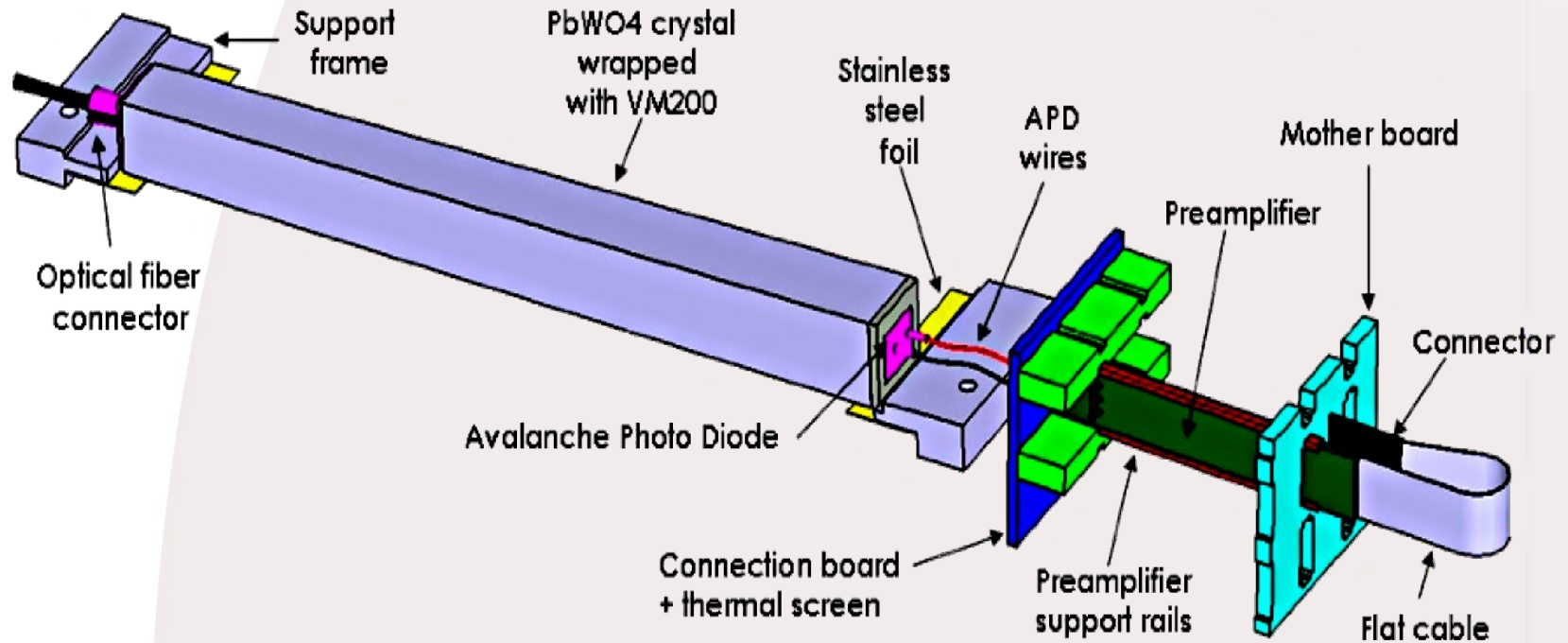


ECal amplification chain: simulation, measurements and characterization

Gabriel Charles

