

Stéphane Chauvie
Pablo Cirrone
Giacomo Cuttone
Francesco Di Rosa
Susanna Guatelli
Alex Howard
Sébastien Incerti
Mikhail Kossov
Anton Lechner (new)
Alfonso Mantero
Barbara Mascialino
Luciano Pandola
MG Pia
Michela Piergentili
Alberto Ribon
Giorgio Russo
Giovanni Santin
Bernardo Tomé
Jakub Moscicki
Andreas Pfeiffer
Witold Pokorski

Geant4

Advanced Examples

<http://www.ge.infn.it/geant4/examples>

M.G. Pia

On behalf of the Advanced Examples Working Group

Geant4 Workshop

Lisbon, 9-14 October 2006

Mission

**Investigate, evaluate and demonstrate
Geant4 capabilities
in various experimental environments**

Provide guidance to Geant4 **users
in realistic experimental applications**

Provide **feedback to Geant4 **developers**
about successful results, problems etc.**

Identify **requirements for further Geant4
improvements and **extensions** to
address new experimental domains**

Advanced Examples

1. air_shower
2. brachytherapy
3. *cell_irradiation*
4. composite_calorimeter
5. cosmicray_charging
6. gammaray_telescope
7. hadrontherapy
8. *human_phantom*
9. IAr_calorimeter
10. medical_linac
11. microbeam
12. *nanotechnology*
13. purging_magnet
14. *radiation_monitor*
15. radioprotection
16. raredecay_calorimetry
17. Rich
18. Tiara
19. underground_physics
20. xray_fluorescence
21. xray_telescope

- Released
- *In preparation*
- Wide experimental coverage
 - HEP
 - Space science/astrophysics
 - Medical physics
 - Radiobiology
 - Detector technologies
- Wide Geant4 coverage
 - Geometry features
 - Magnetic field
 - Physics (EM and hadronic)
 - Biological processes
 - Hits & Digis
 - Analysis
 - Visualisation, UI

Responsibilities

1. air_shower
2. brachytherapy
3. *cell_irradiation*
4. composite_calorimeter
5. cosmicray_charging
6. gammaray_telescope
7. hadrontherapy
8. *human_phantom*
9. lAr_calorimeter
10. medical_linac
11. microbeam
12. *nanotechnology*
13. purging_magnet
14. *radiation_monitor*
15. radioprotection
16. raredecay_calorimetry
17. Rich
18. Tiara
19. underground_physics
20. xray_fluorescence
21. xray_telescope

Vision & coordination *

1. Bernardo Tomé (LIP)
2. Susanna Guatelli * * = INFN
3. *Barbara Mascialino **
4. Alberto Ribon (CERN)
5. ?
6. ? *
7. Pablo Cirrone + Susanna Guatelli *
8. *Susanna Guatelli **
9. ? *(thanks to Alberto Ribon for maintenance!)*
10. Michela Piergentili *
11. Sébastien Incerti (IN2P3)
12. *Susanna Guatelli + Alessandro Montanari **
13. ?
14. *Susanna Guatelli **
15. Susanna Guatelli *
16. Mikhail Kossov (CERN)
17. ? *(thanks to Alex Howard for maintenance!)*
18. ? *(thanks to Alex Howard for maintenance!)*
19. Luciano Pandola *
20. Alfonso Mantero *
21. Giovanni Santin (ESA)

Responsibility

● Orphans

- Original authors quit the Collaborations (or are not collaborators at all)

● Desirable adoptions

- `purging_magnet`: playground for transportation in magnetic field
- `cosmicray_charging`: widest physics coverage
- `RICH`, `lAr_calorimeter`: important detector techniques
- `Tiara`: event biasing, neutron physics
- Volunteer “parents” welcome: effort required = maintenance

● Retirements

- Examples without an identified responsible will be **retired**

● Lesson learned

- Examples must have a responsible **Geant4 collaborator**
- No external user contributions only

Validation

- **Goal:** document quantitatively the validation of the physics selections of all advanced examples
 - Objectively supported physics options rather than “educated guess”
PhysicsLists
- **Strategy**
 - **Generic** validation studies of processes/models used
Collaboration with Geant4 Physics Working Groups desirable
 - **Specific** validation studies with ad hoc experimental data
Collaboration with experimental teams

Orphan
Under development

Validation

1. air_shower
2. brachytherapy
3. *cell_irradiation*
4. composite_calorimeter
5. cosmicray_charging
6. gammaray_telescope
7. hadrontherapy
8. *human_phantom*
9. IAr_calorimeter
10. medical_linac
11. microbeam
12. *nanotechnology*
13. purging_magnet
14. *radiation_monitor*
15. radioprotection
16. raredecay_calorimetry
17. Rich
18. Tiara
19. underground_physics
20. xray_fluorescence
21. xray_telescope

- 1.
2. Generic + Specific
3. Specific
- 4.
- 5.
- 6.
7. Generic + Specific
8. *Not pertinent*
- 9.
10. Generic + Generic + Specific
11. Generic + Specific
12. Specific
- 13.
14. Specific
15. Generic (EM, partly hadronic)
- 16.
17. *TNS?*
18. *NSS 2006?*
- 19.
20. Generic + Specific
- 21.

