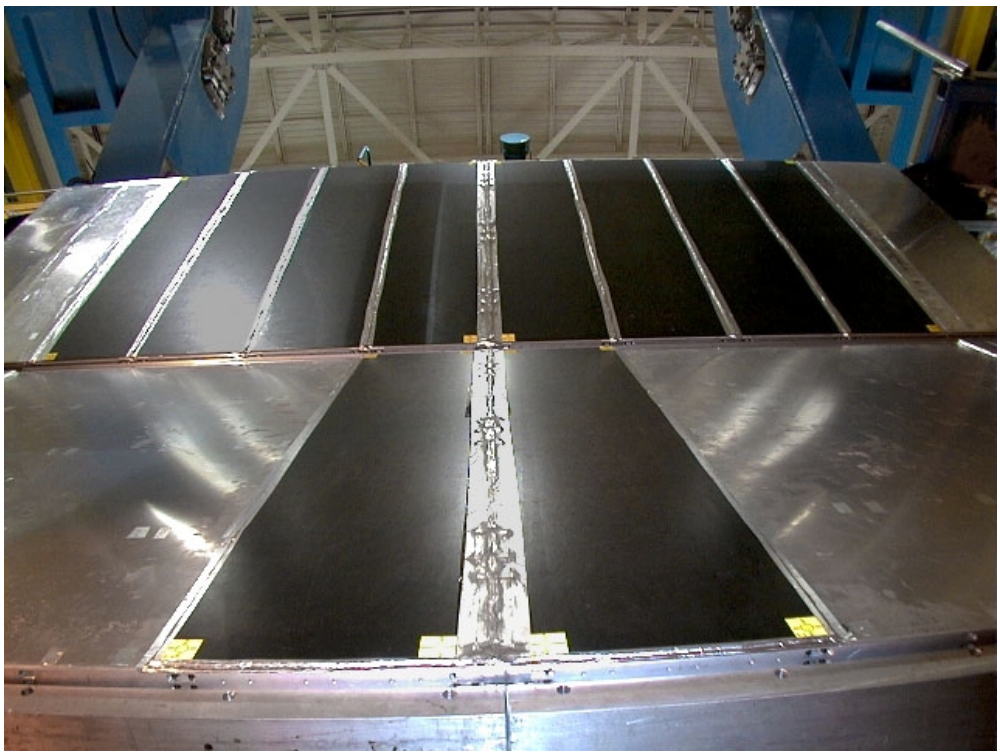
PHENIX

Time-of-Flight Software (Online/Offline)

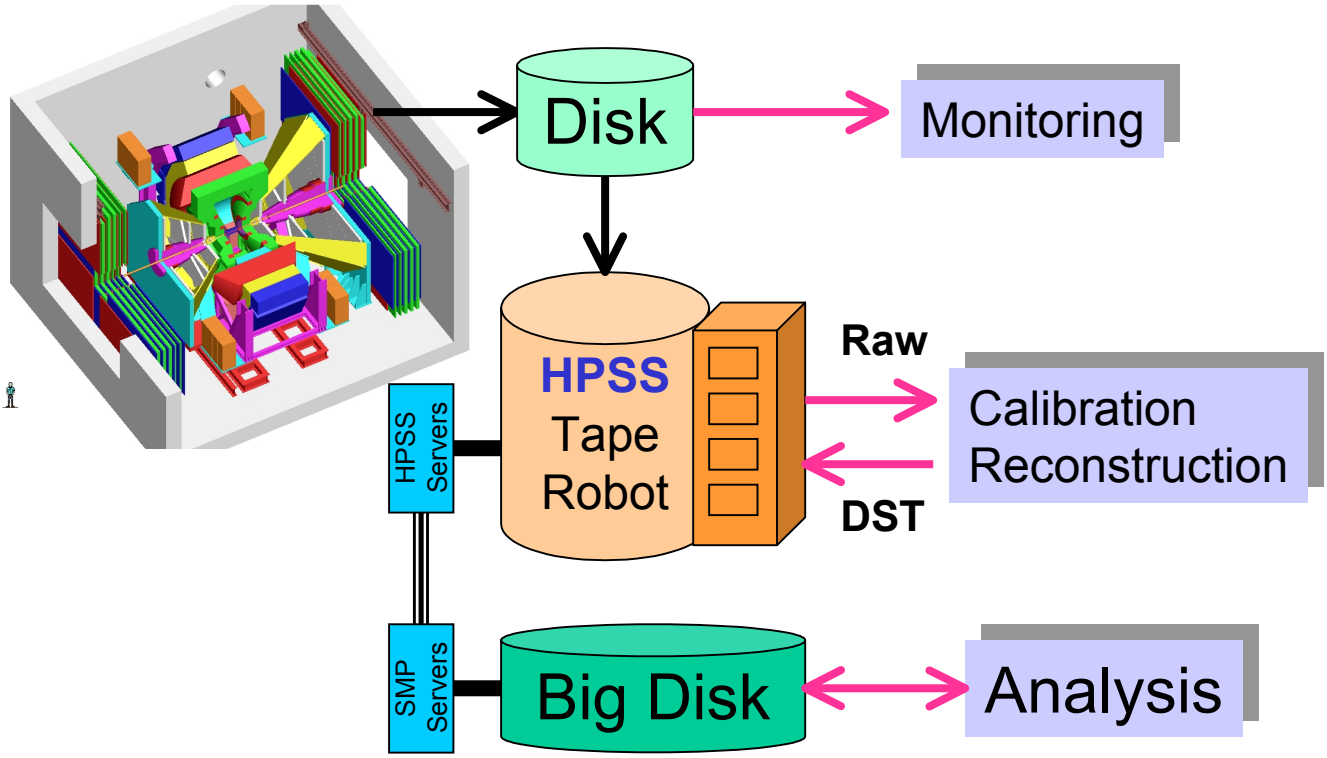


Akio Kiyomichi

Univ. of Tsukuba

Nov. 18, 1999

Online/Offline Process



- **Online**
  - Monitoring
- **Offline**
  - Calibration
  - Reconstruction
  - Physics Analysis

- Standard language for PHENIX is **C++**

Data Format

- Raw Data (DCM format)
  - **PRDF**: **PHENIX** Raw Data Format

- TOF-PRDF

```
   Bits 31-29  28-20  19-16  15-0
index
-----------------------------------------------
  0          0       0      15    Flag Word
  1          0       0       6    Module #  DCM module?
  2          0       0       6    Event #
  3          0       0       6    Beam CLK #
  4          0       0       6    Detector ID = 0x0700
  ..................
  m          0       0       6    FEM Event #  <--- at each FEM
  m+1        0       0       6    FEM Address
  m+2        0       0       6    AMU Cell Time
  m+3        0       0       6    AMU Cell Pre
  m+4        0       0       6    AMU Cell Post
  ..................
  m+n*3      0       n      12    ch N time    <---- for each ch
  m+n*3+1    0       n      10    ch N pre  (skipped if zero
suppressed)
  m+n*3+2    0       n       9    ch N post
  ..................
  last-1     0       7       7    Parity Word
  last       0       7       7    Last Word
-----------------------------------------------
Word length (no zero suppression)
= 5 + 5*16 + 3*16*16 + 2
= 855
```

Detail information are in

http://www.phenix.bnl.gov/phenix/project_info/electronics/dcm/DCM_formats/PHENIX_Formats/tof_format_pub.htm

Data Format (cont.)

