25%
Philips	BUK7508-55	-2 V	55 V	55%	40%
Harris	HUF75639P3	-2 V	100 V	50%	35%

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SEE Test Results

SEGR results

Max. VDS without SEGR		Parameters		Max. VDS in%	
Mfr.	Type	VGS	VDS	LET = 14,1	LET=34,0
Philips	PHP50N06T	-2 V	55 V	75% P	70% P
Philips	BUK456-200A	-2 V	200 V	65% P	50% P
Siemens	BUZ100S	-2 V	55 V	80% P	70% P
Siemens	BUZ100SL	-2 V	55 V	80% P	70% P
Siemens	BUZ341	-2 V	200 V	50% P	30%
SGS-Thomson	SP60	-2 V	60 V	100% P	60%
SGS-Thomson	SP100V	-2 V	100 V	100% P	60%
SGS-Thomson	SP200V	-2 V	200 V	70%	50% P
Siemens	SPP1N60S5	-2 V	600 V	50% P	40% P
Philips	BUK7508-55	-2 V	55 V	70% P	60% P
Harris	HUF75639P3	-2 V	100 V	60% P	40% P

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