

VMM ASIC irradiation studies (2013 – 2017)



Collaboration

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VMM will be used at the s-LHC → Should test radiation tolerance and SEU ASIC specifications: 130 nm Technology, 64 channels, BNL design

VMM will be used by ATLAS muon Micromegas group and also as the SRS FE chip

Irradiation took place at the Tandem Accelerator

Credits: T. Alexopoulos

Nuclear Reaction	Energy Range (MeV)	Range (MeV)
${}^7\text{Li}(p,n){}^7\text{Be}$	1.9 to 8.4	0.1 to 6.7*
${}^2\text{H}(d,n){}^3\text{He}$	0.8 to 8.4	3.9 to 11.5**
${}^3\text{H}(d,n){}^4\text{He}$	0.8 to 8.4	16.4 to 25.7***

[0.1,0.5] MeV & quasimonoenergetic up to ~2.5 MeV
 ** Quasimonoenergetic neutrons up to ~7.5 MeV
 *** Monoenergetic neutrons [16.4,22] MeV



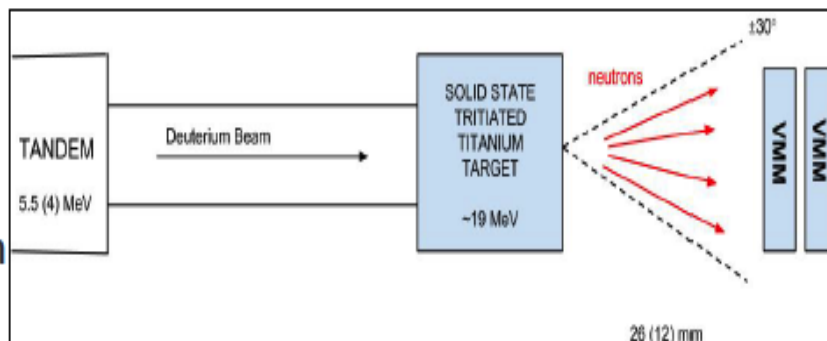
Tritium target (10 ci):

~ 10^6 neutrons/cm²s of 18-22 MeV

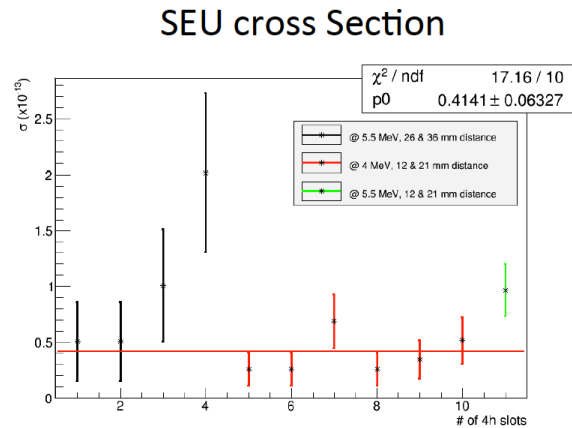
Testing:

2 days @ $E_d = 5.5$ MeV, VMMs @ 26,36 mm

3 days @ $E_d = 4$ MeV, VMMs @ 12,21 mm



Irradiate VMM1 with high energy neutrons (~ 20 MeV)



Use Tritiated solid target ${}^3\text{H}(d,n){}^4\text{He}$
Instantaneous flux(max): 1.8×10^7 n/cm²/s
Total flux: 3.1×10^{11} n/cm²

SEU Cross section = $(4.1 \pm 0.7) \times 10^{-14}$ cm²/bit

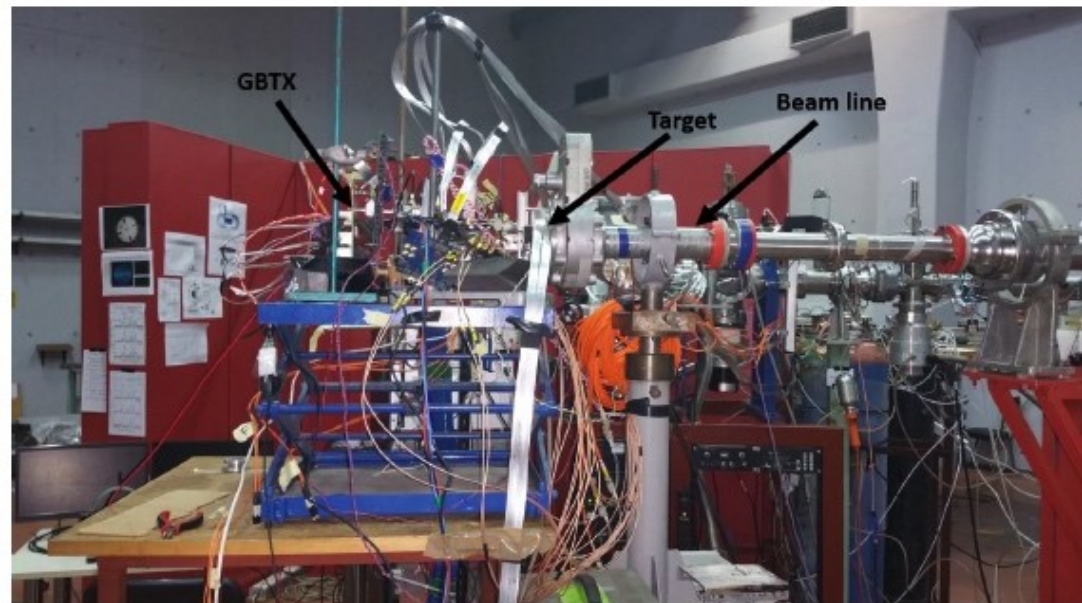
**Conclusion: SEU occurrences non tolerable ,
provision for auto-correction in new VMM2,
VMM3 versions.**

Work published in JINST

DAY	Distance (cm)	Fluence (n/cm ² s)	Time (s)	Neutrons (n/cm ²)
1-2	29.8	5.26E+03	53280	3.36E+08
3	14.5	2.22E+04	39540	8.78E+08
4	16.7	1.67E+04	36180	6.04E+08
5	14.4	1.32E+05	8940	1.18E+09
Total			173220	4.99E+05

Distance, fluence, time and flux

RECENT TESTS: May 2017
and soon new test beam



Setup at Demokritos