TOF Basic Tables for each slat

```
/* Raw data structure [dTofRaw.idl] */
struct dTofRaw {
  short id;         /* Reference key */
  short slatid;     /* Slat ID(0-1055)[refer to dTofGeo]*/
  short sector;     /* Sector (0-1) */
  short side;       /* South=0,North=1*/
  short panel;      /* Panel  (0-3) */
  short slat;       /* Slat   (0-95) */

  short cell[2];    /* AMU cell ID (0-63)
                       [0] = Lower PMT, [1] = Upper PMT */
  short qvc[2];     /* QVC value in channel (0-4095) */
  short tvc[2];     /* TVC value in channel (0-4095) */
};
```

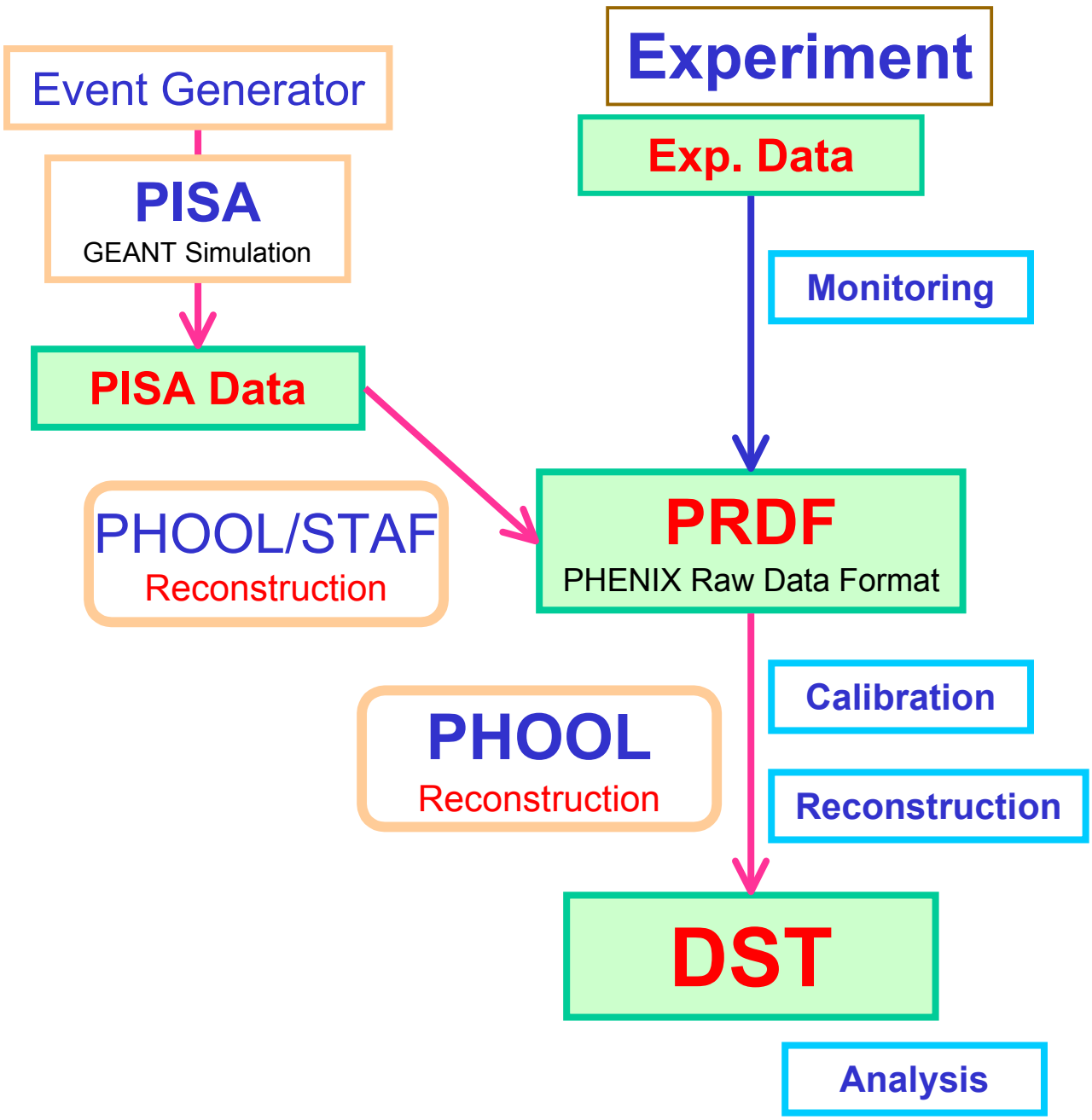
```
/* End-product data structure [dTofReconstructed.idl] */
struct dTofReconstructed {
  short id;         /* Reference key */
  short slatid;     /* Slat ID(0-1056)[refer to dTofGeo]*/
  short sector;     /* Sector (0-1) */
  short side;       /* South=0,North=1*/
  short panel;      /* Panel  (0-3) */
  short slat;       /* Slat   (0-95) */

  float tof;        /* Time-of-flight */
  float eloss;      /* Energy loss */
  float xtof[3];    /* TOF hit position */
  float xtrk[3];    /* Projected track position */
};
```

PHENIX

Event Data I/O

- Simulation (PISA)
  - ZEBRA output
  - ROOT output (under development)
  - Create pseudo Raw data
- Monitoring, Calibration
  - read PRDF
  - write constants to Objectivity database
- Reconstruction
  - read PRDF
  - write DST
- Analysis
  - read DST
  - write histogram

Data Flow

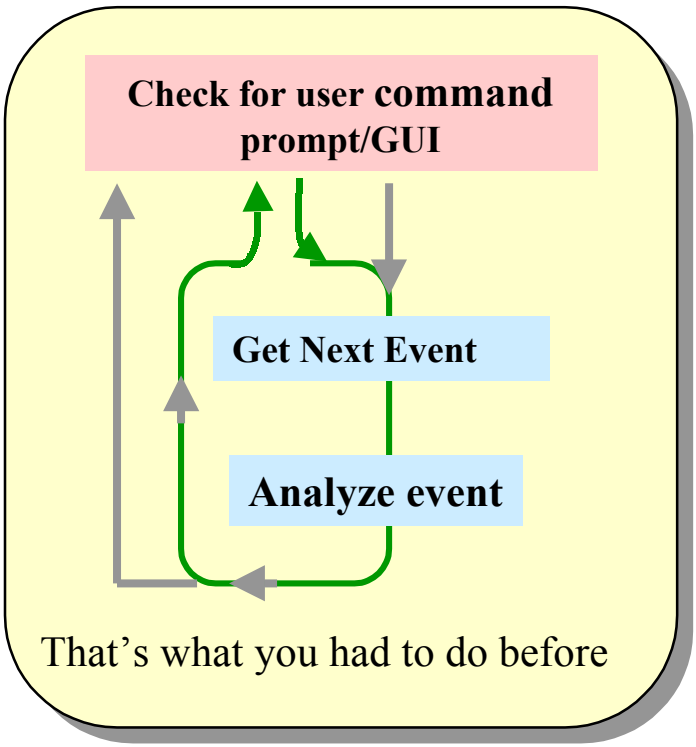

Experiment
Event Generator
Exp. Data
PISA
GEANT Simulation
Monitoring
PISA Data
PHOOL/STAF
Reconstruction
PRDF
PHENIX Raw Data Format
Calibration
PHOOL
Reconstruction
Reconstruction
DST
Analysis

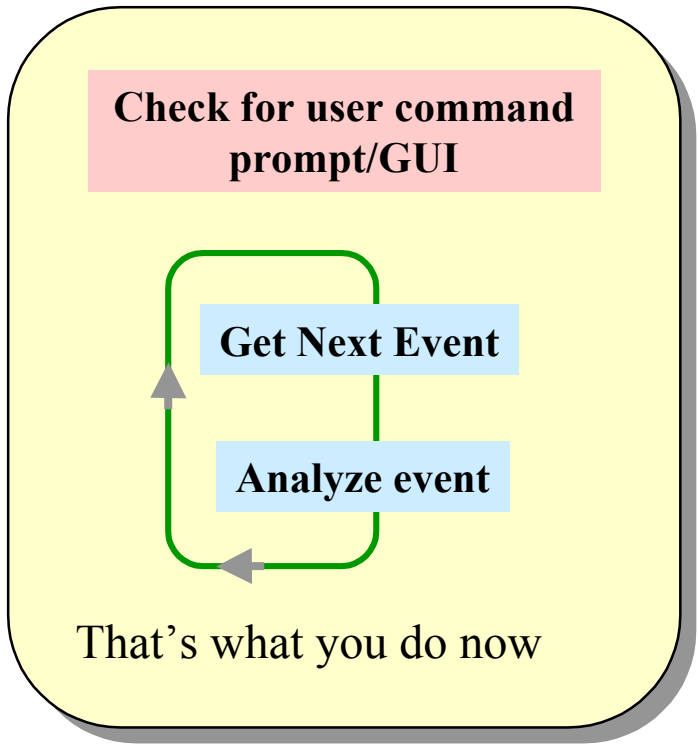
Online Software

- read from PRDF
- Platform : ROOT(monitoring), EPICS(Slow Control)
- Monitoring
  - ROOT, multi-thread ROOT
    - Pulse height (QVC gain)
    - TOF peak
  - EPICS
    - HV value
    - Temperature from ADAM
- read/write Objectivity Database
  - Geometry
  - Calibration
  - HV/Temperature

Online Tool
Multi-threaded ROOT

- Multi-thread ROOT is developed by M.Purschke. It's working.
- It will be integrated official ROOT package.





