SBS software and tracking

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Hall A winter '19 collaboration meeting
Jefferson Lab, January 30-31, 2018

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Overview

SBS Software:

- Project overview and milestones.
- Simulation digitization;
- Interface with analysis;

Tracking:

- status for G_M^n;
- status for G_E^p;

Summary

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SBS Software:
Project overview

*** Main goals:**

- "End-to-end" simulation:
production of pseudodata + simulation of data sizes;
- Analysis of pseudodata to test analysis chain

***** Both simulation and analysis framework need to be:

→ *modular* (ease configuration changes);

→ *accessible* (ease handling for new people);

→ *flexible* (ease inclusion of new configurations);

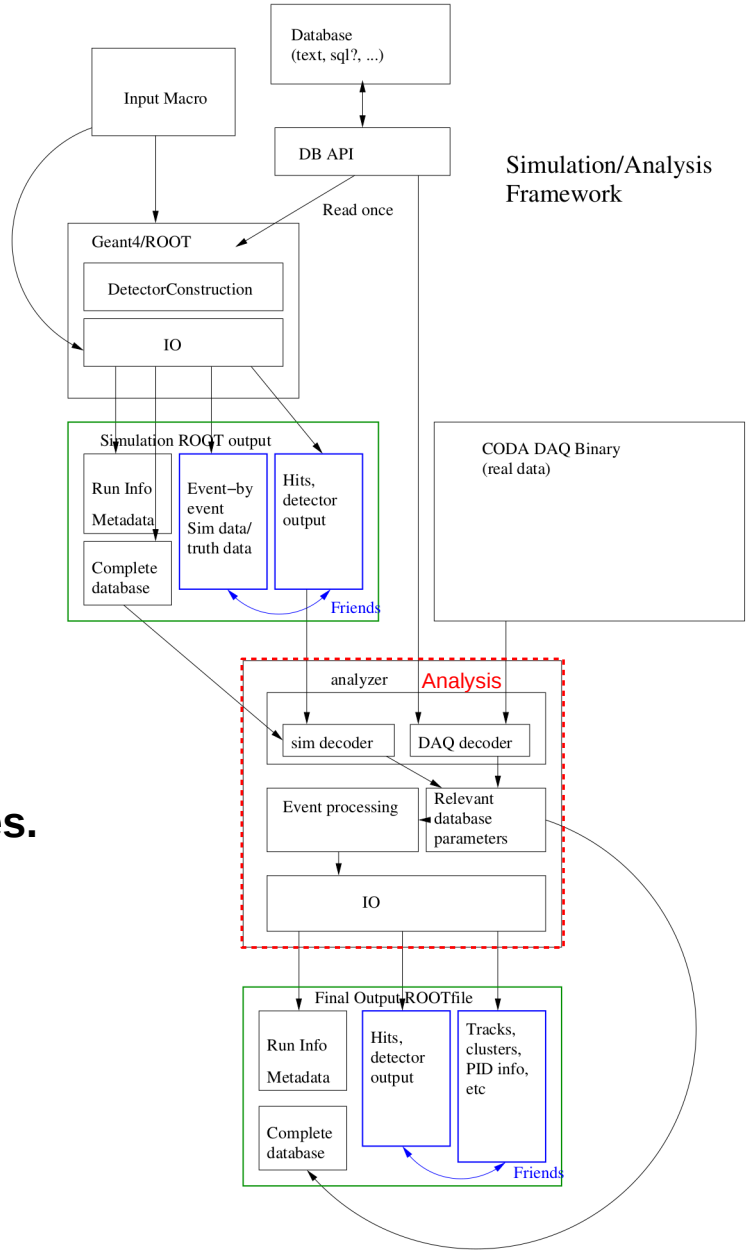
***** Also need:

- Well defined IO formats and standards
- Flexible database to accomodate both MC and data (SQL ?);

Strong requirement:
Online and offline analysis both need to be ready and tested, and pseudo-data sets have to be analyzed before data taking
(most likely winter 2021).
=> critical given high luminosities / high detectors and DAQ rates.

Geant4 based G4SBS simulation is up and running, and has already produced useful and compelling results (e.g. G_M^n ERR).

Project management:
**** Well defined responsibilities and milestones*** (next slide)
Redmine as management tool.



