- W. Chen et al. *The* γ p$\rightarrow$ π^+ n *Single Charged Pion Photoproduction.* Tech. rep. CLAS Analysis Proposal PR08-003, 2008

In addition to this document, there is a wealth of information to be found in the wiki pages at

`http://clasweb.jlab.org/rungroups/g12/wiki`

which has served as a repository for all things related to the *g12* experiment. The dissertations associated with this experiment contain a lot of information as well:

- John T. Goetz. "Ξ Hyperon Photoproduction from Threshold to 5.4 GeV with the CEBAF Large Acceptance Spectrometer". PhD thesis. University of California Los Angeles, 2010
- Craig Bookwalter. "A Search for Exotic Mesons in γ p $\rightarrow$ π^+ π^+ π^- n with CLAS at Jefferson Lab". PhD thesis. Florida State University, 2012
- Diane Schott. "A Search for an Exotic Meson in the γ p $\rightarrow$ Δ^{++} π^- η Reaction". PhD thesis. Florida International University, 2012
- Mukesh Saini. "Search for New and Unusual Stangonia using CLAS". PhD thesis. Florida State University, 2013
- Jason Bono. "First Time Measurements of Polarization Observables for the Charged Cascade Hyperon in Photoproduction". PhD thesis. Florida International University, 2014
- Michael C. Kunkel. "Photoproduction of π^0 on hydrogen with CLAS from 1.1 GeV - 5.45 GeV using $e^+e^-\gamma$ decay". PhD thesis. Old Dominion University, 2014
- Shloka Chandavar. "Photoproduction of Scalar Mesons Using the CEBAF Large Acceptance Spectrometer (CLAS)". PhD thesis. Ohio University, 2015

1.1 Trigger Configurations

The *g12* experiment was the first Hall *B* run-period to implement field programmable gate array (FPGA) processors to handle the trigger logic of the CLAS detector. With this new FPGA-powered triggering system, came the ability to modify the trigger quickly during the experiment. While potentially dangerous — these changes must be accounted for in total-cross-sectional analyses for example — this allowed the group to tune the trigger to get the highest possible rate of physical events.

The trigger bits used during the *g12* running period are defined in Tables 2, 3 and 4. They generally consisted of a number of tracks which were the coincidence of any one of the four start counter paddles and any of the 57 time-of-flight paddles in a given sector. The hardware and configuration did not allow triggering on two tracks in the same sector because there were only six signals coming from the TOF — one for each sector. The coincidence of these tracks with the photon tagger, called the "Master-OR," is defined in Table 5.

There were two sets of thresholds for the EC labeled *photon* and *electron*. These labels did not mean photon or electron specifically, but were considered a first-order approximation. The actual particle identification was done much later in the analysis of the reconstructed data. The thresholds for the CC and EC during the *g12* running period are shown in Table 6.

Table 1: The running conditions of the *g12* experiment.

E_{beam} of photon	5.715 GeV
Beam Polarization	Circular
e^- Current	60–65 nA
Tagger Range	5% - 95% of e^- energy
Tagger Trigger Range	3.6–5.441 GeV
Torus Magnet	$\frac{1}{2}B_{\text{max}}$ (1930 A)
Target Length	40 cm
Target Center (z location)	–90 cm
Target Material	ℓH_2
Target Polarization	None
Start Counter Offset	0 cm
Radiator Thickness	10^{-4} radiation lengths
Collimator Radius	6.4 mm

Table 2: Trigger configuration for *g12* runs from 56363 to 56594 and 56608 to 56647. $(\text{ST}\times\text{TOF})_i$ indicates a single *prong* which is a trigger-level track defined as a coincidence between a start counter and time-of-flight hit in the i^{th} sector or any sector if the subscript index, i, is not specified. An added ×2 or ×3 indicates the coincidence of multiple *prongs* which are not in the same sector. MORA and MORB represent coincidences with tagger hits within a certain energy range as specified in Table 5.