M.Purschke's Talk @computing meeting Oct.99
http://www.phenix.bnl.gov/WWW/publish/purschke/talks/compmtg06-oct-99

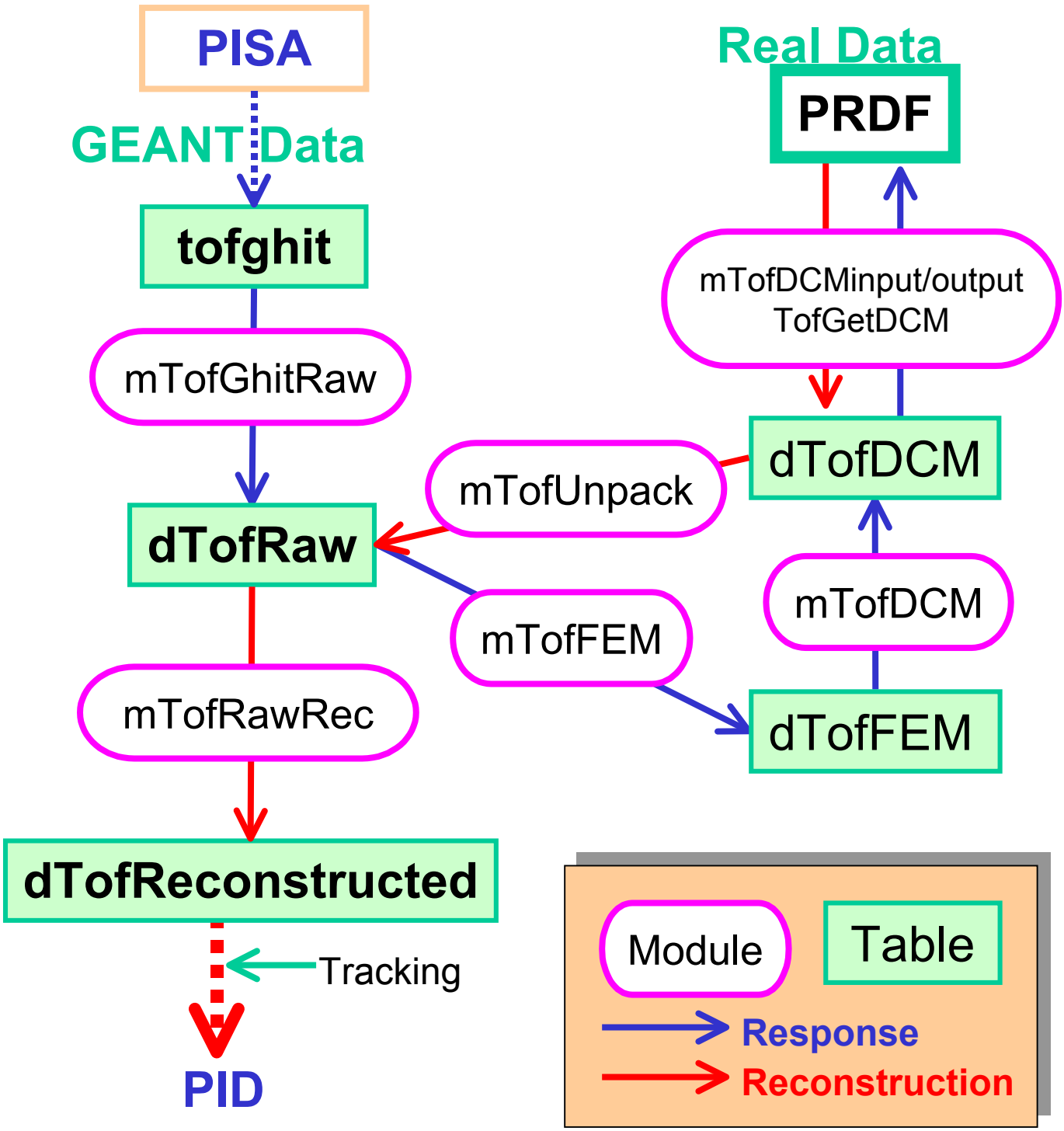
M.Kaneta's document
http://www.phenix-j.rhic.bnl.gov/tof/online/multi-threaded_root/

Offline Software

- Simulation
  - PISA: **PHENIX** Integrated Simulation Application
  - GEANT3 based simulation package
- Calibration
  - read PRDF
  - reach Calibration Parameters
- Reconstruction
  - convert from PRDF to DST
    - using Calibration Parameters
- Physics Analysis
  - PID, spectrum, etc,etc

- PHOOL: **PHENIX** Object Oriented Library
  - Offline framework (I/O, Analysis)
- STAF: Old offline framework

Offline Data Flow (w/Simulation)

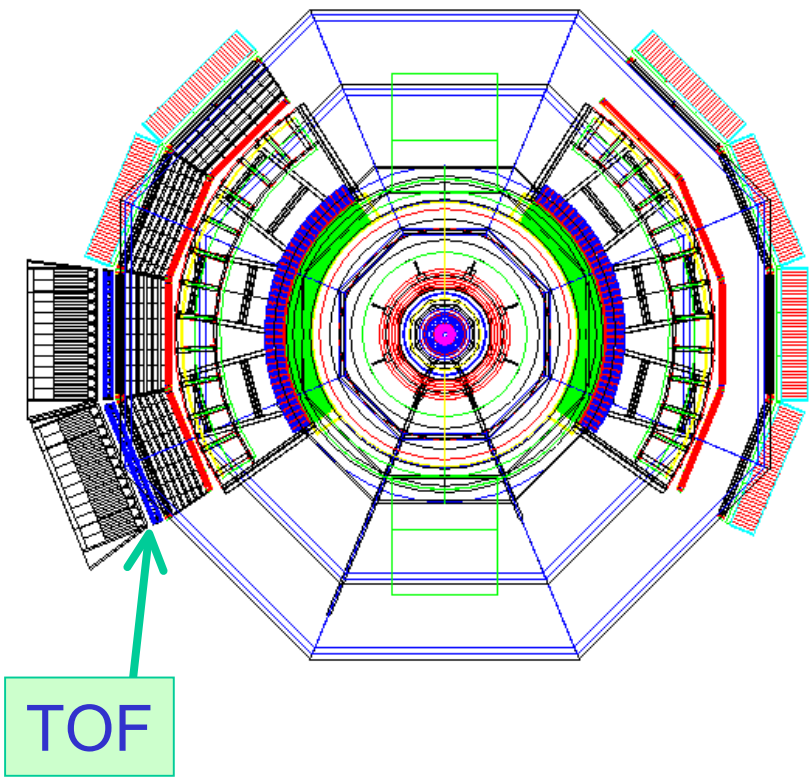


PISA

PHENIX Integrated Simulation Application

- GEANT3 Based Simulation Package
- All of PHENIX detectors, materials
- ZEBRA output

