Event Builder

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CLAS Collaboration Meeting

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Overview

- EventBuilder is the last CLAS12 service run, after all detectors' reconstructions
- Retrieve event-based quantities, e.g. RF, heliticy, live-time
- Associate detector responses to create "particles"
  - Forward Detectors, Central Detector, Forward Tagger
- Define event start time based on Forward Detectors and RF
- Perform particle identification
- Write all info into REC* hipo banks

clas12-offline-software / reconstruction / eb / src / main / java / org / jlab / service / eb /

baltzell EBAnalyzer: cleanup/fix/comment simple pid logic	
..	
EBAnalyzer.java	EBAnalyzer: cleanup/fix/comment simple pid logic
EBEngine.java	EB: remove duplicate code EBMatching/EBCentral
EBHBEngine.java	FT and Tracks Bank
EBMatching.java	EB: remove duplicate code EBMatching/EBCentral
EBRadioFrequency.java	reconstruction/eb and clas-reco/detector: formatting, unused removals...
EBTBEngine.java	FT and Tracks Bank
EBio.java	changed trigger type in EB banks to long to match new RUN::config
EventBuilder.java	EB: remove duplicate code EBMatching/EBCentral

Output Banks

High level hipo banks for physics analyses

- Names are prefixed by "REC", in EVENT.json
  - https://github.com/JeffersonLab/clas12-offline-software/blob/master/etc/bankdefs/hipo/EVENT.json

- REC::* is based on time-based tracking, RECHB::* on hit-based

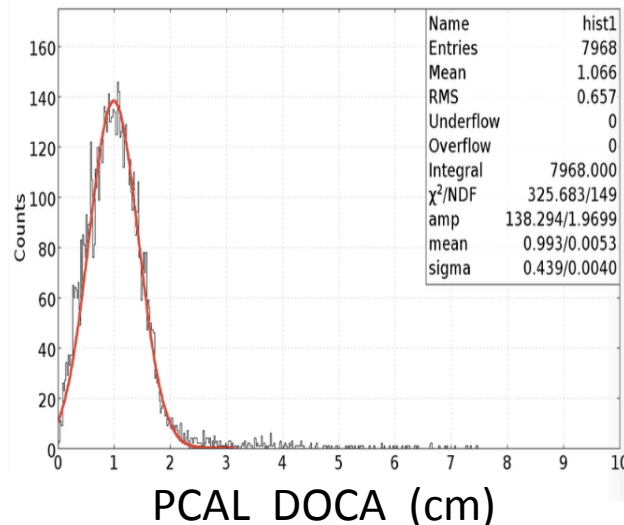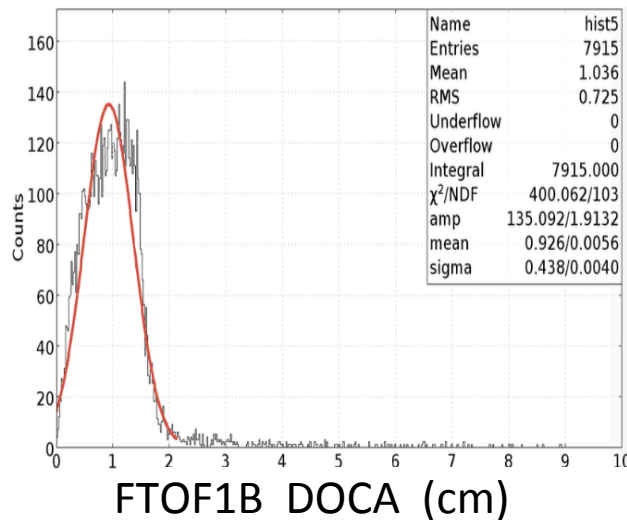- In the end, we may keep only REC banks for analysis, and drop all lower level info, resulting in "DSTs"

The main examples:

- REC::Event
  - run/event #, event time, trigger bits, helicity, etc

- REC::Particle
  - pid, charge, momentum, etc

- REC::"ResponseType"
  - e.g. Calorimeter, Scintillator, Cherenkov, Track
  - hit/cluster energies, positions, times, shapes
  - contains index pointers to
    - REC::Particle
    - corresponding clusters/hits in lower-level detector banks

See backup slides for some details

Jefferson Lab

Creating Particles

- Charged particles: associate detector responses with tracks based on geometric matching
    - Currently loose, flat detector-dependent cuts on DOCA between track and detector hit

Name	hist5
Entries	7915
Mean	1.036
RMS	0.725
Underflow	0
Overflow	0
Integral	7915.000
χ^2/NDF	400.062/103
amp	135.092/1.9132
mean	0.926/0.0056
sigma	0.438/0.0040

FTOF1B DOCA (cm)

