Update on Requirements

44th Geant4 Technical Forum
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CERN

Marc Verderi
LLR, Ecole polytechnique
On behalf of the Geant4 Collaboration

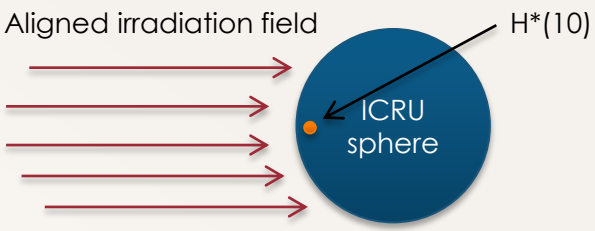
Requirements Tracking System Page:
https://jira-geant4.kek.jp/secure/Dashboard.jspa?selectPageId=10000

New requirements

Requirements from radioprotection and radiophysics : activation and dose calculation

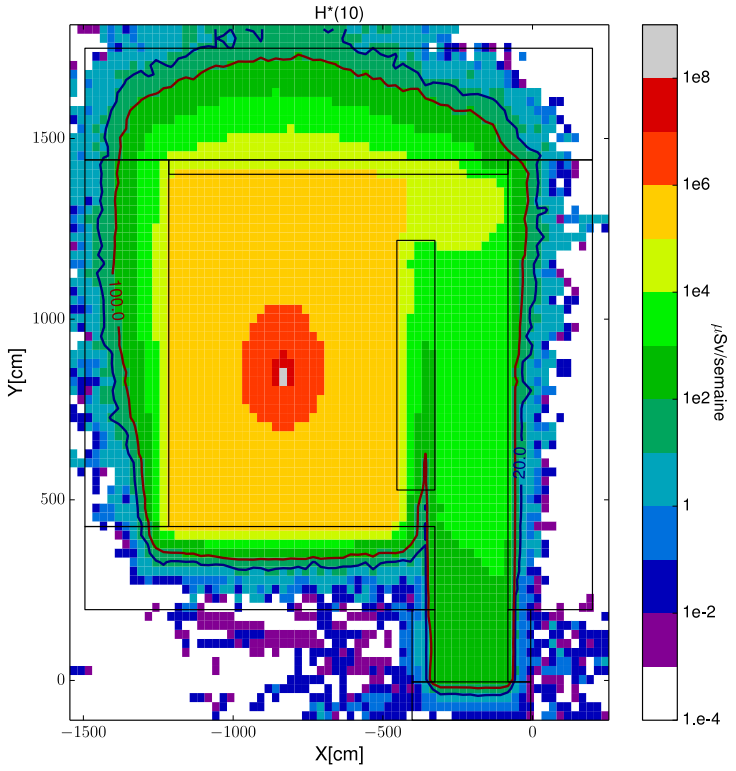
- Requirements from hospital in beam therapy
  - Presentation at 43rd TF, May 2016
  - By Laurent Desorgher, Centre hospitalier universitaire vaudois
    - Also main developer of related functionnalities
  - https://indico.cern.ch/event/522574/contributions/2155895/

- Doses with operational estimator H*(10)
  - Estimate dose at 10 mm depth in a "ICRU sphere"
    - {30 cm ∅, tissue eq., 1 g/cm^3, mass composition 76.2% O, 11.1% C, 10.1% H, 2.6% N}



  - Conversion coefficients from ICRP74
    - Fluence values → H*(10) ones
    - ICRP74 provides coefficients for protons, e-, gammas, neutrons

Example of H*(10) map in protontherapy



4302 - 4305 : Series of Requirements from Radioprotection and Radiophysics

- Requester: Laurent Desorgher
  - And is also responsible or co-responsible for responding to these requests.