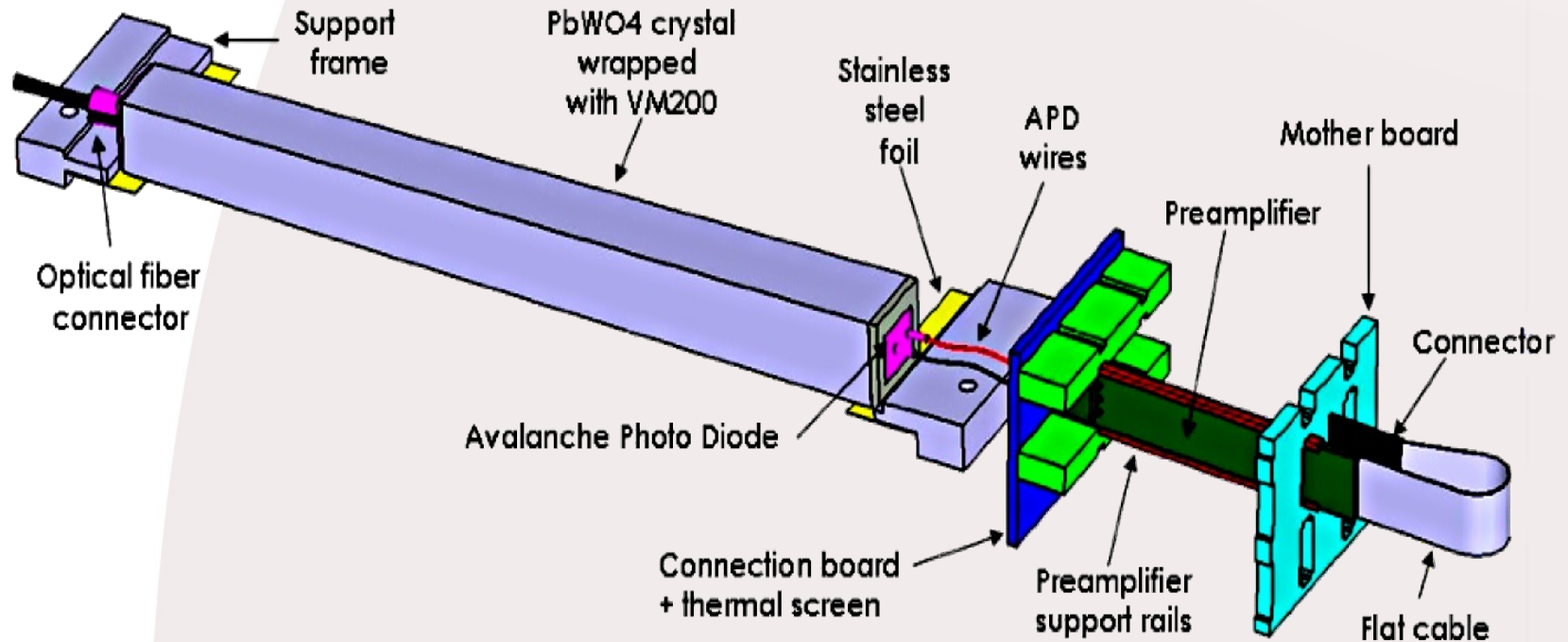
IPNO

CNRS-IN2P3
Université Paris-Sud



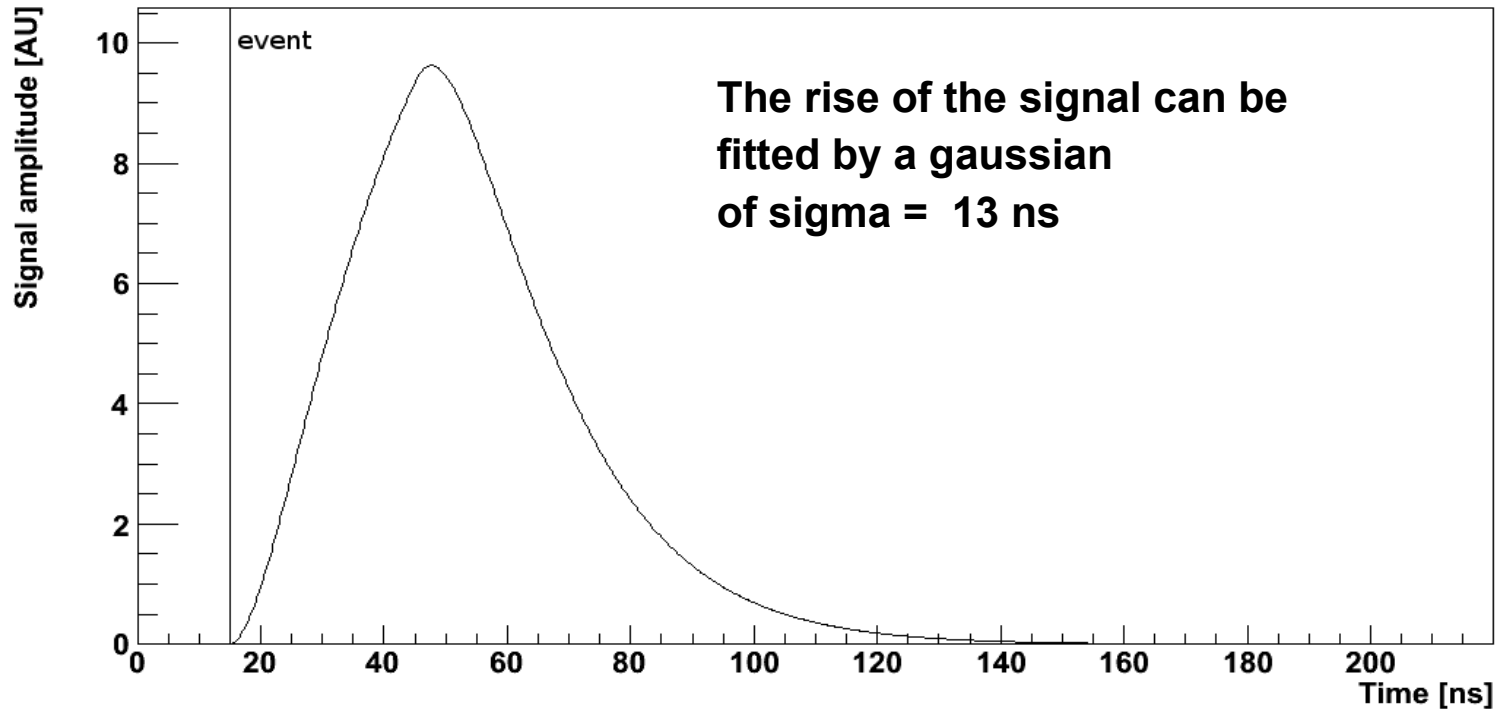
Aims:

