### First Results on Dec 2015 Proto120 Beam Test





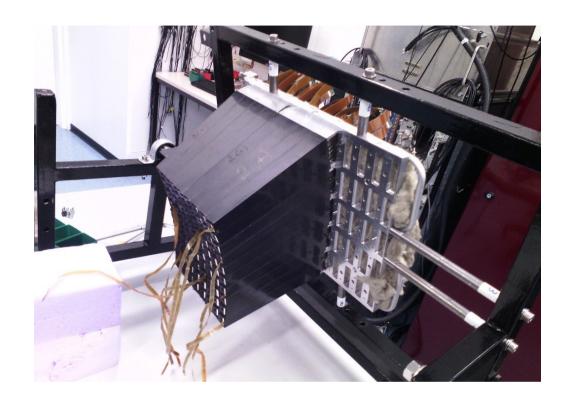
Hans-Georg Zaunick 2nd Physics Institute JLU Giessen



PANDA CM, 01-Mar-2016

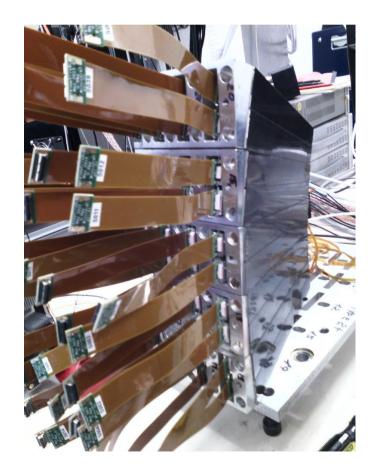






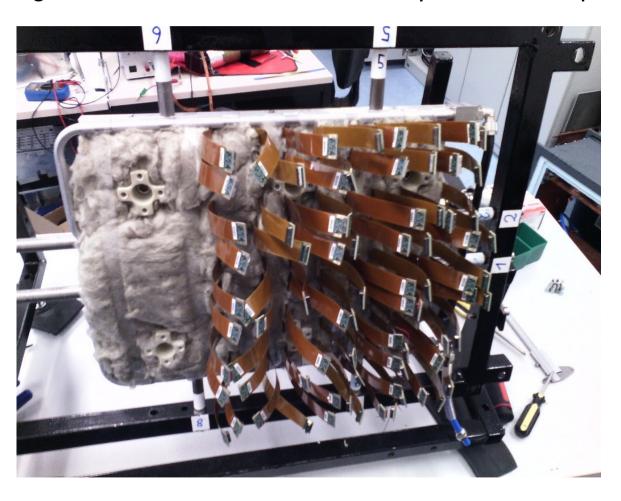
- Assembly of 2 crystal blocks (type 2 and 3)
- 80 crystals equipped with matched pairs of APDs based on information from APD database

