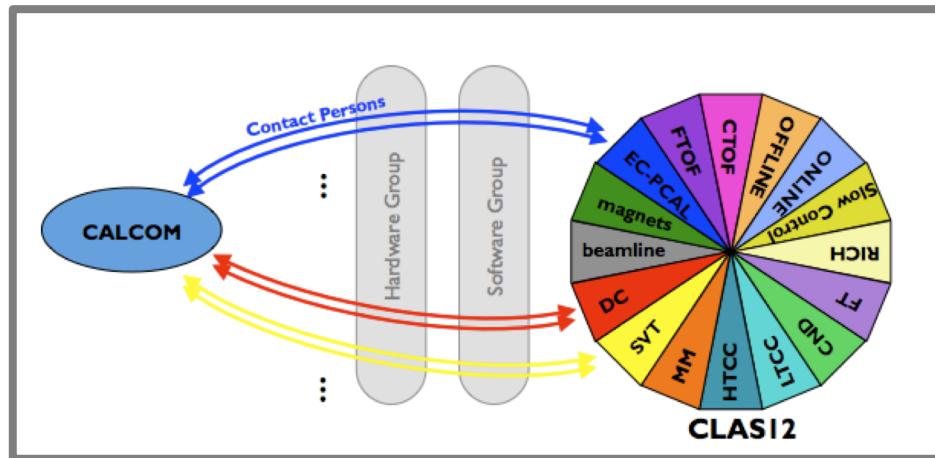


CALCOM ACTIVITIES

Daniel S. Carman - CLAS Collaboration Meeting - November 10, 2020



CALCOM Roles and Responsibilities

1. Coordinate ongoing calibration activities for all detector subsystems:
 - Work with CCC to set priorities
 - Work with Analysis Coordinators to organize efforts and to help ensure things proceed according to outlined schedule
 - Work with subsystem calibrators to ensure issues are resolved
2. Develop and optimize calibration procedures:
 - Work with subsystem groups to optimize calibration procedures and calibration suites
 - Investigate issues in detector response that affect performance
 - Develop documentation and tutorials for calibration suites
 - Help to define standards for subsystem calibration metrics (e.g. energy, time, position resolution)
3. Help to develop plans for calibration tools and commissioning plans of new experimental setups

CLAS12 Calibration and Commissioning

Contents [hide]

- 1 CALCOM Committee
- 2 CLAS12 Subsystem Contact Persons
- 3 Commissioning Plans
- 4 CLAS12 Calibration
- 5 Meetings and Minutes

CALCOM Committee

The role of the CALCOM (Calibration and Commissioning) Group is to be responsible for the development of the tools/algorithms to calibrate the CLAS12 detector and to help ensure that the design performance specifications are met. In addition the CALCOM group is responsible for developing the CLAS12 commissioning plan and overseeing its execution.

The committee is composed by:

- Daniel Carman [\(chair / hardware\)](#)
- Raffaella De Vita [\(software / hardware\)](#)
- Gagik Gavalian [\(common tools\)](#)
- Maurizio Ungaro [\(simulation\)](#)
- Veronique Ziegler [\(reconstruction\)](#)



CLAS12 Subsystem Contact Persons

System	Subsystem	Contact Person(s)	Software Contact Person
Calorimeters	ECAL	C. Smith	C. Smith
	SVT	Y. Gotra	V. Ziegler
	MM	M. Defurne	F. Bossu, M. Defurne
Central Tracker	RTPC	M. Hattaway	D. Payette
	HTCC	Y. Sharabian	N. Markov, W. Phelps
	LTCC	M. Ungaro	M. Ungaro
Cerenkov Counters	RICH	M. Contalbrigo	M. Mirazita
	FT-Cal	R. De Vita	R. De Vita
	FT-Hodo	N. Zachariou	R. De Vita
Forward Tagger	FT-Trk	R. De Vita	V. Ziegler
	DC	M.D. Mestayer	V. Ziegler
	FMT	M. Defurne	V. Ziegler
RF		R. De Vita	R. De Vita
Scintillation Counters	FTOF	D.S. Carman	D.S. Carman
	CTOF	D.S. Carman	D.S. Carman
	CND	S. Niccolai	P. Chatagnon
	BAND	F. Hauenstein	F. Hauenstein

Commissioning Plans

- KPP Commissioning Plan
 - CLAS12 KPP Demonstration Slides
- Engineering Run Commissioning Plan
 - Analysis of electron and hadron rates for CLAS12 calibration and commissioning
- Calibration Challenges: Dec. 2016 [Aug. 2017](#)

