



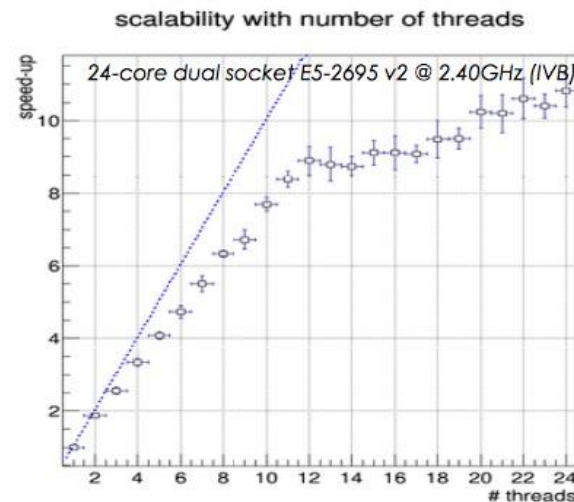
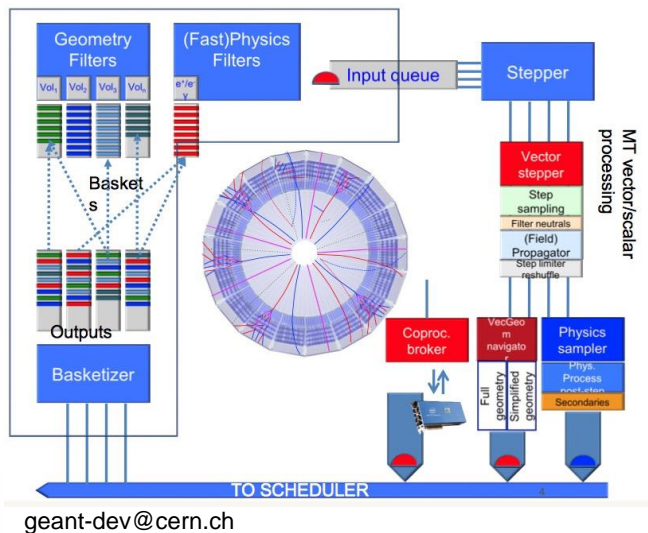
GeantV – An(other, final) overview

Federico Carminati (CERN) for the GeantV development team



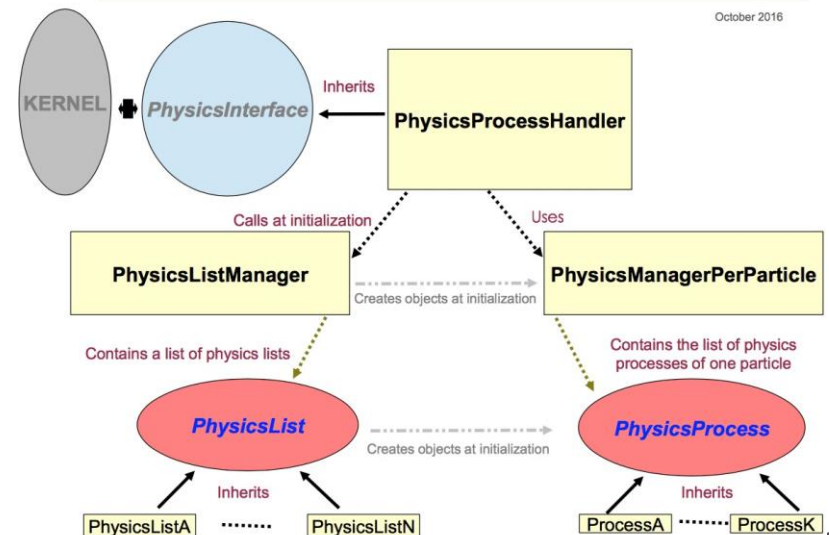
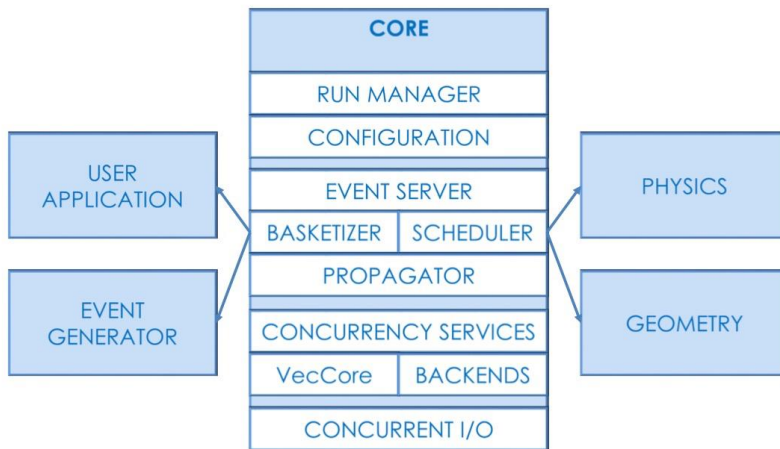
Where are we - framework

