

VETO Performance

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PRIMEX note 75

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The goal of this analysis was to determinate probability of matching gamma by VETO using data from 2nd Snake scan.

1 Probability of direct matching gamma by VETO

In snake scan conditions we will have direct matching of VETO by beam photons.

To select data we applied the following cuts:

- 1) exactly one hit in TRIGTHIT bank with id=1 (MOR) and time within ± 20 ns

$$\begin{aligned} & \text{banks-} \rightarrow \text{TRIGTHIT} \rightarrow \text{trigthit}[i].\text{id} == 1; \\ & \text{abs}(\text{banks-} \rightarrow \text{TRIGTHIT} \rightarrow \text{trigthit}[i].t) < 20; \end{aligned}$$

- 2) exactly one cluster in calorimeter with energy between 0.8 and 8.0 GeV

$$\begin{aligned} & \text{banks-} \rightarrow \text{HYCALCLUSTER} \rightarrow \text{bank.nrow} == 1; \\ & 0.8 \text{ GeV} < \text{banks-} \rightarrow \text{HYCALCLUSTER} \rightarrow \text{hycalcluster}[i].E < 8.0 \text{ GeV}; \end{aligned}$$

- 3) exactly one reconstructed TAGGER hit within ± 20 ns time

$$\begin{aligned} & \text{banks-} \rightarrow \text{TAGM_LR} \rightarrow \text{bank.nrow} == 1; \\ & \text{abs}(\text{banks-} \rightarrow \text{TAGM_LR} \rightarrow \text{tagm_lr}[i].t) < 20; \end{aligned}$$

- 4) cluster energy corresponds tagger energy

$$\text{abs}(\text{cluster_energy}/\text{tagger_energy} - 1) < 0.1;$$

- 5) HyCal energy corresponds cluster energy

$$\text{energy_hycal} - E_{cl} < 0.20 \text{ GeV}.$$

In analysis each event was checked for VETO status. Existent VETO statuses (according to new VETO code written by Yang) presented in tab. 1.

Table 1. VETO statuses and their description.

Veto status	Description
-1	No information from VETO, no match
0	VETO has some information from another counters, no match
1	x matching only
2	x matching and t
10	y matching only
20	y matching and t
11	1 and 10
12	2 and 10
21	1 and 20
22	2 and 20

Probability to match gamma by VETO was defined as a ratio of number of events when cluster has had VETO status 11,12,21 or 22 to all selected events.

Most of channels have probability to match gamma by VETO less then 0.1%. But some of them have probability greater than 1%. These groups of modules have some regularity presented on fig. 1 in yellow color.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	
69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	
103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137
137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	
171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	
205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	
239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	
273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	
307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	
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477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	
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579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	
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681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	
715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	
749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	
783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	
817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	
851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	
885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	
919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	
953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	
987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	
1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	
1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	
1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	
1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	

Fig. 1. HyCal matrix (central part). Yellow zones – modules with higher probability to match gamma by VETO (zone 1), the rest – modules with low (less 1%) probability (zone 2).

Another group of modules (1335-1340, 1521, 1527, 1528, 1561, 1562, 1594, 1595, 1596) have low statistics (less then 1K event) – therefore these 14 modules were excluded from analysis.

Probability to match gamma by VETO for different beam energy ranges (for energy less then 2.5 GeV, from 2.5 to 3.5 GeV and greater than 3.5 GeV) presented on fig. 2-7, and in the Table 2.