CLAS12 Calibration

Calibration Priorities 2020/2021

- Calibration order and priorities RG-A/B/F [1] [\[2\]](#)

Information for Analysis Coordinators:

- How to calibrate? [2] [\[3\]](#)
- What are the calibration standards for CLAS12? [3] [\[4\]](#)
- Calibration and Software Development and Calibration Teams: [4] [\[5\]](#)
- Run-Based Monitoring
- CCDB Tables and Usage Policies
- CLAS12 Hardware Status Word Definitions



Calibration Suite Documentation:

- BAND:
- Cherenkov:
 - HTCC:
 - LTCC: suite [\[1\]](#)
 - RICH: suite [\[2\]](#), manual [\[3\]](#)
- CND: suite [\[1\]](#), tutorial [\[2\]](#), algorithms [\[3\]](#)
- CTOF: suite [\[1\]](#), tutorial [\[2\]](#), algorithms [\[3\]](#), ccdb [\[4\]](#), geometry [\[5\]](#)
- CVT:
 - MM:
 - SVT: suite [\[1\]](#)
- DC: suite [\[1\]](#), tutorial [\[2\]](#), calibration wikipedia [\[3\]](#)
- ECAL: suite [\[1\]](#)
- FT:
 - FT-CAL: suite, tutorial [\[1\]](#)
 - FT-HODO: suite, tutorial [\[1\]](#)
- FTOF: suite [\[1\]](#), tutorial [\[2\]](#), algorithms [\[3\]](#), ccdb [\[4\]](#), geometry [\[5\]](#)
- RF: suite, tutorial [\[1\]](#)
- RTPC: geom [\[1\]](#), ccdb [\[2\]](#)
- DC and FMT alignment: [5] [\[6\]](#)

Meetings and Minutes

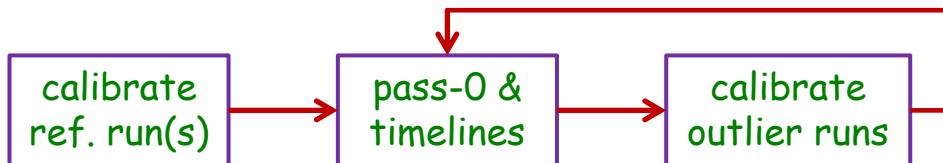
- Bluejeans meeting connection: [6] [\[7\]](#)
- 2011 Meetings
- 2012 Meetings
- 2013 Meetings
- 2014 Meetings
- 2015 Meetings
- 2016 Meetings
- 2017 Meetings
- 2018 Meetings
- 2019 Meetings
- 2020 Meetings



"Pass-1" Calibration Priorities

Priority	Run Period	Run Range	Time Period
	RG-A F18	4763 - 5031	Jul. → Sep. 2020
	RG-F W/Sum20	11674, 12478	Mar. → Sep. 2020
	RG-B F19	11023 - 11301	Aug. → Oct. 2020
	RG-A Spr19	6608 - 6783	Aug. → Oct. 2020
1	RG-B W20	11324 - 11571	Oct. → Nov. 2020
2a	RG-F W20	11582 - 12282	Nov. → Dec. 2020
2b	RG-F Sum20	12389 - 12955	Nov. → Dec. 2020
3a	RG-A Spr18 II	3862 - 4326	Nov. 2020 → Jan. 2021
3b	RG-A Spr18 I	3029 - 3861	Dec. 2020 → Mar. 2021
4	Eng. Run	1960-2999	Feb. → Apr. 2021
Pass-2			

CLAS12 Calibration Sequence



1) DC and Beam-Offset Calibrations:

- ❑ time → distance calibration for reference runs
 - relies only on crude ST calibration from FTOF
- ❑ complete beam (x,y) offset calibration

2) FTOF Calibration:

- ❑ energy and timing calibration for reference runs
 - calibrate offset between CTOF FADC and TDC time

3) RF Calibration:

- ❑ run-by-run calibration after FTOF calibrations - pass-0 files

4) CLAS12 Subsystem Calibration:

- ❑ CND, CTOF, DC, ECAL, FT (Hodo, Cal), HTCC, LTCC, RICH
 - complete for reference runs
 - calibration uses event ST from FTOF and EB PID
- ❑ Check EB constants and ECAL e/γ sampling fraction

