# GeantV fast simulation ideas and perspectives

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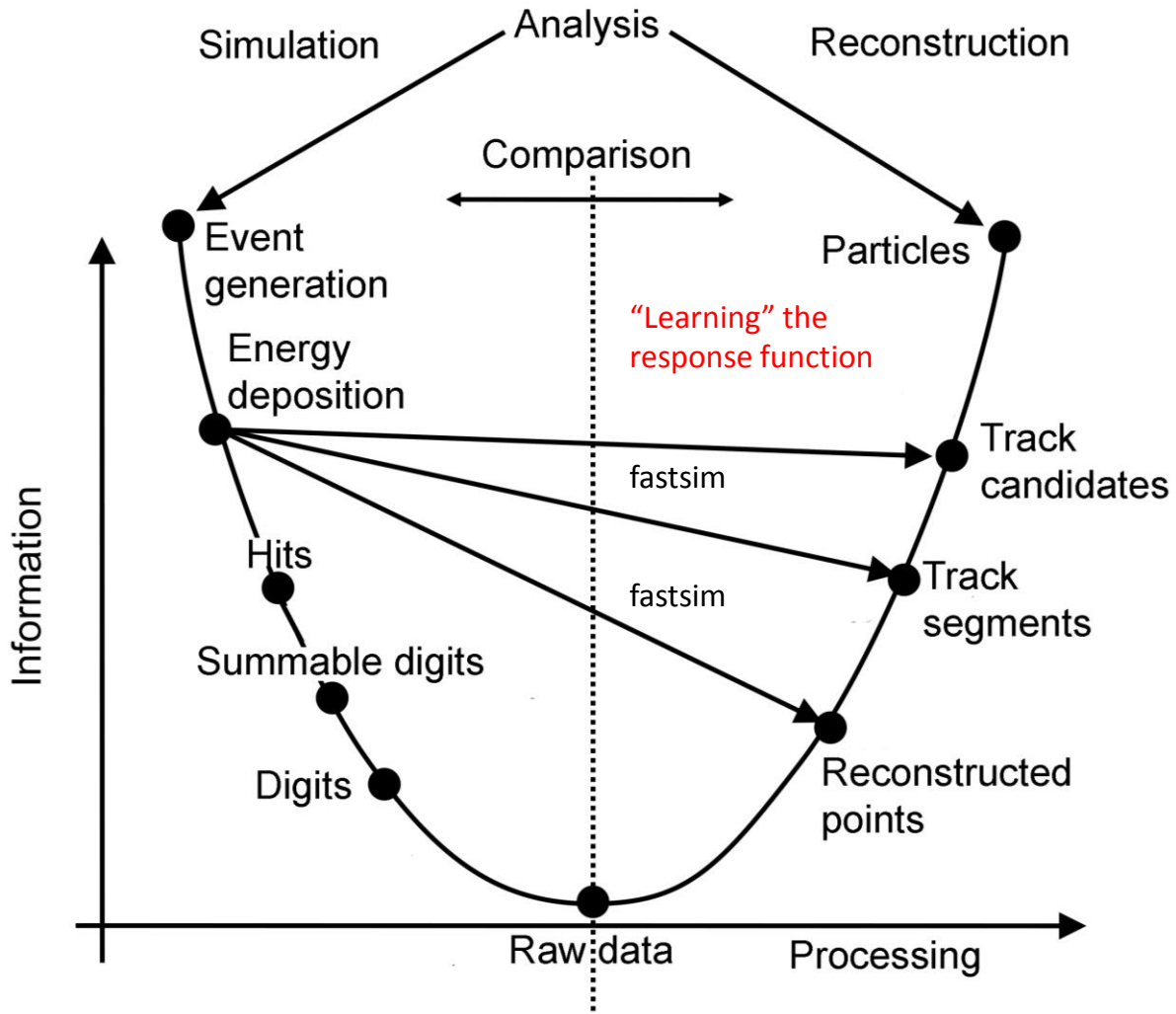
# THE GEANTV PROJECT

# Background

- In the best case the speedup from GeantV will be O(10)
- From the estimations collected informally, at least O(100) is needed
- This is the realm of fast simulation