- ROOT-in-PISA project is on going
  - ROOT formatted PISAoutput



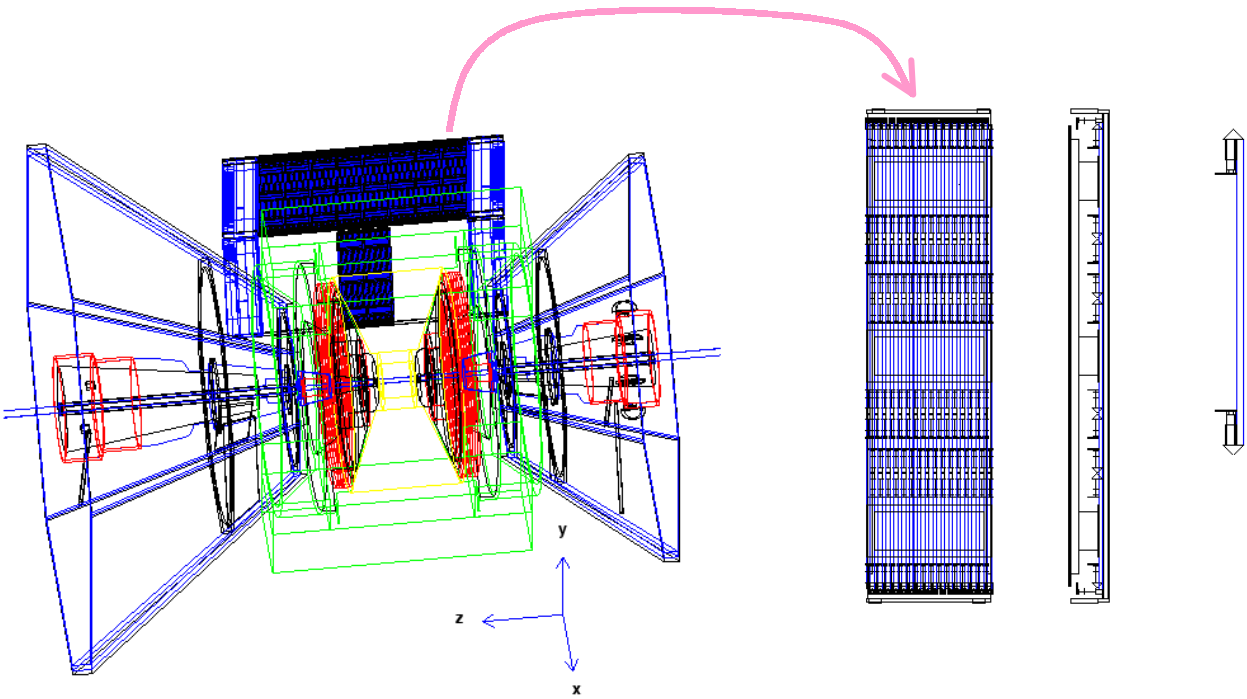
PHOOL

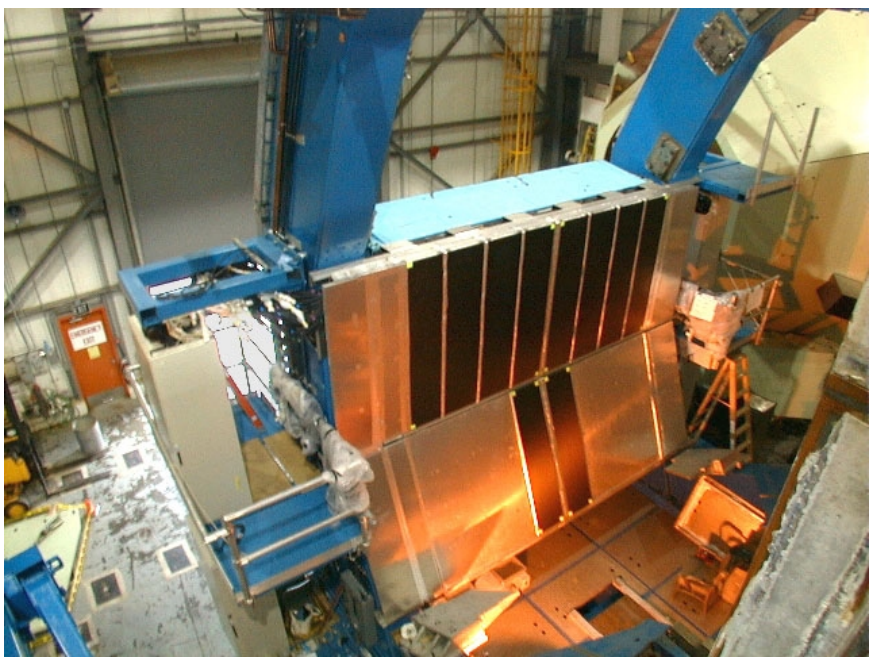
PHENIX Object Oriented Library

- ROOT based Class library
- A Framework for data-handling and I/O
- Flexible tree-structure in memory

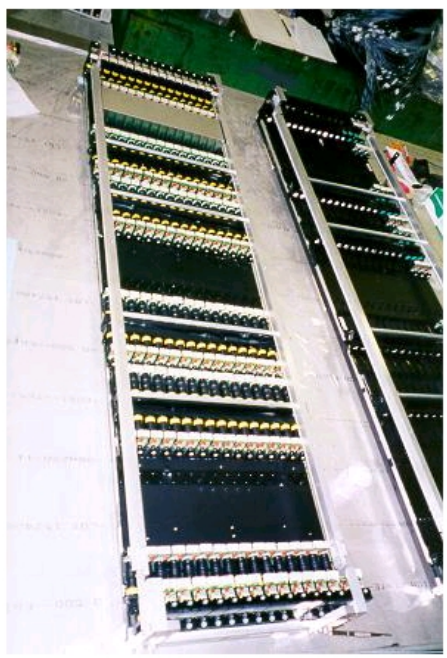
- It will integrate with online system

TOF Geometry in PISA



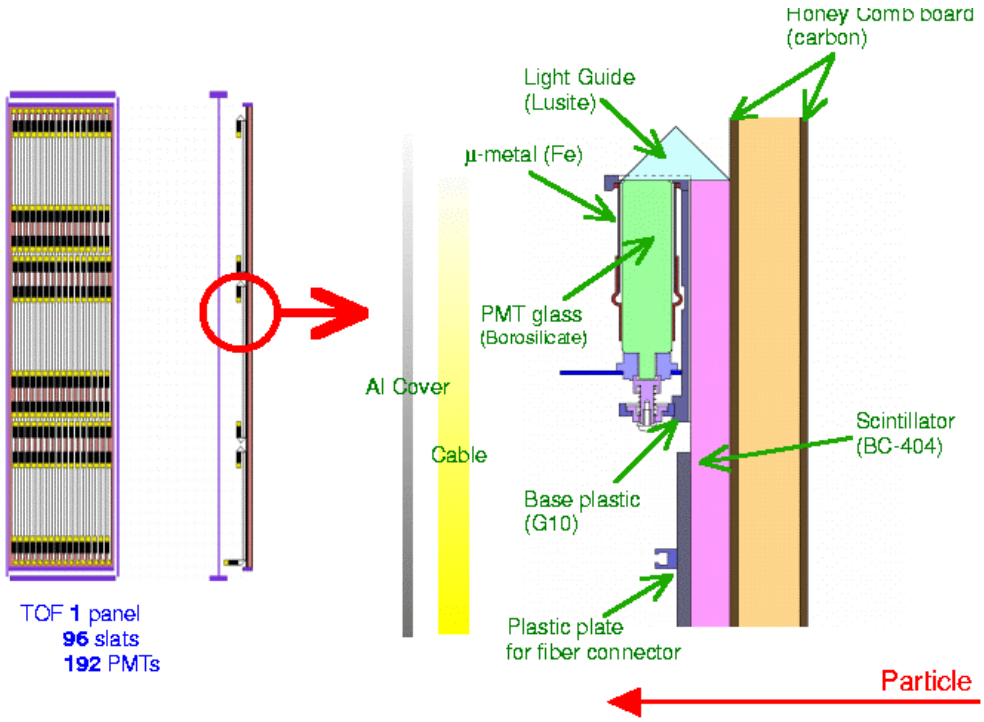


TOF 10 panels on East Arm



1 panel

TOF materials

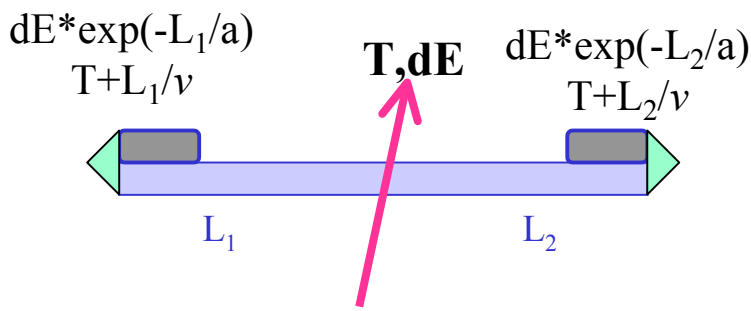


- Sensitive volume
  - Scintillator (BC404)
- Other Materials
  - Honeycomb board
  - Cable
  - Plastic plate
  - PMT (glass, mu-metal)
  - Al frame, cover

TOF Response in PISA

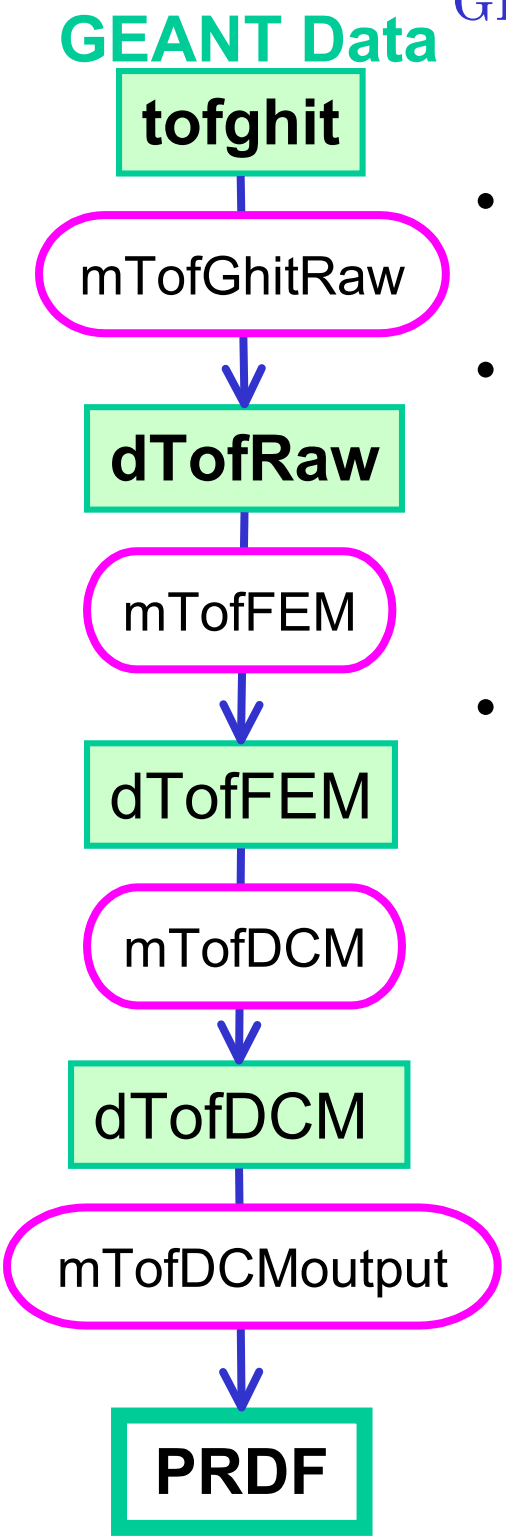
- Response in PISA
  - Energy Loss (step by step [GUSTEP])
  - Flight Times (TOF)

