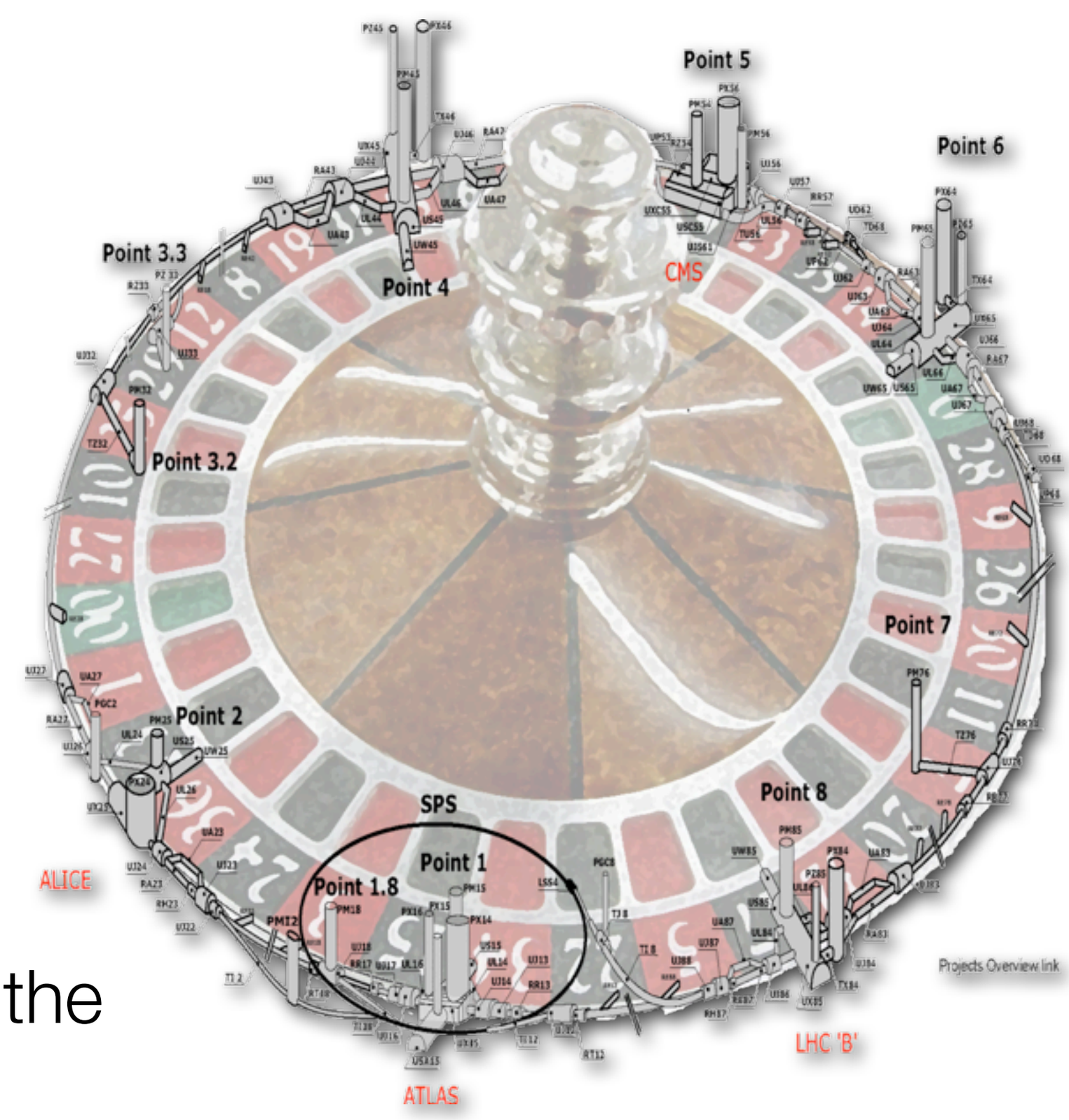
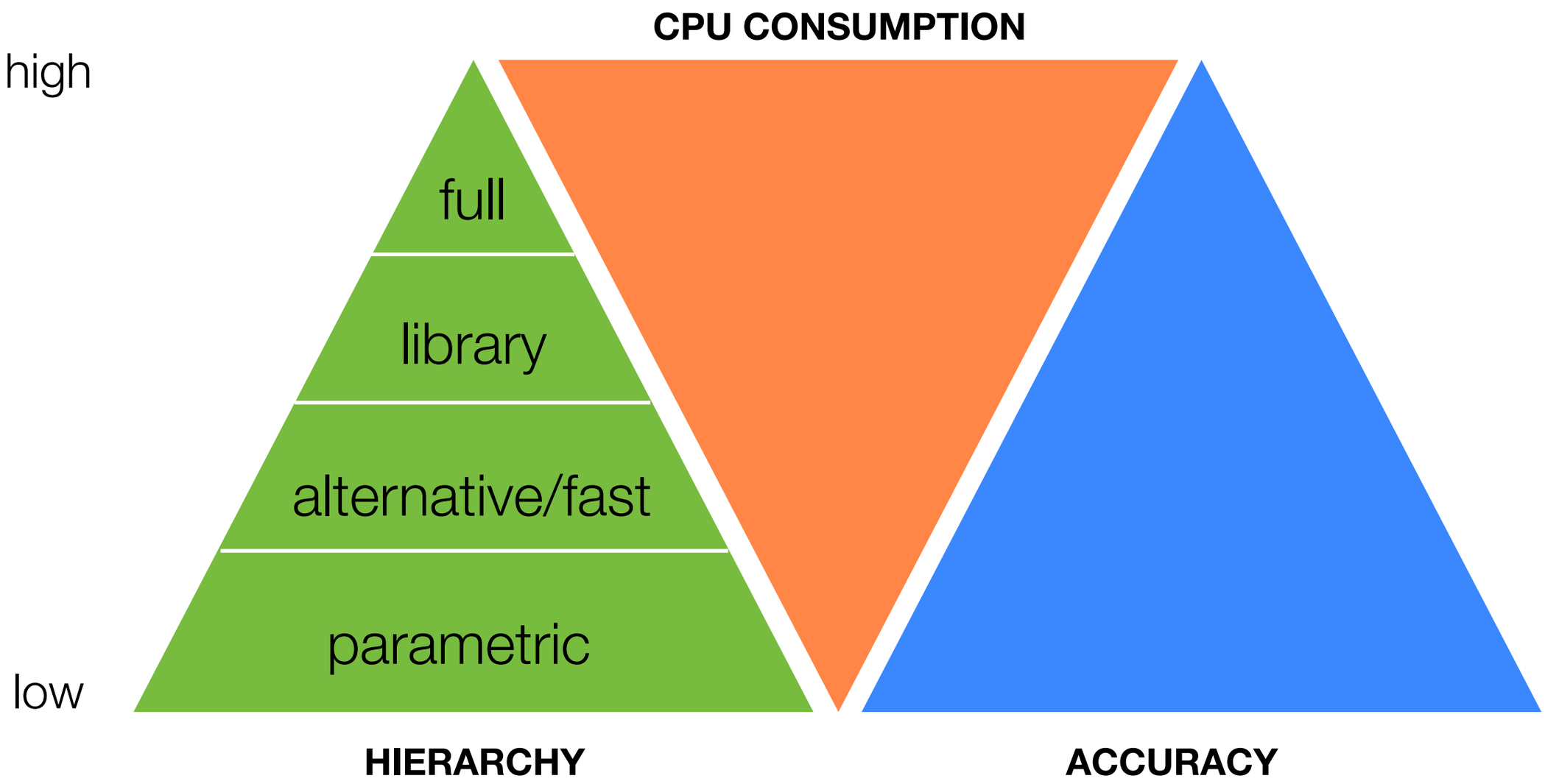


