Geant 5
an update

Concurrency Forum

03 July 2013

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Just as a reminder

- Explore the possibility to recast particle transport so that it takes advantage from the newest technologies

Grand strategy

Simulation job

Create vectors

We are concentrating here

But we should look also here

Use vectors

Basic algorithms

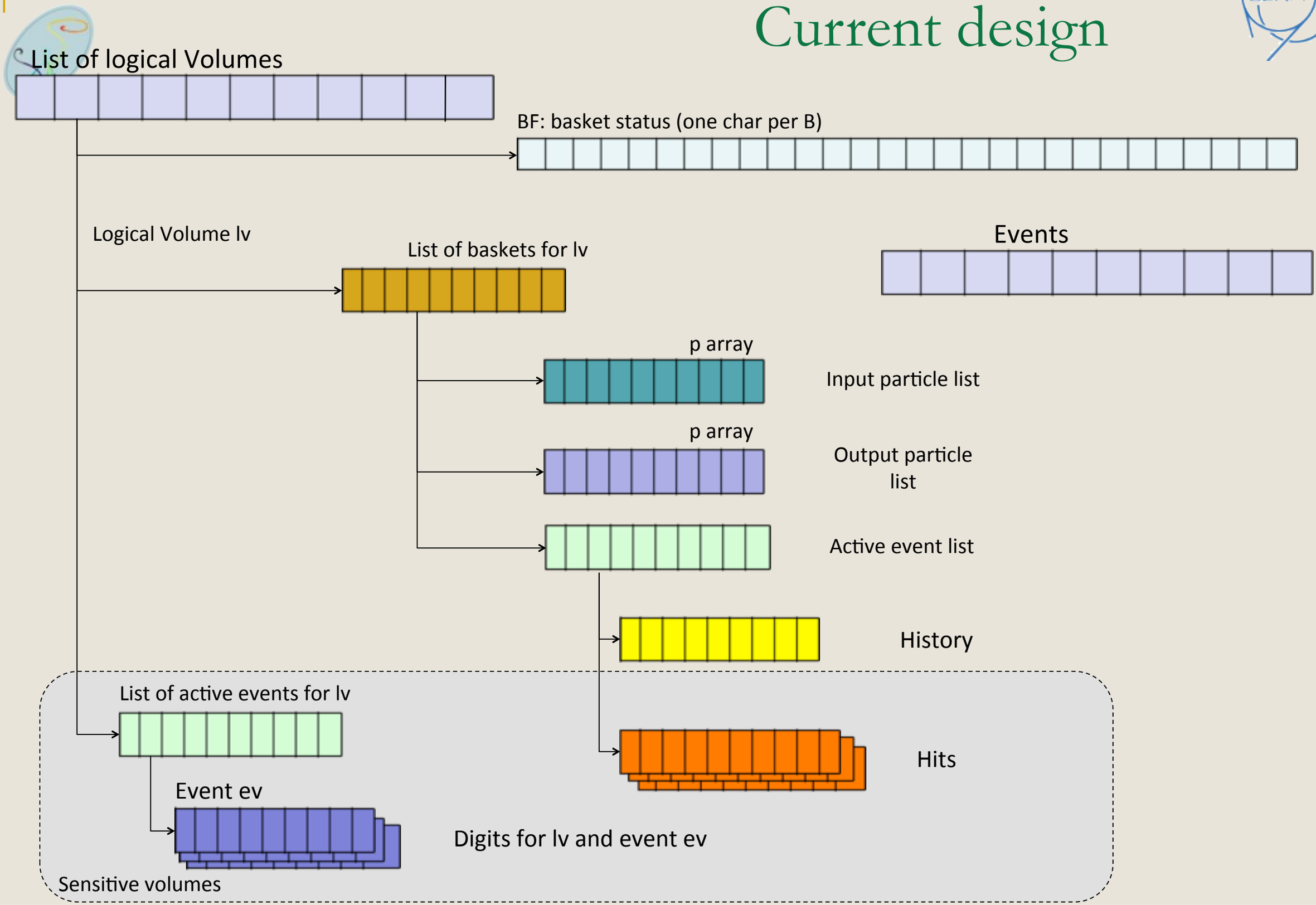
Three major direction of work

- Transport prototype
  - A.Gheata
- Physics interactions
  - J.Apostolakis, F.Carminati, Ga-In Kim (SumStudent)
- Geometry optimisation
  - S.Wenzell, M.Bandieramonte (Catania), R.Sehgal (BARC), L.Duhem (Intel), J.Valles (SumStudent)