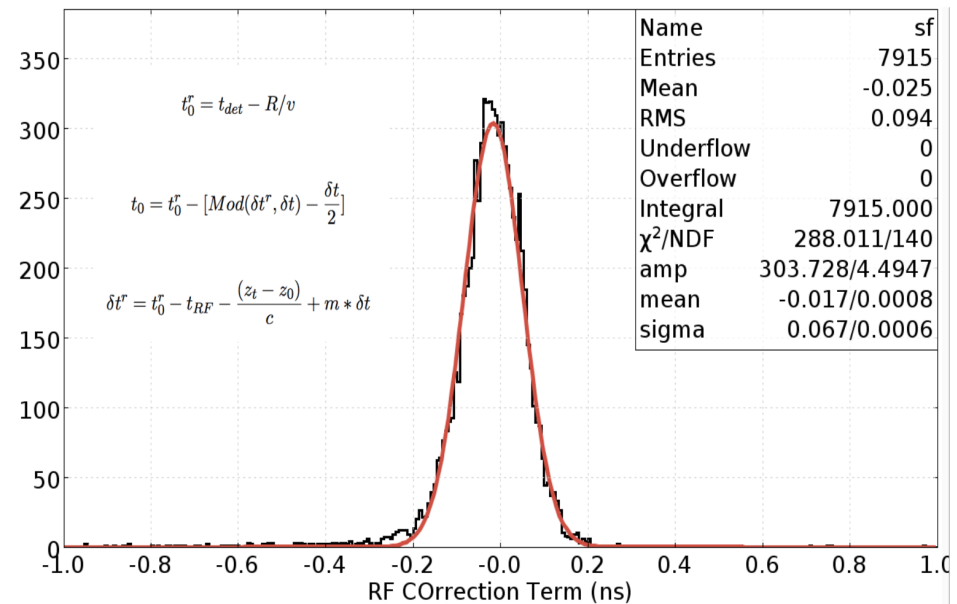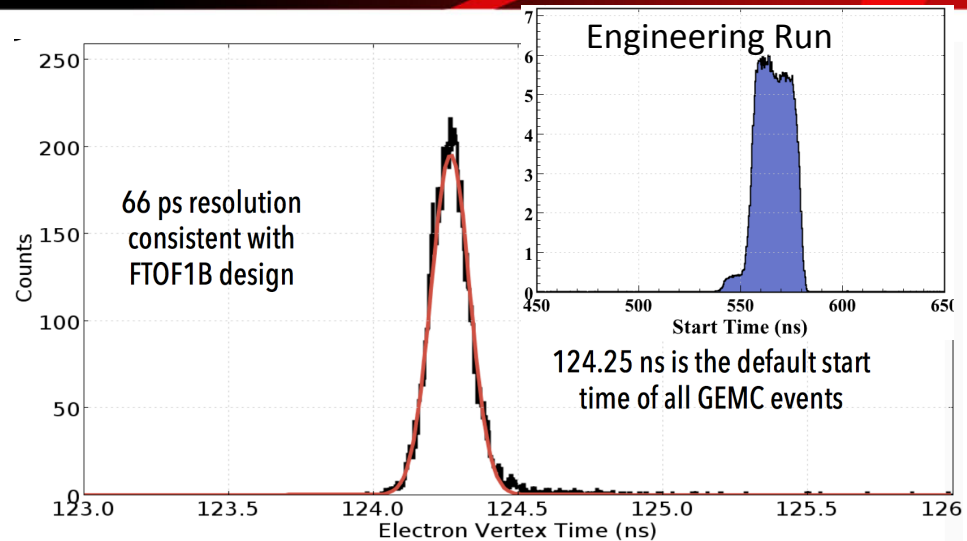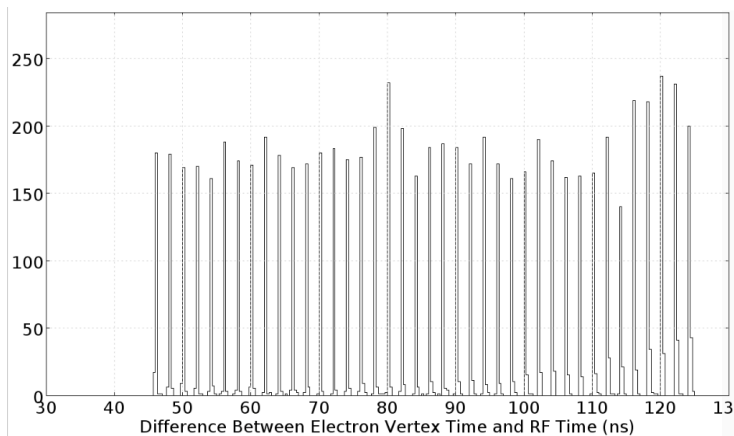| Name	hist1
Entries	7968
Mean	1.066
RMS	0.657
Underflow	0
Overflow	0
Integral	7968.000
χ^2/NDF	325.683/149
amp	138.294/1.9699
mean	0.993/0.0053
sigma	0.439/0.0040

PCAL DOCA (cm)

- Identify trackless ECAL hits as neutrals, assume straight trajectory, and associate with other detectors' unmatched hits based on geometric matching
- Matching quality (normalized distance) reported in output

ForwardTagger and CentralDetector matching is currently just imported from their dedicated recon services

Event Start Time

- Choose "Trigger Particle"
  - Prefer highest energy electron, if one exists, requiring
    - ECAL sampling fraction
    - HTCC nphe
    - FTOF response
  - Else
    - highest energy track with FTOF
      - assumed a π
    - *implemented, not in master yet, to be for pass0*

- Construct particle's vertex time and calibrated RF TDC signal to identify start time as nearest RF bunch time at vertex

66 ps resolution consistent with FTOF1B design

Engineering Run

124.25 ns is the default start time of all GEMC events

Electron Vertex Time (ns)

Start Time (ns)