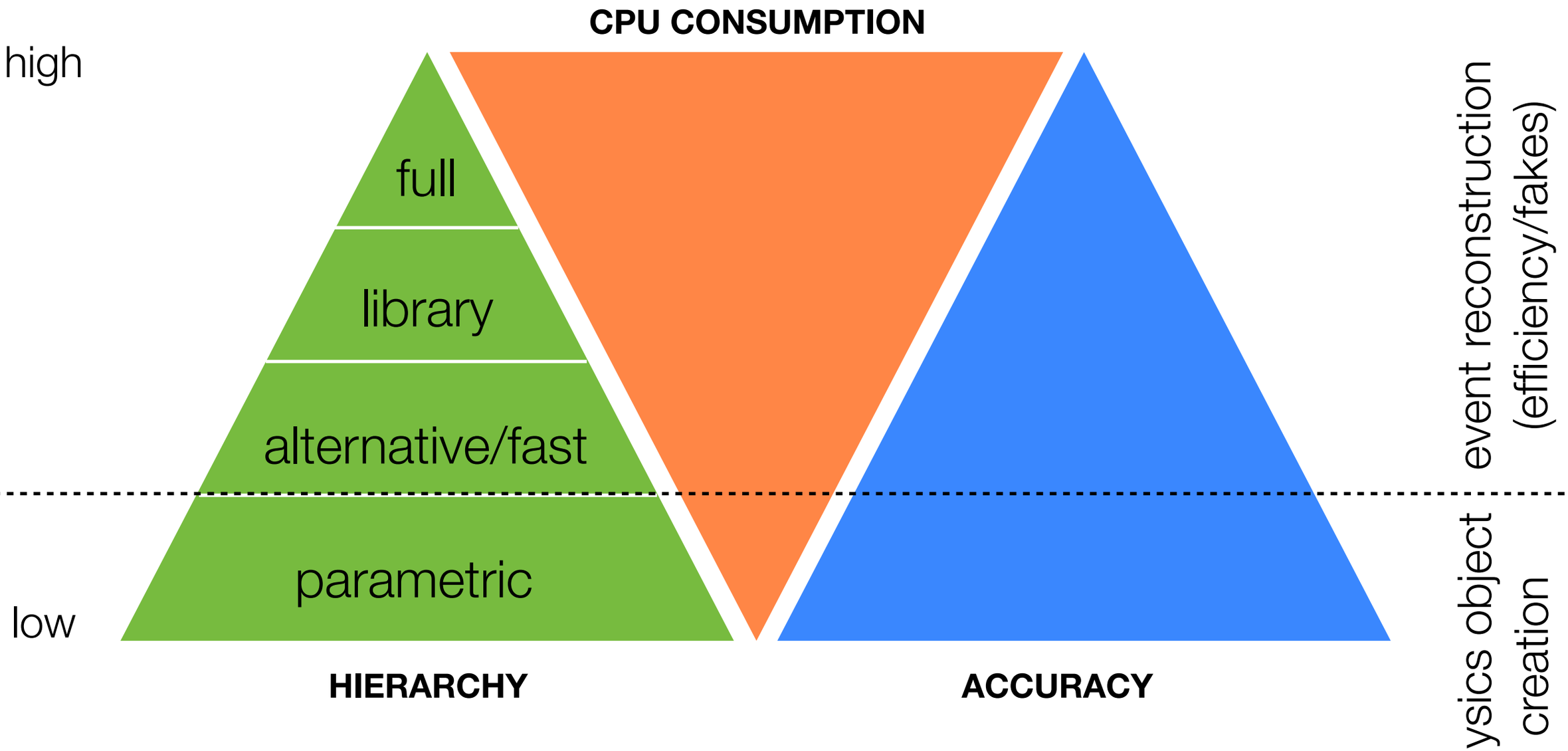
MC production in the Tera event era

A. Salzburger (CERN)

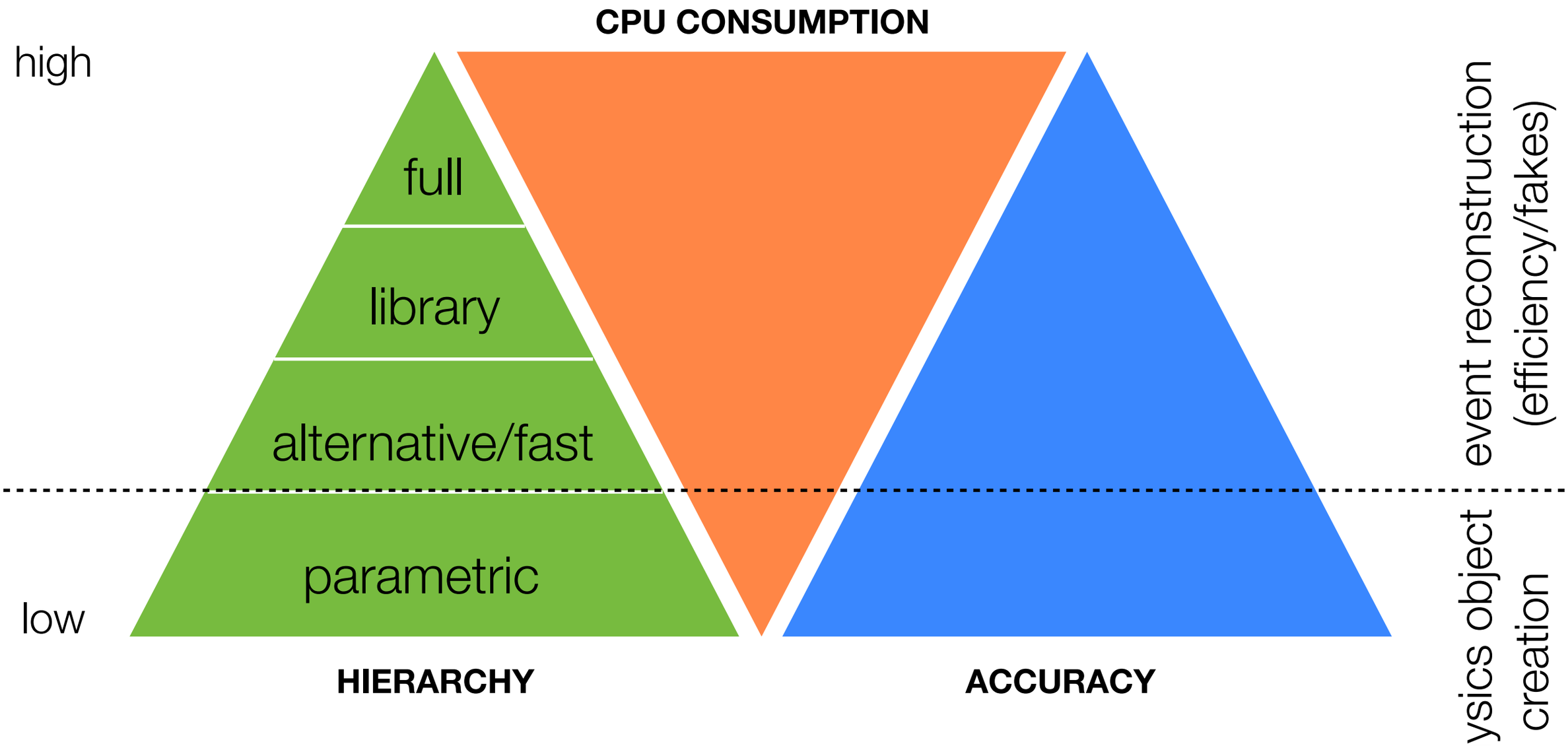
The simulation hierarchy pyramid



The simulation hierarchy pyramid

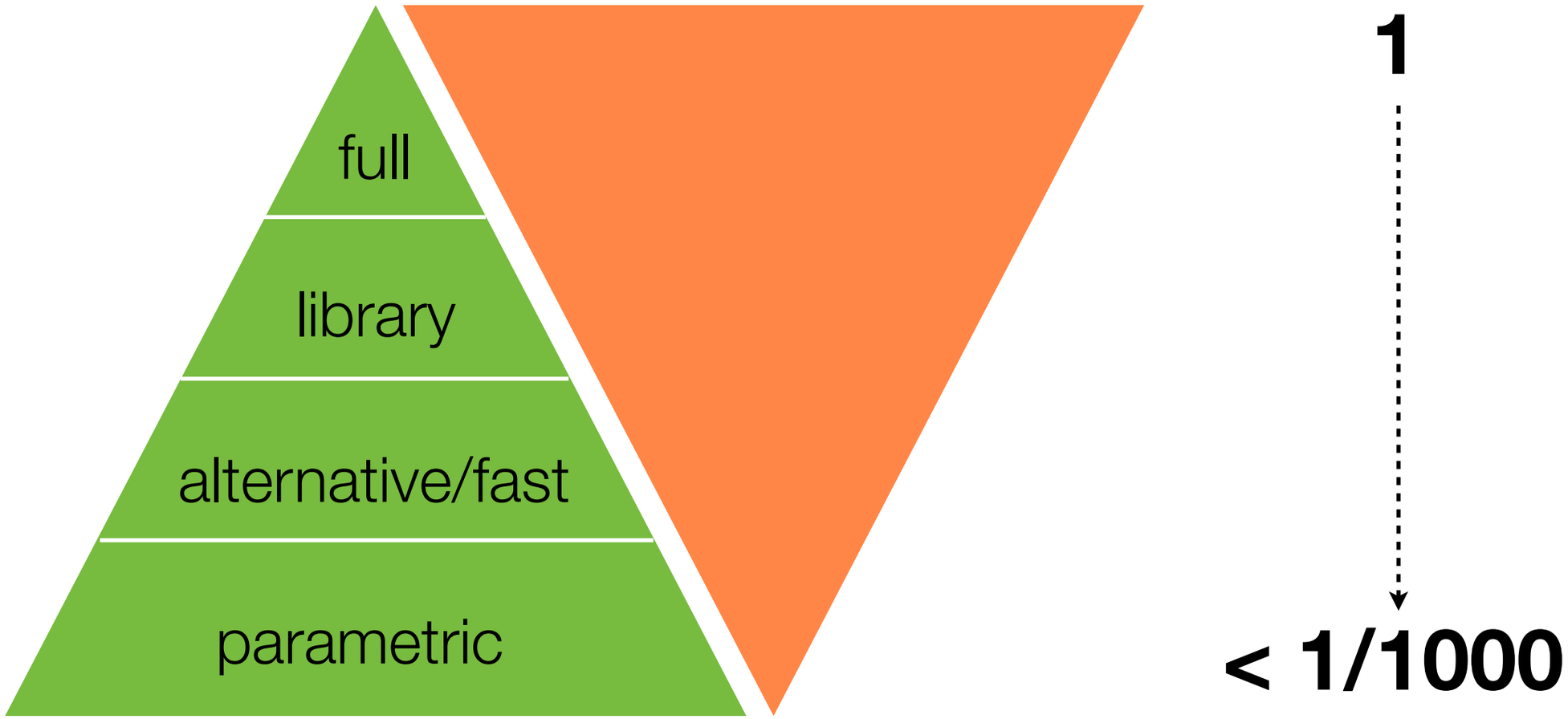


The simulation hierarchy pyramid



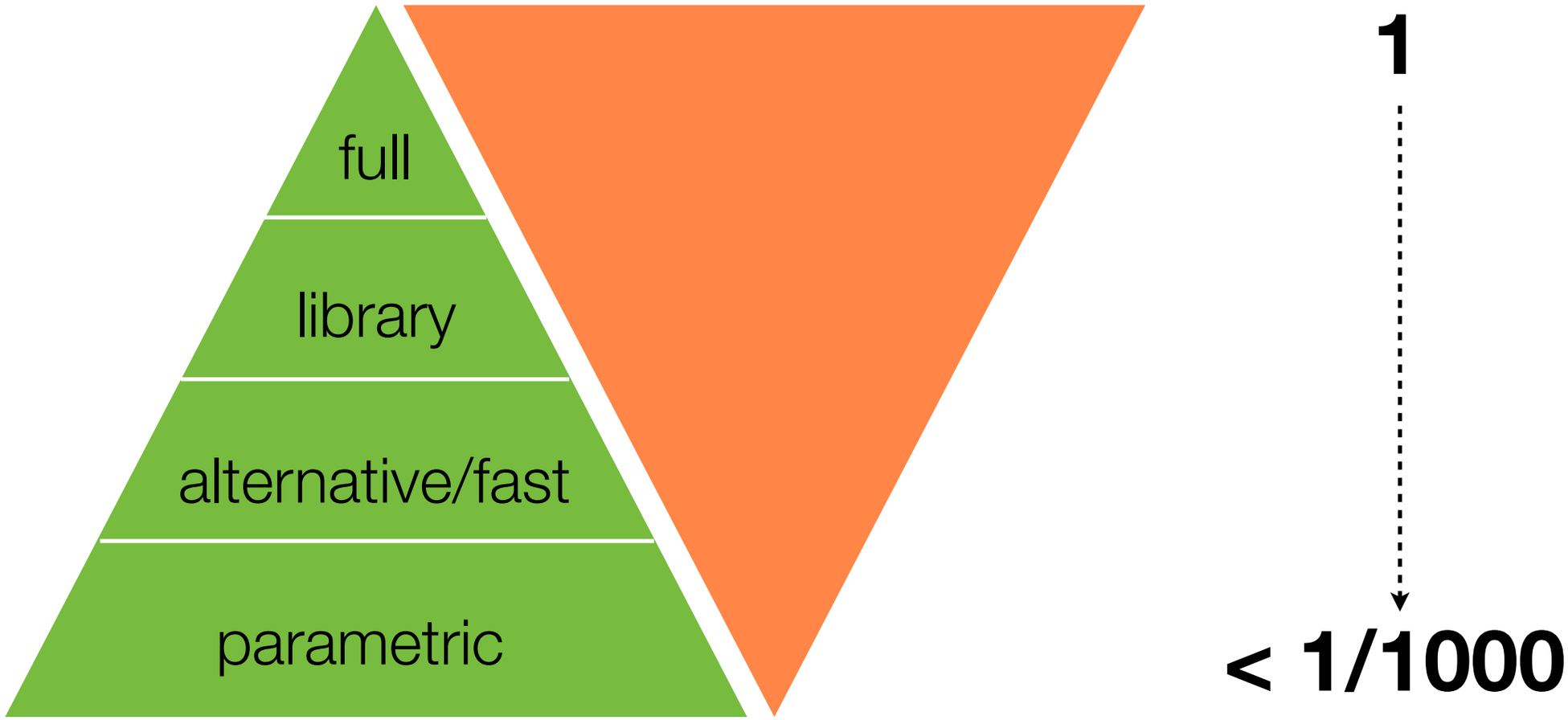
*the picture is quite trivial, finding the optimal working point is NOT !

Potential speed-ups: simulation



- This sets the simulation into the ~ Hz level regime*

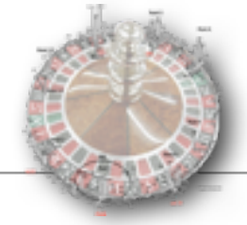
Potential speed-ups: simulation

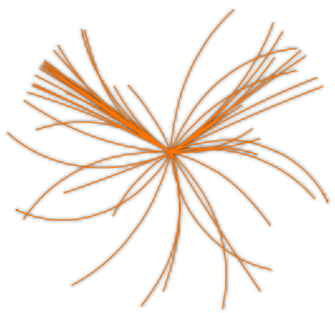


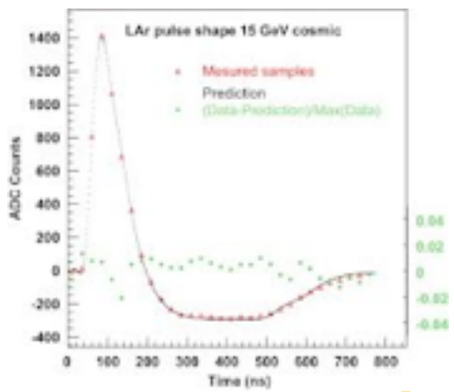
- This sets the simulation into the ~ Hz level regime*

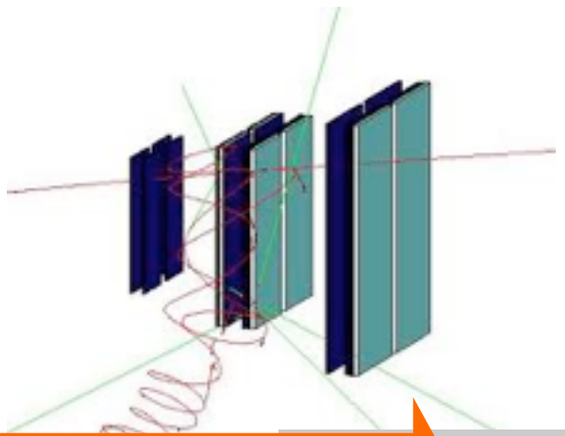
*I will speak about the consequences of this today

The full MC production chain



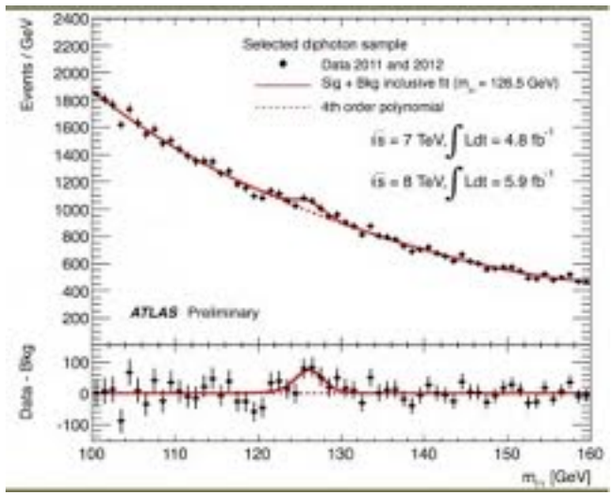






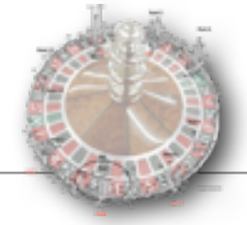
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Rootification**

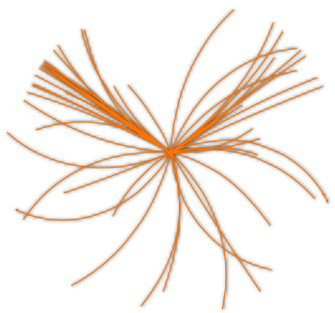
EVGEN → HITS → DIGITS → ESD/AOD → TTree/THist

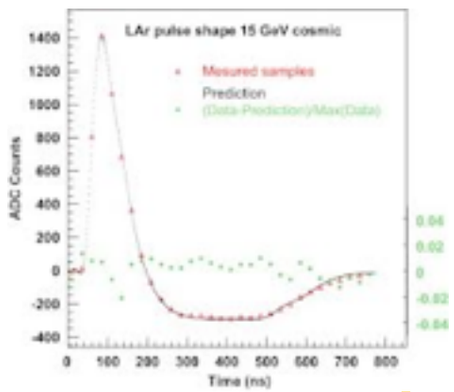


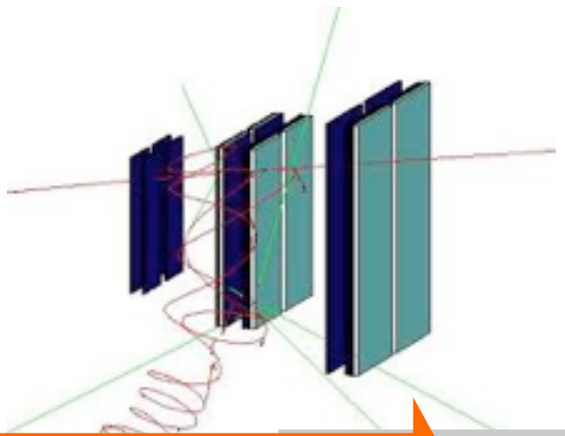
Analysis

The full MC production chain





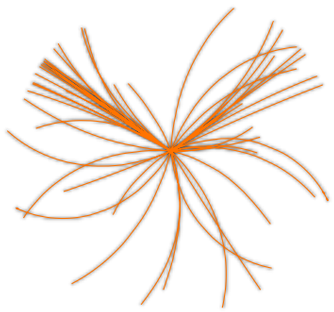




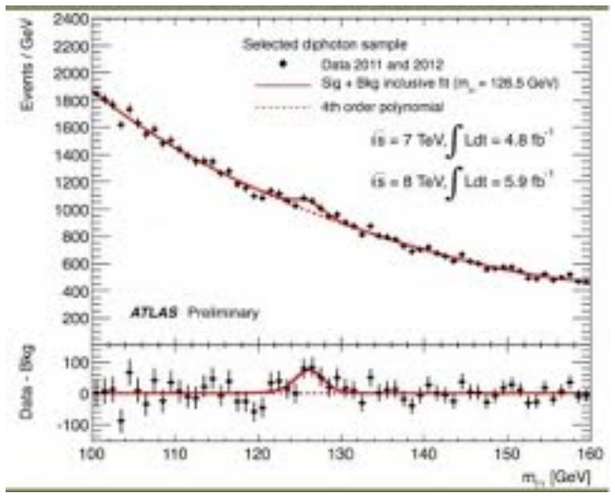
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Rootification**

EVGEN → HITS → DIGITS → ESD/AOD → TTree/THist

RDOs

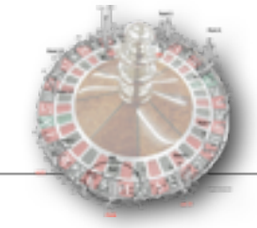


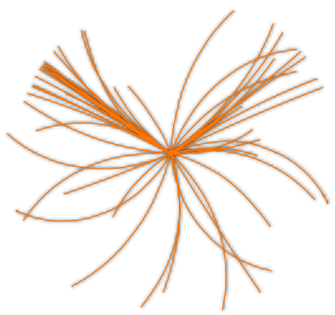
μ times

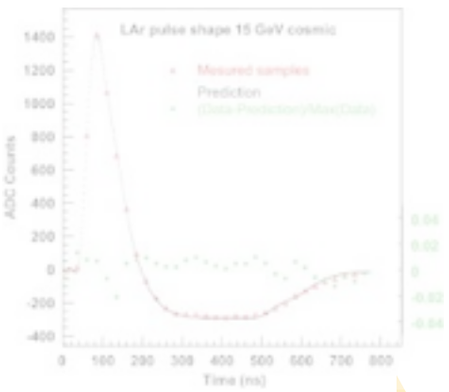


Analysis

Event generation





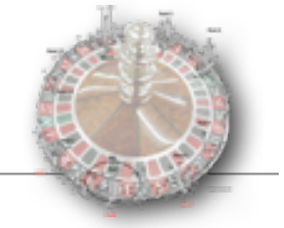


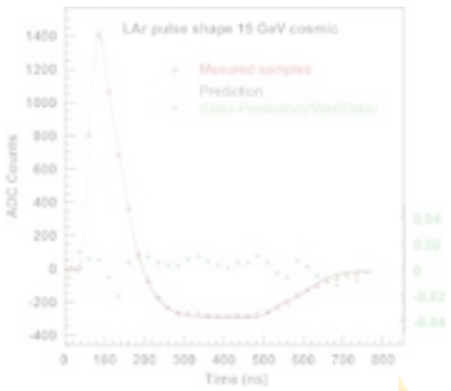
Event Generation → Detector Simulation → Digitization → Reconstruction → Rootification

- **Event Generators are usually “external” software**
  - barely in the control of experiments
  - event generation does indeed take quite some time

- **Speed-up possibility**
  - filtering, biasing, forcing (e.g. decay)
  - select only events that create the signature you want
    (don’t make high stats to pick out the tail effects you need)

Detector simulation





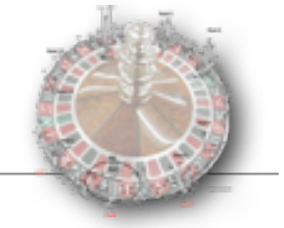
Event Generation → **Detector Simulation** → Digitization → Reconstruction → Rootification

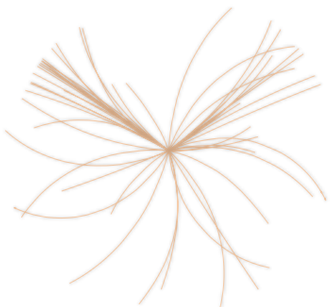
- This is what the WS was mainly about

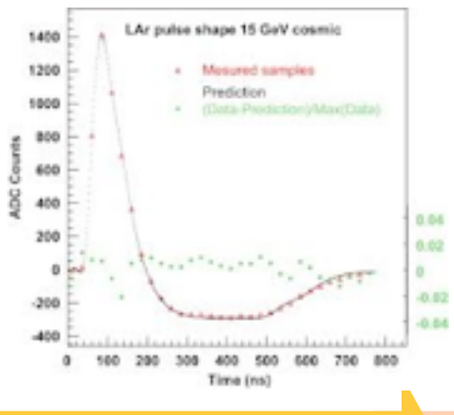
- Speed-up possibility

- parallelism & modern computing architectures
- partial event simulation (when feasible)
- fast simulation techniques (see talks of this week)