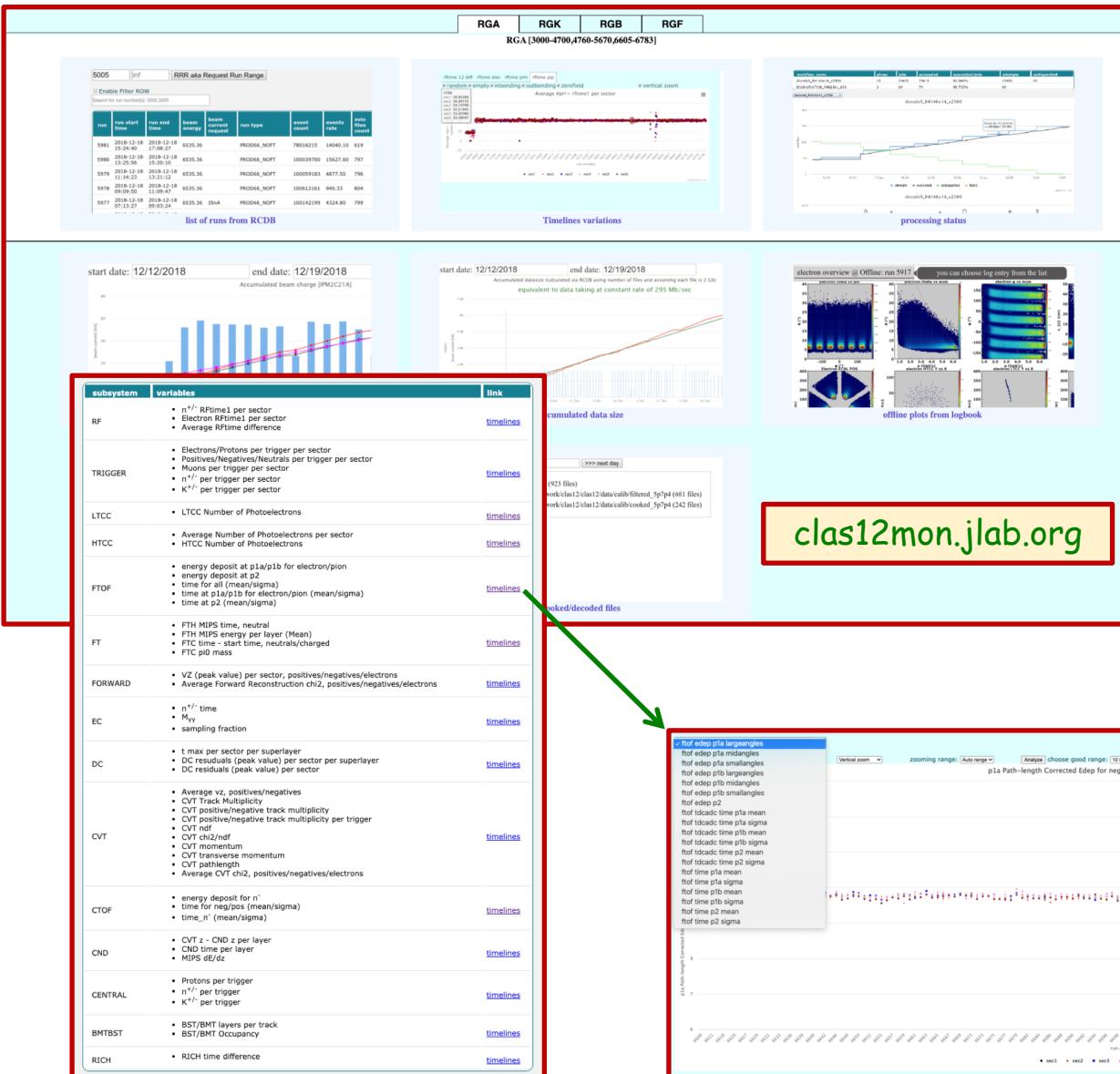


CLAS12 Global Performance Specs

System	Spec	Achieved	Spec	Achieved
BAND	$\langle \text{eff}_n \rangle = 35\%$	TBD	$\langle \delta t \rangle = 300 \text{ ps}$	< 300 ps
CND	$\langle \text{eff}_n \rangle = 10\%$	~10%	$\langle \delta t \rangle = 150 \text{ ps}$	170 ps
CTOF	$\langle \delta t \rangle = 80 \text{ ps}$	85-95 ps		
DC	$\langle \delta x \rangle = 250 - 400 \mu\text{m}$	225 - 500 μm		
ECAL	$\sigma_E/E = 10\%/\sqrt{E}$	10%/ \sqrt{E}	$\langle \delta t_\gamma \rangle < 500 \text{ ps}$	~500 ps
FT	$\sigma_E/E < 2\%/\sqrt{E} + 1\%$	3% @ 4 GeV	$\langle \delta t \rangle < 300 \text{ ps}$	~160 ps
FTOF	$\langle \delta t_{p1b} \rangle = 60-110 \text{ ps}$	70 - 120 ps (p1b)	$\langle \delta t_{p1a} \rangle = 100-200 \text{ ps}$	90 - 250 ps (p1a)
HTCC	$\langle \text{nphe} \rangle = 16$	11-12	$\langle \text{eff}_e \rangle > 99\%$	> 99%
LTCC	$\langle \text{nphe} \rangle = 15$	10-13	$\langle \text{eff}_\pi \rangle > 90\%$	> 90%
RICH	$\langle \delta t \rangle < 1 \text{ ns}$	0.5 ns	$\pi/K \text{ rej} > 500$	TBD
