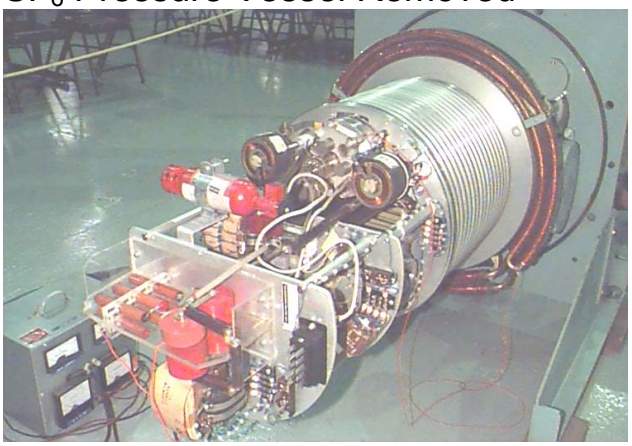
Overview of the Van de Graaff Setup

June 7-8, 2004 Analysis Meeting Meeting 1
Gary Godfrey - SLAC

The Van de Graaff (VG) is a small electrostatic accelerator that accelerates ~10 uA of protons and H_2^+ up to ~400 KeV kinetic energy.

SF_6 Pressure Vessel Removed

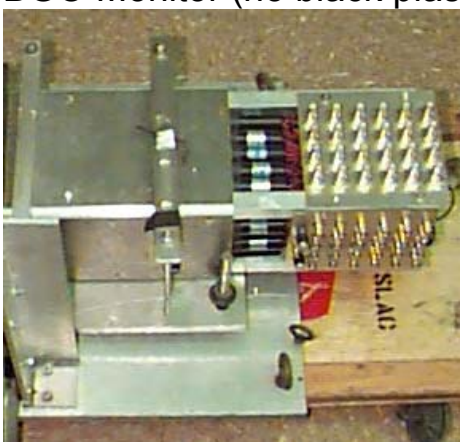


VG installed by Bldg 33 Cleanroom

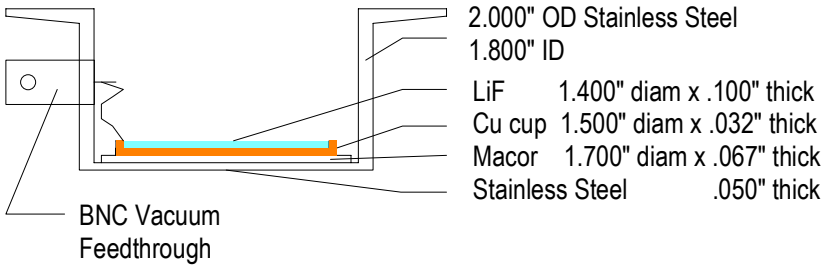
Target and BGO Monitor in Cleanroom

VG Control Panel + BGO DAQ

BGO Monitor (no black plastic wrap)



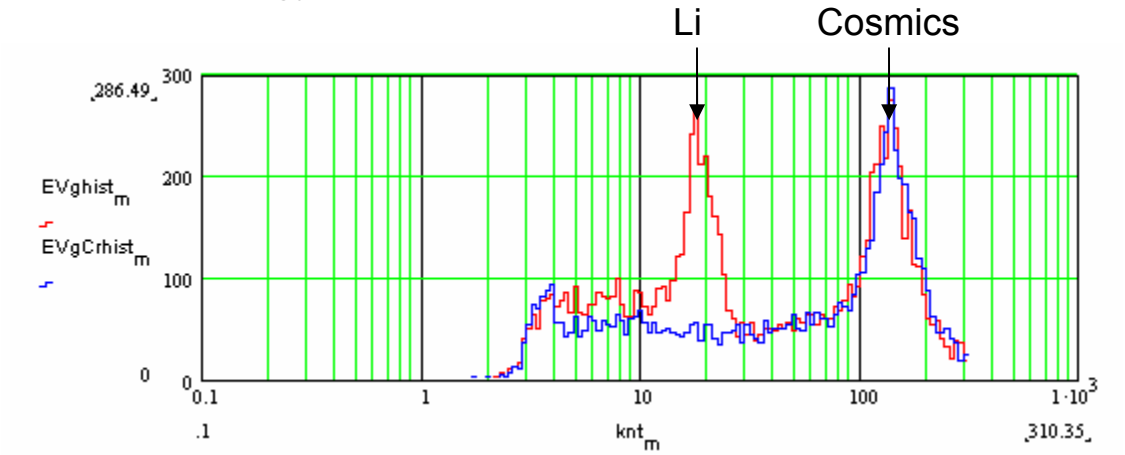
LiF Target Construction (Faraday Cup)



