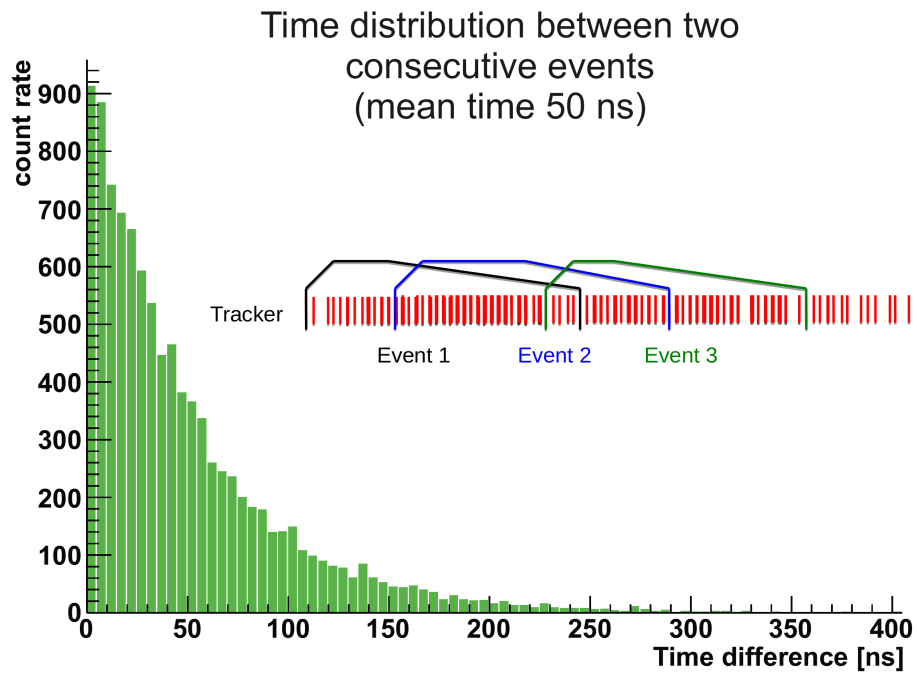


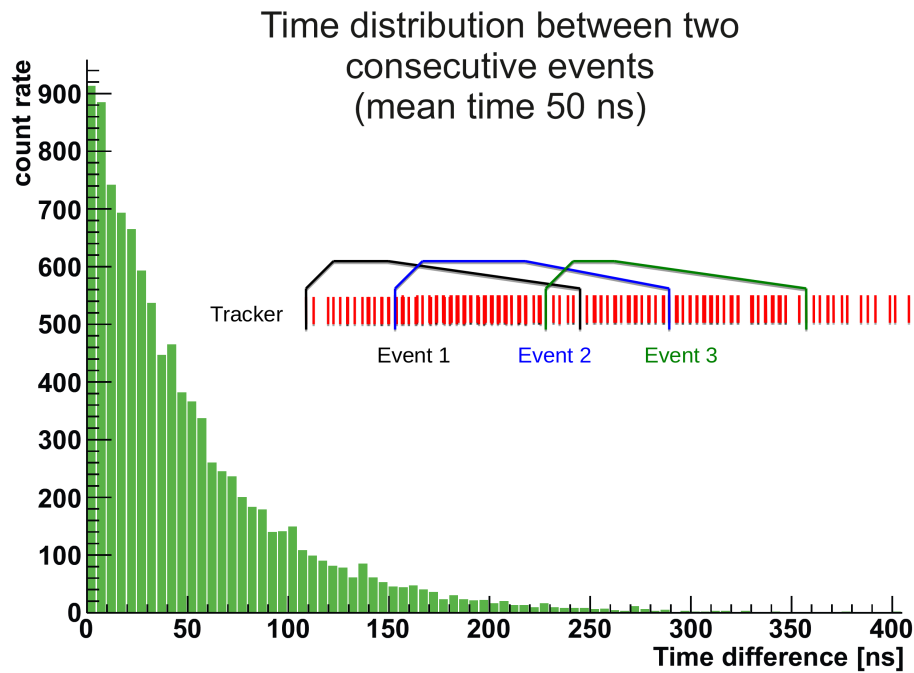
Time Based Reconstruction

Dominik Steinschaden

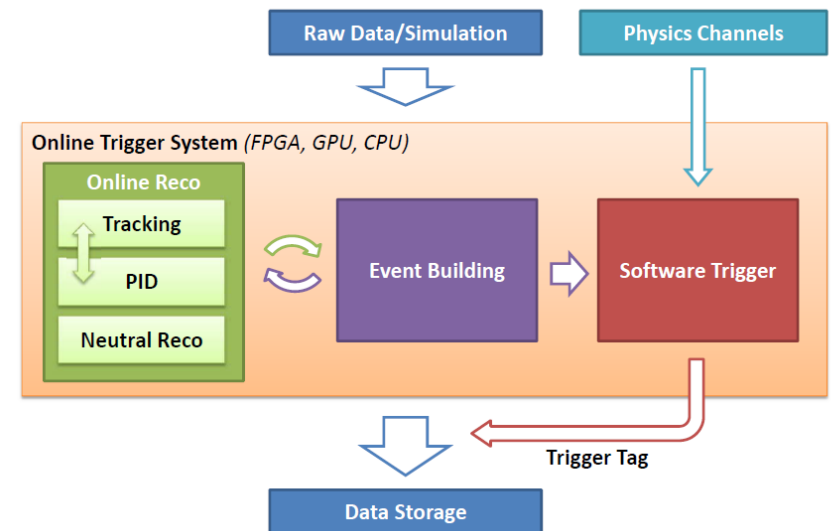
Content

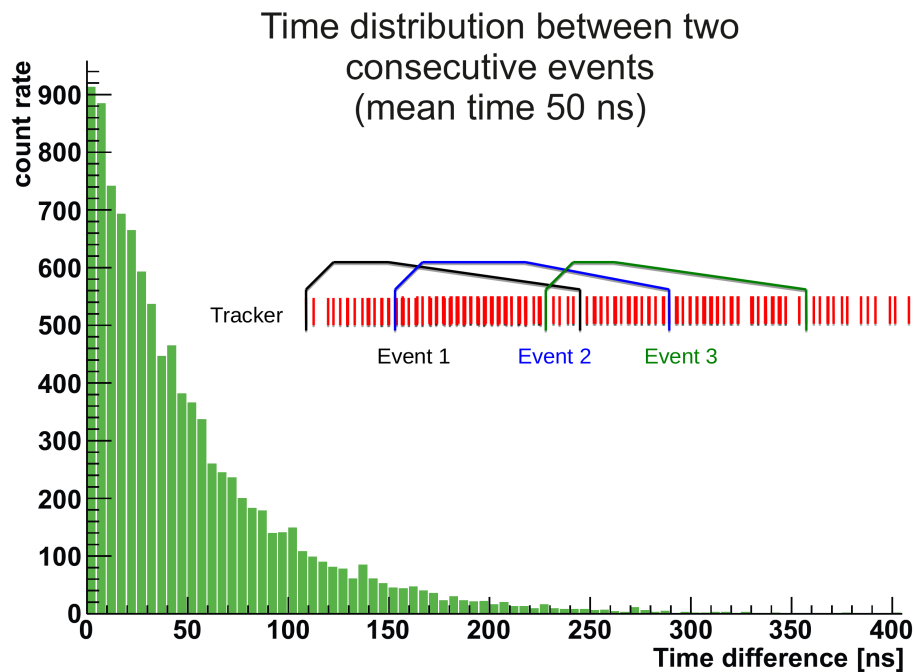
- Introduction
- PndBranchBurstBuilder
- Time based reconstruction
 - SttCellTrackFinder
- Status / Outlook