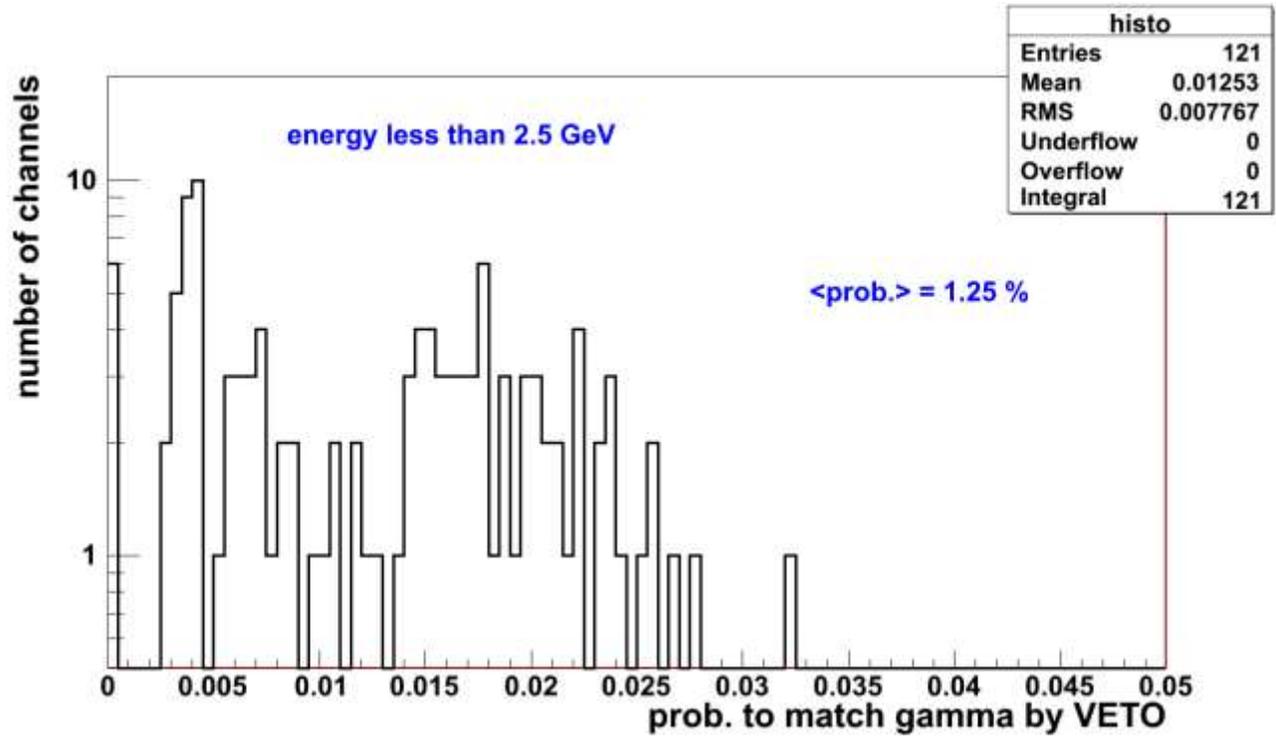


Fig. 2. Probability to match gamma by VETO for beam energy less then 2.5 GeV (area 1).