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SBS Software:
Project milestones

	Software activities	Experiment running and analysis
	Completed: Full simulation interfaced to analysis *Completed:* Decoders and channel level analysis	
Fall 2018	Began analysis of digitized simulated experiments	
Jan 2019	Collection of online and offline analysis and displays	
2019	Neutron FF experiment simulated analysis *Goal*: G_M^n tracking to 80% efficiency, 8 Hz + Proton FF experiment simulated analysis	
2020	**Jan: G_M^n, G_E^n ready for analysis** Proton FF experiment simulated analysis Online, offline scripts finalized from commissioning	March: G_M^n installation begins
2021	Goal: G_E^p tracking to 80% efficiency, 3 Hz **Jun: G_E^p ready for analysis** Start simulated analysis of SIDIS, TDIS	**Jan: G_M^n start of run** G_M^n analysis begins **Fall: G_E^n start of run**
2022	**Jan: SIDIS ready for analysis**	**Fall: G_E^p start of run?**
2023		G_E^p analysis begins? **SIDIS start of run?**

We want analysis ready for experiment one year before it goes on floor

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SBS Software:
Project responsibilities/work force

Collaboration Workforce

- Consistent and active workforce
- Weekly regular meetings

Subproject	
Subgroup and Organization	ANL
Front end decoding	JLab, INFN, ANL, CMU, UVA
GEM Analysis and Tracking	JLab, UConn, UVA
HCal	CMU
ECal	UConn
Coordinate Detector	CNU
Timing Hodoscope	Glasgow
GRINCH Cerenkov	W&M
Bigbite Legacy	ANL

- Spokespeople are responsible for experimental analysis

Institution	Collaborators (FTE/yr)
ANL	Riordan (0.2)
CMU	Quinn, Cornejo (0.5)
CNU	Monaghan, Brash, students
Glasgow	Annand, Hamilton, Montgomery
INFN	Cisbani, Musico
JLab	Camsonne (0.2), Hansen (0.1), Future Postdoc?
UConn	Puckett (0.2), Fuchey (0.5), Student (0.5)
UVA	Liyanage, Gnanvo, Future postdoc?, Di, Jian
W&M	Averett, Ayerbe-Gayoso

Professor/Staff Postdoc Student

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Slide borrowed from Seamus Riordan's talk at past software review

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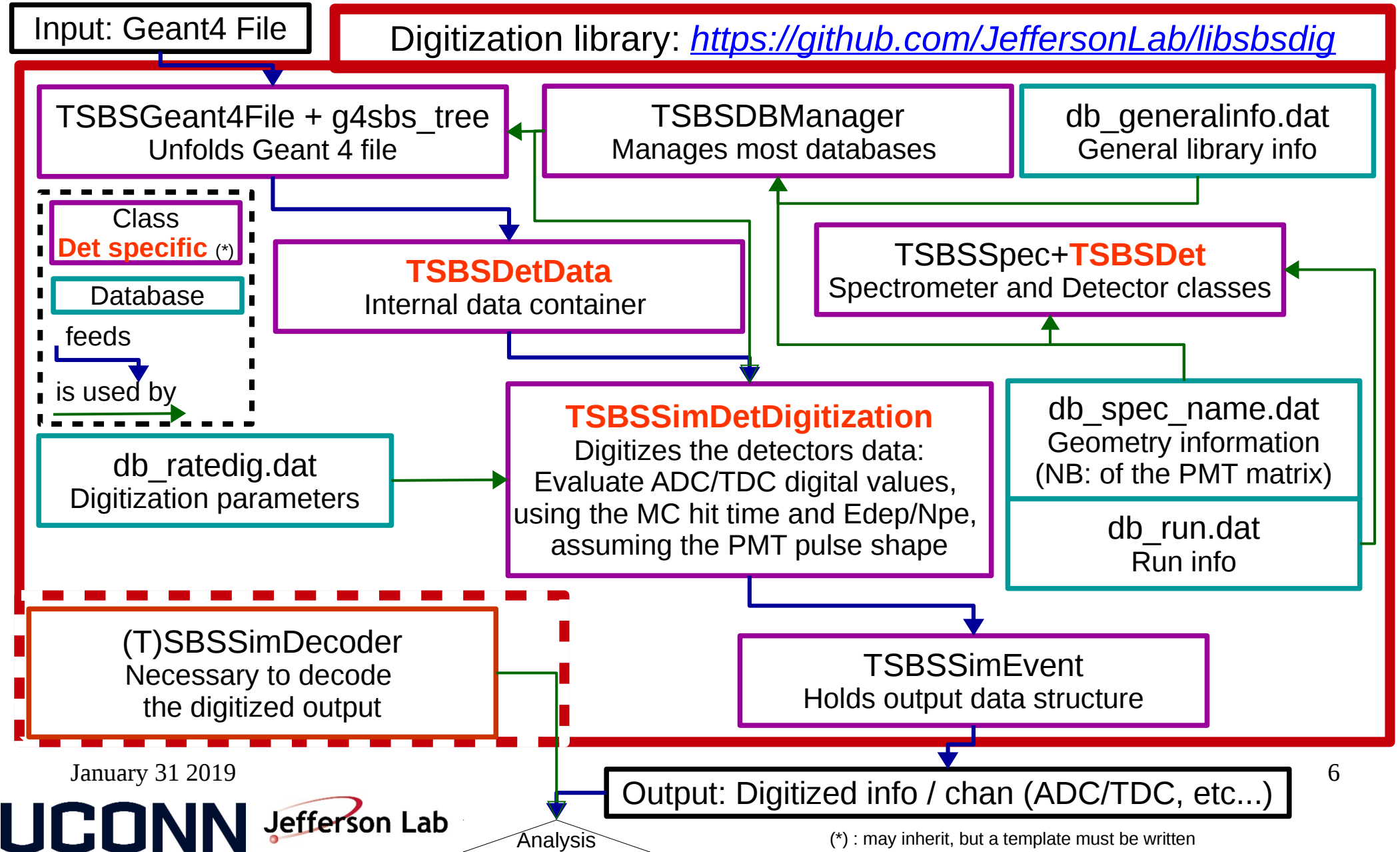
SBS Software Project:
Simulation digitization

