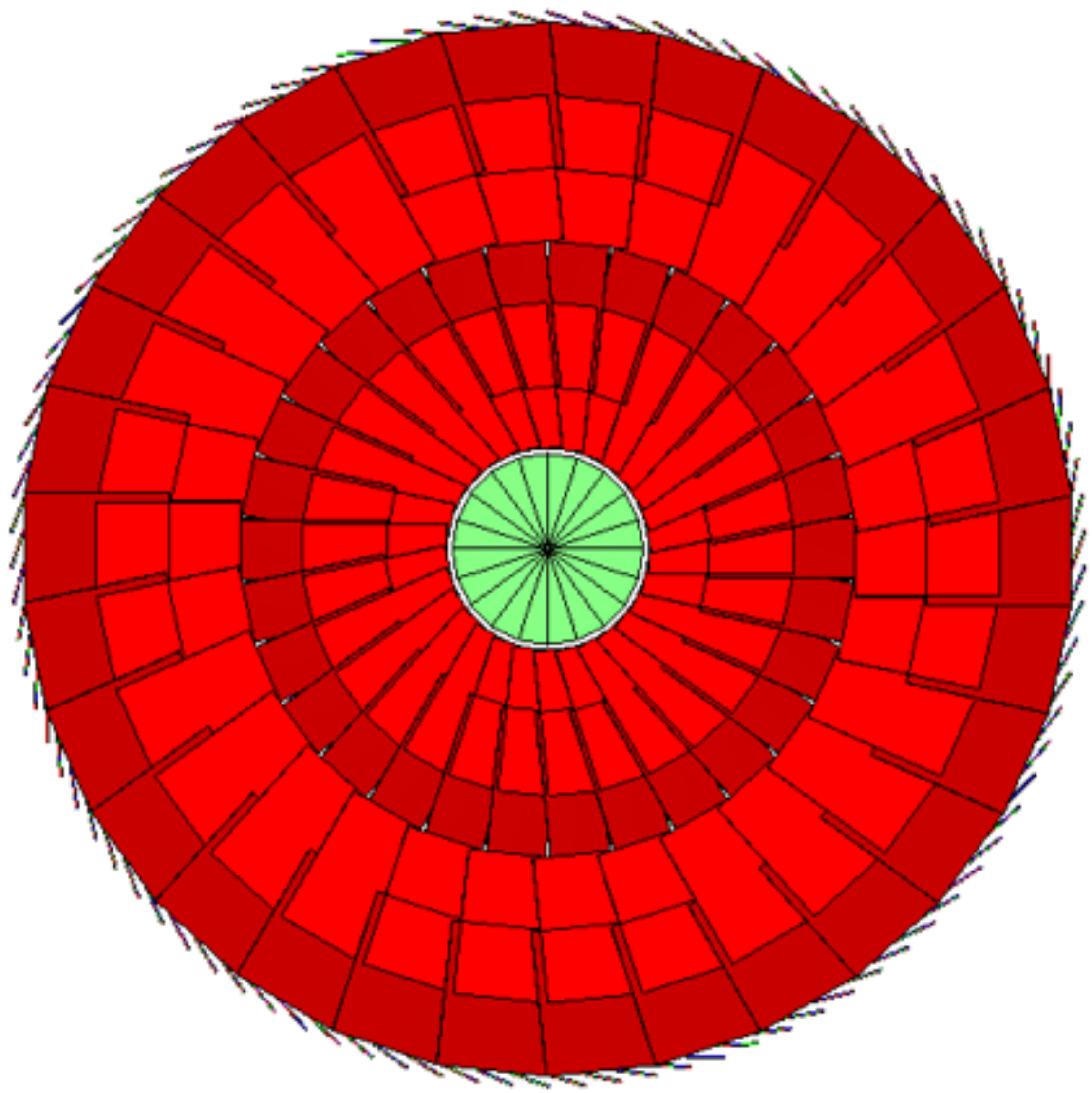
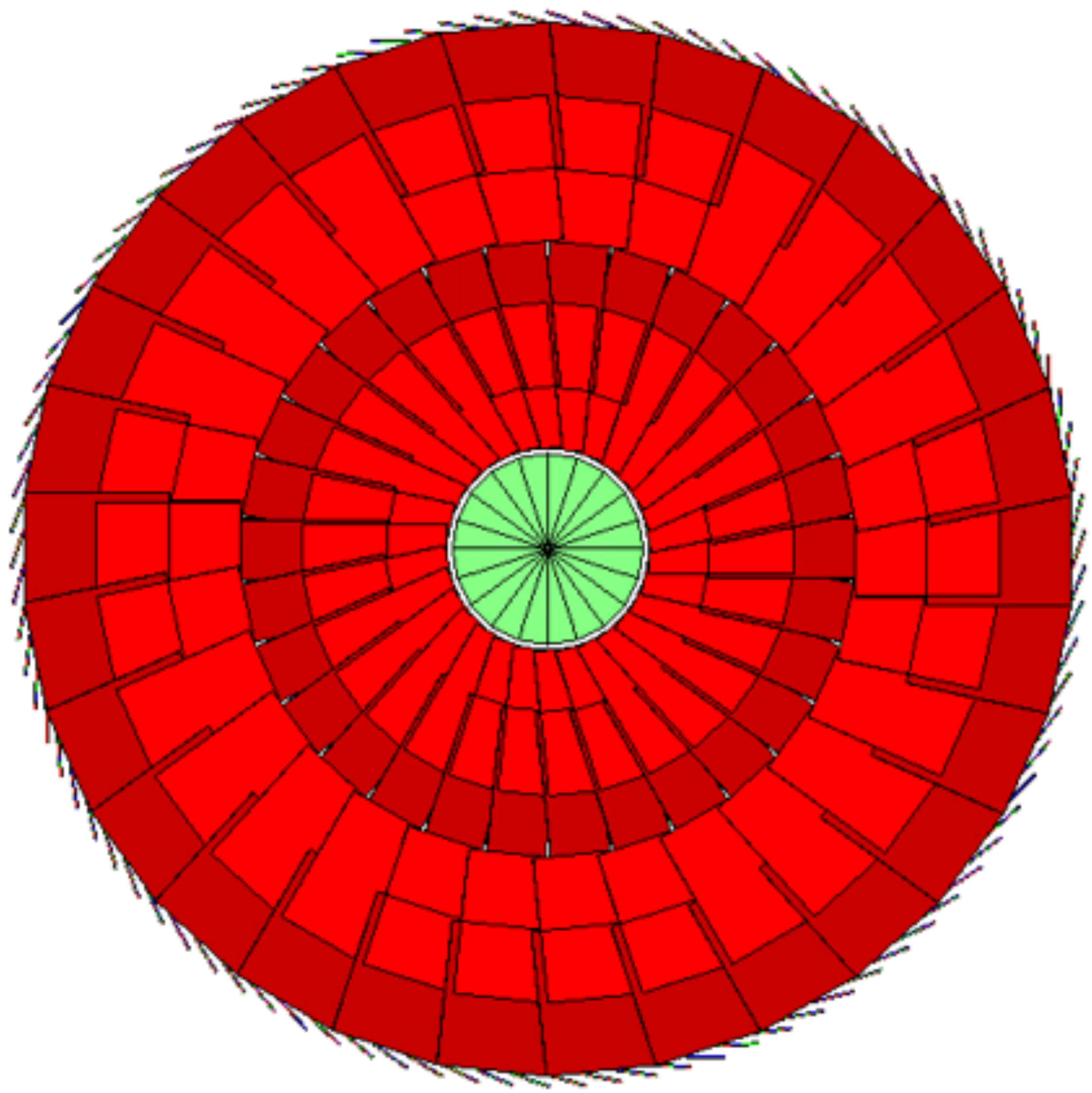