- characterize the preamplifiers in terms of gain and noise
- determine the light yield



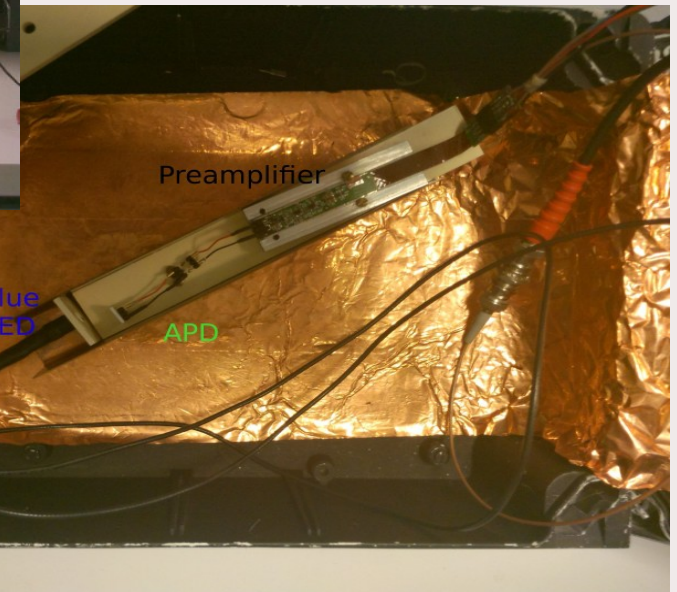
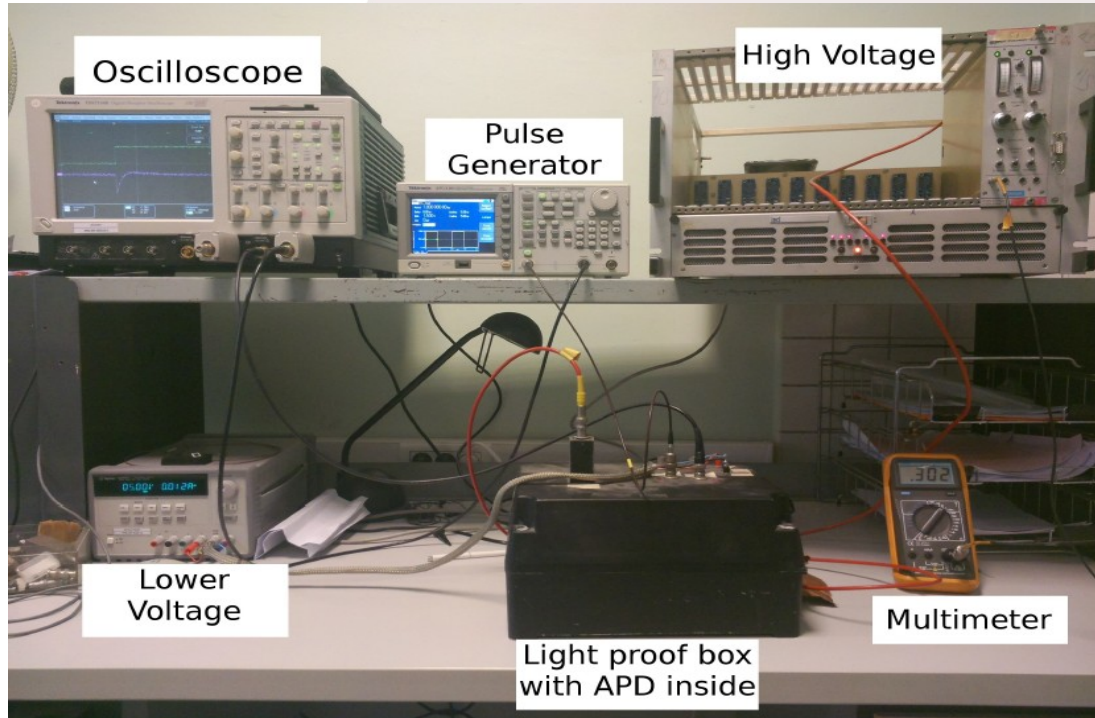
Aims:

- characterize the preamplifiers in terms of gain and noise
 - necessary to know the input shape of the signal
- determine the light yield

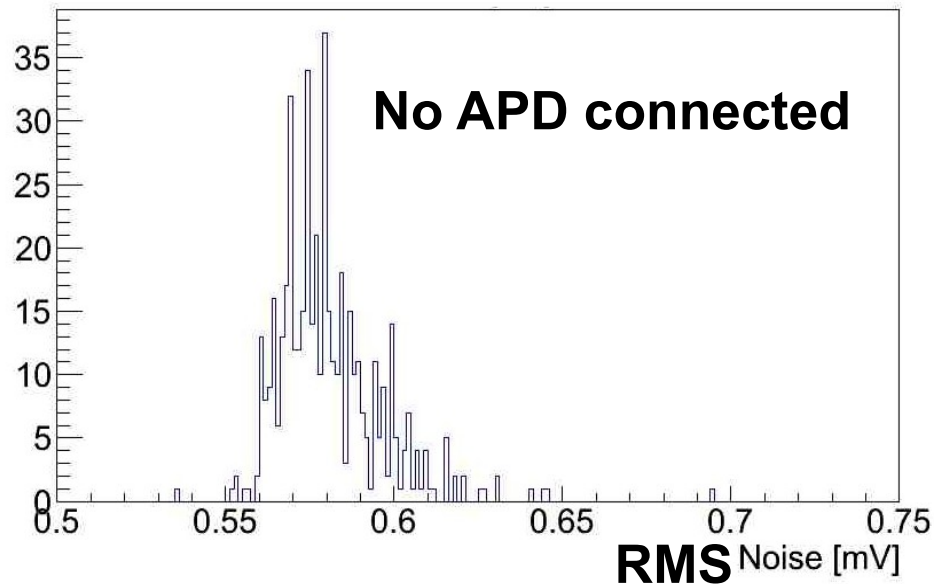


Simulation of the shape of the input signal, by convoluting the time response of the crystal and of the APD.

Characterization setup



Except for the test of the APD itself, for the characterization, the preamplifier was directly connected to the pulse generator.



When a capacitor is connected to the preamplifier to simulate the APD, the spread remains identical while the most probable value is 1.14 mV (around 3.3 MeV)

The theoretical threshold can be deduced:

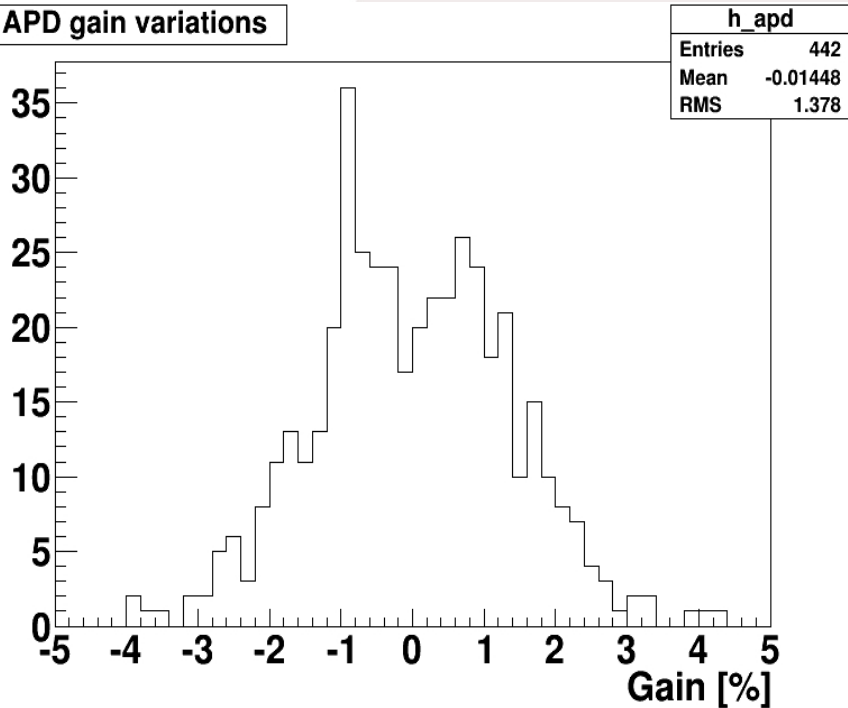
$$\sigma_{noise} = \sqrt{1.3^2 + 3.3^2 + E/N_{\gamma e}}$$