SVT	$S/N > 10$	~14	$\langle \delta x \rangle = 50 - 65 \mu\text{m}$	TBD

*Entries highlighted in red have not yet met specs

Calibration Timelines



rga
pass0/v2.2.29
pass0/v2.2.28a
pass0/v2.2.28
pass0/v2.2.27
pass0/v2.2.26
pass0/v2.2.25
pass0/v2.2.23
pass0/v2.2.22
pass0/v2.2.21
pass0/v2.2.20
pass1/ga
pass0/v2.2.16
pass0/v2.2.15
pass0/eng_v1.1
pass0/v2.2.5b
pass0/v2.2.11
pass0/v2.2.10
pass0/v2.2.9
pass0/v2.2.8
pass0/v2.2.8ak
pass0/v2.2.5a
pass0/v2.2.5
pass0/v2.2.5
pass0/v2.2.3
pass0/v2.2.2a
pass0/v2.2.2
pass0/v2.2.1
pass0/v58
pass0/v52
pass0/v30
pass0/v26
pass0/v15
2019/pass0/v0
pass0/v11
pass0/v0
pass0/v5
pass0/v7
pass0/v14

```
rgb
passo/v24.14
passo/v24.14_v24.21
passo/v25.1
passo/v24.10
passo/v24.8
passo/v24.6
passo/uw/assim_corrected/age
passo/v24.1
passo/v21.8.1
passo/v21.7.3_v21.7.5
passo/v21.7.5
passo/v21.7.3_final
passo/v21.7.3_all
passo/v21.7.3
passo/v21.7.3_old
passo/v22.3
passo/v21.7.2
passo/v21.7.1
passo/v21.7.1_old
passo/v21.6.x
passo/v21.6.1
passo/v21.6.1_old
passo/v21.3.2
passo/v21.3.1
passo/v19.3
passo/v19.3_oldest
passo/v20
passo/v16
passo/v15
v0
passo/v9
passo/v4
passo/v5
passo/v6
```

