



On-Orbit Status of the ISS Intravehicular Tissue Equivalent Proportional Counter (IV-TEPC)

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On behalf of the Advanced Radiation Instrumentation Project for
ISS



Background

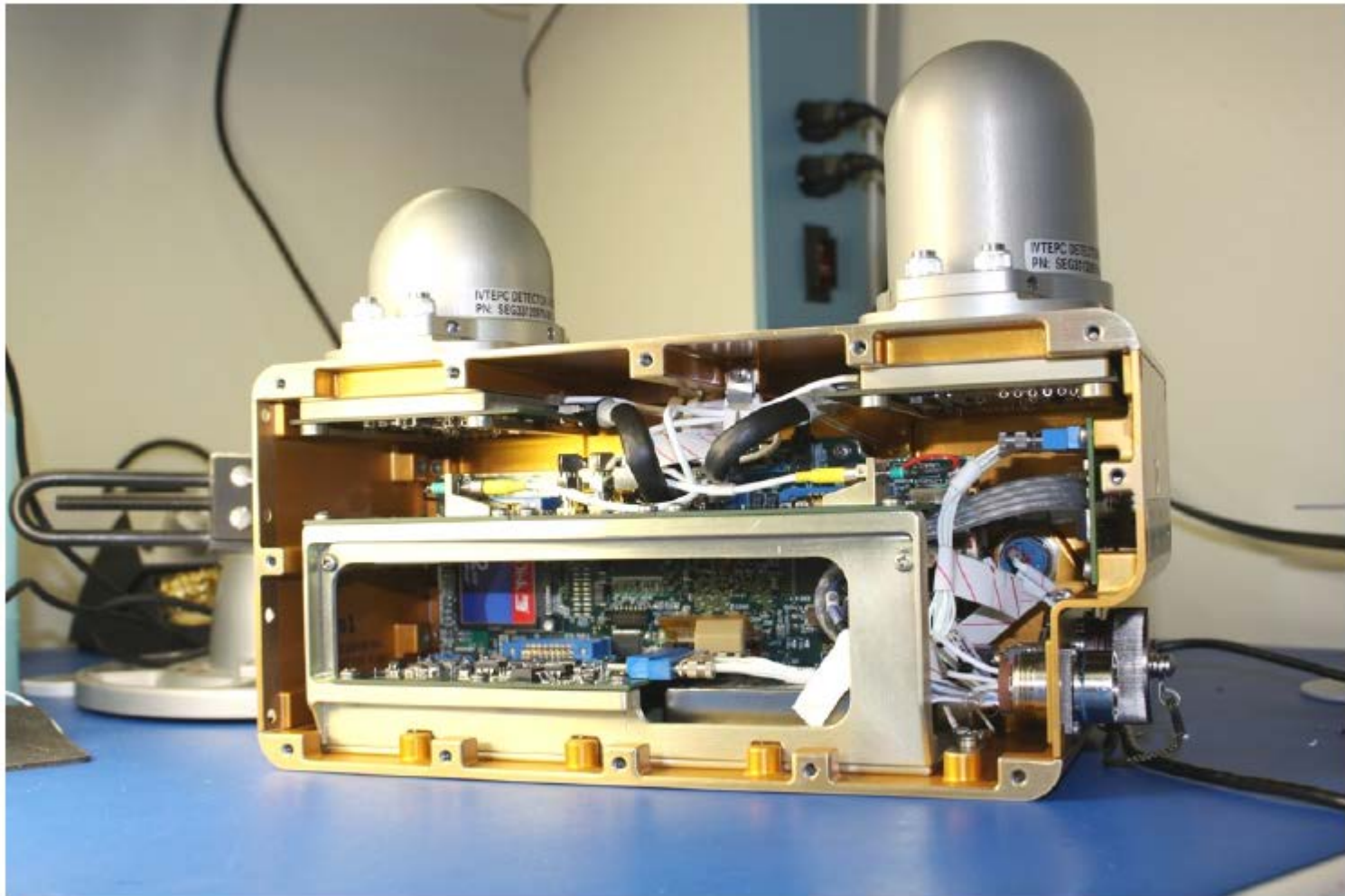
- ISS Tissue Equivalent Proportional Counter
 - Current on-orbit unit functioning nominally (since 2007)
 - Version first flown in 2000, developed in late 1990s.
 - Hardware exceeding design life
 - Replacement parts not available
- IV-TEPC project initiated to Support ISS operations to 2020
 - Part of new NASA monitoring suite, that will also include ISS RAD and Timepix
 - First time 2 TEPCs operating simultaneously on ISS
 - New IV-TEPC will be surveying ISS after checkout and comparison with current TEPC



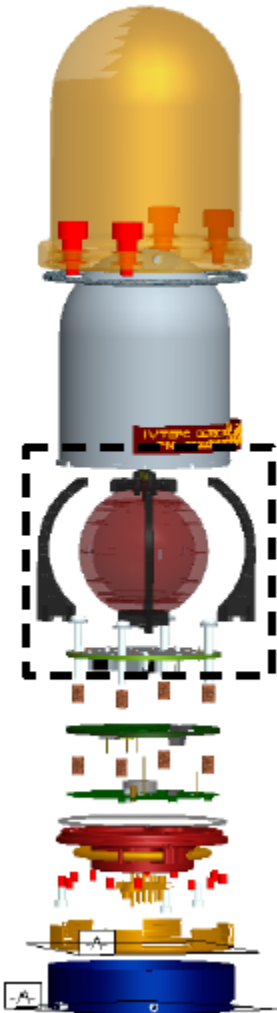
IV-TEPC First Flight Unit



Interior View



Sphere Construction



- Tissue Equivalent Sphere
 - A150 Plastic
 - Sphere consists of 10-12 Slices
 - Slices are separated by sheets of low Density Polyethylene (LPDE) for electrical insulation
 - A cathode wire is impeded into each slide to provide high voltage

Sphere Specifications



**Small
Sphere**



**Large
Sphere**

	Diameter (in)	Thickness (mm)	# of Slices
Large IV	1.5 (3.8 cm)	5	12
Small IV	0.5 (1.27 cm)	3	10



Spectrometer Specifications

- The spectrometer unit provides both a high gain and low gain 4096 channel output for each detector.
- The linear range of the high gain circuit is typically from channel 20 to 2500. The linear range for the low gain circuit is typically from channel 40 to 3750.
- Gain Ratio between High/Low Gain is ~ 37
- Large Detector- $S/N 1005$ $k_1 = 1.37E-4$ $\mu\text{Gy keV}^{-1} \mu\text{m}$
- Small Detector - $S/N 1004$ $k_2 = 1.57E-3$ $\mu\text{Gy keV}^{-1} \mu\text{m}$

Detector 1 -1005

150 keV/ μm Proton LG channel: 508

LG/HG transition = 17 keV/ μm

	y per Ch.		start	stop	
HG	.00787	keV/ $\mu\text{m}/\text{ch}$	275	2160	
LG	.2952	keV/ $\mu\text{m}/\text{ch}$	57	3000	

Detector 2 -1004

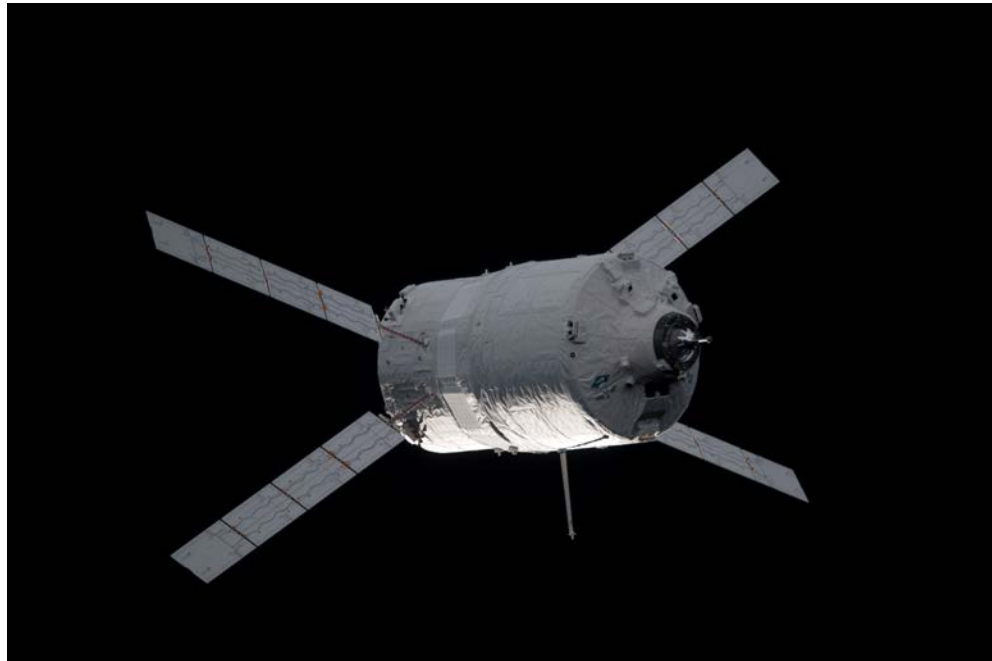
150 keV/ μm Proton LG channel: 380

LG/HG transition = 20 keV/ μm

	y per Ch.		start	stop	
HG	.0105	keV/ $\mu\text{m}/\text{ch}$	275	1904	
LG	.394	keV/ $\mu\text{m}/\text{ch}$	50	3000	



The first manifested ISS IV–TEPC detector apparatus was launched to ISS on March 23, 2012 onboard the ATV3 “*Edoardo Amaldi*” ISS resupply flight.