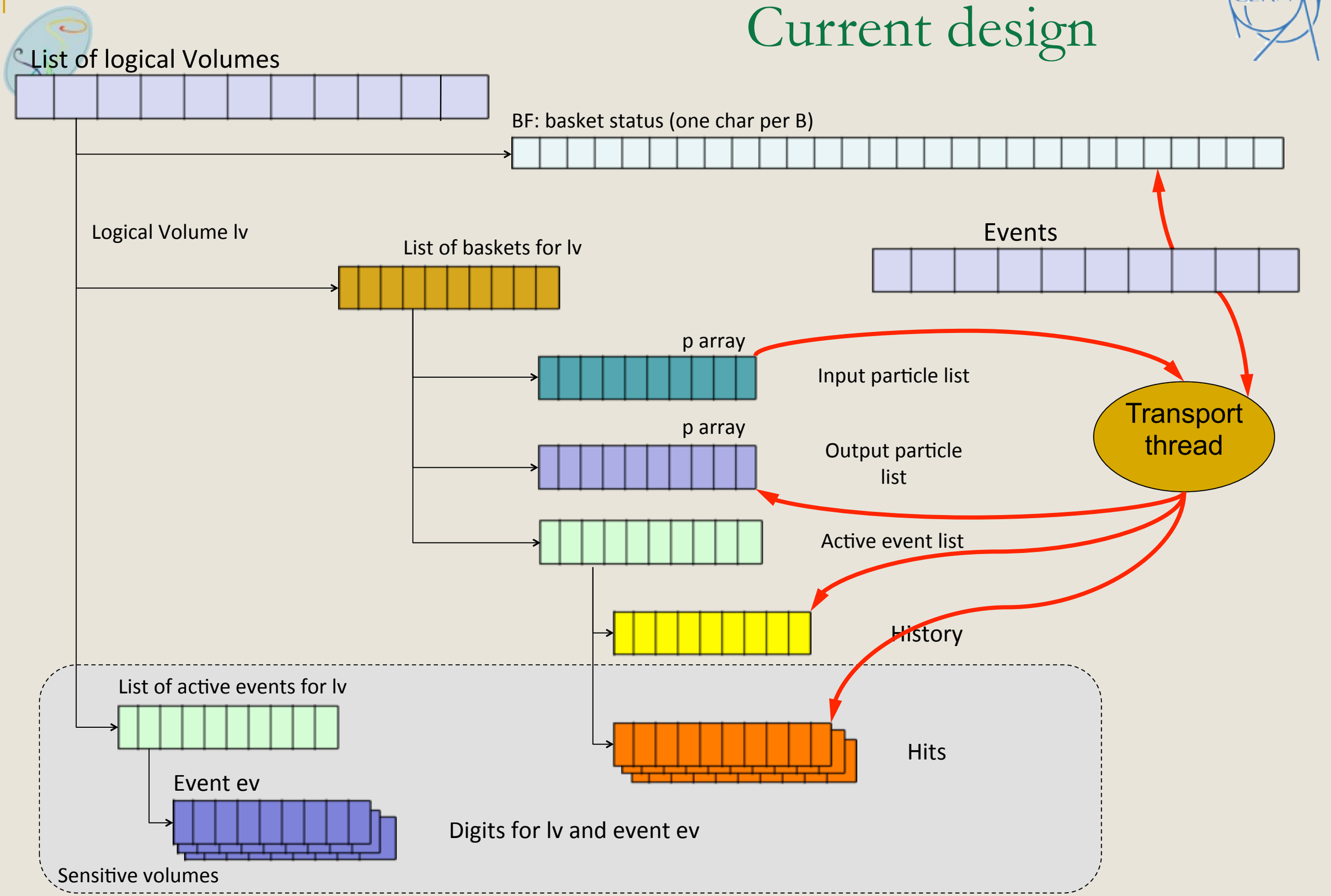
Transport prototype

- This has been presented already
  - No change since the design presented