- ▶ Multi-threaded transport engine that collects tracks in baskets
 - Numa aware & MPI-capable for multi-level parallelism
 - TBB version available
- ▶ Speed ratio GEANTV/GEANT4 $\sim 2.5-3.5$ *in similar conditions*
 - Not a benchmark per se... just a “sanity test”... and a good omen



Where are we – design

- ▶ Component & interface design
 - Implemented for the new EM physics
- ▶ Physics-list interface
- ▶ Draft design of the integration of fast simulation



October 2016

Where are we – development model

- ▶ Integrated development model
 - git + cmake + jenkins + jira + cdash
- ▶ Continuous integration + merge requests
- ▶ Coding convention checker (clang-format + ECLAIR)
- ▶ Coverity analysis
- ▶ Website with installation information and documentation

S	W	Name	Last Success	Last Failure	Last Duration
		BuildCernVMKernel	5 mo 23 days - #13	5 mo 15 days - #15	17 min
		CernVM-Launch	9 hr 36 min - #49	12 days - #19	12 min
		CernVM-Launch_tests	8 hr 51 min - #46	5 days 8 hr - #39	1 min 41 sec
		CernVMSetupBuildEnvironment	19 hr - #17704	1 mo 4 days - #16798	0.34 sec
		Check-VecGeom-AVX	20 hr - #365	N/A	5 min 21 sec
		Check-VecGeom-scalar-nospec	20 hr - #368	N/A	1 hr 15 min
		Check-VecGeom-scalar-spec	20 hr - #234	2 days 20 hr - #232	4 hr 44 min