Difference Between Electron Vertex Time and RF Time (ns)

$$t_0^r = t_{det} - R/v$$

$$t_0 = t_0^r - [Mod(\delta t^r, \delta t) - \frac{\delta t}{2}]$$

$$\delta t^r = t_0^r - t_{RF} - \frac{(z_t - z_0)}{c} + m * \delta t$$

Name	sf
Entries	7915
Mean	-0.025
RMS	0.094
Underflow	0
Overflow	0
Integral	7915.000
χ^2/NDF	288.011/140
amp	303.728/4.4947
mean	-0.017/0.0008
sigma	0.067/0.0006

RF COrrection Term (ns)

Particle Identification

- After choosing event start time, identify other charged particles with a loose, simple cut-based logic
  - If HTCC nphe + ECAL Sampling Fraction → e+/e-
    - sampling fraction parameterized from MC

  - Else it's a hadron:
    - Best hypothesis based on minimizing time difference between event start time t_0 and vertex time

$$\Delta t_i = t_0 - \left[t_{FTOF} - \frac{L}{\beta_i(p)} \right], \quad i = \pi/K/p/d/...$$

    - Vetoes from Cerenkov
      - e.g. kaon hypothesis gives best timing, but hit in LTCC and below kaon threshold → reassign to π

  - To be extend to more sophisticated scheme, e.g. likelihood, with RICH

(Simulation)

ECAL Energy vs Momentum

Beta vs Momentum — FTOF 1B
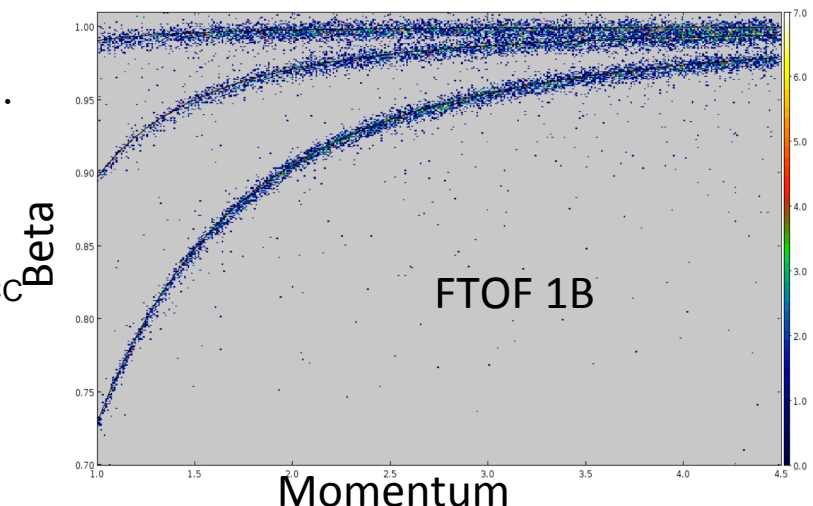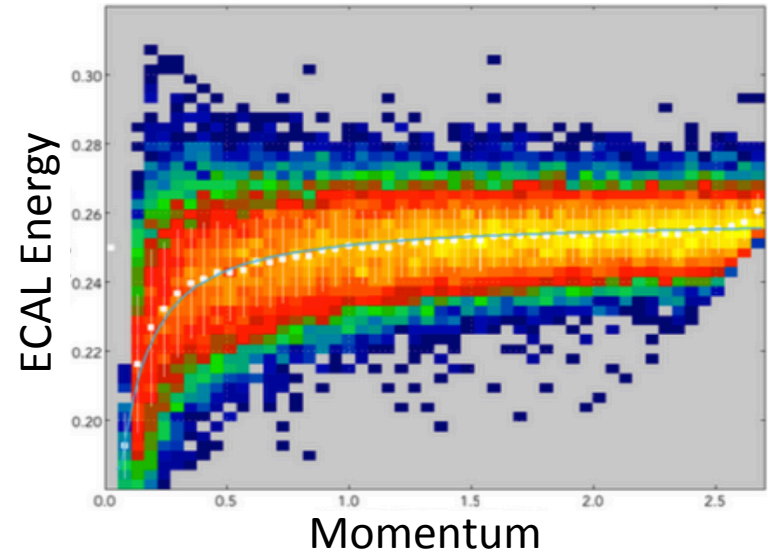
Validation Tests

- To check software progress, MC-based
  - `clas12-offline-software/validation`
  - test files automatically downloaded from webserver
  - decoded, reconstructed, analyzed to perform
    - data sanity checks
    - yields, efficiency / misidentification
  - turn this into a validation service!

Index of /clas12offline/distribution/coatjava/validation_files/eb

Name	Last modified	Size Description		
Parent Directory		-	electronFTgamma.evio.gz	22-Sep-2017 08:51 3.0M
4a.2.0/	22-Sep-2017 20:02	-	electrongamma.evio.gz	22-Sep-2017 08:51 3.3M
4a.2.1-fid-r10/	24-Sep-2017 15:40	-	electrongammaC.evio.gz	22-Sep-2017 19:58 3.0M
4a.2.1-fid-r11/	22-Sep-2017 20:08	-	electrongammaFT.evio.gz	22-Sep-2017 08:51 4.9M
4a.2.1/	22-Sep-2017 20:04	-	electronkaon.evio.gz	22-Sep-2017 08:51 4.9M
			electronkaonC.evio.gz	22-Sep-2017 08:51 4.0M
			electronneutron.evio.gz	22-Sep-2017 19:58 3.4M
			electronneutronC.evio.gz	22-Sep-2017 19:58 3.4M
			electronpion.evio.gz	22-Sep-2017 08:51 5.0M
			electronpionC.evio.gz	22-Sep-2017 08:51 4.1M
			electronproton.evio.gz	22-Sep-2017 08:51 4.8M
			electronprotonC.evio.gz	22-Sep-2017 08:51 4.0M