Published

Existing, to be
published

In preparation

*Apologies for any omissions
Please let me know of other
pertinent validation results
and publications*

Highlights

- **No time to present all the ongoing activities and results**
 - My apologies to the bright, hard-working Geant4 collaborators, whose work and results cannot be shown to the Collaboration
 - ...fortunately they have the opportunity to show them at conferences!
- **More or less random selection among the wealth of available material**
 - No implicit judgment of relative relevance or quality
- **Hadrontherapy**
 - Example of physics validation in Advanced Examples
- **Radiation_monitor**
 - Example of demonstration of Geant4 capabilities for a research domain
- **Human_phantom**
 - Example of an innovative approach with Geant4

Bragg peak validation

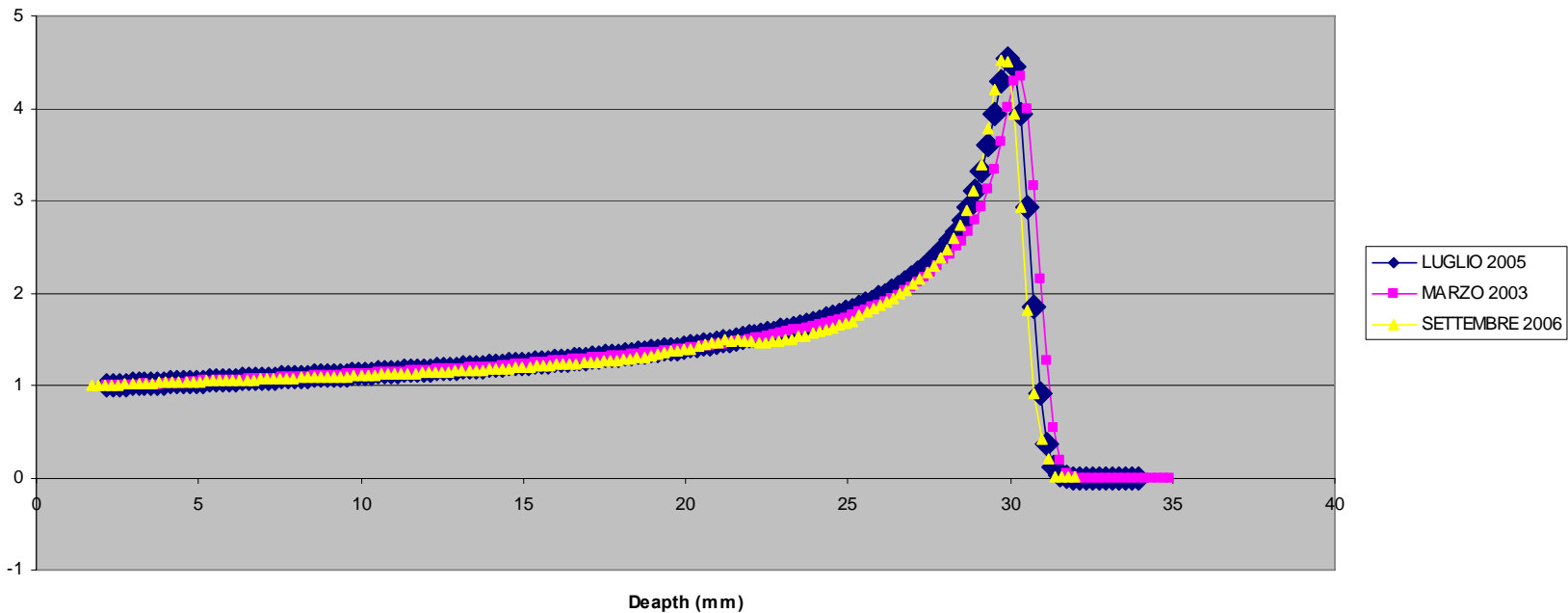
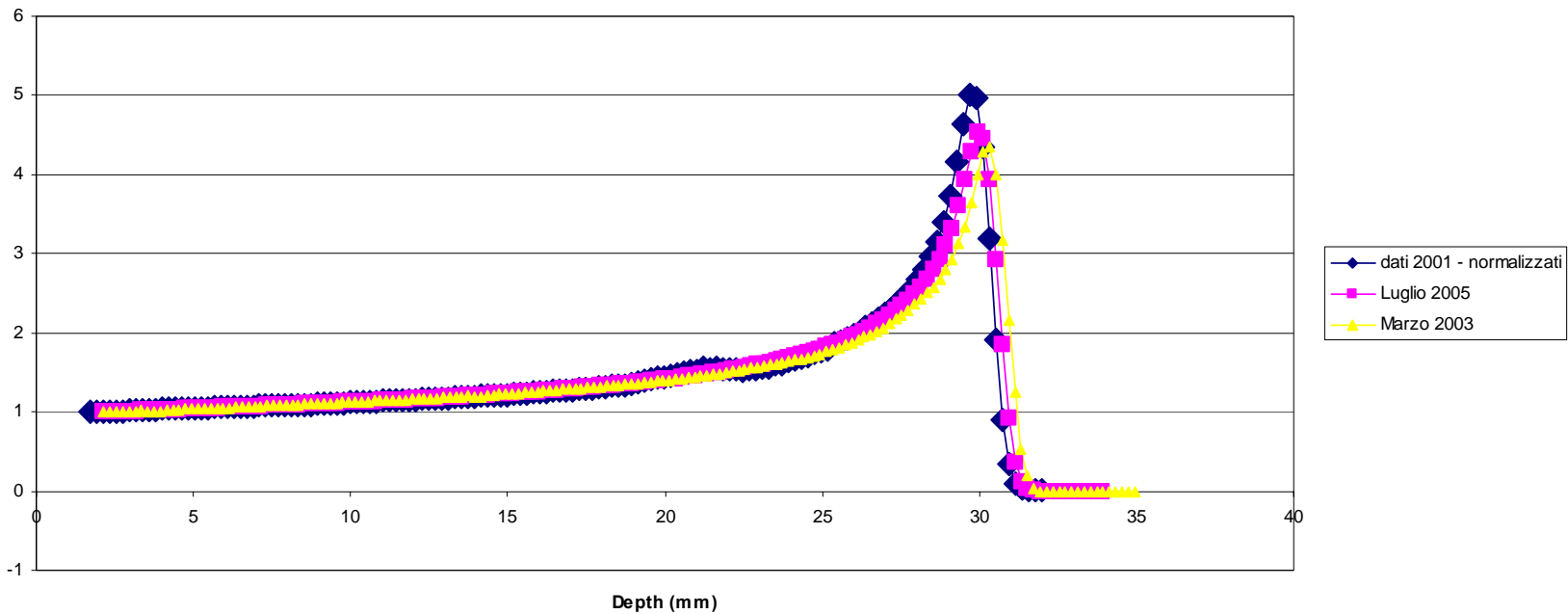
● Goal