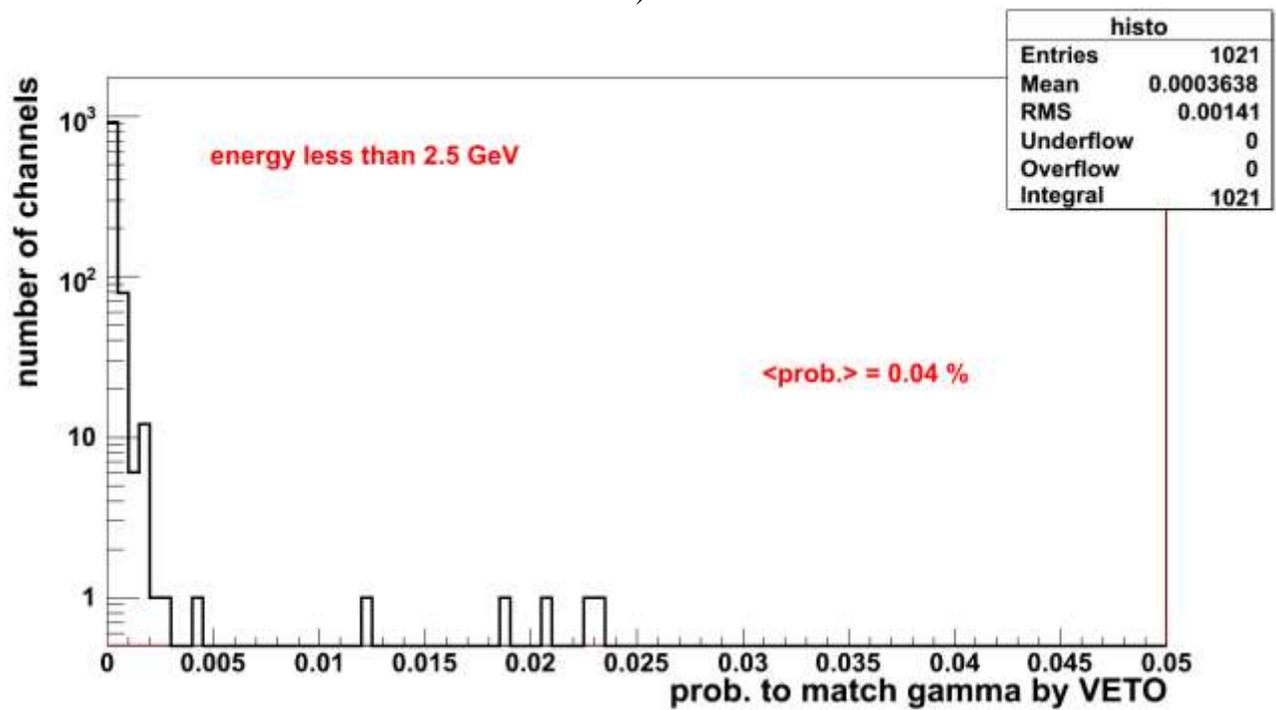


Fig. 3. Probability to match gamma by VETO for beam energy less then 2.5 GeV (area 2).