- 2-particle test events
  - FD: electron plus another, in different sectors
    - e^- : **1-9 GeV**
    - other (hadron/photon): **1-4.5 GeV**
    - away from detector edges (ϕ/θ)
  - `Clas12FastMC` at generator level to ensure expected trajectories intersect all relevant detectors
    - i.e. account for B-fields, acceptance
    - very useful tool
  - FT/CD events available
    - FT tests working
      - electron ~ 99%, photon ?
    - CD tests just a skeleton currently

- * Neutron / photon separation unfinished; currently based only on ECAL "topology", timing-based separation to be implemented
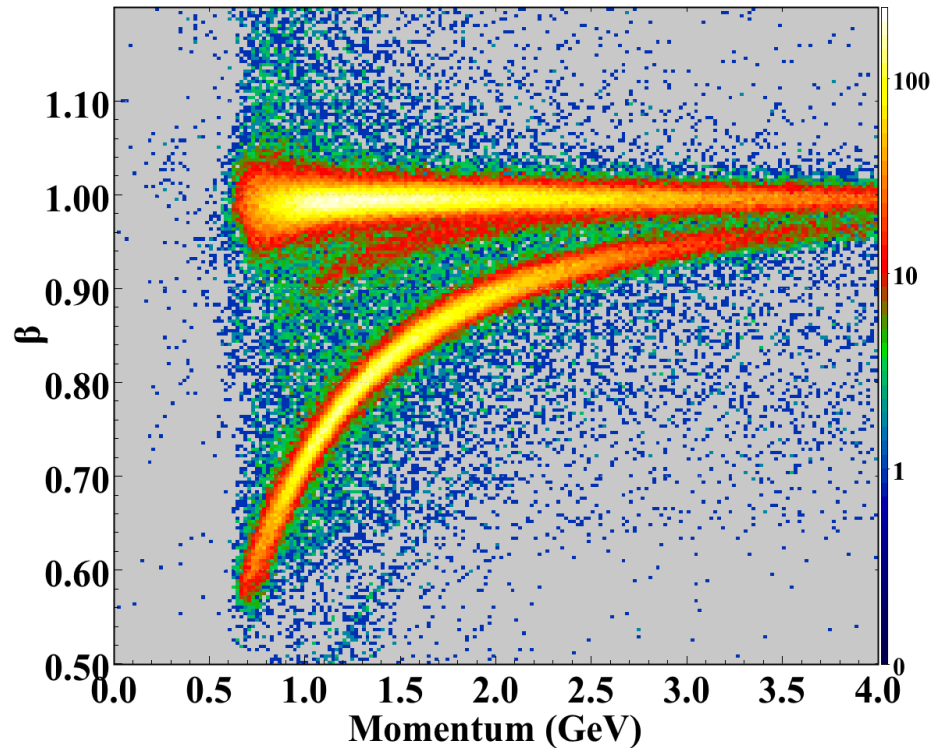
Forward Detectors		MC Truth				
		e	π	K	p	γn
P I D (%)	e	99				
	π		89	16	3	
	K		5	68		
	p		3	6	94	
	γn					>90*

A rough efficiency based on 1K events for each, averaged over given kinematics, used to help track software development. For e / hadrons, demoninator requires a track; any other detector/reconstruction inefficiencies, kaon decay, track-matching, etc, are absorbed. Empty cell means <<1%.

Hadron PID in Forward Detectors

Engineering Run Data, 10.6 GeV, 5 nA
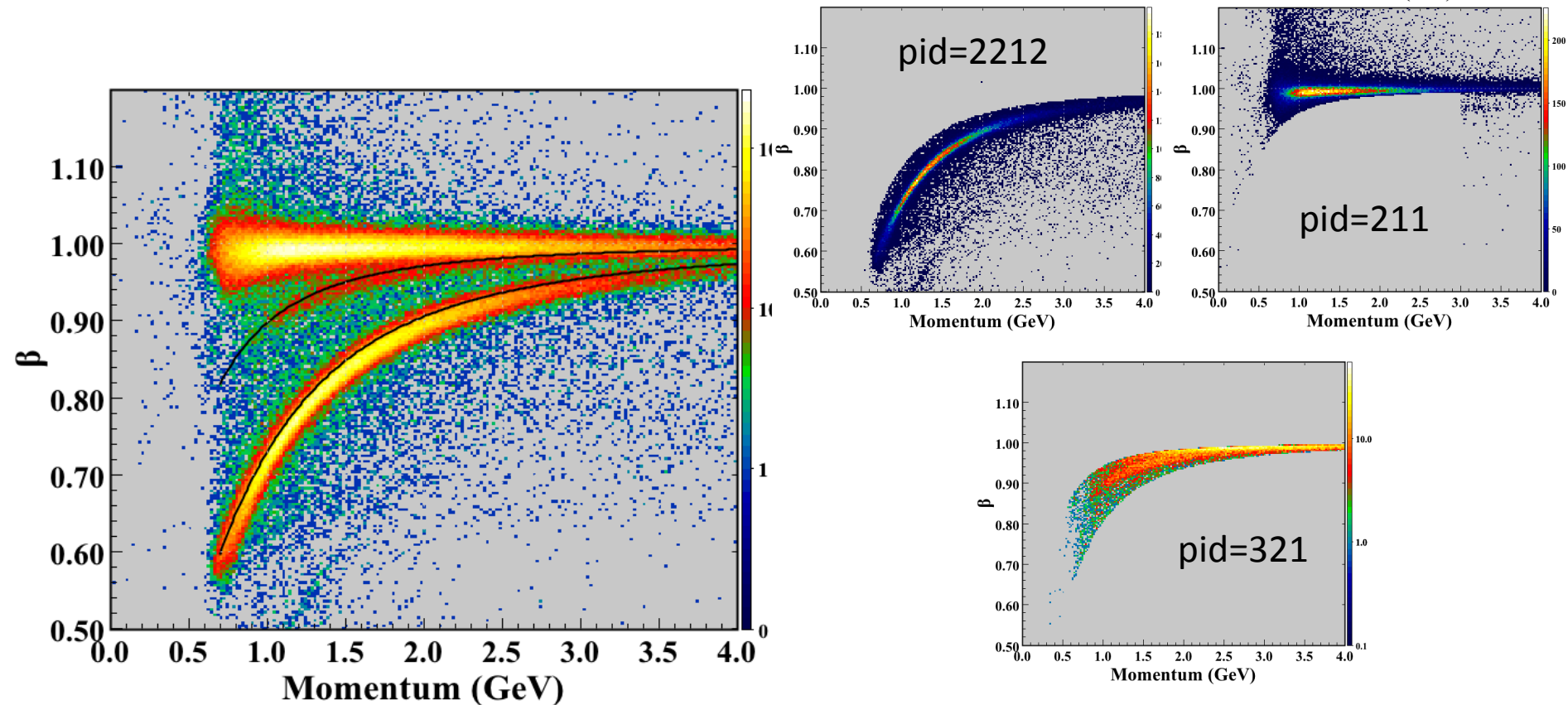Only requirement is good start time (first REC::Particle is an electron)