# Definition


Simulation
Analysis
Reconstruction
Comparison
Event generation
Energy deposition
Particles
"Learning" the response function
Track candidates
fastsim
Hits
fastsim
Track segments
Summable digits
Digits
Reconstructed points
Information
Raw data
Processing

# History

- Fastsim has historically been introduced almost as an “afterthought” or a “user hook” in simulation programmes
  - Geant4 introduced fastsim hooks early, but they were not “abused” – Why?
- In GeantV we would like to introduce fast simulation in the framework

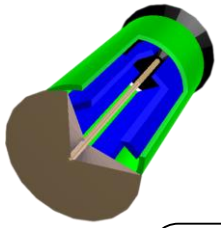
# What and how?

- It is possible to activate fast simulation on a user filter
  - e.g. region / particle /energy basis
- Provide generic tools to correlate output information (e.g. digits, rec points, or even tracks) with MC truth for selected particles
- A choice of basic fast simulation algorithms will be proposed for trackers and for calos

# Too detector specific?

- The same was said for detailed simulation before EGS came out!
- User code definitely needs to be involved, so the approach must be user code friendly…
- We do not pretend to cater for all cases, but to offer a reasonable “library” of algorithms on which to build, and a framework to easily embed user code

**GeantV:**
**Trying things differently**



Scheduler

Basket of tracks

Dispatching

Basketizer

Basket of tracks

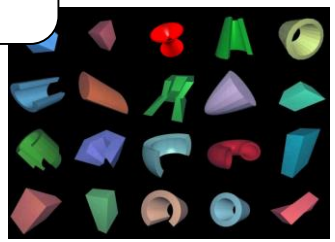
MIMD

SIMD

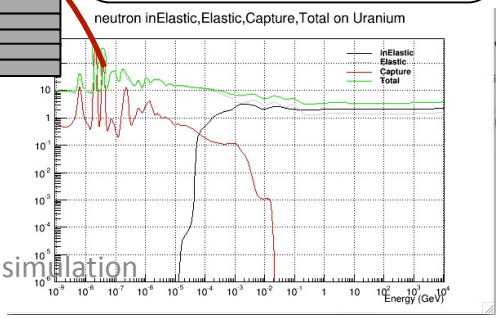
Geometry navigator

Physics

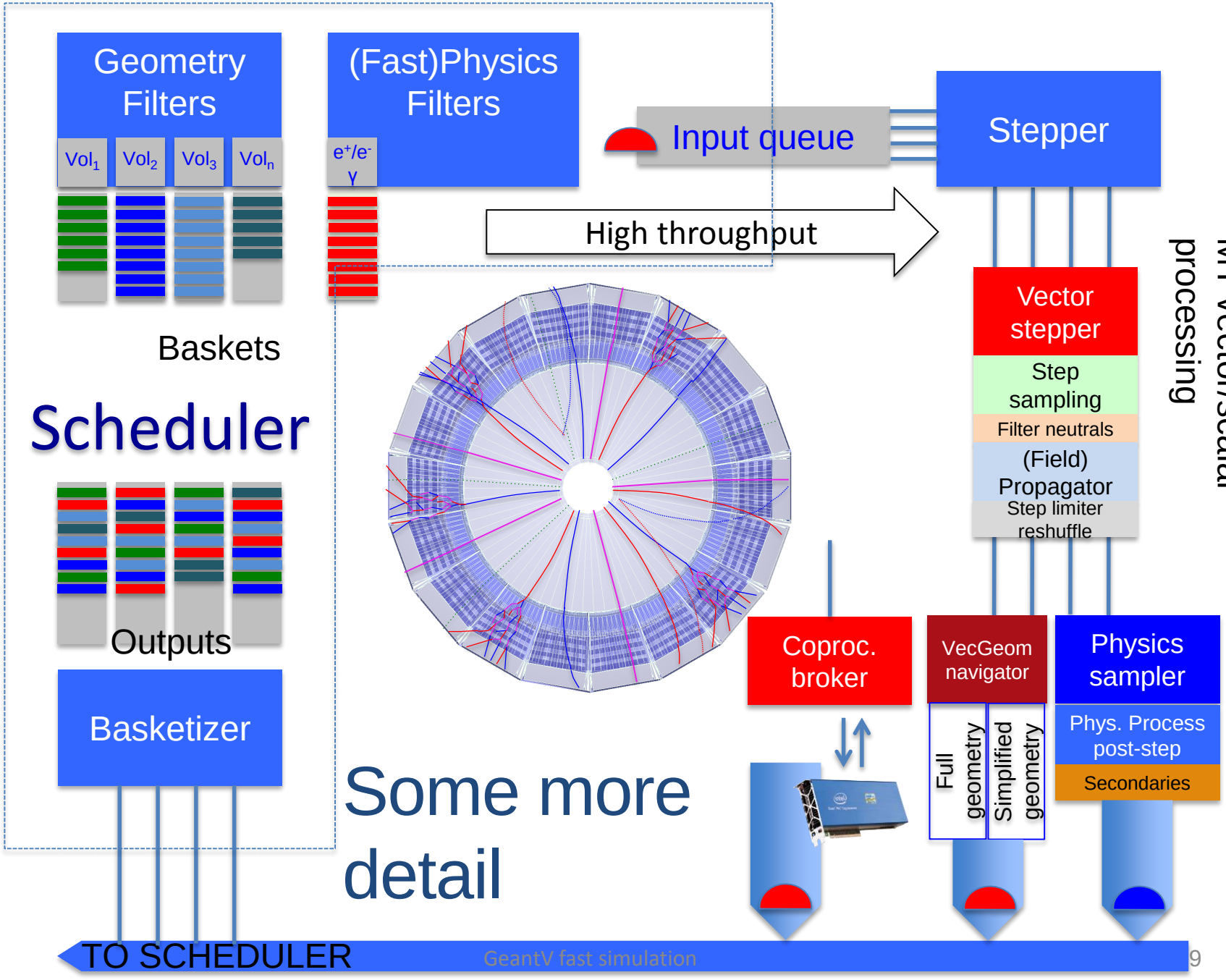
Geometry algorithms



x-sections



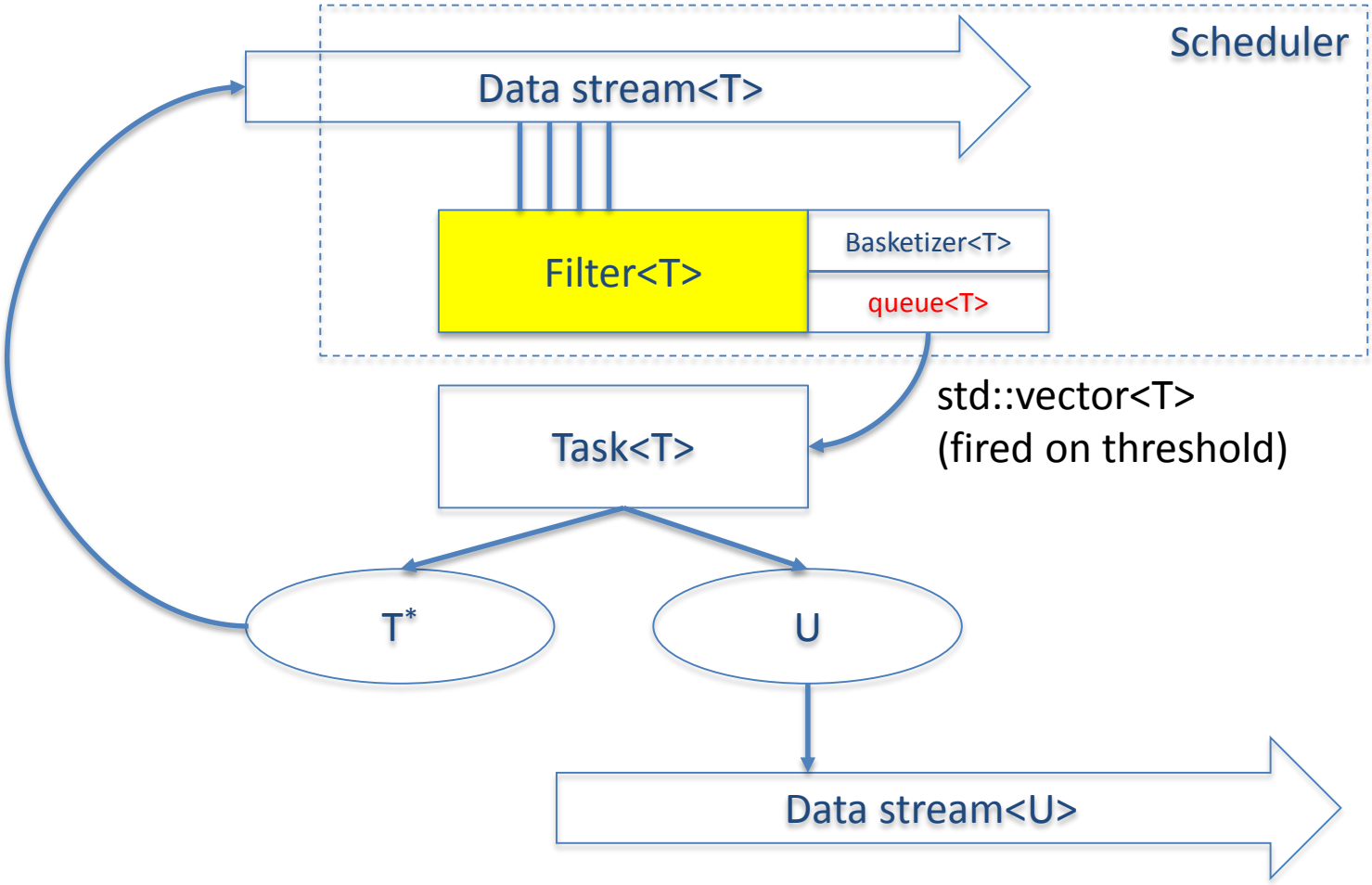

Reactions


Geometry Filters
Vol1
Vol2
Vol3
Voln
(Fast)Physics Filters
e+/e-
γ
Input queue
Stepper
High throughput
Vector stepper
Step sampling
Filter neutrals
(Field) Propagator
Step limiter reshuffle
MT vector/scalar processing
Baskets
Scheduler
Outputs
Basketizer
Coproc. broker
VecGeom navigator
Full geometry
Simplified geometry
Physics sampler
Phys. Process post-step
Secondaries
Some more detail
TO SCHEDULER

# Who controls the game?

- Fast simulation creates bridges between simulation and tracking/reconstruction
- How to interconnect in an experiment independent way these components?
- All is about scheduling the work and data flow, using a common concurrent infrastructure
- GeantV proposes tools for this kind of approach
  - Simulation is a natural place to apply these parameterizations and to check their effect
  - The library to learn the parameterizations and compare with MC truth is independent, but can be delivered with GeantV (as long as it stays generic)

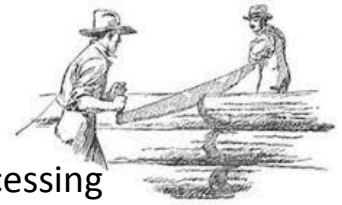
# GeantV concurrent tasks



# The complex scheduling business

- Efficient concurrent *basketizers*
  - Filtering tracks by several possible locality criteria
    - Geometry, (fast)physics process
  - Giving reasonable size vectors all along the simulation