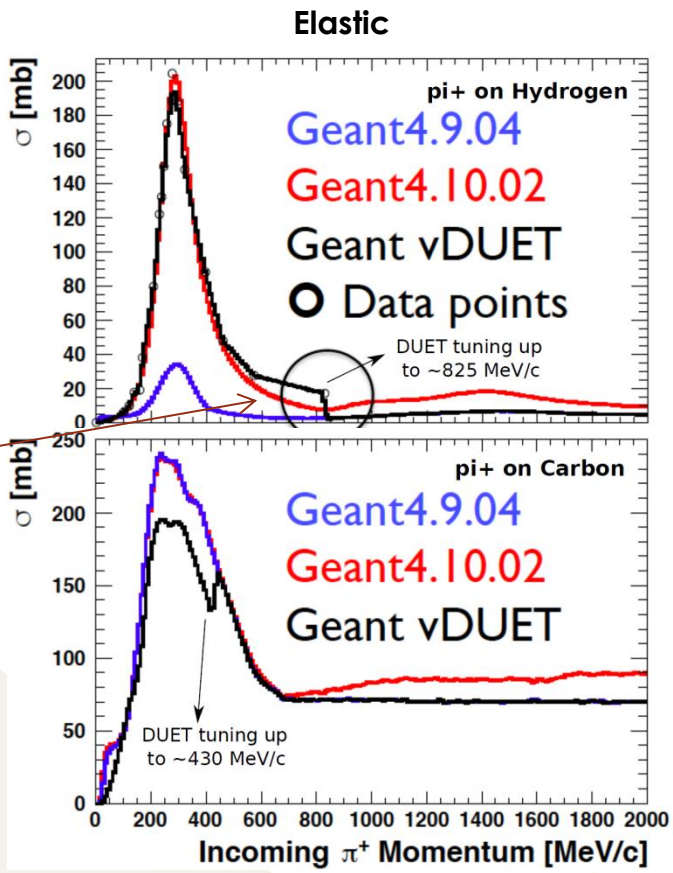
- **4302** : *Tallying of the ambient dose equivalent H*(10) (value + error or tally)*
  - Needed in activation and dose calculation studies
  - **Request for having H*(10) tally value *and* its (stat.) error**
  - Co-resp: Makoto
- **4303** : *Requirements from radioprotection and radiophysics : activation and dose calculation*
  - **Dose H*(10) resulting from radioactive decay at different time windows**
  - Co-resp: Dennis
- **4304** : *Computation of activation in bunker therapy by protons, neutrons, and gammas*
  - **Correct production of activated nuclei by nuclear spallation**
  - Note : Laurent D. agrees to participate to validation
- **4305** : *Definition of irradiation profile for radiation therapy*
  - Radiation therapy involves time dependent beam profile
    - Related activation needs to be simulated
  - Hence request ability for **User defined irradiation profile**

- Status:
  - Prototype solution exists for 4302 and 4303
  - 4305 should in principle be covered by the biasing capabilities of the radioactive decay module, but has to be verified
  - Open

4301 : Need of correct pion elastic model for T2K

- Requester: Tom Feusels for T2K Collaboration
- Responsible:
  - Dennis Wright
- Context:
  - T2K Neutrino oscillation experiment uses selections of neutrino interactions based on the number of detected pions (0, 1, or > 1pi).
    - Detailed understanding of final state interactions and secondary of pions crucial.
  - DUET experiment at TRIUMF performed in order to improve measurements of pion interactions on carbon and water.
- Observation:
  - pi + H : wrong by factor 5-10 in 9.4
  - largely improved in 10.1-p-02
    - even if still problems > 600 MeV/c
  - pi + C : some differences
  - Phys Rev C 92, 035205 (2015)

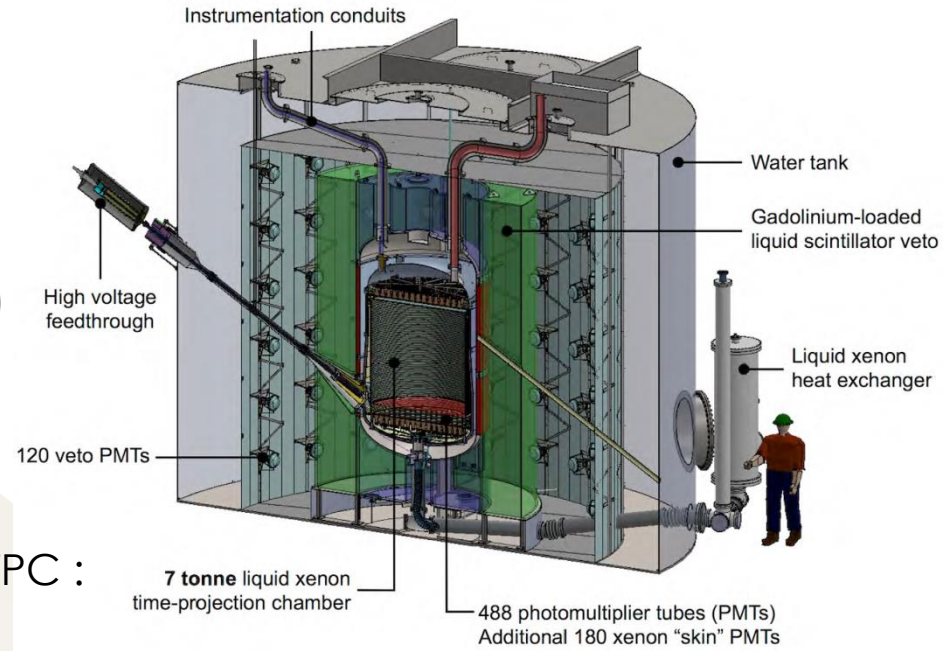
- **Requests/questions:**
  - **Need correct pion elastic model** [precision not specified]
  - Could DUET/T2K provide feedback to Geant4's elastic (and inelastic) models ?
    - Response : feedback welcome !
  - Other generators only have implementation of quasi-elastic processes. How does Geant4 treat quasi-elastic and elastic processes in pion/nucleon - nucleus scattering?
    - Response : elastic treated as separate process ; quasi-elastic is part of inelastic
  - Open