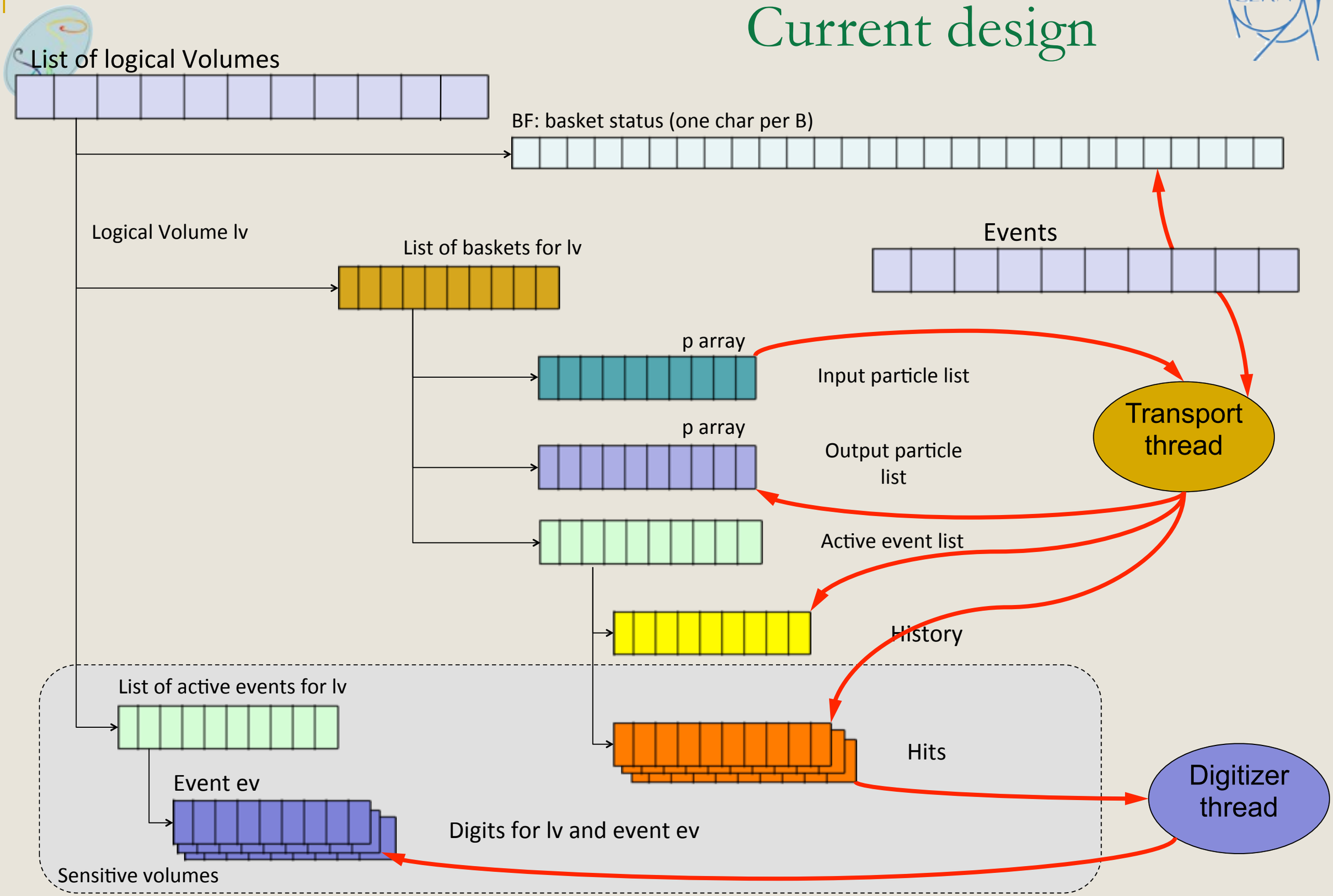
Current design



Current design



Current design