Hadron PID in Forward Detectors

Engineering Run Data, 10.6 GeV, 5 nA
*** Only requirement is good start time (first REC::Particle is an electron)

CCDB

- **Event Builder parameters are stored in CCDB, e.g.**
  - calorimeter sampling fractions
  - position/time matching resolutions
  - various cut values

- **~90% are now being used by EB service, loaded from CCDB in init() using ConstantsManager, no run-dependence yet**

```
+------------------------------------------+
| Type table information                   |
+------------------------------------------+
 Name        :  electron_sf
 Full path   :  /calibration/eb/electron_sf
 Rows        :  1
 Columns     :  11
 Created     :  2017-08-13 13-40-06
 Modified    :  2017-08-13 13-40-06
 DB Id       :  877
+------------------------------------------+
| Columns info                             |
+------------------------------------------+

Columns info
 N.   (type)    : (name)
 0    int       : sector
 1    int       : layer
 2    int       : component
 3    double    : sf1
 4    double    : sf2
 5    double    : sf3
 6    double    : sf4
 7    double    : sfs1
 8    double    : sfs2
 9    double    : sfs3
 10   double    : sfs4
+------------------------------------------+
Comment:
electron sampling fraction fit parameters 1 to 4
```

```
eb ?
  rf ?
    offset ?
    config ?
  electron_sf ?
  photon_sf ?
  neutron_beta ?
  ecal_matching ?
  ftof_matching ?
  ctof_matching ?
  cnd_matching ?
  htcc_matching ?
  ltcc_matching ?
  pid ?
```

Table	[/calibration/eb/electron_sf]	
Variation	default	
Created	2017-08-31 14:03:09	
Run range	0 - inf.	
Author	baltzell	
Exact id	/calibration/eb/electron_sf:0:default:2017-08-31_14-03-09	
[Download text data]		

Comment:

Data:

Show [10 ⬍] entries   Search: [   ]

sector	layer	component	sf1	sf2	sf3	sf4	sfs1	sfs2	sfs3	sfs4
0	0	0	0.263	0.985	-0.036	0.002	0.0166	0	0	0

Showing 1 to 1 of 1 entries   First | Previous | 1 | Next | Last

Summary

- Event Builder Status

  - Trigger Particle / Start Time
    - currently electron-focused

  - Particle Identification
    - simple cut-based algorithm with single PID assignment
    - FD algorithms developed and well-tested
    - FT/CD imported, populated in REC banks, but pid currently unassigned for CD

  - Validation/testing "suite" in use
    - checking yields, efficiencies/misidentification, data sanity checks, for *tractable software development*

  - CCDB now used for 90% of Event Builder parameters

  - Previous contributors: Joseph Newton (ODU), R. De Vita, N. Harrison, G. Gavalian (framework designer)

TODO

- First (e.g. for "pass0")
  - Non-electron trigger particle
  - CD Hadron PID
  - Read helicity, to REC::Event
- Next
  - Bugfixes
  - Still a few unfilled output variables
  - Include ECAL timing for n/γ separation
  - CND Neutral PID
  - Fill detailed tracking banks
    - e.g. REC::Trajectory, REC::TBCovMat, REC::VertDOCA
  - Incorporate RICH
  - Incorporate some validation tests in automatic Travis
  - Documentation!

U.S. DEPARTMENT OF **ENERGY** JSA

Jefferson Lab

Event Builder "REC" Bank Structures

- High level banks for analysis

- REC::Event
  - run/event #, helicity, event time, live time, faraday cup charge, etc

- REC::Particle

- REC::"ResponseType"
  - e.g. Calorimeter, Scintillator, Čerenkov
  - contains index pointers to
    - REC::Particle
    - lower-level detector banks

- REC::Trajectory, REC::TBCovMat, REC::VertDOCA, etc.

