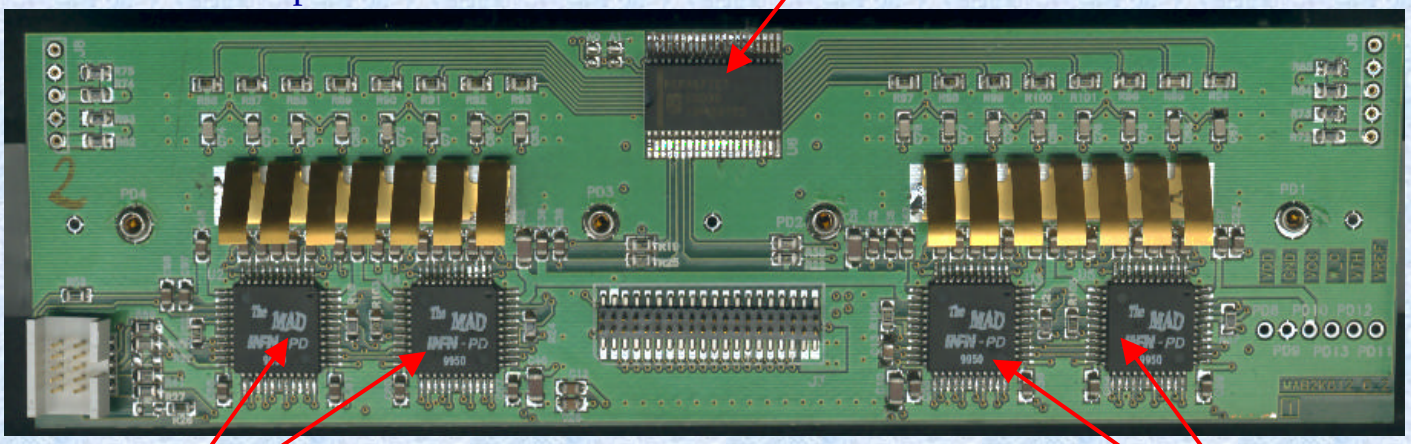
RADIATION TESTS

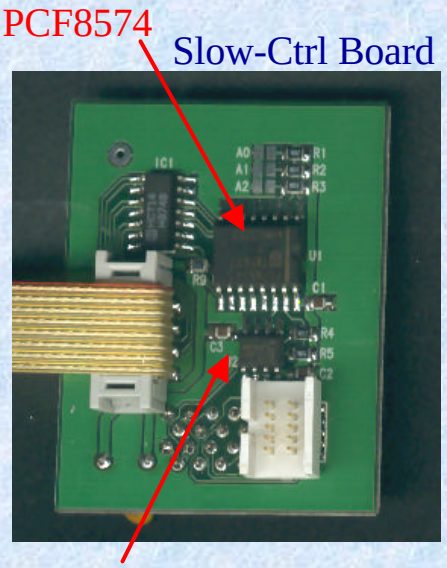
CMS Muon Barrel Frontend Electronics

Frontend Board Up Side

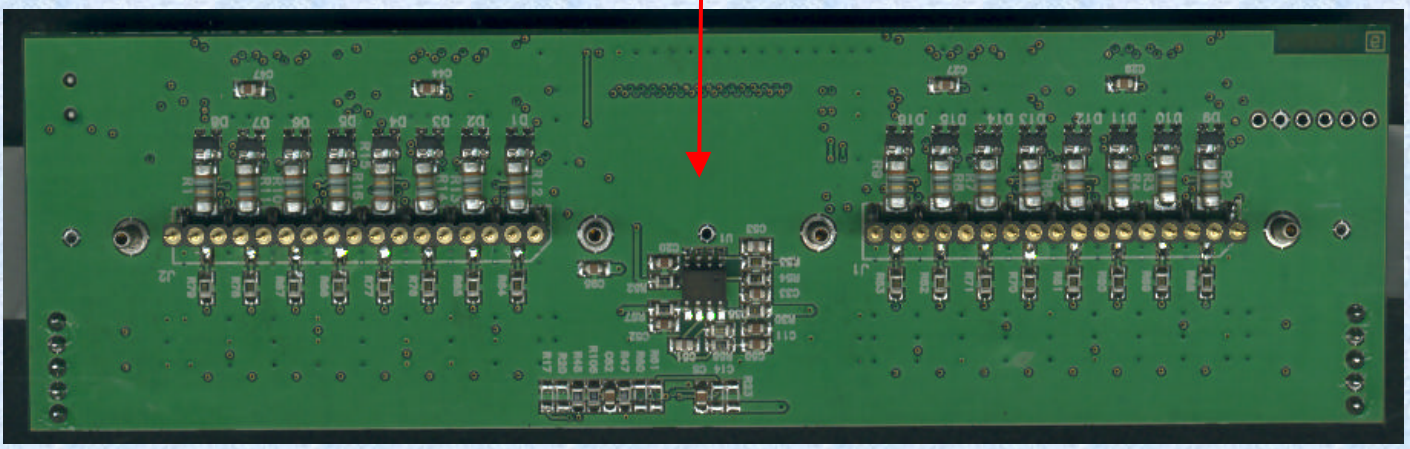


All frontend electronics ASIC and COTS have been tested against radiation to check LHC environment compatibility:

- MAD frontend ASIC (Frontend board)
- Philips PCF8577 (Frontend board)
- Burr-Brown OPA234 (Frontend board)
- Philips PCF8574 (Slow-Ctrl board)
- Philips 82B715 (Slow-Ctrl board)