The VG produces gammas from a Li target.

$$P\ (440\ KeV) + Li^{7} \rightarrow Be^{8*} \rightarrow Be^{8} + \gamma\ (17.6\ \text{or}\ 14.6\ MeV) \quad (2:1)$$

Gammas per 5% Energy Bin in BGO (-60° 18.0")



[MeV]

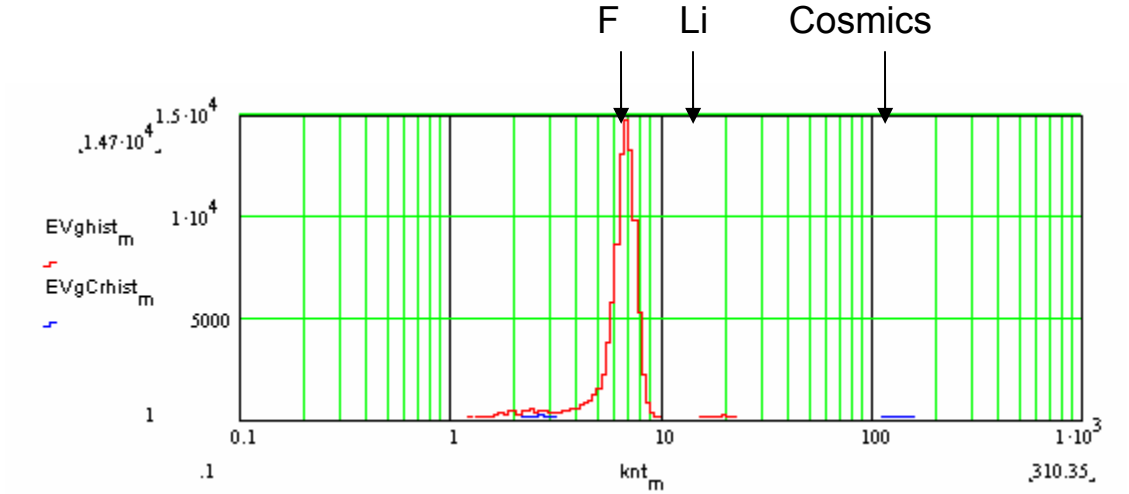
(Red=VG on Blue=VG off)

For triggering the LAT at a higher rate, a different target (LiF) willl be used. This provides a high rate of 6.1 MeV γs as well as the lower rate of 17.6 and 14.6 MeV γs.

$$P\ (340\ KeV) + F^{19} \rightarrow O^{16*} + \alpha$$

$$\rightarrow O^{16} + \gamma\ (6.1\ MeV)$$

Gammas per 5% Energy Bin in BGO (-60° 18.0")



[MeV]

(Red=VG on Blue=VG off)

BGO Photon Flux Monitor

The BGO Monitor is a (7 x 7) array of (2 cm x 2 cm x 20 cm) BGO xtals placed a fixed distance behind the VG target, typically at (-45° 6.0") or (-60° 18.0").

The gains of all xtals were adjusted to be the same (~±5%) by using a Co^{60} source and adjusting the individual PMT HVs.

Pedestals ~20 ±1 channel. Gain ~ 40 KeV / low energy ADC channel

The xtals in each of the four regions in red are analog summed, and the four analog sums are digitized by an Xtal Ball Integrate/Hold Module.

The trigger is: Analog Sum of All 25 Xtals in red > 4 MeV (>2 MeV for LiF target)

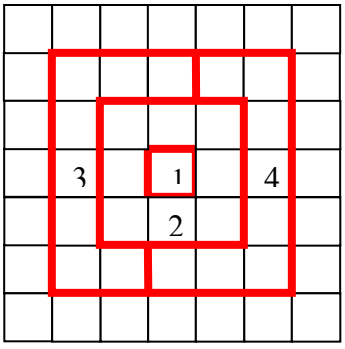
Deadtime for digitization and readout = .60 msec / trigger

A 3 x 3 fiducial volume is defined by requiring (E_1+E_2) > (E_3+E_4).