"bank": "REC::Event",
"group": 30,
"info": "Event Header Bank",
"items": [
    {"name":"NRUN",   "id":1, "type":"int32", "info":"Run Number"},
    {"name":"NEVENT",   "id":2, "type":"int32", "info":"Event Number"},
    {"name":"EVNTime",   "id":3, "type":"float", "info":"Event Time"},
    {"name":"TYPE",   "id":4, "type":"int8", "info":"Event Type (Data or MC)"},
    {"name":"EvCAT",   "id":5, "type":"int16", "info":"Event Category, if >0: e
    {"name":"NPGP",   "id":6, "type":"int16", "info":"Number of Final (Timed-ba
    {"name":"TRG",   "id":7, "type":"int32", "info":"Trigger Type (CLAS12_e-,
    {"name":"BCG",   "id":8, "type":"float", "info":"Faraday Cup Gated (Coulom
    {"name":"LT",   "id":9, "type":"double","info":"Clock"},
    {"name":"STTime",   "id":10, "type":"float", "info":"Event Start Time (ns)"},
    {"name":"RFTime",   "id":11, "type":"float", "info":"RF Time (ns)"},
    {"name":"Helic",   "id":12, "type":"int8", "info":"Helicity of Event"},
    {"name":"PTIME",   "id":13, "type":"float", "info":"Event Processing Time (UN

"bank": "REC::Particle",
"group": 31,
"info": "Reconstructed Particle Information",
"items": [
    {"name":"pid",   "id":1, "type":"
    {"name":"px",   "id":2, "type":"
    {"name":"py",   "id":3, "type":"
    {"name":"pz",   "id":4, "type":"
    {"name":"vx",   "id":5, "type":"
    {"name":"vy",   "id":6, "type":"
    {"name":"vz",   "id":7, "type":"
    {"name":"charge",   "id":8, "type":"
    {"name":"beta",   "id":9, "type":"
    {"name":"chi2pid",   "id":10, "type":"
    {"name":"status",   "id":11, "type":"

{
    "bank": "RECHB::Cherenkov",
    "group": 313,
    "info": "Cherenkov Respons
    "items": [
        {"name":"index",
        {"name":"pindex",
        {"name":"detector",
        {"name":"sector",
        {"name":"nphe",
        {"name":"time",   "id":6, "type":"floa
        {"name":"path",   "id":7, "type":"floa
        {"name":"chi2",   "id":8, "type":"floa
        {"name":"x",   "id":9, "type":"floa
        {"name":"y",   "id":10, "type":"floa
        {"name":"z",   "id":11, "type":"floa
        {"name":"theta",   "id":12, "type":"floa
        {"name":"phi",   "id":13, "type":"floa
        {"name":"dtheta",   "id":14, "type":"floa
        {"name":"dphi",   "id":15, "type":"floa
        {"name":"status",   "id":16, "type":"int1
    ]
},

REC::Banks

```
etc/bankdefs/hipo/
├── BMT.json
├── BST.json
├── CLAS6EVENT.json
├── CND.json
├── CVT.json
├── DATA.json
├── DC.json
├── DETECTOR.json
├── ECAL.json
├── EVENT.json
├── FT.json
├── HEADER.json
├── HTCC.json
├── LTCC.json
├── MC.json
└── TOF.json
```

```
*********************** EVENT # 2   ***********************
+----+-------------------------------+----------+---------+--------+
| id|                          name| entries|    group| items|
+----+-------------------------------+----------+---------+--------+
|  0|                      DC::tdc|      79|    20612|      5|
|  1|                     DC::doca|      79|    20614|      5|
|  2|                    HTCC::adc|       2|    21511|      7|
|  3|                   REC::Event|       1|      330|     13|
|  4|                   RUN::config|      1|       11|     10|
|  5|                REC::Particle|       3|      331|     11|
|  6|                       RUN::rf|      3|       12|      2|
|  7|              REC::Calorimeter|      5|      332|     25|
|  8|            HitBasedTrkg::HBHits|    78|    20621|     17|
|  9|                REC::Cherenkov|      2|      333|     16|
| 10|        HitBasedTrkg::HBClusters|    12|    20622|     23|
| 11|        HitBasedTrkg::HBSegments|    12|    20623|     28|
| 12|              REC::Scintillator|      5|      335|     17|
| 13|                   REC::Track|       2|      336|     16|
| 14|         HitBasedTrkg::HBCrosses|     6|    20625|     18|
| 15|          HitBasedTrkg::HBTracks|     2|    20626|     34|
| 16|                    HTCC::rec|       1|    21522|     17|
| 17|          TimeBasedTrkg::TBHits|    78|    20631|     17|
| 18|       TimeBasedTrkg::TBClusters|    12|    20632|     23|
| 19|                   ECAL::calib|      5|    20824|      9|
| 20|       TimeBasedTrkg::TBSegments|    12|    20633|     30|
| 21|        TimeBasedTrkg::TBCrosses|     6|    20635|     18|
| 22|         TimeBasedTrkg::TBTracks|     2|    20636|     34|
| 23|                  FTOF::rawhits|    12|    21220|     13|
| 24|                    FTOF::hits|    12|    21221|     25|
```