Frontend Board Down Side

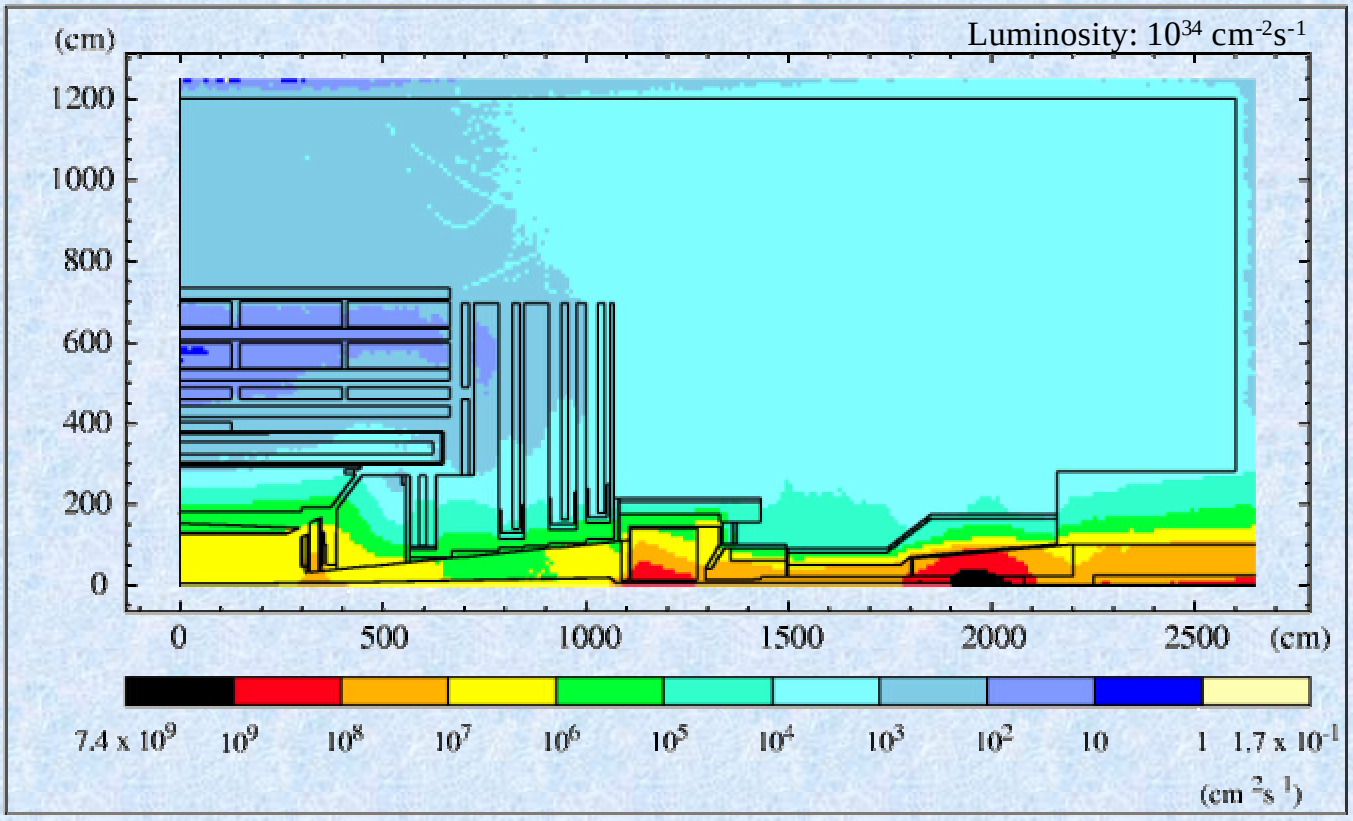


RADIATION TESTS

Heavy Ions and Neutrons Irradiation

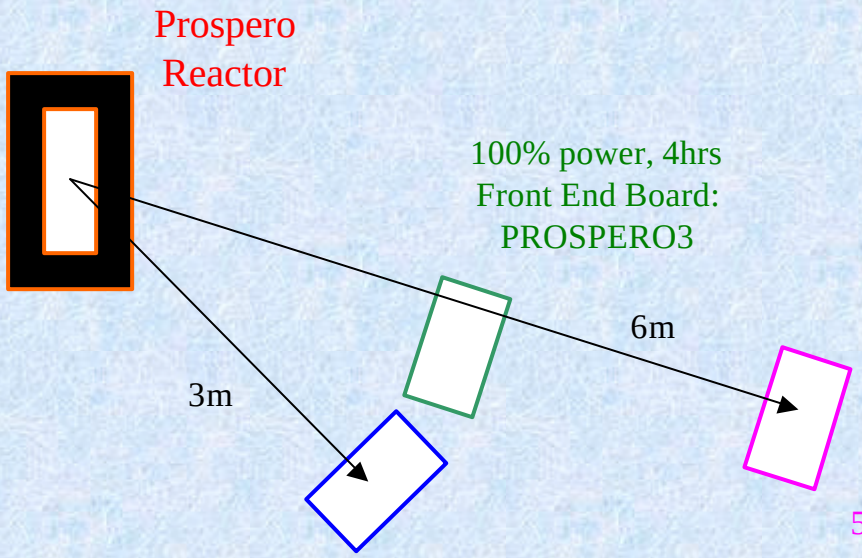
In CMS barrel irradiation flux is very low,
only neutron flux can give problems by
Single Event Effects:

5 10^{10} n/cm^2 for 10y activity (10% thermal)