Purpose: Convert simulation files produced by G4SBS to files containing digital information such as ADCs and TDCs



(*) : may inherit, but a template must be written

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SBS Software Project:
Simulation digitization

Digitization library status:

Repository: *https://github.com/JeffersonLab/libsbsdig*

* All detectors used in G_M^n/G_E^n have been introduced in the framework.

* GEM digitization library now added as a package on the main repository

* Current digitization speed on the order of **0.1 Hz** (for G_E^p @ full background)
  => We'll investigate how to speed it up.

* Few other subsystems to be introduced: G_E^p Ecal, (DB) SIDIS RICH, (DB) TDIS LAC, mTPC.

SBS Software:
SBS-offline analysis

SBS-offline analysis library: *https://github.com/JeffersonLab/SBS-Offline*

* Decoding, basic analysis of CODA data in Hall A analyzer
* Decoders available for all subsystems (including MPD, FADC)
* Output and low-level analysis of channel-level data completed

* Clustering, tracking (more in following), inter-detector association underway
* Optics models, spin transport, etc to be finalized.

Online and Event Displays:

* being agregated in SBS-offline - individual groups are responsible
* Software exists for legacy Bigbite systems (including optics)
* Will continue to develop through assembly/commissioning period up to runs

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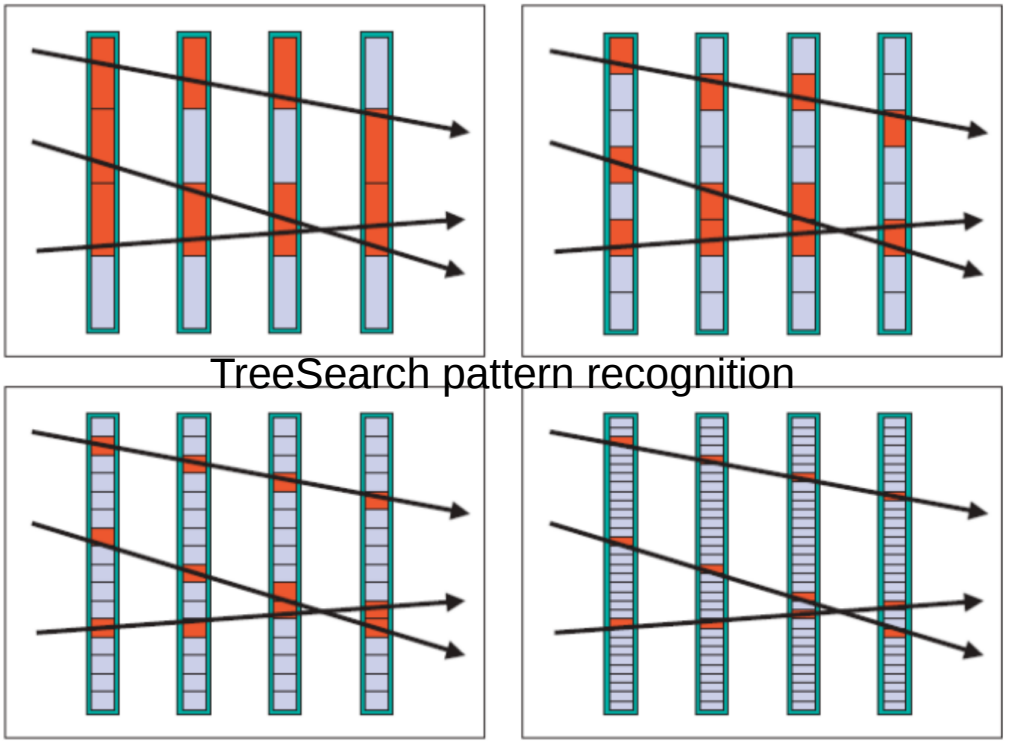
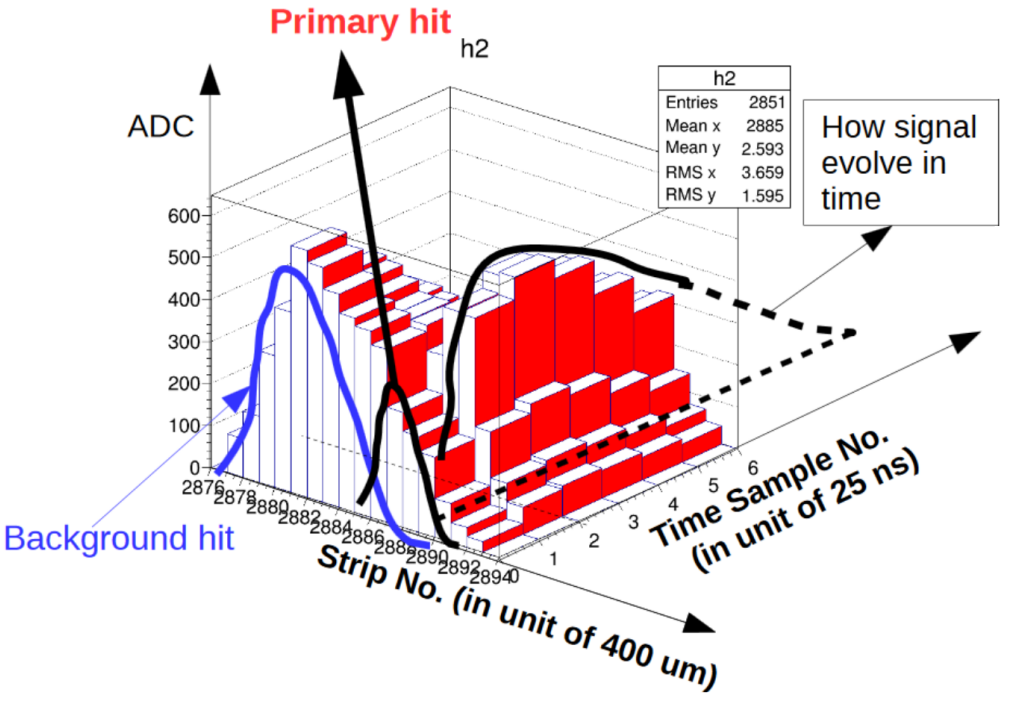
GEM tracking Software

* Primary deployed algorithm using recursive TreeSearch
(raw combinatorics also employed for some analyses)
* GEMs provide six time samples over 25ns bins with jitter
* Hits are differentiated by fitting to spatial and temporal components
* Require amplitude matching between x-y components to obtain full 3D reconstruction
* General restrictions are placed on search areas based on other detector knowledge
* Basic multithreading implemented



