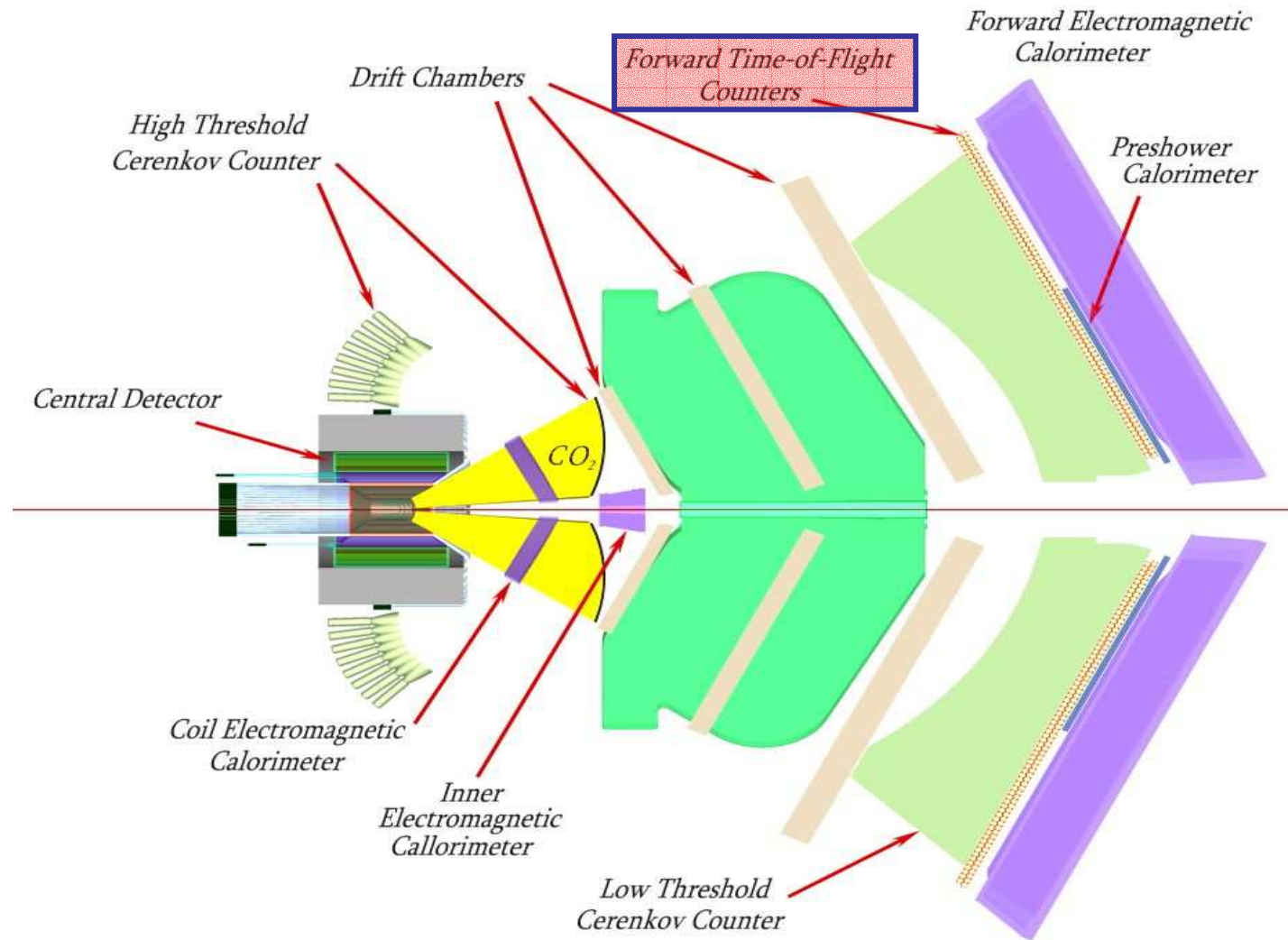


Forward Time-of-Flight Upgrade



PED Efforts in FY06

- | | |
|--|--------|
| ➤ Student Training | 8/2005 |
| ➤ PMT and Scintillator Acquisition | 8/2005 |
| ➤ Assembly Hall Acquisition | 9/2005 |
| ➤ Data Acquisition System | 6/2006 |
| ➤ Detector Lab Infrastructure | 7/2006 |
| ➤ Verification of Electronics Specifications | 8/2006 |
| ➤ Calibration of Different TDCs | 7/2006 |
| ➤ Verification of Current ToF Specifications | 8/2006 |
| ➤ First Prototype Tests for ToF12 | 9/2006 |