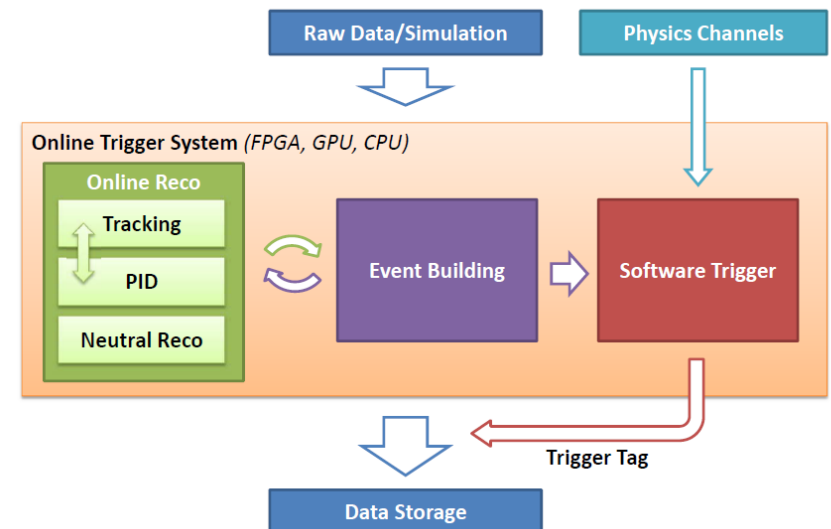


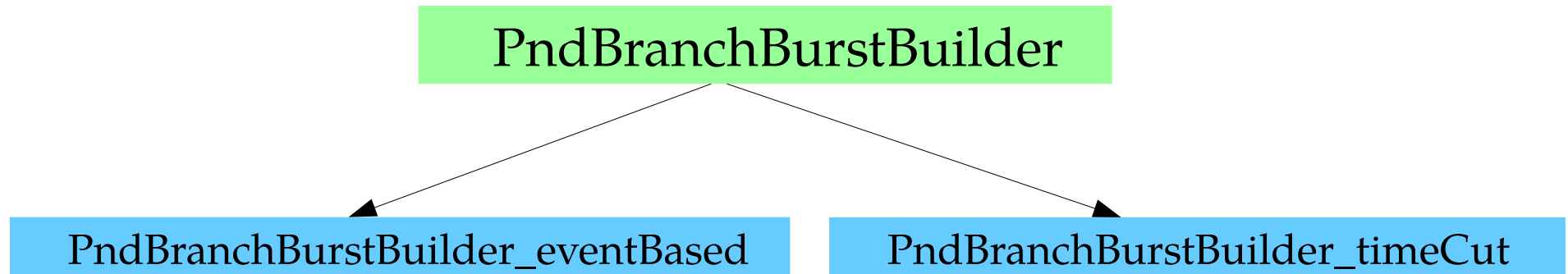
- Perform online tracking and event building
- Software trigger
- ...





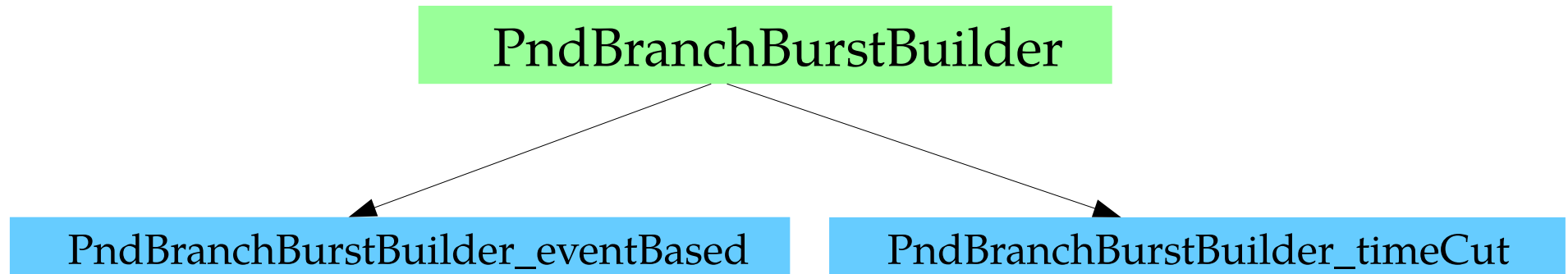
- Break continuous data stream into processable data packages
- Perform online tracking and event building
- Software trigger
- ...





class PndBranchBurstBuilder: public FairTask

- SetOutputPrefix(TString prefix)
- AddInputBranch(TString branchName)
- SetPersistence(Bool_t val)
- virtual InitStatus Init()
- virtual void Exec(Option_t* opt)
- (pure) virtual TClonesArray* GetBurstData(size_t inBranchNum)



PndBranchBurstBuilder

PndBranchBurstBuilder_eventBased

- Simulate burst data
 - in event based simulation
 - Combine defined number of events
 - `SetNEvents(int num)`

PndBranchBurstBuilder

PndBranchBurstBuilder_eventBased

- Simulate burst data
 - in event based simulation
 - Combine defined number of events
 - `SetNEvents(int num)`

```
//-----
//##### Set all tasks #####
//-----

PndBranchBurstBuilder_eventBased* combi = new PndBranchBurstBuilder_eventBased();
combi->AddInputBranch("STTHit");
combi->SetOutputPrefix("Burst");
combi->SetNEvents(nCombi);
combi->SetPersistence(kTRUE);
fRun->AddTask(combi);

PndSttCellTrackFinderTask *cellTrackFinder = new PndSttCellTrackFinderTask();
cellTrackFinder->SetPersistence(kTRUE);
cellTrackFinder->AddHitBranch("Burst_STTHit");
fRun->AddTask(cellTrackFinder);
```

PndBranchBurstBuilder

PndBranchBurstBuilder_eventBased

- Simulate burst data
 - in event based simulation
 - Combine defined number of events
 - **SetNEvents(int num)**

```
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//##### Set all tasks #####
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cellTrackFinder->SetPersistence(kTRUE);
cellTrackFinder->AddHitBranch("Burst_STTHit");
fRun->AddTask(cellTrackFinder);
```

```
*****
*      Row      * Instance * Burst_Sci *
*****
*      0 *      0 *      *
*      1 *      0 *      *
*      2 *      0 * 13.245389 *
*      2 *      1 * 24.491572 *
*      2 *      2 * 24.471389 *
*      2 *      3 * 25.018425 *
*      2 *      4 * 25.188193 *
*      2 *      5 * 25.904298 *
*      2 *      6 * 266.71400 *
*      2 *      7 * 58.633559 *
*      2 *      8 * 60.608678 *
*      2 *      9 * 66.869991 *
*      3 *      0 *      *
*      4 *      0 *      *
*      5 *      0 * 112.00627 *
*      5 *      1 * 269.59419 *
*      5 *      2 * 269.57725 *
*      5 *      3 * 272.71817 *
*      5 *      4 * 277.82846 *
*      5 *      5 * 280.33215 *
*      5 *      6 * 285.55529 *
*      5 *      7 * 295.08023 *
*      5 *      8 * 295.06235 *
*      5 *      9 * 295.00204 *
*      5 *     10 * 295.25728 *
```

PndBranchBurstBuilder

PndBranchBurstBuilder_eventBased

- Simulate burst data
 - in event based simulation
 - Combine defined number of events
 - **SetNEvents(int num)**

```
//-----
//##### Set all tasks #####
//-----

PndBranchBurstBuilder_eventBased* combi = new PndBranchBurstBuilder_eventBased();
combi->AddInputBranch("STTHit");
combi->SetOutputPrefix("Burst");
combi->SetNEvents(nCombi);
combi->SetPersistence(kTRUE);
fRun->AddTask(combi);

PndSttCellTrackFinderTask *cellTrackFinder = new PndSttCellTrackFinderTask();
cellTrackFinder->SetPersistence(kTRUE);
cellTrackFinder->AddHitBranch("Burst_STTHit");
fRun->AddTask(cellTrackFinder);
```

Not sorted in time!

```
*****
*      Row      * Instance * Burst_Sci *
*****
*      0 *      0 *      *      *
*      1 *      0 *      *      *
*      2 *      0 * 13.245389 *
*      2 *      1 * 24.491572 *
*      2 *      2 * 24.471389 *
*      2 *      3 * 25.018425 *
*      2 *      4 * 25.188193 *
*      2 *      5 * 25.904298 *
*      2 *      6 * 266.71400 *
*      2 *      7 * 58.633559 *
*      2 *      8 * 60.608678 *
*      2 *      9 * 66.869991 *
*      3 *      0 *      *      *
*      4 *      0 *      *      *
*      5 *      0 * 112.00627 *
*      5 *      1 * 269.59419 *
*      5 *      2 * 269.57725 *
*      5 *      3 * 272.71817 *
*      5 *      4 * 277.82846 *
*      5 *      5 * 280.33215 *
*      5 *      6 * 285.55529 *
*      5 *      7 * 295.08023 *
*      5 *      8 * 295.06235 *
*      5 *      9 * 295.00204 *
*      5 *     10 * 295.25728 *
```

PndBranchBurstBuilder

PndBranchBurstBuilder_timeCut

PndBranchBurstBuilder

PndBranchBurstBuilder_timeCut

- Cut data stream periodically
 - `SetTimePeriod(int time)`
 - Only in timebased sim!
 - Need sorted timestamps!