A cosmic spectra (blue VG off) is scaled and subtracted from the VG on spectra (red). The histograms are in 5% energy bins.

An average BGO photon rate is measured for a BGO run corresponding to each EM or LAT run.

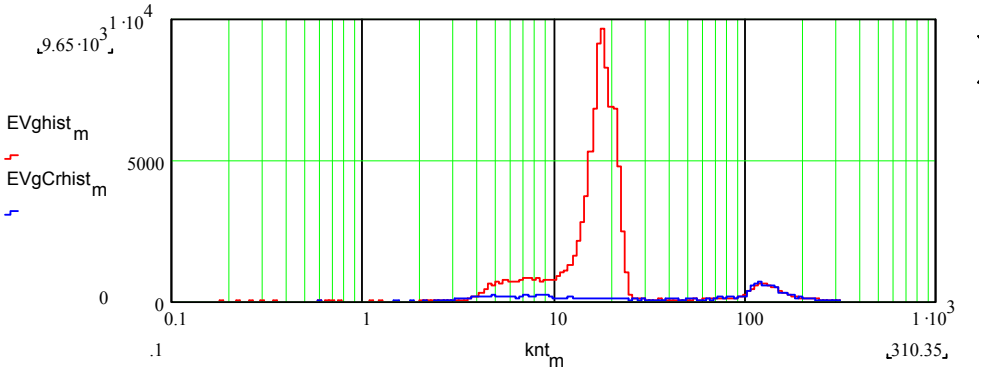
7 X 7 Array of BGO



.1

Gammas per 5% Energy Bin in BGO (-45° 6.0")

Li Cosmics



1 10 100 1000

MeV

Analysis of Each BGO Run

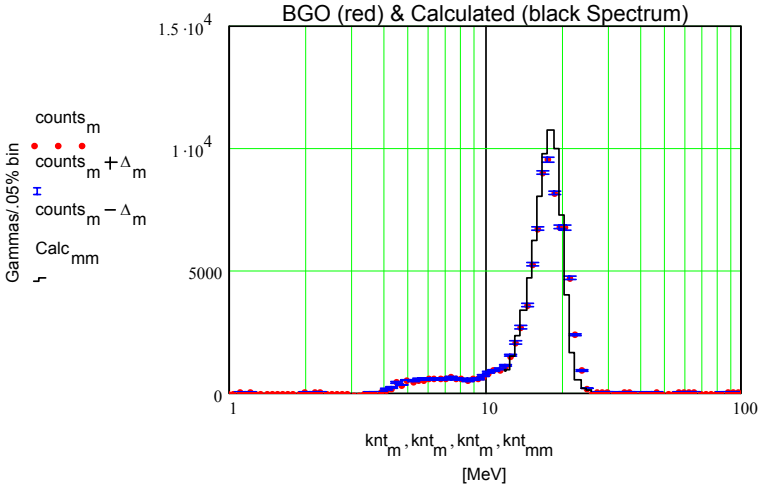
For each run, a time scaled cosmic ray run is subtracted and then the events between fixed energies are summed to find the average rate of photons in the (14.6+17.6) MeV peak for the BGO fiducial area. Dividing this rate by the solid angle of the fiducial area gives the average rate of photons per steradian during the corresponding run of the EM or LAT.

Data from run Van de Graaff run VG42:

fcut = 0.5 Time := 5926. [sec] total = 71248 Rate := $\frac{\text{total}}{\text{Time}}$ Rate = 12.02 [Hz]