For best ASIC characterisation against SEL
heavy ions irradiation is tested too

RADIATION TESTS
Fast Neutrons at PROSPERO Facility

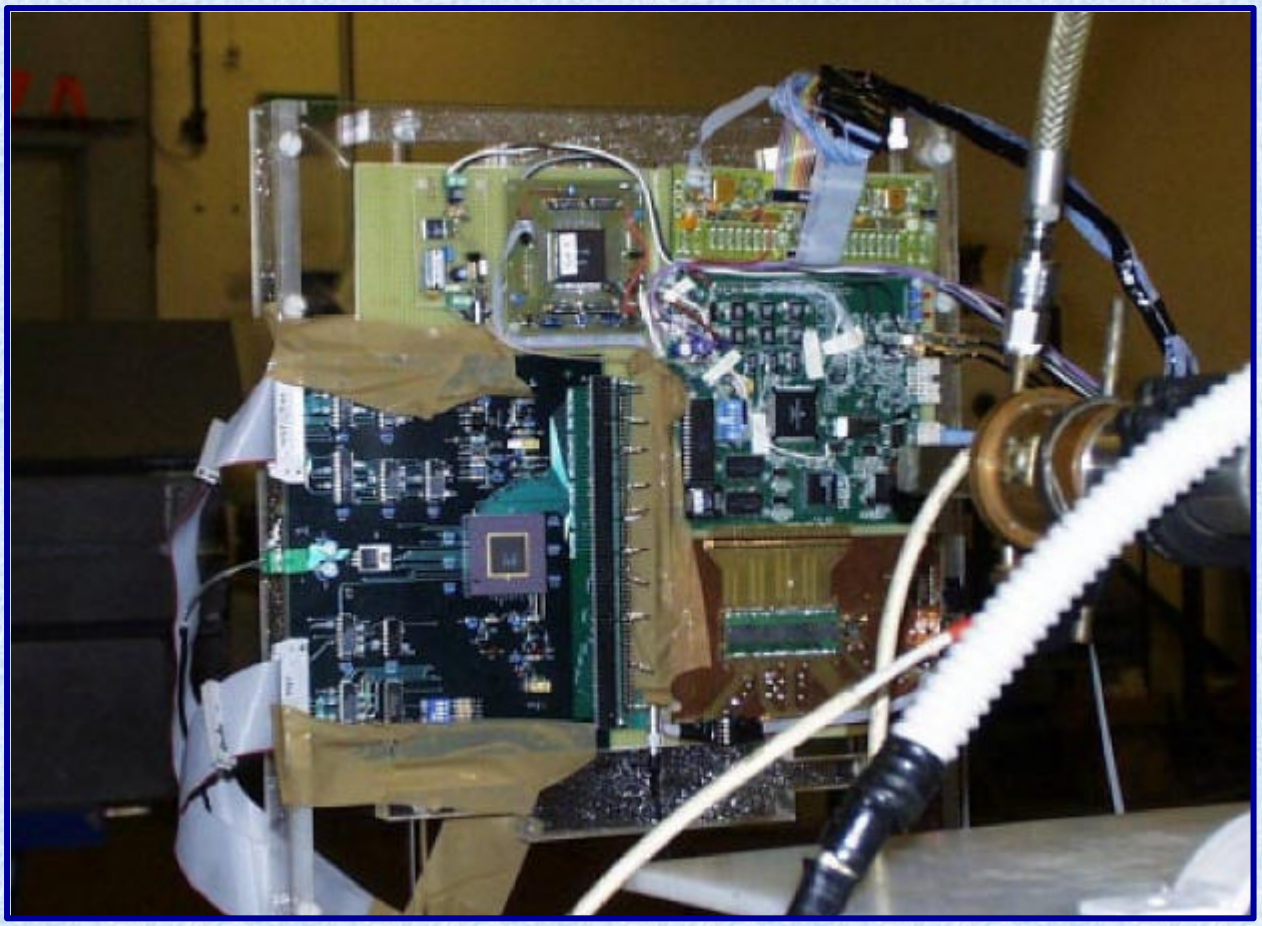


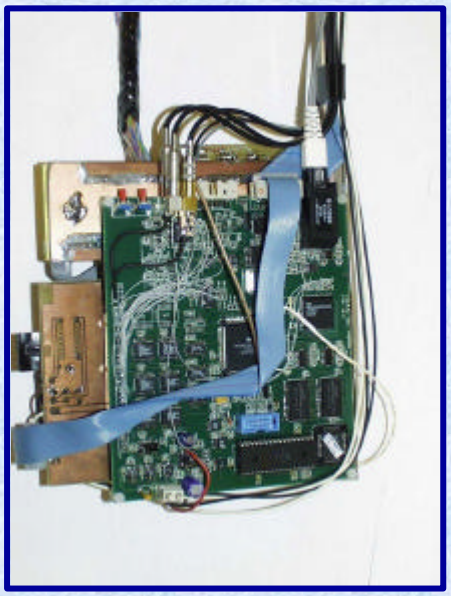
FRONT END BOARD	REACTOR DISTANCE	n/cm^2 EQ. 1MeV(SI)
PROSPERO1	6m	**4.85 10^{10}**
PROSPERO2	3m	**1.53 10^{11}**
PROSPERO3	3m	**1.72 10^{12}**

NO dynamic or static changes measured!