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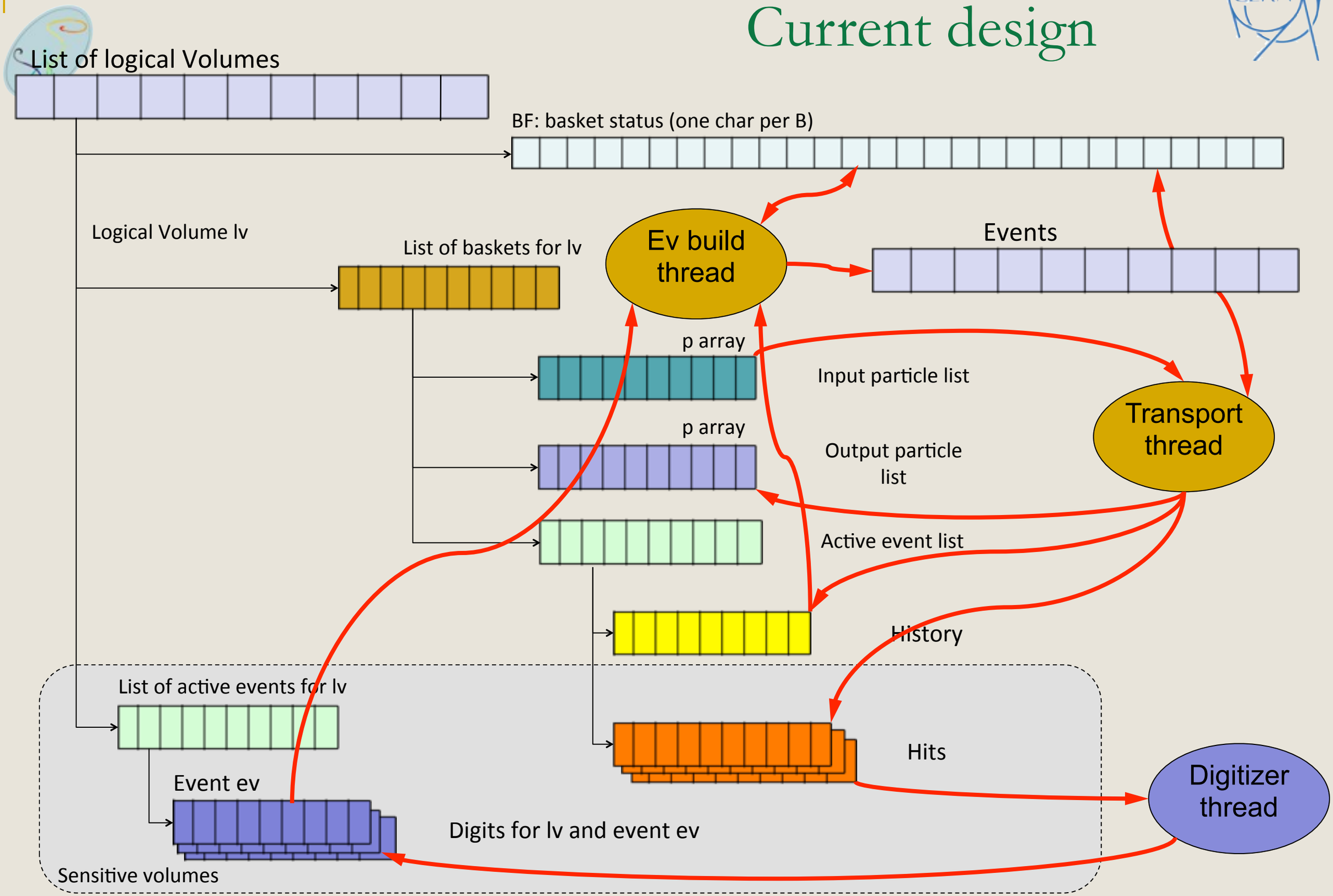
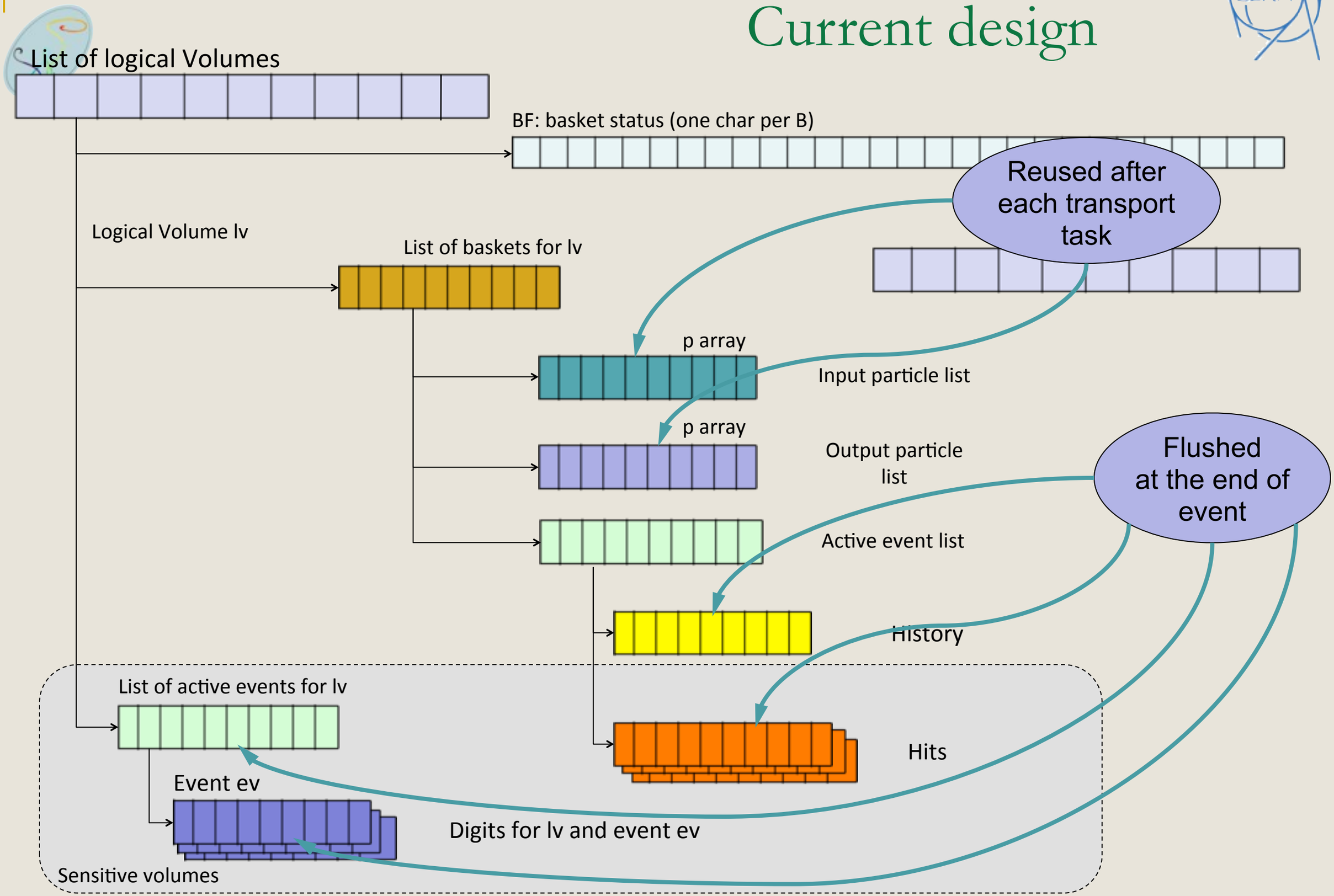