A new Tracker Software Tool for ATLAS in the context of FCC Software Development

A. Salzburger, CERN



~~A new Tracker Software Tool for ATLAS in the context of FCC Software Development~~

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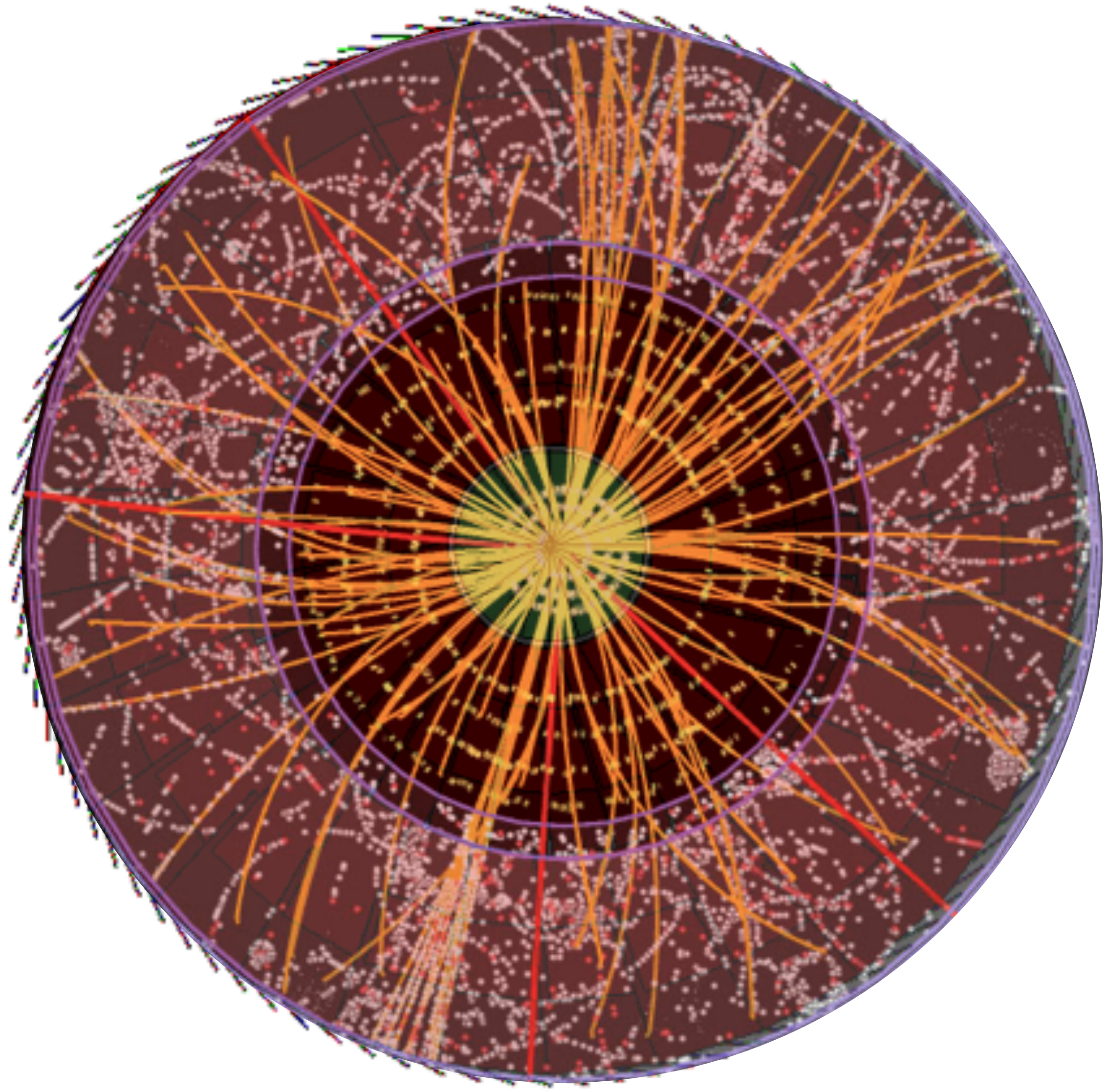


Simulation & reconstruction SW for FCC - lessons from the past and an outlook

A. Salzburger, CERN

Disclaimer & Context

- My experience is ATLAS-centric
  - however, much of this applies to CMS as well

    will try to cover this appropriately
  - it may not all apply directly to FCC-eh (ee/hh)

    will try to stress out where I think this happens

- Why should you be listening to me on this subject ?
  - well, I was invited (to speak on a different topic though)
  - my experienced based on

    initial team that developed the current ATLAS Tracking SW

    architect of the new ATLAS Integrated Simulation Framework (ISF)

    ATLAS reconstruct ruction group convener (currently)