RADIATION TESTS

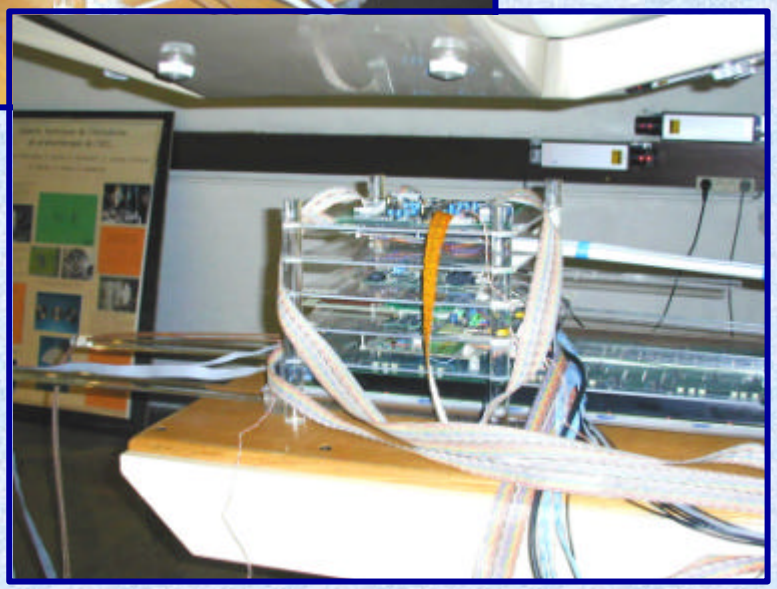
SE induced by Fast and Slow Neutrons at LNL