Digitization

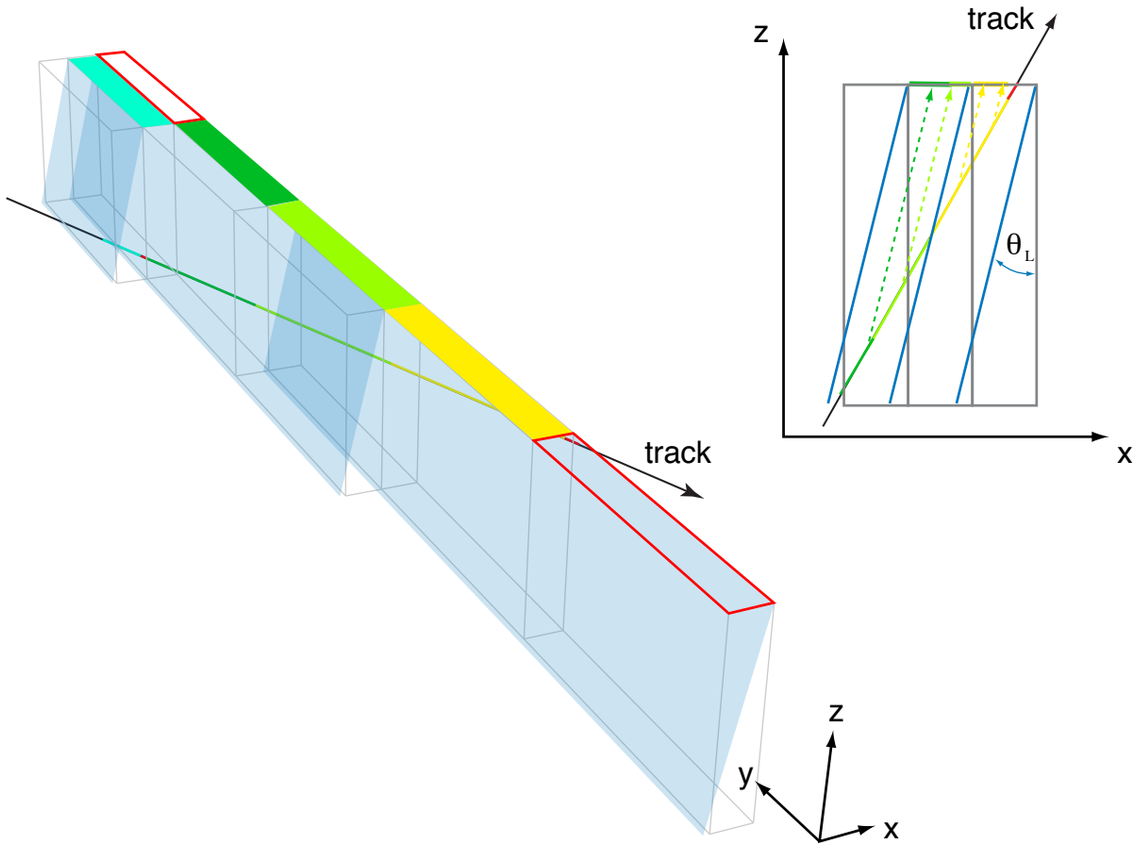




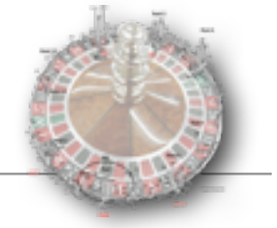


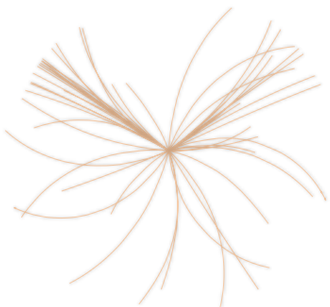
Event Generation → Detector Simulation → **Digitization** → Reconstruction → Rootification

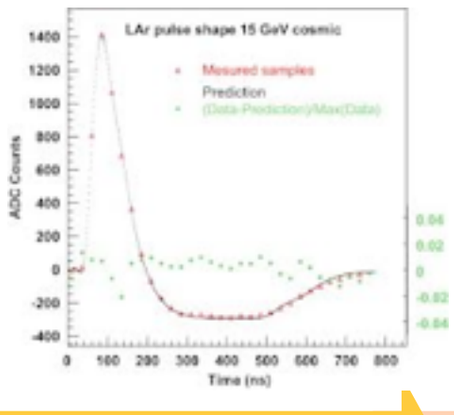
- ‣ Speed-up: Fast digitization modules
- smearing approach (new technologies)
- approximative digitization, e.g. fast geometrical digitization in Si



Digitization

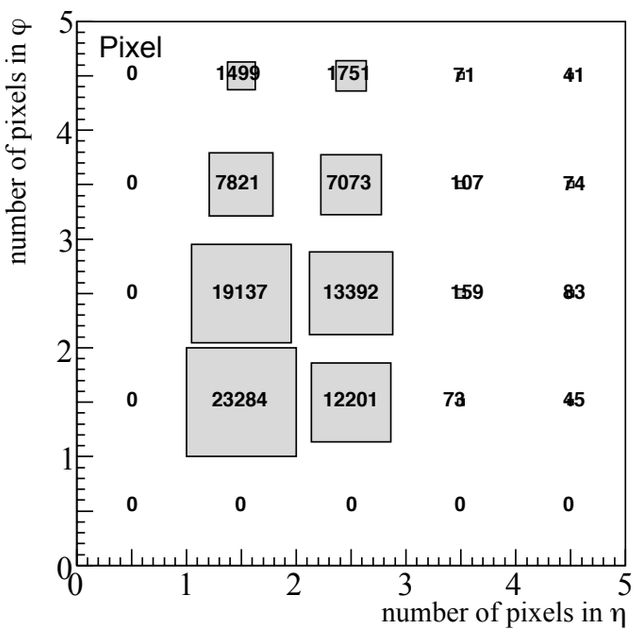


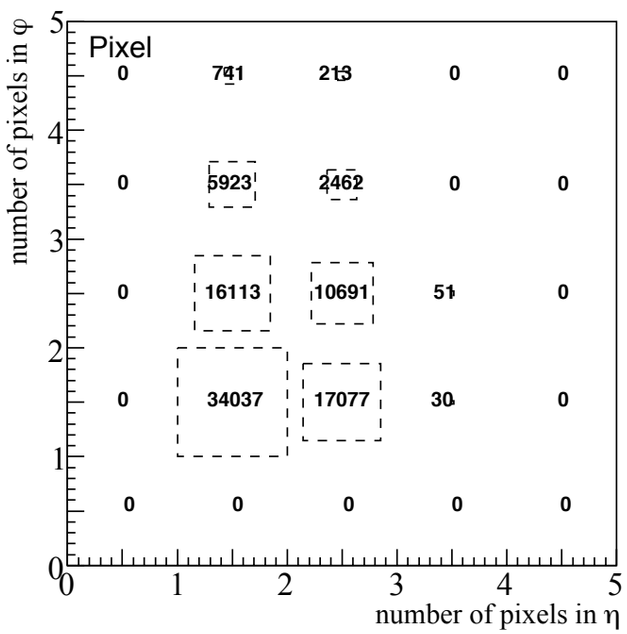


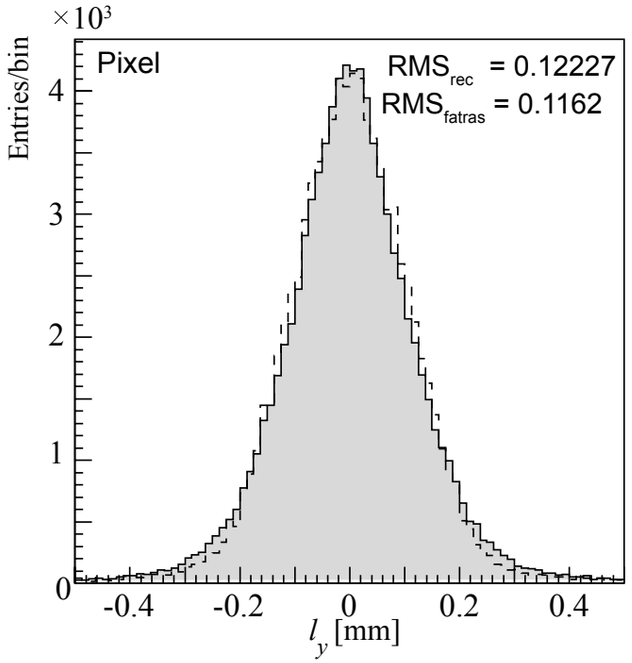


Event Generation → Detector Simulation → **Digitization** → Reconstruction → Rootification

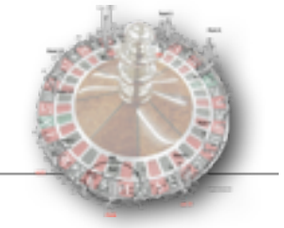
--- FATRAS

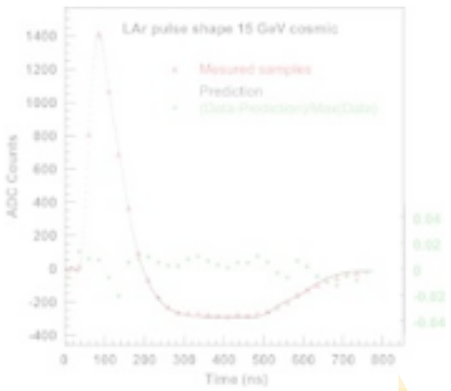


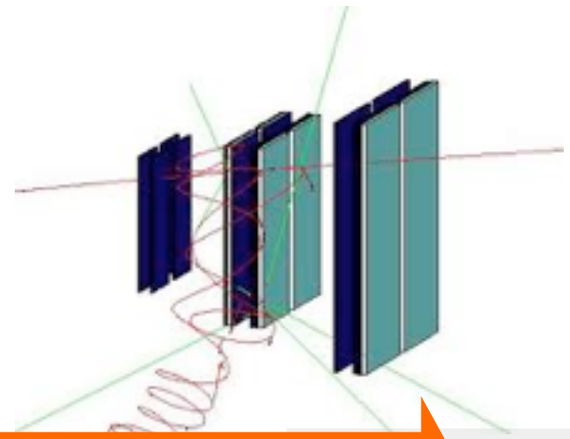


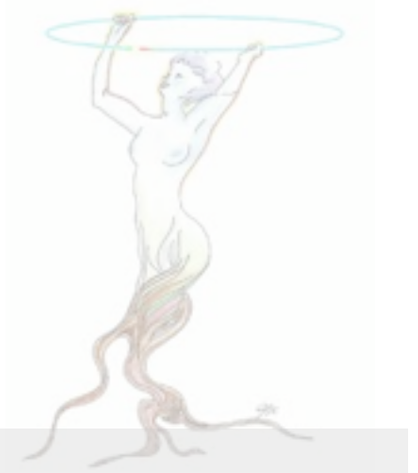


Reconstruction





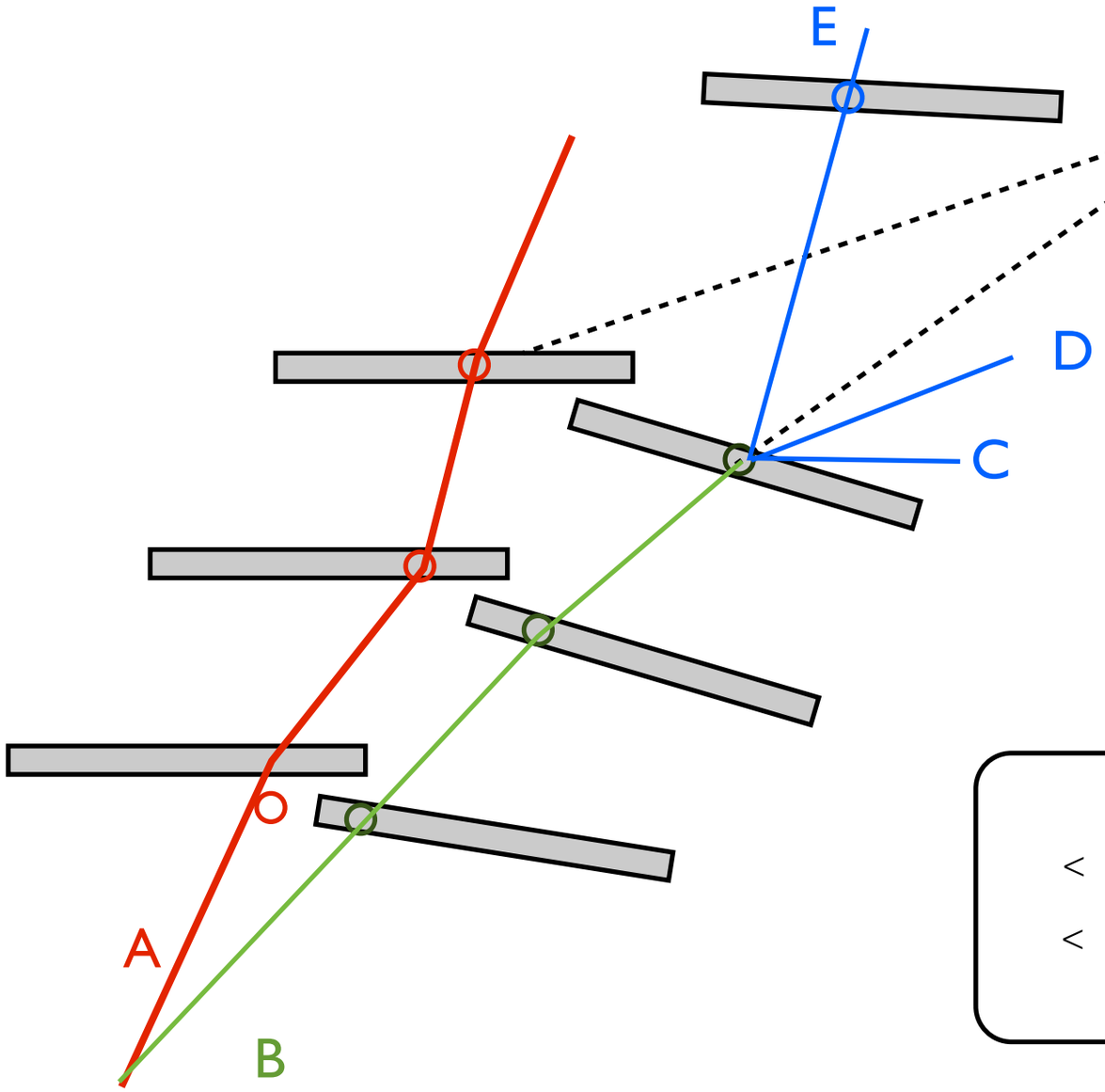




Event Generation → Detector Simulation → Digitization → **Reconstruction** → Rootification

- **Speed-up: Truth seeded/based reconstruction**
- pattern recognition “emulation”
- complete by-passing of the pattern recognition
- physics object creation (DELPHES, ATLFAST)