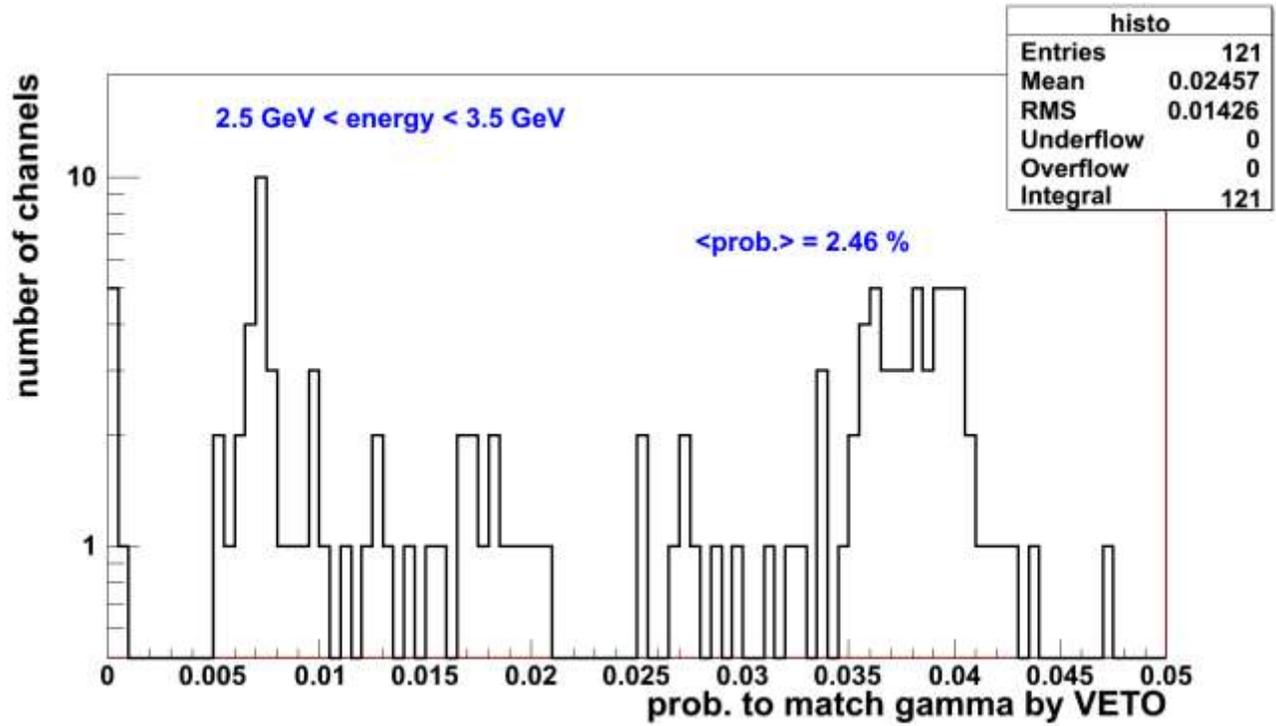


Fig. 4. Probability to match gamma by VETO for beam energy less than 3.5 and greater than 2.5 GeV (area 1).

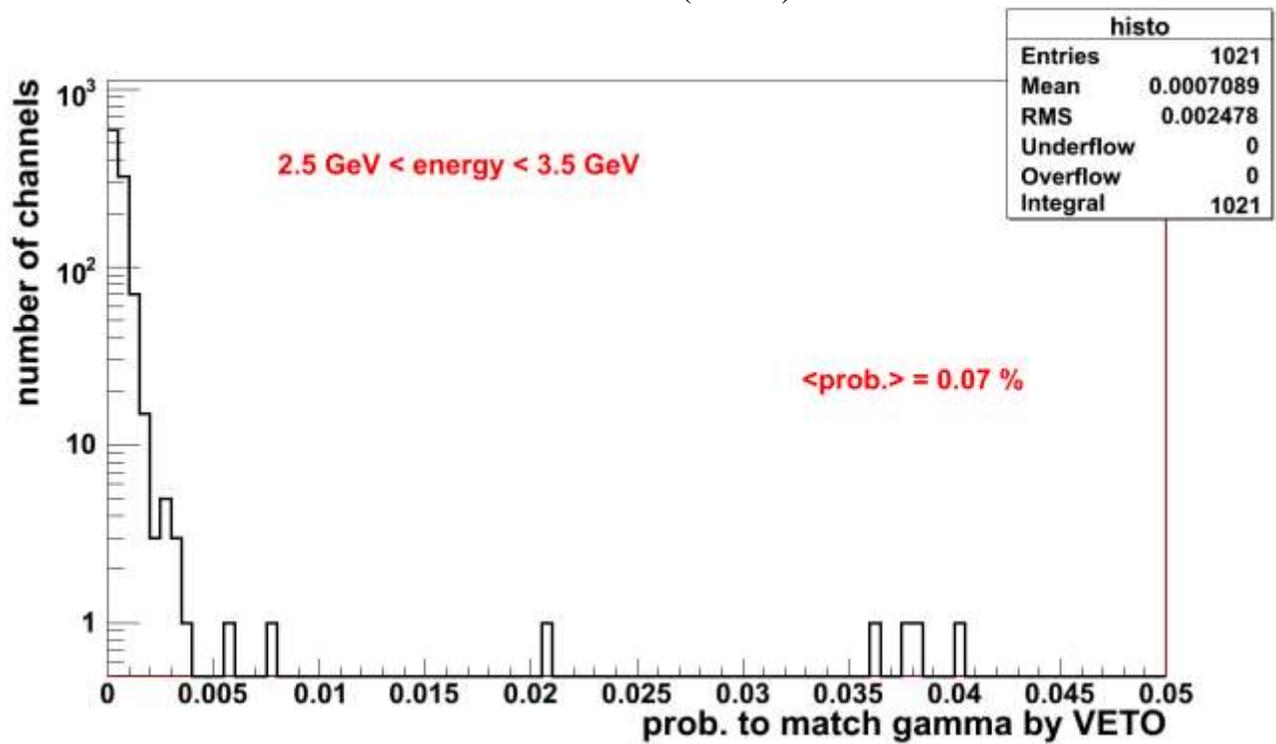


Fig. 5. Probability to match gamma by VETO for beam energy less than 3.5 and greater than 2.5 GeV (area 2).