PndBranchBurstBuilder

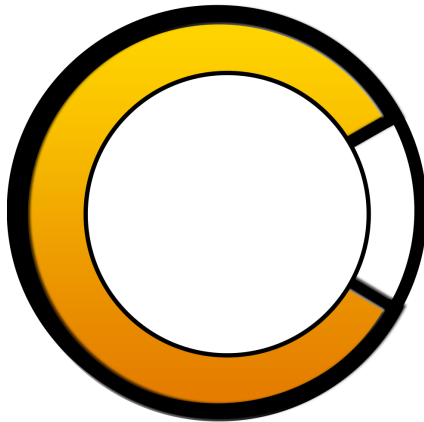


PndBranchBurstBuilder_timeCut

- Cut data stream periodically
 - `SetTimePeriod(int time)`
 - Only in timebased sim!
 - Need sorted timestamps!

- HESR
 - ~ 80% filled
 - ~ 2000 ns revolution time
- ~ 1600 ns beam
- ~ 400 ns gap

PndBranchBurstBuilder

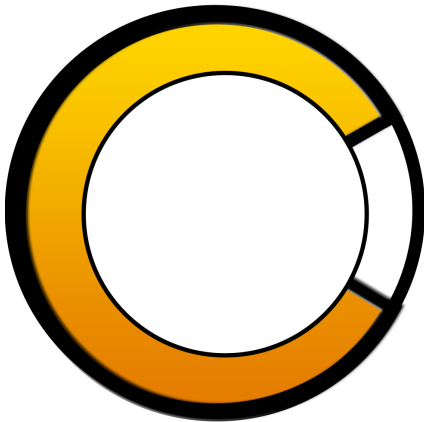


- HESR
 - ~ 80% filled
 - ~ 2000 ns revolution time
- ~ 1600 ns beam
- ~ 400 ns gap

PndBranchBurstBuilder_timeCut

- Cut data stream periodically
 - `SetTimePeriod(int time)`
 - Only in timebased sim!
 - Need sorted timestams!

PndBranchBurstBuilder



- HESR
 - ~ 80% filled
 - ~ 2000 ns revolution time
- ~ 1600 ns beam
- ~ 400 ns gap

PndBranchBurstBuilder_timeCut

- Cut data stream periodically
 - `SetTimePeriod(int time)`
 - Only in timebased sim!
 - Need sorted timestamps!

```
//-----
//##### Set all tasks #####
//-----

PndBranchBurstBuilder_timeCut* burstBuilder = new PndBranchBurstBuilder_timeCut();
burstBuilder->AddInputBranch("STTHit");
burstBuilder->SetOutputPrefix("Burst");
burstBuilder->SetTimePeriod(2000);
burstBuilder->SetPersistence(kTRUE);
fRun->AddTask(burstBuilder);

PndSttCellTrackFinderTask *cellTrackFinder = new PndSttCellTrackFinderTask();
cellTrackFinder->SetPersistence(kTRUE);
cellTrackFinder->AddHitBranch("Burst_STTHit");
fRun->AddTask(cellTrackFinder);
```

PndBranchBurstBuilder

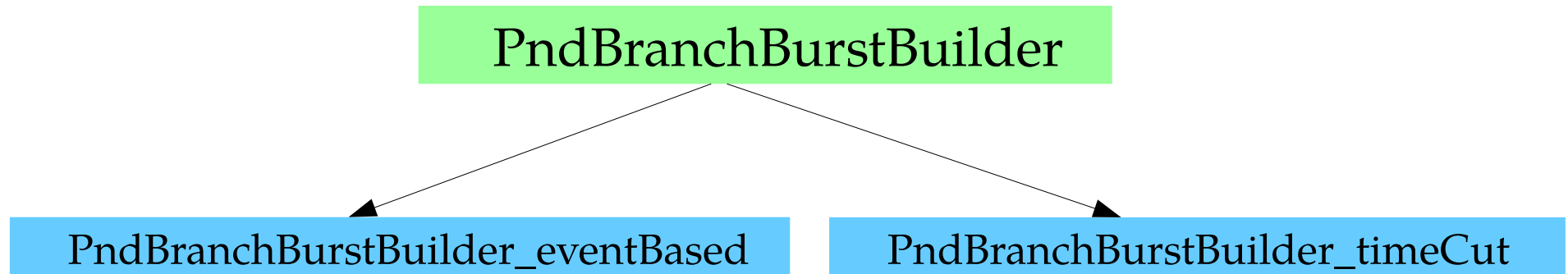
PndBranchBurstBuilder_timeCut

- Cut data stream periodically
 - **SetTimePeriod(int time)**
 - Only in timebased sim!
 - Need sorted timestamps!

```
*****
*      Row      * Instance * Burst_Sci *
*****
*      0 *      0 * 93.258328 *
*      0 *      1 * 222.17709 *
*      0 *      2 * 222.15690 *
*      0 *      3 * 222.70394 *
*      0 *      4 * 222.87371 *
*      0 *      5 * 223.58981 *
*      0 *      6 * 464.39952 *
*      0 *      7 * 566.27125 *
*      0 *      8 * 568.24637 *
*      0 *      9 * 574.50768 *
*      0 *     10 * 1085.6449 *
*      1 *      0 * 2672.4990 *
*      1 *      1 * 2672.4820 *
*      1 *      2 * 2675.6230 *
*      1 *      3 * 2680.7333 *
*      1 *      4 * 2683.2369 *
*      1 *      5 * 2688.4601 *
*      1 *      6 * 2928.5217 *
*      1 *      7 * 2928.5038 *
*      1 *      8 * 2928.4435 *
*      1 *      9 * 2928.6987 *
*      2 *      0 * 4353.0549 *
*      2 *      1 * 4473.5797 *
*      2 *      2 * 4473.8398 *
*      2 *      3 * 4474.3739 *
```

```
//-----
//##### Set all tasks #####
//-----
PndBranchBurstBuilder_timeCut* burstBuilder = new PndBranchBurstBuilder_timeCut();
burstBuilder->AddInputBranch("STTHit");
burstBuilder->SetOutputPrefix("Burst");
burstBuilder->SetTimePeriod(2000);
burstBuilder->SetPersistence(kTRUE);
fRun->AddTask(burstBuilder);

PndSttCellTrackFinderTask *cellTrackFinder = new PndSttCellTrackFinderTask();
cellTrackFinder->SetPersistence(kTRUE);
cellTrackFinder->AddHitBranch("Burst_STTHit");
fRun->AddTask(cellTrackFinder);
```



- Upload to trunk ~ end of September
 - Adjustment of Fairlinks missing
(If needed)

Time based Reconstruction

SttCellTrackFinder

Status from PCM 2/2017:

- Updated interface
 - Works now with any input branch name
 - “PndSttHit”
 - You can specify an output prefix
 - Works now also with bursts of events
- Evaluate the efficiency for time based data
 - Work ongoing

- Simulation
 - Generator: DPM
 - Momentum: 7 GeV/c
 - 10 000 events
- Digitization (event based)
- Digitization (time based)
 - 2, 20 MHz event rate
 - 1600 ns beam
 - 400 ns gap
- Reconstruction (SttCellTrackFinder)
 - Event based
 - Event based data bursts
 - 1 – 60 events /burst
 - Time based bursts
 - 2, 20 MHz

```
// -----
//##### Set all tasks #####
// -----

PndBranchBurstBuilder_eventBased* combi = new PndBranchBurstBuilder_eventBased();
combi->AddInputBranch("STTHit");
combi->SetOutputPrefix("Burst");
combi->SetNEvents(nCombi);
combi->SetPersistence(kTRUE);
fRun->AddTask(combi);

PndSttCellTrackFinderTask *cellTrackFinder = new PndSttCellTrackFinderTask();
cellTrackFinder->SetPersistence(kTRUE);
cellTrackFinder->AddHitBranch("Burst_STTHit");
fRun->AddTask(cellTrackFinder);
```