 ASIC flex PCBs v6 with leftand right-hand connector configuration



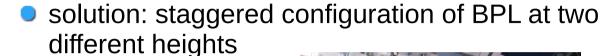
C20 - 1	R A	S P B	E R R	Y <u>1</u>	RA	S P B					Buffer board:
366 368 353 379 324 317 176 321				C10:2 W043	A10:4 S007						
3 - 0											
\$ 94.86 \$ \$ 90 \$ 82.80 \$ \$ \$ \cdot \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	300	300							К		
C20   3   SQS   C20   1   WQS   C20   3   SQS   C20   1   WQS   A10   3   SQS   A10   3   SQ	5 < 0 > 364,86	5 <0> 362,90			10 <1> 2 369,69						PCB 0
275	C20:3 S038	C20:1 W038	C10:3 S020	C10:1 W059	A10:3 S039	A10:1 W055	A11:3 S009	A11:1 W005			
Section   Sect						A14, B14				Depolished crystals	
C21   S032   C21   W030	2/5								L	Dolished erretals	
C21   S032   C21   W030	5 < 0 > 345.98	5 <0> 377,30	5 < 1 > 367,41	5 < 1 > 343,89	10 <1> 345,58	10 <1> 371.48	10 <0> 374,58	10 <0> 369,78		Polistieu crystais	PCB 1
A21, B27	C21:4 S032									Crystals + blue led	
Section   Sect	A17, B17	A18, B18	A19, B19	A20, B20	A21, B21	A22, B22				,	
4 - CD	360	370		364	332	333	315	335	R		
C21:3 S036 C21:1 W034 C11:3 S021 C12:2 W034 C25 A26, B26	1 < 0 > 362 E0	1 <0> 262.16	58	11	12	13	14	15			SADC Connectors
A26, B25	C21:3 S035	C21:1 W034	C11:3 S021	C11:1 W044	<b>A20</b> :3 S011	<b>A20</b> :1 W031	A21:3 S018				
## Copyright	A25, B25			A28, B28	A29, B29	A30, B30					1 3 1 3
## Act   State   State	292	287	274	255		246	569		L		2 4 2 4
F20: 4   S034   F20: 2   W035   F21: 4   S022   F21: 2   W041   F21: 4   S010   F21: 4   S01	4 405 070 40	4 405 000 00									PCB 0 PCB 1
A38, B33  A38   A34, B34   A35, B35   A36, B36   A37, B37   A38, B36   A38, B36   A38, B38   A40, B40   A21, B41   A22   RVB, A41, B41   A42, B42   A43, B43   A43, B43   A44, B44   A45, B45   A56, B56   A57, B57   A56, B56   A37, B37   A38, B38   A38, B38   A40, B40   A21, B41   A42, B42   A43, B43   A44, B44   A45, B45   A56, B56   A37, B37   A38, B38   A38, B38   A40, B40   A21, B41   A42, B42   A43, B43   A44, B44   A45, B45   A56, B56   A38, B39   A44, B44   A45, B45   A56, B56   A37, B37   A38, B38   A40, B40   A21, B41   A42, B42   A43, B43   A44, B44   A45, B45   A56, B56   A38, B39   A44, B44   A56, B45   A56, B56   A36, B36   A34, B43   A35, B30   A44, B44   A56, B56   A36, B36   A34, B43   A35, B30   A44, B44   A56, B56   A36, B36   A34, B43   A35, B30   A46, B44   A56, B56   A36, B36   A34, B43   A36, B36   A36, B36   A36, B36   A34, B43   A35, B30   A46, B44   A56, B56   A36, B36   A36,											5 1 1
3 <				F21:2 W041	F21:4 S010						Backplane:
3 <				390	331				Ь		HVA.2 HVB.4
3 <	301	332		21 21	22	23			К		
F20:3 SO47 F20:1 WO35 F21:3 SO29 F21:1 WO47 F21:3 SO39 F21:1 WO57 F21:1 WO57 F21:1 WO57 F21:1 WO57 F21:1 WO57	3 < 0 > 347,75	3 <0> 367,10	3 <1> 366,69	3 < 1 > 344,94	8 <1> 369,47	8 < 1 > 358,20	8 < 0 > 345,67				HVB.2 HVA.4
3 <		F20:1 W035	<b>F21</b> :3 S029	F21:1 W047	F21:3 S003*	F21:1 W032	F20:3 S043				HVA.1 HVB.3
3 <				A44, B44 200	A45, B45 250	A46, B46			١.		
3 < 0	201	209		<b>260</b>	230				L		HAPTING WAY
37.1 38.2 38.6 LED 36.3 32.3 34.9 34.1 32.7 Solution (a) Solution (b) Solution (c)	3 < 0 > 367,03	3 <0> 368,40	3 <1> 350,29	3 < 1 > 375,72	8 <1> 363,17	8 <1> 363,46	8 < 0 > 373,28				
386 LED 363 323 349 341 32/				F11:2 W045	<b>F11</b> :1 S0002	F11:3 W060					
386 LED 363 323 349 341 32/	49 BA9	4000 B50 B50		A52, B52	A53, B53	A54, B54					
31 32 33 34 05 55 05 7.1	37.1	<b>382</b>		363	323	349			R		
\$\begin{array}{c c c c c c c c c c c c c c c c c c c					32	33					
A57, B59, B59	0000 SO45	MU33									
291 285 254 LED 278 36,33 7 <1 361,77 7 <1 361,77 7 <1 361,21 7 <0 373,22 7 <0 366,37    22 <1 374,72 2 <1 366,33 7 <1 361,77 7 <1 361,77 7 <1 361,21 7 <0 373,22 7 <0 366,37    22 1 374,72 2 <1 366,33 7 <1 366,33 7 <1 361,77 7 <1 361,21 7 <0 373,22 7 <0 366,37    22 1 4 5044 A21:2 W029 A20:4 5025 A20:2 W050 A67, B67 A68, B68 A69, B69 A70, B70 A71, B71 A72, B72 A73, B73 A74, B21		Managara B58		A60, B60	A61, B61						
2 < 1 > 374,72	291	285	<b>254</b> LED			238	248	247	l i		
A21: 4 SO44 A21: 2 WO29 A20: 4 SO25 A20: 2 WO50 A68, B68 A69, B69 A69, B69 A70, B70 A71, B71 A72, B72 A74, B74		annananananananananananananananananana	53	36	37	38	39	40	_		
A66, B65 378 362 LED 369 369 325 343 322 337  1 <	annum	annum annum annum									
355 378 362 LED 369 325 343 322 337 45 1 <				A20:2 W050	C20:1 S006						
1 < 0 > 376,68   1 < 0 > 367,22   1 < 1 > 364,10   1 < 1 > 364,05   6 < 1 > 374,32   6 < 1 > 353,77   6 < 0 > 364,43   6 < 0 > 370,67    A21:3				369	325	3/13			D.		
1 < 0 > 376,68   1 < 0 > 367,22   1 < 1 > 364,10   1 < 1 > 364,05   6 < 1 > 374,32   6 < 1 > 353,77   6 < 0 > 364,43   6 < 0 > 370,67    A21:3	333		EO	41	42	43	4.4	4E			(groon 0 and red 1)
A21:3 S036 A74, B73 S026 A20:1 W048 C20:2 S013 C20:4 W057 C21:2 S024 C21:4 W064 A73, B73 A74, B74 B74 A75, B75 A76, B76 A77, B77 A78, B78 A79, B79 A80, B79		1 <0> 367,22	1 <1> 364,10	1 <1> 364,05	6 <1> 374,32	6 <1> 353,77	6 < 0 > 364,43	6 < 0 > 370,67		FEE-ID:	000-0-0110
258 266 262 LED 256 232 218 251 241 L APD I DE CREATE APP I L		The same of the sa	<b>A20</b> :3 S026	A20:1 W048	<b>EC20</b> : 2 S013	C20:4 W057	C21:2 S024	C21:4 W064			Cable ID Geo
1<0> 377,96  377,96  4<1 374,12  1<1> 345,89  6<1> 374,49  6<1> 36,90  6<0> 371,30  6<0> 359,39  1  1  1  1  1  1  1  1  1  1  1  1  1			A/5, B/5	A/6, B/6	A//, B//	A/8, B/8	251	A80, B80	١.	APD I NG brown	R,T=45
1<0> 377,96  377,96  4<1 374,12  1<1> 345,89  6<1> 374,49  6<1> 36,90  6<0> 371,30  6<0> 359,39  1  1  1  1  1  1  1  1  1  1  1  1  1	250	ZOUmmenter man		<b>250</b>	<b>232</b> 47	48	<b>231</b>	<b>241</b>	L	LG blue	
top T Y P E 3 botte top T Y P E 2 bottom	1 < 0 > 377,96	annana ana ana ana ana ana ana ana ana		1 <1> 345,89	6 <1> 374,49	6 <1> 360,90	6 < 0 > 371,30	6 < 0 > 359,39		APD II IG orange	
	top T	ΥP	E 3	botte	top T	ΥP	E 2	botto	om		

- new design of cooling plate, spacers and intermediate plate
- feed-through of ASIC cables into the warm part now unproblematic





ASIC cables still relatively stiff – problematic dense packing of backplane PCBs









Ok for Proto120. But not for slice design due to limited clearance to inner edge of magnet

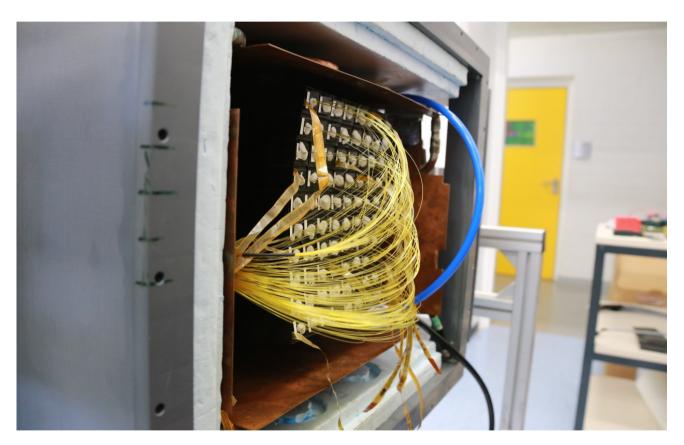


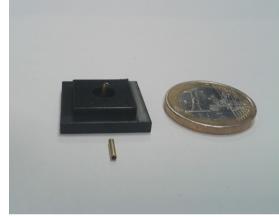
- integration of remaining electronics critical: several faulty connections due to dense cabling
- contact problems mainly in ribbon cables for signals but also in new cable scheme for ASIC slow control

conclusion: re- and new design of entire electronics from BPL PCB on (including HV distribution)



 all crystals equipped with monitoring light fibers fed into the crystal by a new (but not final) front stopper