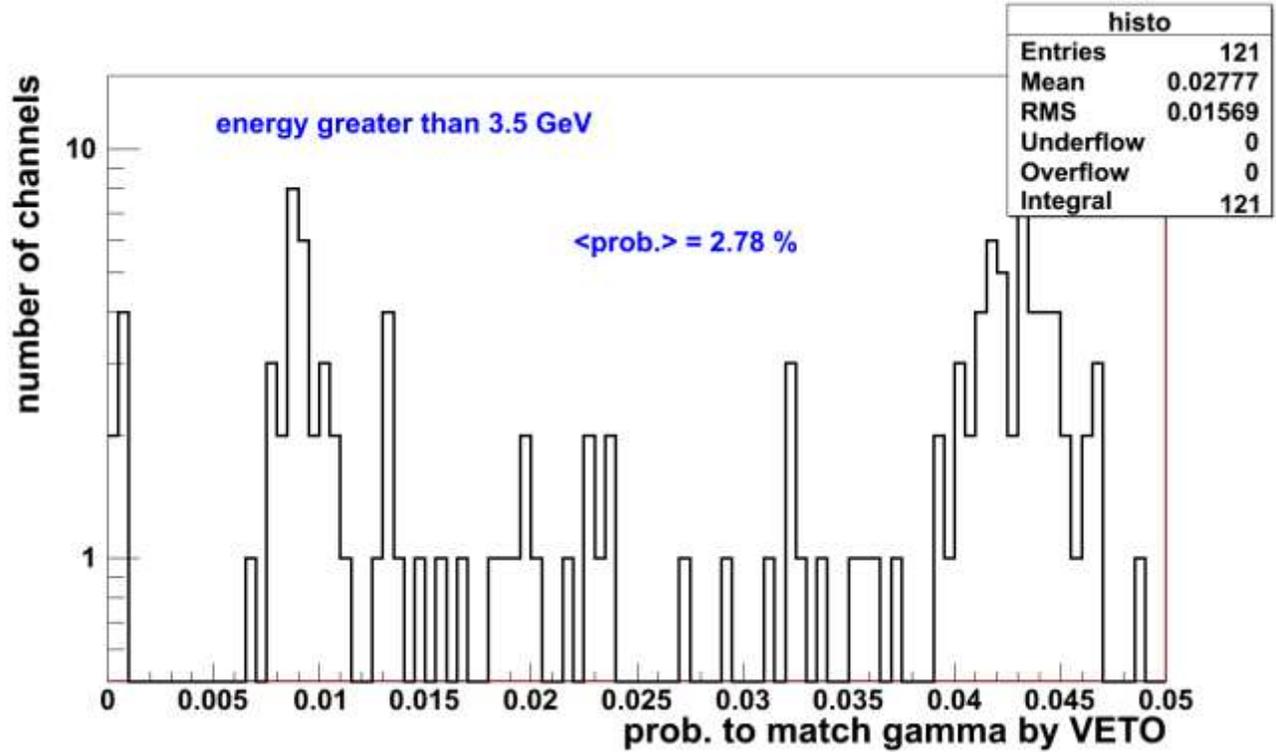


Fig. 6. Probability to match gamma by VETO for beam energy greater then 3.5 GeV (area 1).