Truth tracking concepts



HIT Container <A B E>

(fast) digitization

PRD Container

+

PRD_MultiTruthCollection

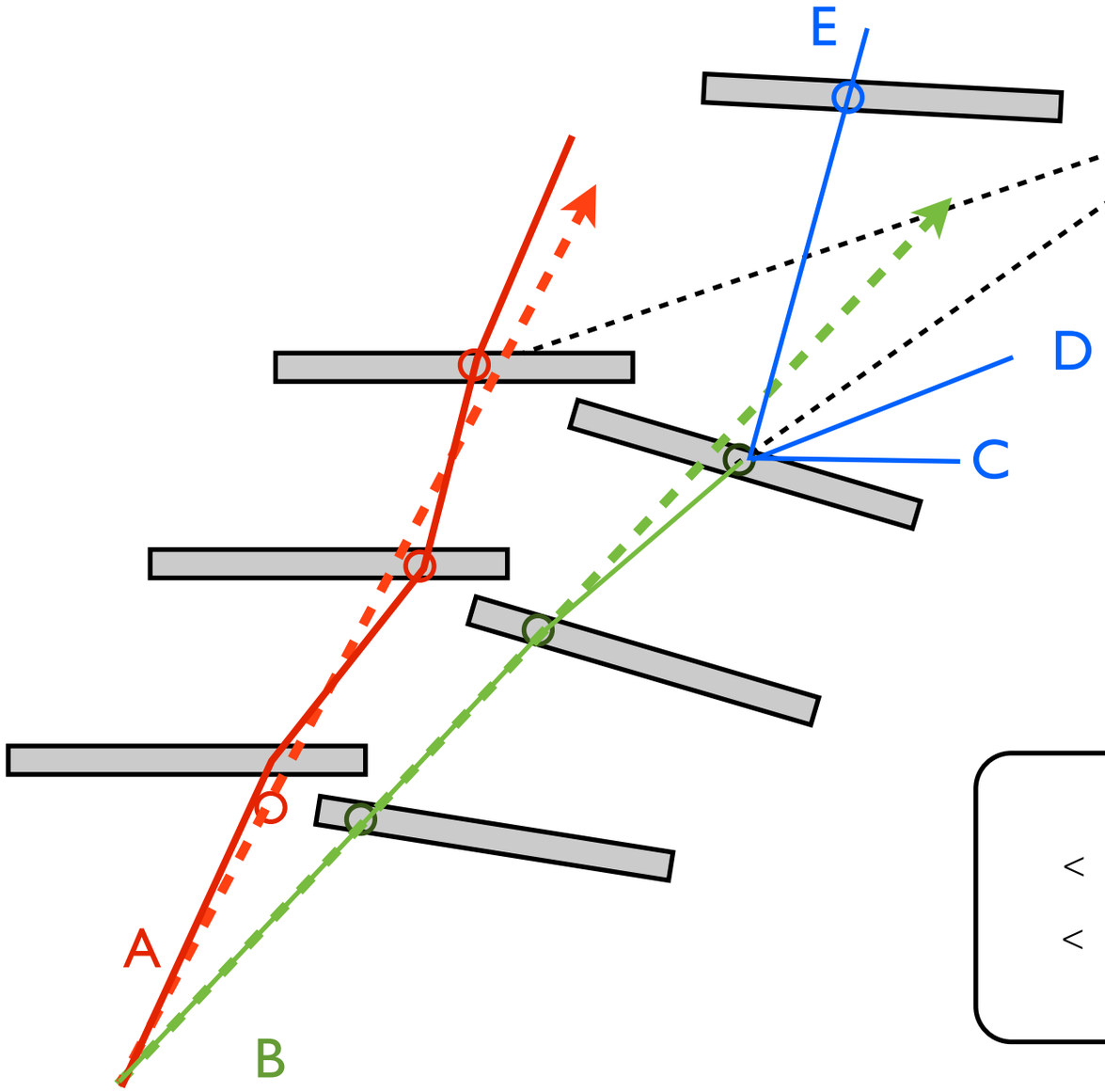
Pseudo Tracking

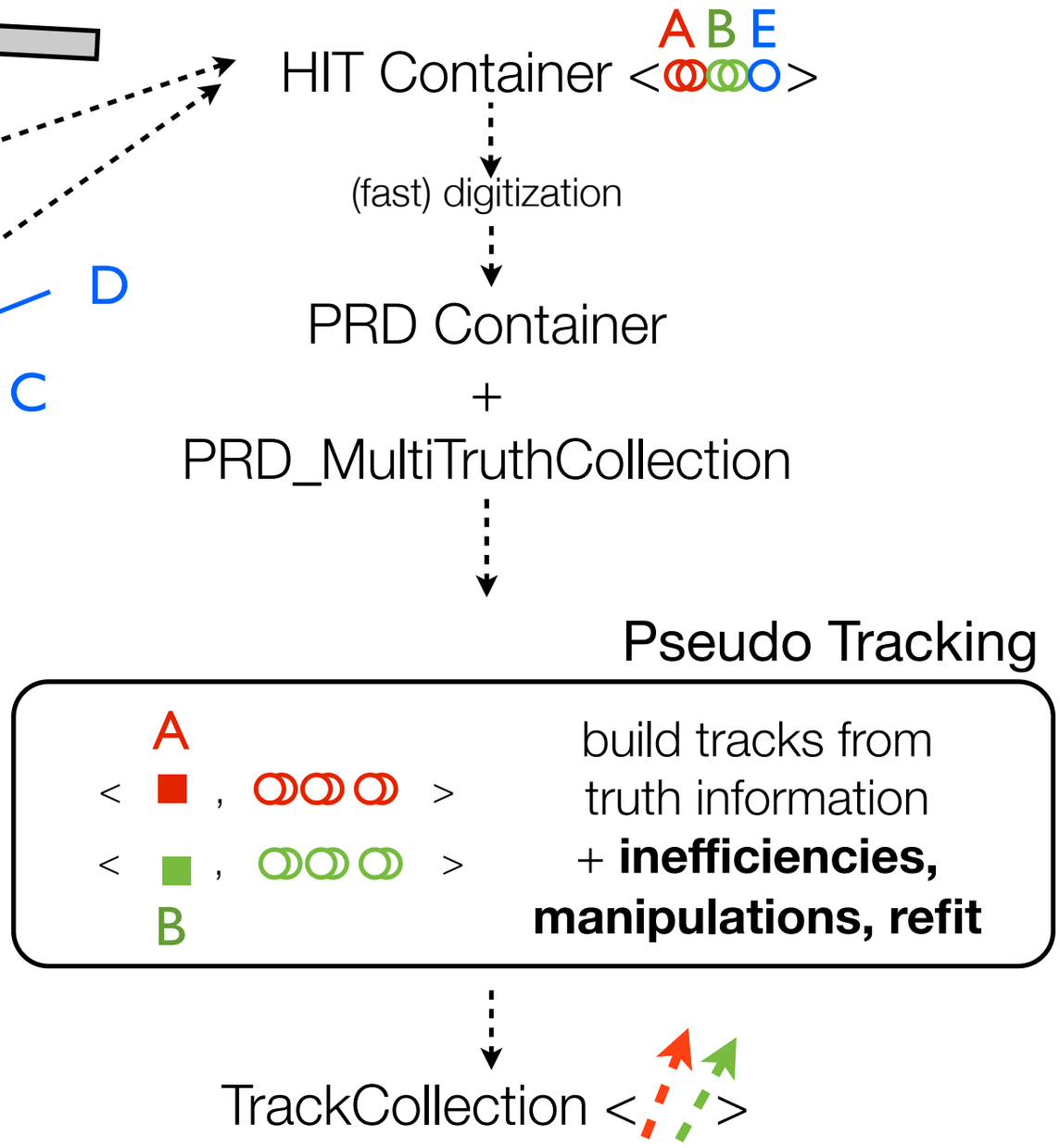
A
< ■ , ◎◎◎ >
< ■ , ◎◎◎ >
B

build tracks from truth information + **inefficiencies, manipulations, refit**

- Material effects will be taken into account in this concept
- Inefficiencies modeled rather accurately
- No fakes ... this is one of the most challenging aspect of fast simulation

Truth tracking concepts

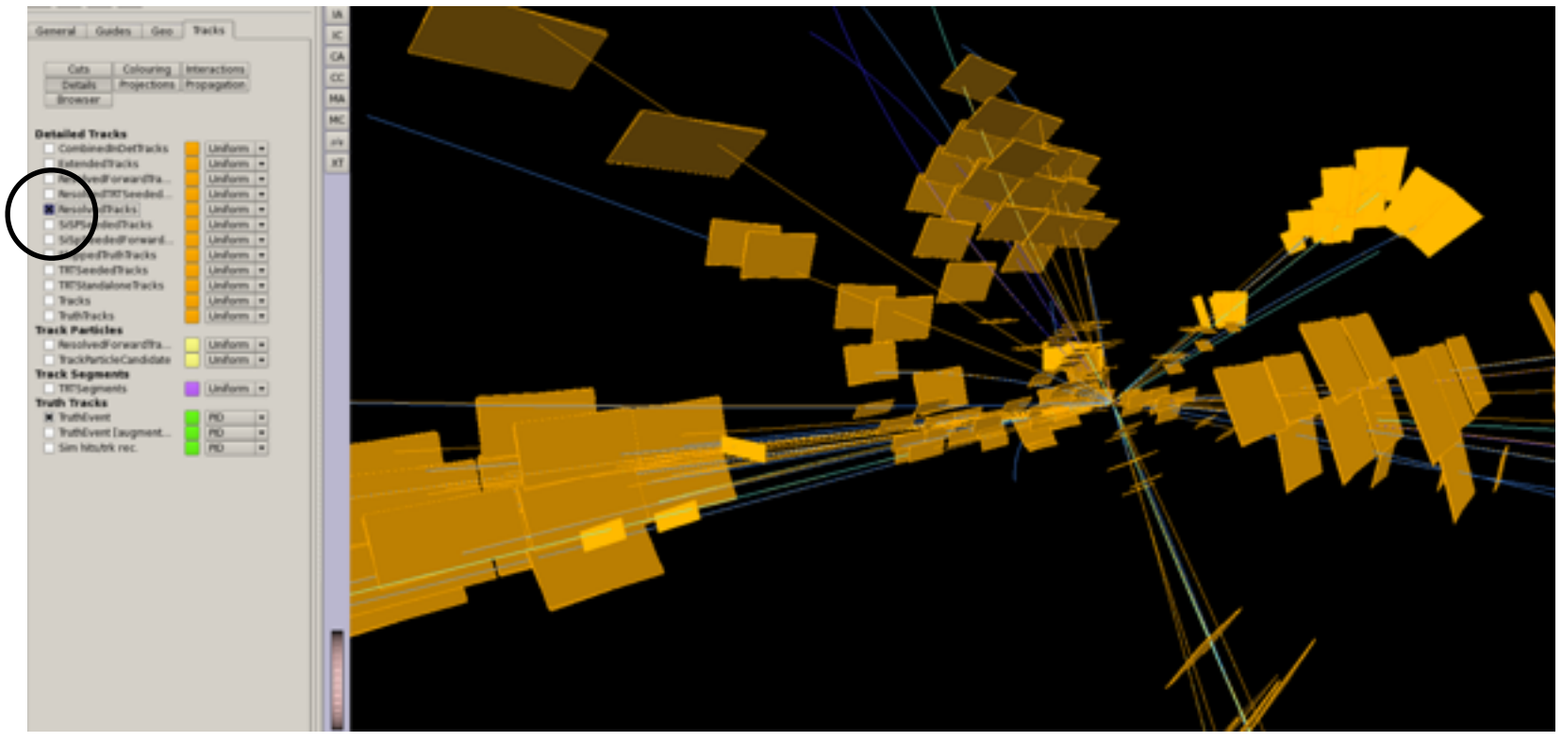




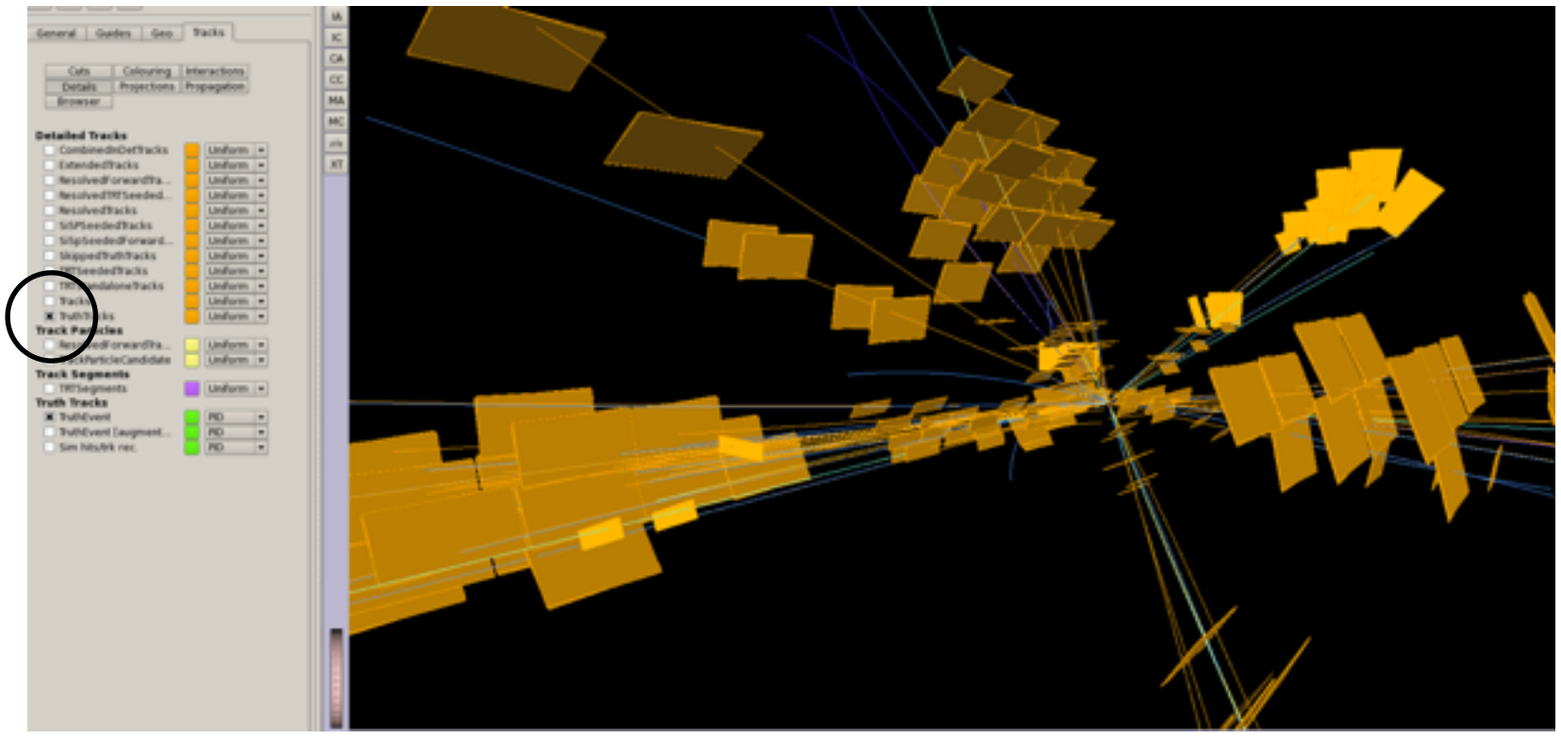
- Material effects will be taken into account in this concept
- Inefficiencies modeled rather accurately
- No fakes ... this is one of the most challenging aspect of fast simulation

Truth tracking

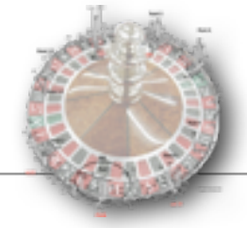
reconstructed tracks

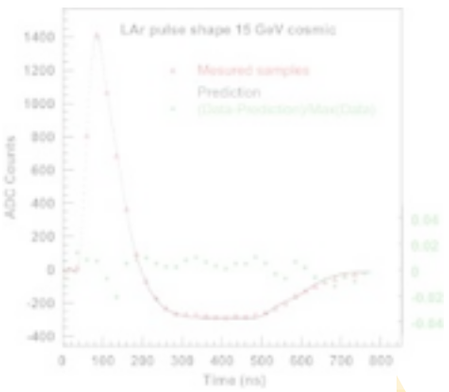


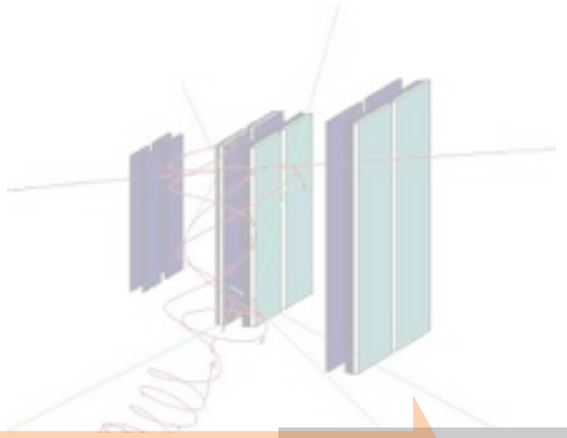
truth tracks



Rootification & Analysis



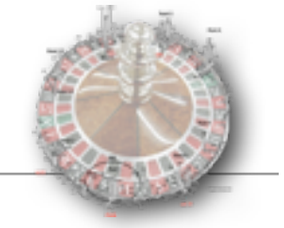


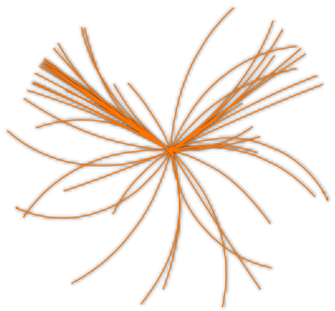


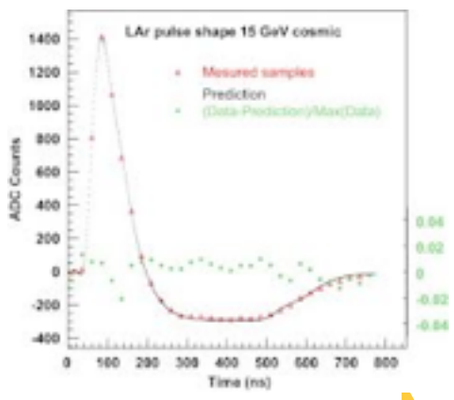
Event Generation → Detector Simulation → Digitization → Reconstruction → **Rootification**

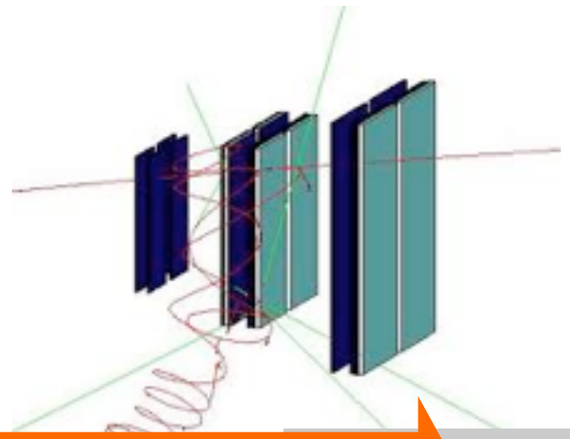
- **Speed-up possibilities:**
- optimise your I/O for analysis
- update to a newer ROOT version (if you dare)
- be smarter !

