



Community software: Geant4

4th ACTS Developers Workshop,
7th - 10th November 2023,
Orsay,
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Overview



- History & Geant4 Structure
- Around Daily Life
- List of Random Thoughts

History & Geant4 Structure

Geant4 – Brief history



- **RD44 project (CERN) :**
- **Goal : Assess benefit of OO technologies for (LHC) detector simulation**
- April 97 - First alpha release
- July 98 - First beta release

**R&D
phase
1994 - 1998**

- **December 98 : Geant4 1.0**
- ...
- Several major evolutions:
 - Migration STL, “cuts per region”, parallel worlds...
- **December 2013 : Geant4 version 10.0**
 - **Multi-threading support**
 - **Evolved to “tasking” in 2021, with 11.0**
- ...
- December 2022 : Geant4 version 11.1

**Production
phase
From 1999**

- We currently provide one beta release (in June) and one public release (in December) per year.
 - + patches, as they come

The Geant4 Collaboration Structure



- **~130 collaborators, ~30 FTE (self-declared & not audited)**
 - HENP-bound 40%, Space/Medical-bound 20%, free research 40%
- It is structured in **16 Working Groups (WG)** (backup slide)
- Has currently **3 Task Forces (TF)**
 - Collaboration Evolution (transient TF), R&Ds (permanent TF), Physics Validation (permanent TF)
 - (+ Web site renovation (transient TF, closed this year))
- **The Steering Board (SB) -23 members- is the driving body**
 - Composed of WG representatives (number depends on WG size) + spokesperson (SB chair) + deputy spokesperson
 - WG representatives are elected by WG members every 2 years
 - Spokesperson is elected every 2 years by the Collaboration, after WG representative election
 - Yearly work plan, monitor activities, monitor elections, setup TF(s), approve memberships, tutorials, etc.
 - Meets 4 – 6 times a year
- **The Oversight Board -11 members- is composed of the major funding agencies & institutions representatives**
 - provides support, ensures achievements & directions are consistent with Agencies & Institutions priorities, triggers reviews
 - **Geant4 has no common funds : each institution support its members**
 - Representatives of CERN, ESA, FNAL, INFN, IN2P3, KEK, LIP & TRIUMF, LPI, SLAC, Spain, STFC & G4AI
 - Meets 1 – 2 times a year
 - Report from Collaboration activities, and discussion of any specific issues

Other Geant4 Bodies



- **Publication Board**
 - 3 members, one renewed per year
- **Early Career Researchers Committee**
 - Created last year, after Collaboration wide discussion at Collaboration meeting
 - Has one representative at Steering Board meetings
- **Architecture Team**
 - Used to be very active at the early stages of Geant4
- **Technical Forum**
 - Forum of developers & users
 - Meets 3 – 4 times a year
 - Is in particular consulted for Geant4 yearly work plan (see later)
- In addition, Geant4 has **“liaisons” with various experiments:**
 - Liaison = one Geant4 member in close contact with large experiments / projects
 - Is the case for LHC experiments
 - But also for CALICE, OpenGATE, etc.

Around Daily Life

Development & Distribution Model



Development



GitLab

- **Development repository (geant4-dev)**
 - Development and experimental area
- **Restricted to Geant4 members & Geant4 “contributors”**
- Developer proposes a Merge Request (MR)
 - MR evaluated by WG coordinators
 - Undergoes system testing, continuous & nightly
- Order of ~1000 MRs / year
- Campaigns of validation for public releases

Distribution

Geant4 web page

GitHub

- **Public repository (geant4)**
 - Mirror of geant4-dev for public releases & patches
- Open to anyone Pull Request (PR)
 - Evaluated by responsible Geant4 developers, and then eventually integrated in geant4-dev
- Order of ~10 PRs / year



CVMFS, mainly for LHC experiments

- Monthly development snapshots
- For early feed-back

Geant4 & Open Development Model ?