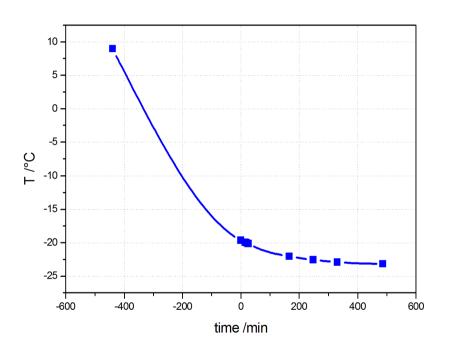


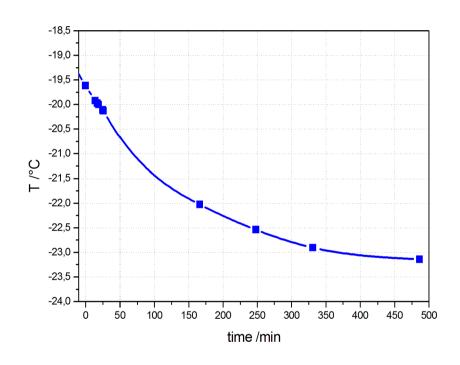
Data taking with pulser performed – Analysis not started yet



## **Observations**

 Cooling down to -25 °C took longer than in previous tests (~ 18h vs 12h)

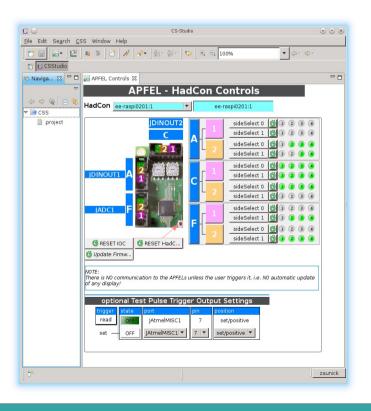


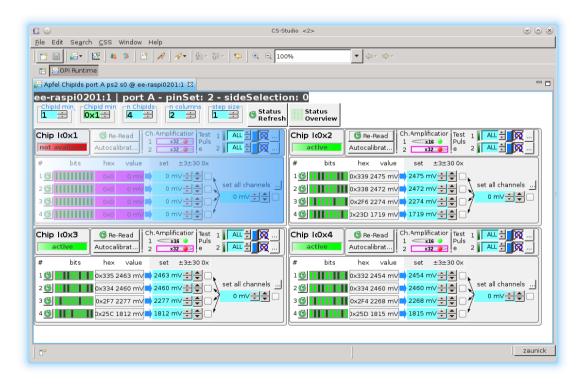


→ improve thermal Insulation (not under focus for this beam test)

### **Observations**

- Reliability of internal signal and slow-control connections very bad. Box had to be warmed up and reopened during beam test due to connection faults
- New slow control distribution hardware (SC Multiplexer boards) not working as intended. Workaround with hand-tinkered cables
- New slow control CSS macros (GSI) utilized. Usability ok.
   Stability to be improved + features to be added





## Observations

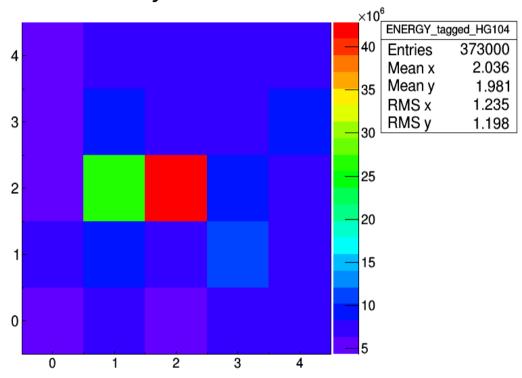
 Noise and pick-up appeared to be higher compared to previous beam tests. But due to limited preparation time no focus on optimal grounding/shielding

## **Data Analysis**

Started analysis of data set for depolished crystal matrix

Detector was aligned to incorporate beam into the central crystal

exclusively

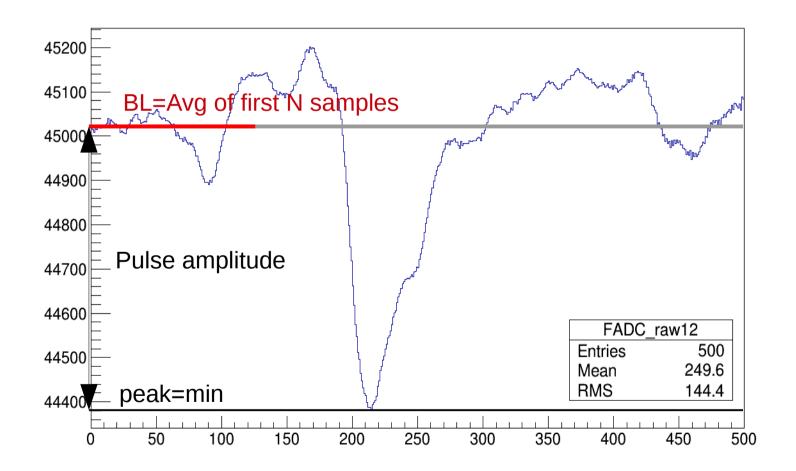


Mean deposited energy in 5x5 matrix during one run (a.u.)