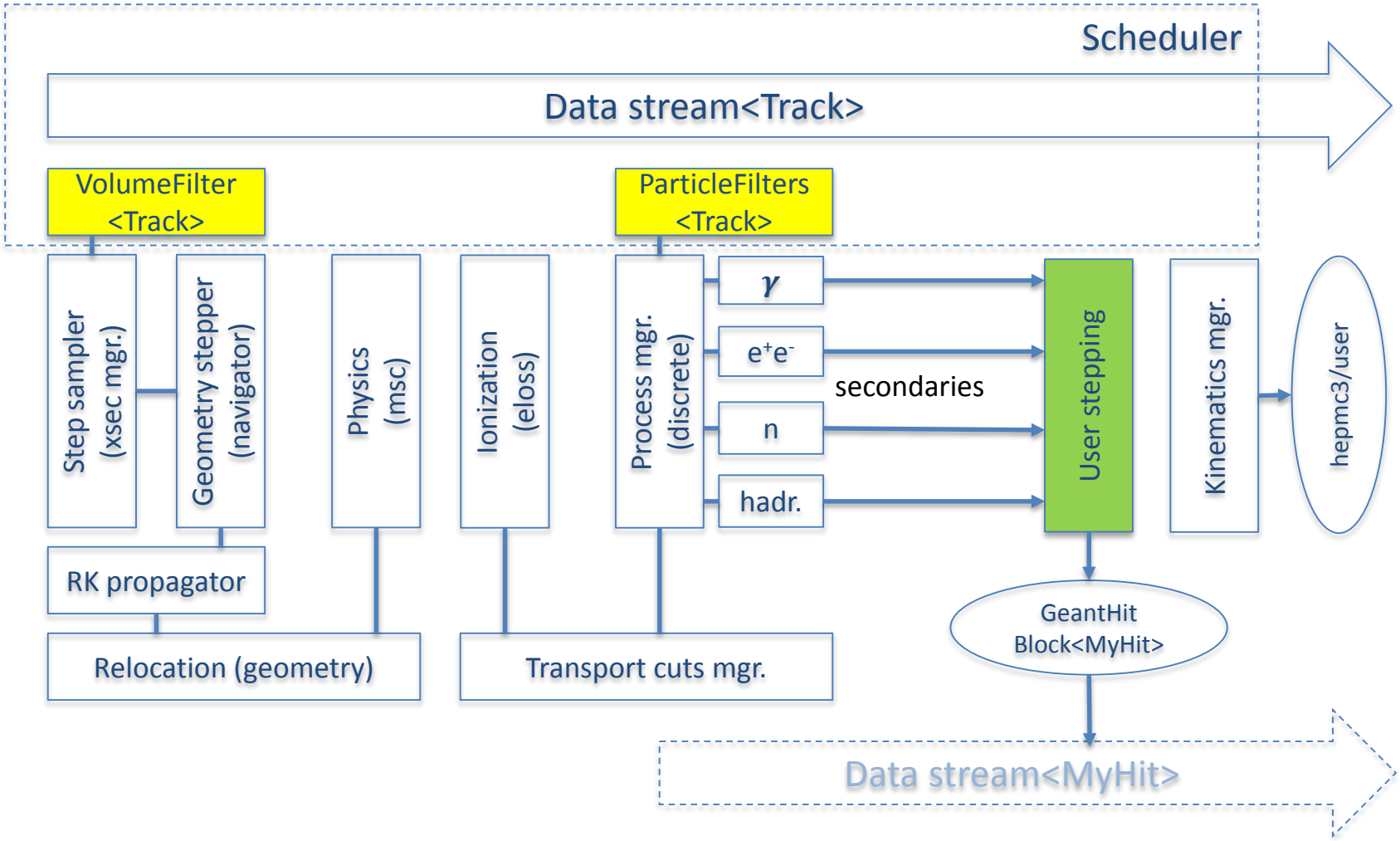
- Provide scalable & balanced workload
  - Minimize memory footprint
  - Minimize cool-down phase (tails)
    - Using concurrent event injection and prioritized processing