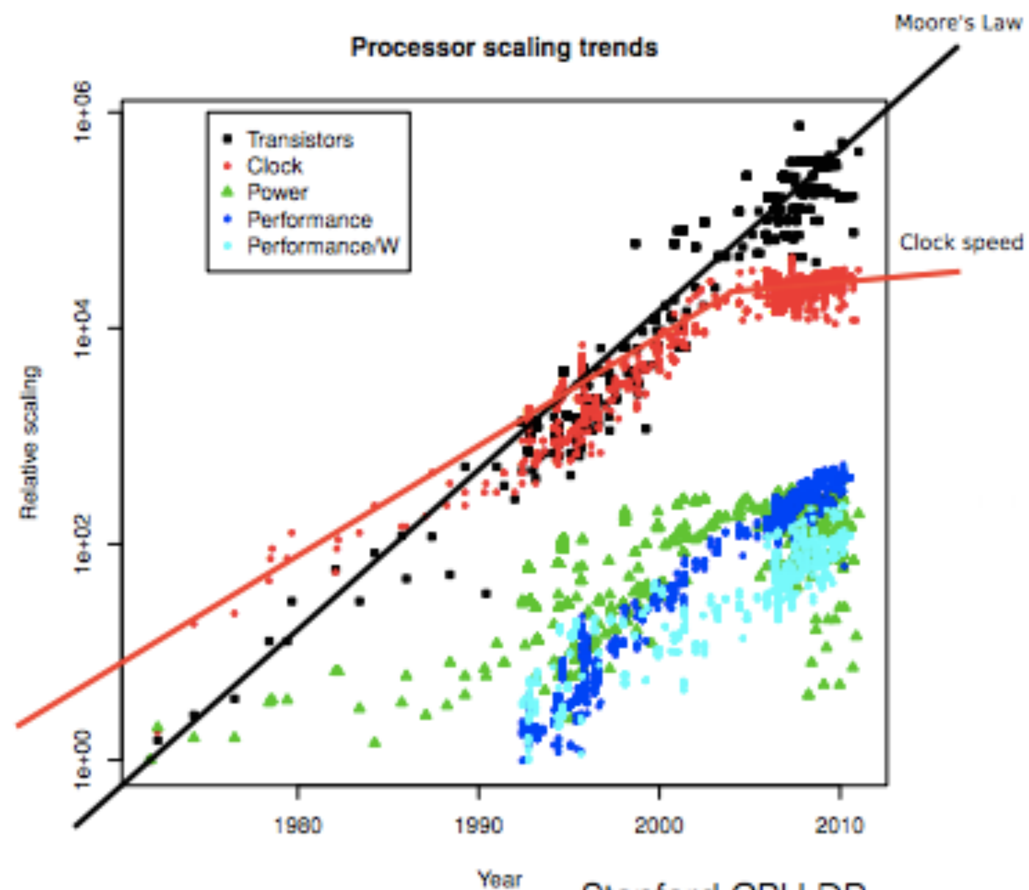
    ATLAS Phase-2 Inner Detector layout TF leader (currently)

    joined the FCC SW project because I think we should learn from the past and make things better (i.e. I'm an optimist)

SW frameworks & Event Data (-> Benedict)

- Historical review:
  - LHCb developed the Gaudi framework (2000)
    15 year old framework
  - ATLAS adopted to Gaudi in 2003 (as Gaudi-Athena project)
    developed as GaudiAthena
  - CMS rewrote the framework CMSSW in 2006/2007
- Analysis SW became focus during Run-1
  - simplified ROOT-readable formats
- Next paradigm shift expected
  - see various talks at this year's CHEP:
    http://chep2015.kek.jp
  - move towards concurrency

G. Stewart



Stanford CPU DB

Status at the end of LS1

- LHC software has been stress-tested like no other HEP software before
  - and it was a great success, however …
  - several areas of concerns - many addressed in LS1

    MC statistics became limiting factor of same analysis

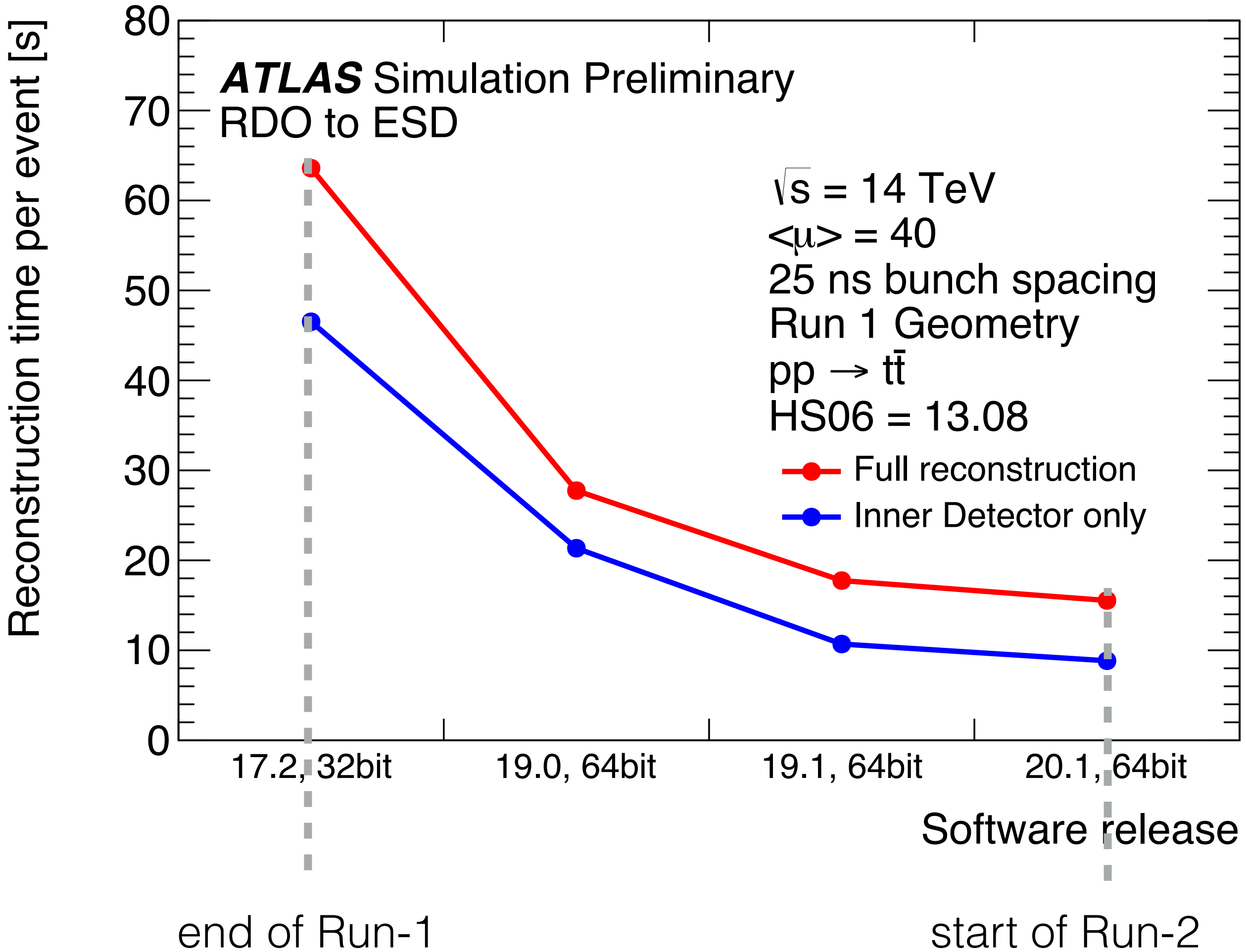
    HLT trigger processing was running at the peak

    pile-up became an issue for reconstruction

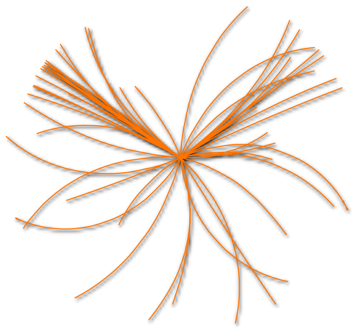
- Run-2 computing was at risk
  - flat computing budget projections (at best)
  - increased pile-up
  - increase CM energy
  - increase HLT rates
  - LHC experiments had to act