ISS IV-TEPC unpackaged and placed on SM panel 327 on April 23, 2012





Initial Diagnostics



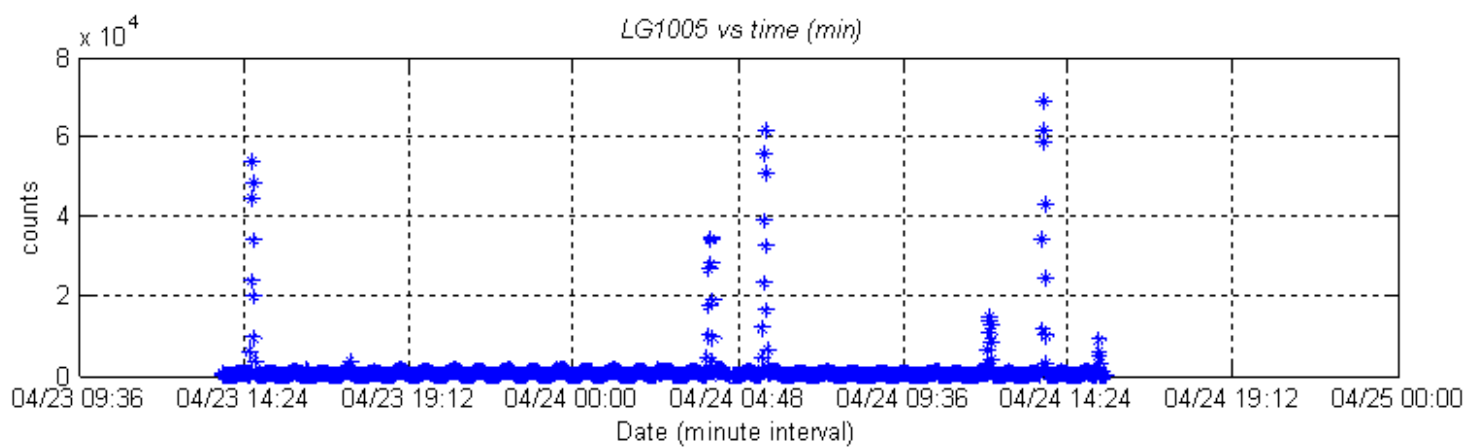
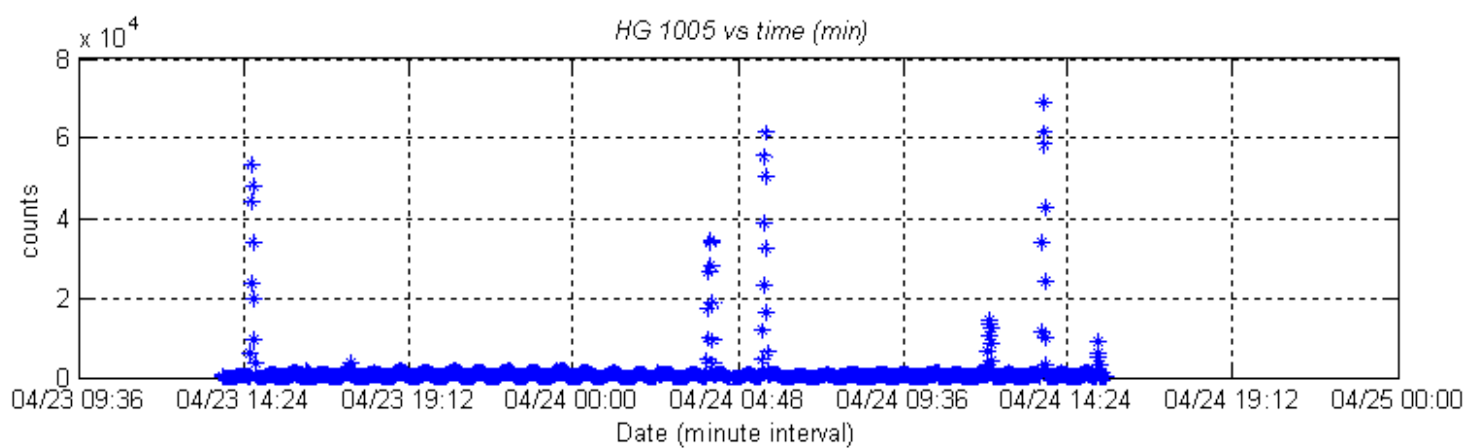
IV-TEPC STATUS

Summary Pg. 1/7

Time: 23Apr12 13:37:24
Alarm: Clear Mode: DataAcq
Elapsed Time: 000/00:05:16
----Channel 1 Detector----
Dose Rate: 0.1 uGy/m
Dose Eqv Rate: 0.3 uSv/m
Cum Dose: 0.872 uGy
Cum Dose Eqv: 3.833 uSv
----Channel 2 Detector----
Dose Rate: 0.1 uGy/m
Dose Eqv Rate: 0.1 uSv/m
Cum Dose: 0.684 uGy
Cum Dose Eqv: 1.148 uSv

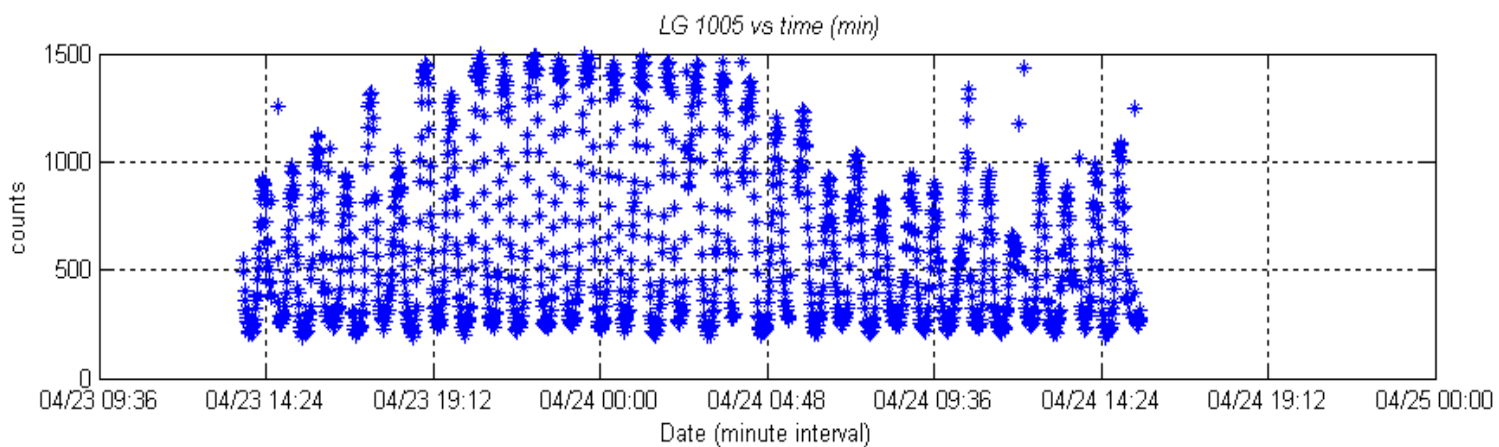
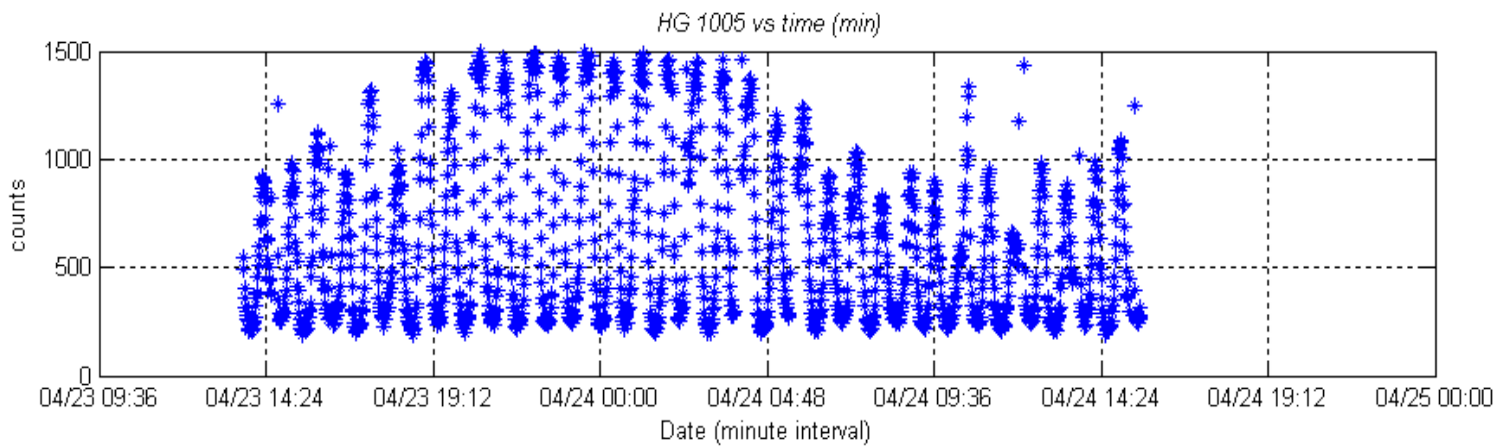


Total counts vs. time (Large)