Open requirements

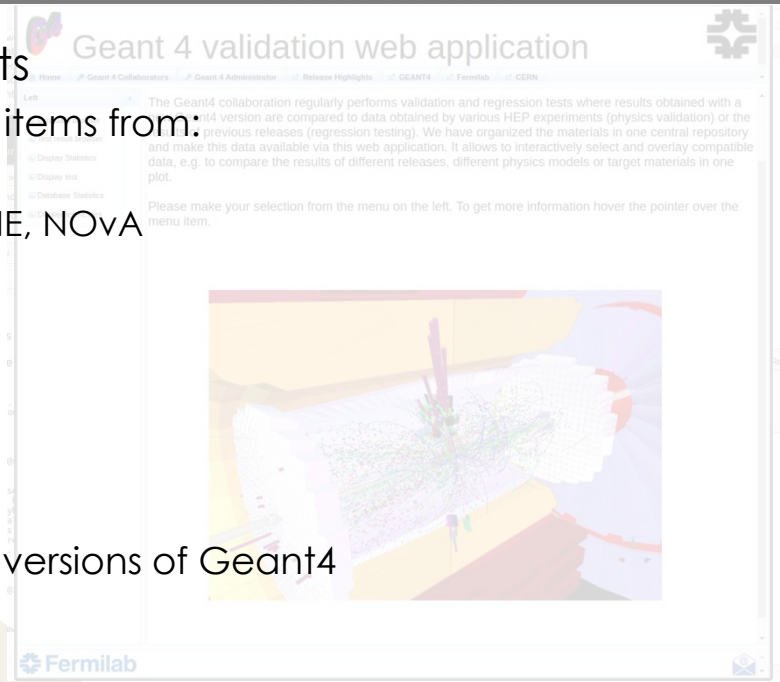
4004 : Treatment of gamma cascades after neutron capture (Gd, Xe)

- Requester: LUX-ZEPLIN (LZ)
  - 2nd-generation dark-matter detector
    - WIMPs detection from few GeV/c2 to several 100 TeV/c2.
  - Request made at 40th TF @ FNAL (link)
- Responsibles:
  - Dennis Wright, Makoto Asai
- Scope:
  - Gd-loaded liquid scintillator around TPC :
    - Used in veto of background events from PMT themselves
      - that could scatter into detector volume
    - Will be used for detailed understanding of background coming from detector as well
- Status:
  - Patch 10.2.p01 released on 2016 March 2nd should correct.
    - Feed-back from LZ expected.
  - Open.



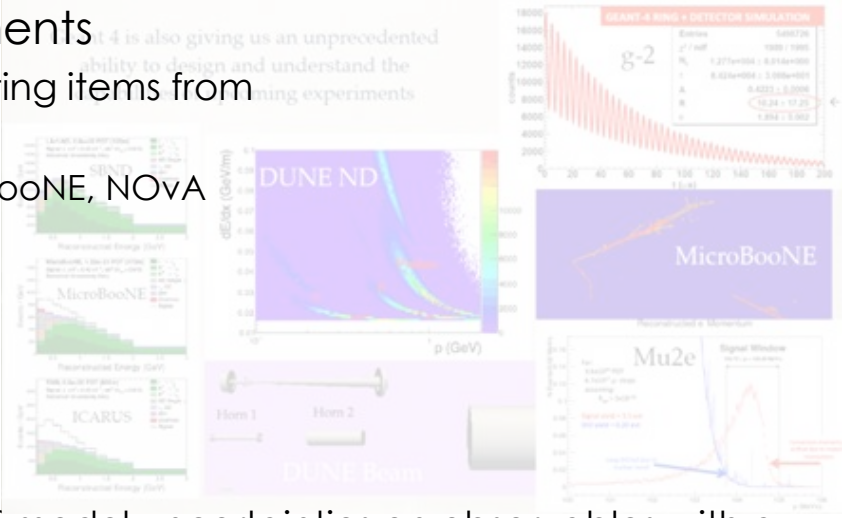
4003 : Validation of new versions of Geant4