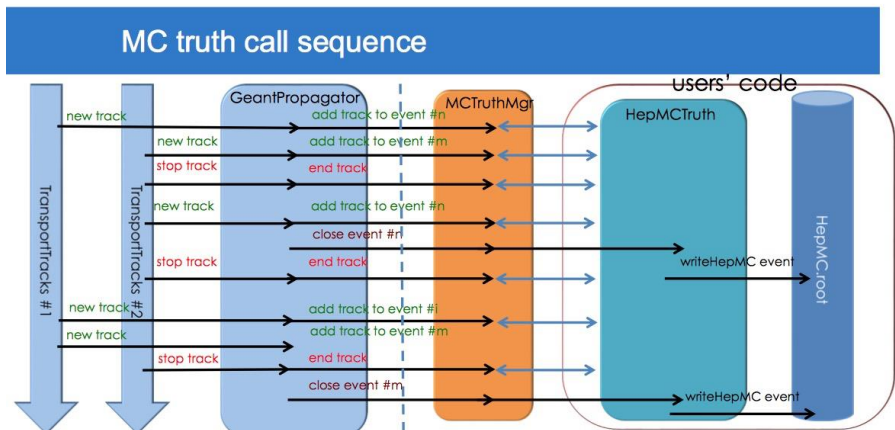
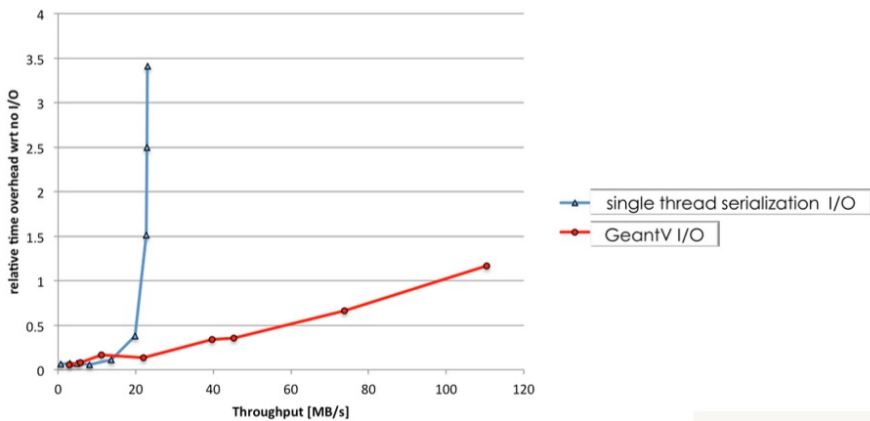
Site	Build Name	Update			Configure			Build			Test			Build Time
		Files	Error	Wgrn	Error	Wgrn	Build	Not Run	Fail	Pass				
logapp-sic6-x86-64-9.cern.ch	Linux-x86_64-sic6-gcc49-VecGeom-scalar-auto-nospec-Debug	0	0	0	0	0	163	0	4	0		21 hours ago		
logapp-sic6-x86-64-29.cern.ch	Linux-x86_64-sic6-gcc49-VecGeom-vc-auto-nospec-Release	0	0	0	0	0	166	0	3	1		21 hours ago		
logapp-sic6-x86-64-17.cern.ch	Linux-x86_64-sic6-gcc49-VecGeom-vc-auto-nospec-Release	0	0	0	0	0	165 ¹	0	2	2		21 hours ago		
logapp-cc7-x86-64-10.cern.ch	Linux-x86_64-cc7-gcc49-VecGeom-vc-sse-Release	0	0	0	0	0	165 ¹	0	0	4		19 hours ago		
logapp-sic6-x86-64-26.cern.ch	Linux-x86_64-sic6-gcc49-VecGeom-scalar-auto-nospec-Release	0	0	0	0	0	165 ¹	0	0	4		21 hours ago		
logapp-sic6-x86-64-23.cern.ch	Linux-x86_64-sic6-gcc49-VecGeom-vc-sse-Release	0	0	0	0	0	165 ¹	0	0	4		19 hours ago		
logapp-cc7-x86-64-18.cern.ch	Linux-x86_64-cc7-gcc49-VecGeom-vc-sse-Debug	0	0	0	0	0	163	0	0	4		19 hours ago		
logapp-sic6-x86-64-18.cern.ch	Linux-x86_64-sic6-gcc49-VecGeom-vc-auto-nospec-Debug	0	0	0	0	0	163 ¹	0	0	4		21 hours ago		



Where are we – I/O & MCTruth

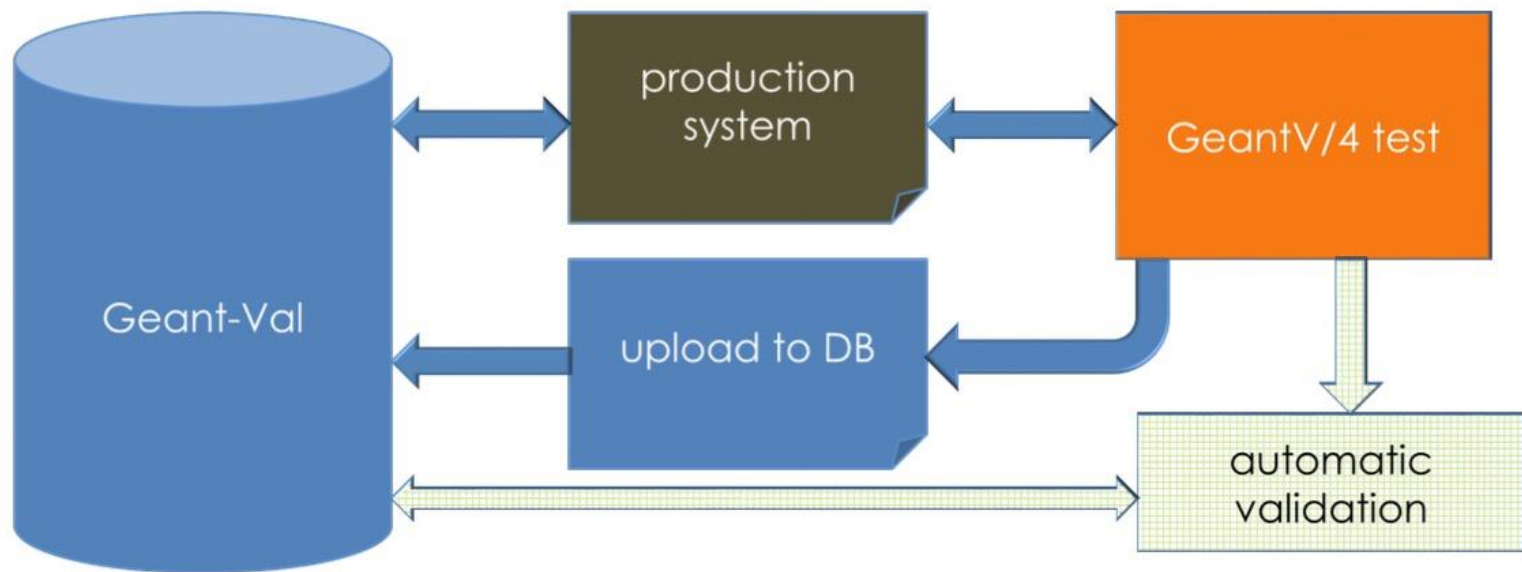
- ▶ Proof-of-principle of efficient parallel I/O
 - Code to be integrated into ROOT for general use
- ▶ Generator interface to HepMC
- ▶ MCTruthMgr class prototype
 - Challenging in a parallel world...