rgf

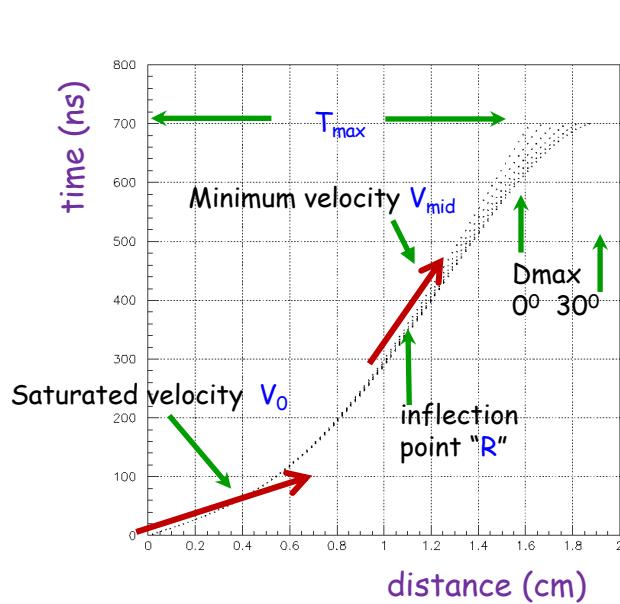
CLAS12 Subsystem Calibration Team

System	Group Leader	Developer(s)	Calibrator(s)
BAND	Larry Weinstein	Florian Hauenstein, Efrain Segarra	Florian Hauenstein, Efrain Segarra
CND	Silvia Niccolai	Pierre Chatagnon	Pierre Chatagnon, Paul Naidoo, Silvia Niccolai
CTOF	Daniel S. Carman	Louise Clark	Daniel S. Carman
DC	Mac Mestayer	Veronique Ziegler, Taya Chetry	Taya Chetry, Bradley Yale, Caleb Fogler
ECAL	Cole Smith	Cole Smith	Cole Smith
FT	Raffaella De Vita	Raffaella De Vita, Nick Zachariou	Raffaella De Vita, Nick Zachariou
FTOF	Daniel S. Carman	Louise Clark	Daniel S. Carman, Christopher McLauchlin
HTCC	Youri Sharabian	Nick Markov, Will Phelps	Nick Markov, Will Phelps
LTCC	Maurizio Ungaro	Maurizio Ungaro	Valerio Mascagna, Marco Leali
MVT	Maxime Defurne	Maxime Defurne	Maxime Defurne
RF	Raffaella De Vita	Raffaella De Vita	Jose Carvajal
RICH	Marco Contalbrigo	Marco Mirazita	Marco Mirazita
RTPC	Sebastian Kuhn	David Payette	Mohammad Hattawy
SVT	Yuri Gotra	Yuri Gotra	Yuri Gotra

Recent CALCOM Topics

- 1) Drift Chamber calibration:
 - Dependence of $t \rightarrow d$ on P_{atm}
 - t_0 calibration and global offset
 - Sector dependence of calibration
- 2) Magnetic field studies:
 - New vs. old torus field
 - Finalize solenoid map/alignment
- 3) Detector efficiency:
 - Quantify detector efficiencies
 - Determine hardware status tables
 - Model detector hardware thresholds in simulation data
- 4) Detector alignment:
 - FMT layer alignment
 - CVT (SVT, BMT) alignment
 - RICH mirror alignment
- 5) Support new experimental equipment:
 - BONUS12 RTPC
 - ALERT - ATOF, AHDC
- 6) Calibration procedure improvements
 - FT-Cal energy calibration algorithm
 - Update HTCC suite
 - Implement LTCC timing calibration
 - Remove CTOF hit time resolution dependence
 - ECAL sampling fraction tool
- 7) Documentation development and repository updates
- 8) Calibration status, plans, issues, timelines

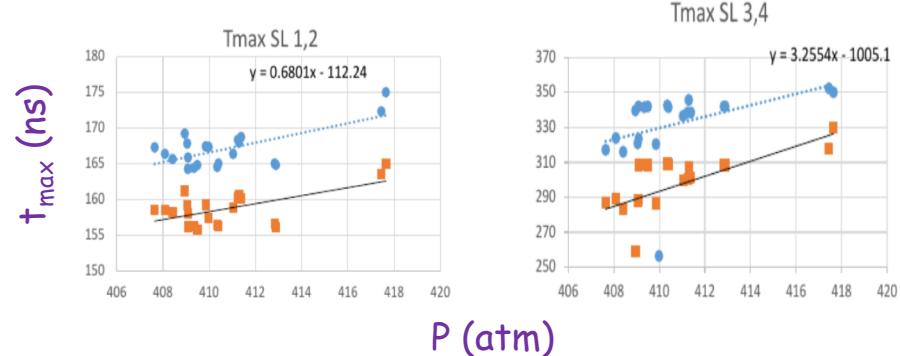
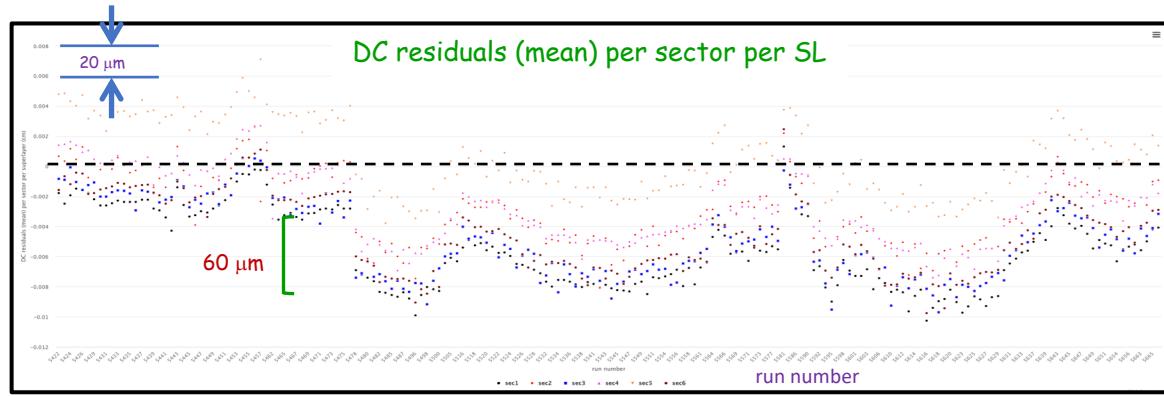
DC Calibration Studies