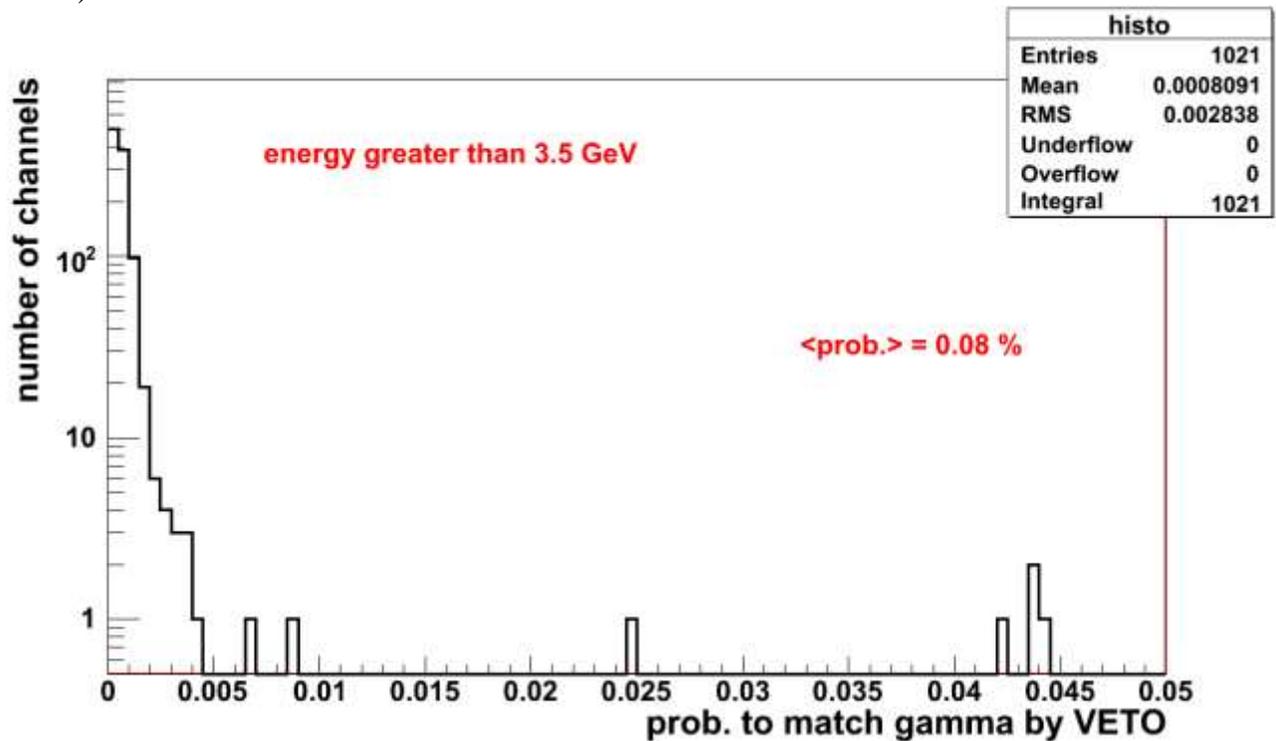


Fig. 7. Probability to match gamma by VETO for beam energy greater then 3.5 GeV (area 2).

Table 2. Average probability to match gamma by VETO for area 1 and 2 and for different beam energy ranges.

	$E < 2.5 \text{ GeV}$	$2.5 \text{ GeV} \leq E < 3.5 \text{ GeV}$	$E \geq 3.5 \text{ GeV}$
Area 1 (121 modules)	$1.25 \pm 0.09 \%$	$2.46 \pm 0.16 \%$	$2.78 \pm 0.15 \%$
Area 2 (1021 modules)	$0.04 \pm 0.01 \%$	$0.07 \pm 0.03 \%$	$0.08 \pm 0.02 \%$
All modules together	$0.29 \pm 0.03 \%$		

Average probability for gamma to be matched by VETO (status 11,12,21,22) for all crystal modules is about 0.3%.

2 Investigation of albedo matching

We have studied VETO hits distribution as a function of distance from beam. This information can be used to calculate VETO matching of one gamma quantum from pi0 decay triggered by albedo from another gamma quantum of the same pi0 decay. To calculate this distance we used VETO hit coordinate corresponding to X and Y VETO plates intersection. This distribution can be used in the future Monte-Carlo to simulate exact VETO response.