GeantV concurrent I/O
8 data producer threads + 1 I/O thread



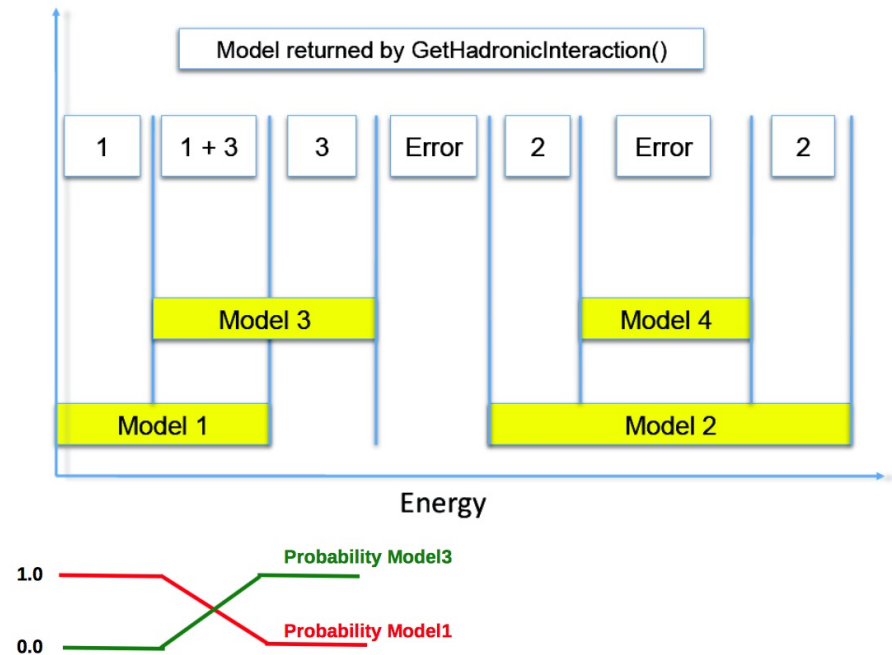
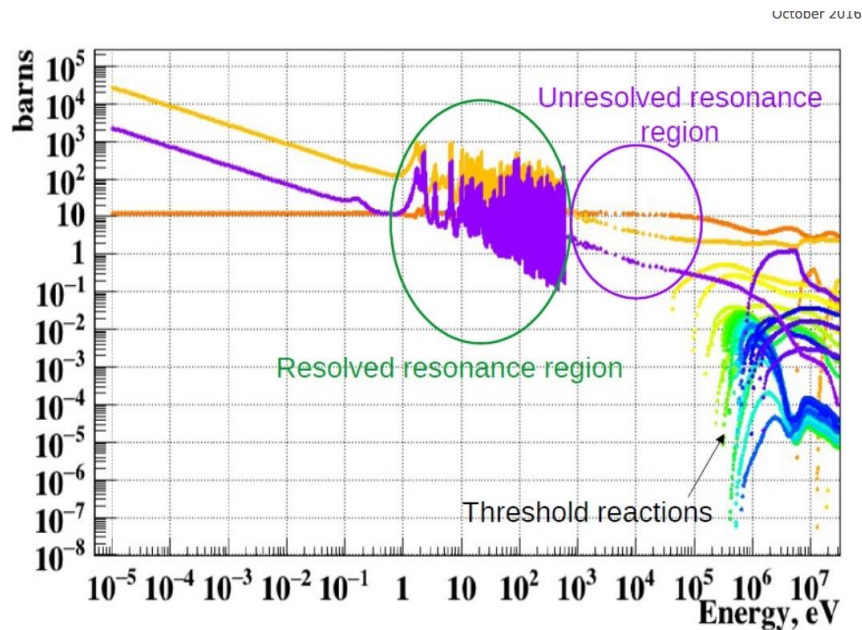
Where are we – validation