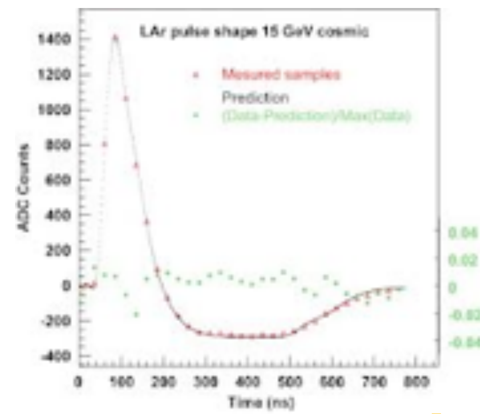
    and they did:

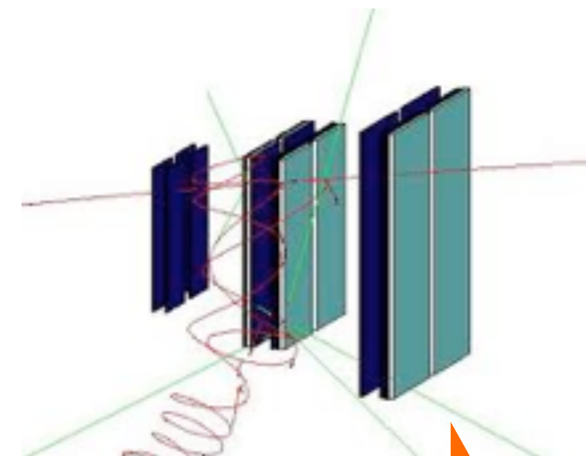
CMS achieved similar improvement



Monte Carlo simulation chain








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

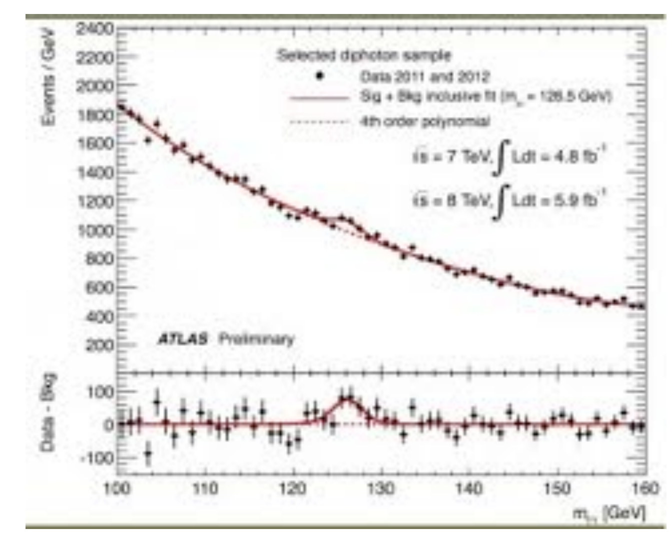
EVGEN

HITS

DIGITS

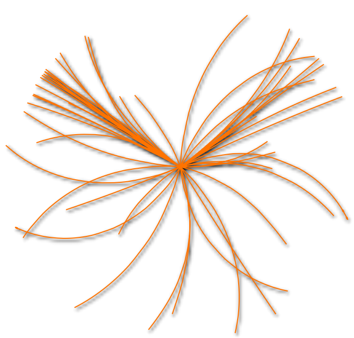