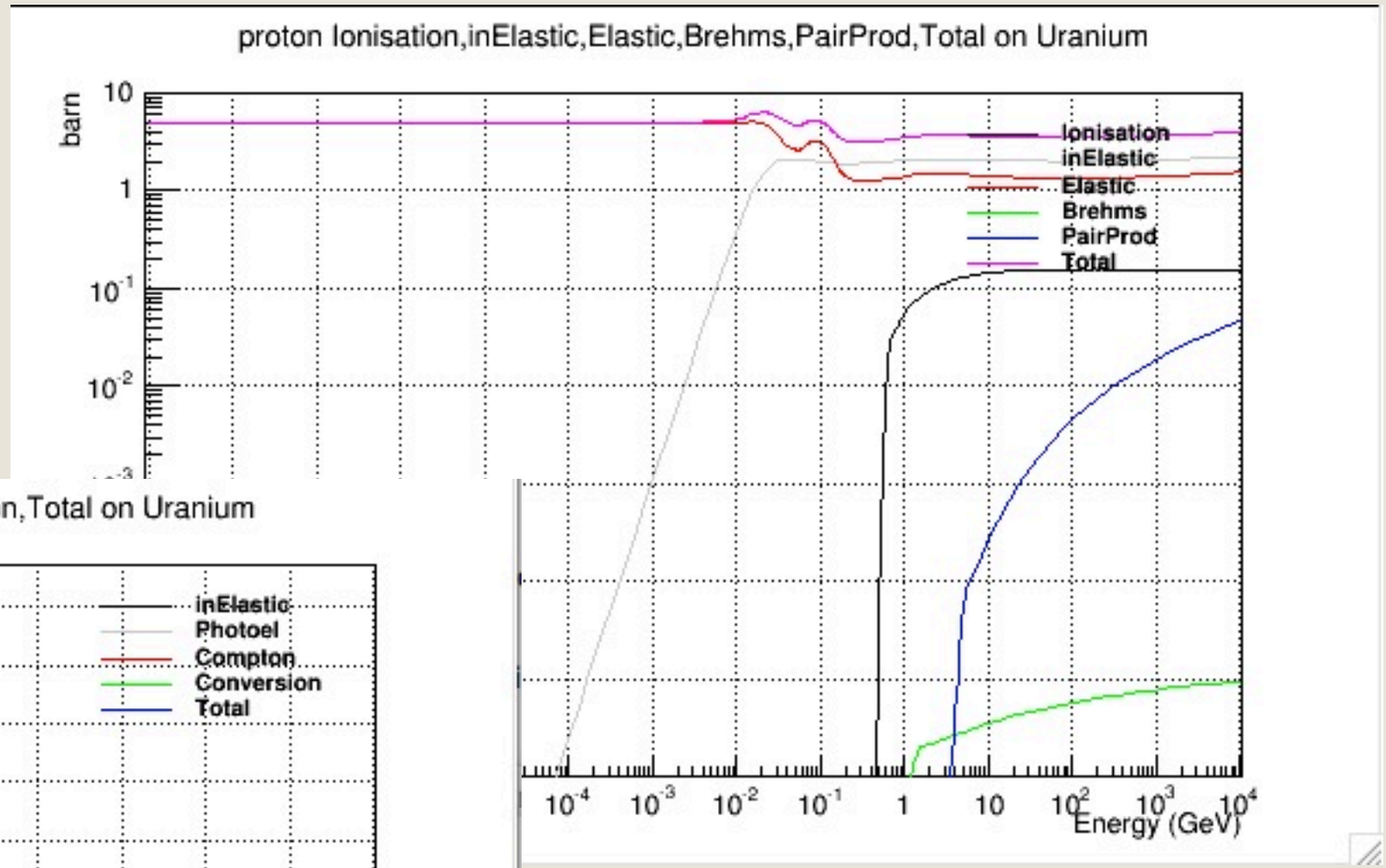
Current design

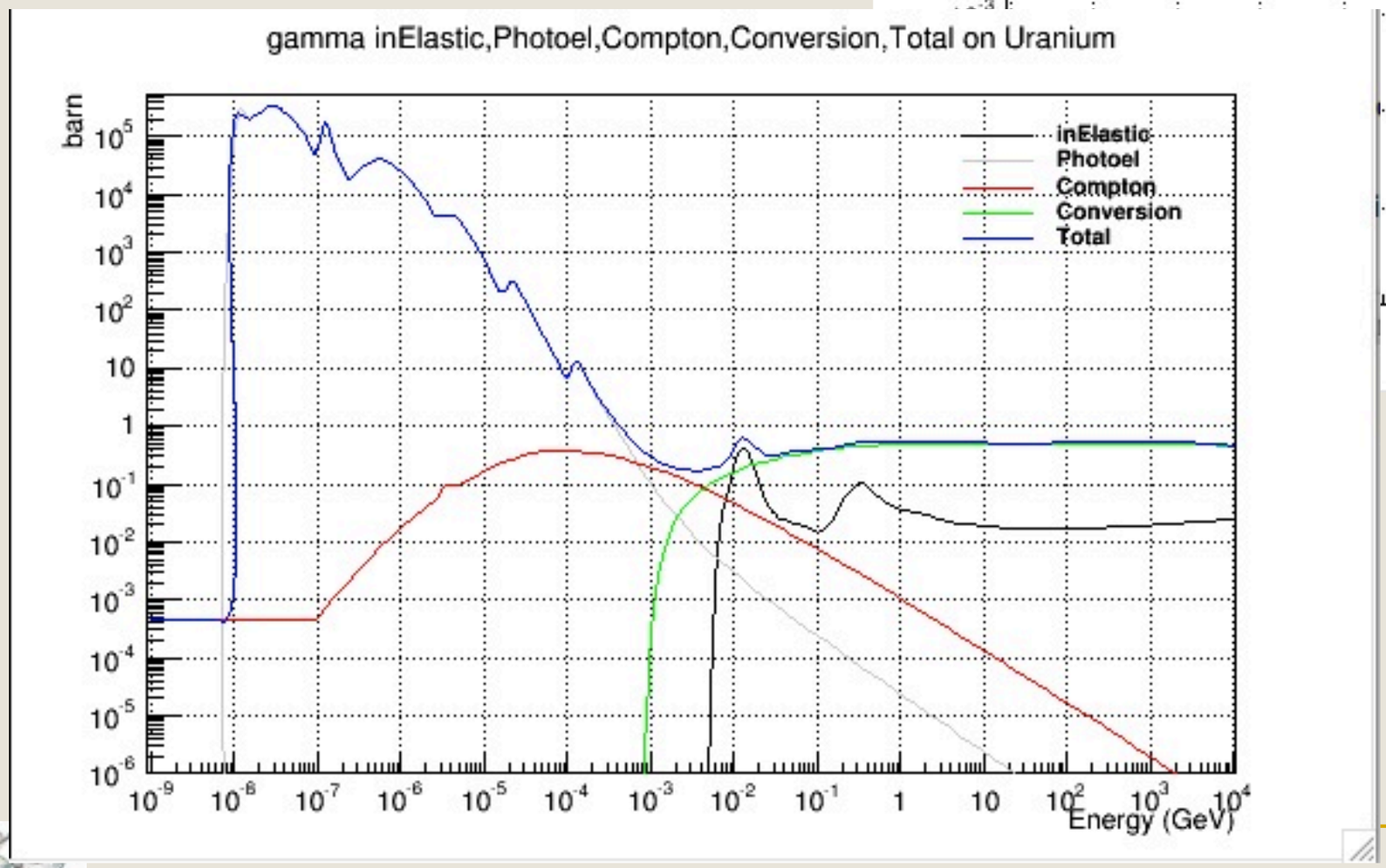


Physics

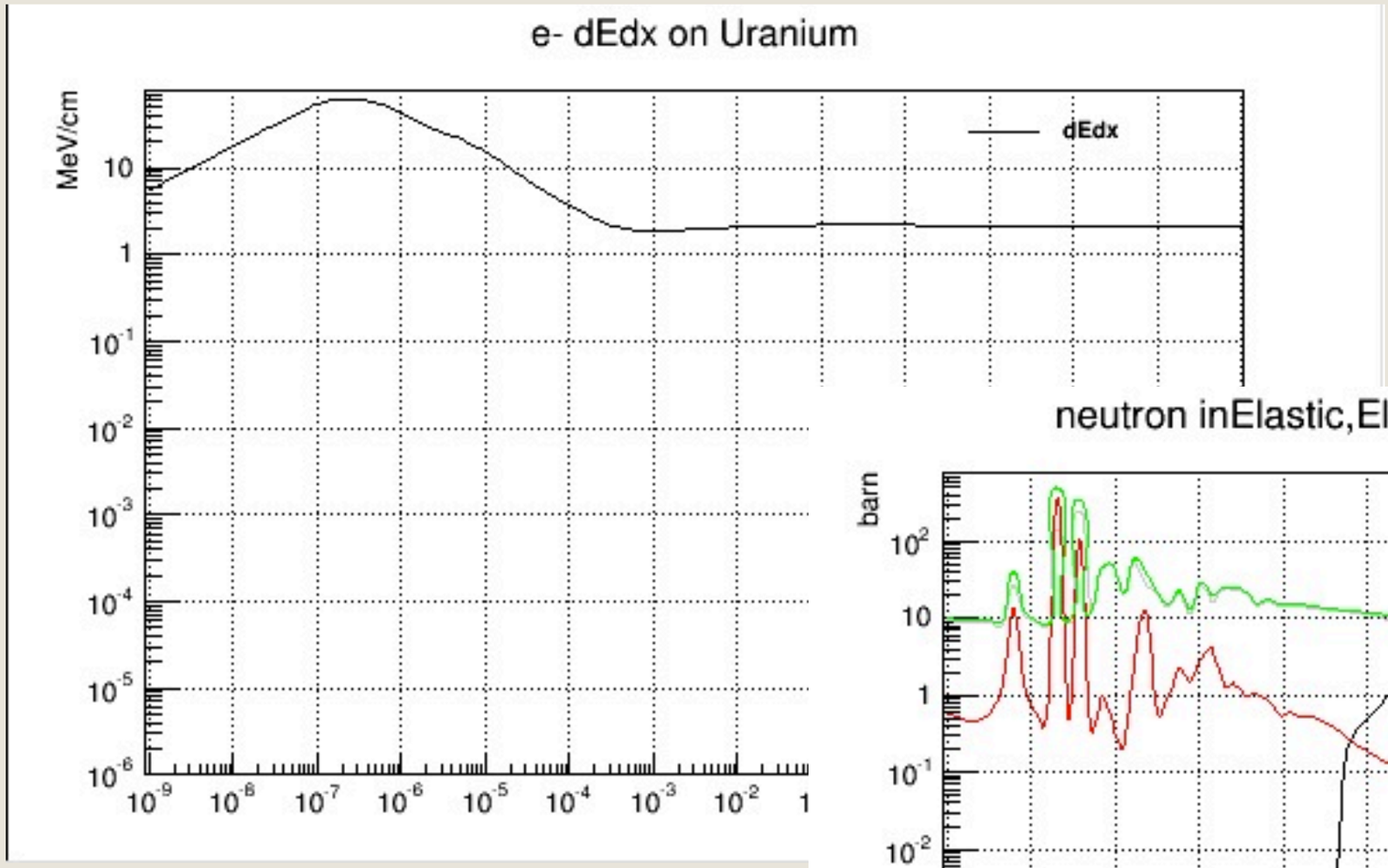
- Collection of cross sections, MS and Dedx from G4
  - Done, however…
  - Still several problems with extraction of x-secs from G4
- Total size of x-secs (100 bins) for CMS 84MB
- Structure for secondary particle designed, but we cannot sample interactions yet