Time-to-distance functional:

$$T(x) = a x + b x^2 + c x^3 + d x^4$$

- Simple calculus: $(a, b, c, d) \rightarrow (V_0, V_{mid}, R, T_{max})$
- Physically meaningful parameters
- Published data for V_0, V_{mid}



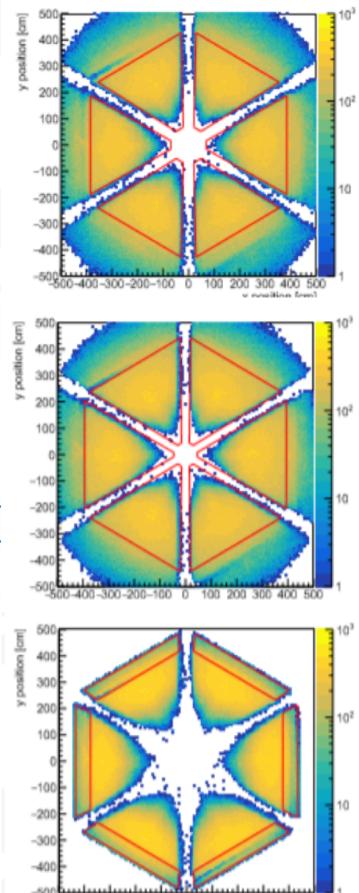
Correlate $t \rightarrow d$ parameters
with atm. pressure in Hall B