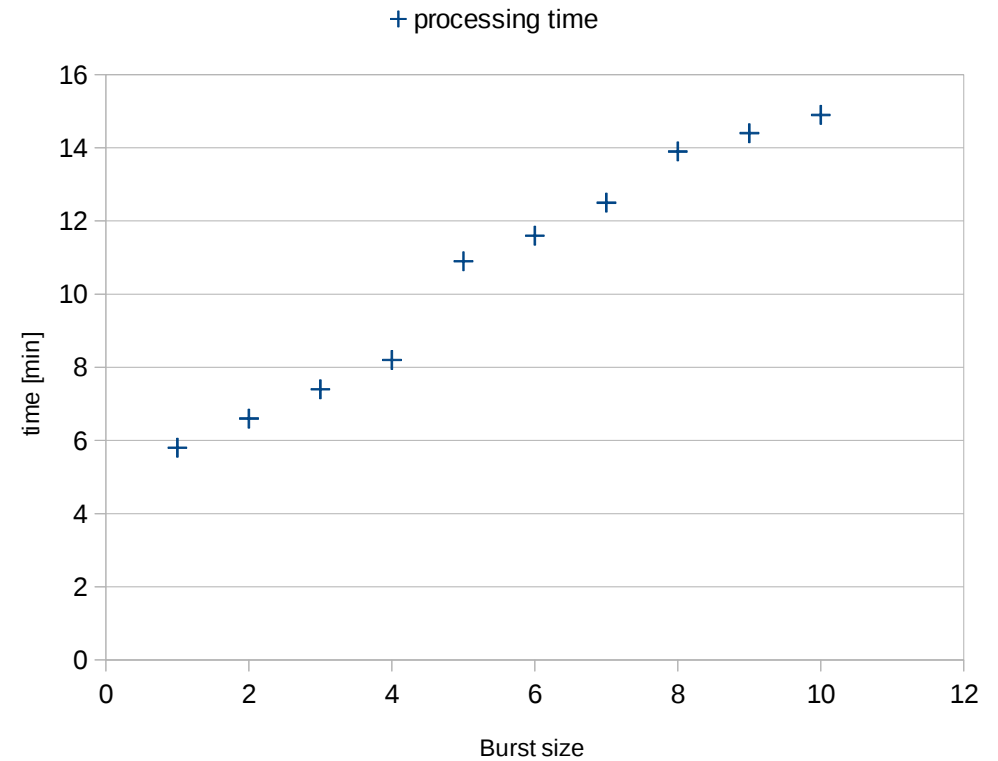
```
// -----
//##### Set all tasks #####
// -----

PndBranchBurstBuilder_timeCut* burstBuilder = new PndBranchBurstBuilder_timeCut();
burstBuilder->AddInputBranch("STTHit");
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cellTrackFinder->AddHitBranch("Burst_STTHit");
fRun->AddTask(cellTrackFinder);
```

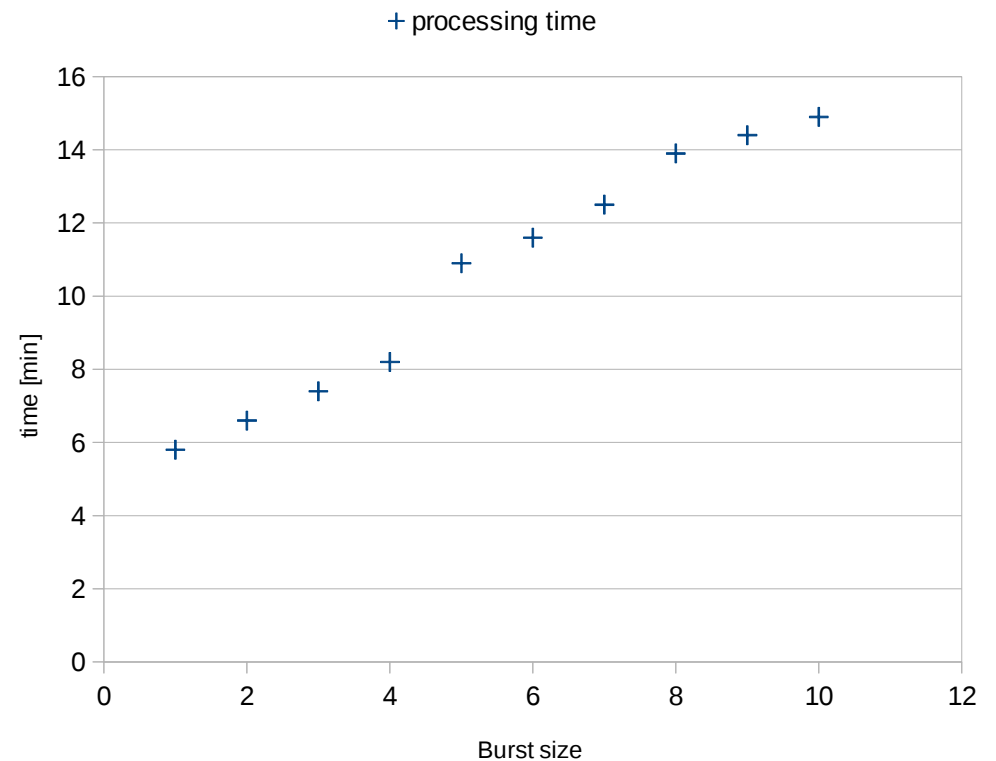
- Burst reconstruction works!
- Total processing time ~ burst size

Reco processing time



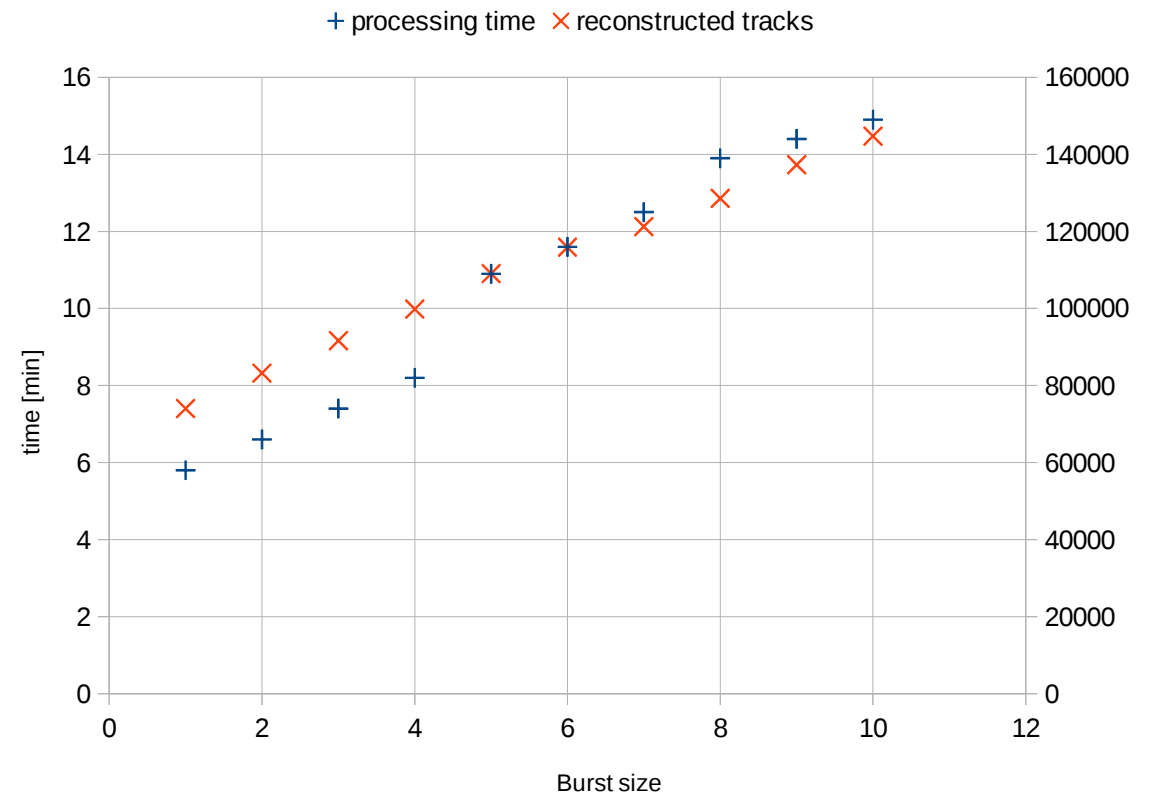
- Burst reconstruction works!
- Total processing time ~ burst size
 - Less packages
 - More tracklets per package
 - => more combinatorics