accomplished by



PED Efforts in FY07

- | | |
|--|--------|
| ➤ Prototype Tests for Different Geometries | 8/2007 |
| ➤ Prototype Tests with Different PMTs | 8/2007 |
| ➤ Overall Optimized Time Resolution | 8/2007 |
| ➤ Prototype Detector Beam Tests @ JLab | 9/2007 |
| ➤ Planning of Final Detector Design | 9/2007 |
| ➤ Design of Detector Assembly Tools | 9/2007 |

accomplished by

PED Efforts in FY08

- Detector Calibration System Design 9/2008
- Complete Detector Design 9/2008
- Detector Component Acquisition 9/2008
- Complete Infrastructure for Assembly 9/2008

accomplished by

Key Milestones for PED

- | | |
|--|--------|
| ➤ Student Training | 8/2005 |
| ➤ PMT and Scintillator Acquisition | 9/2005 |
| ➤ Assembly Hall Acquisition | 8/2005 |
| ➤ Complete Infrastructure for Assembly | 8/2006 |
| ➤ Optimizing Detectors and Electronics | 8/2007 |
| ➤ Prototype Detector Beam Tests | 9/2007 |
| ➤ Complete Detector Design | 9/2008 |

accomplished by

Key Milestones for Construction

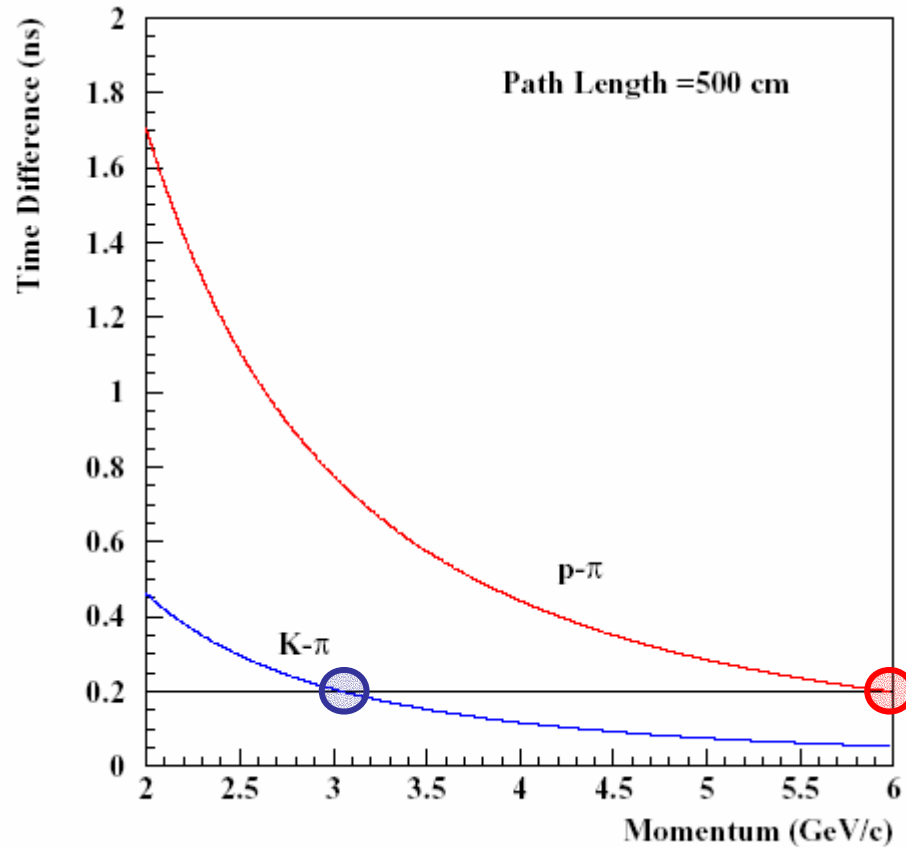
- Ordering all detector components
- Testing all detector components
- Staged assembly of ToF counters
- Testing Electronics
- ToF counter frame
- Mounting and cabling
- Readout and final testing

9/2008	1/2009
9/2008	9/2010
9/2008	1/2011
5/2009	9/2010
1/2010	1/2011
1/2011	7/2011
2/2011	9/2011