Taya Chetry

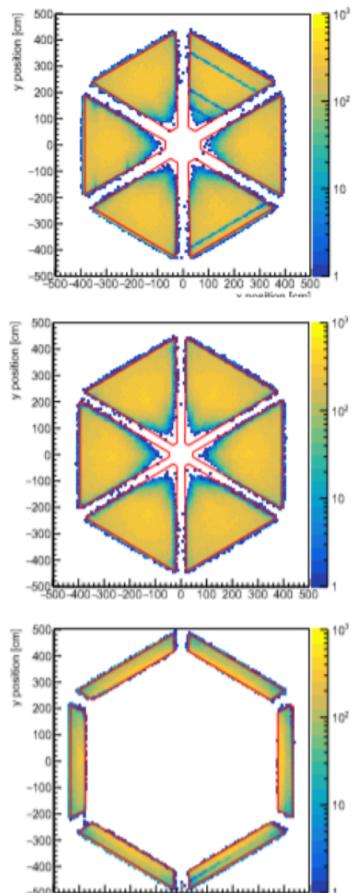
FTOF Efficiency Studies

FTOF hit/DC track

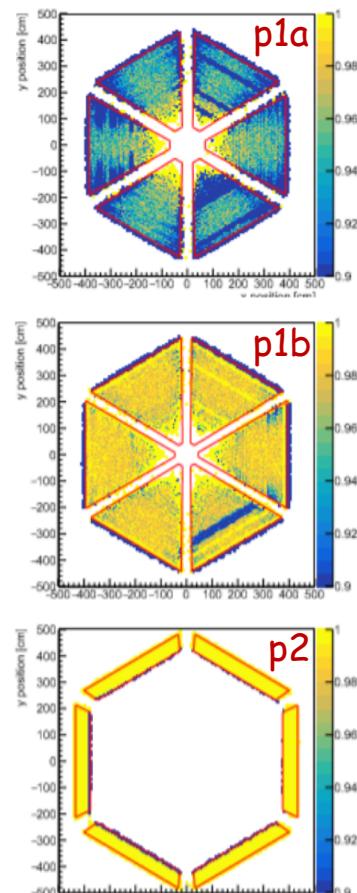
denominator



numerator

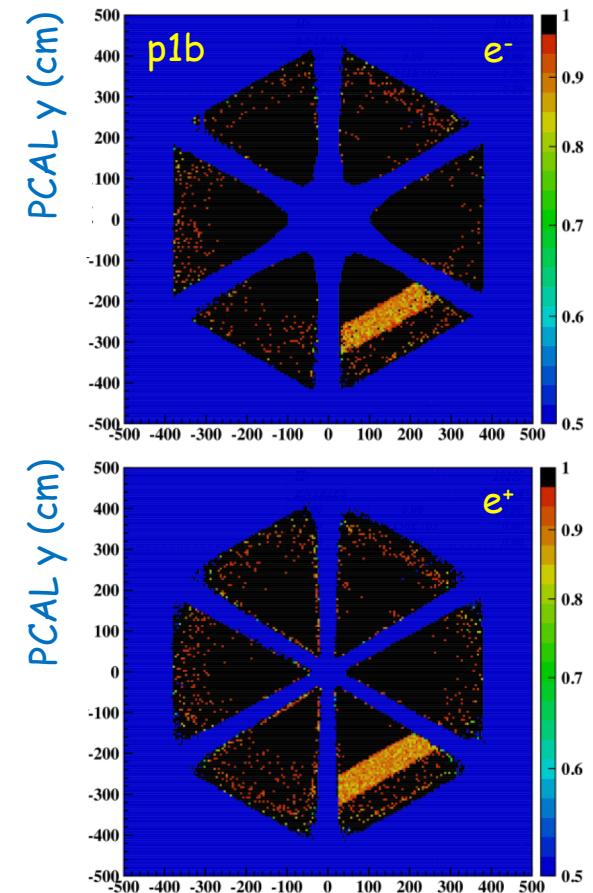


efficiency



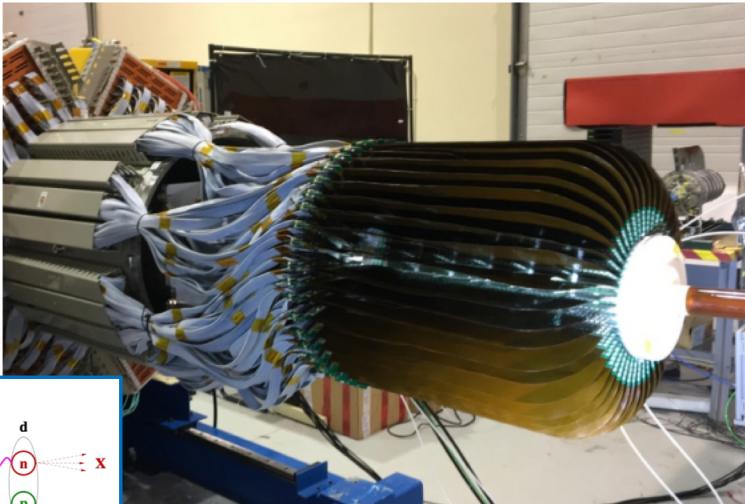
FTOF hit/PCAL hit

efficiency



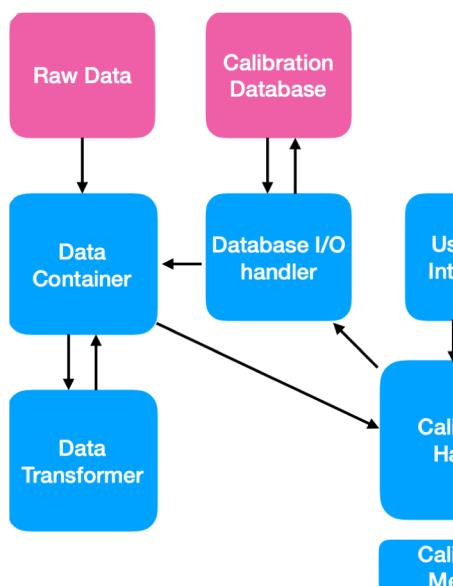
Matthew Nicol

New Experimental Setups



BONUS12 RTPC commissioning plan and calibration procedures

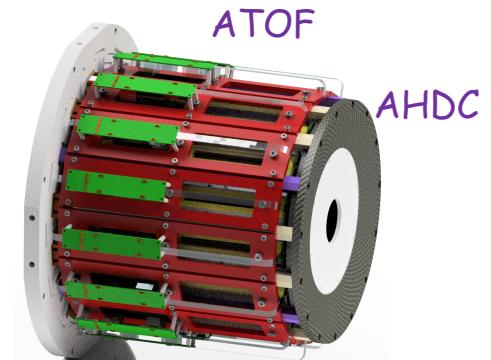
Mohammad Hattawy



ALERT Calibration Suite

follows development
of FTOF and CTOF

Michael Paolone



A Low Energy Recoil Tracker

Calibration Work Before Pass-2

Category	Task	Description	Priority (1-4)
			1=high, 4=low
			* needs further information
Calibration	DC cable-dependent and global T0	Repeat T0 calibration and asses the necessity for "global" T0 constants. Relevant for pass2 software preparation because of the potential need of new implementation in the DC package	1
Calibration	DC sector dependent calibrations	Assess the sector dependence of Time-to-distance calibrations	1
Calibration	BMT HV tables	Fill BMT HV tables with correct values for Lorentz angle calculation	1
Calibration	CTOF hit-position dependence	Develop a correction for the residual dependence on hit-position of CTOF timing. Relevant for pass2 software preparation because of the potential changes needed in CTOF reconstruction	1*
Calibration	Status tables	Extend standard calibrations to include component status	2
Calibration	DC pressure dependence	Validate pressure-dependent corrections to time-to-distance	2
Calibration	FT energy calibration	Explore possible improvements to energy calibration	2
Calibration	LTCC timing calibration	Extend LTCC calibrations to include timing offsets	3

Summary

- The CLAS12 CALCOM group has been meeting weekly since 2011
 - Develop calibration tools and procedures
 - Incorporate new subsystems as they become part of CLAS12
 - Establish and optimize calibration procedures
 - Discuss calibration stability and issues