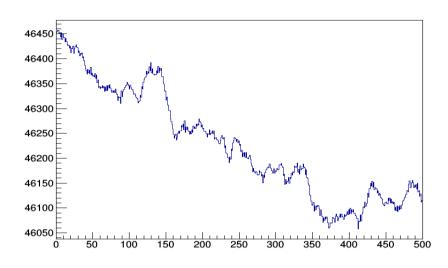
R A	S P B	E R R	у 1	l R A	SPR	FRR	Y 4
C20 · 4 S037	C20 · 2 W040	C10 · 4 S030	C10 · 2 W043	■ 410 · 4 SOO7	A10 · 2 \ \M054	A11:4 S008	A11:2 W001
366	368	353	A4, B4 379 1 5<1> 344,33	324	317	176	321
	"	60	1	2	3	4	5
5 < 0 > 364,86	5 <0> 362,90	5 < 1> 362,73	5 <1> 344,33 C10:1 W059	10 <1> 369,69	10 <1> 345,94	10 < 0 > 345,21	10 <0> 370,13
A9, B9	A10, B10	C10:3 S020 A11, B11 <b>271</b> 59	A12, B12	A13, B13	A10.1 W055 A14, B14	A11 . 3 S009 A15, B15	A11.1 W005 A16, B16
275	273	271	270	223	226	220	224
E < 0 24E 00	277 20	59	6 5 42 00	7	8 271.40	9 274.50	10
5 SU2 345,98	3 5 < U> 3/7,3U	5 < 12 367,4.	A12, B12 <b>270</b> 5 <1> 343,89 C11 : 2 W042	10 <1> 345,58	10 <12 3/1,48	10 < 0> 3/4,58	10 <0> 369,78
A17, B17	A18, B18	A19, B19	A20, B20	A21, B21	A22, B22	A23, B23	A24, B24
360	370	367	364	332	333	315	335
4 < 0 > 262 50	1 4 0 262 16	58	11 4 < 1 > 245 72	12	13	14	15
C21:3 S035	C21:1 W034	C11:3 S02:	A20, B20 364 11 4<1> 345,73 C11:1 W044	A20:3 S011	A20:1 W031	A21:3 S018	A21:1 W006
A25, B25	A26, B26	A27, B27	A28, B28 <b>255</b> 16 4<1> 345,48 F21:2 W041	A29, B29	A30, B30	A31, B31	A32, B32
292	287	2/4	255	5/1	246	569	243
4 < 0> 373,42	4 <0> 363,90	4<1> 369,74	4 <1> 345,48	9 <1> 345,52	9 <1> 345,41	9 < 0 > 344,72	9 < 0 > 344,99
F20:4 S034	F20:2 W030	F21:4 S022	F21:2 W041	F21:4 S010	F21:2 W058	F20:4 S017	F20:2 W002
A33, B33	A34, B34	A35, B35	A36, B36	A37, B37	A38, B38	A39, B39	A40, B40
381	352	375	390	331	316	216	177
3 < 0> 347.75	3 <0> 367.10	56 3 < 1 > 366 69	21 244 04	22	23	24	25
F20:3 S047	F20:1 W035	F21:3 S029	121.1 1104/	7 21 . 3 309,47	721.1 77032	1 20 . 0 0040	720.1 11000
F20:3 S047 A41, B41	F20:1 W035 A42, B42	F21:3 S029 A43, B43	A44, B44	A45, B45	A46, B46	A47, B47	A48, B48
F20:3 S047 A41, B41 <b>261</b>	F20 : 1 W035 A42, B42 289	F21:3 S029 A43, B43 259 LED	A44, B44 280	A45, B45 250	A46, B46 570	A47, B47 252	A48, B48 237
F20:3 S047 A41, B41 <b>261</b> 3 <0> 367,03	F20:1 W035 A42, B42 <b>289</b> 3 <0> 368,40	F21:3 S029 A43, B43 259 LEC 55 3 <1> 350,29	A44, B44 280 26 3 <1> 375,72	A45, B45 <b>250</b> 27 8 <1> 363,17	A46, B46 <b>570</b> 28 8 <1> 363,46	A47, B47 <b>252</b> 29 8 <0> 373,28	A48, B48 237 30 8 <0> 361,03
F20: 3 S047 A41, B41 <b>261</b> 3 <0> 367,03	F20:1 W035 A42, B42 <b>289</b> 3 3 <0> 368,40	F21:3 S029 A43, B43 259 LEC 55 3 <1> 350,29 F11:4 S028	F21 : 2 W041 A36, B36 390 21 3<1> 344,94  A44, B44 280 26 3<1> 375,72  F11 : 2 W045	A45, B45 <b>250</b> 27 8 <1> 363,17 F11:1 S0002	A46, B46 <b>570</b> 28 8 <1> 363,46 F11:3 W060	A47, B47 <b>252</b> 29 8 <0> 373,28 F10:1 S005*	A48, B48 237 30 8 <0> 361,03 F10:3 W062
F20:3 S047 A41, B41 <b>261</b> 3<0> 367,03 A49,849	F20:1 W035 A42, B42 <b>289</b> 3 3 <0> 368,40 W039	F21:3 S029 A43, B43 259 LEC 55 3 <1> 350,29 F11:4 S028 A51, B51	A44, B44 280 26 3<1> 375,72 F11:2 W045 A52, B52	A45, B45 <b>250</b> 27 8 <1> 363,17 F11 :1 \$0002 A53, B53	A46, B46 570 28 8 <1> 363,46 F11:3 W060 A54, B54	A47, B47 <b>252</b> 29 8 <0> 373,28 F10:1 S005* A55, B55	A48, B48 237 30 8 <0> 361,03 F10:3 W062 A56, B56
F20:3 S047 A41, B41 <b>261</b> 3<0> 367,03 371	F20:1 W035 A42, B42 <b>289</b> 3 3 <0> 368,40 A50,250 382	F21:3 S029 A43, B43 <b>259</b> LEC 55 3<1> 350,29 F11:4 S028 A51, B51 386 LEC	A44, B44 280 26 3<1> 375,72 F11:2 W045 A52, B52 363	A45, B45 250 27 8 <1> 363,17 F11:1 S0002 A53, B53 323	A46, B46 570 28 8 <1> 363,46 F11:3 W060 A54, B54 349	A47, B47 <b>252</b> 29  8 < 0 > 373,28  F10:1 S005* A55, B55  341	A48, B48 237 30 8 <0> 361,03 F10:3 W062 A56, B56 327
F20:3 S047 A41, B41 <b>261</b> 3 <0> 367,03 749,0549	F20:1 W035 A42, B42 <b>289</b> 3 3 <0> 368,40 369,050 382	F21:3 S029 A43, B43 259 LEC 55 3<1> 350,29 F11:4 S028 A51, B51 386 LEC 54 2<1> 367,71	A44, B44  280  26  3<1> 375,72  F11:2  W045  A52, B52  363  31  2<1> 355,20	A45, B45 250 27 8 <1> 363,17 F11:1 00002 A53, B53 323 323 7 <1> 360,20	A46, B46 570 28 8 <1> 363,46 F11: 3 W060 A54, B54 349 33 7 <1> 356,68	A47, B47 <b>252</b> 29  8 <0> 373,28  F10:1  S005*  A55, B55  341  34  7 <0> 357,80	A48, B48 237 30 8 < > 361,03 F10:3 W062 A56, B56 327 35 7 < > 354,14
749.642 7371	382	711:4 S028 A51, B51 386 LEC 54 2 <1> 367,71	A52, B52 363 31 2 <1> 355,20	F11:1 S0002 A53, B53 323 32 7 <1> 360,20	7 <1> 356,68	7 <0> 357,80	7 <0> 354,14
749.642 7371	382	711:4 S028 A51, B51 386 LEC 54 2 <1> 367,71	A52, B52 363 31 2 <1> 355,20	F11:1 S0002 A53, B53 323 32 7 <1> 360,20	7 <1> 356,68	7 <0> 357,80	7 <0> 354,14
749.642 7371	382	711:4 S028 A51, B51 386 LEC 54 2 <1> 367,71	A52, B52 363 31 2 <1> 355,20	F11:1 S0002 A53, B53 323 32 7 <1> 360,20	7 <1> 356,68	7 <0> 357,80	7 <0> 354,14
749.642 7371	382	711:4 S028 A51, B51 386 LEC 54 2 <1> 367,71	A52, B52 363 31 2 <1> 355,20	F11:1 S0002 A53, B53 323 32 7 <1> 360,20	7 <1> 356,68	7 <0> 357,80	7 <0> 354,14