- ▶ Validation Database prototype with Web interface
- ▶ Soon to be used both for GEANT4 and GEANTV validation



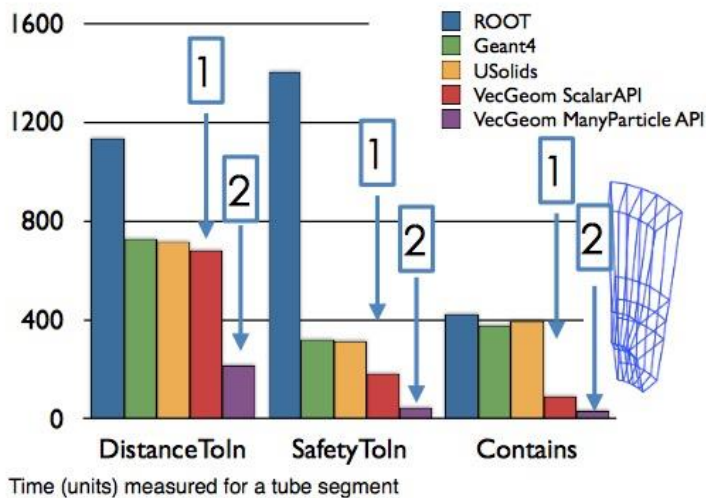
Where are we – hadronic & n physics

- ▶ Design of the hadronic interface and first planning of the development
- ▶ Handling of ENDF neutron files
 - This is a major breakthrough!

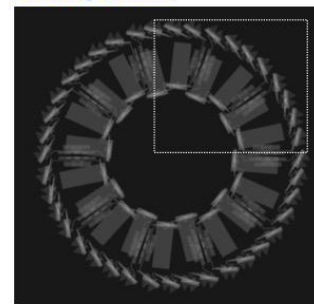


Where are we – geometry & navigation

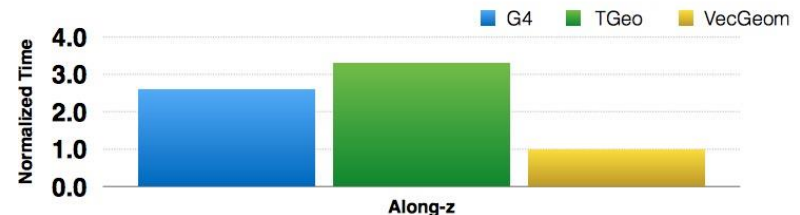
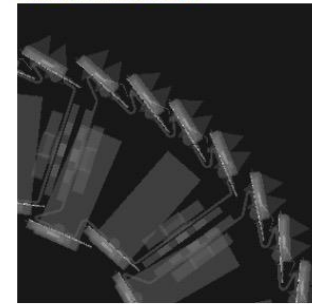
- ▶ High-performance geometry code for basic shapes
 - To become the default for ROOT and GEANT4 when validated
- ▶ Fast & portable SIMD-capable navigation system
 - Specialized navigation, auto-generation of navigators
 - Capable of running CMS, ALICE and LHCb detectors
 - Possible adoption by GEANT4 & TGeo