- Quantitative validation of Geant4 against high precision experimental data
- Publication-quality results
- Validated PhysicsList for proton Bragg peak applications

● > 2 year long project

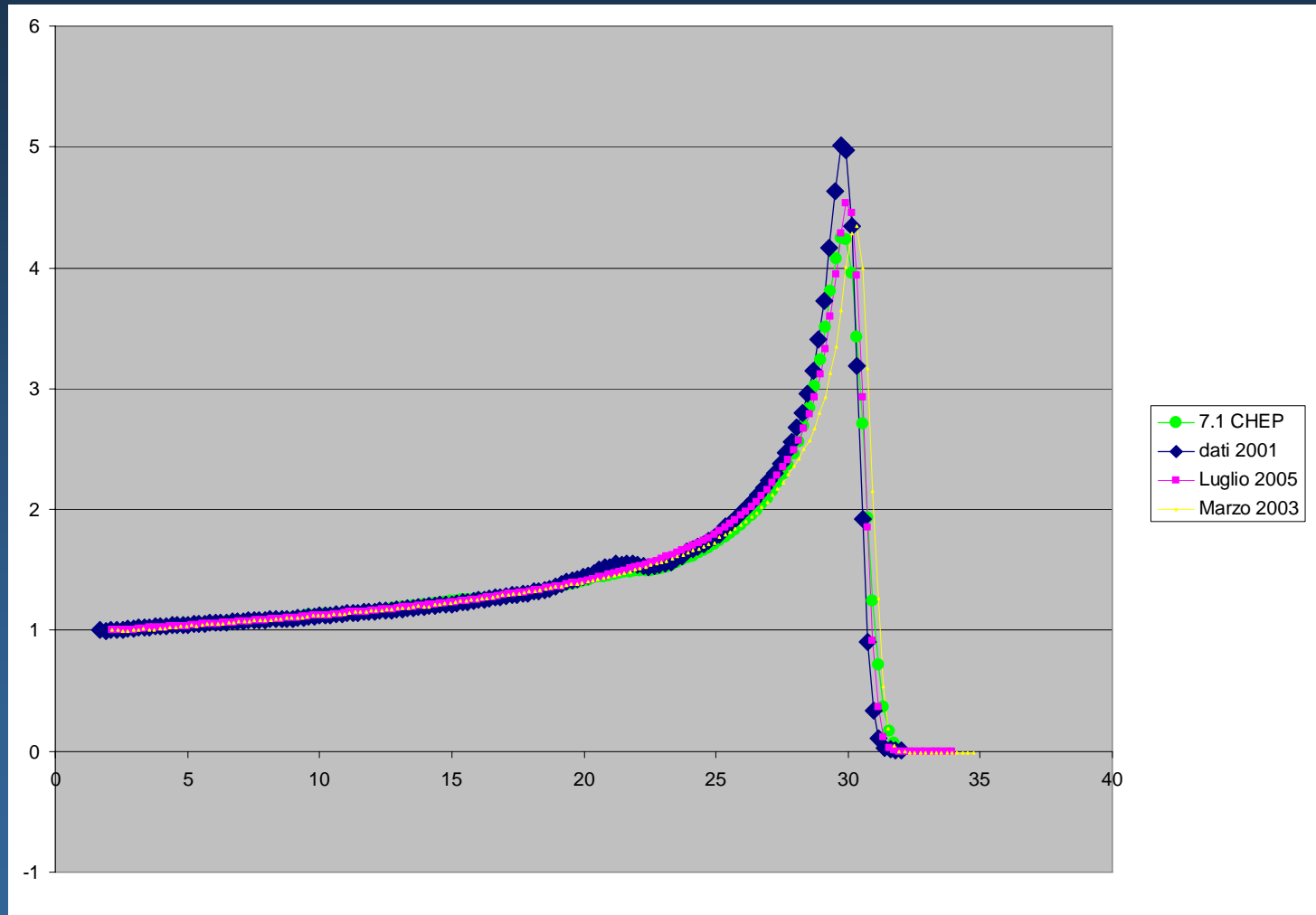
- Major difficulty encountered: understand experimental data
- Part-time availability of project members (jobless/overworked)
- Preliminary results: Geant4 mini-workshop, Genova, July 2005
- Intermediate results: CHEP 2006
- Final results: NSS 2006