FADC fluctuations

Nphe fluctuations

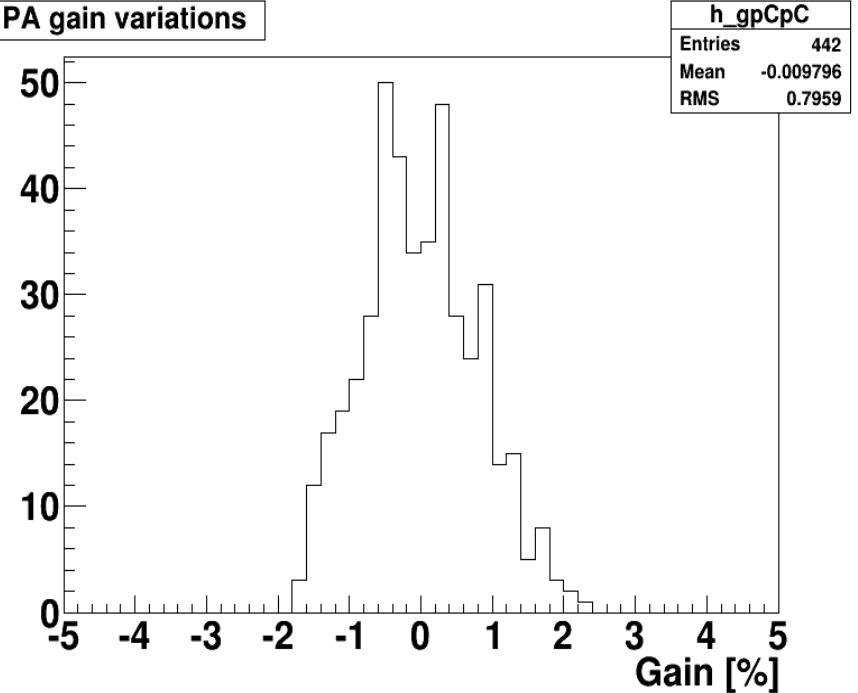
APD and preamplifier gain variations

APD gain variations



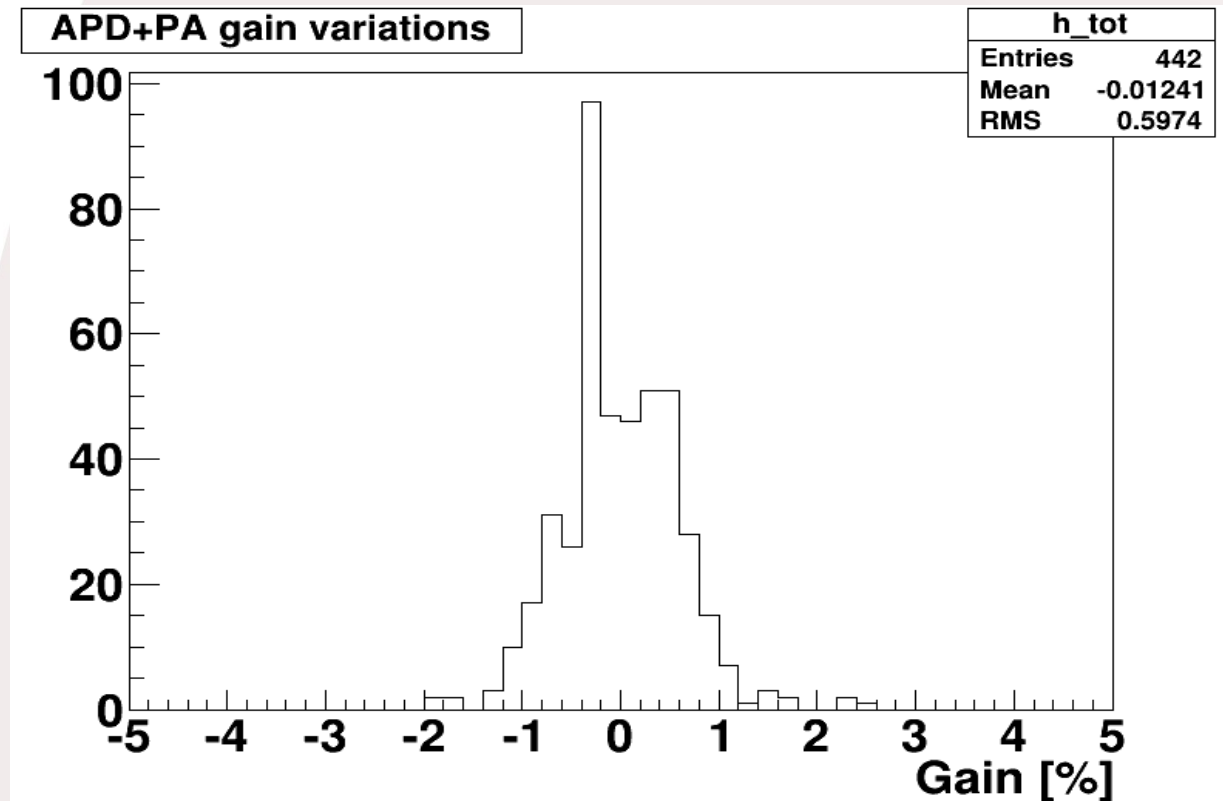
Provided by : see Michel's talk

PA gain variations



Mean value is around 225 pC/pC

Total gain variations



The APDs and the preamplifiers are coupled to reduce the variations as much as possible.

Most of the couples APD+PA have gain variations below 1% of the mean value.

LEFT TOP BOARD

345	348	363	400	407	433	440	475	475	481	428	290	290	18	3	119	155	374	378
347	375	372	408	408	443	447	359	351	422	431	483	499	91	4	61	80	478	445
346	363	367	295	399	383	384	354	189	423	429	293	298	94	2	113	70	446	477
348	371	364	403	397	380	378	357	377	423	421	299	300	97	3	14	194	376	474
339	351	361	292	406	450	475	356	356	439	425	294	291	91	112	147	62	473	453

LEFT BOTTOM BOARD

350	397	398	296	394	266	275	399	391	35	34	250	242	15	131	74	83	463	457
325	398	311	391	387	268	276	399	394	39	37	245	247	73	88	145	35	456	470
349	399	319	385	392	274	269	397	390	38	38	249	251	81	124	130	28	451	449
358	313	319	395	388	271	270	393	396	34	33	243	246	81	120	26	77	479	476
354	398	312	396	390	273	272	398	390	35	36	241	244	149	69	123	127	448	455

RIGHT TOP BOARD

287	277	87	88	91	151	264	262	87	137	182	172	178	180	98	174	223	192	199
296	280	289	139	124	132	258	255	27	92	184	185	171	188	106	183	197	204	203
288	283	119	86	140	36	253	256	130	32	189	181	419	420	409	391	219	194	196
281	278	73	85	33	25	257	260	139	29	186	187	262	414	418	419	416	411	413
285	282	71	84	129	134	261	259	36										415

RIGHT BOTTOM BOARD

34	36	409	409	79	89	493	502	332										318
36	36	391	393	111	76	494	496	330	324	84	148	146	13	152	96	297	297	319
133	133	293	293	78	32	495	504	330	317	117	115	24	21	63	72	211	215	204
73	138	295	293	64	110	503	500	316	314	150	16	207	213	202	205	218	214	205
121	82	362	364	17	114	499	498	321	318	20	118	210	209	212	208	212	213	209