view along z-direction

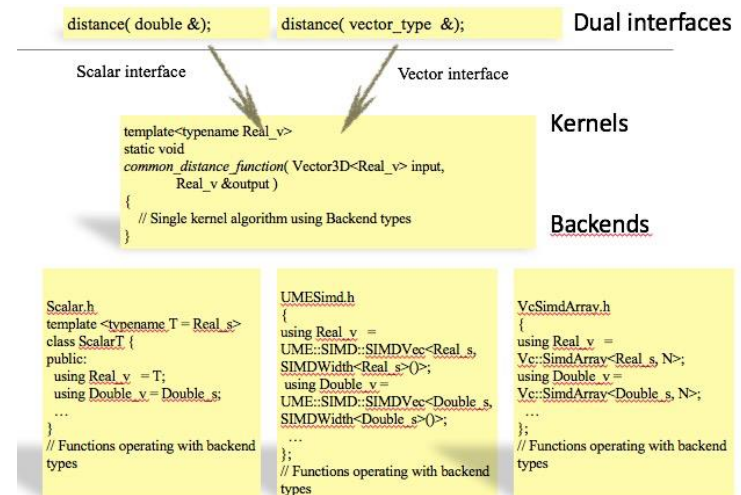
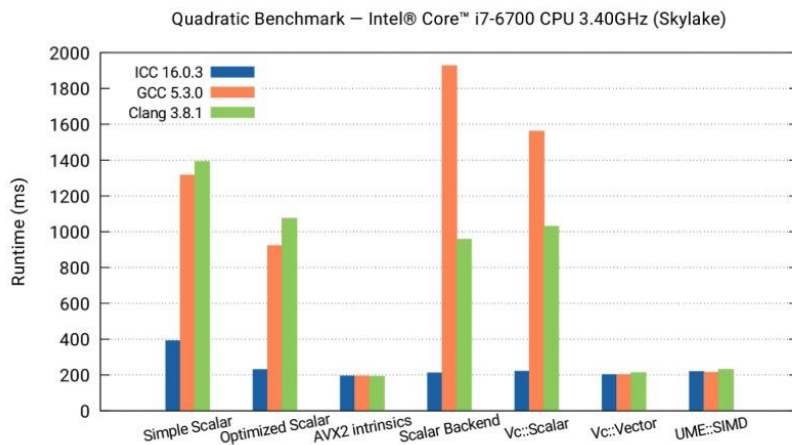