g12 runs 56363–56594, 56608–56647			
bit	definition	L2 multiplicity	prescale
1	$\text{MORA}\cdot(\text{ST}\times\text{TOF})_1\cdot(\text{ST}\times\text{TOF})$	–	1
2	$\text{MORA}\cdot(\text{ST}\times\text{TOF})_2\cdot(\text{ST}\times\text{TOF})$	–	1
3	$\text{MORA}\cdot(\text{ST}\times\text{TOF})_3\cdot(\text{ST}\times\text{TOF})$	–	1
4	$\text{MORA}\cdot(\text{ST}\times\text{TOF})_4\cdot(\text{ST}\times\text{TOF})$	–	1
5	$\text{MORA}\cdot(\text{ST}\times\text{TOF})_5\cdot(\text{ST}\times\text{TOF})$	–	1
6	$\text{MORA}\cdot(\text{ST}\times\text{TOF})_6\cdot(\text{ST}\times\text{TOF})$	–	1
7	ST×TOF	–	1
8	MORA·(ST×TOF)×2	–	1
11[a]	MORB·(ST×TOF)×2	–	1
12	(ST×TOF)×3	–	1

[a] bit 11 and MORB were included in the trigger starting with run 56519.

Table 3: Trigger configuration for *g12* runs from 56595 to 56607 and 56648 to 57323. (EC×CC) represents a coincidence between the electromagnetic calorimeter and the Čerenkov subsystems within a single sector using the thresholds as described in Table 6. ECP represents the *photon* threshold trigger from the EC. See Table 2 for other explanatory details.

g12 runs 56595–56607, 56648–57323			
bit	definition	L2 multiplicity[a]	prescale
1	MORA·(ST×TOF)	1	1000/300[b]
2	MORA·(ST×TOF)×2	2/–[c]	1
3	MORB·(ST×TOF)×2	2	1
4	ST×TOF	1	1000/300
5	(ST×TOF)·ECP×2	1	1
6	(ST×TOF)·(EC×CC)	2	1
7	MORA·(ST×TOF)·(EC×CC)	–	1
8	MORA·(ST×TOF)×2	–	1
11	(EC×CC)×2	–	1
12	(ST×TOF)×3	–	1

[a]Level 2 triggering was turned off on all bits for runs 56605, 56607 and 56647.

[b]Prescaling for bits 1 and 4 were 1000 for runs prior to 56668 at which point they both were changed to 300.

[c]Level 2 triggering of bit 2 was set to 2 for runs prior to 56665 at which point it was turned off.

Table 4: Trigger configuration for the single-sector runs of *g12*. Trigger bits 7–12 were not used for these runs. See Table 2 for explanatory details.

bit	definition	L2 multiplicity	prescale
1	$\mathrm{MORA{\cdot}(ST{\times}TOF)_1}$	sector 1	1
2	$\mathrm{MORA{\cdot}(ST{\times}TOF)_2}$	sector 2	1
3	$\mathrm{MORA{\cdot}(ST{\times}TOF)_3}$	sector 3	1
4	$\mathrm{MORA{\cdot}(ST{\times}TOF)_4}$	sector 4	1
5	$\mathrm{MORA{\cdot}(ST{\times}TOF)_5}$	sector 5	1
6	$\mathrm{MORA{\cdot}(ST{\times}TOF)_6}$	sector 6	1

Table 5: Master-OR definitions for *g12*. The TDC counters were used in the trigger and since each of these corresponds to several energy paddles, the energies given here are approximate. T-counter number 1 corresponds to the highest energy photon of approximately 5.4 GeV. Both MORA and MORB are referenced in terms of the trigger logic in Tables 2, 3 and 4. The *single-sector* runs are listed in Table 8.

	MORA		MORB	
run range	T-counters	energy (GeV)	T-counters	energy (GeV)
56363–56400	1–47	1.7–5.4	–	–
56401–56518	1–25	3.6–5.4	–	–
56519–57323	1–19	4.4–5.4	20–25	3.6–4.4
single-sector	1–31	3.0–5.4	–	–

Table 6: Threshold values for the electromagnetic calorimeter (EC) and Čerenkov counter (CC) during the *g12* running period. EC thresholds are shown as *inner/total*, and CC thresholds are shown as *left/right*.

EC		CC
photon	*electron*	
50/100 mV	60/80 mV	20/20 mV
150/300 MeV	180/240 MeV	~0.4 photo-electrons

1.2 Lists of Runs

The runs for this experiment range from 56855 to 57317 inclusive. The runs that made it into Tables. 7 and 8 qualified upon success of reconstructing final-state hadrons using the cooking program's default particle identification in coordination with the hand-written notes by the shift takers. Other runs of note include those used specifically for calibration in Table 9 and normalization, zero-field and empty-target runs in Table 10.