MC production chain & pile-up



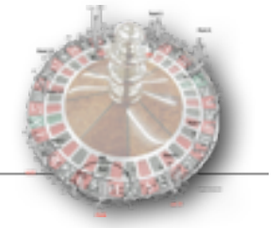


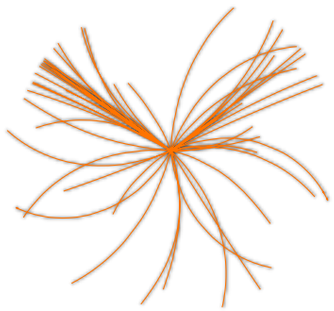


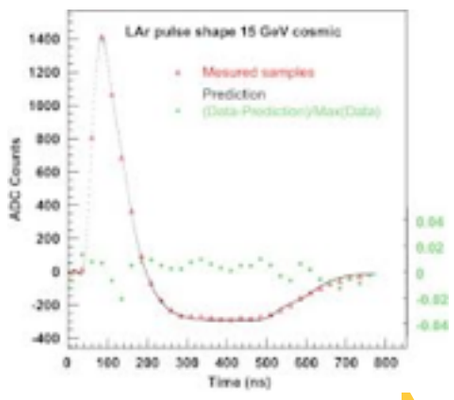


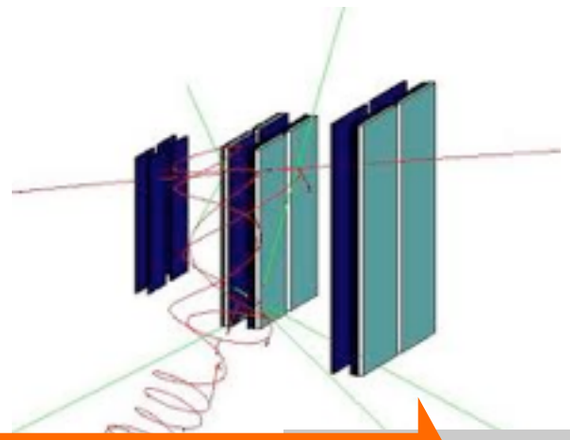
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Analysis**

MC production chain & pile-up

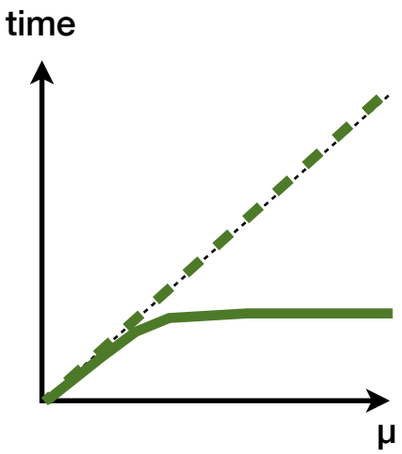




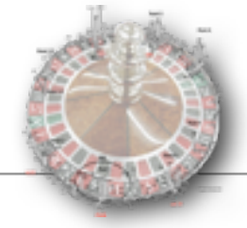


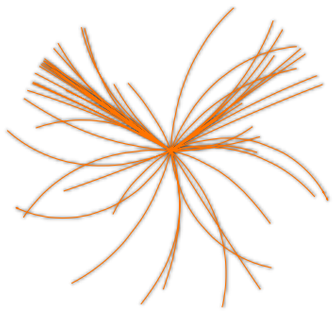


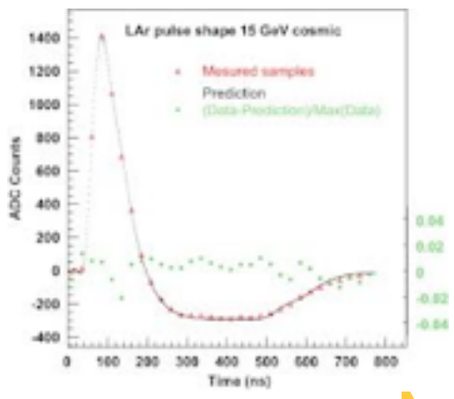
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Analysis**

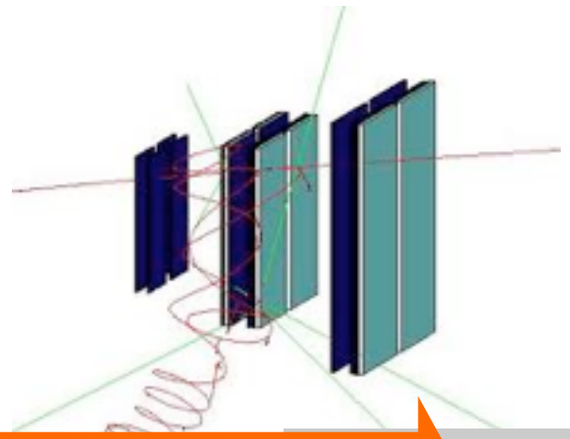


MC production chain & pile-up

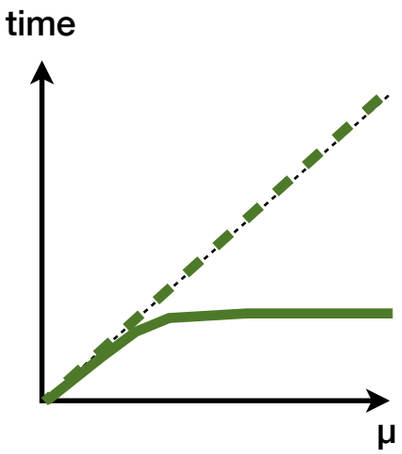


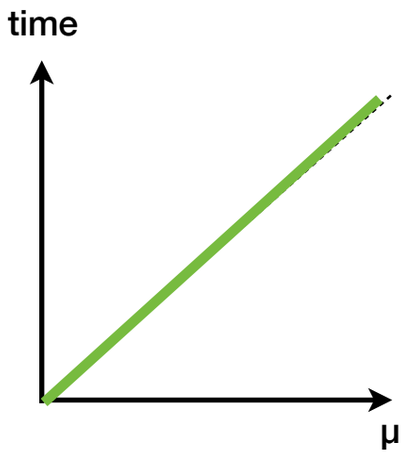




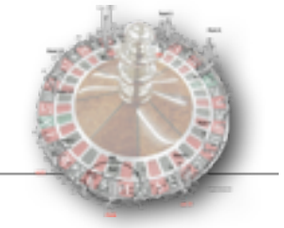


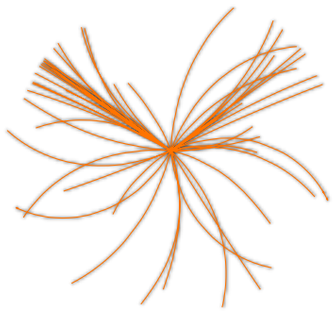
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Analysis**

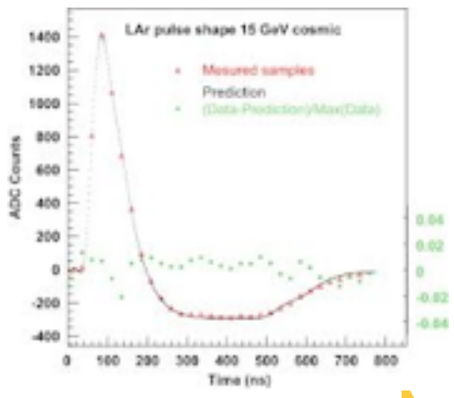


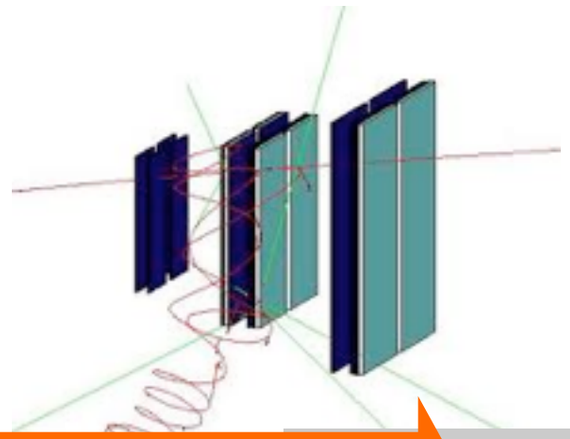


MC production chain & pile-up









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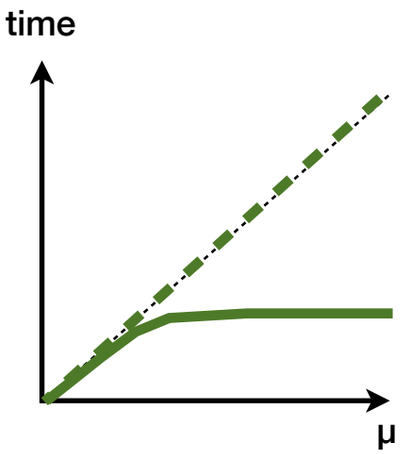
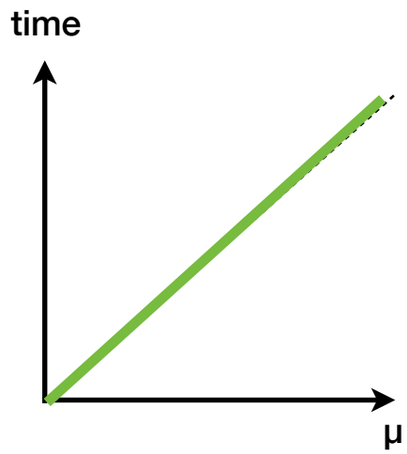
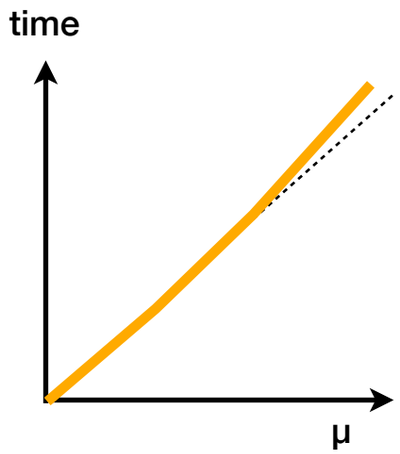
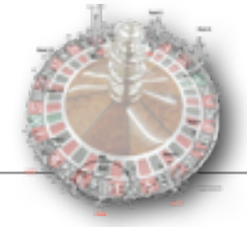
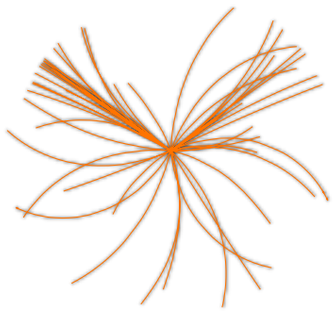


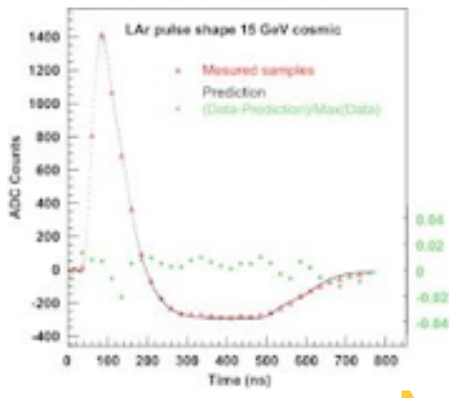


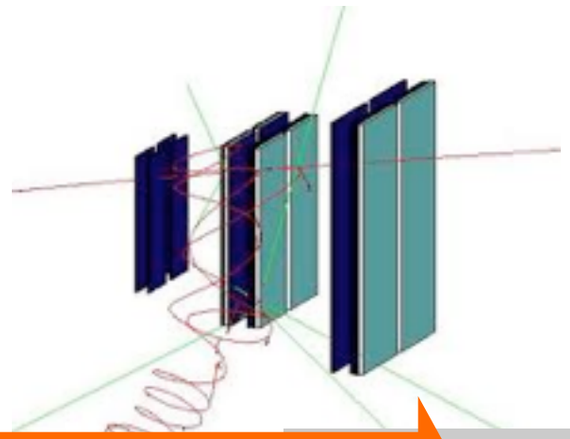


MC production chain & pile-up

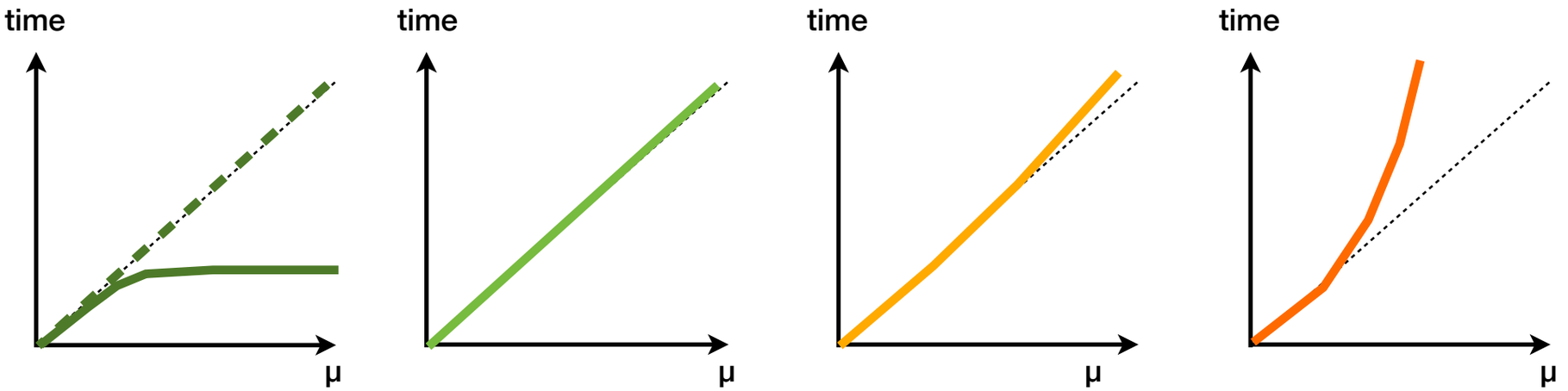




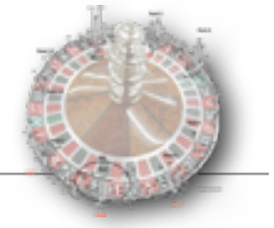


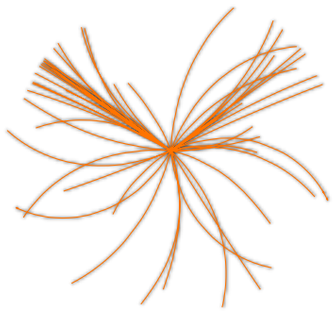


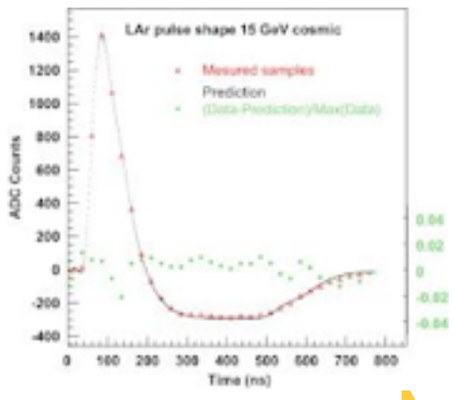
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Analysis**