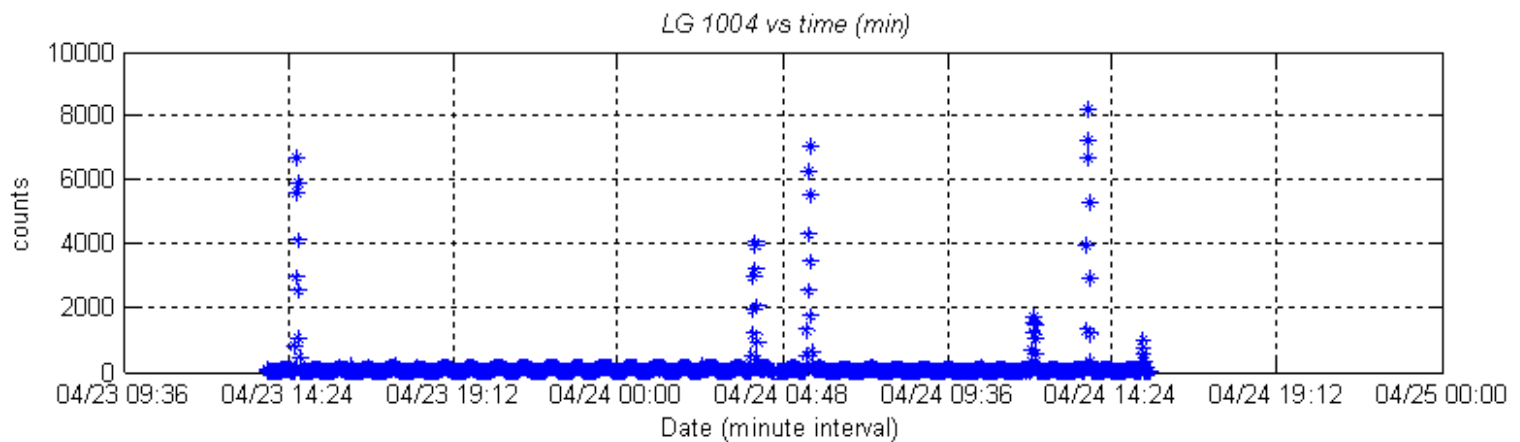
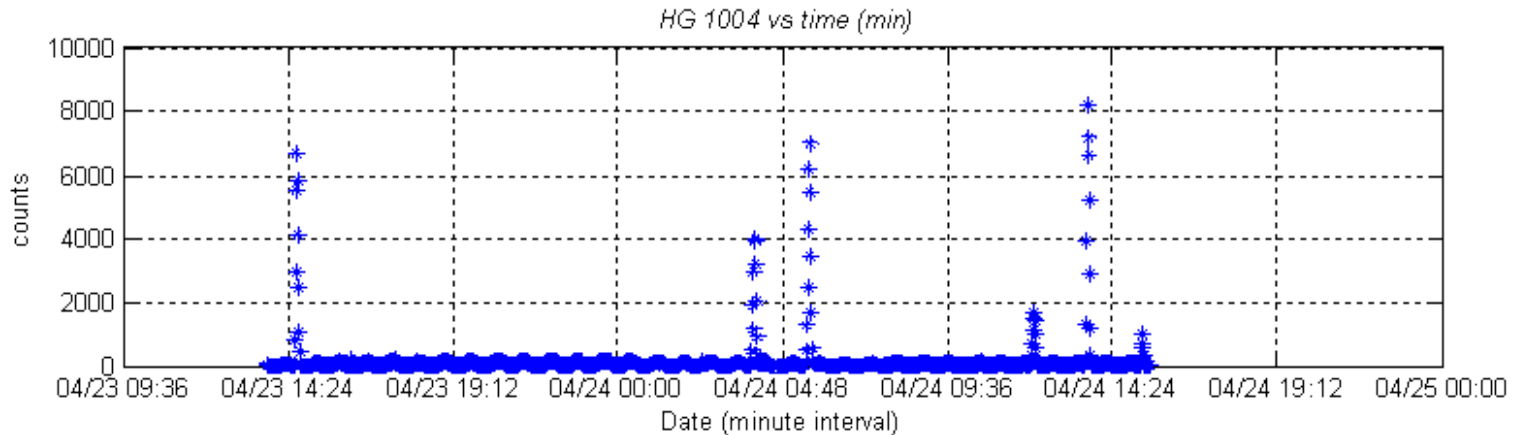


Total counts (GCR) vs. time (Large)



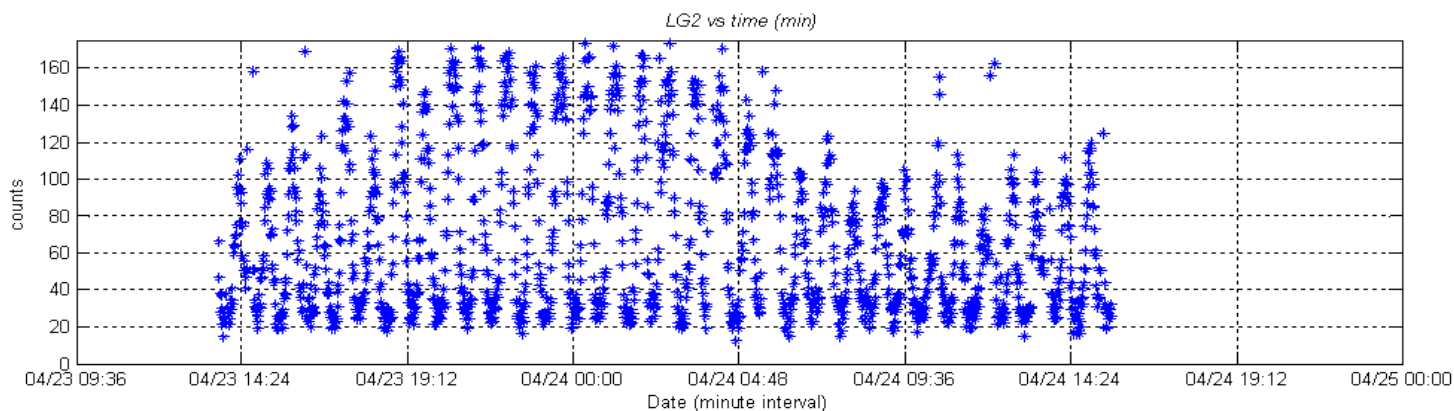
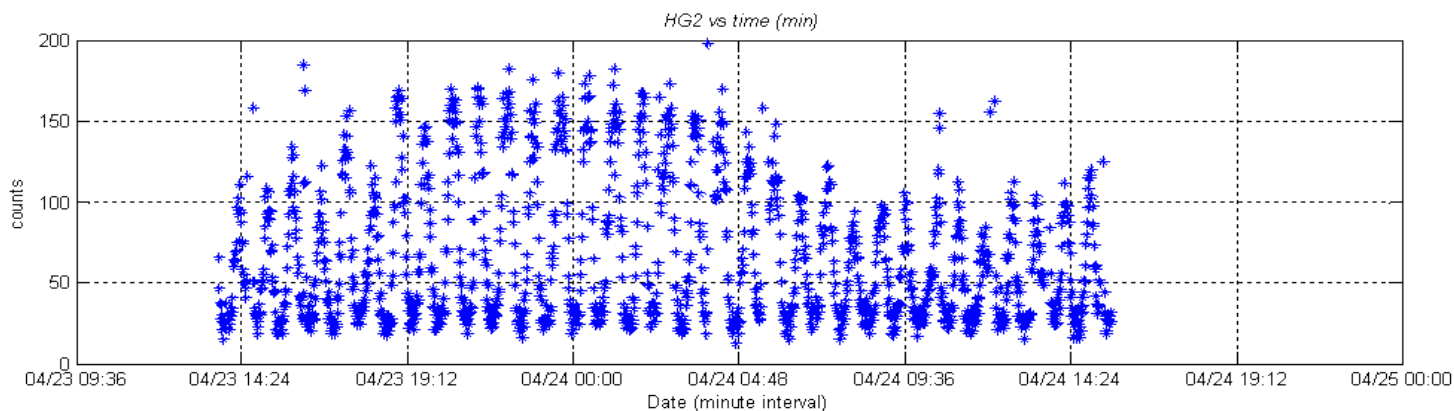


Total counts vs time (Small)



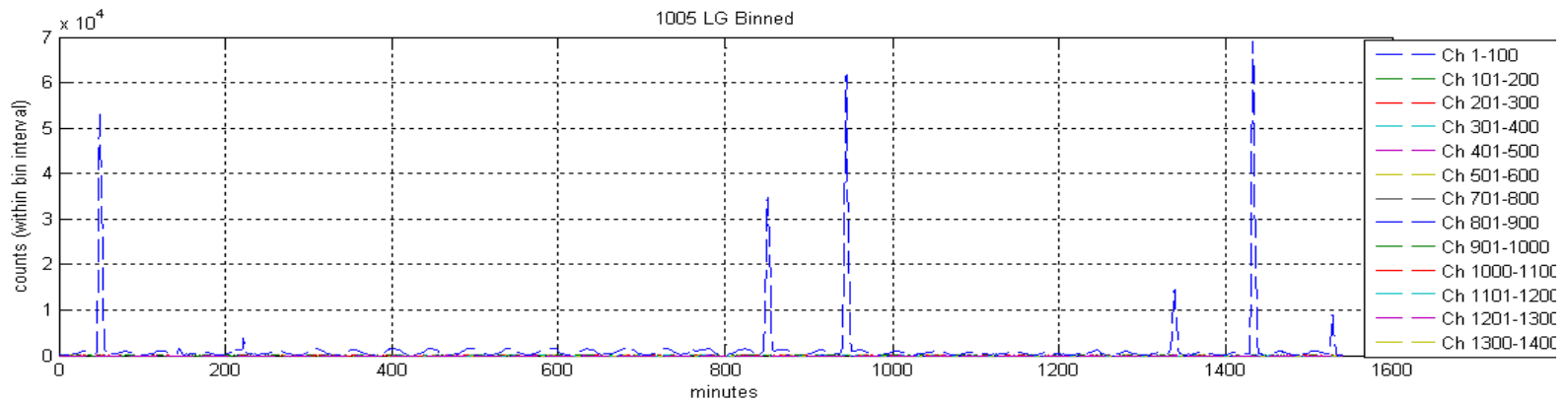
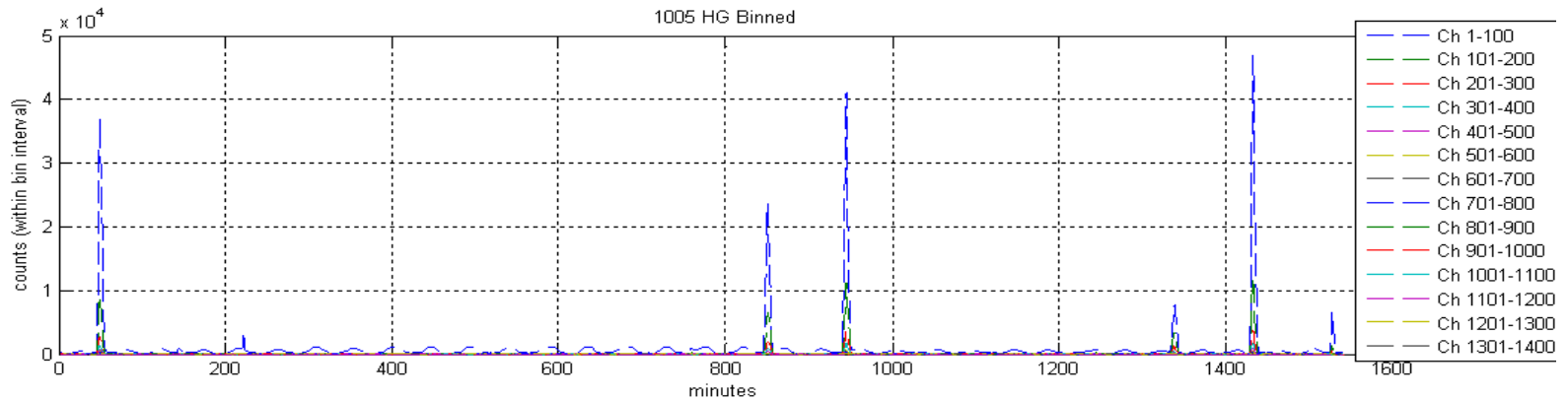