- **Geant4 has not adopted an “Open Development Model”**
 - Open Development Model = opening GitLab to public
 - We think this model is **not adapted to Geant4**:
 - **Because of the specific constraints of physics developments**:
 - **Time scale of developments** : spans over months, years
 - GitLab repository is a development and an **experimental area** : **physics models may be tried and withdrawn**
 - **Physics validation takes time and can not be automated**:
 - **O(month) for full validation**, made for beta and public releases
 - Results & **changes of results** have to be examined by humans
 - These constraints make the snapshot of repository code **not usable** at any arbitrary time t .
 - **Partial opening of the development** adopted though two years ago
 - With the “**contributor**” status \approx “light member status”
 - Contributor = **knowledgeable user** who can provide bug fixes or additional light functionalities
 - In practice, appears as an interesting status to **lower the barrier to enroll new members**:
- But please note that **the strong physics validation aspect is specific to Geant4 !**
 - **It does not mean this Open Development Model has not to be adopted by ACTS !**

Collaboration Process



▪ **January:**

- Renewal of membership
 - Through web + (re)approval of Collaboration Agreement
- Collection of year work items in each WG
- Dedicated SB meeting to state on membership and iterate on work items
 - Cross-category items specially discussed

▪ **By March:**

- **Presentation and discussion of yearly work plan at Technical Forum**
- Users & Experiments are consulted for prioritization, needed features, etc.

▪ **By June:**

- Beta release
- Help for feedback from large experiments

▪ **September/October**

▪ **Yearly Collaboration Meeting**

- Alternate place as : 1 Europe – 1 Asia/Australia – 1 Europe – 1 America – 1 Europe...
- **State on developments & issues, shape/adjust December public release**
- **Collaboration wide discussions**
 - Technical/technological, Collaboration functioning & difficulties, possible improvements, generation transfer knowledge, forward looking, etc.
 - Show to be important for helping with the “sense of Collaboration”

▪ **October – Early December**

- Release phase
- (final) releases of codes, staged per domain
- **Rounds of wide validations**

▪ **Beginning of December**

- **Public release**
- **Together with documentation**

Interaction With Users



- Announcement mailing list
 - Releases, patches, but also workshops, tutorials, etc.
- Bugzilla
- **Discourse**
 - For daily support & questions
- **Technical Forum meetings**
 - Typically 2 @ CERN, with HEP topics but not only
 - One during Collaboration Meeting, with host topic as main item, often medical in practice
- **Liaisons with experiments & projects**
- Dedicated workshops : **Geant4 Space Users Workshop**
 - Next one beginning of December, in Pasadena (restarting series, after suspension by pandemic)
- **Tutorials**
 - Regular tutorials organized in CERN, Italy/INFN, France/in2p3, Japan, Korea, US
 - Tutorials organized on demand
 - We try our best to respond !
 - Tutorials typically span over one week
 - **The in person format is specially rich of interaction with users !**
 - **These tutorials often lead to interesting/challenging requirements**

List of Random Thoughts

Some thoughts, shared or mines, on our experience



- **Having a large experiment using Geant4 since the beginning –the SLAC BaBar experiment– had been critical to reach production level**
- We had critics on the size of the SB
 - I don't share them : having the complete panel of competences has very often shown to be useful
- The SB has last say of anything regarding the Collaboration operations
 - **This flexibility saves from detailing lengthy and complicated regulations**
 - For which we are, at the end, not competent
- **Members wish to know what happens in the SB**
- **The value comes from people**, not from regulations, nor processes, etc.
 - Good people can always improve regulations, processes...
 - The opposite is way less true...
- **Regulations are useless...**
 - ... **until you need them**, because of delicate situations
 - A hole in these can be a source of endless torments...
 - **Regulations must foresee limit cases**
- **Even after ~30 years, interactions with users continue to bring rich & surprising use-cases...**
- **Even after ~30 years, we feel we are still at the beginning of it...**
- **Abstraction is a blessing**
 - **Geant4 flexibility originates from it**
 - **Its inter-/trans-disciplinarity and related benefits too**
- **Simple/clean design**, reflecting simple/key concepts, **lasts forever**
 - Even if key concepts can be difficult to identify
 - G4VProcess, G4VSolid, etc.
- Anytime we mixed concepts, we have been in troubles later on
 - This can stick to your shoes forever...
- **Modularity is an other blessing**
- Mixing (CPU) “performances” and concepts makes it messy and tricky afterwards
 - **Simple/clean concepts are often natively performant**
- Simple/clean concepts makes it possible/easier to evolve to new technologies, new ideas, etc.
- **Quality & reliability are way more critical than performances for many, if not all, users**
 - Because quality gives a reference point you can try to reach by other means later on

Thank you !