ESD/AOD

TTree/THist



Analysis

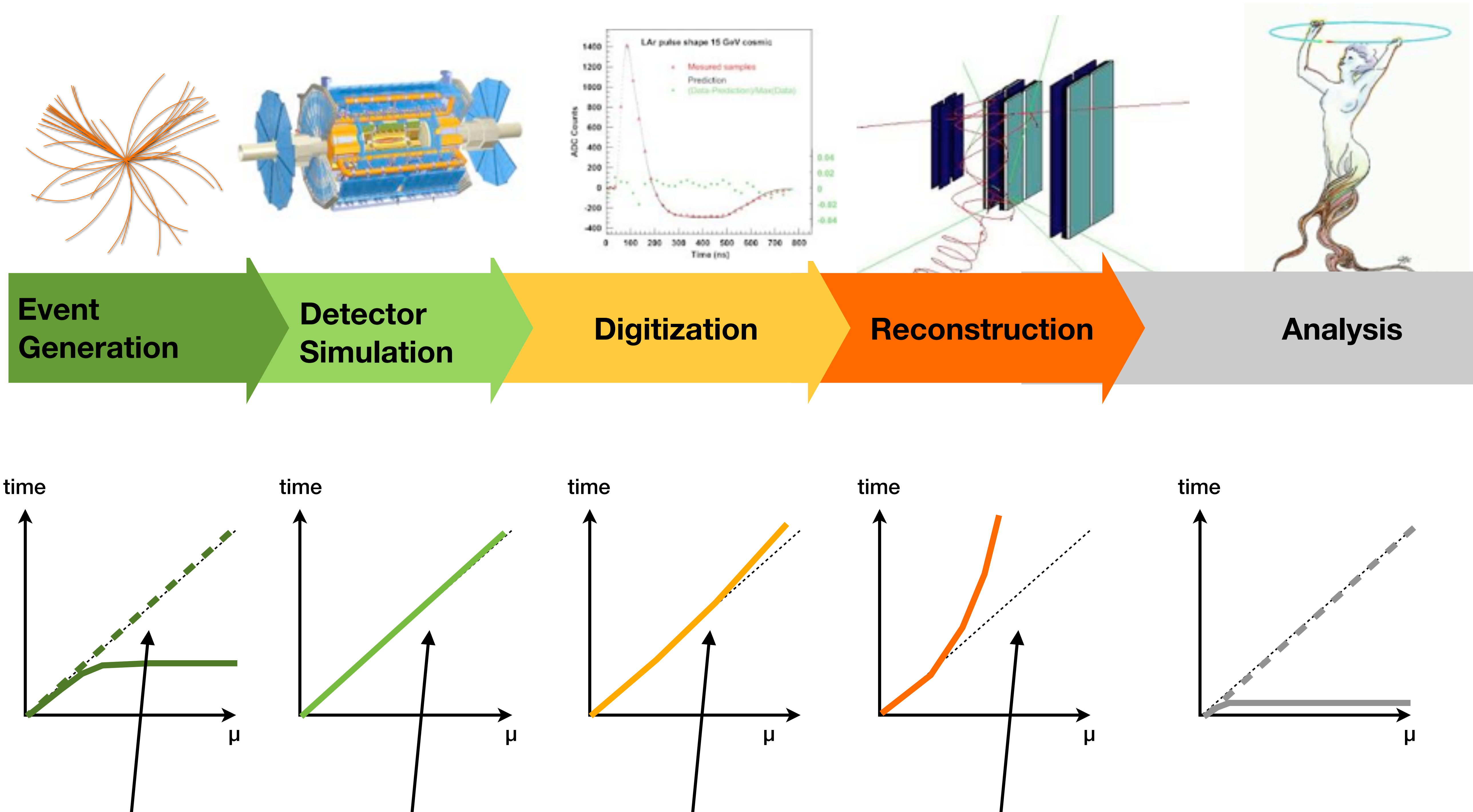
RDOs




μ times

Not a big issue for FCC-eh

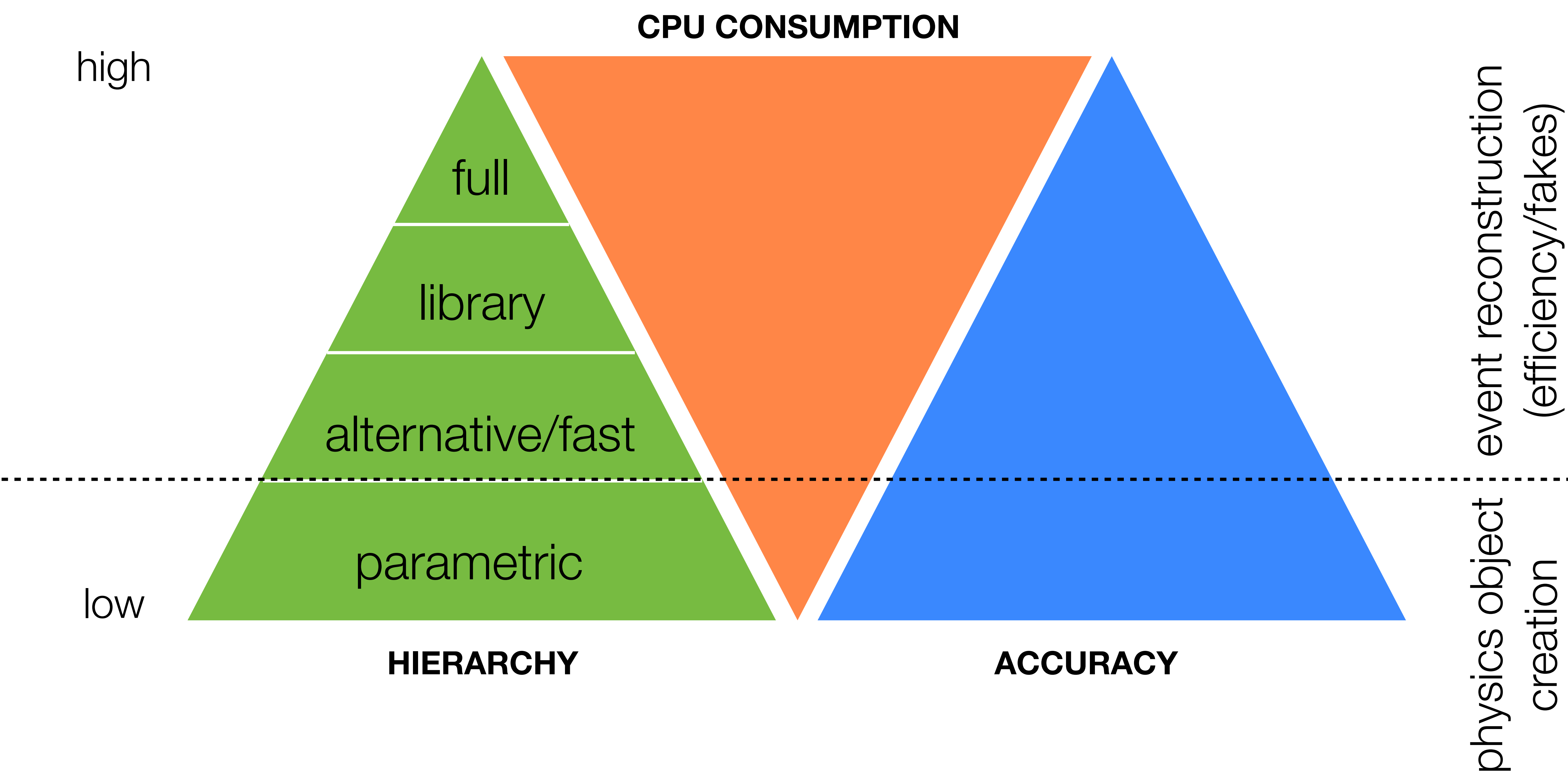
Monte Carlo production, statistics and μ



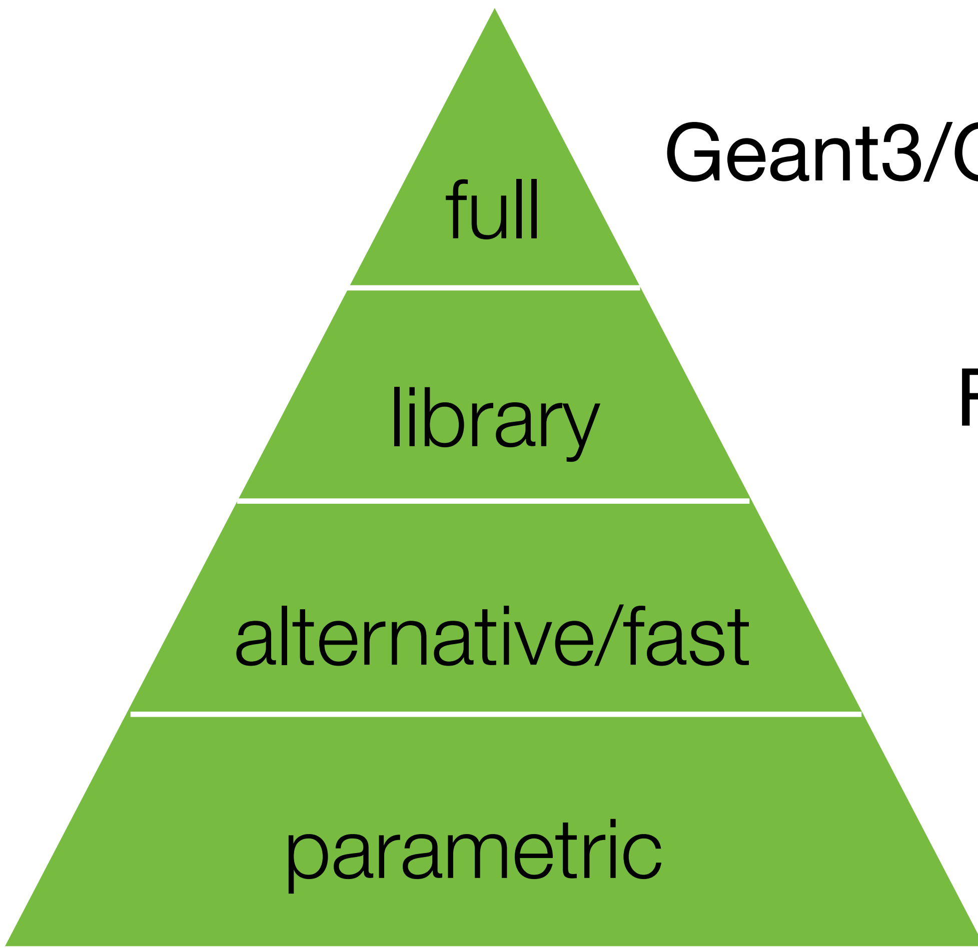
If μ stays low - linear timing dependency for N events