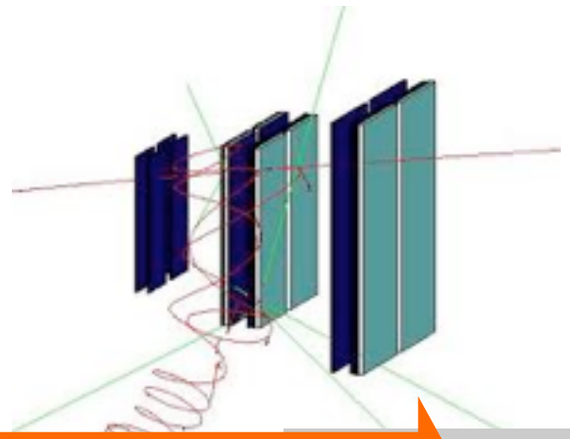


MC production chain & pile-up

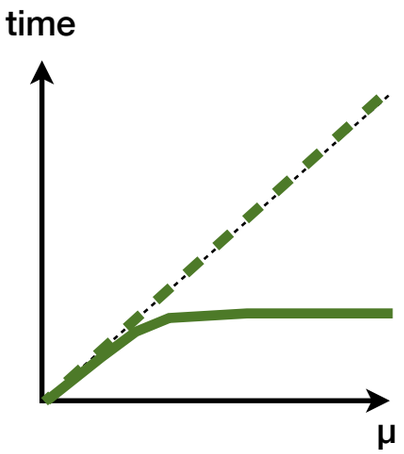


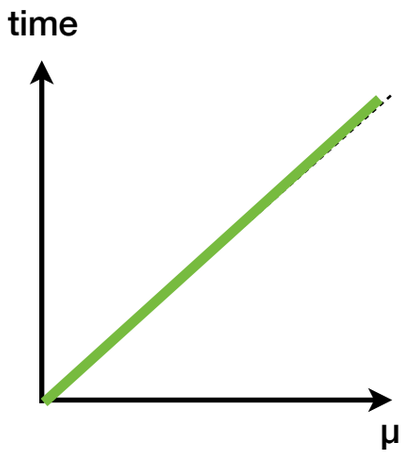


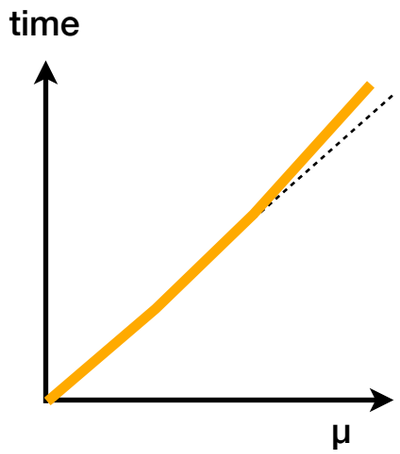


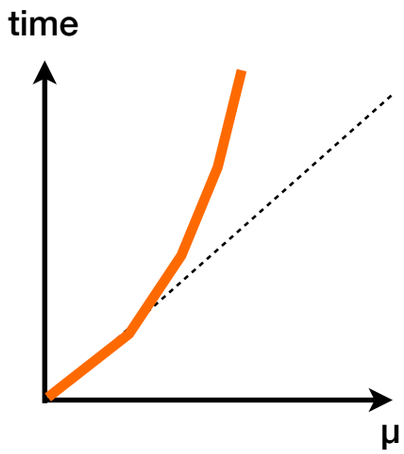


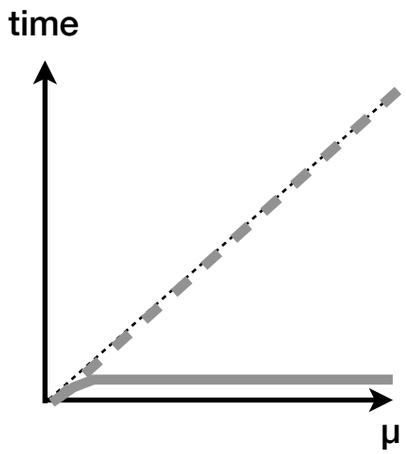
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Analysis**





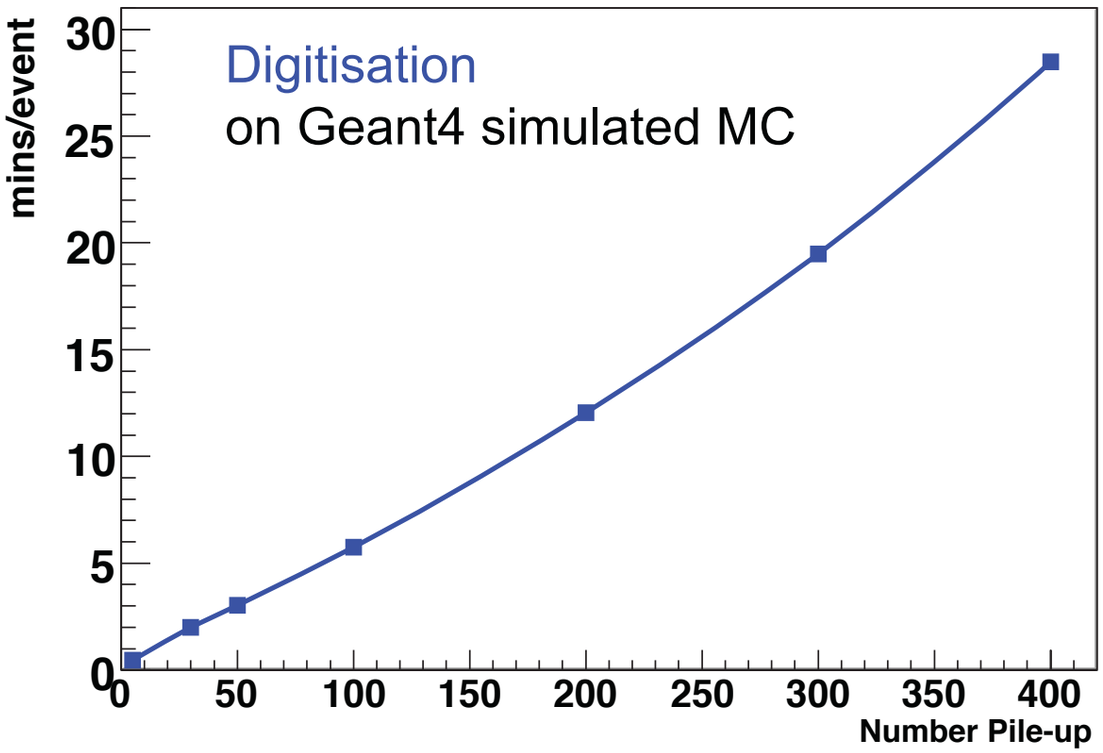


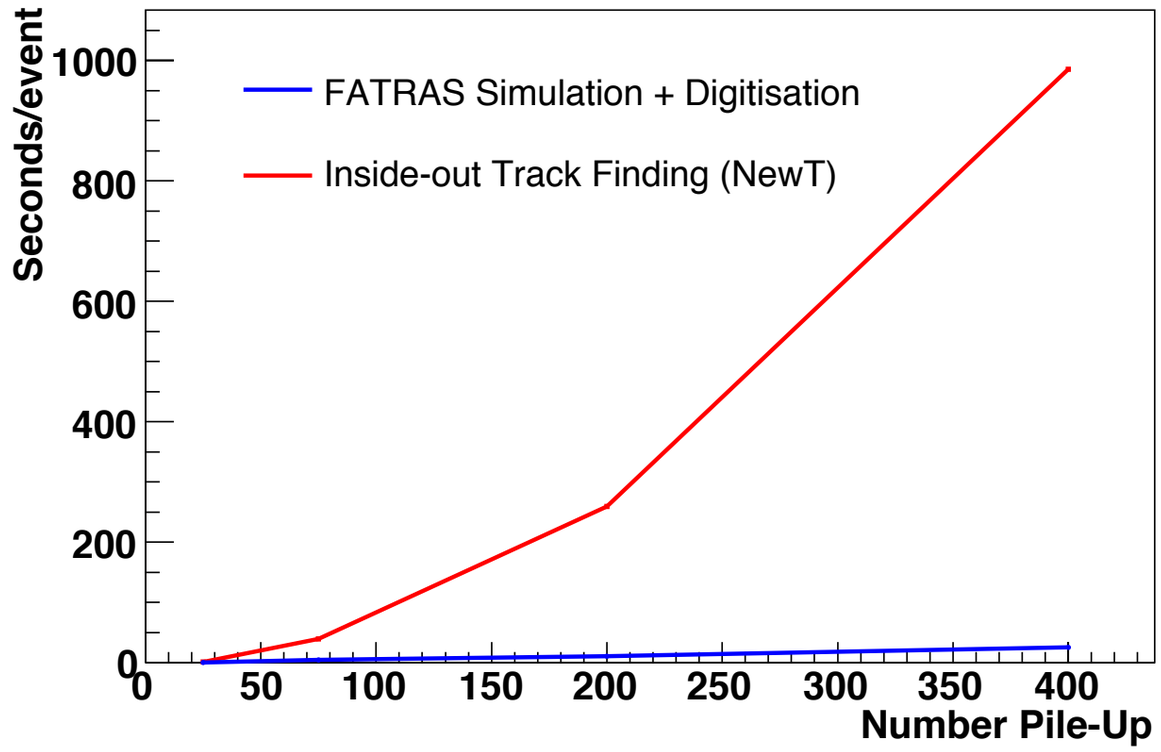




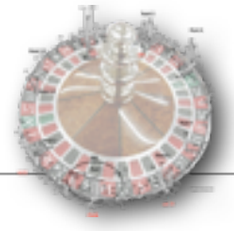
From my DESY days

- Situation of 2009 in the context of ATLAS upgrade simulation
- Upgrade simulation / digitization / reconstruction
  - simulation is not the issue in this context !



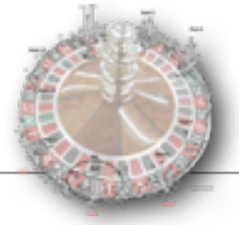


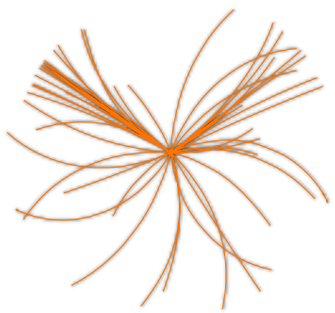
From my DESY days

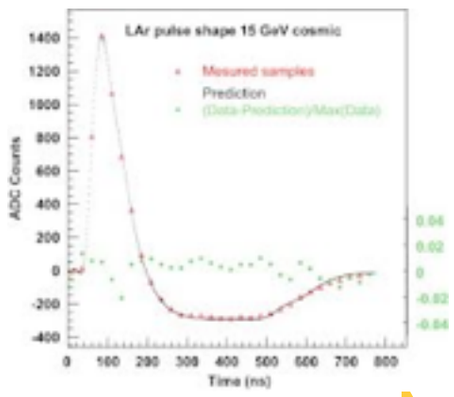


- A bit of eye-candy

Full MC production chain: Disk requirements



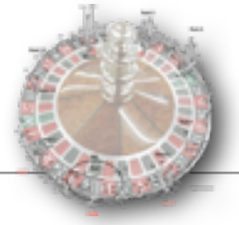


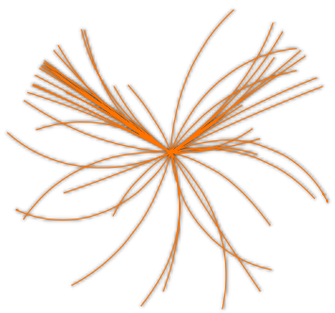


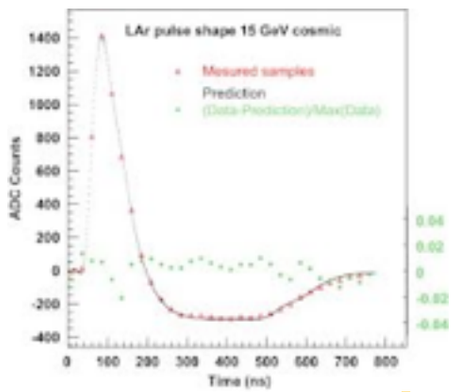
Event Generation	Detector Simulation	Digitization	Reconstruction	Rootification
EVGEN	HITS	DIGITS	ESD/AOD	TTree/THist
10 kB	few 100 kB to 1MB		1-few MB/ few 100 kB	few 100 kB/ < 1kB

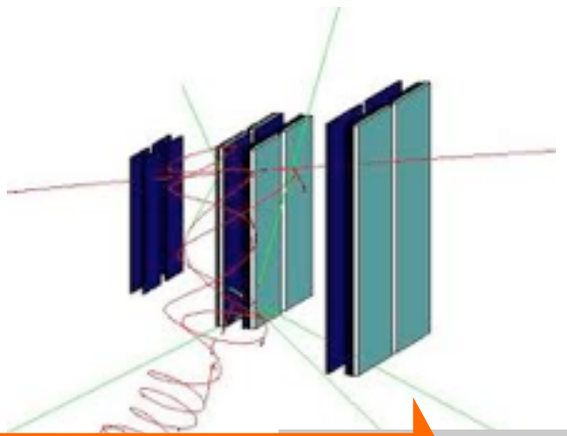
disk usage/event

Full MC production chain: Disk requirements









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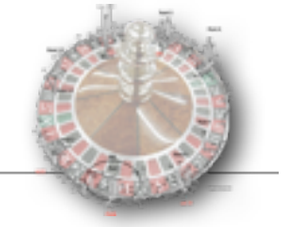
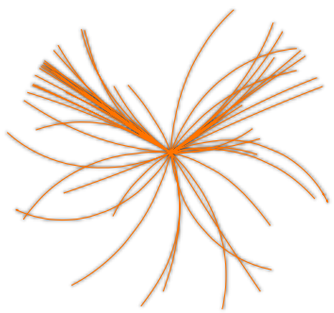
EVGEN	HITS	DIGITS	ESD/AOD	TTree/THist
10 kB	few 100 kB to 1MB		1-few MB/ few 100 kB	few 100 kB/ < 1kB

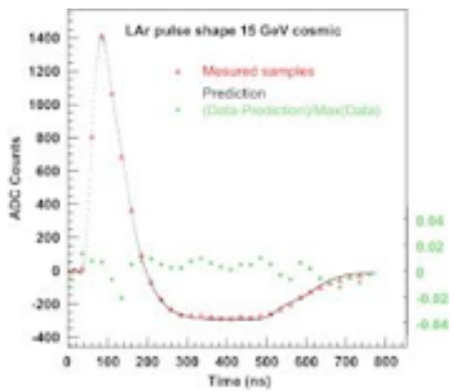
disk usage/event

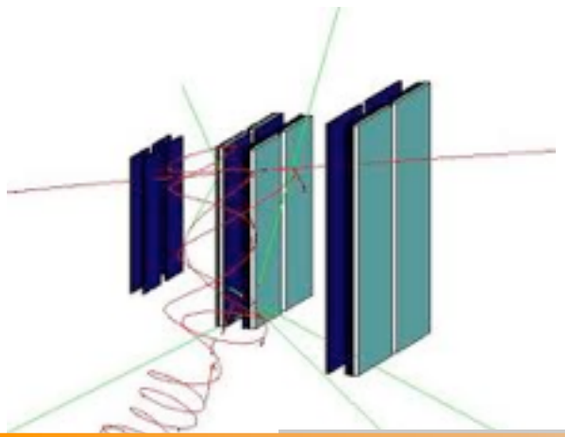
- Imagine a Hz-era full chain: you are becoming immediately I/O dominated
- the handling of the datasets on the grid will take more time than re-producing

MC production single-pass chain







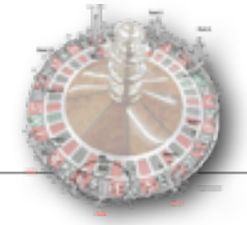


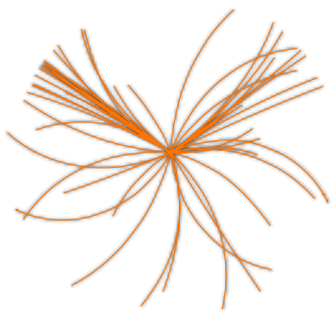
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Rootification**