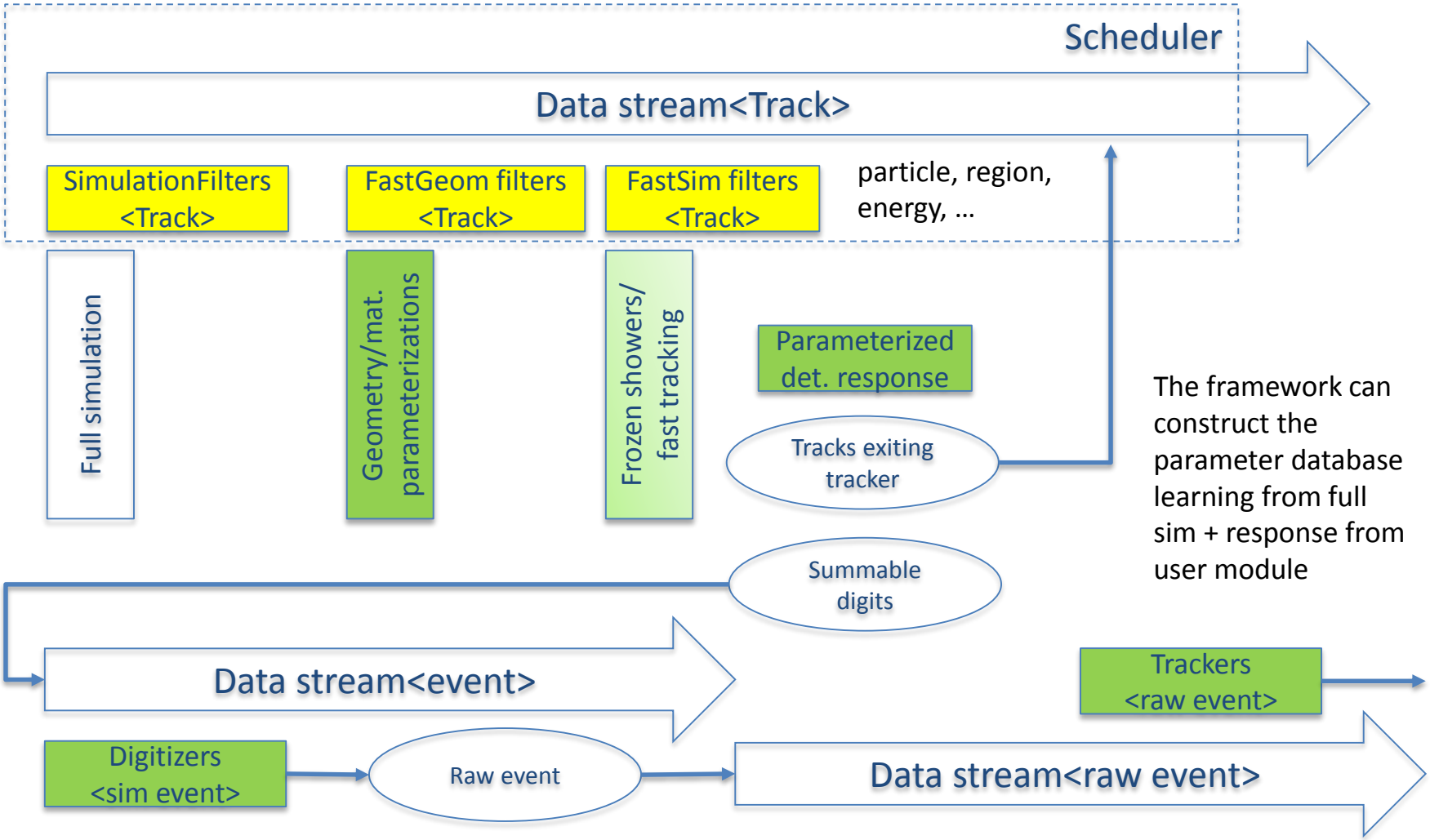
- Adaptive behavior to maximize performance
  - Dynamic switch of vector/scalar processing
  - Learning dynamically the “important” filters
  - Adjust dynamically event slots to control memory

- Accommodate additional concurrent processing in the ~~simulation~~ workflow
  - Hits/digits/kinematics I/O
  - Digitization/reconstruction tasks