zoom of white rectangle



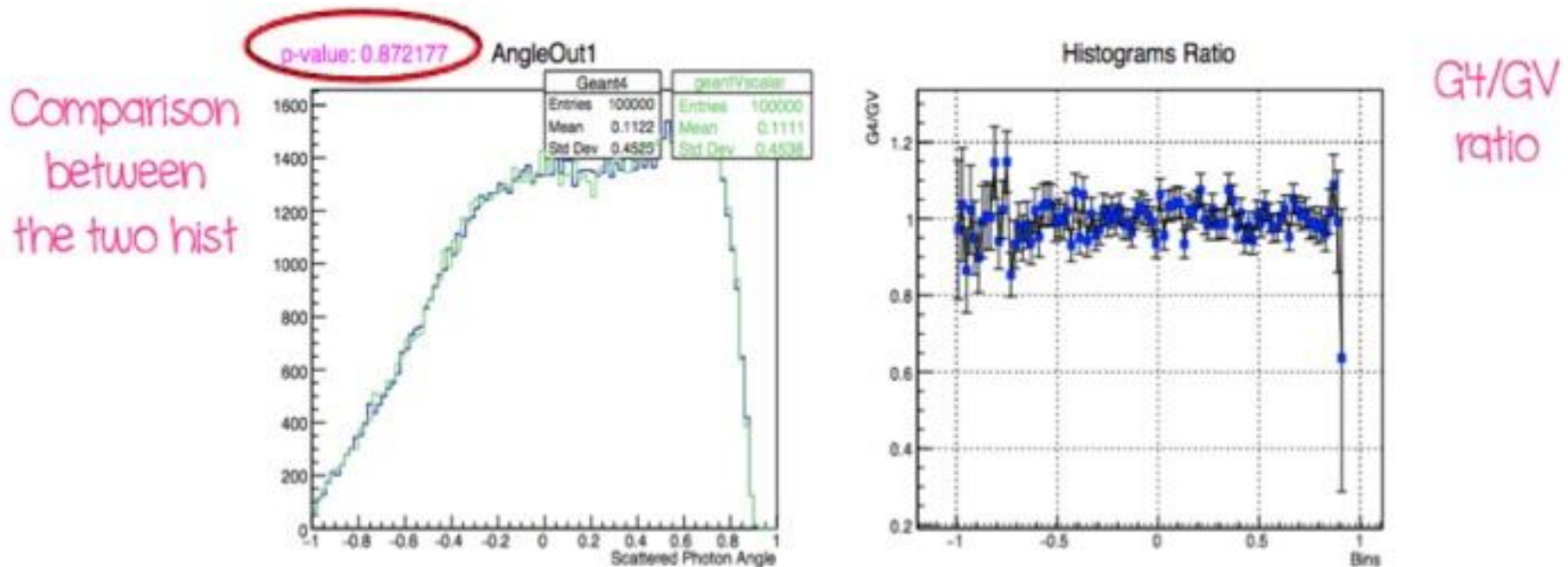
Where are we – SIMD developments

- ▶ Generic & portable SIMD implementation of vector operations
 - Same code, optimal performance, including on CUDA
- ▶ Template specialization allows to
 - Express algorithms with high-level language
 - Hide machine dependencies
 - Concentrate machine-dependent source code into a single package
- ▶ Future-friendly solution
 - Till the compiler gets there... or something similar is adopted by the standard



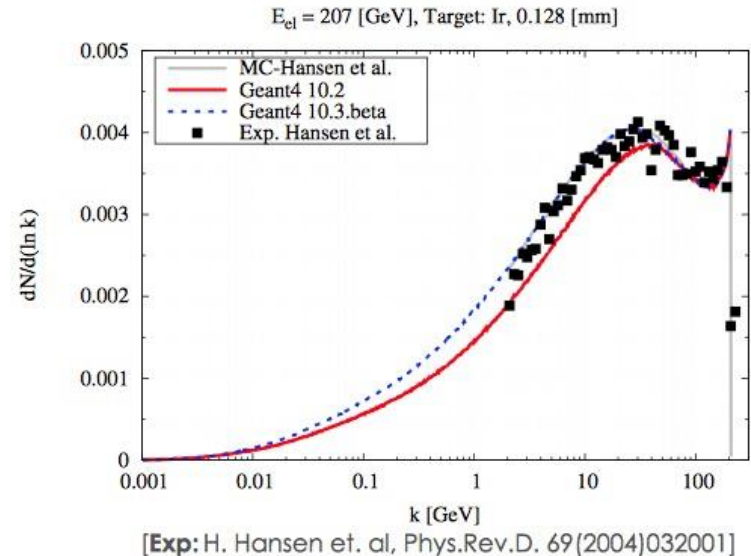
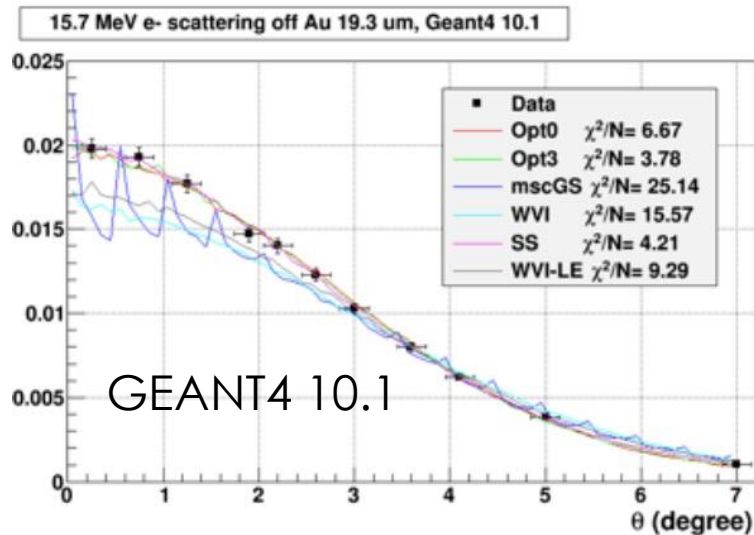
Where are we – optimizing G4 physics

- ▶ Vectorization of EM-gamma models from GEANT4
- ▶ Vectorizable sampling algorithm (alias)
- ▶ Validated against original GEANT4 code