REC::Banks

```
"bank": "REC::Event",
"group": 330,
"info": "Event Header Bank",
"items": [
        {"name":"NRUN",     "id":1,  "type":"int32", "info":"Run Number"},
        {"name":"NEVENT",   "id":2,  "type":"int32", "info":"Event Number"},
        {"name":"EVNTime",  "id":3,  "type":"float", "info":"Event Time"},
        {"name":"TYPE",     "id":4,  "type":"int8", "info":"Event Type (Data or MC)"},
        {"name":"EvCAT",    "id":5,  "type":"int16", "info":"Event Category, if >0:  e-, e-p, e-pi+...
        {"name":"NPGP",     "id":6,  "type":"int16", "info":"Number of Final (Timed-based) Reconstruct
        {"name":"TRG",      "id":7,  "type":"int32", "info":"Trigger Type (CLAS12_e-, FT_CLAS12_h, CLA
        {"name":"BCG",      "id":8,  "type":"float", "info":"Faraday Cup Gated (Coulomb)"},
        {"name":"LT",       "id":9,  "type":"double", "info":"Clock"},
        {"name":"STTime",   "id":10, "type":"float", "info":"Event Start Time (ns)"},
        {"name":"RFTime",   "id":11, "type":"float", "info":"RF Time (ns)"},
        {"name":"Helic",    "id":12, "type":"int8", "info":"Helicity of Event"},
        {"name":"PTIME",    "id":13, "type":"float", "info":"Event Processing Time (UNIX Time = second
    ]
```

```
"bank": "REC::Particle",
"group": 331,
"info": "Reconstructed Particle Information",
"items": [
    {"name":"pid",      "id":1,  "type":"int32", "info":"particle id in LUND conventions"},
    {"name":"px",       "id":2,  "type":"float", "info":"x component of the momentum"},
    {"name":"py",       "id":3,  "type":"float", "info":"y component of the momentum"},
    {"name":"pz",       "id":4,  "type":"float", "info":"z component of the momentum"},
    {"name":"vx",       "id":5,  "type":"float", "info":"x component of the vertex"},
    {"name":"vy",       "id":6,  "type":"float", "info":"y component of the vertex"},
    {"name":"vz",       "id":7,  "type":"float", "info":"z component of the vertex"},
    {"name":"charge",   "id":8,  "type":"int8",  "info":"particle charge"},
    {"name":"beta",     "id":9,  "type":"float", "info":"particle beta measured by TOF"},
    {"name":"chi2pid",  "id":10, "type":"float", "info":"Chi2 of assigned PID"},
    {"name":"status",   "id":11, "type":"int16", "info":"particle status (represents detector coll
]
```

Event Builder Output Banks

"bank": "REC::Particle",
"group": 331,
"info": "Reconstructed Particle Information",
"items": [
    {"name":"pid",   "id":1,   "type":"int32", "info":"particle id in LUND conventions"},
    {"name":"px",   "id":2,   "type":"float", "info":"x component of the momentum"},
    {"name":"py",   "id":3,   "type":"float", "info":"y component of the momentum"},
    {"name":"pz",   "id":4,   "type":"float", "info":"z component of the momentum"},
    {"name":"vx",   "id":5,   "type":"float", "info":"x component of the vertex"},
    {"name":"vy",   "id":6,   "type":"float", "info":"y component of the vertex"},
    {"name":"vz",   "id":7,   "type":"float", "info":"z component of the vertex"},
    {"name":"charge",   "id":8,   "type":"int8", "info":"particle charge"},
    {"name":"beta",   "id":9,   "type":"float", "info":"particle beta measured by TOF"},
    {"name":"chi2pid",   "id":10, "type":"float", "info":"Chi2 of assigned PID"},
    {"name":"status",   "id":11, "type":"int16", "info":"particle status (represents detector coll
]

"bank": "REC::Scintillator",
"group": 335,
"info": "Scintillator Responses for Particles bank",
"items": [
    {"name":"index",   "id":1,   "type":"int16", "info":"index of the hit in the specific detector bank"},
    {"name":"pindex",   "id":2,   "type":"int16", "info":"row number in the particle bank hit is associated with"},
    {"name":"detector",   "id":3,   "type":"int8", "info":"Detector ID, defined in COATJAVA DetectorType"},
    {"name":"sector",   "id":4,   "type":"int8", "info":"Sector of the Detector hit"},
    {"name":"layer",   "id":5,   "type":"int8", "info":"Layer of the Detector hit"},
    {"name":"component",   "id":6,   "type":"int16", "info":"Component of the Detector hit"},
    {"name":"energy",   "id":7,   "type":"float", "info":"Energy associated with the hit"},
    {"name":"time",   "id":8,   "type":"float", "info":"Time associated with the hit"},
    {"name":"path",   "id":9,   "type":"float", "info":"Path from vertex to the hit position"},
    {"name":"chi2",   "id":10, "type":"float", "info":"Chi2 (or quality) of hit-track matching"},
    {"name":"x",   "id":11, "type":"float", "info":"X coordinate of the hit"},
    {"name":"y",   "id":12, "type":"float", "info":"Y coordinate of the hit"},
    {"name":"z",   "id":13, "type":"float", "info":"Z coordinate of the hit"},
    {"name":"hx",   "id":14, "type":"float", "info":"X coordinate of the matched hit"},
    {"name":"hy",   "id":15, "type":"float", "info":"Y coordinate of the mathced hit"},
    {"name":"hz",   "id":16, "type":"float", "info":"Z coordinate of the matched hit"},
    {"name":"status",   "id":17, "type":"int16", "info":"hit status"}
]