Table 7: List of successfully reconstructed production runs and their beam currents in nA.

runs	current (nA)	runs	current (nA)	runs	current (nA)
56363	20	56605	60	56900-56908	60
56365	30	56608-56612	60	56914-56919	60
56369	30	56614-56618	60	56921-56922	60
56384	5	56620-56628	60	56923	65
56386	20	56630-56636	60	56924	70
56401	50	56638-56644	60	56925	80
56403	70	56646	60	56926-56930	60
56404	60	56653-56656	60	56932	60
56405	50	56660-56661	60	56935-56940	60

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runs	current (nA)	runs	current (nA)	runs	current (nA)
56406	40	56665-56670	60	56948-56956	60
56408	80	56673-56675	60	56958	60
56410	90	56679-56681	60	56960-56975	60
56420-56422	5	56683	60	56977-56980	60
56435	5	56685-56696	60	56992-56994	60
56436	15	56700-56708	60	56996-57006	60
56441	35	56710-56724	60	57008-57017	60
56442	30	56726-56744	60	57021-57023	60
56443	20	56748-56750	60	57025-57027	60
56445-56450	60	56751-56768	65	57030-57032	60
56453-56459	60	56770-56772	65	57036-57039	60
56460-56462	70	56774-56778	65	57062-57069	60
56465	70	56780-56784	65	57071-57073	60
56467-56472	70	56787-56788	65	57075-57080	60
56478-56483	70	56791-56794	65	57095-57097	60
56485-56487	70	56798-56802	65	57100-57103	60
56489-56490	70	56805-56815	65	57106-57108	60
56499	70	56821-56827	65	57114-57128	60
56501	60	56831-56834	65	57130-57152	60
56503	57	56838-56839	65	57159-57168	60
56504	56	56841-56845	65	57170-57185	60
56505-56506	40	56849	65	57189-57229	60
56508-56510	60	56853-56862	65	57233-57236	60
56513-56517	60	56864	65	57249-57253	60
56519	60	56865-56866	60	57255-57258	60
56521-56542	60	56870	65	57260-57268	60
56545-56550	60	56874-56875	60	57270-57288	60
56555-56556	60	56877	60	57290-57291	60
56561-56564	60	56879	60	57293-57312	60
56573-56583	60	56897-56898	60	57317	60
56586-56593	60	56899	65		

Table 8: A list of the single-sector runs using the trigger configuration described in Table 4.

run	current (nA)	run	current (nA)
56476	24	56910	35
56502	24	56911	30
56520	24	56912	25
56544	24	56913	24
56559	24	56933-4	24
56585	24	56981-3[a]	24
56619	24	56985[a]	15
56637	24	56986	15
56663-4	24	56989	24
56697	24	57028	24
56725	24	57061	24
56747	24	57094[b]	24
56769	24	57129	24
56804	24	57155-6	24
56835	24	57237-8	24
56869	5		

[a]No Level-2 trigger was used for runs 56981-56985

[b]A shorter ST ADC gate was implemented starting with run 57094.

Table 9: A list of the runs which were calibrated for the subsystems: tagger (TAG), start counter (ST), and time-of-flight (TOF). The calibrations were committed into the database for the range starting with the run shown and ending with the run just prior to the next listed run. A brief reason for calibration is given in the last column.

run	systems affected	reason
56363	TAG, ST, TOF	start of run
56503	ST	ST adjustment
56508	"	" "
56661	TAG, ST, TOF	trigger and ST changes
56663	"	" "
56665	"	" "
56666	"	" "
56670	TAG	vacuum problem in tagger fixed
56673	TAG, ST, TOF	trigger change
56732	"	RF related problems fixed by Accelerator group
56765	TAG	T20 left HV problem
56766	"	T20 left HV adjusted
56782	TAG, ST, TOF	changes in calibration database
56855	"	" "
56923	"	start of intensity studies
57094	"	changes in calibration database
57154	ST	adjusted ST ADC timing in gate

Table 10: List of special calibration runs done during the *g12* experiment.

run	current (nA)	description
56397	0.05	normalization
56475	10	zero-field
56511	0.05	normalization, tagger TDC-left
56512	0.05	normalization, tagger TDC-right
56584	0.05	normalization
56682	0.05	normalization
56790	0.05	normalization
56931	0.05	normalization
56947	0.05	normalization

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