Reco processing time



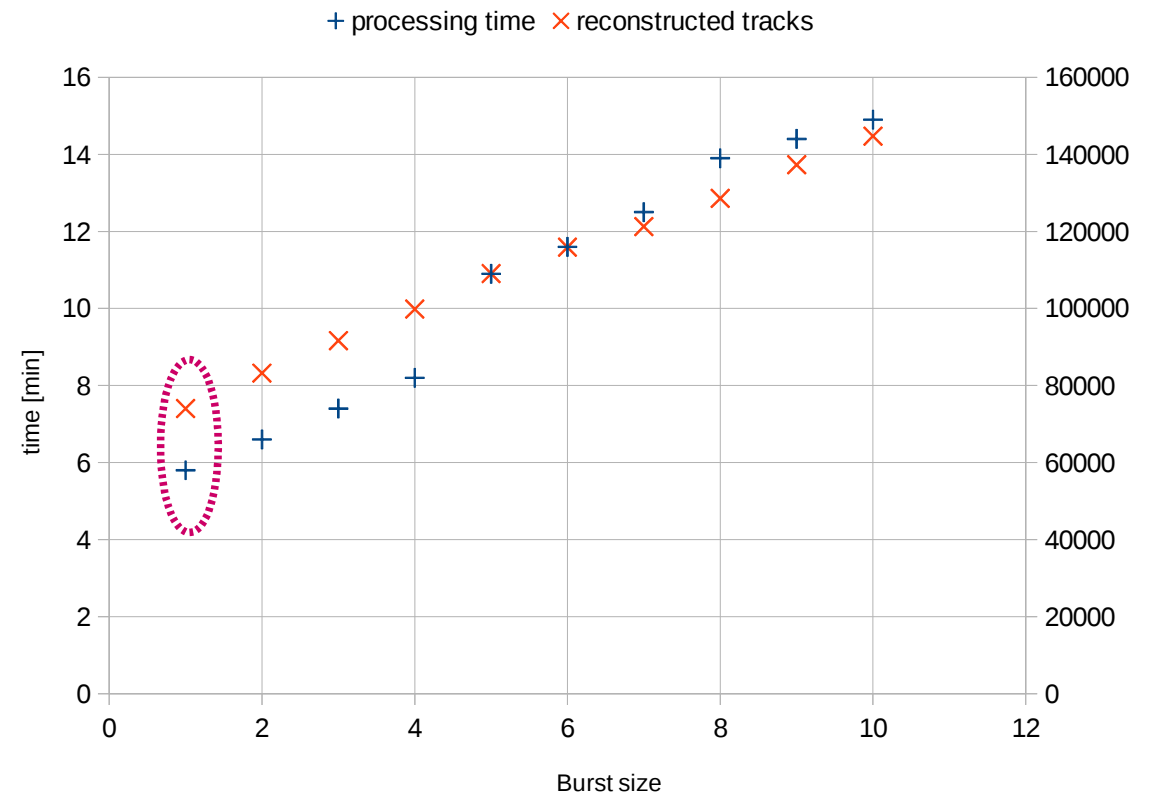
- Burst reconstruction works!
- Total processing time ~ burst size
 - Less packages
 - More tracklets per package
 - => more combinatorics
- Total # reconstructed tracks ~ burst size
 - # MC Tracks constant
 - => increased number of ghost tracks

Reco tracks and processing time



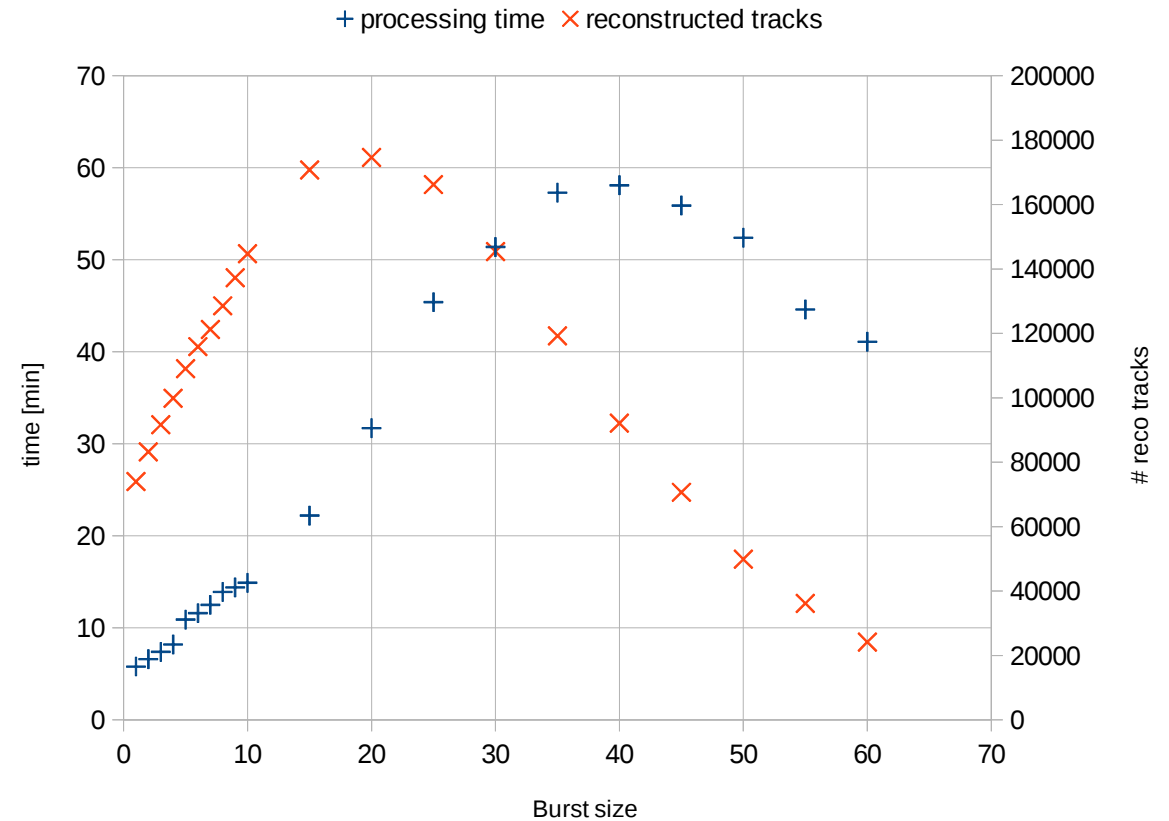
- Burst reconstruction works!
- Total processing time ~ burst size
 - Less packages
 - More tracklets per package
 - => more combinatorics
- Total # reconstructed tracks ~ burst size
 - # MC Tracks constant
 - => increased number of ghost tracks
- Event based = 1 event/burst reconstruction

Reco tracks and processing time

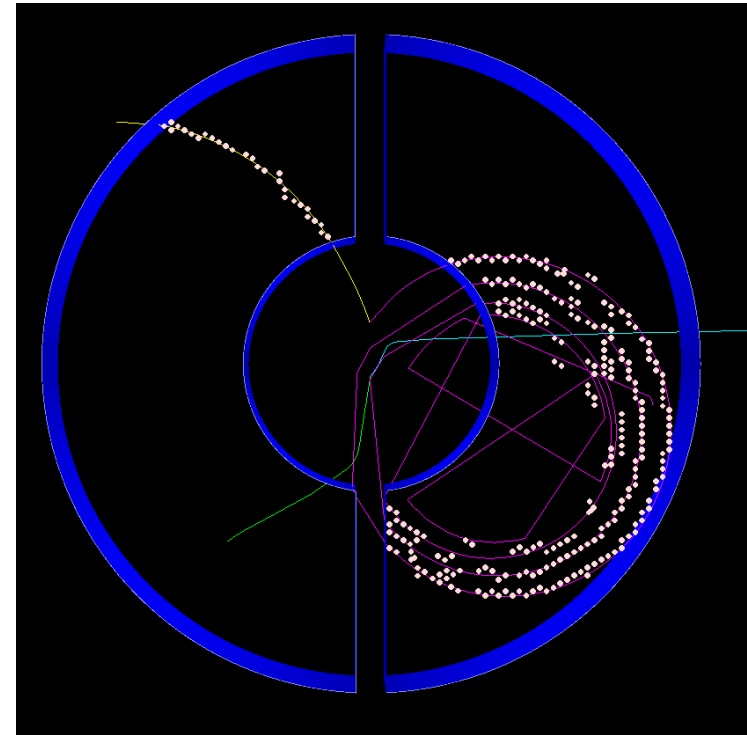


- Burst reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Event based = 1 event/burst reconstruction