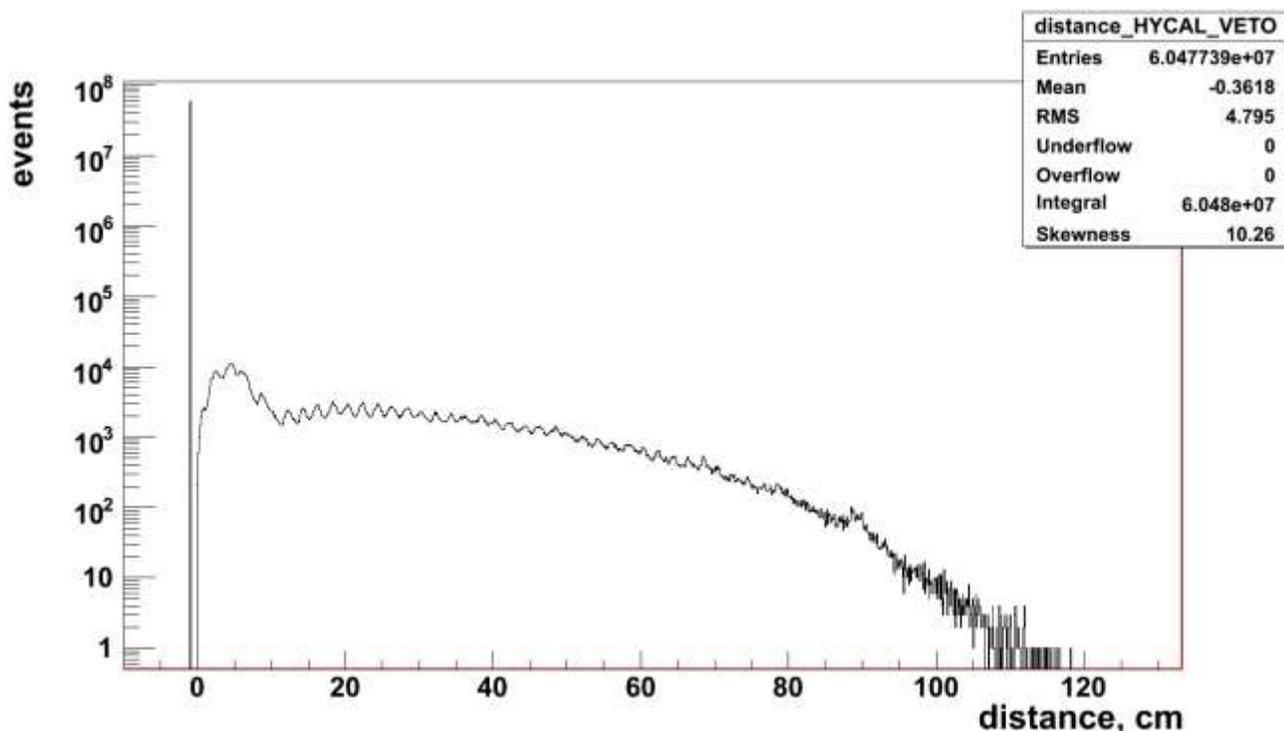


Fig. 8. Distribution of VETO hits distance from cluster.

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From the picture it is easy to see the region of direct VETO matching (0 to 10 cm). Another part where distance greater than 10 cm corresponds to back splash or Compton scattering which occur before VETO. Value “-1” means that we don't have any signal in VETO. The average probability to get VETO hit induced by passing beam photon is about 0.2%.

All information about probability to match gamma by VETO for different energies for all HyCal modules can be found in the file:
 /home/vtarasov/VETO_study/direct_matching.txt

All information about VETO hit distribution by distance from gamma hit point on HyCal can be found in the file:
 /home/vtarasov/VETO_study/albedo_distribution.txt