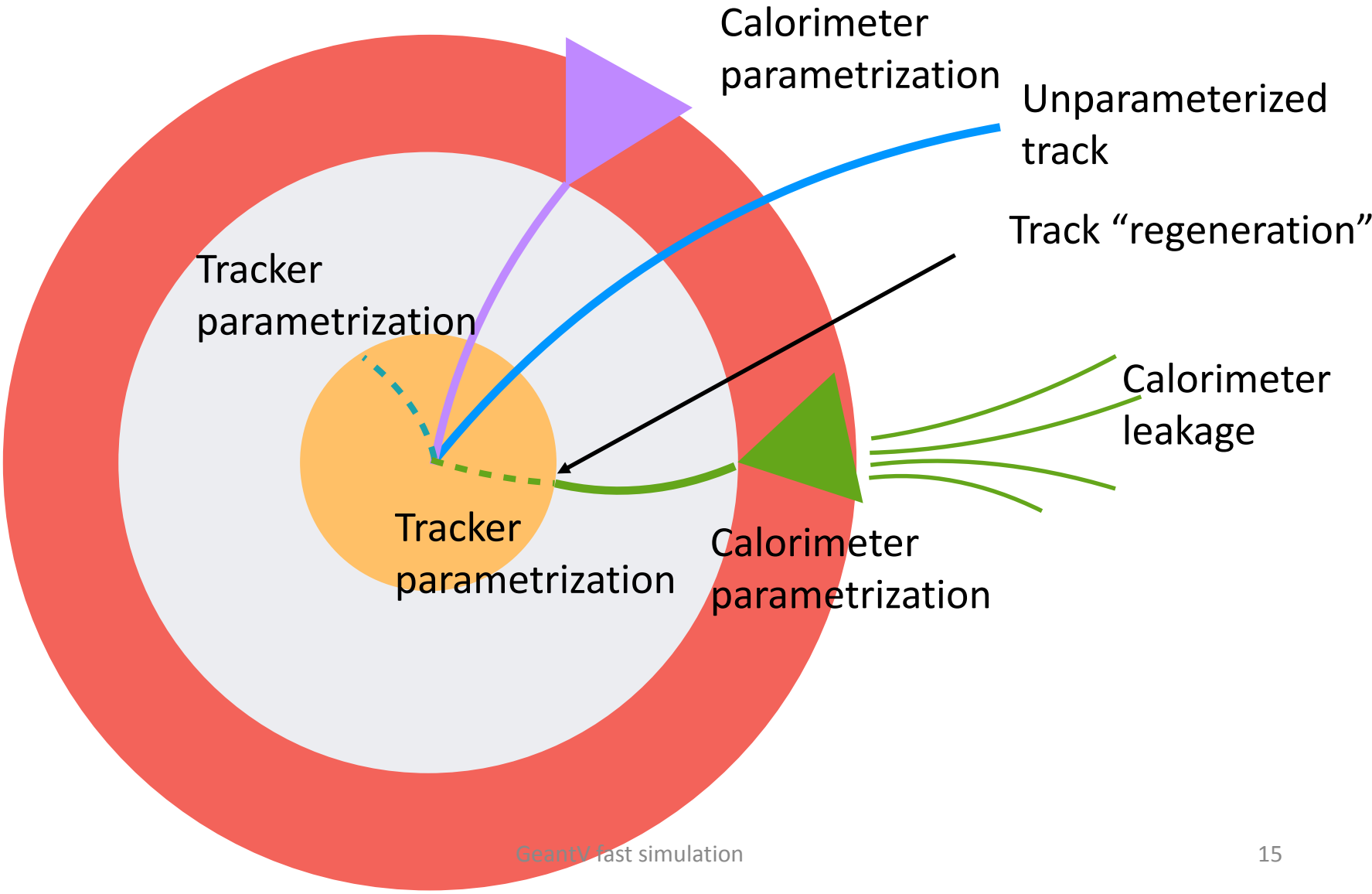
# GeantV simulation flow



# Embedding fast simulation



# Combined simulation



# Framework functions

- Provide tools to
  - Build libraries of parametrized quantities from detailed simulation
  - Compare detailed and parametrized simulation
  - Allow user-driven switch between different options (full, parametrization, param+regeneration)
- Apply these tools to simple examples (provided)
  - Generalizing in experiment-independent manner starting from these

# And…

- Parametrized simulation is considerably more “vector friendly” then detailed one

# In summary

- We are not proposing a “one fit all” solution
- We are proposing a “toolbox” providing scheduling and interconnection hooks, plus simple examples
- We want to learn from you new use cases, discuss how to accommodate them