Reco tracks and processing time

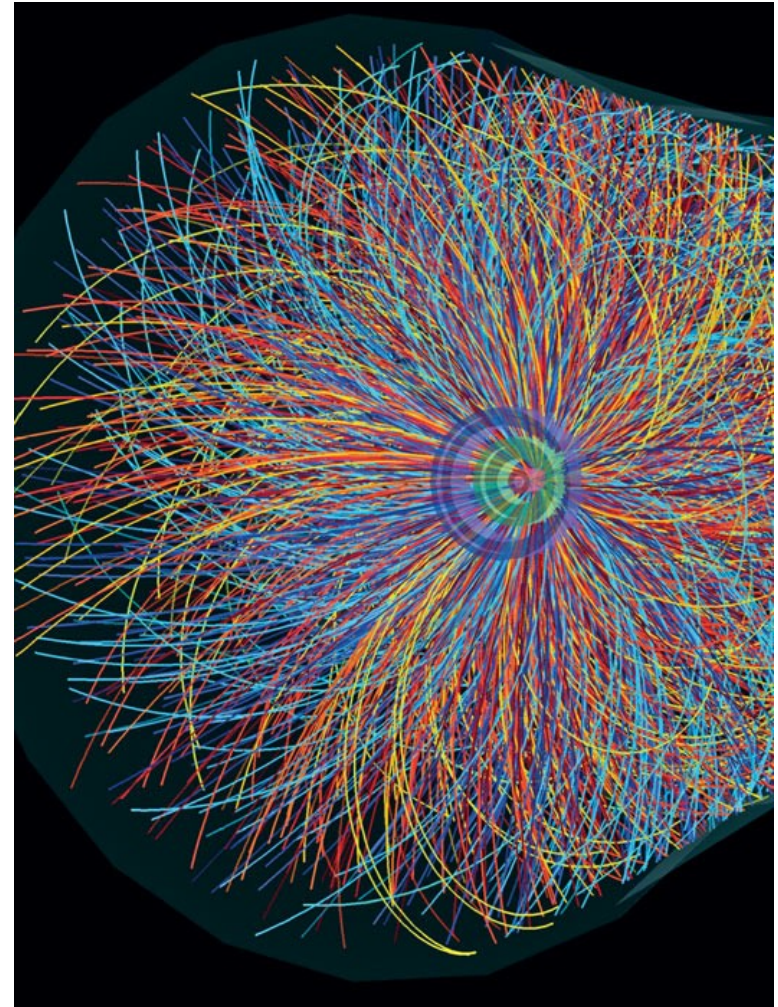


- Burst reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Event based = 1 event/burst reconstruction



$$p\bar{p} \rightarrow \Lambda\bar{\Lambda} \rightarrow p\pi^- \bar{p}\pi^+$$

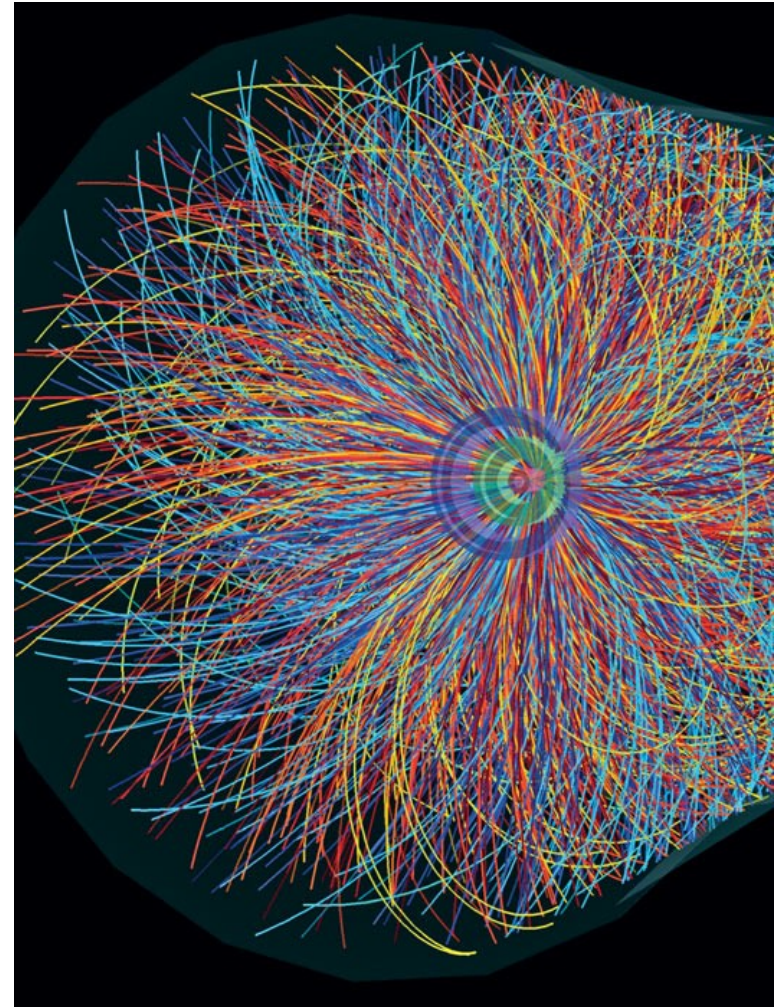
- Burst reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Event based = 1 event/burst reconstruction



Cern courier 31 may 2012

Alice lead lead collision

- Burst reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Event based = 1 event/burst reconstruction
- Large burst size
 - Less separated tracklets (seeds)
 - Still high combinatoric (processing time)
 - Less reconstructed tracks