Which data are the good reference?



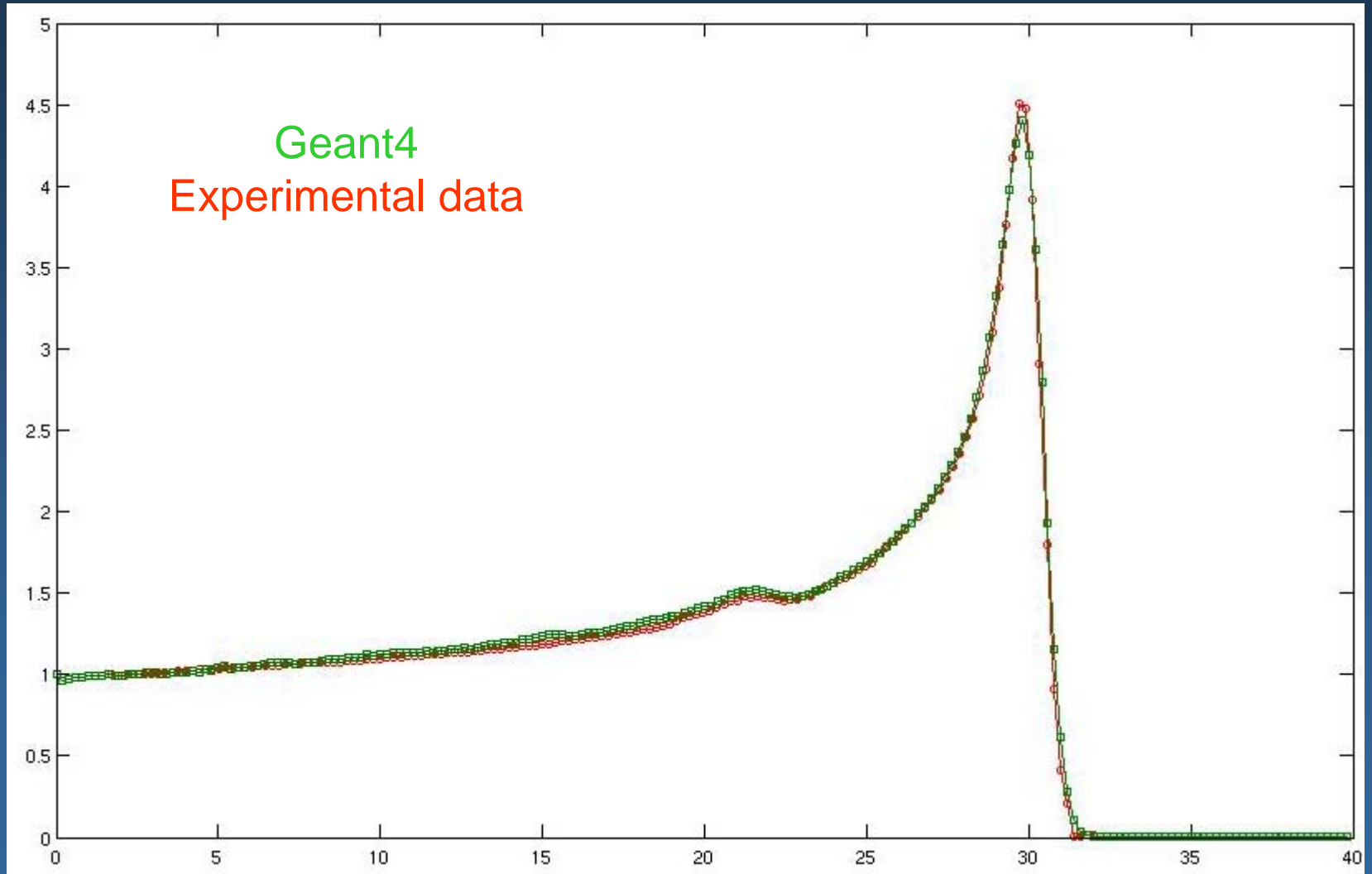
The control of systematic effects is a major issue in any physics analysis

