# TDC calibration using a new pulser:

- Principle: Have a new pulser, which produces randomly stops exactly 5ns apart.
- Aim: To calibrate all TDC differentially by providing external starts for the PiLas laser diode.
- Implement the pulser hardware in the prototype setup in ESA.
- Debug the software on the data already taken.
- Modify already existing Jose's software developed for previous calibrations.
- Check the stability of the new calibration constants.

### Usual test beam electronics setup:

Trigger in the Test Bear	n a
ringger in the rest bear	11_4 JV-1. JV-2
CC pulses:	MCP in Slot 3, Pad 1 (CFD out),
JV-1: to - 1857 ns	MCP in Slot 3, Pad 23 (CFD out).
JV-2: to ns	TOPQtz Pad 1 (disc pulse)
	New high resolution TOF counter.
Out <sup>JV-2</sup> Out Bldg 420	Quantacon anode (disc. pulse).
In In ESA floor Philips 715 Not used because it wa	s found flatty
CFD CFD disc To Generate (in mo	ovable 1 ack): Gar y Var ner 's electronics
	Common START for LeCroy 3377 TDC (Crate #2)
LRS 621S NIM/ECL 160	ns Timing marker, Y-dir: Strip 1, TDC ch.1
	RT (Philips TDC), and CFD markers (in movable rack
160 ns To generate COMMON ST	act (Philips 11)C), and CFD markets (in movable fack
160ns+64ns ADC gate, 110ns	long & Computer trigger (Crate #2)
	ION START for Philips TDC (Crate #2)
NIM	
PiLas laser New high	ADC slot 3,
(ext. trigger) resolution IOF	TAC
(pos. slope) counter:	- Lecity Abc,
TOP Quartz 9327	2249W, 11bits, slot 12, crate 2, ch.
Fiber Burle MCP-PMT,	Philips 706
splitter Pad i = 1,2 (2.4kV)	B: 120 blog.     Philips TDC 7186, 25 ps/ent., slot 13, crate 2, ch. 1, 2       Image: the state in the stat
att. 10x	slot 12, crate 2, ch. 0, 1
Fiber #3 BOT Quartz	Philips TDC 7186, 25ps/cnt.
(10%) Burle MCP-PMT,	Philips 706 slot 13, crate 2, ch. 3, 4
Pad i = $3,4$ (2.4kV)	11 mV th.
	LeCioy ADC,
14 dB	2249W, 11bits,
Lectoy	att 2249W, 11bits, slot 12, crate 2
Large Scintillator	att. 2249W, 11bits, slot 12, crate 2 ch. 2, 3
Large Scintillator	att 2249W, 11 bits, stol 12, ctate 2 ch, 2, 3 Philips 7DC 7186, 25 ps/cnt. Stol 73, 62 ps/cnt.
Large Scintillator	att 224990, 11bits. slot 12, crate 2 ch. 2, 3 Philips 706 11 mV th.
Large Scintillator	ati 2249W, 11bits, 50112; cata 2 ch. 2, 3 Philips TDC 7186, 25ps;cnt. 11 mV th. B+20 bide, LeCtov ADC;
Large Scintillator 18x Burle MCP.PMT, Splitter To Russian Pad i = 1-4 (2.3kV) MCP	ati 2249W, 11bits, 50112; cata 2 ch. 2, 3 Philips TDC 7186, 25ps;cnt. 11 mV th. B+20 bide, LeCtov ADC;
Large Scintillator lar Burle MCP.PMT, To Russian Padi = 1-4 (2.3kV) MCP Var.	ati 2249W, 11bits, 50112; crate 2 ch. 2, 3 Philips 706 11 mV th. B420 bidg. LeCtoy ADC,
Large Scintillator	att 22.99%, 11bits, 22.99%, 11bits, ch, 2, 3 Philips 706 11 m <sup>3</sup> th. B-130 bldg. LeCtory ADC. 20 dB att db 20 bldg. LeCtory ADC. 20 dB att db 20 bldg. LeCtory ADC.
Large Scintillator Burle MCP.PMT, To Russian Padi = 1-4 (2.3kV) MCP Var. Quantiscon PMT, <sup>10</sup> Large trigger Scintillator,	ati 2249W, 11bits, 50112; cata 2 ch. 2, 3 Philips TDC 7186, 25ps;cnt. 11 mV th. B+20 bide, LeCtov ADC;
Large Scintillator	att 22.99%, 11bits, 22.99%, 11bits, ch, 2, 3 Philips 706 11 mV th. B-420 bldg, B-420 bldg, B-420 bldg,
Large Scintillator Burle MCP.PMT. To Russian Padi = 1-4 (2.3kV) MCP Var. att. Quanticon PMT, <sup>132</sup> Uanticon PMT, <sup>132</sup> Fiber 72 (10%) K. Double rejection counter (15%)	att 224 997, 11 bits; 224 997, 11 bits; bit 12, crate 2 ch, 2, 3 Plaips 706 11 mV th. B420 bidg. LeCtory ADC. 20 dB att B-120 bidg. LeCtory ADC. B-120 bidg. B-120 bidg. LeCtory ADC. B-120 b
Large Scintillator	an     22.95%, 11bits, ch, 2, 3       Philips 706     Philips TDC 7186, 35peicnt, sket 13, crate 2, ch, 16, 2, 18, 9, 11 11 m² th.       D dB att     B-420 bldg, D dB att       Philips TDC 7186, 25ps cnt, sket 13, crate 2, ch, 6, 7, 6, 9       D dB att     State 2, ch, 6, 7, 6, 9       Philips TDC 7186, 25ps cnt, sket 13, 2cnte 2, ch, 6
Large Scintillator Burle MCP-PMT, To Russian Padi = 1-4 (2.3kV) MCP Var. att Quanticon PMT, loss Fiber 42 (10%) About the rejection counter (L5KV) Anode Plaines Panado	ati 22.99%, 11bits, 22.99%, 11bits, ch, 2, 3 Philips 706 11 mV th. B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 7, 6, 9, 11 B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 6, 7, 6, 9 LeCtory ADC,
Large Scintillator Burle MCP.PMT. To Russian Padi = 1-4 (2.3kV) MCP Var. 102 Unanticon PMT, To Puscient Construction Var. 103 Unanticon PMT, 103 Unanticon PMT, 105 Output rejection counter (10%) Anode Plains 11 mVC	ati 22.99%, 11bits, 22.99%, 11bits, ch, 2, 3 Philips 706 11 mV th. B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 7, 6, 9, 11 B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 6, 7, 6, 9 LeCtory ADC,
Large Scintillator Burle MCP-PMT, To Russian Padi = 1.4 (2.3kV) MCP Var. att Quanticon PMT, by Lector Competinger Scintillator, & Double rejection counter (10%) Anote Dynade	ati 22.99%, 11bits, 22.99%, 11bits, ch, 2, 3 Philips 706 11 mV th. B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 7, 6, 9, 11 B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 6, 7, 6, 9 LeCtory ADC,
Large Scintillator Burle MCP.PMT. Padi = 1-4 (2.3kV) Var. 10% Var. 2000 PMT. 10% Var. 10% Var. 10% 10% 10% 10% 10% 10% 10% 10% 10% 10%	ati 22.99%, 11bits, 22.99%, 11bits, ch, 2, 3 Philips 706 11 mV th. B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 7, 6, 9, 11 B-420 bidg. LeCtory ADC, Philips TDC 7186, 25 ps cnt, abc 13, cnte 2, ch, 6, 7, 6, 9 LeCtory ADC,
Large Scintillator Burle MCP.PMT, To Russian Padi = 14 (2.3kV) MCP Var. ut. Quanticon PMT, log Fiber #2 (10%) To protetype Leed G lass Anode	afi 22.99%, 110is ati 22.99%, 110is ch, 2, 3 Philips 706 11 m* 0i. 10 B ati Philips TDC 7186, 25ps(at., 10 B ati Philips TDC 7186, 25ps(at., 10 B ati Philips TDC 7186, 25ps(at., 10 C 113, Cate 2 ch, 10 C 113,
Large Scintillator Burle MCP.PMT. To Russian Padi = 1-4 (2.3kV) MCP Var. To Russian Padi = 1-4 (2.3kV) Var. Uantiscon PMT, UZ Fiber #2 (10%) To protetype Leed Glass Anode	an 22.99% 110is ch 2,3 Philips TDC 7186, 25 point. 11 mV 0. E 420 bldg. D 42 m TDC 7186, 25 point. 12 mV 0. E 420 bldg. D 42 m TDC 7186, 25 point. about 13, crate 2 ch, 6, 7, 8, 9 B 420 bldg. Philips TDC 7186, 25 point. about 13, crate 2, ch, 6 b. LeCroy ADC; mV.