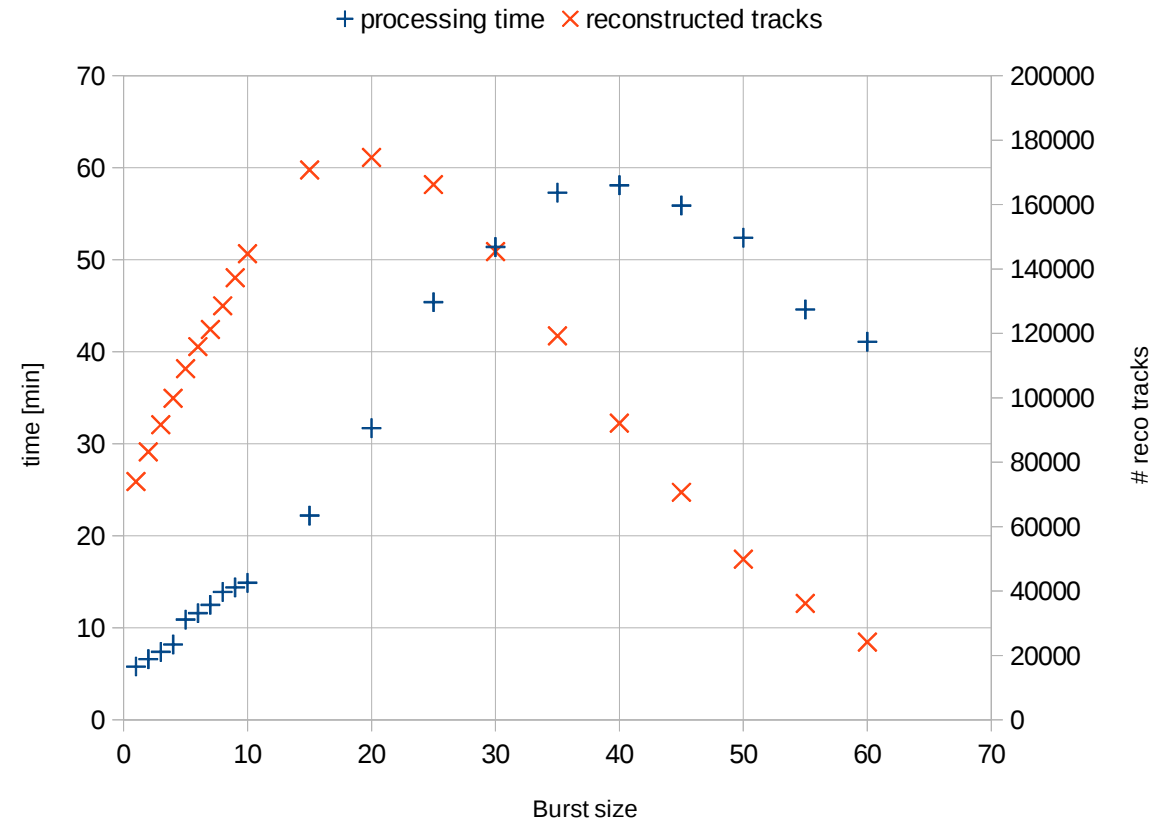


Cern courier 31 may 2012

Alice lead lead collision

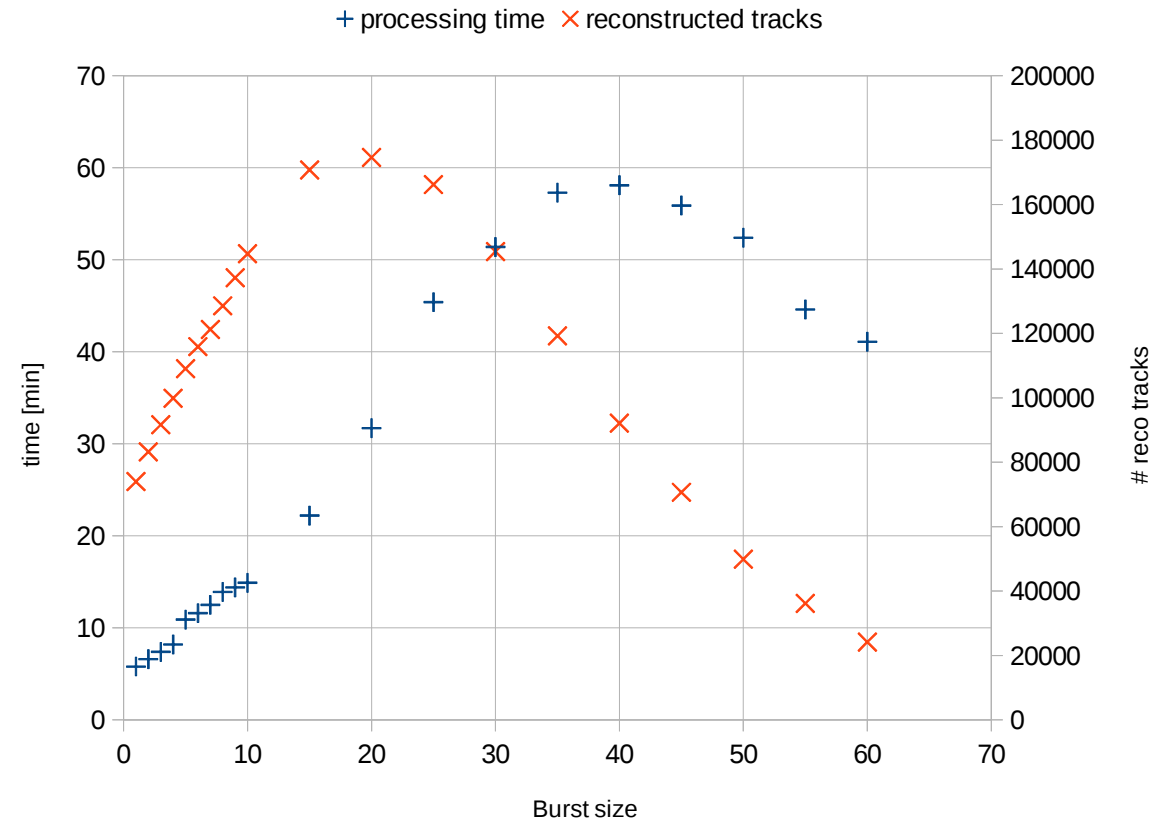
- Burst reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Event based = 1 event/burst reconstruction
- Large burst size
 - Less separated tracklets (seeds)
 - Still high combinatoric (processing time)
 - Less reconstructed tracks
- Time information not used

Reco tracks and processing time



- Burst reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Event based = 1 event/burst reconstruction
- Large burst size
 - Less separated tracklets (seeds)
 - Still high combinatoric (processing time)
 - Less reconstructed tracks
- Time information not used
 - Additional coordinate
 - More separate tracklets
 - Less combinatorics

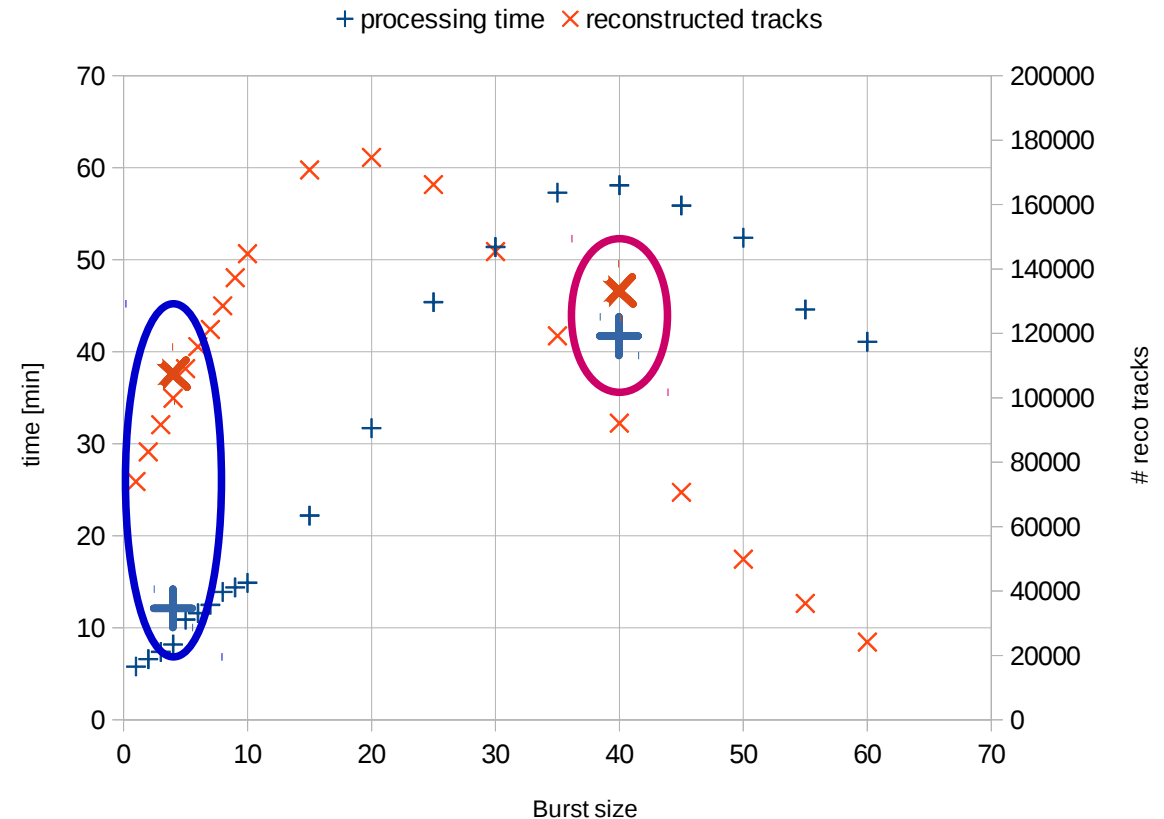
Reco tracks and processing time



First full time based track reconstruction with pandaroot!