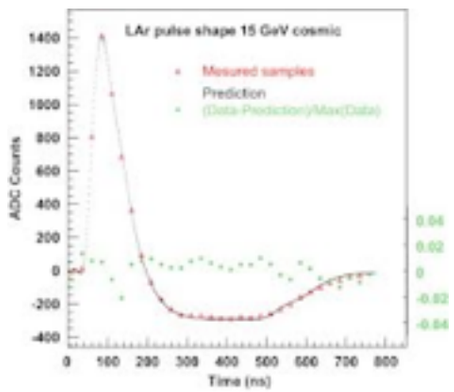
EVGEN ⟶ TTree/THist

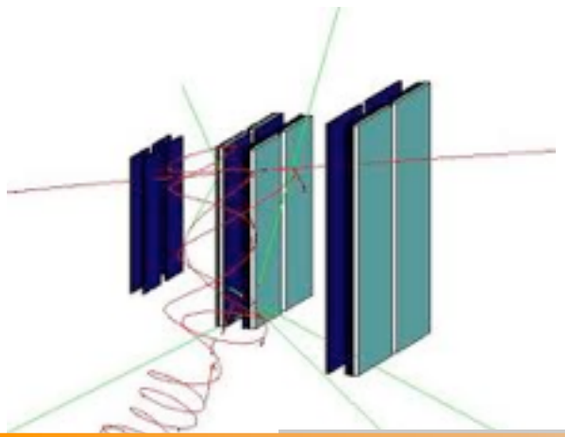
- Let's assume the single-pass MC production chain becomes possible
  - a single job that produces EVGEN to analysis format
  - or even includes the event generation as well
- Re-simulating would become faster than retrieving the dataset

MC production single-pass chain







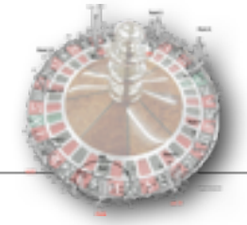


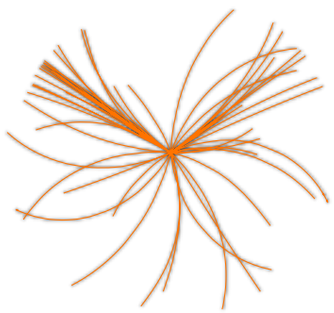
Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Rootification**

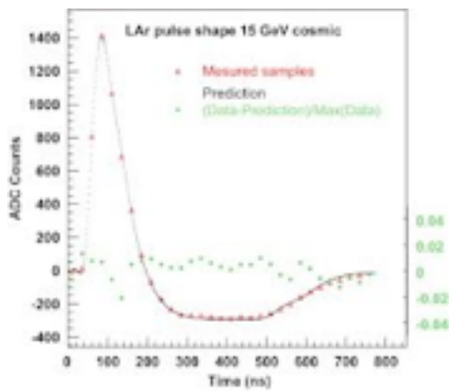
EVGEN ⟶ TTree/THist

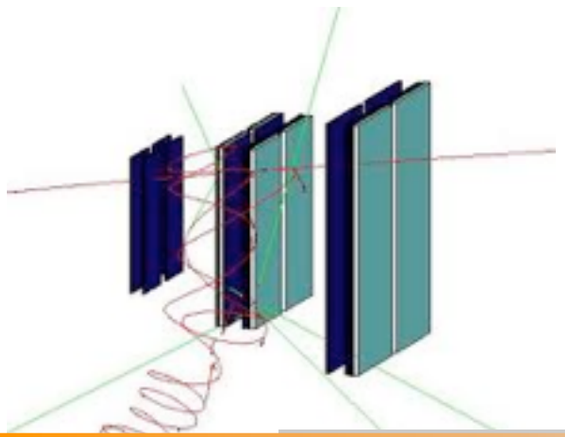
- How to do pile-up in this case ?
  - this is (at first sight) a similar problem to doing pile-up in a fully parametric simulation (e.g. Delphes)
  - we discuss about this already a bit this week

MC production single-pass chain









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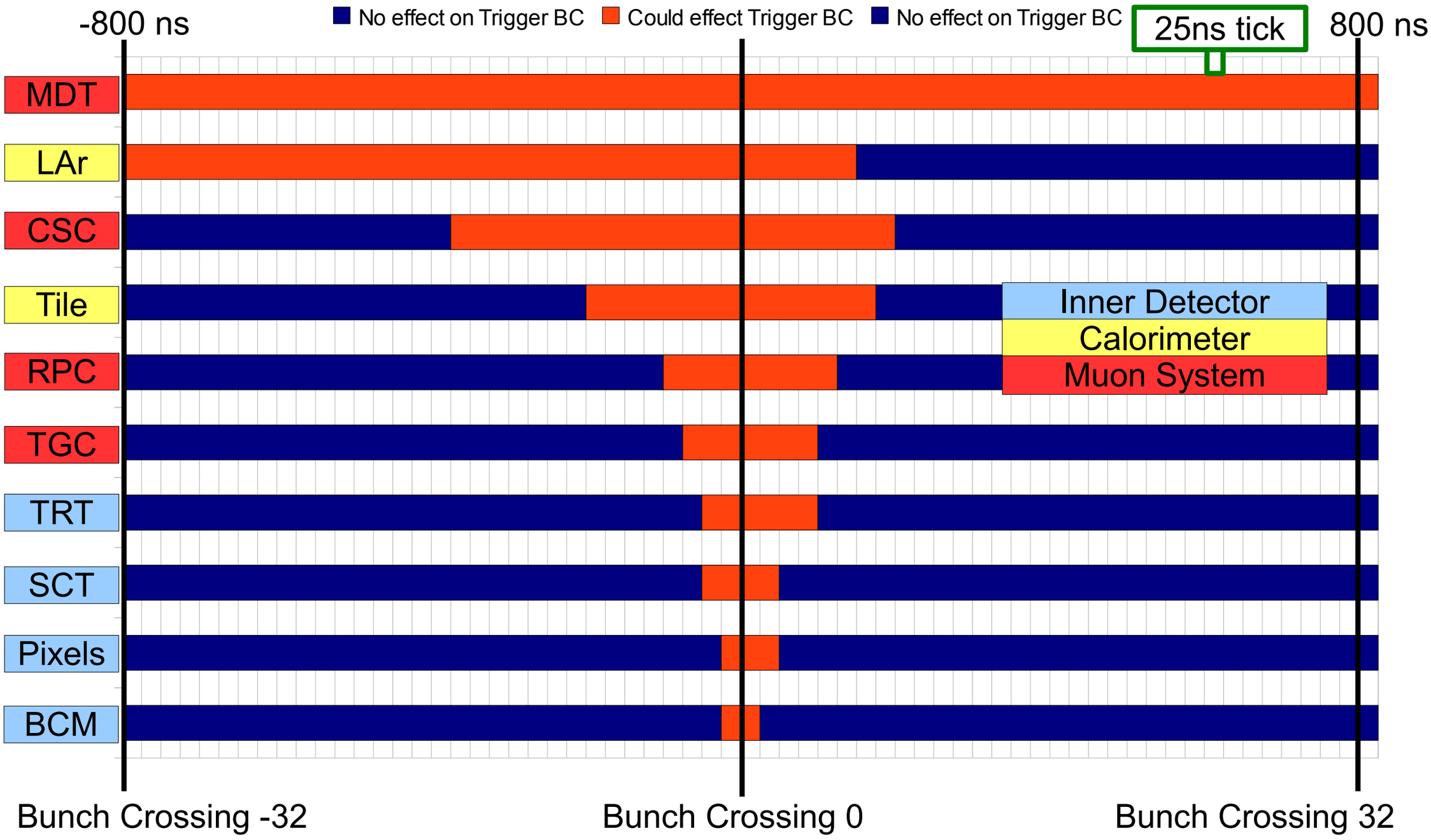
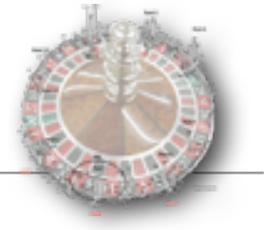
*Let me now contradict what I said on tuesday

MC production single-pass chain

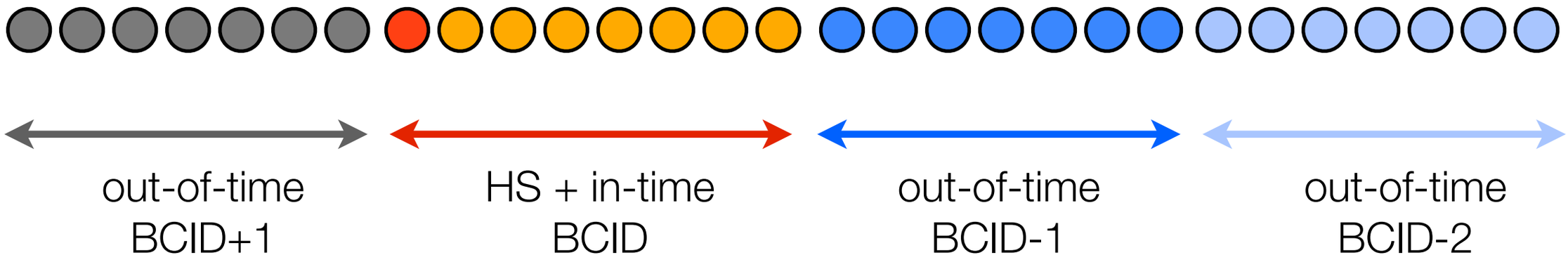


On the fly pile-up simulation



- In-time (IT) pile-up: ✓ (EVGEN pile-up machinery)
- Out-of-time (OT) pile-up:
  in the past (TDR) modeled by in-time pile-up contribution:
  - good approximation in some areas
  - different detectors would need different “additional” in-time pile-up

- A bit more clever EVGEN pile-up : let’s decode the BCID (Bunch Crossing ID)



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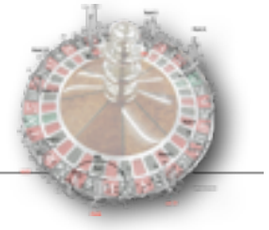

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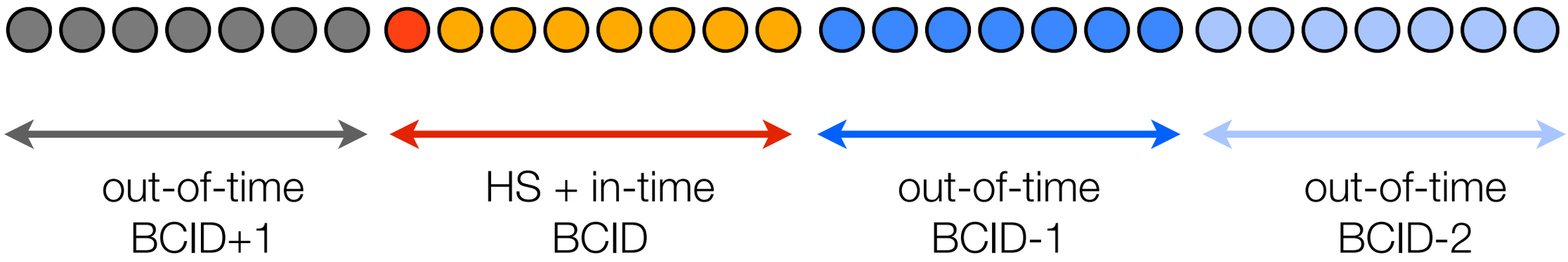
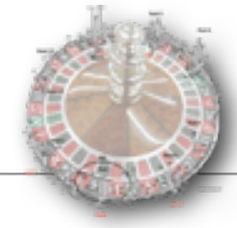
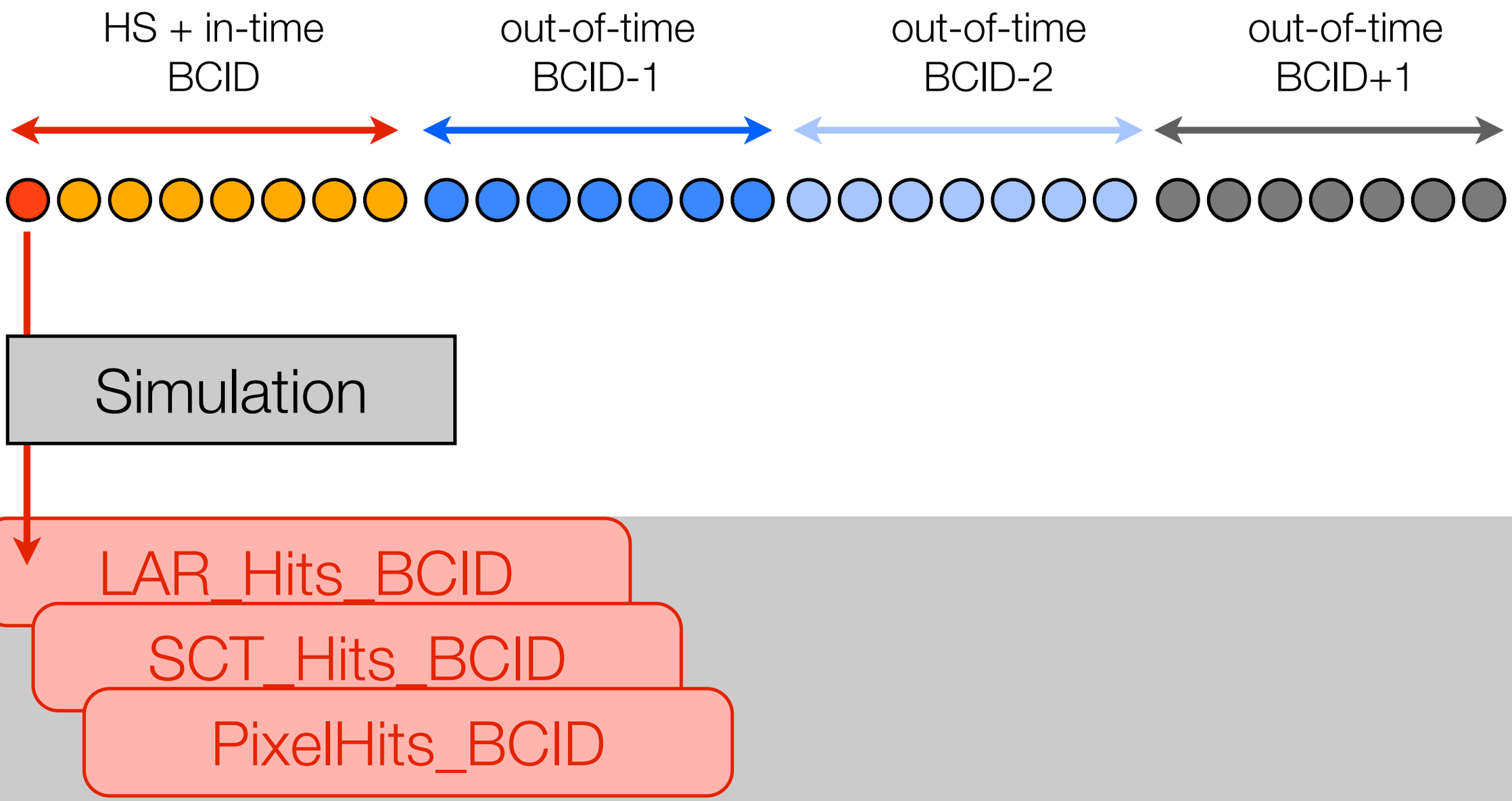


- see Federica’s contribution from Wednesday!