789-849. 371. 371. 201. 291.	759.4550 382 759.4558 285 285	F11:4 S028 A51, B51  386 LEC 54 2 <1> 367,71 F11:3 S023 A59, B59 254 LEC 53 2 <1> 374,72	F11:2 W045 A52, B52 363 31 2<1> 355,20 F11:1 W046 A60, B60 278 36 2<1> 366,33	F11:1 S0002 A53, B53  323 32 7 <1> 360,20 F11:2 S004 A61, B61 234 37 7 <1> 361,77	F11:3 W060 A54, B54 349 33 7 <1> 356,68 F11:4 W052 A62, B62 238 7 <1> 361,21	F10:1 S005* A55, B55 341 34 7 < 0> 357,80 F10:2 S042 A63, B63 248 39 7 < 0> 373,22	F10:3 W062 A56, B56 327 35 7 < 0> 354,14 F10:4 W003 A64, B64 247 40 7 < 0> 366,37
789-849. 371. 371. 201. 291.	759.4550 382 759.4558 285 285	F11:4 S028 A51, B51  386 LEC 54 2 <1> 367,71 F11:3 S023 A59, B59 254 LEC 53 2 <1> 374,72	F11:2 W045 A52, B52 363 31 2<1> 355,20 F11:1 W046 A60, B60 278 36 2<1> 366,33	F11:1 S0002 A53, B53 323 323 7 <1> 360,20 F11:2 S004 A61, B61 234 37 7 <1> 361,77	F11:3 W060 A54, B54 349 33 7 <1> 356,68 F11:4 W052 A62, B62 238 7 <1> 361,21	F10:1 S005* A55, B55 341 34 7 < 0> 357,80 F10:2 S042 A63, B63 248 39 7 < 0> 373,22	F10:3 W062 A56, B56 327 35 7 < 0> 354,14 F10:4 W003 A64, B64 247 40 7 < 0> 366,37
739.6457 757.65	382 382 382 285 285 285 285 378	### ### ### #### #### ###############	F11:2 W045 A52, B52 363 31 2<1> 355,20 F11:1 W046 A60, B60 278 36 2<1> 366,33	F11:1 S0002 A53, B53 323 323 7 <1> 360,20 F11:2 S004 A61, B61 234 37 7 <1> 361,77	F11:3 W060 A54, B54 349 33 7 <1> 356,68 F11:4 W052 A62, B62 238 7 <1> 361,21	F10:1 S005* A55, B55 341 34 7 < 0> 357,80 F10:2 S042 A63, B63 248 39 7 < 0> 373,22	F10:3 W062 A56, B56 327 35 7 < 0> 354,14 F10:4 W003 A64, B64 247 40 7 < 0> 366,37
739.6457 757.65	382 382 382 285 285 285 285 378	### ### ### #### #### ###############	F11:2 W045 A52, B52 363 31 2<1> 355,20 F11:1 W046 A60, B60 278 36 2<1> 366,33	F11:1 S0002 A53, B53 323 323 7 <1> 360,20 F11:2 S004 A61, B61 234 37 7 <1> 361,77	F11:3 W060 A54, B54 349 33 7 <1> 356,68 F11:4 W052 A62, B62 238 7 <1> 361,21	F10:1 S005* A55, B55 341 34 7 < 0> 357,80 F10:2 S042 A63, B63 248 39 7 < 0> 373,22	F10:3 W062 A56, B56 327 35 7 < 0> 354,14 F10:4 W003 A64, B64 247 40 7 < 0> 366,37
739.6457 757.65	759-450 382 769-450 7882 769-450 7	### ### ### ### ### ### ### ### ### ##	F11:2 W045 A52, B52 363 31 2<⊅ 355,20 F11:1 W046 A60, B60 278 2<▷ 366,33 A20:2 W050 A68, B68 369 41 1<▷ 364,05	F11: 1 S0002 A53, B53 32 7 <1> 360,20 F11: 2 S004 A61, B61 234 37 <1> 361,77 C20: 1 S006 A69, B69 325 42 374,32	F11:3 W060 A54.B54 349 33 7 <1>> 356.68 F11:4 W052 42.882 42.B62 238 7 <1>> 351.21 C20:3 W053 A70, B70 343 43 6 <1>> 353.77	F10:1 S005° A55, B55 341 34 7 < □ 357,80 F10:2 S042 A63, B63 248 39 7 < □ 373,22 C21:1 S014 A71, B71 322 44 6 < □ 364,43	F10:3 W062 A56, B55 327 35 7 <□> 35 354,14 F10:4 W003 A64, B64 247 40 366,37 C21:3 W061 A72, B72 337 45 6 <□> 370,67
739.6457 757.65	759-450 382 769-450 7882 769-450 7	### ### ### ### ### ### ### ### ### ##	F11:2 W045 A52, B52 363 31 2<⊅ 355,20 F11:1 W046 A60, B60 278 2<▷ 366,33 A20:2 W050 A68, B68 369 41 1<▷ 364,05	F11: 1 S0002 A53, B53 32 7 <1> 360,20 F11: 2 S004 A61, B61 234 37 <1> 361,77 C20: 1 S006 A69, B69 325 42 374,32	F11:3 W060 A54.B54 349 33 7 <1>> 356.68 F11:4 W052 42.882 42.B62 238 7 <1>> 351.21 C20:3 W053 A70, B70 343 43 6 <1>> 353.77	F10:1 S005° A55, B55 341 34 7 < □ 357,80 F10:2 S042 A63, B63 248 39 7 < □ 373,22 C21:1 S014 A71, B71 322 44 6 < □ 364,43	F10:3 W062 A56, B55 327 35 7 <□> 35 354,14 F10:4 W003 A64, B64 247 40 366,37 C21:3 W061 A72, B72 337 45 6 <□> 370,67
2014 374 374 375 291 A21:4 S044 A55, B65 3755 1 < D 376,68 A21:3 S036 A21:3 S036 A73, B73 258	759-450 382 769-450 7882 769-450 7	### ### ### ### ### ### ### ### ### ##	F11:2 W045 A52, B52 363 31 2<⊅ 355,20 F11:1 W046 A60, B60 278 2<▷ 366,33 A20:2 W050 A68, B68 369 41 1<▷ 364,05	F11: 1 S0002 A53, B53 32 7 <1> 360,20 F11: 2 S004 A61, B61 234 37 <1> 361,77 C20: 1 S006 A69, B69 325 42 374,32	F11:3 W060 A54.B54 349 33 7 <1>> 356.68 F11:4 W052 42.882 42.B62 238 7 <1>> 351.21 C20:3 W053 A70, B70 343 43 6 <1>> 353.77	F10:1 S005° A55, B55 341 34 7 < □ 357,80 F10:2 S042 A63, B63 248 39 7 < □ 373,22 C21:1 S014 A71, B71 322 44 6 < □ 364,43	F10:3 W062 A56, B55 327 35 7 <□> 35 354,14 F10:4 W003 A64, B64 247 40 366,37 C21:3 W061 A72, B72 337 45 6 <□> 370,67
739.6457 757.65	759-450 382 769-450 7882 769-450 7	### ### ### ### ### ### ### ### ### ##	F11:2 W045 A52, B52 363 31 2<1> 355,20 F11:1 W046 A60, B60 278 36 2<1> 366,33	F11: 1 S0002 A53, B53 32 7 <1> 360,20 F11: 2 S004 A61, B61 234 37 <1> 361,77 C20: 1 S006 A69, B69 325 42 374,32	F11:3 W060 A54.B54 349 33 7 <1>> 356.68 F11:4 W052 42.882 42.B62 238 7 <1>> 351.21 C20:3 W053 A70, B70 343 43 6 <1>> 353.77	F10:1 S005° A55, B55 341 34 7 < □ 357,80 F10:2 S042 A63, B63 248 39 7 < □ 373,22 C21:1 S014 A71, B71 322 44 6 < □ 364,43	F10:3 W062 A56, B55 327 35 7 <□> 35 354,14 F10:4 W003 A64, B64 247 40 366,37 C21:3 W061 A72, B72 337 45 6 <□> 370,67