Total counts (GCR) vs. time (Small)



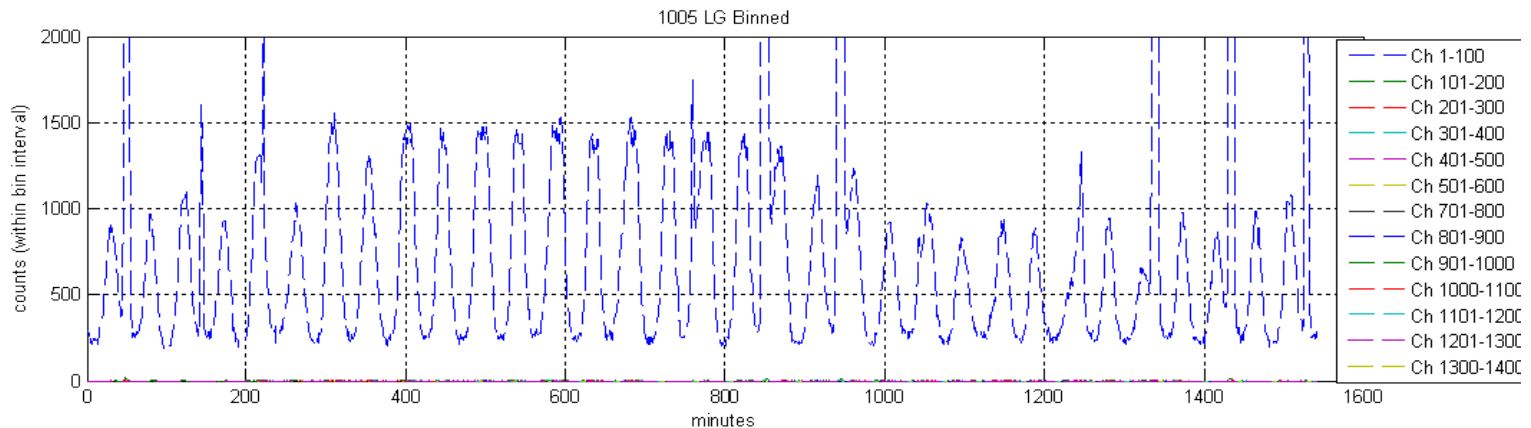
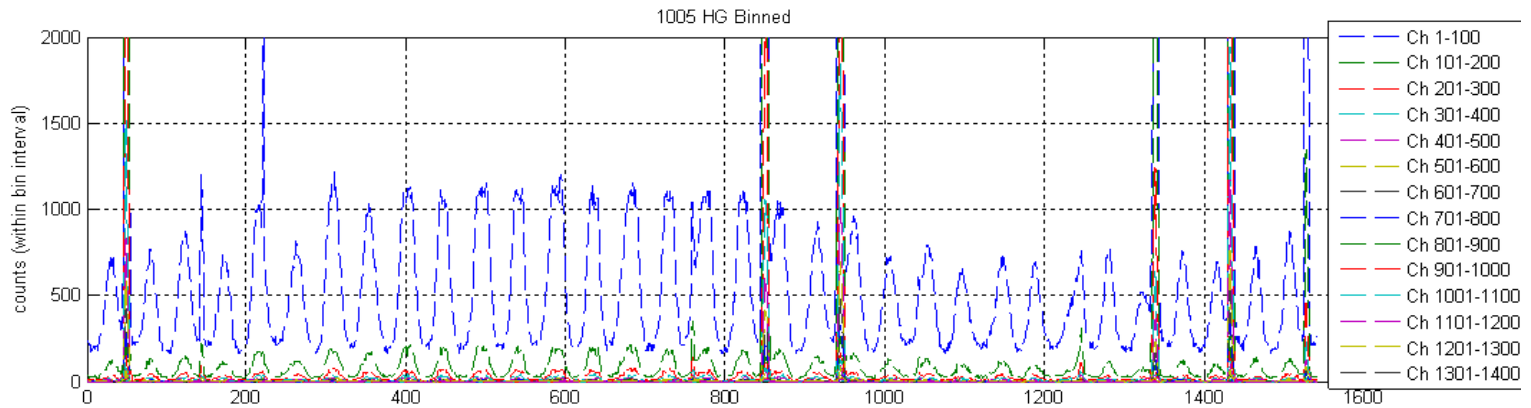


Binned Channels vs. time (Large)



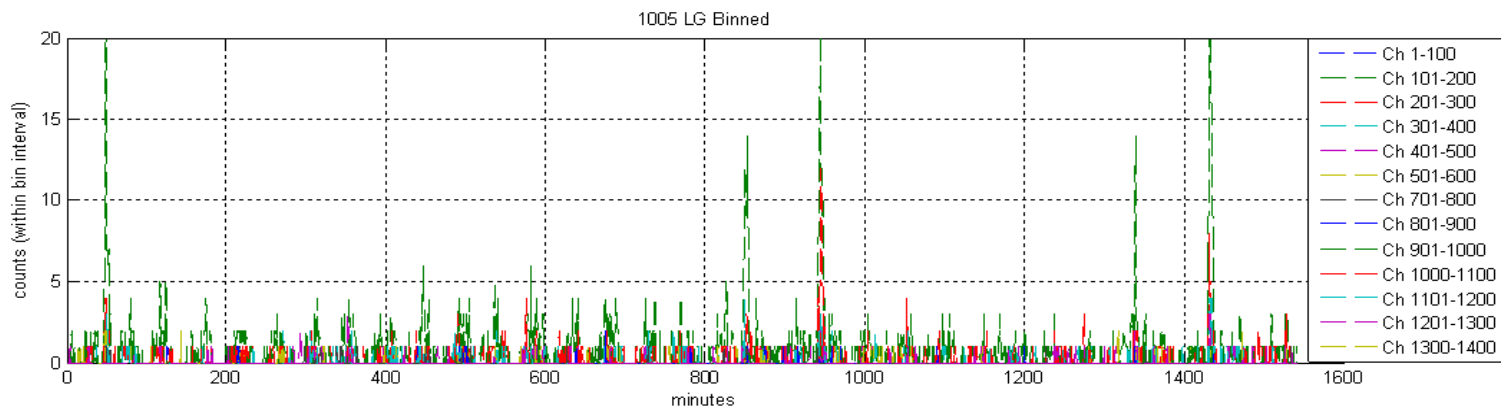
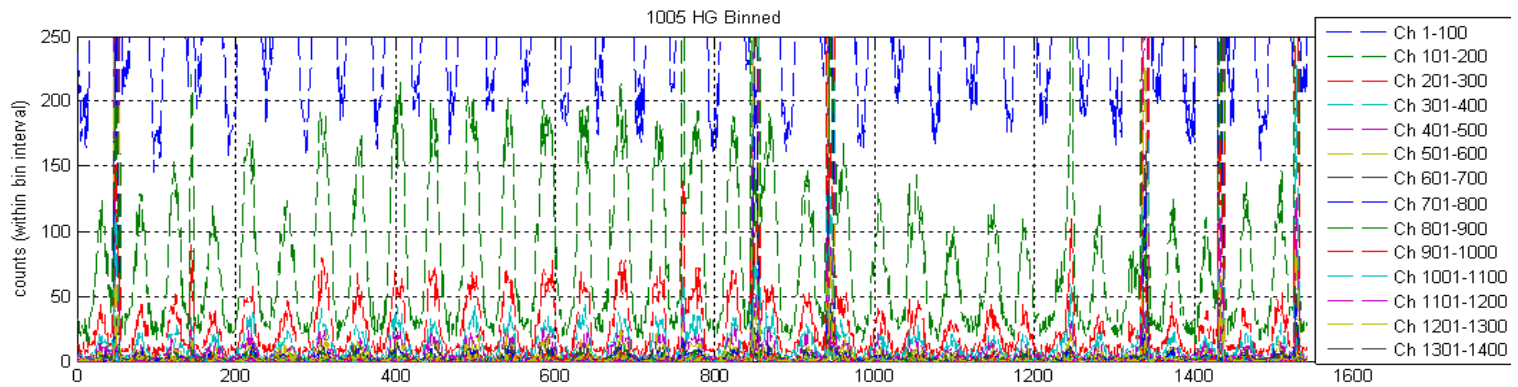


Binned Channels vs. time (Zoom) (Large)