Provided by : see Michel Garçon's talk

Preamplifiers mapping

LEFT TOP BOARD

N130	N132	N134	N432	N437	N136	N433	N434	N135	N140	N437	N137	N435	N436	N133	N146	N138	N438	N139	N439	N471	N101	N479	N422
N131	N133	N135	N435	N436	N137	N437	N138	N141	N440	N438	N139	N439	N140	N134	N139	N439	N141	N142	N440	N143	N111	N146	N418
N132	N134	N136	N436	N437	N138	N438	N139	N142	N441	N439	N140	N440	N141	N135	N140	N440	N142	N143	N441	N144	N112	N147	N117
N133	N135	N137	N437	N438	N139	N439	N140	N143	N442	N440	N141	N441	N142	N136	N141	N441	N143	N144	N442	N145	N113	N148	N419
N134	N136	N138	N438	N439	N140	N440	N141	N144	N443	N441	N142	N442	N143	N137	N142	N442	N144	N145	N443	N146	N114	N149	N420
N135	N137	N139	N439	N440	N141	N441	N142	N145	N444	N442	N143	N443	N144	N138	N143	N443	N145	N146	N444	N147	N115	N150	N421
N136	N138	N140	N440	N441	N142	N442	N143	N146	N445	N443	N144	N444	N145	N139	N144	N444	N146	N147	N445	N148	N116	N151	N422

LEFT BOTTOM BOARD

N430	N432	N434	N436	N438	N440	N442	N444	N100	N282	N501	N138	N283	N284	N100	N430	N100	N101	N102	N103	N104	N105	N106	N107
N431	N433	N435	N437	N439	N441	N443	N445	N101	N283	N502	N139	N284	N285	N101	N431	N101	N102	N103	N104	N105	N106	N107	N108
N432	N434	N436	N438	N440	N442	N444	N446	N102	N284	N503	N140	N285	N286	N102	N432	N102	N103	N104	N105	N106	N107	N108	N109
N433	N435	N437	N439	N441	N443	N445	N447	N103	N285	N504	N141	N286	N287	N103	N433	N103	N104	N105	N106	N107	N108	N109	N110
N434	N436	N438	N440	N442	N444	N446	N448	N104	N286	N505	N142	N287	N288	N104	N434	N104	N105	N106	N107	N108	N109	N110	N111
N435	N437	N439	N441	N443	N445	N447	N449	N105	N287	N506	N143	N288	N289	N105	N435	N105	N106	N107	N108	N109	N110	N111	N112
N436	N438	N440	N442	N444	N446	N448	N450	N106	N288	N507	N144	N289	N290	N106	N436	N106	N107	N108	N109	N110	N111	N112	N113
N437	N439	N441	N443	N445	N447	N449	N451	N107	N289	N508	N145	N290	N291	N107	N437	N107	N108	N109	N110	N111	N112	N113	N114

RIGHT TOP BOARD

N108	N109	N110	N111	N112	N113	N114	N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131
N109	N110	N111	N112	N113	N114	N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131	N132
N110	N111	N112	N113	N114	N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131	N132	N133
N111	N112	N113	N114	N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131	N132	N133	N134
N112	N113	N114	N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131	N132	N133	N134	N135
N113	N114	N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131	N132	N133	N134	N135	N136
N114	N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131	N132	N133	N134	N135	N136	N137
N115	N116	N117	N118	N119	N120	N121	N122	N123	N124	N125	N126	N127	N128	N129	N130	N131	N132	N133	N134	N135	N136	N137	N138

RIGHT BOTTOM BOARD

N280	N281	N282	N283	N284	N285	N286	N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303
N281	N282	N283	N284	N285	N286	N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304
N282	N283	N284	N285	N286	N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304	N305
N283	N284	N285	N286	N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304	N305	N306
N284	N285	N286	N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304	N305	N306	N307
N285	N286	N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304	N305	N306	N307	N308
N286	N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304	N305	N306	N307	N308	N309
N287	N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304	N305	N306	N307	N308	N309	N310
N288	N289	N290	N291	N292	N293	N294	N295	N296	N297	N298	N299	N300	N301	N302	N303	N304	N305	N306	N307	N308	N309	N310	N311

V. Iurasov

These two maps will be used next week to install the crystals and the preamplifiers.

Total gain mapping



V. Iurasov

This gain map can be loaded into the software database.

It could also be used to compare with the calibration but the variations are very small.