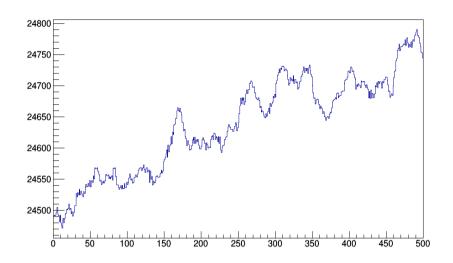
## **Data Analysis**

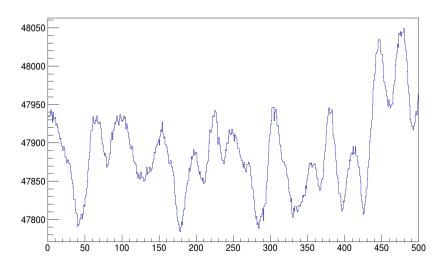
- Simple peaking algorithm with adaptive base line
- For each channel and event extract mean(BL) and RMS(BL)
- Define pulse amplitude = Max ( bl-min, max-bl)

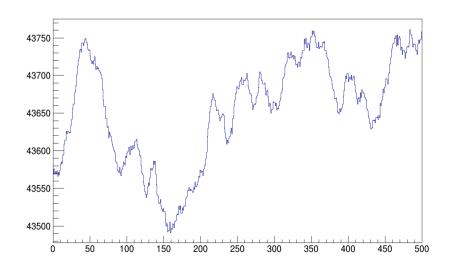


# Noise



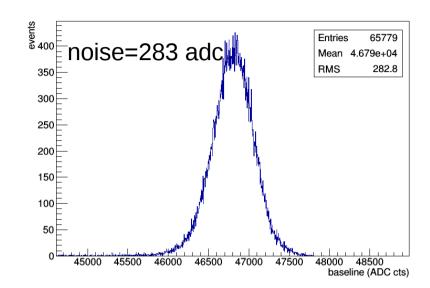




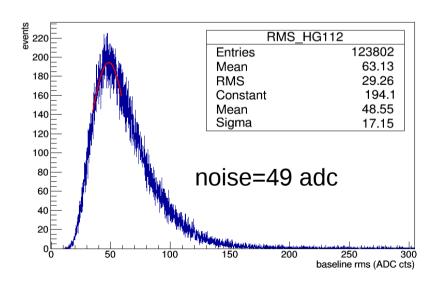


#### Two types of relevant noise definitions:

- Distribution of baseline mean values
  - Indicates the presence of low frequency fluctuations (EMI, pick-up etc.)
  - Less relevant for event-by-event reco due to adaptive BL

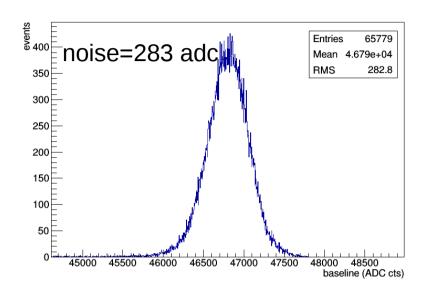


- Distribution of baseline rms values
  - characterizes the noise relevant at signal timing and sampling frequencies
  - Determines the lower bound of the signal noise



#### Two types of relevant noise definitions:

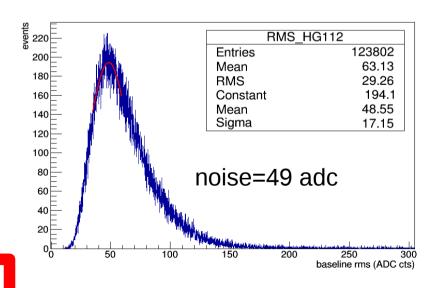
- Distribution of baseline mean values
  - Indicates the presence of low frequency fluctuations (EMI, pick-up etc.)
  - Less relevant for event-by-event reco due to adaptive BL



- Distribution of baseline rms values
  - characterizes the noise relevant at signal timing and sampling frequencies
  - Determines the lower bound of the signal noise

coarse energy calibration coefficient ~ 40 ch/MeV:

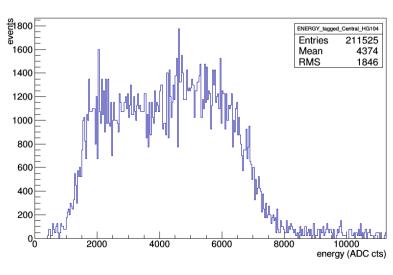
sigma(Noise) ~ 1.2 MeV and  $E_{thr}$  ~ 3.6 MeV



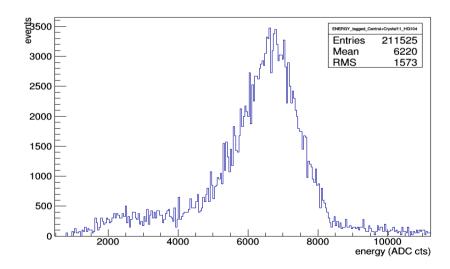
# **Energy Extraction**

- Detector misalignment: e-deposit never in only one crystal
- Clustering required even for simple analyses
- Start with Poor-man clustering (w/o cross calibration): 3 energy sum of central and neighbor