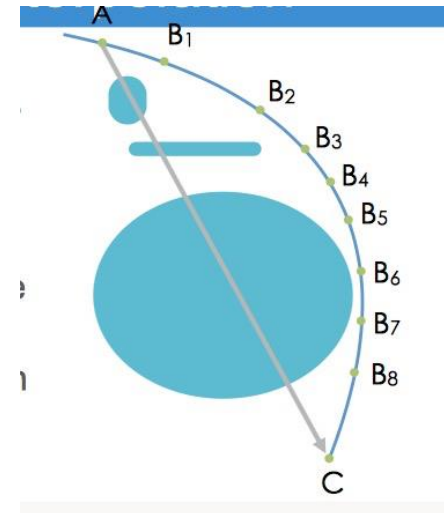
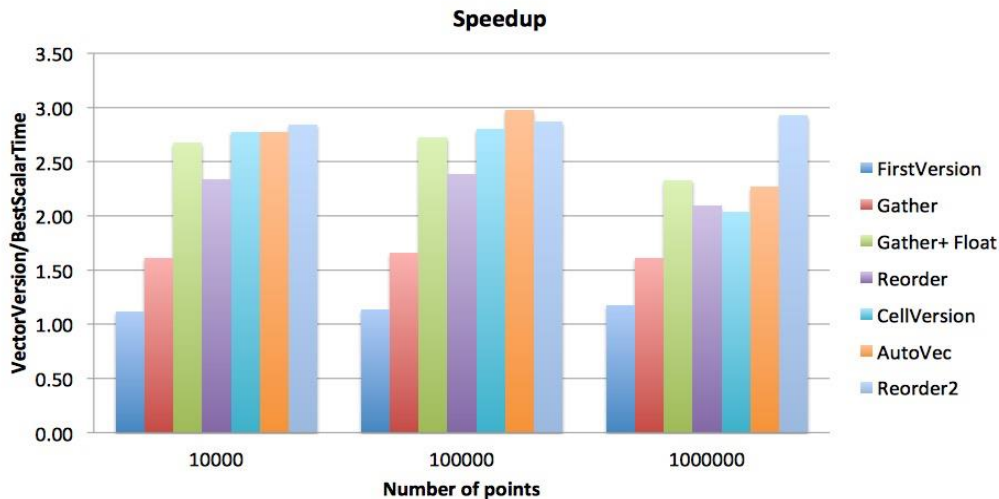
Where are we – new physics models

- ▶ Complete rewrite of e^\pm processes & multiple scattering
 - Faster & better than GEANT4 10.1
- ▶ Validated with data and GEANT4 counterpart
- ▶ Part of the GEANT4 10.2 experimental physics list
- ▶ Vector friendly algorithms... vectorization is next step



Where are we – magnetic field

- ▶ New vectorized algorithm for transport in magnetic field
- ▶ Scalar version integrated, vector version being integrated



Where are we – collaboration with experiments

- ▶ Integration tests with the CMSSW toy framework ongoing
- ▶ Trials of USolids/VecGeom with full CMSSW/GEANT4
- ▶ ALICE integration of USolid/VecGeom via Tgeo
- ▶ Considering implementation of VecGeom navigator in TGeo

(Wo)manpower

- ▶ The current level of effort will allow us to have a reasonable prototype by end 2017 for transport and EM physics
- ▶ For hadronic interactions, by end 2018 it is possible to retrofit GEANT4 physics
 - Plan-B in Alberto's slides
 - But this would not exploit the full potential of our approach
- ▶ To develop new hadronic models we would need support from experts
 - We estimate need for 2 experts FTEs starting ... now
- ▶ Fast simulation also needs additional effort
 - One FTE here would be necessary
 - The best experience is in the experiment and collaborating with them is mandatory

Open questions

- ▶ Random number generator & reproducibility
 - We know how to do that, however we are still looking into RNG with good quality and short state
 - Otherwise we have a plan-B, which is not quite as good
- ▶ Fast simulation
 - We have designed the integration into the framework, but we have no resources to start working on that
 - We held a fast simulation workshop with experiments <https://indico.cern.ch/event/523577>
- ▶ Release cycle
 - We have a strategy but we never applied it yet, the code being too fluid for the moment

Open questions – packaging

- ▶ Where do we put VecCore, USolids/VecGeom, the vector math routines and so on...?
- ▶ We need appropriate (common) mechanisms for GEANTV, GEANT4 and ROOT to depend on these components
 - Without embedding them in the respective distributions
- ▶ We seriously need to start thinking about modularizing our environment
 - And this applies also to GEANTV
- ▶ HSF could help us here

Conclusions

- ▶ Looking forward for your input...