Fit Parameters

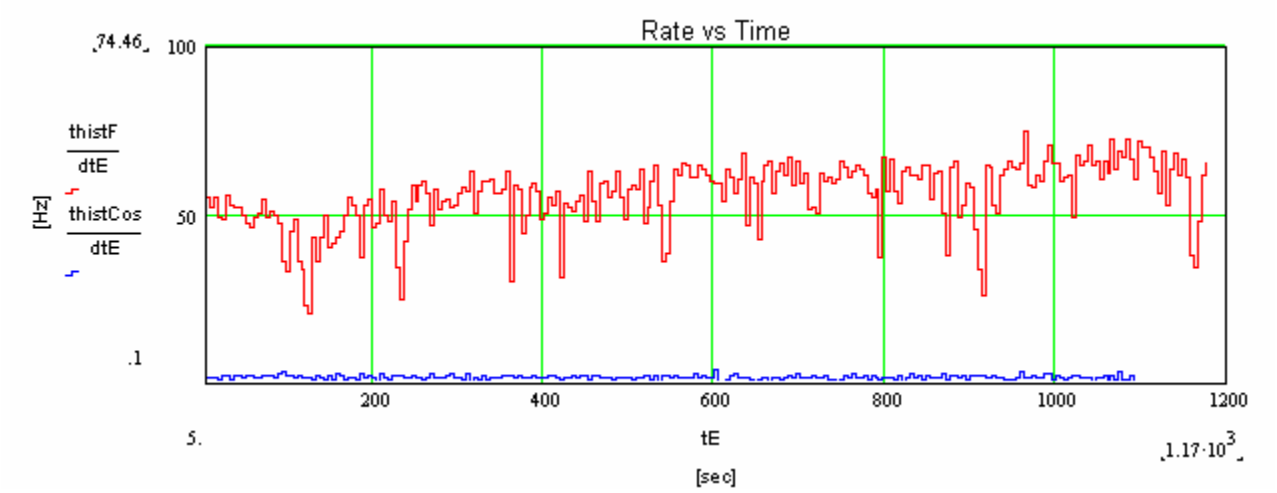
Peak #1	Peak #2	
$Eres_1 = 14.59$	$Eres_2 = 17.62$	[MeV]
$\Gamma_1 = 1.5$	$\Gamma_2 = 0.01$	[MeV]
$\sigma BGO_1 = 1.46$	$\sigma BGO_2 = 1.76$	[MeV]
$rel_1 = 0.5$	$rel_2 = 1$	



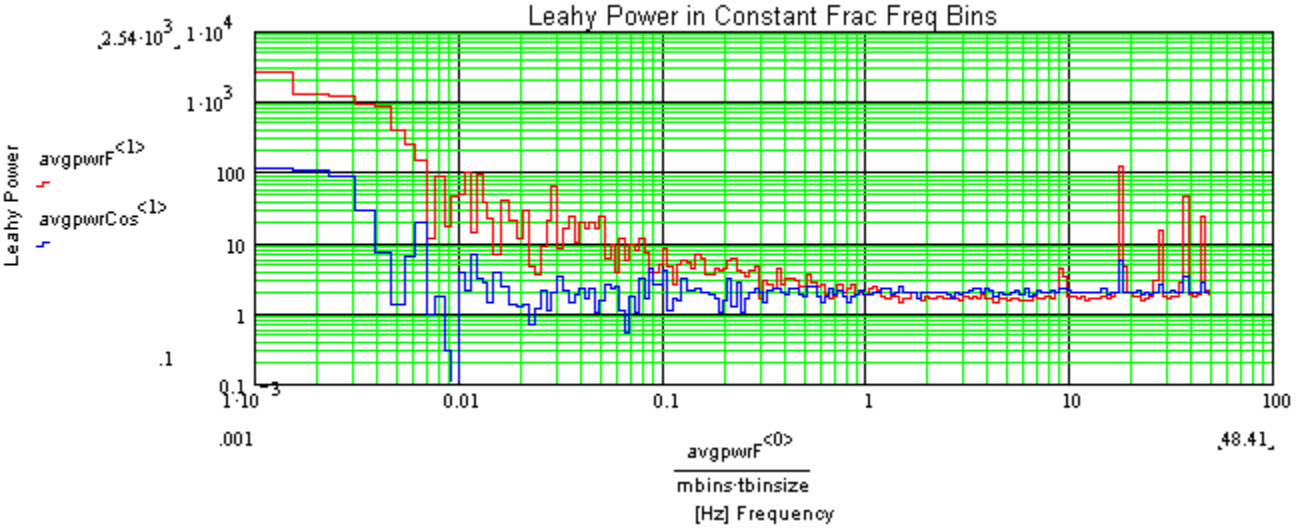
Characterizing the VG photon rate versus time (LiF)

Rate in BGO fiducial volume vs time:

Red=VG ON, 6 MeV photons Blue=VG OFF, cosmics



Leahy Power in 5% freq bins:



a) Peaks at harmonics of 10 Hz due to minimum computer clock tick = .05 sec

b) Photon .01 – 1 Hz rise probably due to VG variability (not seen in cosmics)

c) .001-.01 Hz rise probably due to variable computer clock (seen in photons and cosmics).

d) GPS Timing Module(ordered) for PC will time tag BGO events with a long term accuracy of ±2 usec and tick of 100 nsec.