**Energy spectrum (photon energy 100 MeV)** 

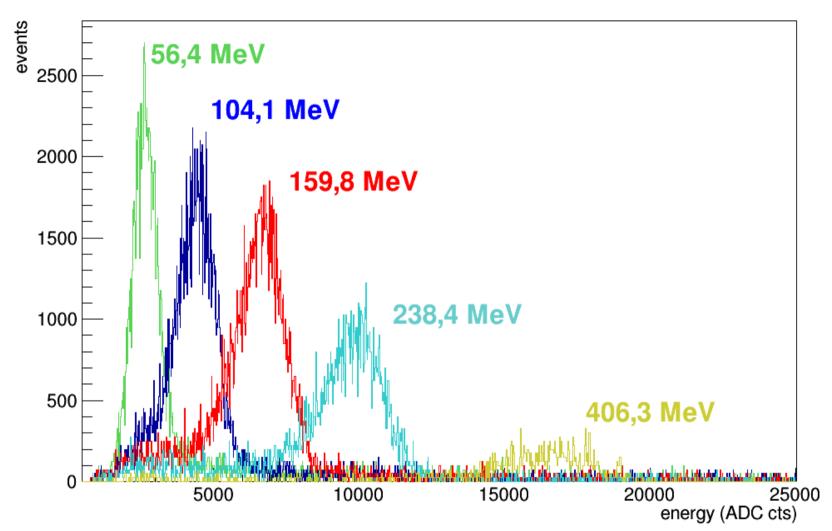


Central crystal only



Central crystal + left neighbor

# **Energy Extraction**



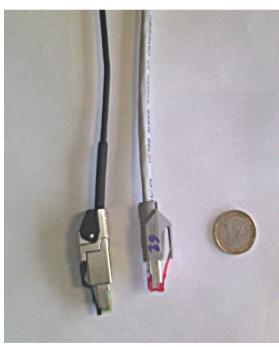
- Reasonable energy spectra for low energies
- Higher photon energies get spread over larger crystal number
  - → full clustering + cross calibration required

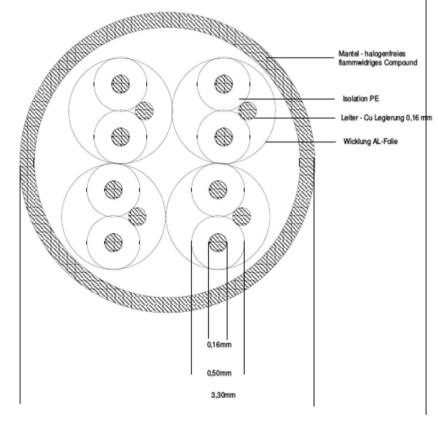
# Test of new signal cable

- Development of ultra-thin differential cables started with company BEDEA (Asslar/Germany)
- First prototype with stainless steel cores (0.1mm): attenuation too high

 Second prototype produced in May 2015 with copper cores (.16mm) and improved mechanical stability



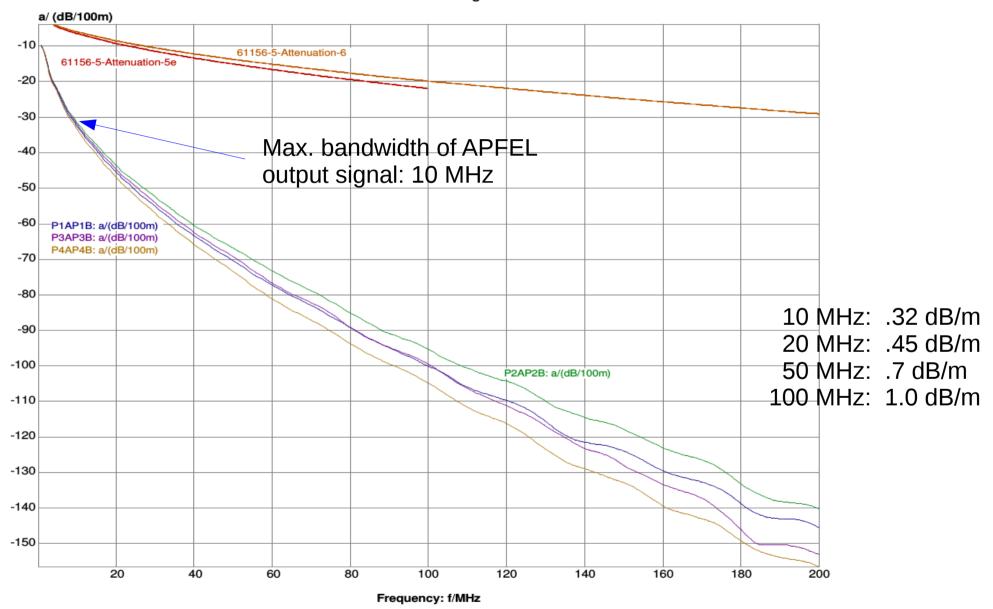




## New signal cable - Attenuation

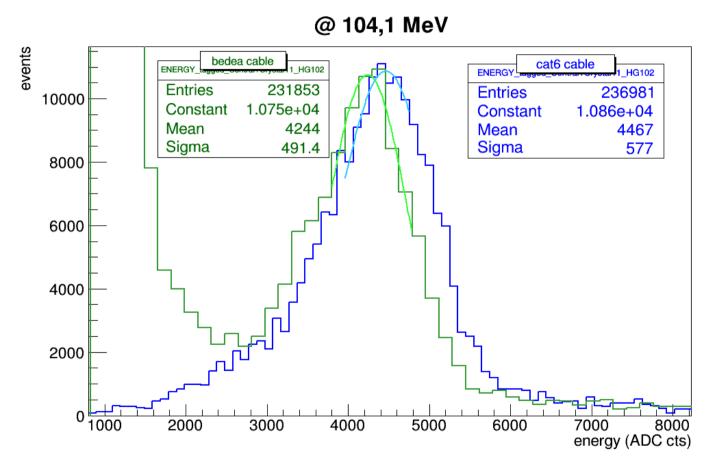
Balanced pair cables (IEC61156-1/-5): Attenuation I(St)2X(PiMF) 4x2x0,16 FRNC 4x2x0,16 FRNC 13026202

300.0 kHz - 200.0 MHz Test length: 19.50m



## Test of new signal cable

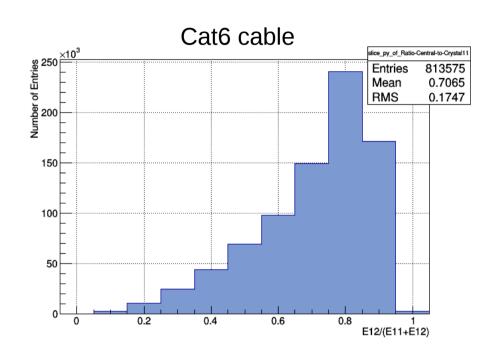
 Comparison of 2-crystal-sum between standard cable (cat6) and Bedea cable measured at the same channel under equal conditions

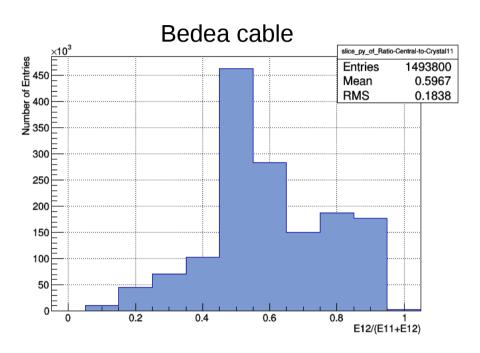


Due to summation no direct comparability between the cables

# Test of new signal cable

 Better observable: ratio of energy deposit between test channel and (2crystal) energy sum