- Digitization (PHOOL/STAF)
  - It make the digitized data for each slat.
  - One data in scintillator slat separate two PMT.
    - PMT gain [QVC] is converted from Energy loss
    - TVC with timing resolution and slewing effect converted from flight times.



TOF Response on PHOOL

GEANT –> PRDF



- Create pseudo raw data from GEANT data
- Include timing resolution, slewing effect and absorption in scintillator

- mTofGhitRaw
  - Convert GEANT/PISA hits into digitized raw data
  - (TOF, Energy loss) --> (TVC,QVC)

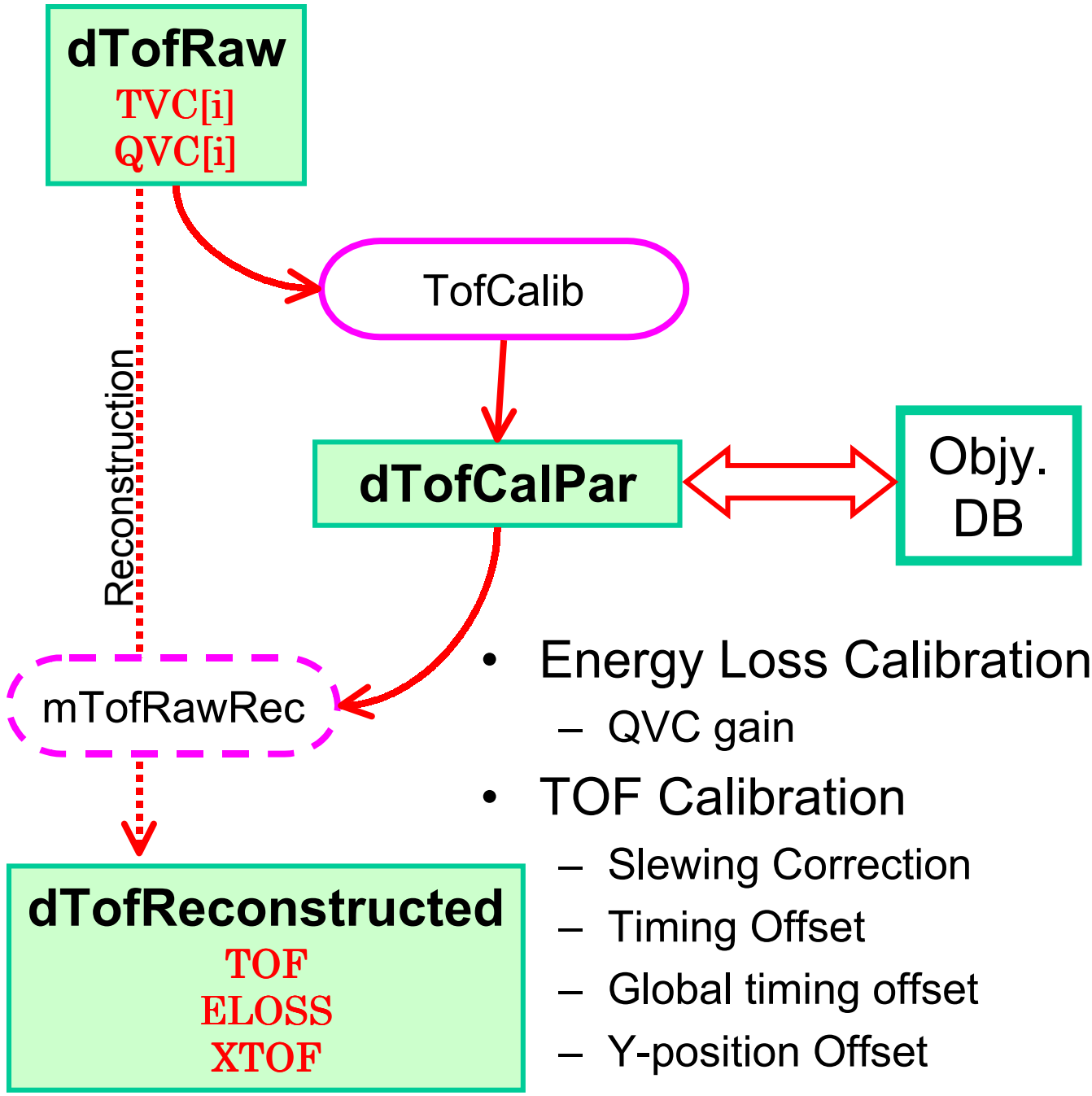
Calibration Parameter

- Measurement
  - TOF = {TVC[0]*Ct[0]+TVC[1]*Ct[1]-(s[0]+s[1])}/2
    - T0[BBC] - T0 - T0[global] - T0[TVC]
  - Y = v/2*(TVC[0]*Ct[0]-TVC[1]*Ct[1])+Y0
  - ELOSS = Cq*sqrt(QVC[0]*QVC[1])

- Parameter

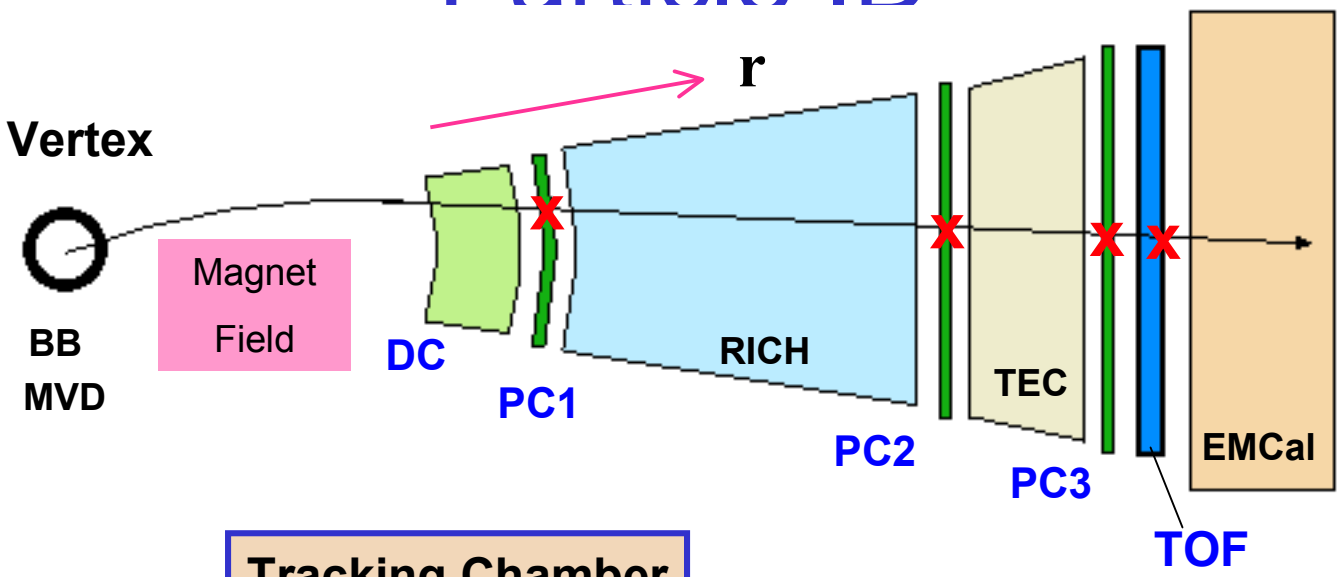
		No.of Parameter
T0	Time offset of each slat	No.of slats
T0[global]	Time offset of a run	1
T0[TVC]	Time offset of each TVC	
Y0	Y-position offset	No.of slats
Cq	QVC gain conversion [eV/ch]	No.of slats
Ct[i]	TVC gain conversion [ps/ch]	No.of PMT
s[i]	Slewing correction function	No.of PMT
	– s[i] = a[i] +b[i]/sqrt(QVC[i])	
v	light velocity in the scintillator	No.of slats