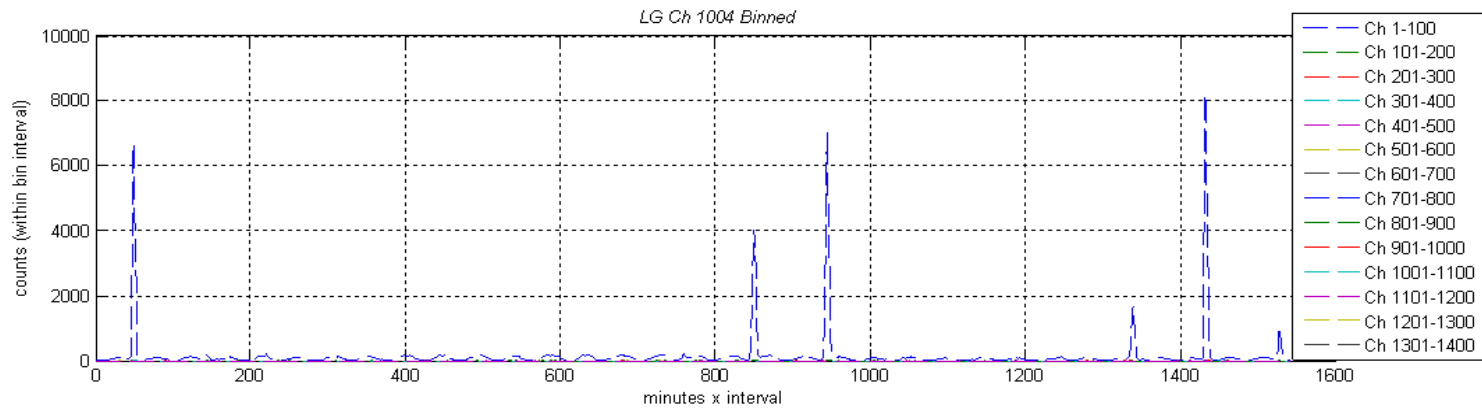
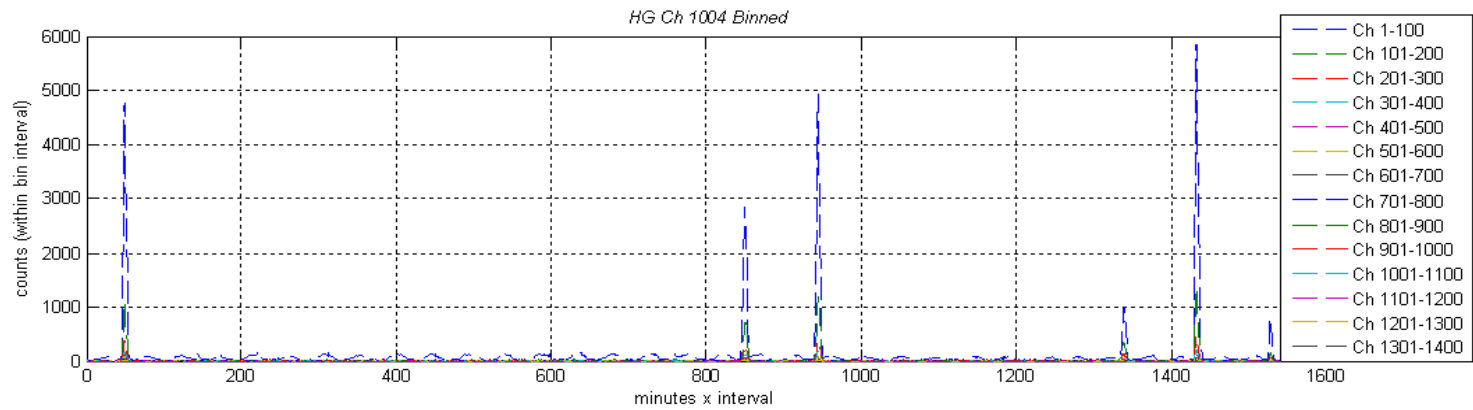


Binned Channels vs. time (Zoom) (Large)



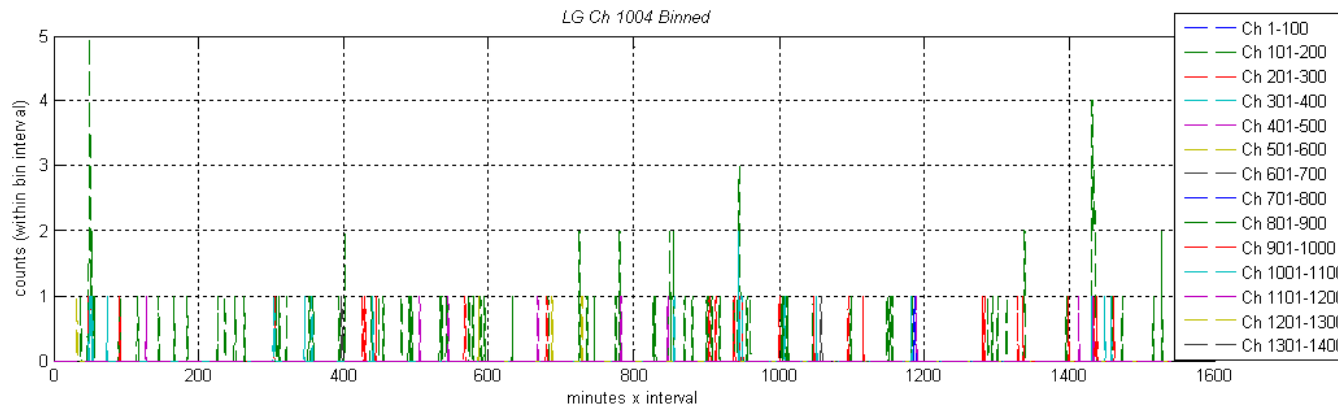
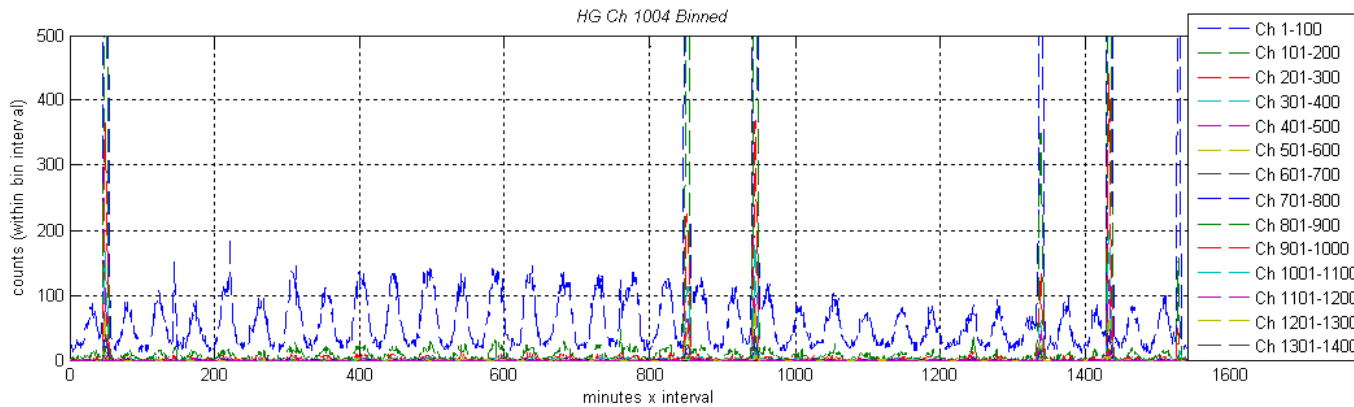


Binned Channels vs. time (Small)



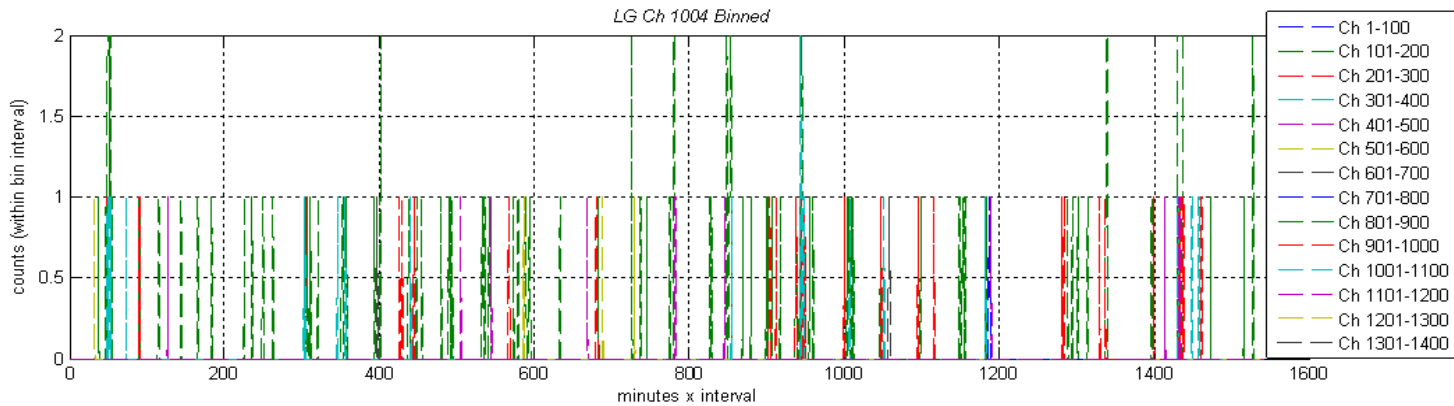
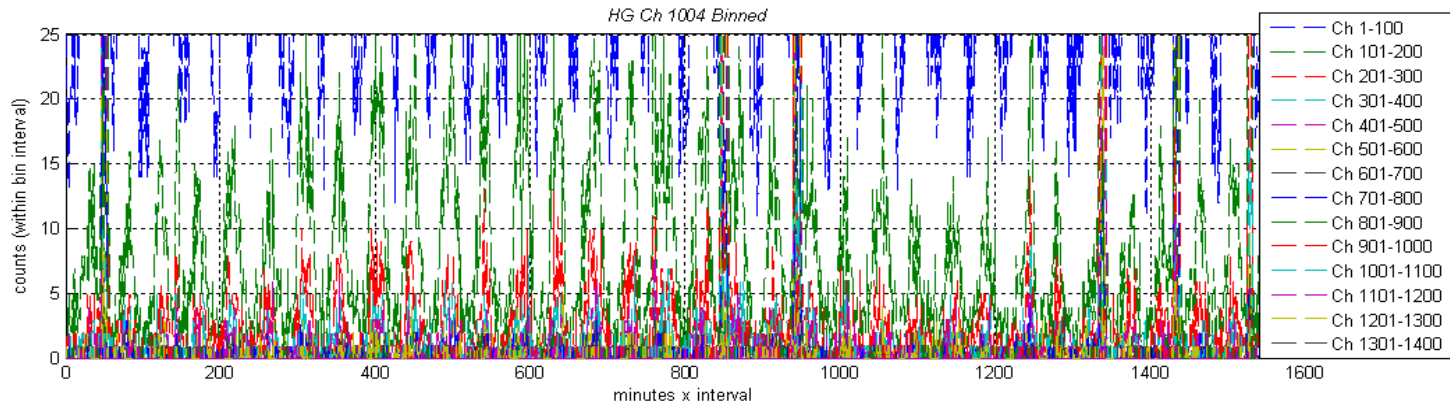