TreeSearch pattern recognition



Plot credit :
Danning Di

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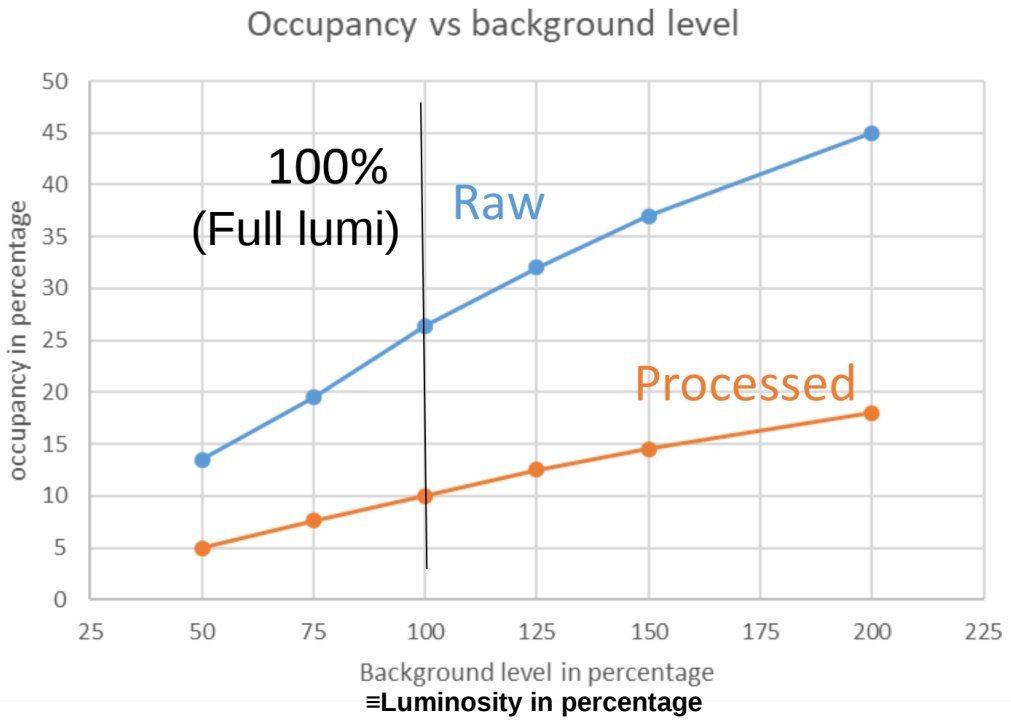
SBS Tracking:
Status for G_M^n

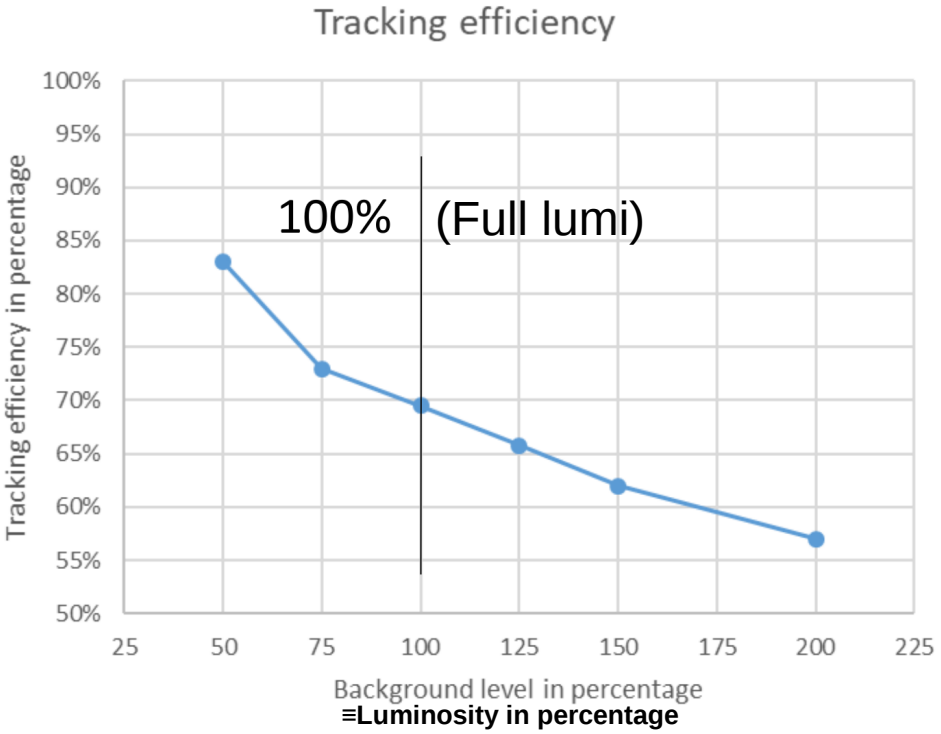
Since 2016:

* Improved simulated GEM response and validation based on data from constructed GEMs
* Observe larger and wider background response
* Event reconstruction at 70% tracking efficiency (2020 goal 80%)

=> processing speed 3 Hz (2020 goal 8Hz)