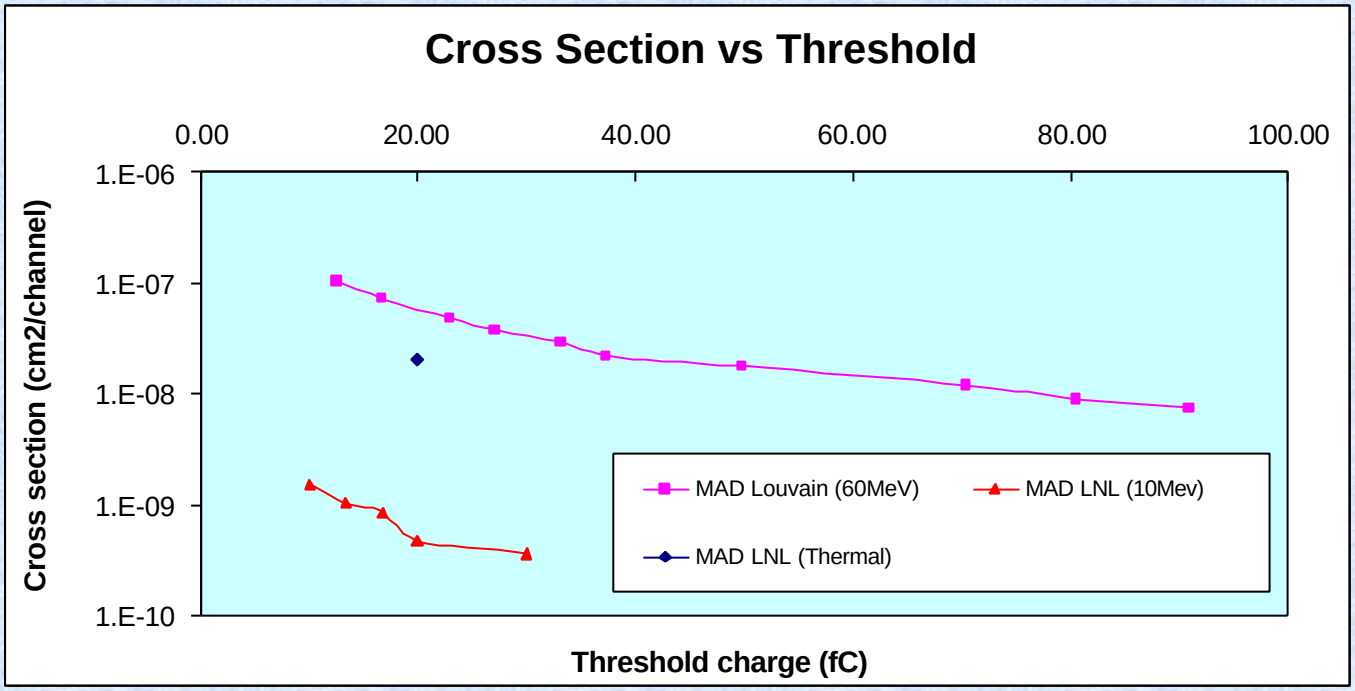
RADIATION TESTS

SE induced by Fast Neutrons at Louvain

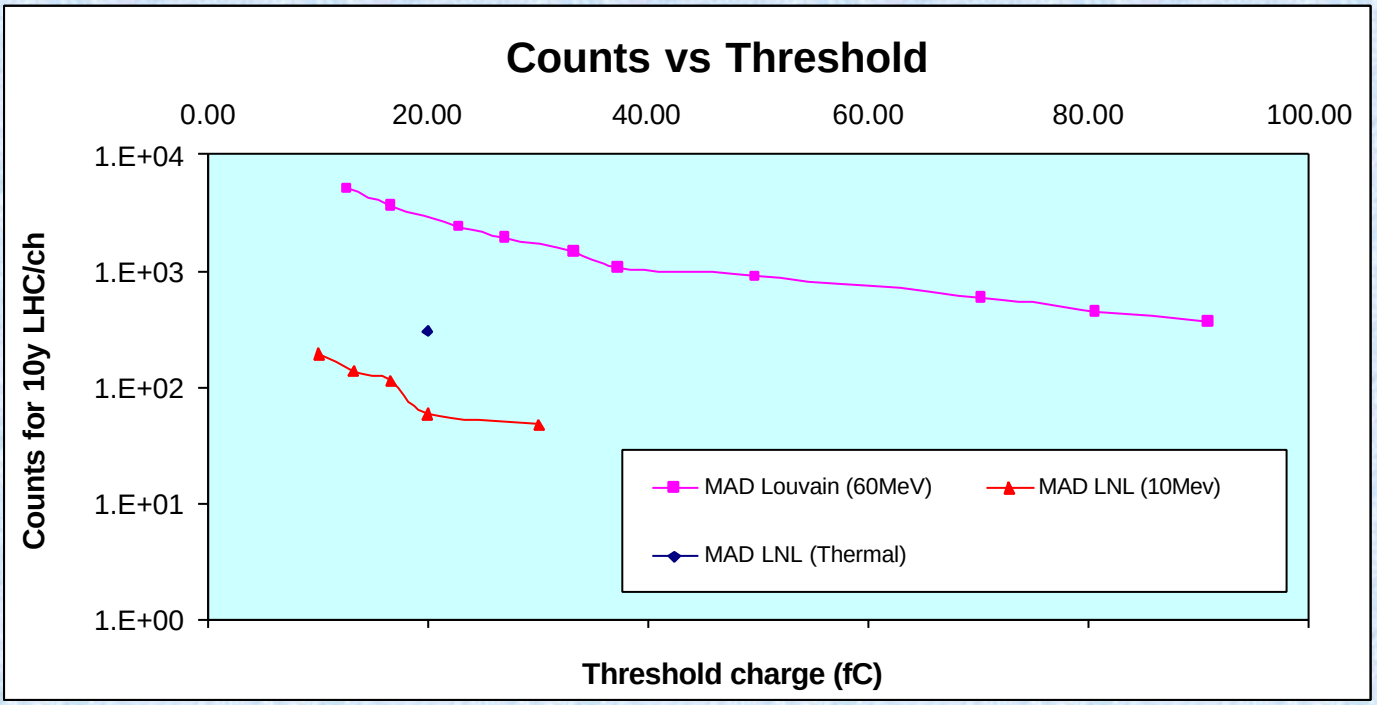


RADIATION TESTS

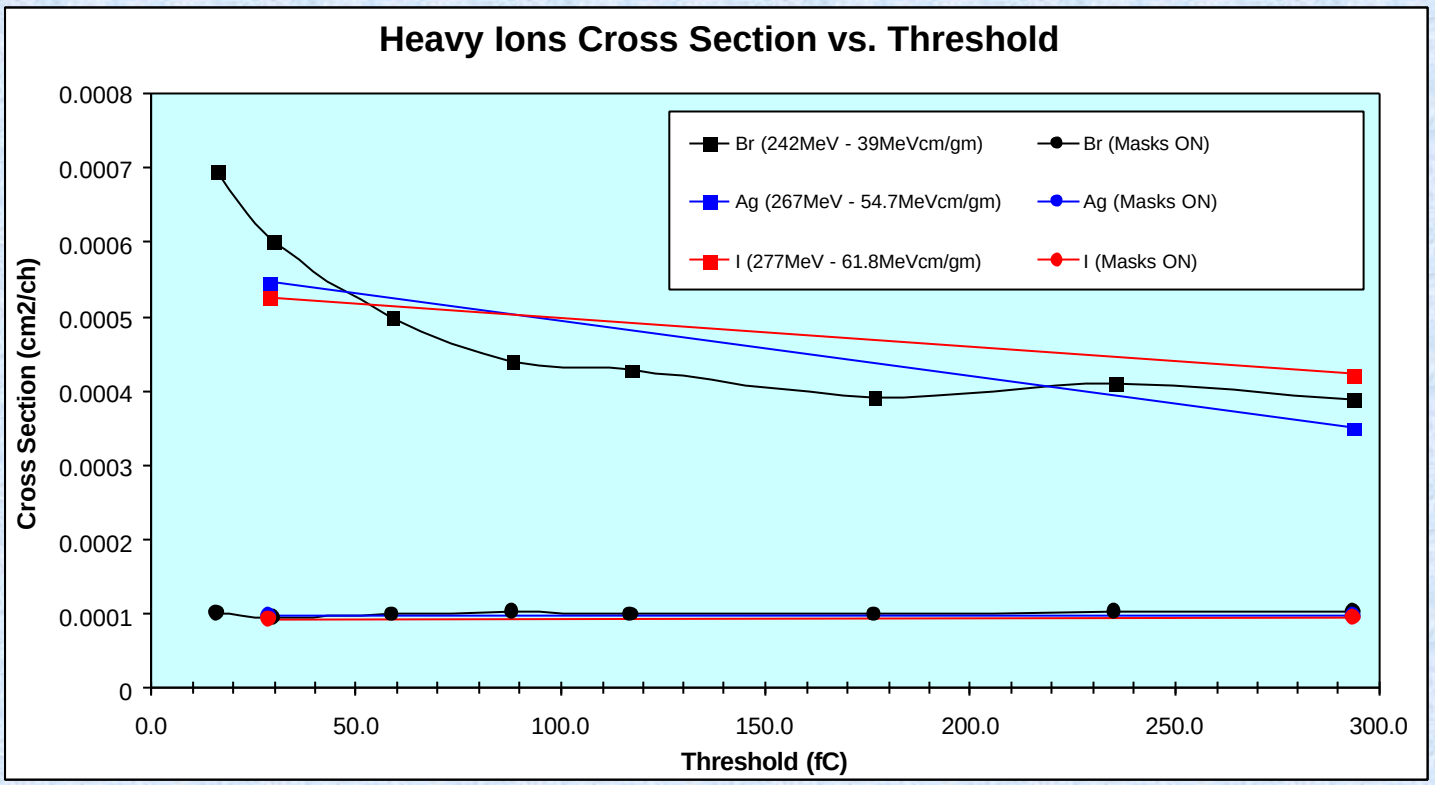
SEU induced by Fast and Thermal Neutrons



From these data we can estimate about few thousand counts for electronic channel for 10y LHC activity



RADIATION TESTS
SEU induced by Heavy Ions



The graph shows the cross section vs. threshold for heavy ions irradiation of a frontend ASIC in 2 cases: in the first input channels are enabled, in the second they are disabled at preamplifier stage (threshold independence) .