to REC::Particle

REC::Banks

```
"bank": "REC::Particle",
"group": 331,
"info": "Reconstructed Particle Information",
"items": [
    {"name":"pid",          "id":1,  "type":"int32", "info":"particle id in LUND conventions"},
    {"name":"px",           "id":2,  "type":"float", "info":"x component of the momentum"},
    {"name":"py",           "id":3,  "type":"float", "info":"y component of the momentum"},
    {"name":"pz",           "id":4,  "type":"float", "info":"z component of the momentum"},
    {"name":"vx",           "id":5,  "type":"float", "info":"x component of the vertex"},
    {"name":"vy",           "id":6,  "type":"float", "info":"y component of the vertex"},
    {"name":"vz",           "id":7,  "type":"float", "info":"z component of the vertex"},
    {"name":"charge",       "id":8,  "type":"int8",  "info":"particle charge"},
    {"name":"beta",         "id":9,  "type":"float", "info":"particle beta measured by TOF"},
    {"name":"chi2pid",      "id":10, "type":"float", "info":"Chi2 of assigned PID"},
    {"name":"status",       "id":11, "type":"int16", "info":"particle status (represents detector coll
]

"bank": "REC::Scintillator",
"group": 335,
"info": "Scintillator Responses for Particles bank",
"items": [
    {"name":"index",        "id":1,  "type":"int16", "info":"index of the hit in the specific detector bank"},
    {"name":"pindex",       "id":2,  "type":"int16", "info":"row number in the particle bank hit is associated with"},
    {"name":"detector",     "id":3,  "type":"int8",  "info":"Detector ID, defined in COATJAVA DetectorType"},
    {"name":"sector",       "id":4,  "type":"int8",  "info":"Sector of the Detector hit"},
    {"name":"layer",        "id":5,  "type":"int8",  "info":"Layer of the Detector hit"},
    {"name":"component",    "id":6,  "type":"int16", "info":"Component of the Detector hit"},
    {"name":"energy",       "id":7,  "type":"float", "info":"Energy associated with the hit"},
    {"name":"time",         "id":8,  "type":"float", "info":"Time associated with the hit"},
    {"name":"path",         "id":9,  "type":"float", "info":"Path from vertex to the hit position"},
    {"name":"chi2",         "id":10, "type":"float", "info":"Chi2 (or quality) of hit-track matching"},
    {"name":"x",            "id":11, "type":"float", "info":"X coordinate of the hit"},
    {"name":"y",            "id":12, "type":"float", "info":"Y coordinate of the hit"},
    {"name":"z",            "id":13, "type":"float", "info":"Z coordinate of the hit"},
    {"name":"hx",           "id":14, "type":"float", "info":"X coordinate of the matched hit"},
    {"name":"hy",           "id":15, "type":"float", "info":"Y coordinate of the mathced hit"},
    {"name":"hz",           "id":16, "type":"float", "info":"Z coordinate of the matched hit"},
    {"name":"status",       "id":17, "type":"int16", "info":"hit status"}
]
```

to detector bank

Jefferson Lab

REC::Banks - Indexing

REC::Banks - Indexing

REC::* Banks Indexing

(Ideally an analysis framework would load the mapping for you!)

```
"bank": "REC::Scintillator",
"group": 335,
"info": "Scintillator Responses for Particles bank",
"items": [
    {"name":"index",       "id":1,   "type":"int16",
    {"name":"pindex",      "id":2,   "type":"int16",
    {"name":"detector",    "id":3,   "type":"int8",
    {"name":"sector",      "id":4,   "type":"int8",
    {"name":"layer",       "id":5,   "type":"int8",
    {"name":"component",   "id":6,   "type":"int16",
    {"name":"energy",      "id":7,   "type":"float",
    {"name":"time",        "id":8,   "type":"float",
    {"name":"path",        "id":9,   "type":"float",
    {"name":"chi2",        "id":10,  "type":"float",
    {"name":"x",           "id":11,  "type":"float",
    {"name":"y",           "id":12,  "type":"float",
    {"name":"z",           "id":13,  "type":"float",
    {"name":"hx",          "id":14,  "type":"float",
    {"name":"hy",          "id":15,  "type":"float",
    {"name":"hz",          "id":16,  "type":"float",
    {"name":"status",      "id":17,  "type":"int16",
]
```

```java
public void loadMap(Map<Integer,List<Integer>> map,
                    DataBank fromBank,
                    DataBank toBank,
                    String idxVarName) {
    map.clear();
    if (fromBank==null) return;
    if (toBank==null) return;
    for (int ii=0; ii<fromBank.rows(); ii++) {
        final int iTo=fromBank.getInt(idxVarName,ii);
        if (map.containsKey(iTo)) {
            map.get(iTo).add(ii);
        }
        else {
            List<Integer> iFrom=new ArrayList<Integer>();
            map.put(iTo,iFrom);
            map.get(iTo).add(ii);
        }
    }
}
```

```java
Map <Integer,List<Integer>> recCalMap=new HashMap<Integer,List<Integer>>();
loadMap(recCalMap,recCalBank,recPartBank,"pindex");
```

```java
if (recCalMap.containsKey(iPart)) {
    // REC::Particle index=iPart has at least one associated calorimeter response.
    // Loop over those responses:
    for (int iCal : recCalMap.get(iPart)) {
        recCalBank.getFloat("energy",iCal);
```