* Continuing to evaluate better separation of broad ADC clusters





G_M^n GEM background at full luminosity (10cm LD2, 45μA)
~100 kHz/cm^2

Plots credit :
Danning Di

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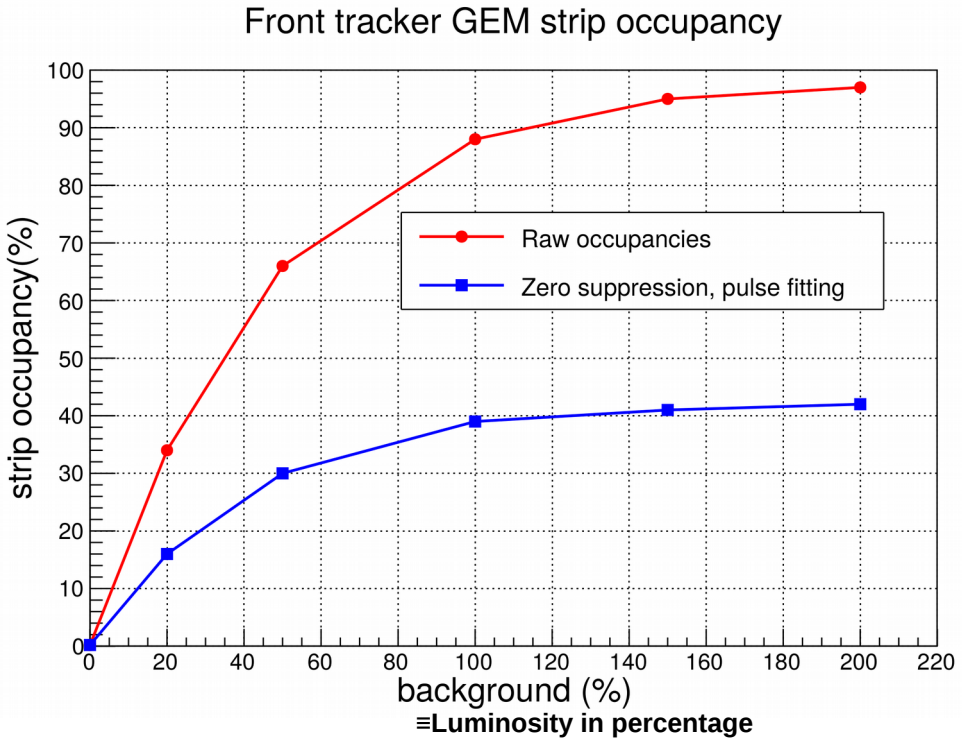
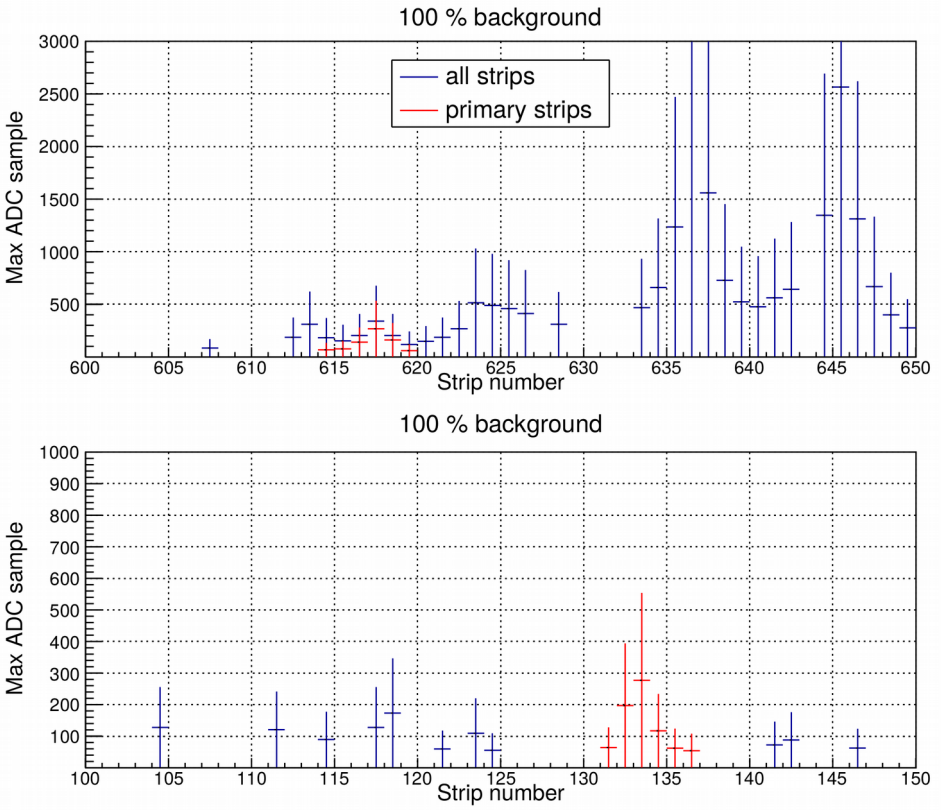
SBS Tracking:
Status for G_E^p

* G_E^p rates roughly factor 5 higher than G_M^n => Goal: 80% efficiency, 3 Hz by mid 2021
* Significant postprocessing will be required – *might* (or not) need to reevaluate TreeSearch
* G_M^n will be critical to understanding high rate data





G_E^p FT background at full luminosity (40 cm LH2, 75 µA)
≥ 500 kHz/cm² (FT)
NB : a 2011 study projected ~10 % occupancies at 100 % background, with the digitization model of the time...