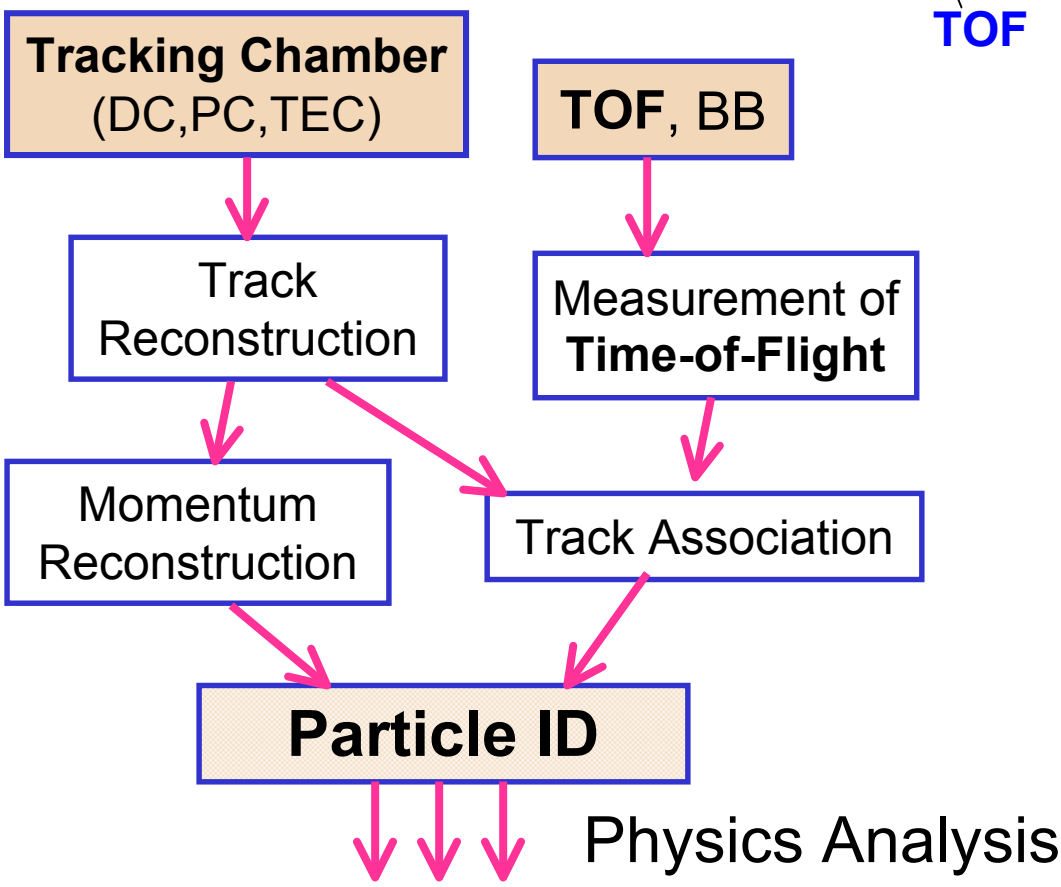
Calibration Chain



- Energy Loss Calibration
  - QVC gain
- TOF Calibration
  - Slewing Correction
  - Timing Offset
  - Global timing offset
  - Y-position Offset