The choice of experimental data series makes a big difference for a precise, quantitative validation



Geant4 7.1 (CHEP 2006) against three series of experimental data

Systematics now under control



Current status and outlook

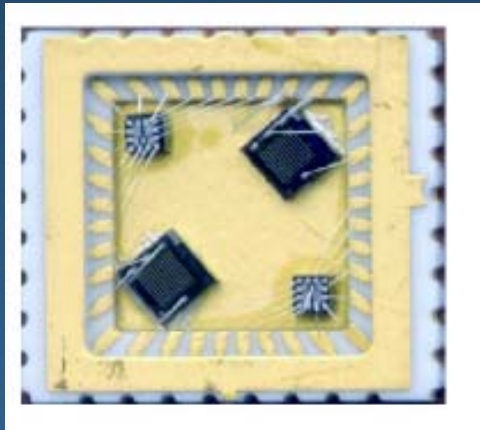
- Further refinement of a systematic effect currently under study
- Production in progress (LNS Catania, Genova)
- Presentation at NSS 2006
- Documented, validated PhysicsList for proton Bragg peak available to users

Radiation monitor

- **Collaboration with CERN RADMON team**
 - Radiation monitoring sensors for all LHC experiments
 - Optimisation of packaging with Geant4
 - Validation against experimental data

- **Results**
 - CHEP, February 2006
 - RADECS, September 2006
 - Siena, October 2006
 - NSS, November 2006
 - Publication