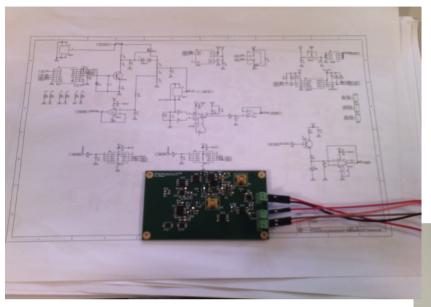


Derive amplitude ratio of test channel between both cables

$$E_{\text{bedea}}/E_{\text{cat6}} \sim 64\% = -2 \text{ dB}$$
 (i.e. 2 dB higher Attenuation than cat6 cable)

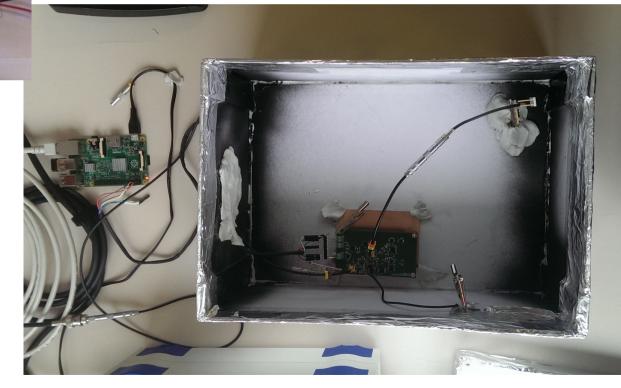
- Attenuation of 2 dB within specs
- Compensation by modification of line driver gain

## **HV** Distribution



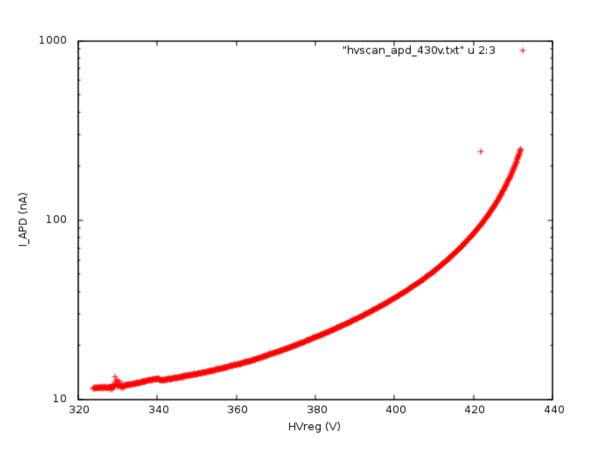
- Distribution of APD bias voltage from one HV cable to 4(8) APDs
- Close to detector → compact, rad hard
- High side shunt regulators for voltage control of individual outputs

- Proof-of-concept prototype with one regulated channel
- Test setup in shielded lighttight box with one reference APD
- Irradiation-characterization test cycles



### **HV** Distribution

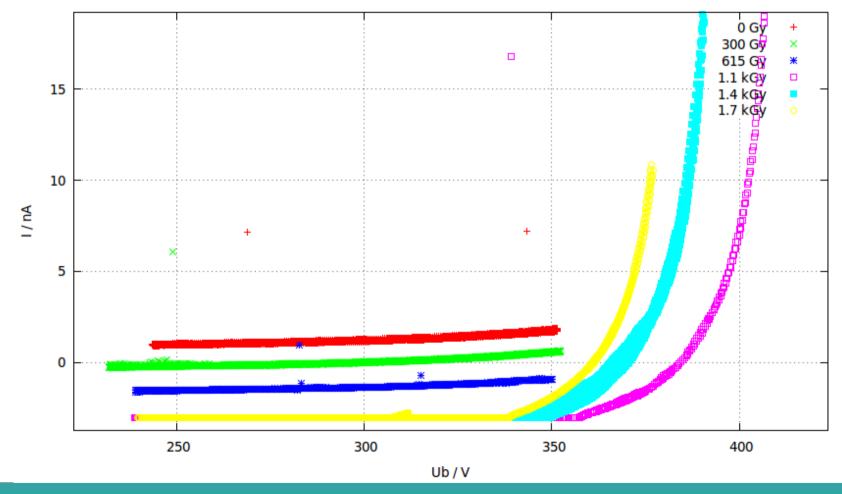
- Regulation of a single channel from HV(In) down to HV(In)-100V with 10bit resolution (0.1V/LSB) I2C Potentiometer
- Measurement of actual APD voltage (17mV LSB, 530V FS) and current (30pA LSB, ca. 1uA FS)
- Scan of HV by stepping through all potentiometer (wiper) settings



```
#ADC1 ch 0: 25129
#ADC2 ch 0: 9368
#Voltage(1) ch 0: 3.141221 V
#Voltage(2) ch 0: 1.171036 V
#HV: 431.68 V
#Current: 249.2 n A
#**********
#RMeas: 1732.56 MOhm
#LM75 temperature: 20.5 C
#X9119 WCR 0: 0
#Wiper HV (V) I (nA) R (MOhm)
  431 917 249.81 1729.013
  431.826 246.16 1754.255
   431.742 243.16 1775.572
   431.670 240.25 1796.737
   431.594 236.97 1821.282
   431.501 234.24 1842.103
   431.433 231.73 1861.829
   431.340 228.46 1888.039
   431.276 226.36 1905.284
   431.166 223.01 1933.399
   431.108 221.07 1950.115
   430.996 218.00 1977.083
     324.898
              11.63 27928.194
              11.66 27848.119
     324.695
              11.64 27904.390
              11.59 28003.459
              11.57 28038.121
     324.365
              11.59 27991.208
     324.262
              11.62 27911.845
              11.60 27935.542
     324.043
              11.57 28014.777
1023 323.939 11.52 28109.280
```

## **HV** Distribution

- Several irradiation-measurement cycles done up to 1.7 kGy with 60Co source
- I/V Characteristic shows shift of measured current towards lower values
- Shift in measured APD voltage towards lower values
- Current clipping at low ADC range limit



## Conclusions

- Beam test in Dec 2015 yielded minimal goal data for depolished 5x5 matrix w/ non-central beam spot
- Data analysis ongoing, currently only ½ FTE
- New design of backend electronics required: stability and space issues
- Concept of HV distribution verified: saving of 7/8 of HV cables

## Conclusions

- Beam test in Dec 2015 yielded minimal goal data for depolished 5x5 matrix
   w/ non-central beam spot
- Data analysis ongoing, currently only ½ FTE
- New design of backend electronics required: stability and space issues
- Concept of HV distribution verified: saving of 7/8 of HV cables