Binned Channels vs. time (Zoom) (Small)





Channels vs. time (Zoom) (Small)



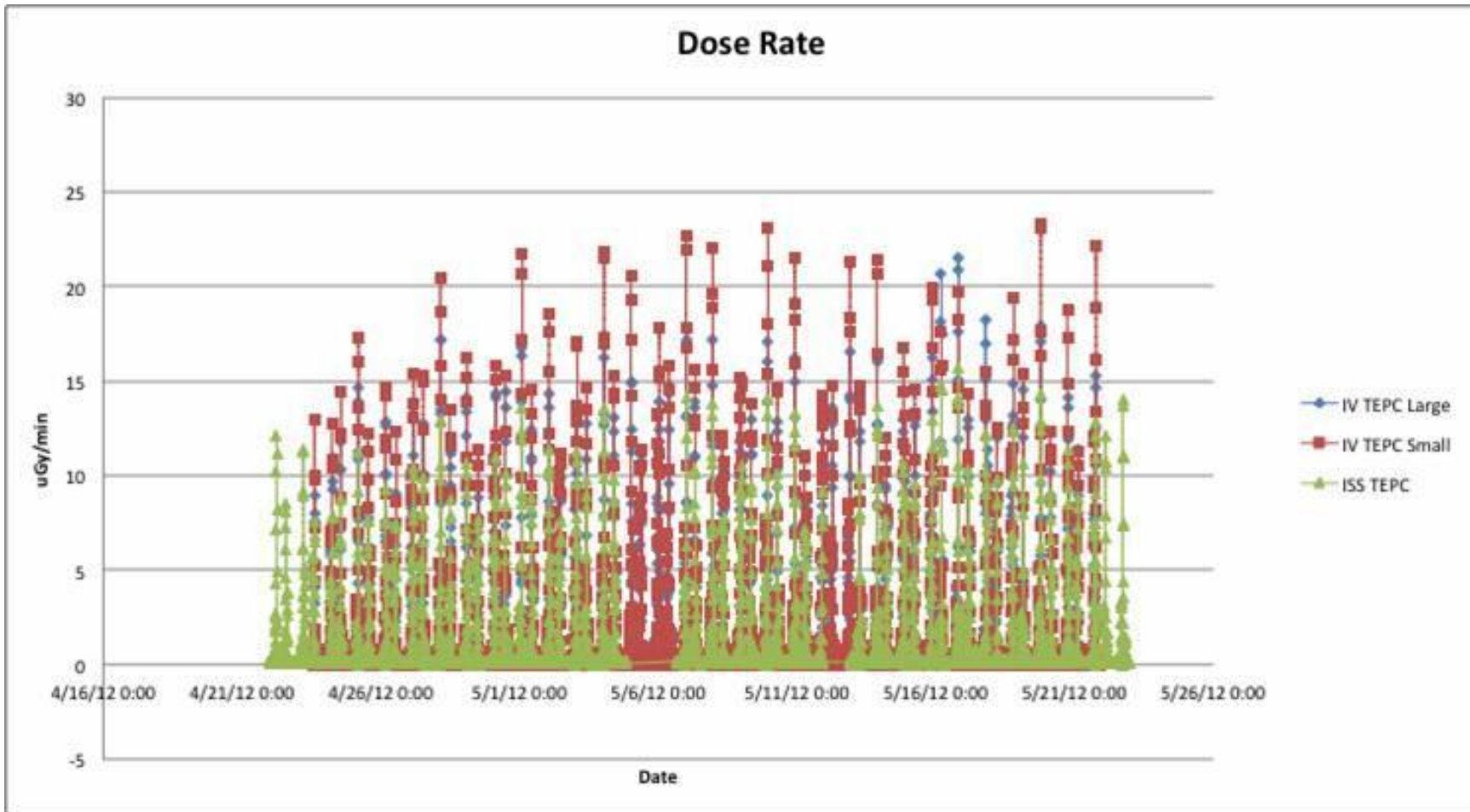


Dosimetry



ISS Service Model Panel 327

Soyuz TMA-04M Docking and Small SPE on 5/17/2012





Large Detector Daily Totals

SM panel 327

date	GCR uGy	GCR Equiv uSv	GCR Quality	Trapped uGy	Trapped Equiv uSv	Trapped Quality	SPE uGy	SPE Equiv uSv	SPE Quality	Total uGy	Total Equiv uSv	Total Quality	time operational (minutes)
23-Apr-12	63.7193149	214.71692	3.3697306	40.8862141	69.8133645	1.70750377	0	0	0	104.6055	284.5303	2.720031	627
24-Apr-12	130.354256	431.27165	3.3084585	165.031103	276.817458	1.67736537	0	0	0	295.3854	708.0891	2.397171	1440
25-Apr-12	131.501204	429.5084	3.2661937	169.688479	292.572401	1.72417363	0	0	0	301.1897	722.0808	2.397429	1440
26-Apr-12	131.53058	446.46706	3.3943974	187.948912	310.132445	1.65008907	0	0	0	319.4795	756.5995	2.368226	1440
27-Apr-12	130.314331	444.10219	3.4079306	213.629351	354.317412	1.65856148	0	0	0	343.9437	798.4196	2.321367	1440
28-Apr-12	130.45521	445.89804	3.4180164	204.622232	329.427556	1.60993042	0	0	0	335.0774	775.3256	2.31387	1440
29-Apr-12	129.286776	432.15276	3.3425906	199.076726	345.208712	1.73404857	0	0	0	328.3635	777.3615	2.367381	1440
30-Apr-12	132.339741	448.5573	3.3894377	219.523624	370.841437	1.68930082	0	0	0	351.8634	819.3987	2.328741	1440
1-May-12	125.130709	425.23762	3.3983474	204.622232	354.317412	1.7315685	0	0	0	329.7529	779.5550	4.797631	1439
2-May-12	132.08817	450.98809	3.4142959	201.109053	338.721532	1.68426795	0	0	0	333.1972	789.7096	2.370097	1440
3-May-12	133.596345	439.3885	3.2889261	234.237498	386.286845	1.64912471	0	0	0	367.8338	825.6753	2.244697	1440
4-May-12	129.47213	451.12741	3.4843593	201.064957	330.776905	1.64512459	0	0	0	330.5371	781.9043	2.365557	1440
5-May-12	127.694669	420.76166	3.2950605	270.343333	455.42175	1.68460507	0	0	0	398.038	876.1834	2.201256	1440
6-May-12	130.519336	429.69124	3.2921654	215.088184	359.458682	1.67121538	0	0	0	345.6075	789.1499	2.28337	1440
7-May-12	127.963413	423.20927	3.3072678	282.921622	469.987063	1.66119174	0	0	0	410.885	893.1963	2.173835	1440
8-May-12	126.442457	423.53564	3.3496315	254.024749	427.752903	1.68390247	0	0	0	380.4672	851.2885	2.237482	1440
9-May-12	132.381364	439.85357	3.3226245	204.526894	335.036429	1.63810451	0	0	0	336.9083	774.89	2.300003	1440
10-May-12	131.708505	430.44923	3.2681961	205.912731	352.576473	1.71226166	0	0	0	337.6212	783.0257	2.319243	1440
11-May-12	130.30417	442.40632	3.3951816	208.246767	346.972538	1.6661605	0	0	0	338.5509	789.3789	2.33164	1440
12-May-12	132.006666	435.58924	3.2997519	212.363327	354.225434	1.66801603	0	0	0	344.37	789.8147	2.293506	1440
13-May-12	128.353249	434.26176	3.3833328	205.73997	351.835666	1.71009875	0	0	0	334.0932	786.0974	2.352928	1440
14-May-12	126.711447	418.28584	3.3010896	213.195721	351.565926	1.649029	0	0	0	339.9072	769.8518	2.264888	1440
15-May-12	120.525593	419.85208	3.4835098	224.671787	378.427087	1.68435518	0	0	0	345.1974	798.2792	2.31253	1439
16-May-12	129.384545	427.85401	3.3068402	269.47007	439.25768	1.63007966	0	0	0	398.8546	867.1117	2.174004	1440
17-May-12	124.568159	412.28881	3.3097448	270.345022	441.811362	1.63425004	20.89354	49.0733	2.348731	415.8067	903.1735	2.172099	1440
18-May-12	130.557388	432.74146	3.3145689	217.578693	367.644823	1.68970968	0	0	0	348.1361	800.3863	2.299062	1440
19-May-12	128.44972	447.35655	3.4827367	214.696442	347.935691	1.62059365	0	0	0	343.1462	795.2922	2.317649	1440
20-May-12	127.916154	440.10893	3.4406048	207.020171	344.952607	1.66627535	0	0	0	334.9363	785.0615	2.343913	1440
21-May-12	120.894343	402.95535	3.33312	220.607837	377.224121	1.70993073	0	0	0	341.5022	780.1795	2.284552	1328
Averages	129.3	434.2	3.4	217.7	363.5	1.7				347.7	799.5	2.4	