Simulation

- Techniques & concepts, e.g. ATLAS



Simulation hierarchy (1)



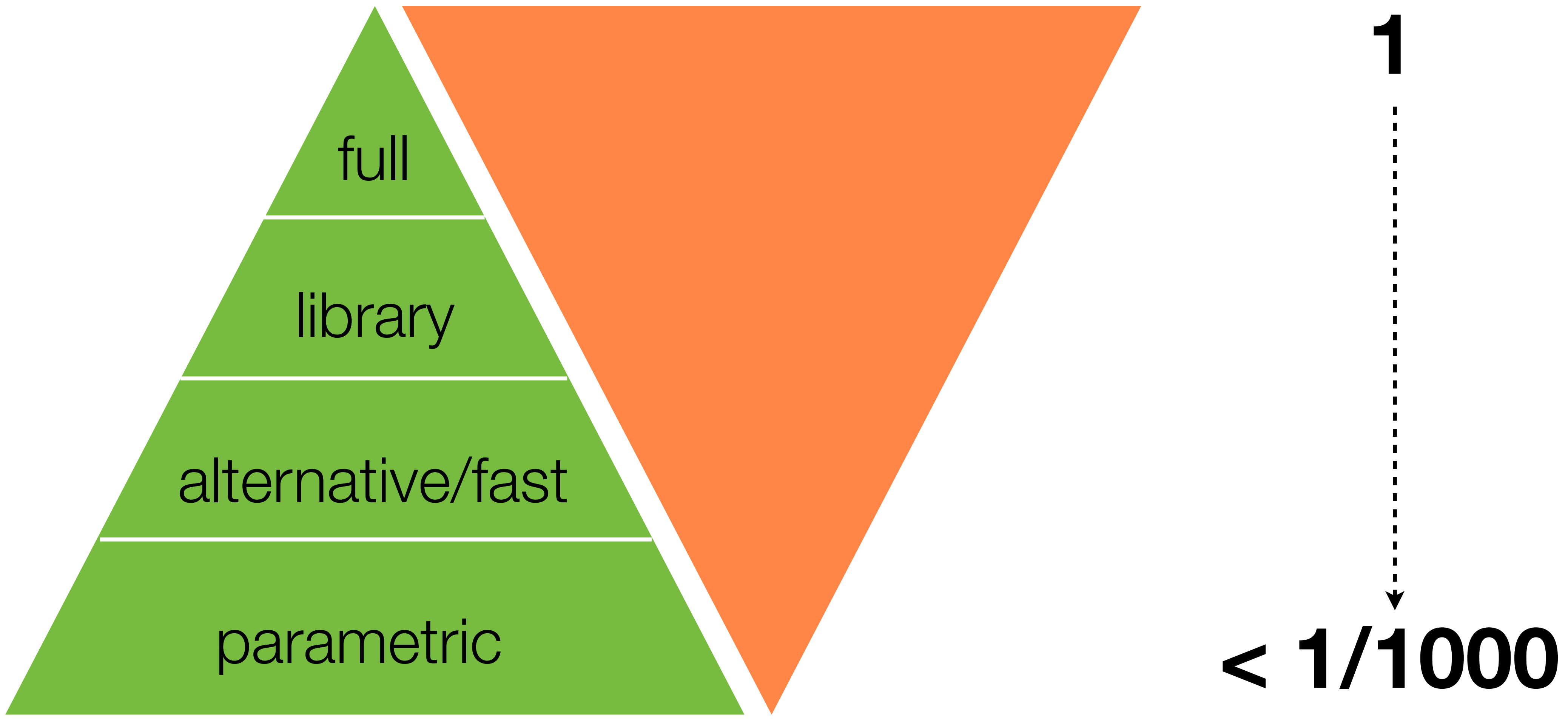
Geant3/Geant4/Flugg/Fluka

Frozen Showers/

Atlfast2(F) / GFlash /
/ CMS Fast Simulation

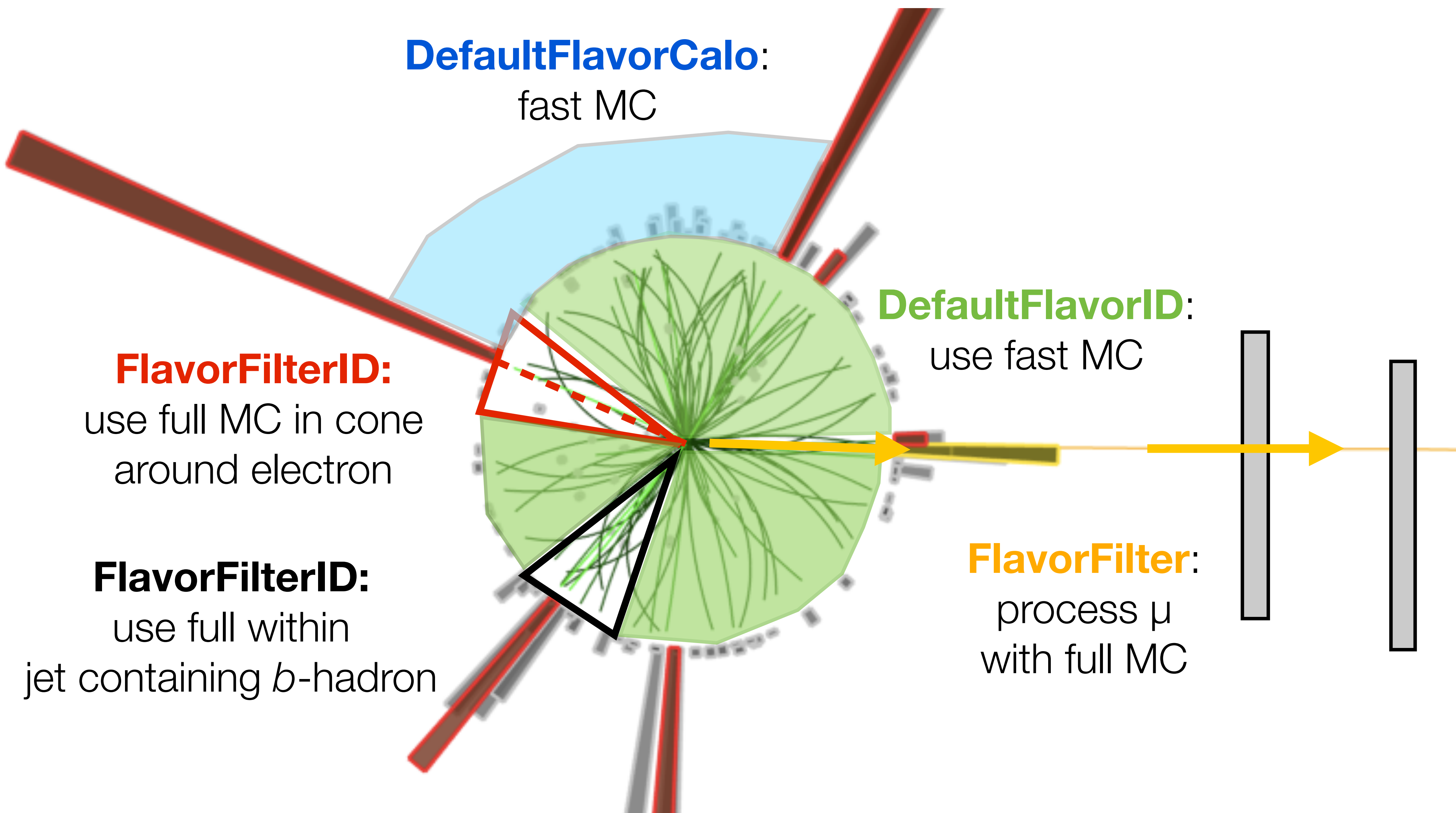
Atlfast, Delphes

Simulation hierarchy (2)



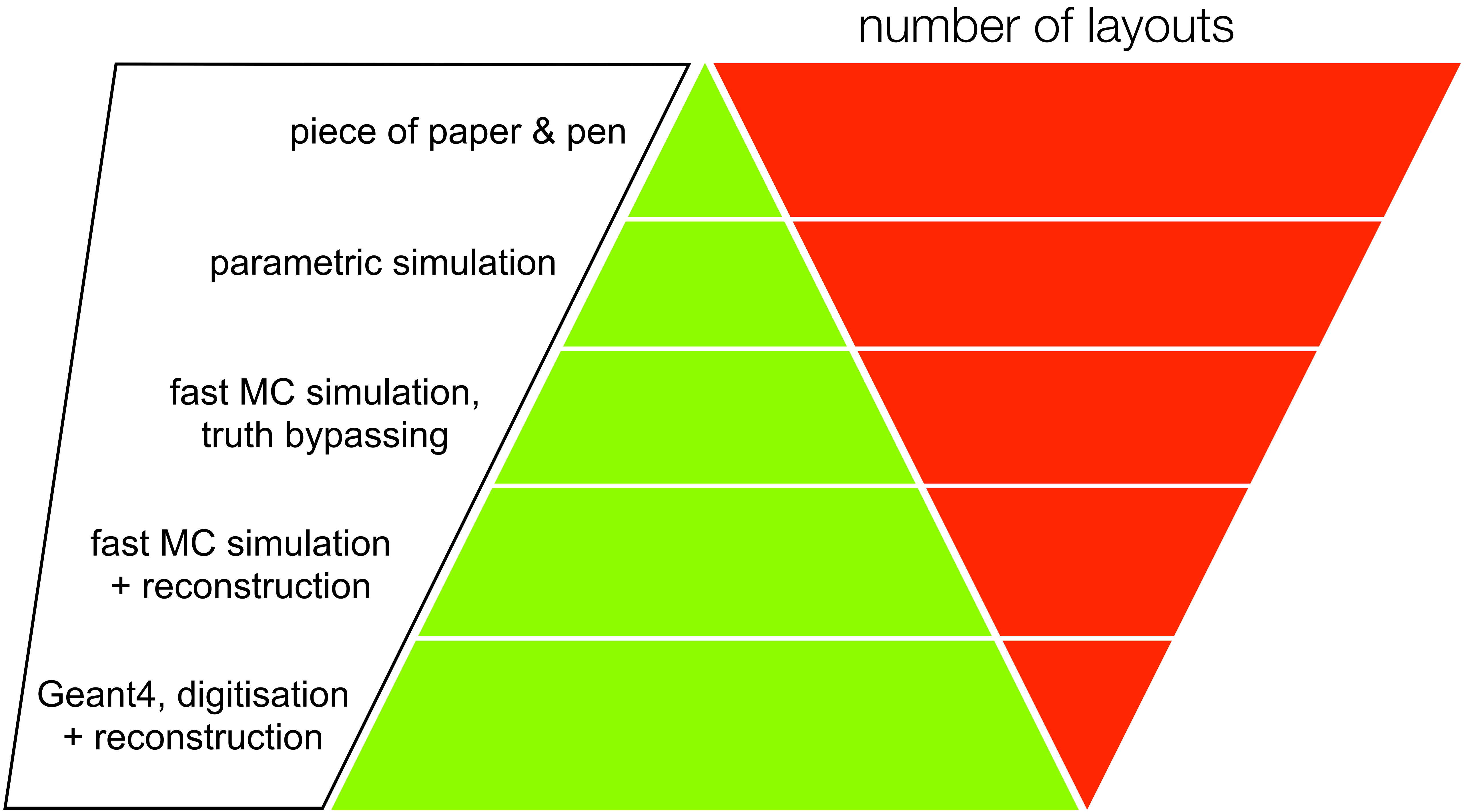
Simulation: the ATLAS ISF project (-> Julia)

- One framework to combine full and fast simulation techniques
  - within one job
  - within one event (e.g. in different sub detectors)