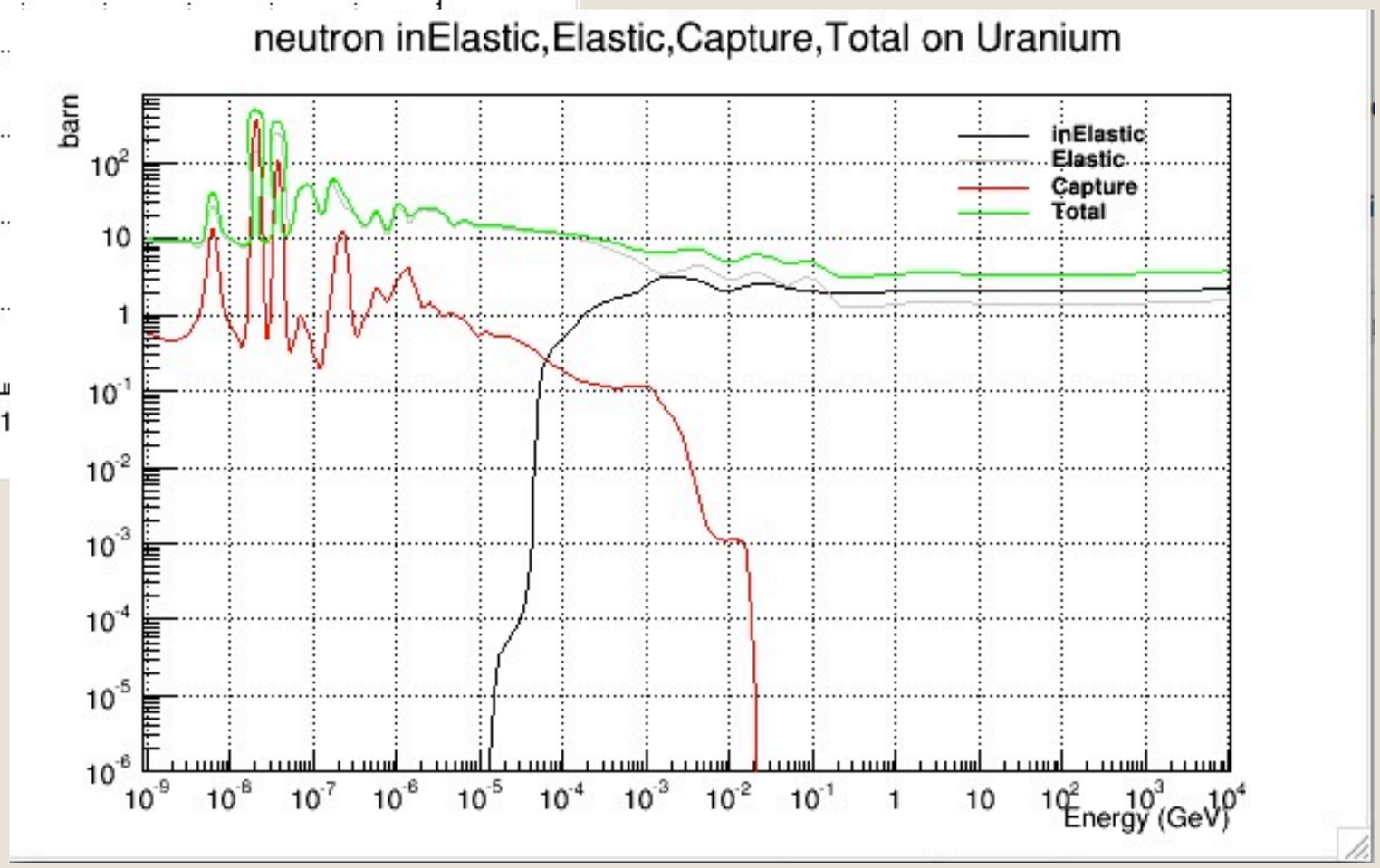
Examples


proton Ionisation,inElastic,Elastic,Brehms,PairProd,Total on Uranium
barn
Ionisation
inElastic
Elastic
Brehms
PairProd
Total
Energy (GeV)


gamma inElastic,Photoel,Compton,Conversion,Total on Uranium
barn
inElastic
Photoel
Compton
Conversion
Total
Energy (GeV)

Some examples





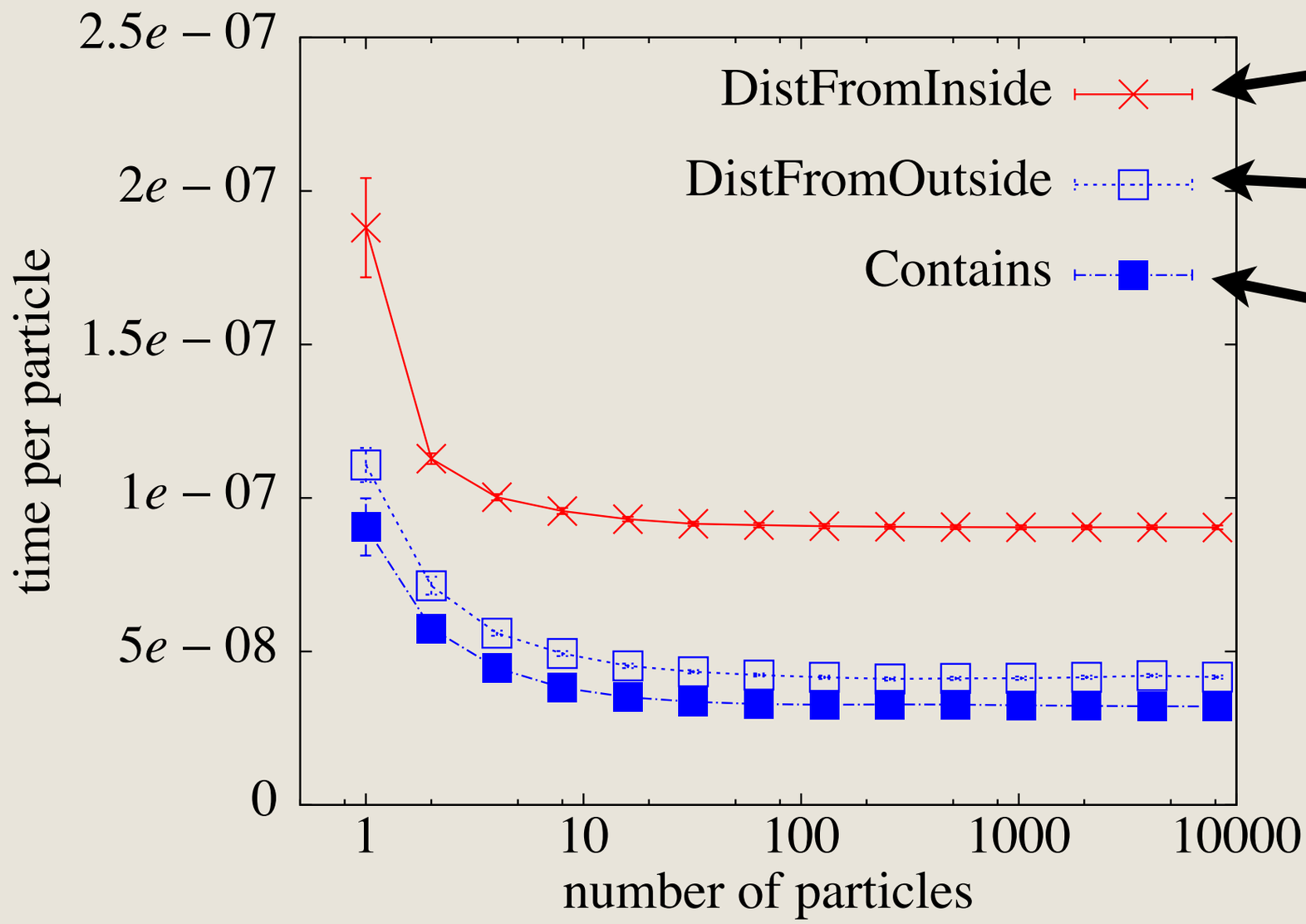
Vector processing: Update on Gains for Geometry Calculations

- Motivation: How much can geometry navigation gain from vector processing of particles?
  - benefit from SIMD instruction sets (see talk by S. Wenzel 5.6.2013)
  - benefit from instruction cache reuse
- To address second point, developed a more systematic benchmark scheme to quantify gains from instruction cache reuse (no code changes necessary)
- For any shape/volume, benchmarker creates automatic test cases (tracks) and probes geometry performances for varying number of particles

(slide by S. Wenzel)

Vector processing: Update on Gains for Geometry Calculations

- Result for realistic shape: TGeoPcon (volume 2) from CMS (10 sections) (testing Root geometry, compiled with -O3)



gain: 2.1(2)

gain: 2.6(2)

gain: 2.8(2)

gains from cache instruction reuse only - no coding necessary

(slide by S. Wenzel)

Vector processing: Update on Gains for Geometry Calculations

- Overview of max speedup for various shapes

preliminary!