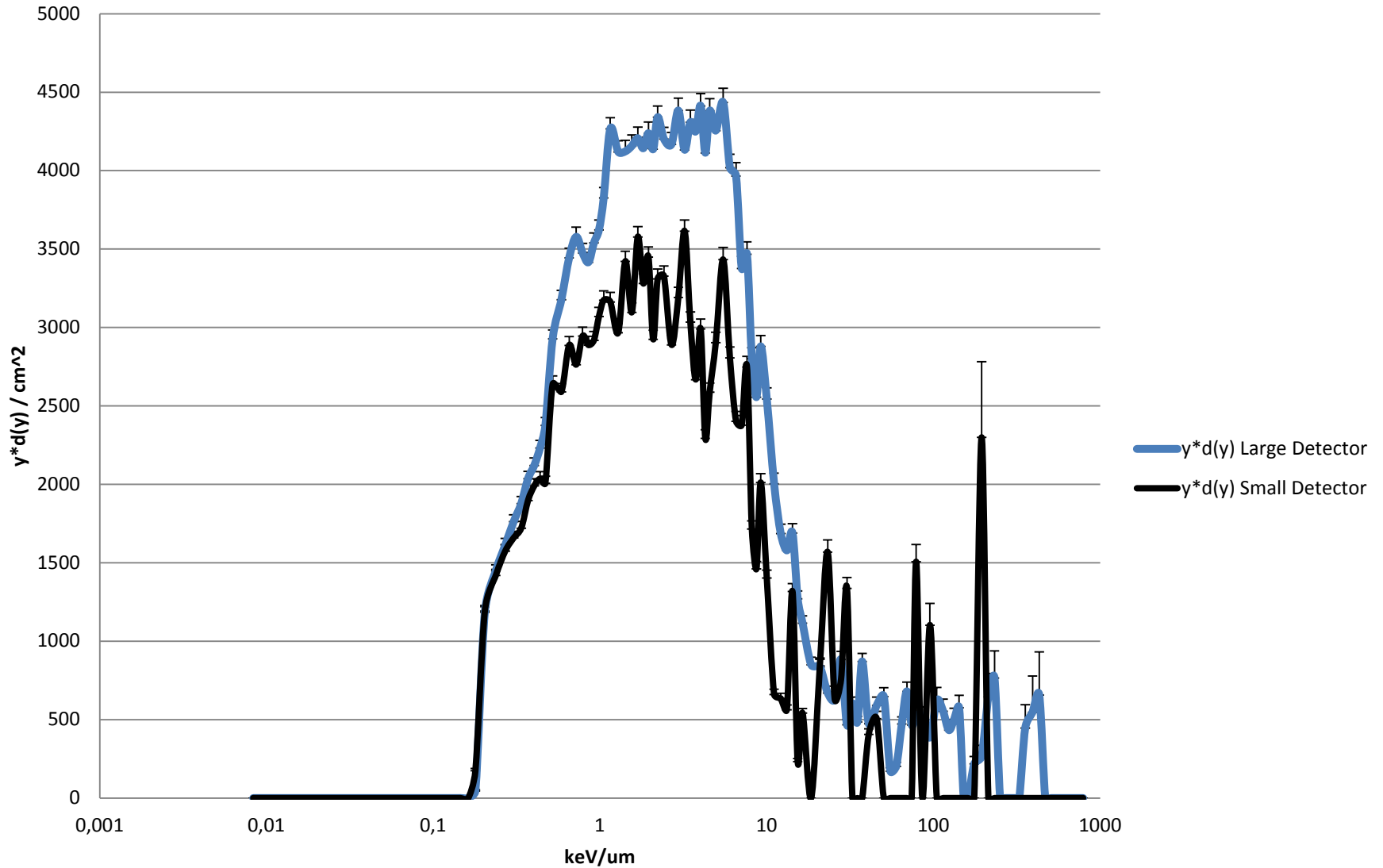
Small Detector Daily Totals

SM Panel 327

date	GCR uGy	GCR Equiv uSv	GCR Quality	Trapped uGy	Trapped Equiv uSv	Trapped Quality	SPE uGy	SPE Equiv uSv	SPE Quality	Total uGy	Total Equiv uSv	Total Quality	time operational (minutes)
23-Apr-12	66.41736	186.0345	2.800993	57.27463	159.8373	2.790718	0	0	0	123.692	345.8719	2.796235	627
24-Apr-12	137.7537	391.3003	2.84058	198.7868	405.9902	2.04234	0	0	0	336.5404	797.2905	2.369078	1440
25-Apr-12	141.2699	423.6664	2.998987	208.0616	470.4092	2.260913	0	0	0	349.3315	894.0756	2.55939	1440
26-Apr-12	138.0355	368.2202	2.667576	225.9436	478.6198	2.118315	0	0	0	363.9791	846.84	2.326617	1440
27-Apr-12	134.8446	363.9126	2.698756	260.7958	517.8126	1.985509	0	0	0	395.6404	881.7252	2.228602	1440
28-Apr-12	136.8402	419.999	3.069266	247.2812	574.1691	2.321928	0	0	0	384.1214	994.1681	2.588161	1440
29-Apr-12	136.5888	354.4566	2.595064	231.5288	446.5668	1.928775	0	0	0	368.1176	801.0234	2.175999	1440
30-Apr-12	137.8078	414.9242	3.01089	260.1644	520.6308	2.001161	0	0	0	397.9722	935.555	2.350805	1440
1-May-12	128.6456	336.0119	2.61192	247.2812	524.5487	2.121264	0	0	0	375.9268	860.5606	9.381698	1439
2-May-12	140.0036	422.2163	3.015754	255.135	491.7472	1.9274	0	0	0	395.1386	913.9635	2.31302	1440
3-May-12	139.0086	391.8213	2.818683	297.9669	623.1484	2.091334	0	0	0	436.9755	1014.97	2.322715	1440
4-May-12	134.6862	359.0001	2.665455	257.0456	540.5134	2.102792	0	0	0	391.7319	899.5135	2.296248	1440
5-May-12	135.5173	417.6803	3.082118	351.1638	718.8291	2.046991	0	0	0	486.6811	1136.509	2.335224	1440
6-May-12	134.2396	336.3412	2.505528	274.2	551.1625	2.010075	0	0	0	408.4396	887.5037	2.172913	1440
7-May-12	137.574	418.9153	3.045018	362.8438	756.0449	2.083665	0	0	0	500.4177	1174.96	2.347959	1440
8-May-12	133.4545	410.7469	3.077804	328.2369	654.1383	1.992885	0	0	0	461.6914	1064.885	2.306487	1440
9-May-12	138.6124	361.9359	2.611136	267.6451	575.9829	2.15204	0	0	0	406.2575	937.9188	2.308681	1440
10-May-12	137.6586	426.9782	3.10172	270.6999	599.0876	2.213106	0	0	0	408.3585	1026.066	2.51266	1440
11-May-12	135.2363	378.7657	2.800769	268.113	531.9883	1.984194	0	0	0	403.3493	910.754	2.257978	1440
12-May-12	137.212	405.3116	2.953907	270.1435	501.2467	1.855483	0	0	0	407.3556	906.5583	2.225472	1440
13-May-12	132.8787	359.6072	2.706281	260.4789	505.6528	1.941243	0	0	0	393.3576	865.26	2.199678	1440
14-May-12	136.2543	404.1947	2.966473	272.48	512.7173	1.881669	0	0	0	408.7343	916.9119	2.243296	1440
15-May-12	122.4105	348.1258	2.843921	284.2851	515.4759	1.813236	0	0	0	406.6956	863.6017	2.12346	1439
16-May-12	135.9186	379.177	2.789737	250.082	507.9305	2.031056	0	0	0	386.0006	887.1075	2.298203	1440
17-May-12	128.6106	390.2994	3.034737	252.7145	484.6982	1.917967	24.93719	101.125	4.055189	406.2623	976.1226	2.402691	1440
18-May-12	135.2506	378.6648	2.799728	275.5943	525.5843	1.907094	0	0	0	410.8449	904.2491	2.20095	1440
19-May-12	136.0737	354.1004	2.602269	267.7575	480.3485	1.793968	0	0	0	403.8312	834.4488	2.066331	1440
20-May-12	130.9587	343.066	2.61965	265.9174	515.9589	1.940298	0	0	0	396.8761	859.0249	2.164466	1440
21-May-12	126.4833	362.1118	2.862922	281.144	585.2697	2.081744	0	0	0	407.6273	947.3815	2.324137	1328
Averages	135.3	383.7	2.8	267.1	538.2	2.0				403.4	925.6	2.6	