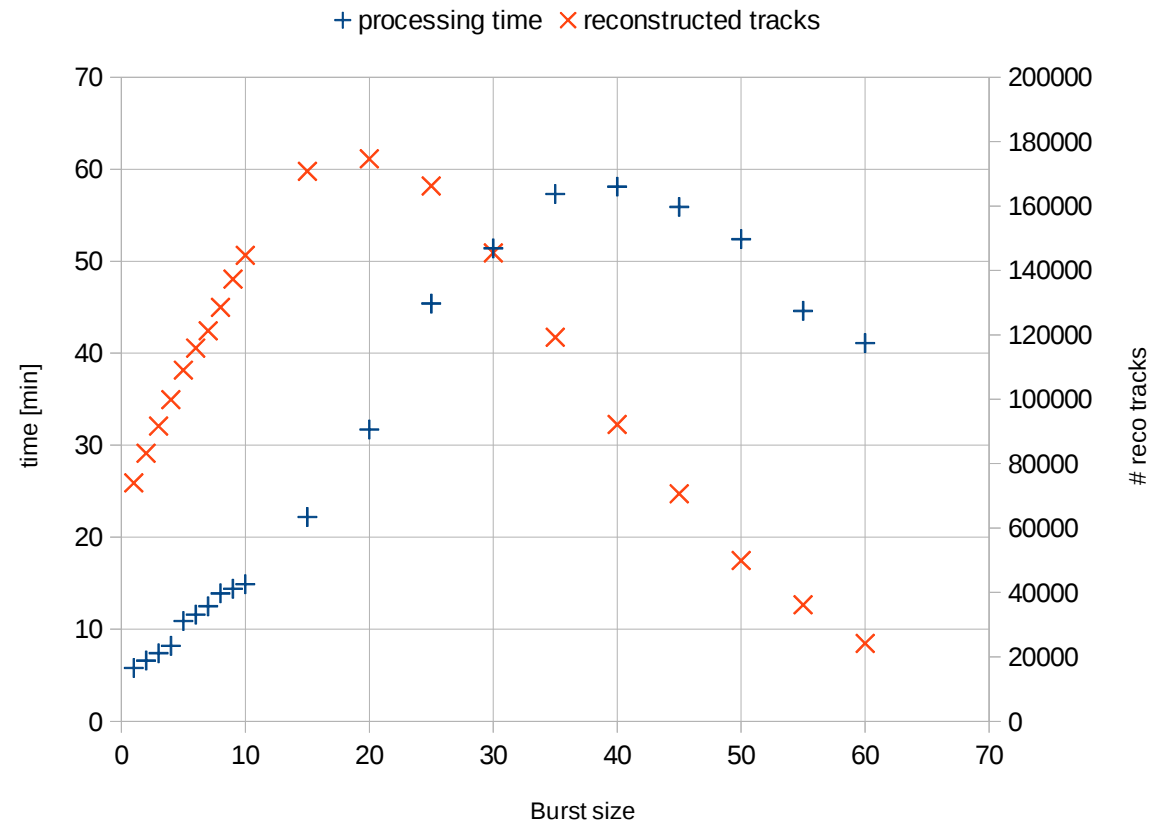
- Timebased reconstruction works!
 - 2 MHz
 - 20 MHz
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Event based = 1 event/burst reconstruction
- Time information not used
- Large burst size
 - Less separated tracklets (seeds)
 - Still high combinatoric (processing time)
 - Less reconstructed tracks

Reco tracks and processing time



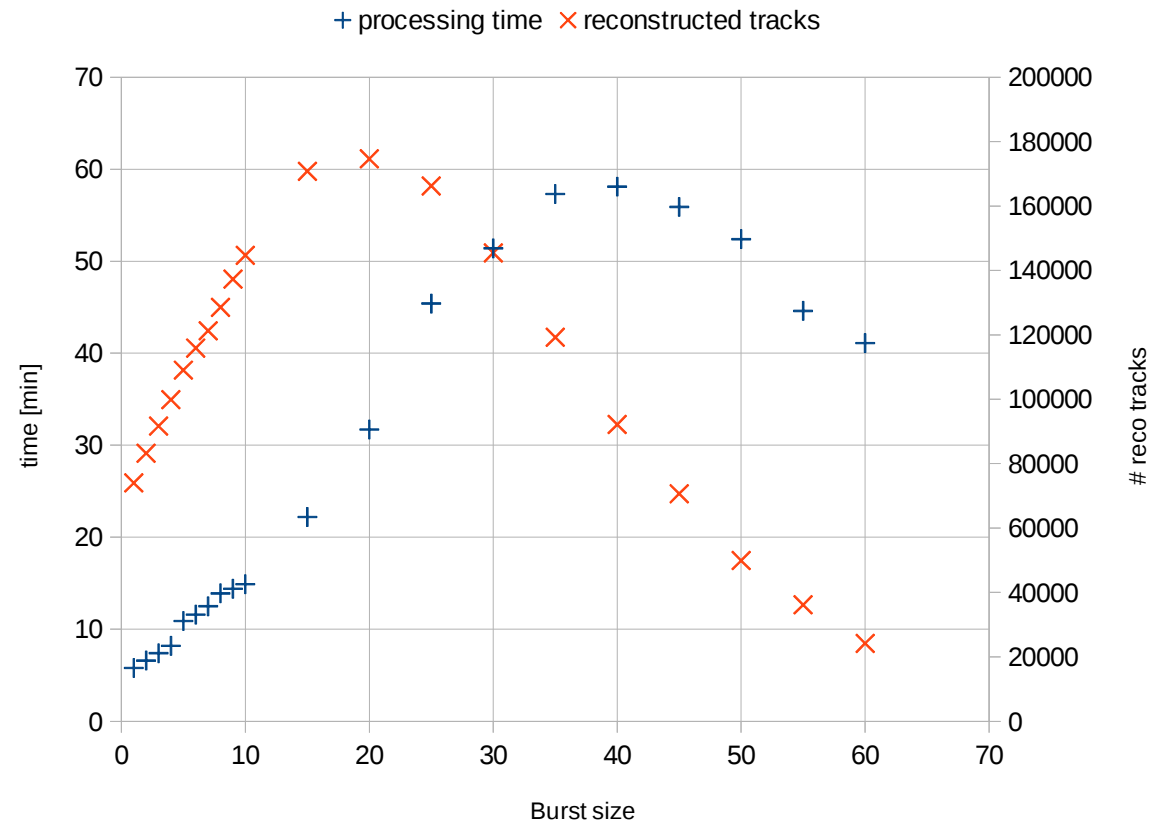
- Burst reconstruction works!
- Timebased reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Time information not used
- Loss of Ghosts or MC Tracks?

Reco tracks and processing time



- Burst reconstruction works!
- Timebased reconstruction works!
- Total processing time $\sim$ burst size
- Total # reconstructed tracks $\sim$ burst size
- Time information not used
- Loss of Ghosts or MC Tracks?
 - We can not study that (now)

Reco tracks and processing time



- Burst reconstruction works!
- Timebased reconstruction works!
- Total processing time ~ burst size
- Total # reconstructed tracks ~ burst size
- Time information not used
- Loss of Ghosts or MC Tracks?
 - We can not study that (now)

Tracking QA Task

- Works only for event based data!
- => we need a more general QA task
 - Event based, burst , time based
 - comparability

Time based digitization

Detector	DigiTask	Flight time	Event time	Time based	FairLinks (time based)
MVD	PndMvdDigiTask				
STT	PndSttHitProducerRealFull			Pile up?	
SciTil/Btof	PndSciTDigiTask				
EMC					
Gem	PndGemDigitize				
Ftof	PndFtofHitProducerIdeal				
DIRC	?				
MDT	?				
FTS	?				
RICH	?				

Time based digitization

- Time based digitization doesn't work out of the box

- Update time based example macros
- Evaluate status unclear detectors

Detector	DigiTask	Flight time	Event time	Time based	FairLinks (time based)
MVD	PndMvdDigiTask				
STT	PndSttHitProducerRealFull			Pile up?	
SciTil/Btof	PndSciTDigiTask				
EMC					
Gem	PndGemDigitize				
Ftof	PndFtofHitProducerIdeal				
DIRC	?				
MDT	?				
FTS	?				
RICH	?				