  - within one detector (in regions of interest)



Monte Carlo for detector design

- A bit tracker specific, but general rules apply



all of those techniques exist in ATLAS/CMS & elsewhere !!

Example: Tracker design - the easy steps

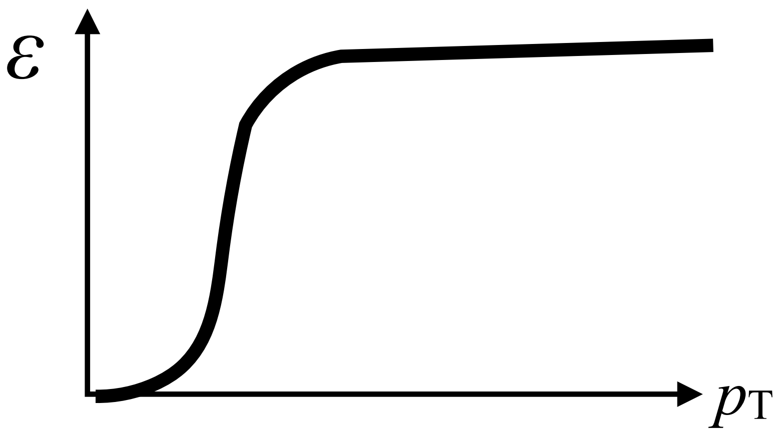
- Estimation of core impact parameter resolution (primaries)
  - can be done on piece of paper: A + B (or extended models) are good to 5-10 %

    models breaks down for large extrapolation distances

    does not hold for <u>dense environments</u> (-> boosted (b-)jets)