Geometry

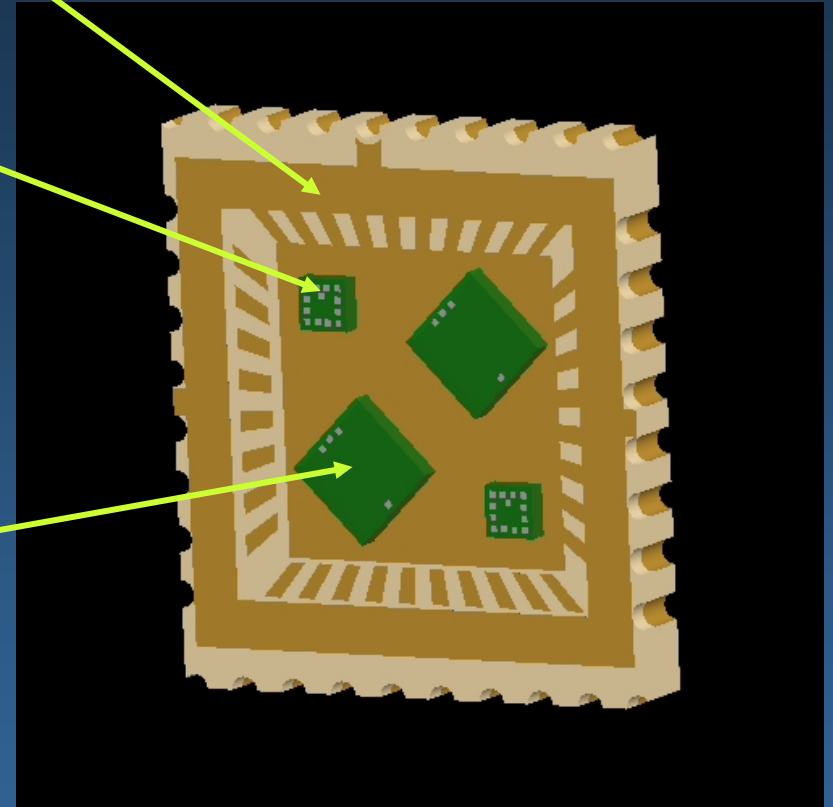


Packaging

REM-TOT-500

LAAS

Geant4 simulation



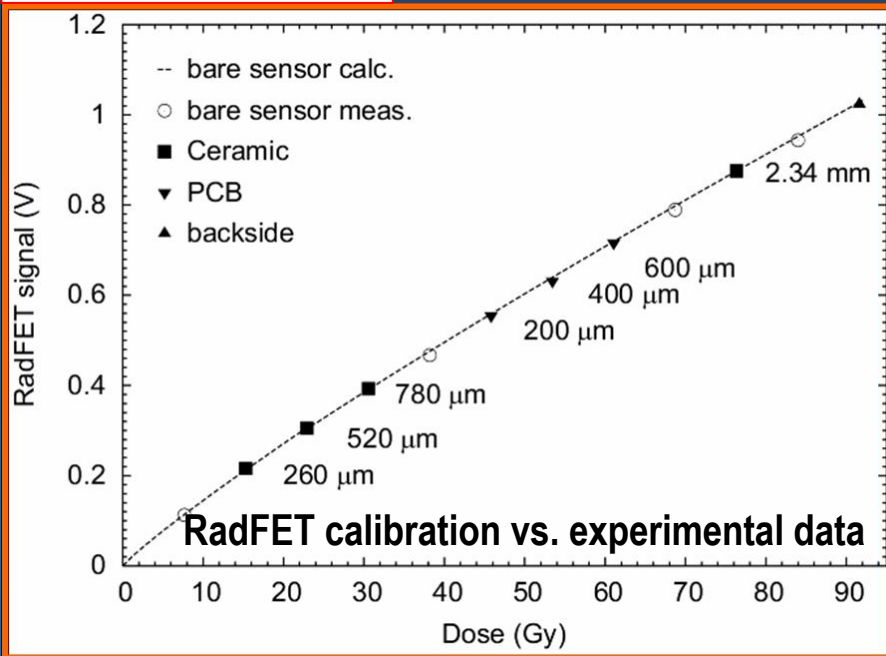
The full geometry has been designed and implemented in detail in the Geant4 simulation

254 MeV protons at PIF facility (PSI)



254 MeV proton beam incident on the sensors
Various material type and thickness, front/back
Measurement: dose

Experimental data



Comparison

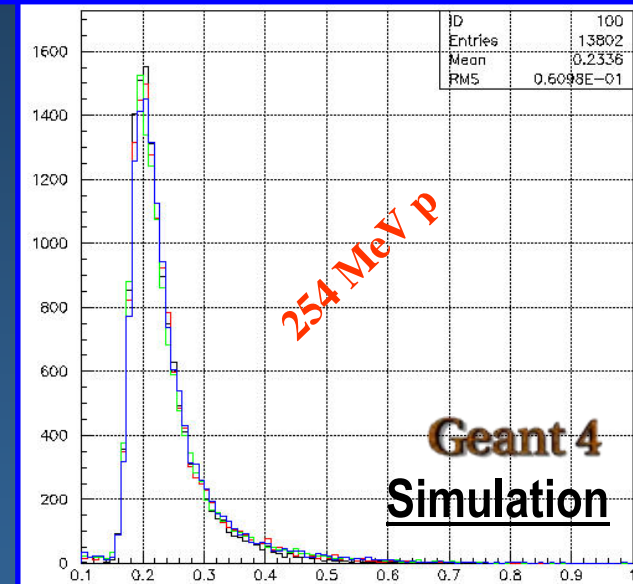


Front incident p – No packaging

Front incident p - Packaging + 520 μm Alumina

Front incident p - Packaging + 780 μm Alumina

Front incident p - Packaging + 2340 μm Alumina



Total energy deposit (MeV) per event in the four chips

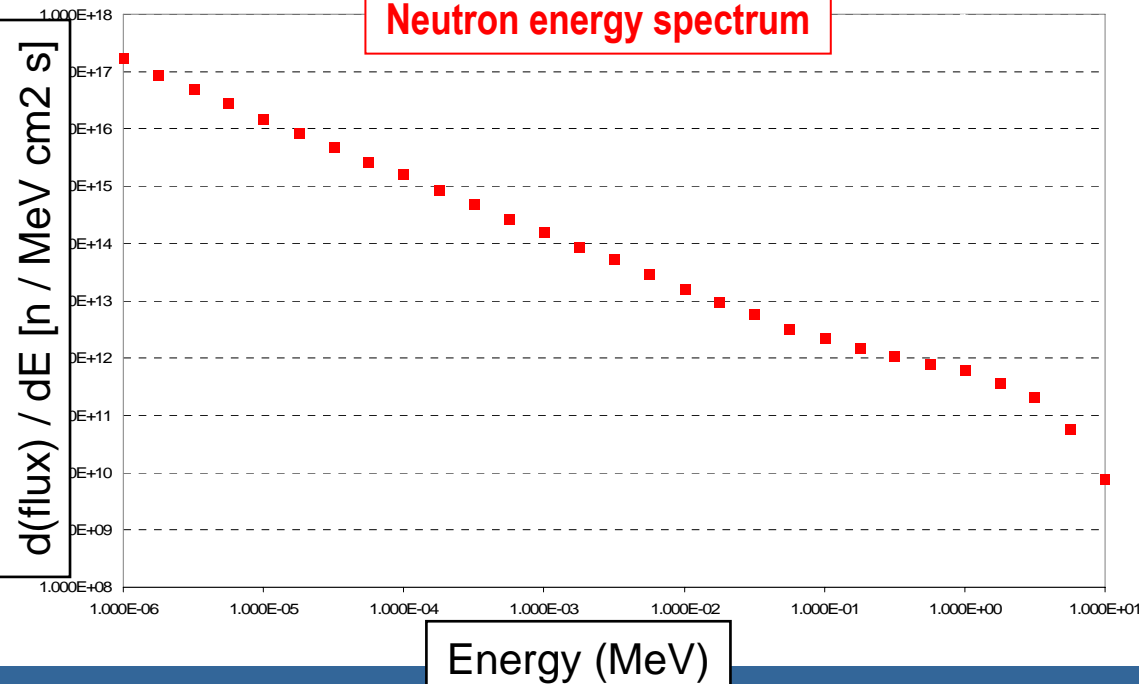
No significant effects observed with different packaging