Backup

Working Groups & Task Forces

Geant4 Working Groups (& rep. @ SB)



- Run, Event, and Detector Response
 - 1 rep.
- Tracking
 - 1 rep.
- Particles and Track
 - 1 rep.
- Geometry and Transport
 - 1 rep.
- Generic Processes and Materials
 - 1 rep.
- Electromagnetic Physics
 - 5 rep.
- Hadronic Physics
 - 3 rep.
- Persistency
 - 1 rep.
- User and Category Interfaces
 - 1 rep.
- Visualization
 - 1 rep.
- Physics Lists and Validation Tools
 - 1 rep.
- Testing and Quality Assurance
 - 1 rep.
- Software Management
 - 1 rep.
- Documentation Management
 - 1 rep.
- Novice & Extended Examples
 - 1 rep.
- Advanced Examples
 - 1 rep.

Geant4 Collaboration Annual Census



As Of January 2023 ; Per WGs

- Total 2023 : 36.50 FTE, 143 members + O(10) contributors
 - Proposed/actual 2022 FTE and #members : 36.62/37.34, 136/137

Working Group	FTE % (prop./actual 2022)	Working Group	FTE % (prop./actual 2022)
Run, event, det.	73 (68/57)	Vis.	138 (142/138)
Particles & tracking	30 (50/30)	Phys. List & val.	112 (54/79)
Geometry	235 (241/237)	Test. & Q/A	91 (108/89)
Gen. proc. & mat.	179 (190/168)	Software Mng	65 (53/44)
EM	1089 (1056/1102)	Documentation	65 (61/67)
Hadronic	607 (674/587)	N&E examples	171 (135/251)
Persistency	41 (41/46)	Adv. examples	210 (184/188)
UI	55 (50/47)	R&D TF	446 (585/483)

- + Management FTE (spokesperson, deputy spokesperson, part of release coordinator): 44% (44/44)
- Notes : numbers are quite inaccurate.
 - FTE numbers are self-declared and not audited.
 - FTE includes contributions from students who declare large FTE numbers.

Geant4 Collaboration Annual Census,

As Of January 2023 ; Per Countries

- Total 2023 : 36.50 FTE, 143 members + O(10) contributors (actual 2022 FTE and #members : 37.34, 137)
- Number of collaborators and their FTE by country / organization
 - In the brackets : (2022)

Country/Organization	Number - FTE	Country/Organization	Number - FTE	Country/Organization	Number – FTE
CERN/Swiss	17(16) – 8.82(9.25)	Russia	8(8)-3.07(3.47)	Korea	6(5)-0.36(0.31)
US	26(24) –5.97(5.49)	Japan	12(11)-1.06(1.02)	Portugal	2(2)-0.13(0.13)
France	29(29)-7.75(8.52)	Spain	5(4)-0.48(0.29)	Canada	2(2)-0.21(0.20)
Italy	11(11)-2.72(2.47)	UK	6(6)-1.14(1.12)	Other Countries	19(18)-4.38(3.90)

- Other countries : Sweden, Denmark, Netherland, Greece, Hungary, Slovakia, Tunisia, South Africa, India, Vietnam, Australia, Argentina, Saudi Arabia
- Note : numbers are quite inaccurate.
 - ESA's contribution scatters to several European countries.
 - Some of Russian contribution may belong to CERN or other organization.
 - HENP-bound 40%, Space/Medical-bound 20%, free research 40%

Task Forces



- **Physics Validation**
 - Permanent task force
 - Monitoring of physics evolution
- **Task Force for R&Ds**
 - Promote longer-term R&D efforts on the exploitation of emerging technologies, computing architectures or software architectural revisions, and new or better physics ideas that would be beneficial to Geant4.
 - Make timely assessments on these R&Ds for their feasibility, benefits and required efforts.
- **Collaboration Evolution**
 - Initiated avec Collaboration wide discussion at Collaboration meeting in 2022
 - Examined, clarified and summarized a series of recommendations to evolve the Collaboration
 - Recommendations submitted to Steering Board for approval and adoption
- **Website Task Force (terminated in 2023)**
 - Revise Geant4 web site
 - Modernize its look and style
 - Ensure long term maintenance