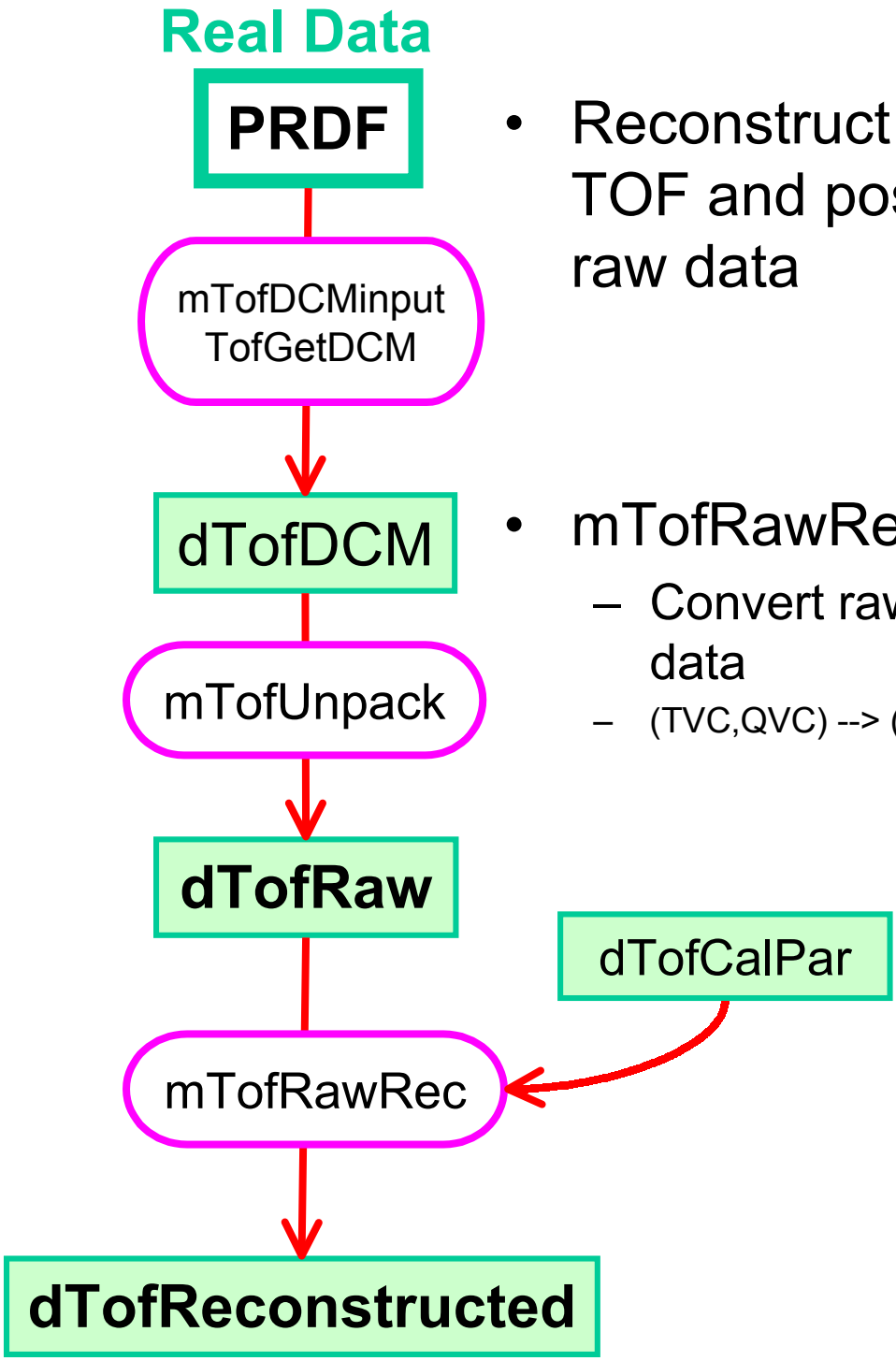
Hadron Measurement
Particle ID





TOF Reconstruction

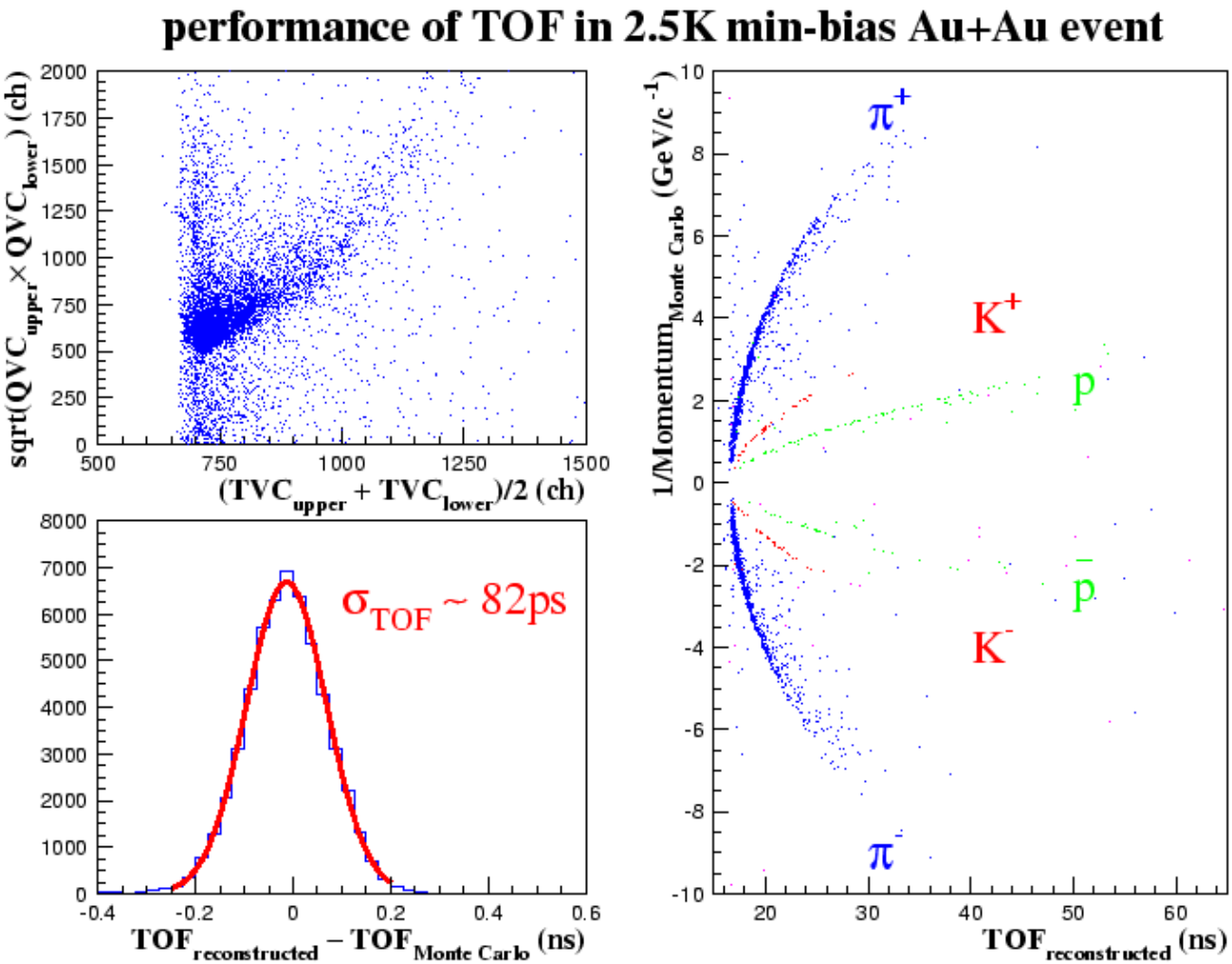
PRDF –> DST



- Reconstruct Energy loss, TOF and position from raw data

- mTofRawRec
  - Convert raw data to DST data
  - (TVC,QVC) --> (TOF, Energy loss)