Geant4 simulation in agreement with experimental data

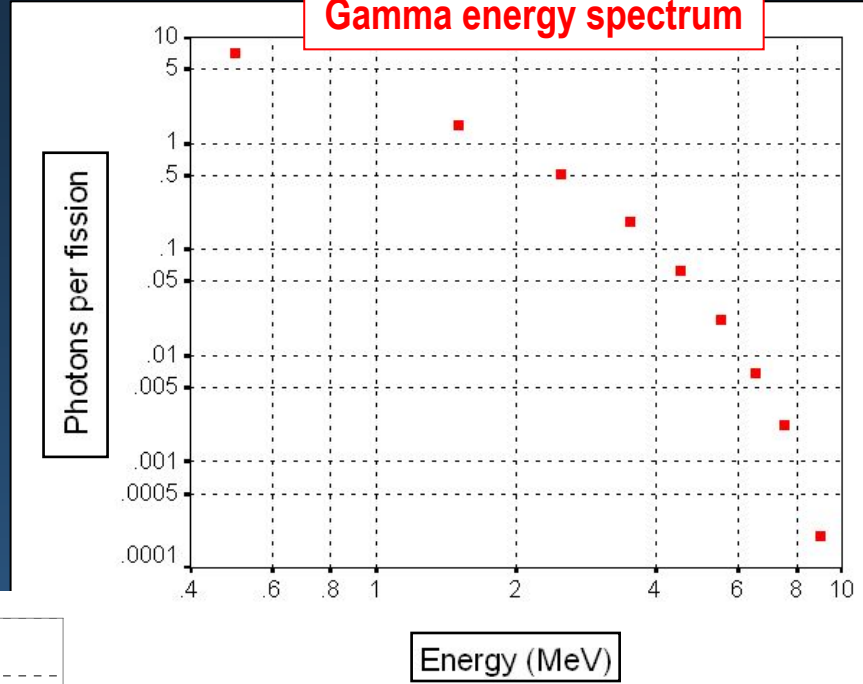
TRIGA neutron reactor facility at JSI



Neutron energy spectrum

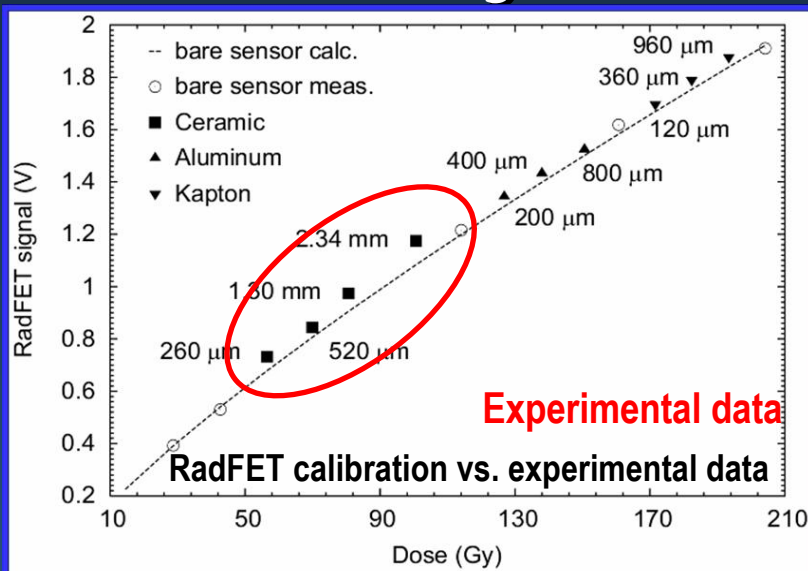


Gamma energy spectrum

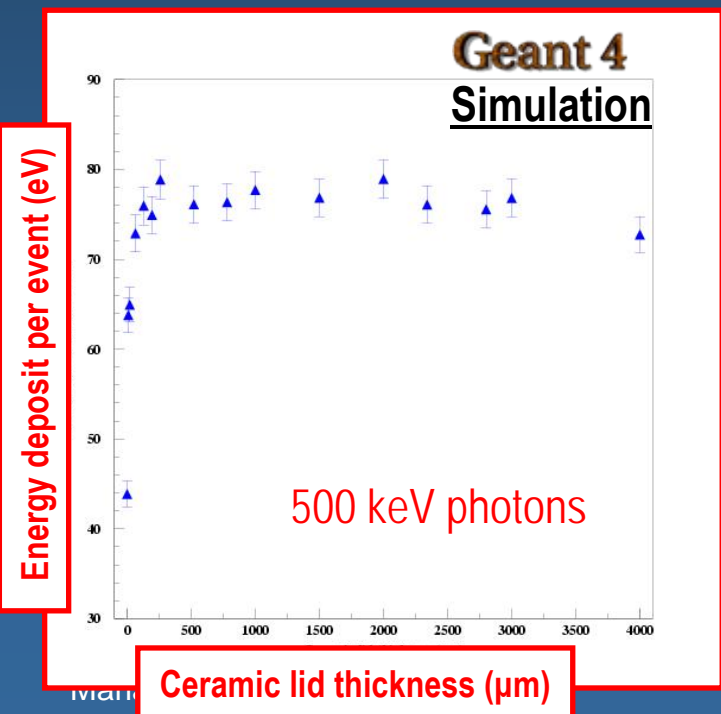