- The role of the CALCOM group has recently expanded to coordinate the ongoing parallel calibrations of the Run Groups
 - This new role has improved coordination, tracking, and efficiency of the process over the past 3-4 months
 - Lessons learned being compiled to continue to smooth out the procedures
- CALCOM is active on a number of fronts:
 - Working to identify and resolve calibration limitations due to algorithms
 - Ensure that calibration standards are maintained vs. time
 - Working on performance studies
 - Capturing hardware status to match Monte Carlo to data
 - Addressing calibration issues in pass-2 work list

Subsystem Calibration Standards

Subsystem	Timeline	Constraint
RF	rftime electron FD mean	< ± 10 ps
	rftime electron FD sigma	< 70 ps
LTCC	ltcc elec nphe sec	12-14
HTCC	htcc nphe sec	11-13
FTOF	ftof edep p1a midangles	9.25-10.5 MeV
	ftof edep p1b midangles	11.25-12.25 MeV
	ftof edep p2	9.2-10.2 MeV
	ftof time p1a mean	< ± 25 ps
	ftof time p1a sigma	< 125 ps
	ftof time p1b mean	< ± 15 ps
	ftof time p1b sigma	< 70 ps
	ftof time p2 mean	< ± 50 ps
	ftof time p2 sigma	< 325 ps
FT	ftc pi0 mass mean	134-136 MeV
	ftc pi0 mass sigma	< 5 MeV
	fth MIPS energy	layer 1: 1.2-1.35 MeV layer 2: 2.7-2.9 MeV
	fth MIPS time mean	layer 1: < ± 200 ps layer 2: < ± 200 ps layer 1: < 1.35 ns layer 2: < 1.1 ns
	fth MIPS time sigma	

Subsystem	Timeline	Constraint
ECAL	ec Sampling	0.24-0.26
	ec gg m mean	131-134 MeV
	ec gg m sigma	< 15 MeV
	ec pim time mean	< ± 40 ps
	ec pim time sigma	< 200 ps
	ec pip time mean	< ± 40 ps
	ec pip time sigma	< 200 ps
CVT		
CTOF	ctof edep	5.7-6.3 MeV
	ctof time mean	< ± 20 ps
	ctof time sigma	< 115 ps
CND	cnd dEdz mean	1.75-2.25 MeV/cm
	cnd dEdz sigma	< 300 MeV/cm
	cnd time neg vtP mean	< ± 100 ps
	cnd time neg vtP sigma	< 300 ps
	cnd zdiff mean	< 0.4 cm
	cnd zdiff sigma	< 4 cm
DC	dc residuals sec sl peak	225-450 μ m
	dc residuals sec sl sigma	< ± 250 μ m
BAND	band adcCorr	Comb1: 1700-1800
	band meantimeadc	Comb2: 1840-1890
	band meantimetdc	
RICH	rich time fwhm max	< 1 ns

Developing tools to analyze timeline data to flag runs that do not meet specs