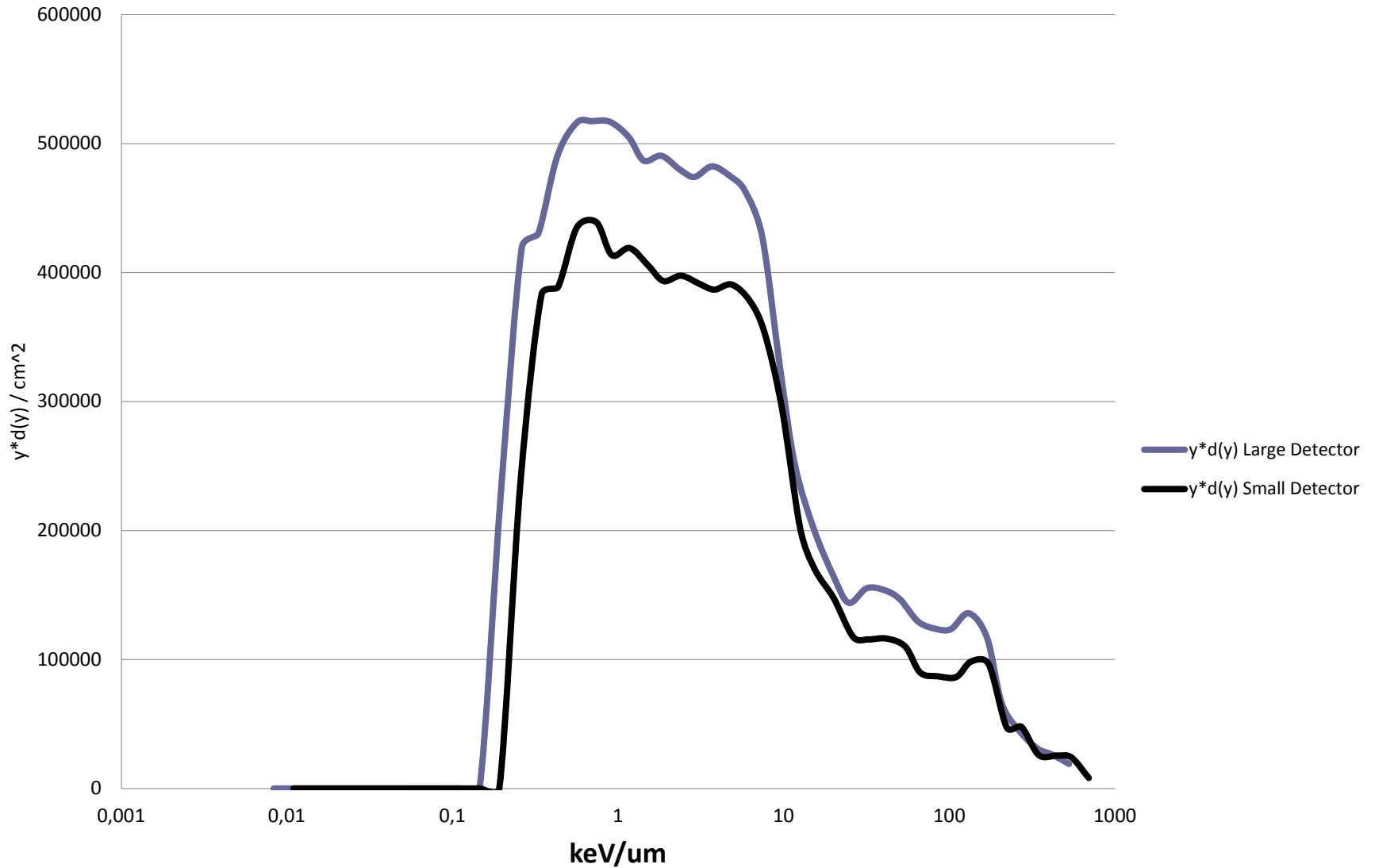


SPE 5/17/2012 $y*d(y)$ IV-TEPC ISS Service Module



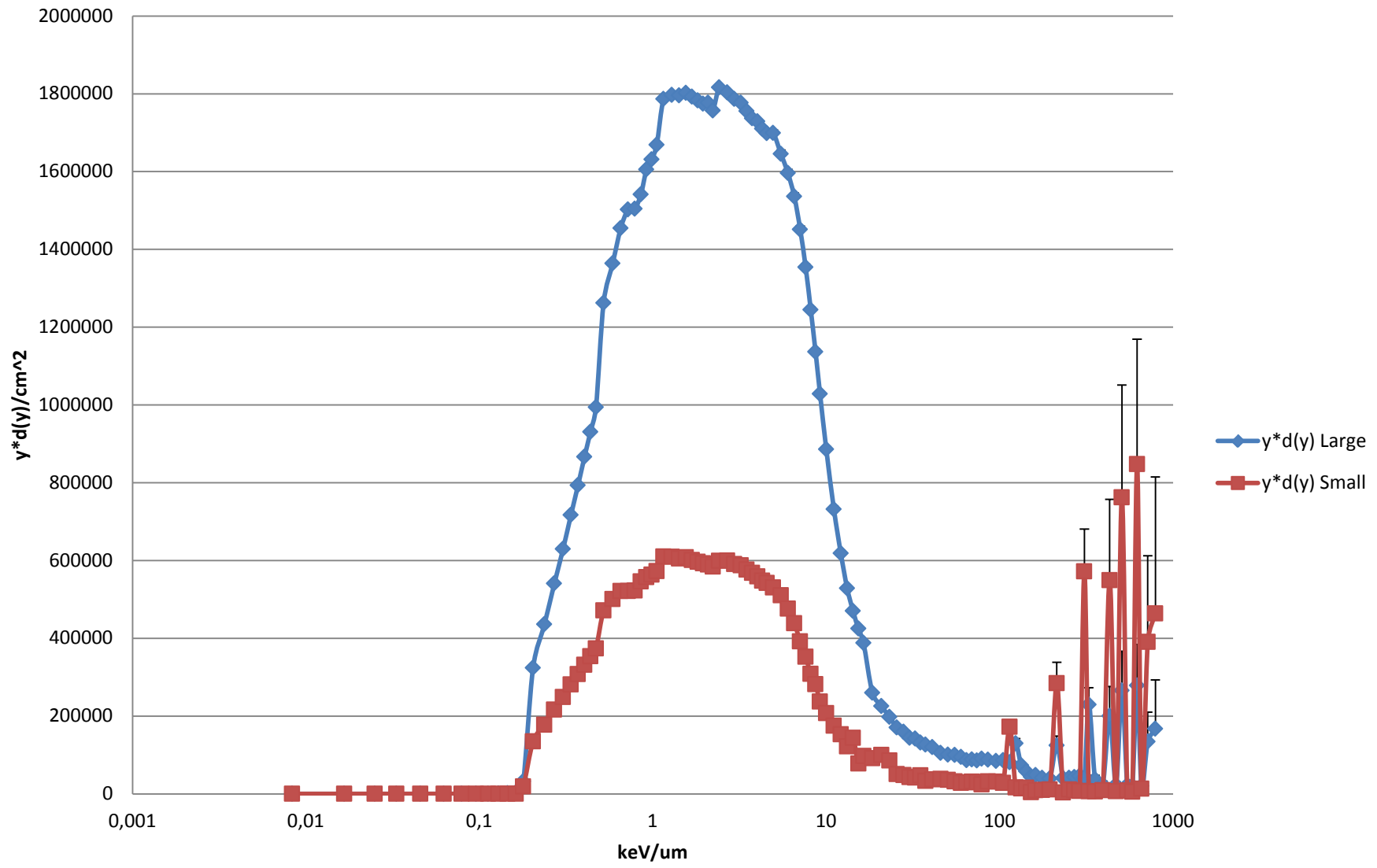


GCR $\gamma^*d(y)$ IV-TEPC ISS Service Module



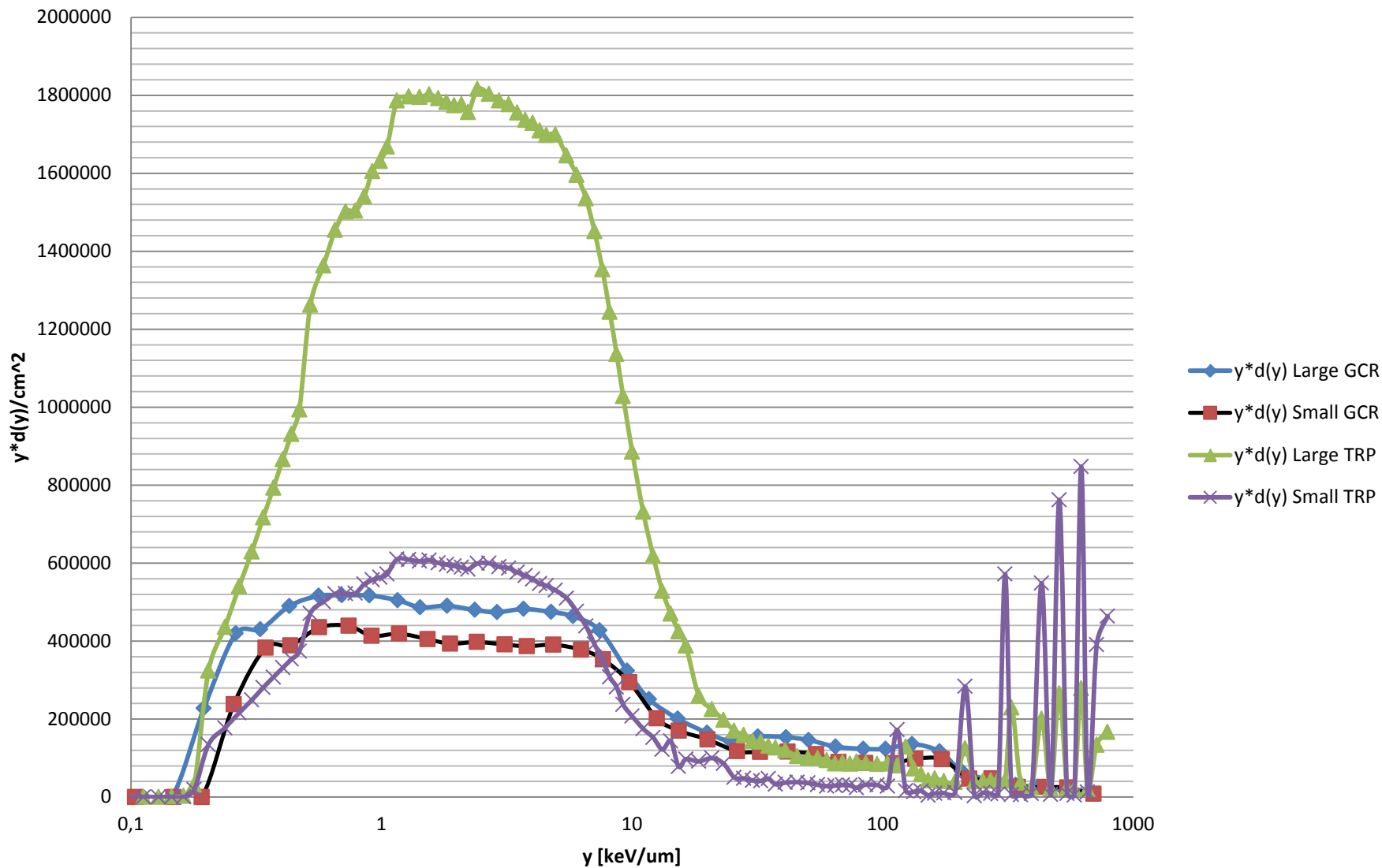


Trapped Radiation SAA $\gamma^*d(y)$ ISS Service Module





GCR $\gamma^*d(\gamma)$ IV-TEPC ISS Service Module 4/23/2012-5/22/2012





Summary

- Change in ISS Station orientation for Soyuz TMA-04m docking coincided with increase in dose response of Large IV-TEPC
- SAA trapped radiations have noted difference in response between Large and Small detectors
 - Differences in Detector Wall / Unit Thickness?
 - Station Orientation?
- Forward Work
 - Evaluating Further Station locations
 - Investigation Effect with Station Attitude
 - IV-TEPC recently turned on in Node 3 on 08/09



Thank you for your attention