Trigger is composed of three scintillators+PM

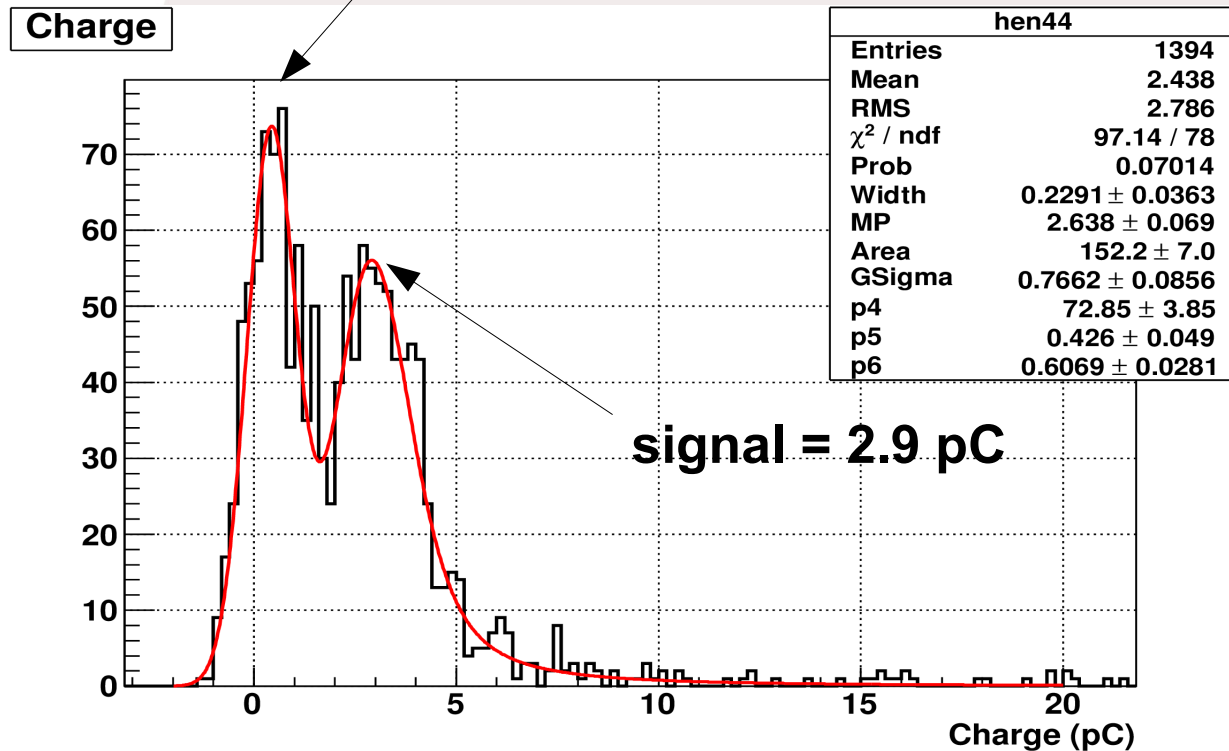
Temperature of the crystal kept stable at 18 deg C

The crystal is placed horizontally

Simulations have shown that the average energy deposition in this configuration is 15 MeV

Pedestal = 0.4 pC

Andrea Celentano



The most probable energy deposition is thus: 2.5 pC

This is compatible with a light yield of 120 ph/MeV and a preamplifier gain of 220 pC/pC

Conclusion

- All the preamplifiers have been characterized in terms of noise and gain
- The preamplifiers have been coupled to APDs to reduce the gain spread over the Ecal
- Map of preamplifier has been produced to install the preamplifiers (next week)
- Map of gain has been produced, can be used in the simulation
- Measurements with a single crystal have shown the consistency of the gain and light yield expectations

Internal technical note with all the details will be published very soon.

$$Q_{MP} = 2.487 \text{ pC}$$

From this, one can derive the crystal light-yield by converting the charge in the number of electrons and dividing this by the gain of the amplifier, the gain of the APD, and the most probable energy deposition:

$$LY_{phe} = \frac{Q_{MP}}{e \cdot G_{APD} \cdot G_{Ampli} \cdot E_{MP}} = 30.8 \text{ phe / MeV}$$

One can also derive the light yield, in optical photons emitted per deposited MeV, by taking into account the APD quantum efficiency ($QE \simeq 0.7$) and the ratio of the APD surface to crystal surface ($S_R = 0.3906$), getting:

$$LY_{\gamma} = \frac{LY_{phe}}{QE \cdot S_R} \simeq 112.6 \text{ photons / MeV}$$

This number is close to the one used in the amplification chain model (120 photons / MeV).