Start

Finish

Requirements



To achieve

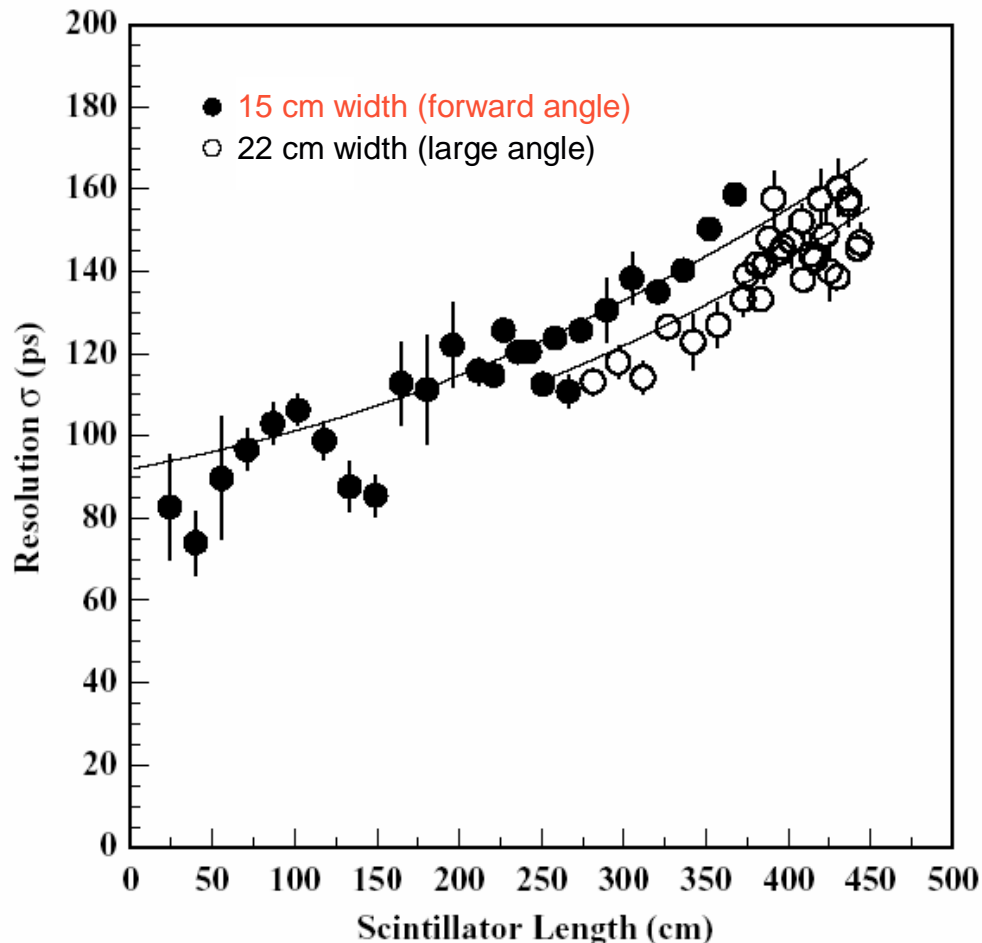
Proton-Pion separation up to 6 GeV/c

and

Kaon-Pion separation up to 3 GeV/c

an improved timing resolution of $\sigma \sim 50$ ps is needed

The Present Time-of-Flight System



$$\sigma_{\text{TOF}}(\text{ns}) = \sqrt{\sigma_0^2 + \frac{\sigma_1^2 + (\sigma_p L/2)^2}{N_{\text{pe}} \exp(-L/2\lambda)}}$$

σ_0 : Electronics

Has to be optimized!

σ_1 : Scintillator and PMT

Has to be optimized!

σ_p : Path-Length Variation

Has to be optimized!

N_{pe} : # of photoelectrons

Has to be tripled!

ToF Cost Evaluation

	Estimate in 1994	Actual Cost	Unit	Channel Count	Cost/Unit old ToF	Cost/Unit in 2005	Channel	Unit	Estimate in 2005
PMT	235	329,0	EA	684	0,481	1,050	828	EA	869,4
Scintillator	98	137,2	m2	30	4,573	4,573	30	m2	137,2
Light Guides	99	138,6	EA	684	0,203	0,050	828	EA	41,4
Voltage Divider	107	149,8	EA	684	0,219	0,219	828	EA	181,3
Mechanical	54	75,6	m2	30	2,520	2,520	30	m2	75,6
Electronics	193	270,2	EA	576	0,469	0,624	828	EA	516,6
Laser	23	32,2	EA	1	32,200	32,200	0	EA	0,0
Total	809	1132,6							1821,5