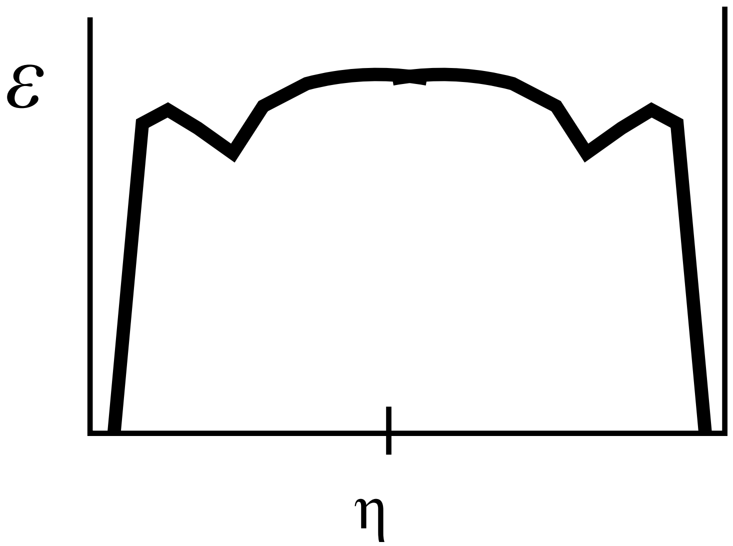
- Estimation of momentum resolution
  - needs accessible field integral & measurement precision

    simplified models (as used in LHC for Phase-2 studies) show 5-10 % agreement with full simulation studies



- Estimation of (generic) tracking efficiency
  - pattern finding efficiency can always be 100%

    though it remains a question of being smart
  - needs knowledge about the material distribution
  - does not describe tracking in <u>dense environments</u>



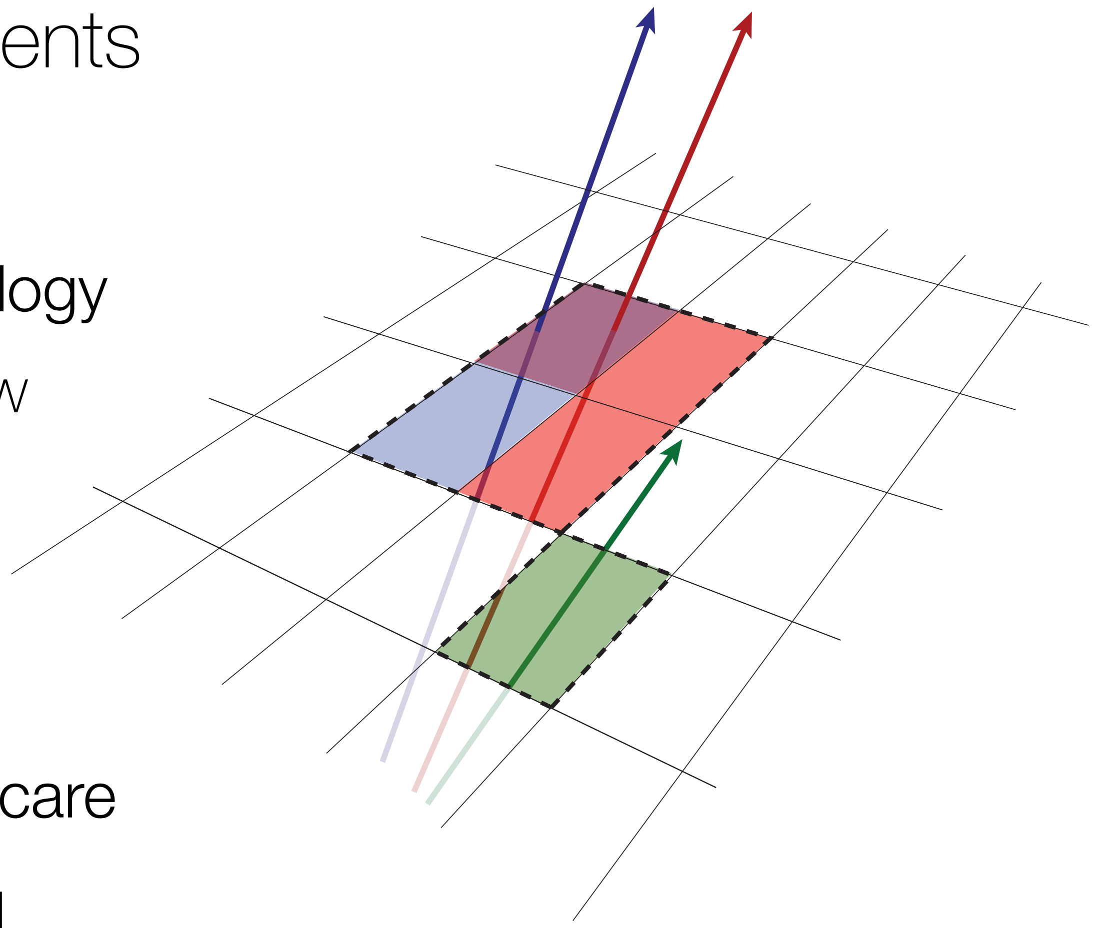
Example: Tracker design - not so easy

- Fake tracks
  - at low μ this is a non-existing issue: our trackers are 0-fake trackers at μ=0
  - becomes an issue at high μ, but we learned how to control it

    increase hit requirements, reduce allowed holes, etc.

- Double track resolution, dense environments
  - can not be deduced as is from first principle
  - needs some input about measurement technology

    more aggressive reconstruction techniques show great success, e.g. ATLAS NN cluster splitter



- Tails, tails & tails
  - b-tagging, precision measurement need more care
  - that's where full simulation needs to be applied

Reconstruction & analysis SW

- Common reconstruction software:
  - not obvious that one shoe fits all

    different needs for different setup (μ)
  - but the fabric and tools SHOULD be shared

    e.g. infrastructure (geometry, EDM): see talks of Benedikt, Julia
    track fitters (Kalman/GSF/EArm)
  - many excellent solution around (and stress-tested) at the LHC

    tracking, calorimetry, particle flow, b-tagging, etc.
- My advice: let's take what's good and rewrite the rest
  - what an obviously bold statement …
- Not entirely clear what the licensing situation is though
  - different experiments have different SW licence policies

Conclusion & Outlook

- There is a lot of good SW around
  - we should use it - AND - we should it wisely
  - it is also a chance of revision what worked and what didn't
- There is a lot of experience around
  - let us learn from the LHC Run-1 (but also from the past, ILC, CLIC)
- Common FCC-ee-eh-hh is a real chance to put our SW on common grounds
  - includes Simulation - Reconstruction - Analysis (!)
  - licence/policy situation for SW is not clear (and should be made clear)