Ion	Energy (MeV)	LET (MeVcm/mg)
Bromine	242	39
Silver	267	54.7
Iodine	277	61.8

RADIATION TESTS

SE Upset and Latch-up induced by Neutrons

SEU

		Threshold (fC)	Flux (n/cm2)	Counts (all channels)	Cross Section (cm2)	Cross Section/ch (cm2)
LOUVAIN 16 channels FEB	**60MEV neutron**	12.6	2.60E+10	42522	1.638E-06	1.024E-07
		16.7	2.60E+10	29932	1.153E-06	7.206E-08
		22.9	2.60E+10	20154	7.763E-07	4.852E-08
		27.1	2.67E+10	16321	6.108E-07	3.817E-08
		33.2	2.67E+10	12555	4.699E-07	2.937E-08
		37.4	2.67E+10	9319	3.488E-07	2.180E-08
		49.7	2.67E+10	7707	2.888E-07	1.805E-08
		70.3	2.67E+10	5057	1.895E-07	1.184E-08
		80.6	2.49E+10	3607	1.451E-07	9.066E-09
		90.9	2.49E+10	2935	1.180E-07	7.377E-09
LNL 3 channels MAD chip	**10MeV neutron**	10.0	1.27E+10	50	4.549E-09	1.516E-09
		13.3	6.95E+09	19	3.091E-09	1.030E-09
		16.7	8.10E+09	19	2.601E-09	8.670E-10
		20.0	8.12E+09	10	1.395E-09	4.650E-10
		30.0	7.79E+09	8	1.092E-09	3.640E-10
		40.0	7.91E+09	4	4.820E-10	1.607E-10
	Thermal neutron	20	9.14E+09	562	6.143E-08	2.048E-08

SEL

No events for 10y LHC activity

RADIATION TESTS

SE Upset and Latch-up induced by Heavy Ions

SEU

	Threshold (fC)	Flux (ions/cm2)	Counts (all channels)	Cross Section (cm2)	Cross Section/ch (cm2)	Masks (analog)
Bromine 242MeV	15.9	2.14E+07	9419	4.40E-04	1.10E-04	ON
	15.9	4.51E+07	125387	2.78E-03	6.95E-04	OFF
	29.7	4.43E+07	106693	2.41E-03	6.01E-04	OFF
	29.7	2.89E+07	11704	4.05E-04	1.01E-04	ON
	58.5	5.74E+07	114609	2.00E-03	4.99E-04	OFF
	58.5	3.25E+07	12975	3.99E-04	9.98E-05	ON
	87.9	2.92E+07	51366	1.76E-03	4.40E-04	OFF
	87.9	2.82E+07	11630	4.12E-04	1.03E-04	ON
	117.1	2.88E+07	49322	1.71E-03	4.28E-04	OFF
	117.1	2.83E+07	11193	3.96E-04	9.90E-05	ON
	176.5	2.55E+07	39982	1.57E-03	3.93E-04	OFF
	176.5	2.26E+07	9055	4.01E-04	1.00E-04	ON
	235.0	3.88E+07	63509	1.64E-03	4.09E-04	OFF
	235.0	3.67E+07	15164	4.13E-04	1.03E-04	ON
	293.5	3.33E+07	51679	1.55E-03	3.88E-04	OFF
	293.5	3.40E+07	13973	4.11E-04	1.03E-04	ON
Silver 267MeV	28.5	6.44E+07	140549	2.18E-03	5.45E-04	OFF
	293.5	6.06E+07	84890	1.40E-03	3.50E-04	OFF
	28.5	5.56E+07	21830	3.93E-04	9.82E-05	ON
	293.5	5.89E+07	22756	3.86E-04	9.66E-05	ON
Iodine 277MeV	28.5	9.43E+07	198516	2.11E-03	5.26E-04	OFF
	293.5	7.82E+07	131693	1.68E-03	4.21E-04	OFF
	28.5	8.65E+07	32901	3.80E-04	9.51E-05	ON
	293.5	1.15E+08	43031	3.75E-04	9.36E-05	ON

SEL

No events found

RADIATION TESTS
Conclusion

All frontend electronics tested
no problems found.

ASIC successfully tested on heavy ions.

Few thousand counts/ch estimated for 10y LHC activity.

In all radiation tests
No LATCH-UP events detected.

Further work could be done for better radiation characterization with proton beams at fixed energy