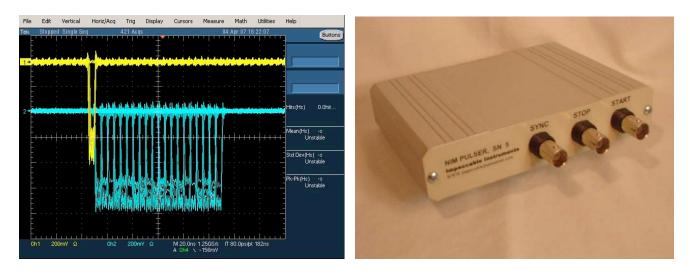
### J.V., 46.2007 Trigger for new TDC calibration . IV-2. MCP in Slot 3; Pad 1 (CFD out), MCP in Slot 3; Pad 23 (CFD out), TOPQtz, Pad 1 (disc. pulse), New high resolution TOF counter, Quantacon anode (disc. pulse), MCC pulses: JV-1: t<sub>0</sub> - 1857 ns JV-2: t<sub>0</sub> ns JV-1 Bldg 420 Ou Start Jeff's Stop ps pulser ESA floor AAAA Out 4 ŧ Philips 7 CFD ovable 1 ack): Gary Varner's ele eiate (in 1 disc Common START for LeCroy 3377 TDC (Crate #2) NIM/ECL LRS:6215 160ns Timing marker, Y-dir: Strip 1, TDC ch.1 160 ns To generate COMMON START (Philips TDC), and CFD markers (in movable tack) ADC gate, 110ns long & Computer trigger (Crate #2) 160ns+64ns MMON START for Philips TDC (Crate #2) 160 ns NIM New high resolution TOF counter: ADC 14 bits ► TAC PiLas laser F (ext. trigger) AMP CFD 9327 TOP Quartz Burle MCP-PMT, Pad i = 1,2 (2.4kV) Philips 706 11 mV th. B-4 20 bldg. Fiber splitter Philips TDC 7186, slot 13, crate 2, ch. rHH 14 dB att. l'o Quartz det. LeCioy LeCroy ADC, 2249W, 11bit slot 12, crate 2, cl. 0, 1 BOT Quartz Burle MCP-PMT, Pad i = 3.4 (2.4kV) Philips TDC 7186, 25ps/cnt. slot 13, cnate 2, ch. 3, 4 Philips 706 11 mV th. 14 dB att. 11 LeCio Large Scintillator Burle MCP-PMT, Pad i = 1-4 (2.3kV) Phi 2, 3. dot 13, crate 2, clr. 7, 8, 9, 10 Philips 706 11 mV th. Splitter To Ru MCP LeCioy ADC, slot 12, ciate 2 ch. 6, 7, 8, 9 B-420 bldg 0-20 dB att LeC 10 x B-420 bldg. TDC 7186, \*\* 2, ch. Quantacon PMT, Large trigger Scintillator & Double rejection count (L5kV) (10%) Philips TDC slot 13, crate 25ps/cnt. Philips 706 11 mV th. LeCroy ADC, slot 12, crate 2, ch. Dynode INV. Lead Glass Anode (1.5kV) To prototype LeCtoy ADC, slot 12, crate 2 ch 5 Fiber #1 (80%) -iF Π