BGO Data Files are ASCI

VG61.DAT

1L	1H	2L	2H	3L	3H	4L	4H	Time	(one line per event)
22	26	248	31	21	26	26	22	5	
20	27	1915	109	776	64	676	53	5	
23	27	253	32	22	27	28	23	5	
22	27	254	32	21	26	26	22	5	
22	27	30	21	21	26	204	31	5	
22	27	30	21	20	26	227	32	5	
24	27	31	21	192	35	32	22	5	
108	30	165	27	21	26	26	22	5	
23	27	252	32	22	26	27	22	5	
22	27	30	22	21	27	152	29	5	
22	27	29	21	21	26	58	24	11	
255	38	30	22	20	27	27	23	11	
23	26	234	31	41	27	27	22	11	
22	26	31	21	21	26	216	31	11	
22	26	31	21	21	26	142	27	11	
22	26	30	21	81	29	191	30	11	
21	26	232	30	20	26	26	22	11	
23	26	162	27	90	30	27	22	11	
32	28	236	31	21	27	27	23	16	
22	27	31	21	22	26	227	31	16	

Average VG Rates

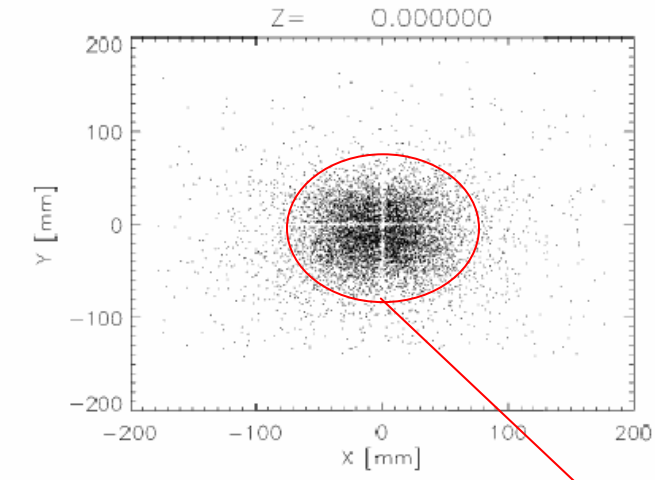
(~20 minute runs)

Target (Lines)	[γ/sec] into 4π sterad	LAT 6 hit TkrTrig Rate (MC acceptance) [Hz]
LiF (17.6 + 14.6 MeV γ)	1,200	300
LiF (6.1 MeV γ)	76,000	1,900 - 19,000 (Trig effic in progress)

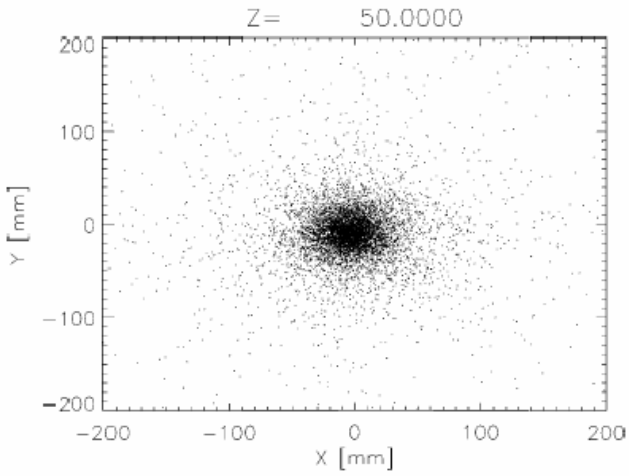
Analysis EM Looking at VG Photons (17 MeV))