	Box	Polycone	Cone	ConeSeg
Safety	**18(2)**	**3.6(3)**	**2.8 (4)**	**2.8(4)**
DistFromIn	**3.9(3)**	**2.1(2)**	**2.3 (2)**	**1.40(4)**
DistFromOut	**3.9(1)**	**2.6(2)**	**2.4(1)**	**1.8 (1)**
Contains	**17(2)**	**2.8(2)**	**10.5(5)**	**3.9(3)**

- Many different factors (for segments less gain?)
- These factors are **trivial gains**: more factors from SIMD expected !

(slide by S. Wenzel)

Update on SIMD optimizations: Test of the Vc library

- In addition to benefit from cache instruction reuse, like to use vector instruction sets (SIMD)
- First good result obtained for Box geometry, relying so far on compiler autovectorization (additional gains up to factor 4)

(see talk by S. Wenzel 5.6.2013)

- However: SIMD autovectorization difficult to achieve
- Alternative: **explicit vectorization** approach:
  - intrinsics ?
  - (gcc) vector extensions ?
  - **Vc library**
    - compiler independent, high level constructs, abstraction of SIMD instruction set without overhead

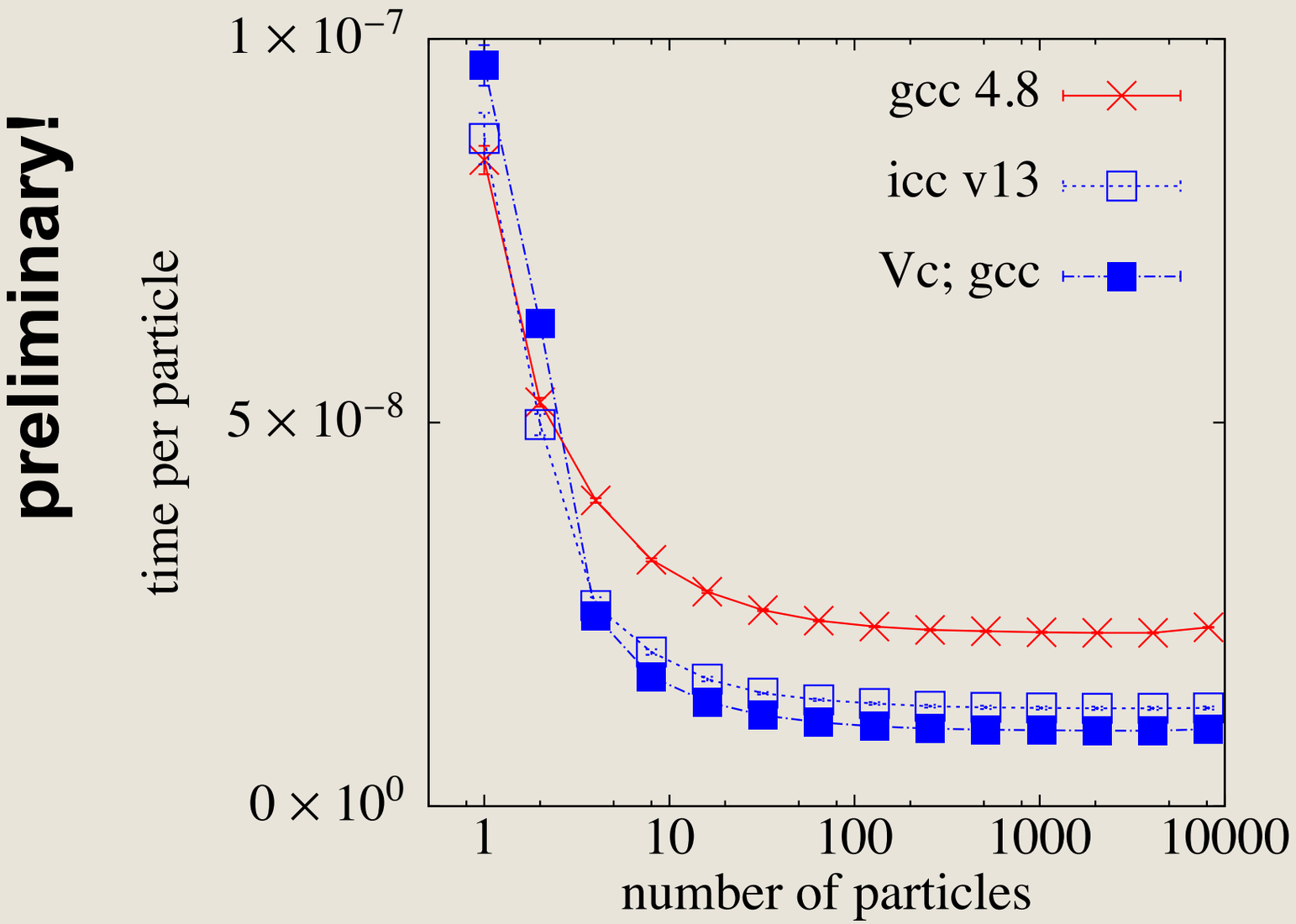
(slide by S. Wenzel)

The big picture

- If (!) by end July we
  - Manage to store x-secs and final states and run a “micromc” which makes sense
  - Have a working transport prototype
  - Have some more vectorised geom methods
- In September we can put it all together
  - For the moment we are on a “success oriented” track

Update on SIMD optimizations: Test of the Vc library

- look at Box::DistFromOutside which did not autovectorize preveously with gcc
- rather positive development experience
- first benchmark result (comparing Vc with autovec (gcc, icc) on AVX)



- this is encouraging !!

(slide by S. Wenzel)