Electronics	Reduced	All
Discriminator	0	46,0
TDC	0	80,0
ADC	0	86,0
Scaler	0	27,0
Pretrigger Board	0	49,0
Cable	98	98,0
Crate	0	35,0
HV	95	95,0
Total	193	516,0

all cost estimates in K\$



ToF Cost Estimate and Timeline

	Cost/Unit in 2005	Channel	Unit	Estimate in 2005	FY08			
					1	2	3	4
PMT	1,050	828	EA	869,4	289,8	289,8	289,8	0,0
Scintillator	4,573	30	m2	137,2	45,7	45,7	45,7	0,0
Light Guides	0,050	828	EA	41,4	13,8	13,8	13,8	0,0
Voltage Divider	0,219	828	EA	181,3	60,4	60,4	60,4	0,0
Mechanical	2,520	30	m2	75,6	0,0	0,0	37,8	37,8
Electronics	0,624	828	EA	516,6	0,0	258,3	258,3	0,0
Laser	32,200	0	EA	0,0	0,0	0,0	0,0	0,0
Total				1821,5	409,8	668,1	705,9	37,8

Electronics	Reduced	All
Discriminator	0	46,0
TDC	0	80,0
ADC	0	86,0
Scaler	0	27,0
Pretrigger Board	0	49,0
Cable	98	98,0
Crate	0	35,0
HV	95	95,0
Total	193	516,0

all cost estimates in K\$



Manpower Estimate and Timeline

	-2	-1	0	FY08 1	2	3	4	Total	Construction Subtotal	PED Subtotal
University Labor (man-weeks)										
Professor	20	30	30	30	30	30	30	200	120	80
Graduate Student	15	20	20	20	20	20	20	135	80	55
Undergraduate Student	40	50	50	50	50	50	50	340	200	140
Staff (Grant)	5	15	15	20	20	20	20	115	80	35
Staff (Other)	2	15	2	2	1	1	1	24	5	19
Contributed University Total	82	130	117	122	121	121	121	814	485	329
Visiting Labor (man-weeks)										
Visiting User	0	0	0	0	0	0	0	0	0	0
Staff (Project)	0	0	0	0	0	0	0	0	0	0
Undergraduate Student	0	0	0	0	0	0	0	0	0	0
Visiting Total	0	0	0	0	0	0	0	0	0	0
Jlab Labor (man-weeks)										
Scientist	0	2	2	2	2	6	10	24	20	4
Mechanical Technician	0	0	0	0	10	10	10	30	30	0
Mechanical Engineer	0	4	4	2	1	1	1	12	5	8
Mechanical Designer	0	8	10	8	2	0	0	28	10	18
Electrical Engineer	0	22	23	0	0	0	0	45	0	45
Electrical Designer	0	10	10	0	0	0	0	20	0	20
Jlab Total	0	46	49	12	15	17	21	159	65	95



PED Tasks

PED Tasks	Electric	Scientist	Mechanic	University
Attach to Carriage		X	X	X
Backing Structure for Scint.		X	X	X
Cable Routing		X		
Pretrigger Design	X	X		
Cross Talk Tests				X
Voltage Divider Optimization	X	X		X
Light Guide Optimization				X
Prototype Detector Optimization				X
Magnetic Shielding Design		X	X	X
PMT Housing and Grounding		X	X	X

Assigned Manpower 2007

- Faculty
 - R.W. Gothe
 - S. Strauch (ROP)
- Post Doc
 - K. Park
- Graduate Students
 - E. Phelps
 - L. Graham (MS)
 - H. Lu
- Undergraduate Students
 - D.R. Gothe

Acquisitions by 2007

- Electronics: NIM (LED, CFD), CAMAC (TDCs), Readout
- Oscilloscopes: DPO 7254 (fast), 1 analog and 2 digital (slow)
- PMTs: 2*9214 (ET), 2*R9779 (Hamamatsu),
2*XP2020, 2*XP2020UR, 2*XP20Y0, 2*XP20D0 (Photonis)
- Voltage Dividers: 2*C638A (ET), 2*R9779 (Hamamatsu),
2*VD124KT, 2*VD127KT, 2*XP20Y0, 2*XP20D0 (Photonis)
- Scintillators: EJ 204 (50, 100, 250 cm), EJ 200 (50, 100, 250, 400 cm)
(ELJEN), BC 404 (20, 50 cm), BC 408 (50, 150, 400 cm) (Saint-Gobain)
- Light Guides: 2*BC 802 (UV blind), 2*BC 800 (Saint-Gobain)
- Wrapping: Tedlar Film, Aluminized Mylar Film, Tape
- Others: 2*CLAS ToF Counters, Detector Lab, Assembly Hall, Infrastructure