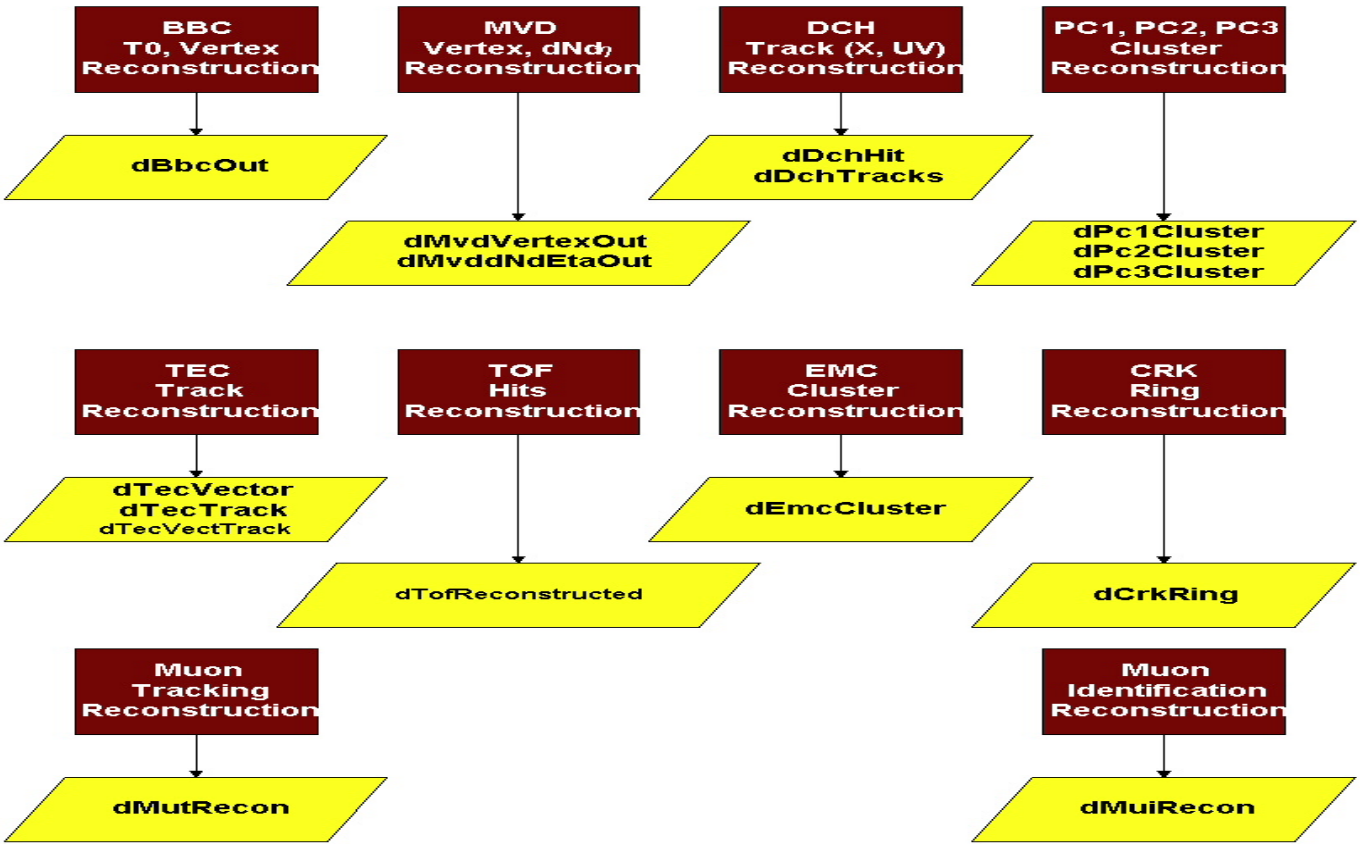
TOF Performance Plot



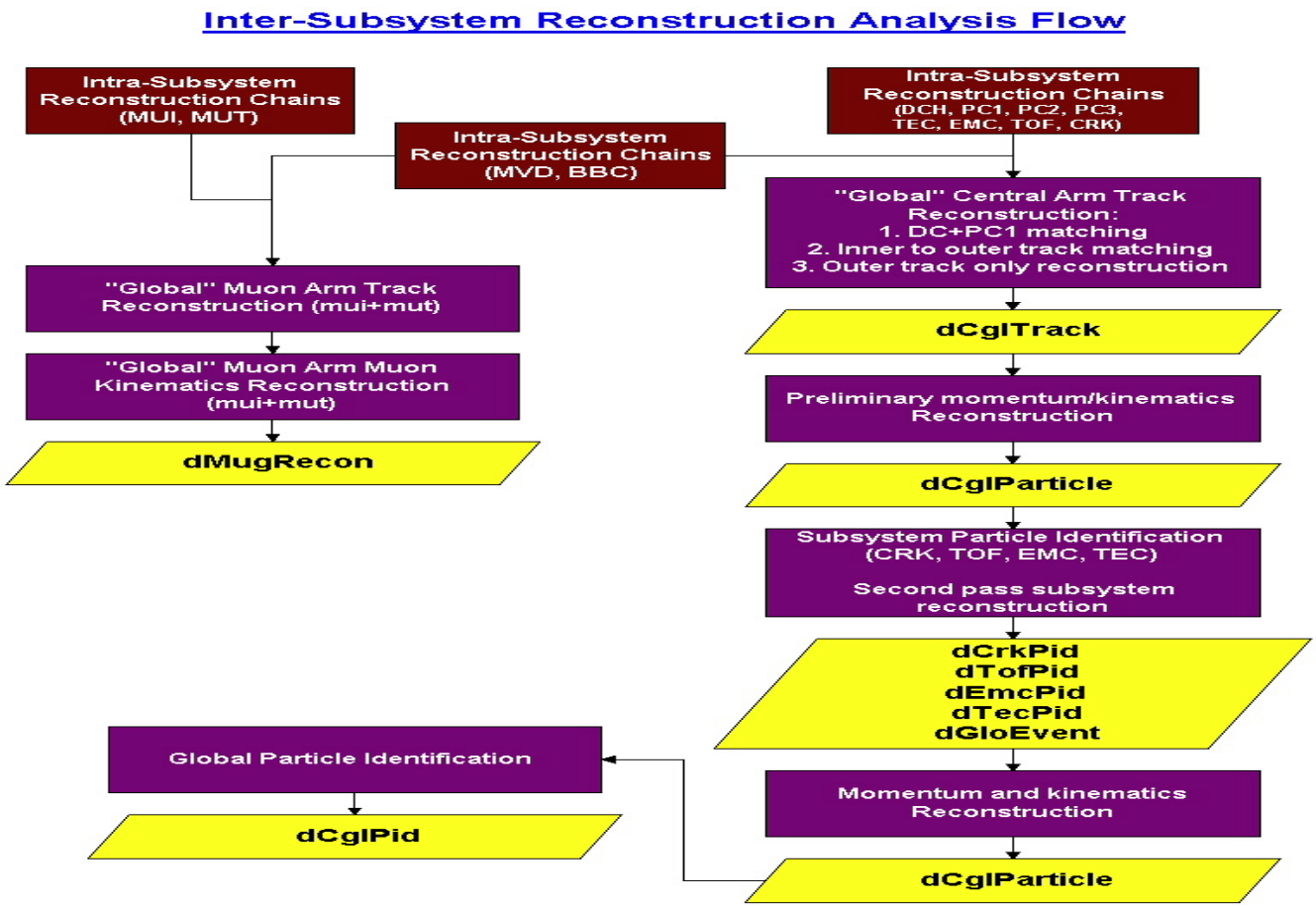
- Evaluation the Reconstructed TOF data and Perfect MC data.

Subsystem Reconstruction

all detectors



Global Tracking

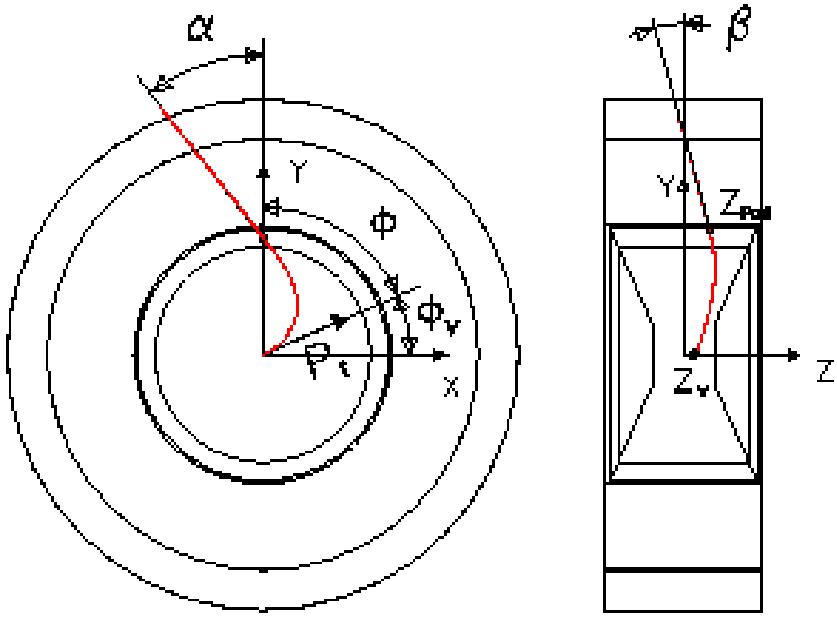


- maintained by Jeffery T. Mitchell(BNL)

http://www.phenix.bnl.gov/WWW/software/luxor/

Momentum Reconstruction

Angle α between track and straight line from R=0 through track intercept at fixed radius.



β, Z_{pad} determined from track projection in plane containing a line.

$1/p_T$, θ, z_V $\longleftrightarrow$ α, β, Z_{pad}

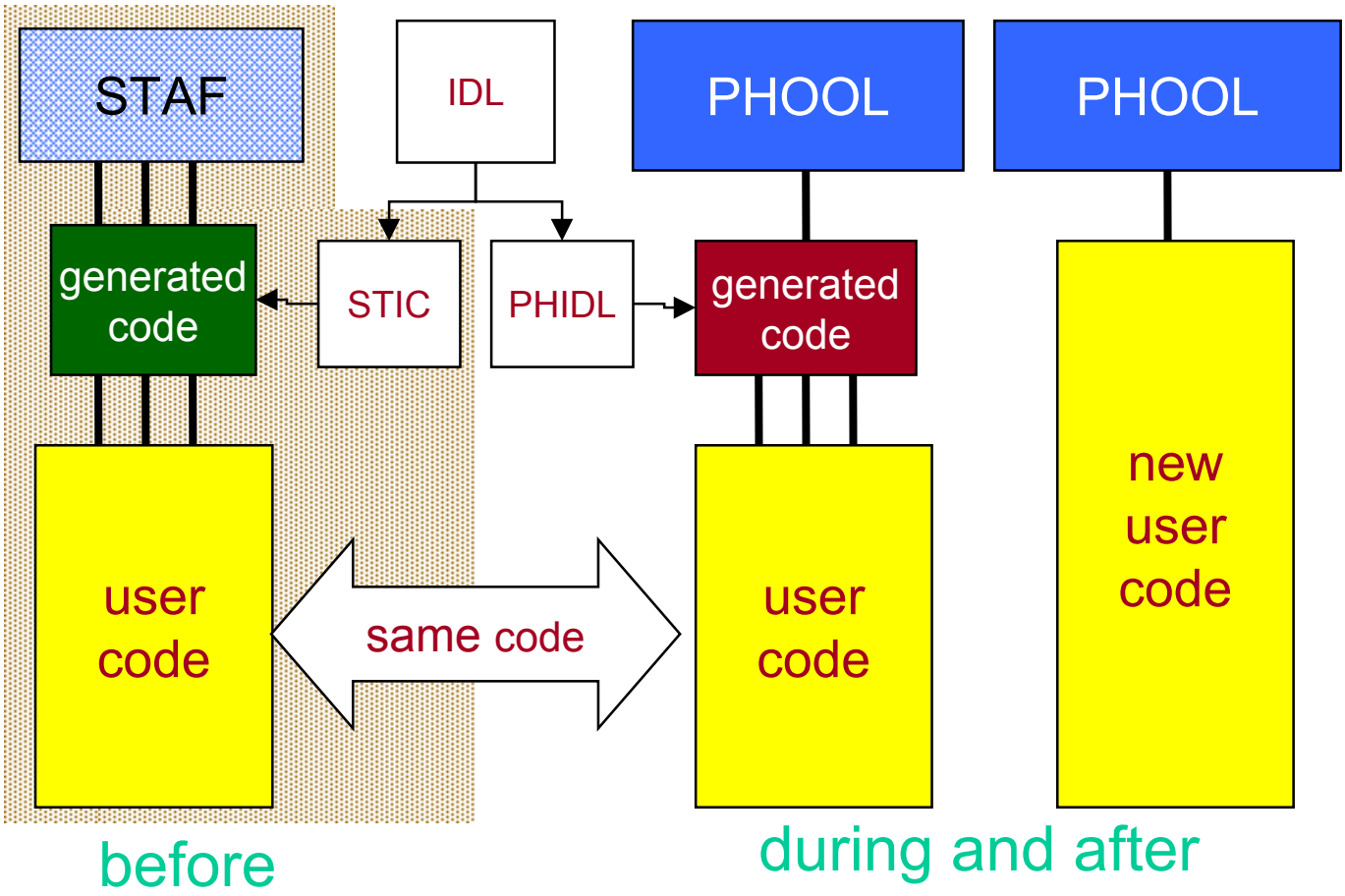
Conclusion & Status

- The official language for PHENIX is C++
- The standard framework for PHENIX is ROOT

- **Online**
  - Y.S. and E.K. started developing TOF online monitoring.
  - M.K. followed multi-thread ROOT and made a document.
  - K.K. developed HV control system using EPICS.
- **Offline**
  - A.K. maintain all of offline code.
  - A.K. started developing calibration code.

STAF/PHOOL

before, during and after



- Most user codes were developed on STAF.
- STAF codes are working on PHOOL by Wrapper.
- New user code should be developed on PHOOL.