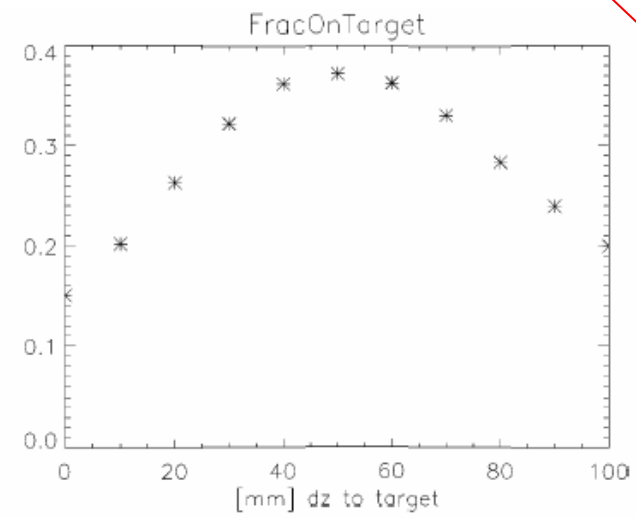
Root Merit Ntuple -> Root2idl (Heather) -> IDL

Tkr1 position in top layer



Tkr1 extrapolated to Target Z=50. mm





~0° Effic = $\frac{\gamma \text{ per steradian seen in EM}}{\gamma \text{ per steradian seen in BGO}}$

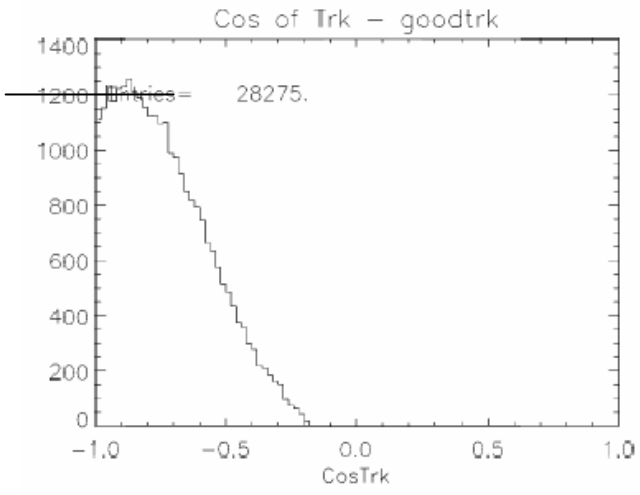
= $\frac{1200/(.02 \times 2\pi \text{ ster})}{1152 \text{ sec} \times 13.35 \text{ Hz} /(.15 \text{ ster})}$

= .093 ± .01 (due to ±5% BGO dist error)

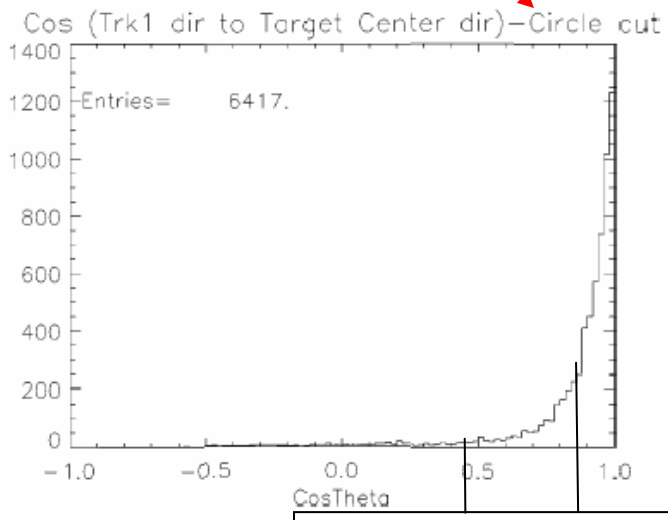
$\theta_{68\ Measured}$ = acos(.88) = 28° (at 0°)
$\theta_{95\ Measured}$ = acos(.46) = 63° (at 0°)

θ_{target} ~ (.75”/2.0”) x (180/π) = 21°

$\theta_{68\ EM\ PSF}$ ~ sqrt($\theta_{68\ Measured}^2 - \theta_{target}^2$) = 21°
$\theta_{95\ EM\ PSF}$ ~ sqrt($\theta_{95\ Measured}^2 - \theta_{target}^2$) = 59°



Tkr1ZDir



$\text{Cos}\theta_{95}$=.46 $\text{Cos}\theta_{68}$=.88
θ_{95}=63.° θ_{68}=30.°