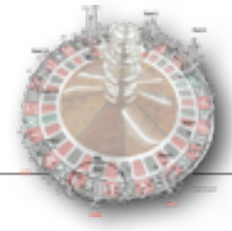
Let's re-order and process them



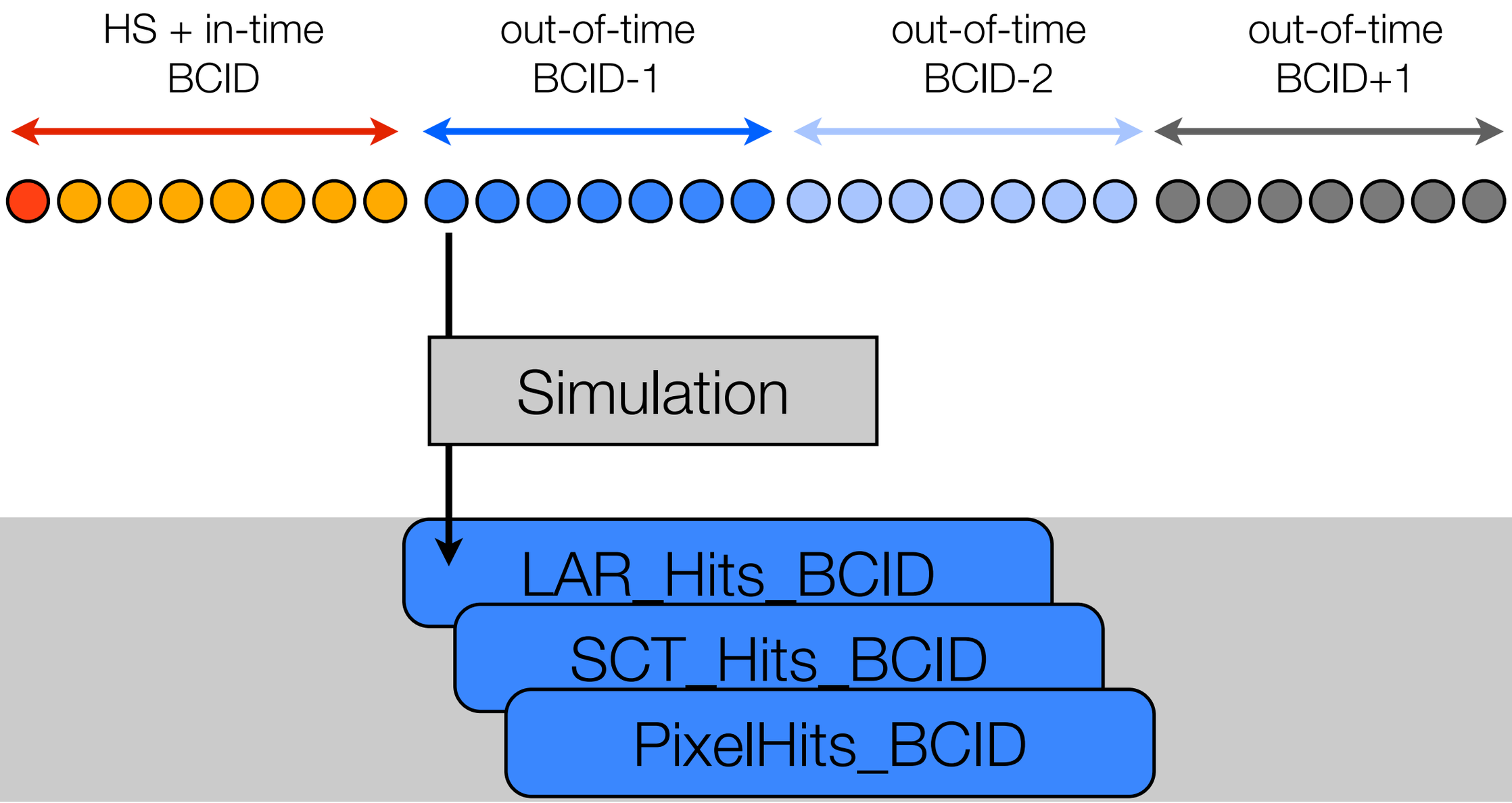
- Start with a BCID(time)-encoded McEventCollection



Let's re-order and process them

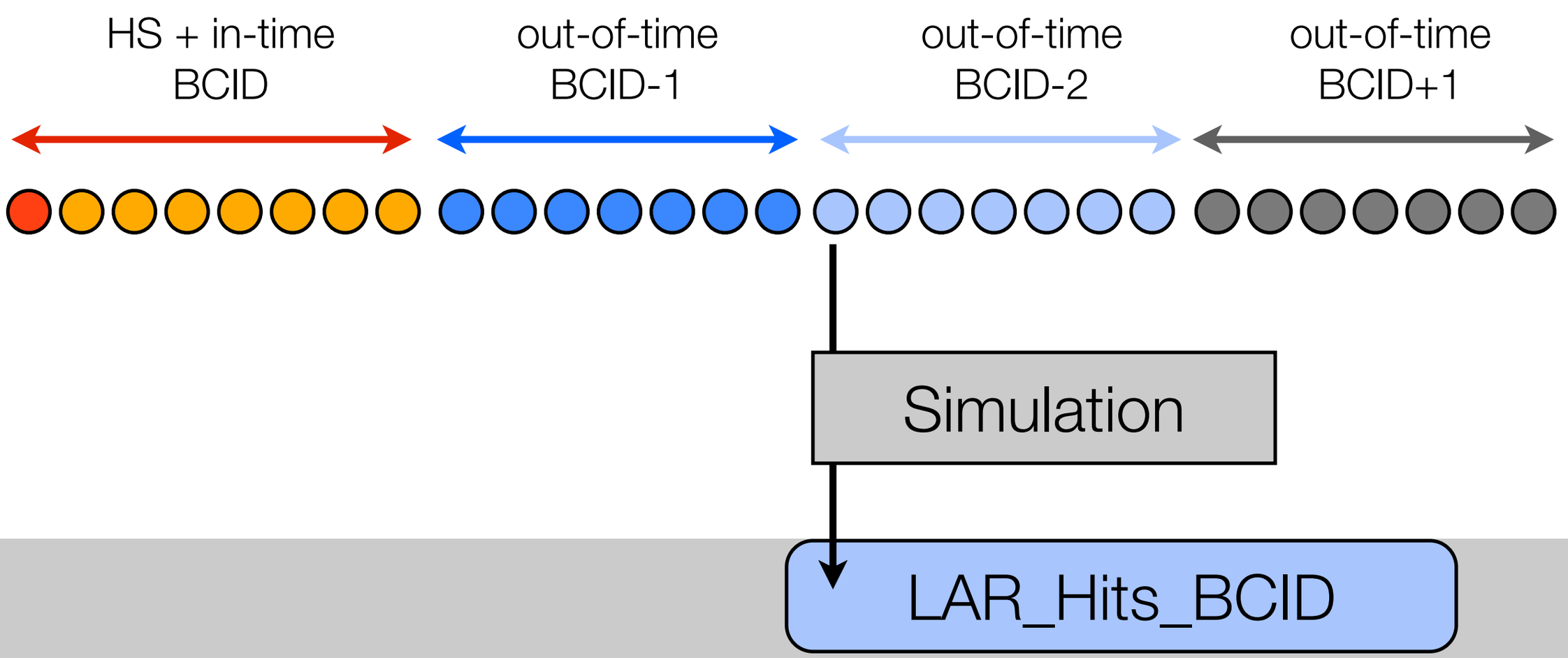


- Start with a BCID(time)-encoded McEventCollection

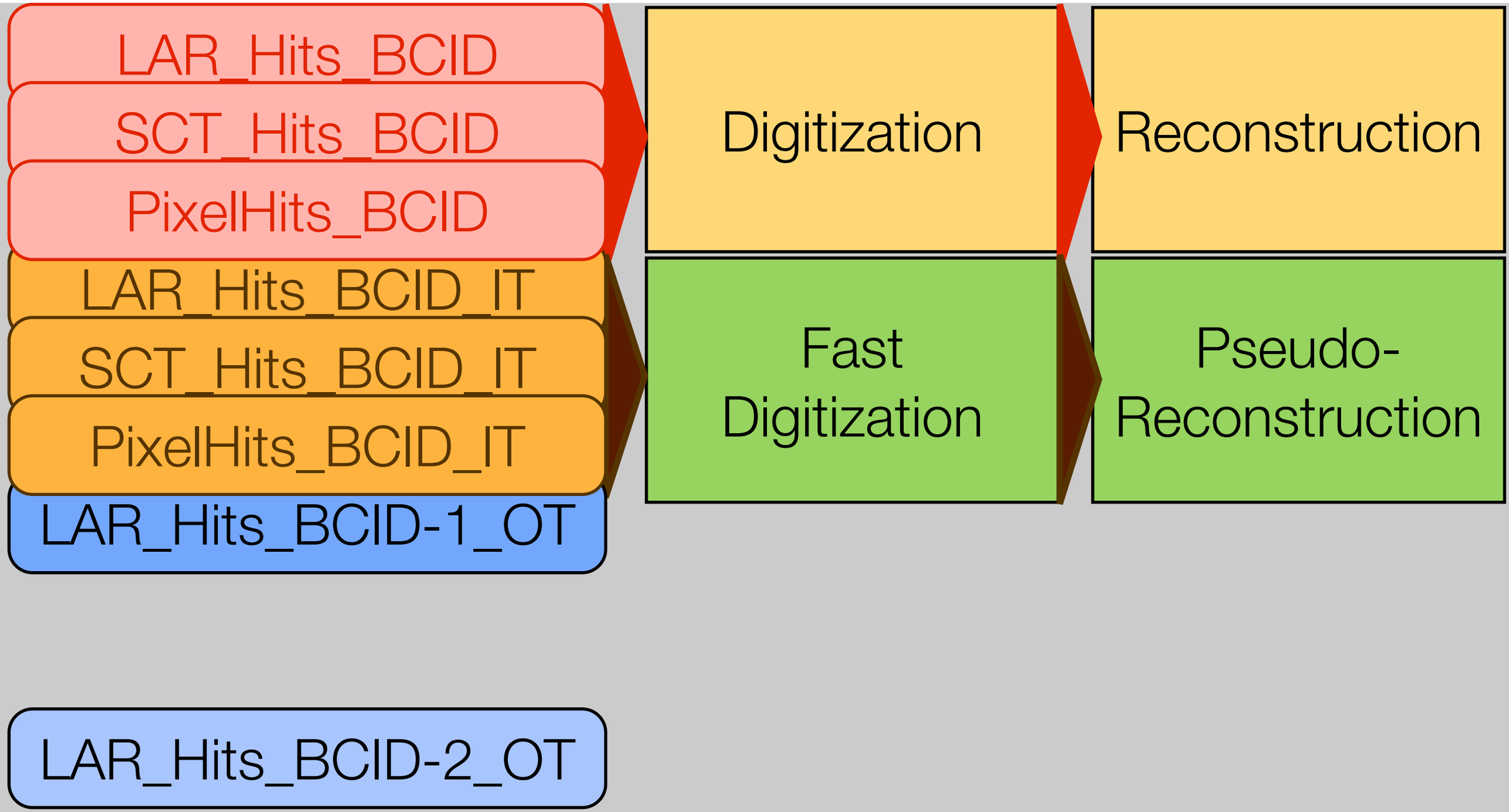


Let's re-order and process them

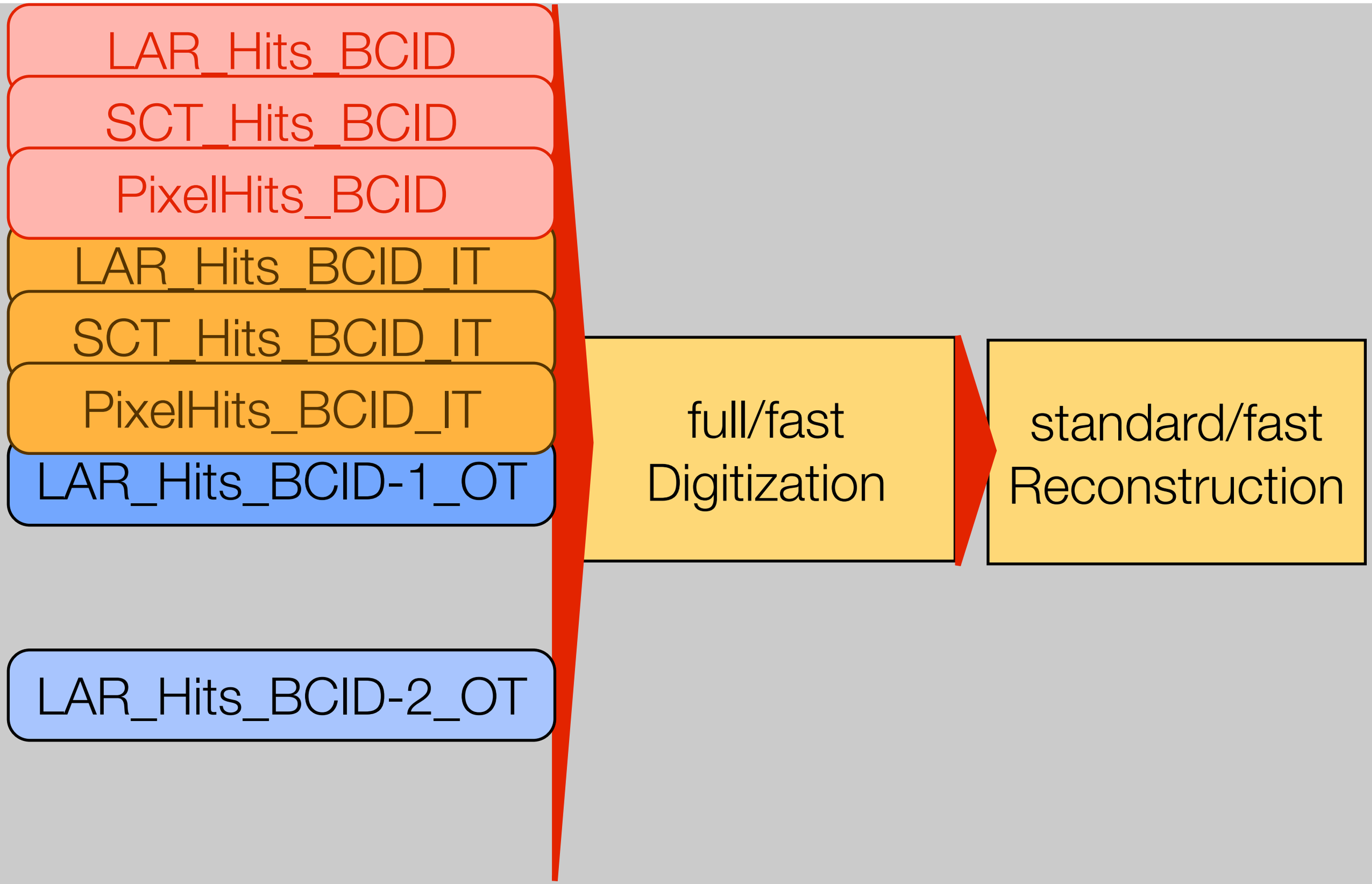
- Start with a BCID(time)-encoded McEventCollection



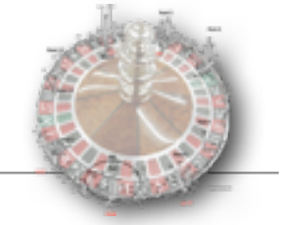
Example: ID with Truth Tracking

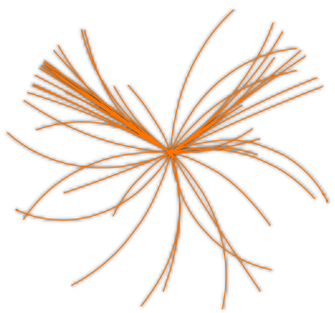


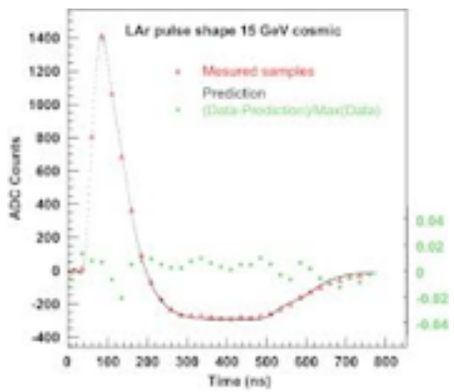
Example: Calorimeter in the same event

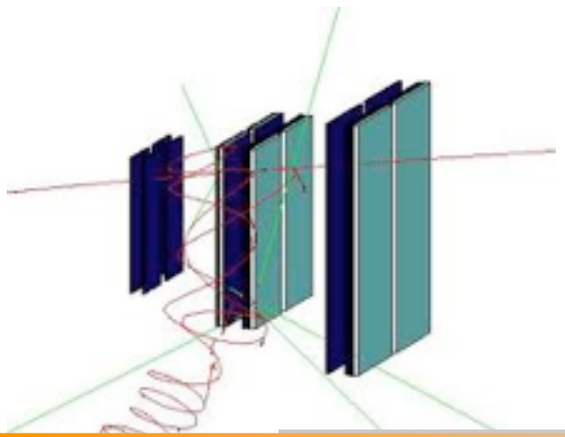


A possible final product









Event Generation → **Detector Simulation** → **Digitization** → **Reconstruction** → **Rootification**

EVGEN → **Hits A** **Hits B** → **Digits A** **Digits B** → **Objects**

EVGEN → Hits A Hits B → Digits A Digits B

EVGEN → Hits B → Digits B

EVGEN → Hits B → Digits B

EVGEN → Hits B → Digits B

TTree/THist

Will we get there ?

- At least we started talking about this

Many thanks for this lively workshop,

your contributions, thoughts & discussions !