## **Setup during a TDC calibration:**

INL [ps]

### Analyze again the calibration of the TAC/ADC system using a new Jeff's pulser (Run 198):

- Jeff's pulser provides START & STOP pulses to Ortec TAC 566.
- Pulser running at 1kHz.
- A new pulser (makes 20 pulses every 5ns, covering as range of 100ns:

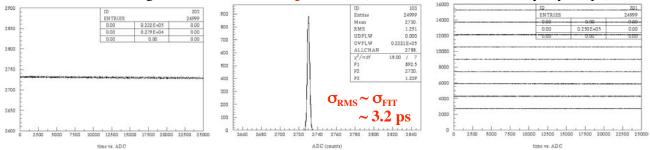


- A departure from an ideal time (calibration done by Jeff using his Ortec 9308 TAC system):

						3.0			-	
Ideal Delay [ns]	Acualt Delay [ns]	Relative Delay [ps]	Delta Delay [ps]	INL [ps]	DNL [ps]					
5	76.0698	-94998.782		0.2850		2.0				
10	81.0668	-90001.734	4997.048	-2.7150	2.952	1.0		1		
15	86.0675	-85001.074	5000.660	-2.0150	-0.660		t	1		
20	91.0702	-79998.320	5002.754	0.6850	-2.754	Error [ps]			A.	
25	96.0718	-74996.743	5001.576	2.2850	-1.576		20	40	60	en '
30	101.0714	-69997.190	4999.553	1.8850	0.447	-1.0		-		~
35	106.0710	-64997.578	4999.612	1.4850	0.388	-2.0	11			
40	111.0708	-59997.762	4999.816	1.2850	0.184		V			
45	116.0704	-54998.196	4999.565	0.8850	0.435	-3.0	-			
50	121.0700	-49998.595	4999.601	0.4850	0.399			Nominal Dela	iy [ns]	
55	126.0695	-44999.005	4999.590	-0.0150	0.410	and the second		DNL [ps]		
60	131.0698	-39998.783	5000.222	0.2850	-0.222	4.0				
65	136.0694	-34999.161	4999.622	-0.1150	0.378	3.0				
70	141.0693	-29999.264	4999.896	-0.2150	0.104		1			
75	146.0691	-24999.494	4999.770	-0.4150	0.230	2.0				
80	151.0690	-19999.569	4999.925	-0.5150	0.075	E 1.0			-	-
85	156.0687	-14999.894	4999.675	-0.8150	0.325	0.0 Eme	1	~~~	1m	~^
90	161.0689	-9999.650	5000.244	-0.6150	-0.244	0	20	40	ě	80 ¥
95	166.0684	-5000.147	4999.503	-1.1150	0.497	-1.0				
100	171.0685	0.000	5000.147	-1.0150	-0.147	-2.0	V	of as (1995), while		
	71.0695	Avg offset [ns]				-3.0	¥	Nominal Dela	ay [ns]	-

- The pulser delay is known to a few ps.

- Run 198 results using a calibration of 2.604ps/counts (from a cable calibration by my scope):



Additional new results from analysis of data from run 198; the new analysis done on 4.4.2007:
Time interval between pulses: 5 ns; TAC 566 full scale range: 50ns => expect 9 peaks in TDC spectrum.