- Requester: Intensity Frontier FNAL experiments
  - Request made at 40th TF @ FNAL (link) , collecting items from:
    - Muon : g-2, Mu2e
    - Neutrino : DUNE, MicroBooNE, MINERvA, MiniBooNE, NOvA
    - Fixed Target : SeaQuest
    - Test Beam : LArIAT
- Responsible:
  - Andrea Dotti
- Scope:
  - Tool to understand differences between any two versions of Geant4
    - not just incremental changes of each release
- Status:
  - Reminder : Geant4 validation database and website available at:
    - http://g4validation.fnal.gov:8080/G4WebAppNG/
    - Note that a re-design with extension to new data and features is being carried on.
  - First proposal : tool used for regression testing (StatTest) can be provided in a public form
    - Will allow to compare a same plot from an application, using two different versions of G4.
  - Andrea Dotti (SLAC) and Hans Wenzel (FNAL) working on it.
  - Today's status : Database is now up and running, populating it.
  - Open.



4002 : Reweightable uncertainties for systematic uncertainties estimation

- Requester: Intensity Frontier FNAL experiments
  - Request made at 40th TF @ FNAL (link) , collecting items from
    - Muon : g-2, Mu2e
    - Neutrino : DUNE, MicroBooNE, MINERvA, MiniBooNE, NOvA
    - Fixed Target : SeaQuest
    - Test Beam : LArIAT
- Responsible:
  - Makoto Asai
- Scope:
  - The technique allows to estimate the effect of model uncertainties on observables with a single MC sample
    - Model uncertainties provided under guidance of experts
    - Suggested from usability of GENIE Neutrino MC Generator



- Status:
  - Actual work is in progress at FNAL:
    - See presentation at the recent hadronics WG meeting :
    - https://indico.cern.ch/event/591077/
  - Note : to tune performances for 10.3, some parameter changes had to be done, hence such interface could be useful for our internal validations, too.
  - Open.

3901 : Complete destruction of Geant4 objects at exit

- Originator:
  - CMS
  - 39th Technical Forum (link)
- Scope:
  - Geant4 utilized in framework
    - But Geant4 leaves undeleted objects after completion.
  - Clean destruction of G4 objects needed
- Responsible:
  - Makoto Asai
- Status:
  - Progress made on the strategy to destroy physics objects in MT
  - Some improvements in 10.3, but still some remaining ones
  - Open.

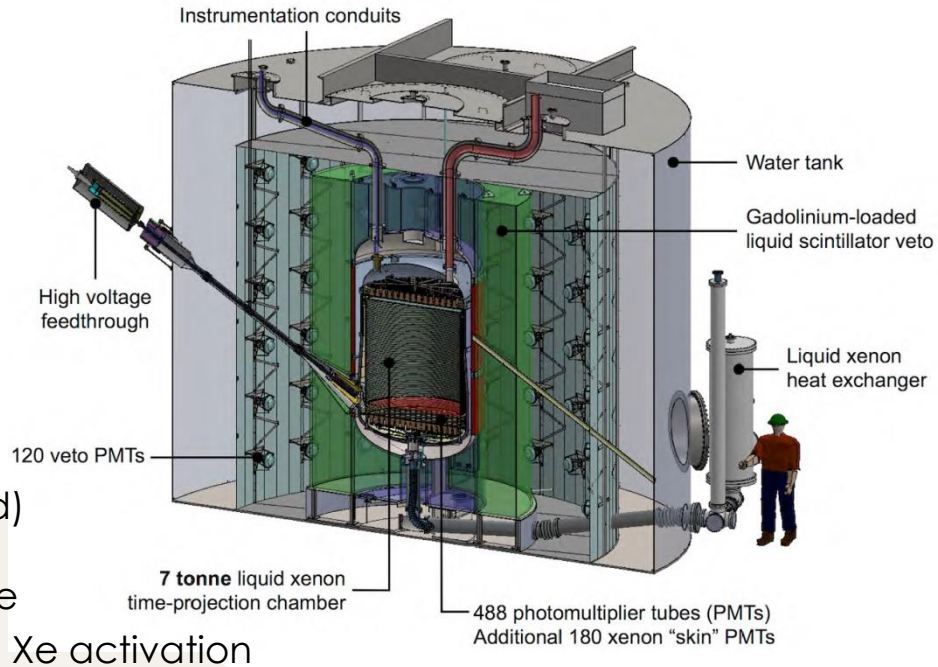
3301 : Multithreading processing driven by experiment framework