Example of strips ADC profiles (zoomed in). Original signal amplitude in red.

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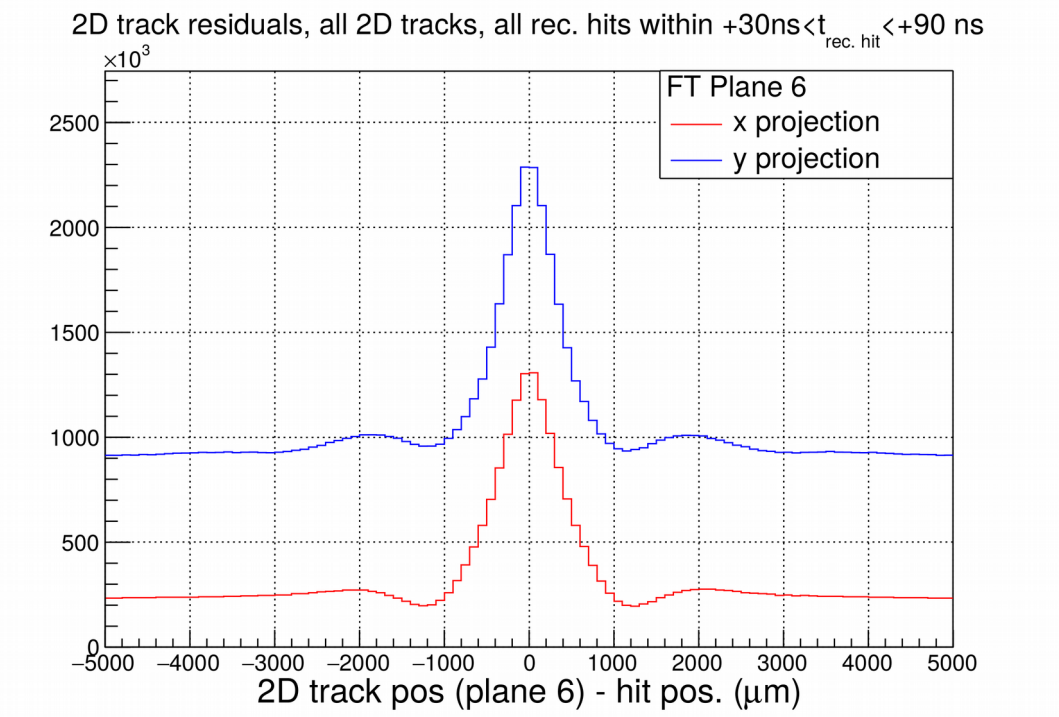
SBS Tracking:
Status for G_E^p

New estimation of G_E^p tracking efficiency in progress

* In spite of background level, tracking seems feasible…
* search region reduction from electron arm / elastic reaction information is crucial to achieve required tracking efficiency.
* currently focusing on this effort: nothing to show yet, but we are breaking through



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Good progress since last update to Hall A colloboration:

* g4sbs simulation interfaced with analysis through a digitization library, with most subsystems included (all of G_M^n/G_E^n).

* SBS offline analysis infrastructure in place within Hall A analyzer

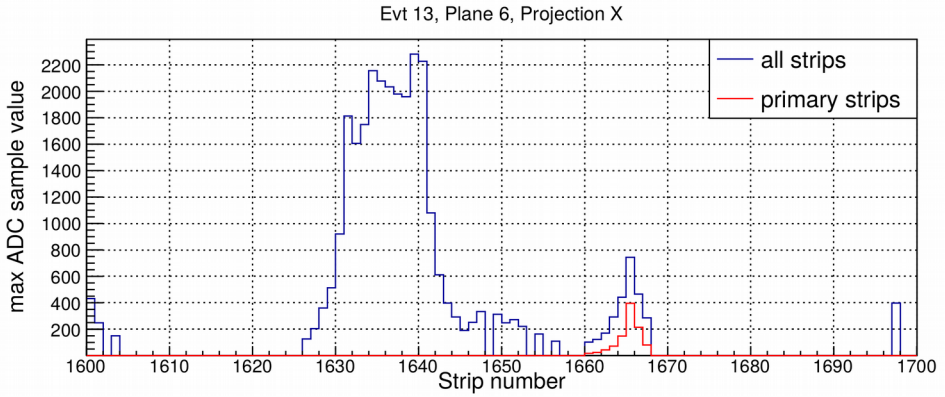
Tracking remains primary challenge for software:

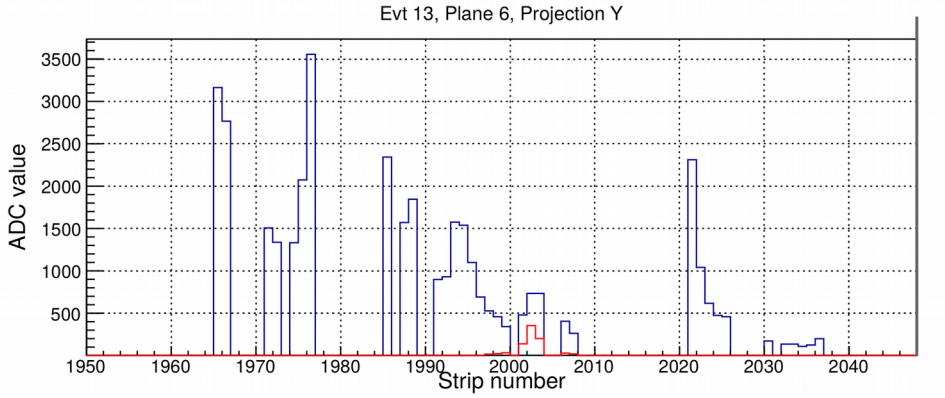
* With updated digitization, occupancies have drastically increased

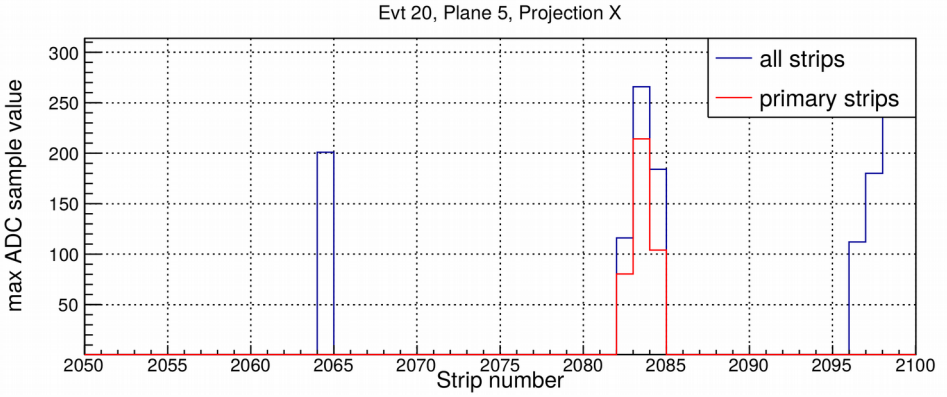
* currently 70 % tracking efficiency, 3Hz processing speed for G_M^n.

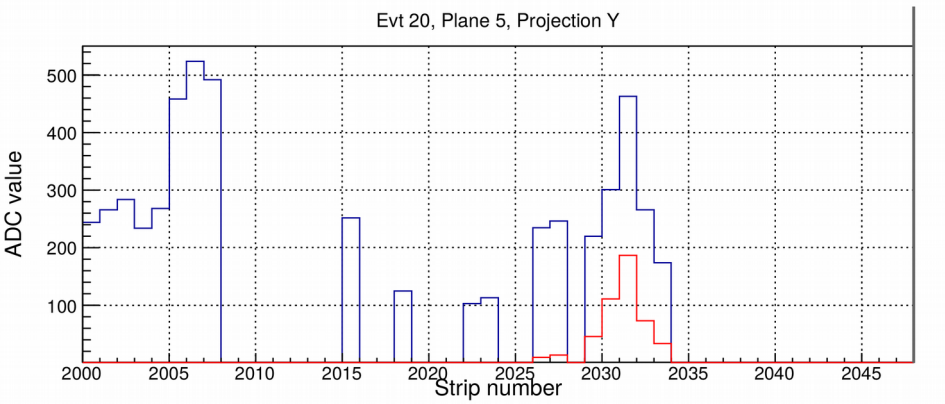
* *work in progress* for G_E^p

Thank you for your attention !









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