- Requester: CMS (but now general)
  - Original request at 33th TF (link)
  - Further information at G4 Collaboration meeting (link)
- Responsibles:
  - Andrea Dotti, Makoto Asai, John Apostolakis.
- Scope:
  - To process multiple events and process multiple modules in same event (gen., sim./G4, trg., reco., ana.) simultaneously
    - Geant4 = one of the modules
  - Framework controls modules execution
    - Geant4 to be controlled with proper messages
  - "Threading Building Blocks" (Intel® TBB) task model adopted
- Status:
  - Progress expected for 10.3
  - On CMS side, issues are now resolved.
  - Both CMS and ATLAS (through Gaudi-Hive) have already migrated to MT.
    - CMS working in MT mode in production; ATLAS on the way to adopt it.
  - Agreed to close this topic, but open a new one to follow-up
    - more focused on the remaining work to do for use of workspaces
  - Propose to close.

Recently closed requirements

4005 : Neutron production in muon showers at the %-level

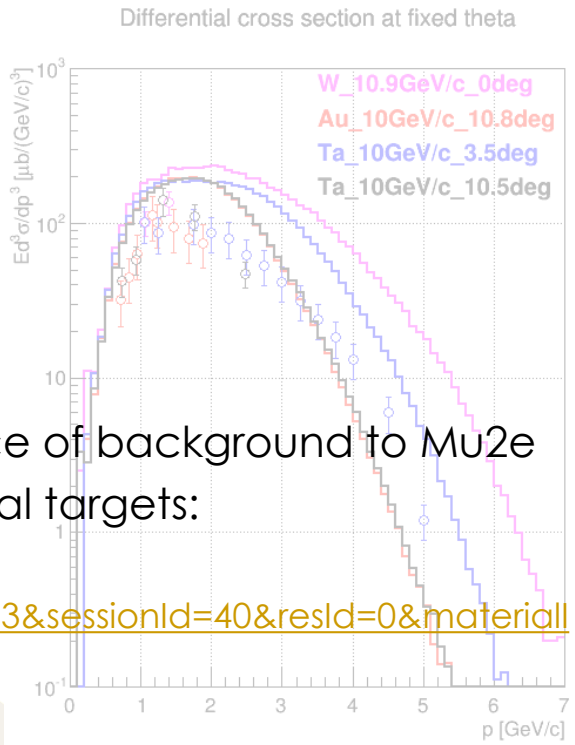
- Requester: LUX-ZEPLIN (LZ)
  - 2nd-generation dark-matter detector
    - WIMPs detection from few GeV/c2 to several 100 TeV/c2.
  - Request made at 40th TF @ FNAL (link)
- Responsibles:
  - Alberto Ribon, Vladimir Ivantchenko
- Scope:
  - Control of the cosmogenic (muon-induced) neutron production (surrounding rock or detector material) as a background source
  - Control in the detector calibration through Xe activation



- Status:
  - Valid requirement, but difficult.
  - Resources needed to address this problem.
  - FNAL requested to seek for resources.
  - Lack of resources to address requirement
  - Closed (will see if "pending/dormant" state could be added to JIRA)

4001 : Anti-proton production from proton beam

- Requester :
  - Mu2e
  - Request made at 40th TF @ FNAL (link)
- Responsible:
  - Alberto Ribon
- Scope:
  - Anti-proton production is the third dominant source of background to Mu2e
  - Discrepancy observed for 10 GeV beam on several targets:
    - see page 18 of:
      - https://indico.fnal.gov/getFile.py/access?contribId=123&sessionId=40&resId=0&materialId=slides&confId=9717
    - and validation plots:
      - http://g4validation.fnal.gov:8080/G4WebAppNG/DisplayTest_1.xhtml?selectedTestDescription=47



- Status:
  - Requested Mu2e to try version 10 (preferably 10.2) to see the improvements.
  - Lack of resources to address requirement.
  - Closed (same comment on having a "pending/dormant" state in JIRA)

3701 : Use of Geant4e in track fitting

- Originator: CMS (but now general).
- Issue:
  - Geant4e is being used by CMS for track fitting:
    - With a forward propagation phase, called "fitter"
    - Followed by a backward propagation, called "smoother"
  - Backward tracking requires the momentum to be flipped, changing the error matrix accordingly
- Request:
  - Improve documentation addressing the case of Kalman fitter scenario (forward & backward) propagation.
  - An automated mode to perform backward propagations in Geant4e:
    - Flip momentum
    - Take care of the error matrix transformation
    - Take care of the error handling
- Responsible:
  - Pedro Arce
- Status:
  - Need confirmation for completion.
  - But CMS has now a working setup.
  - Closed.