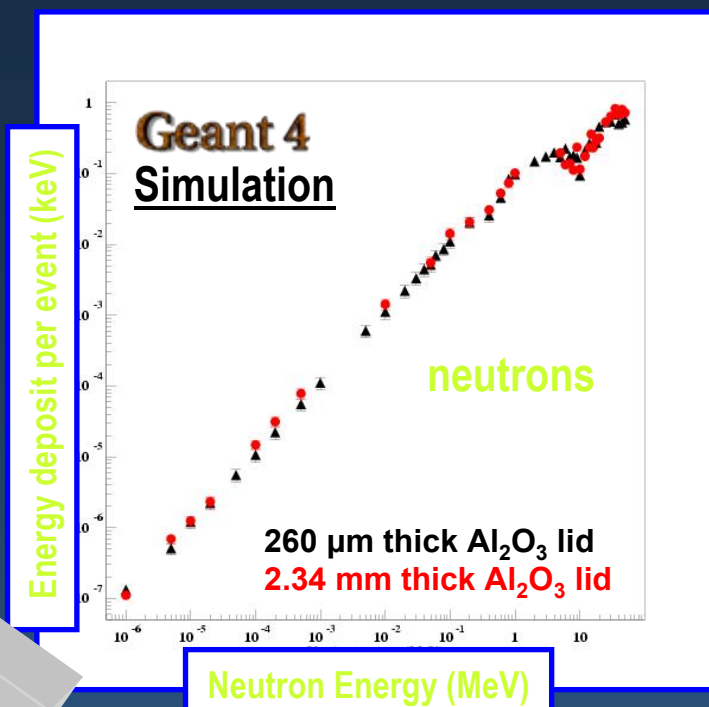


- Study the RadFET response to neutrons
- Study the contamination from photons in the JSI test data
- Comparison between experimental data and Geant4 simulation in progress

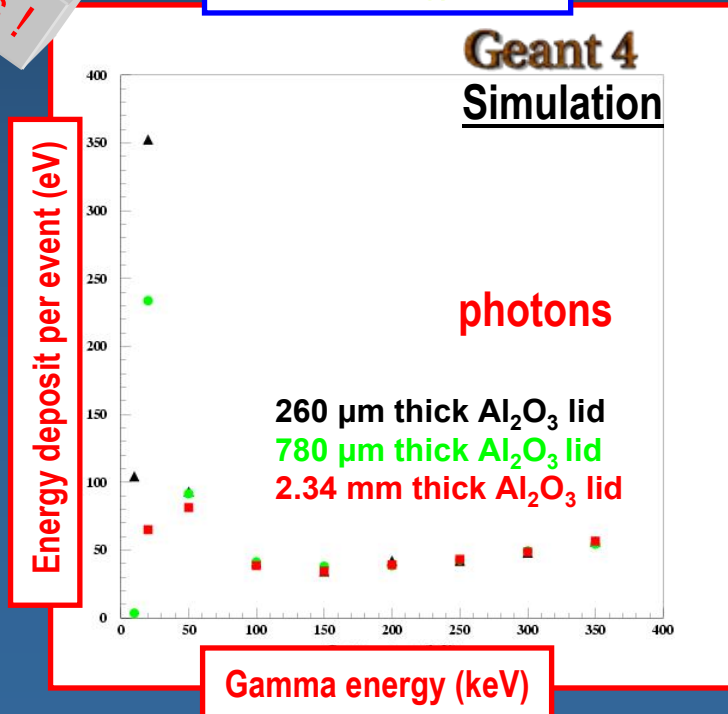
Preliminary results



Work in progress!

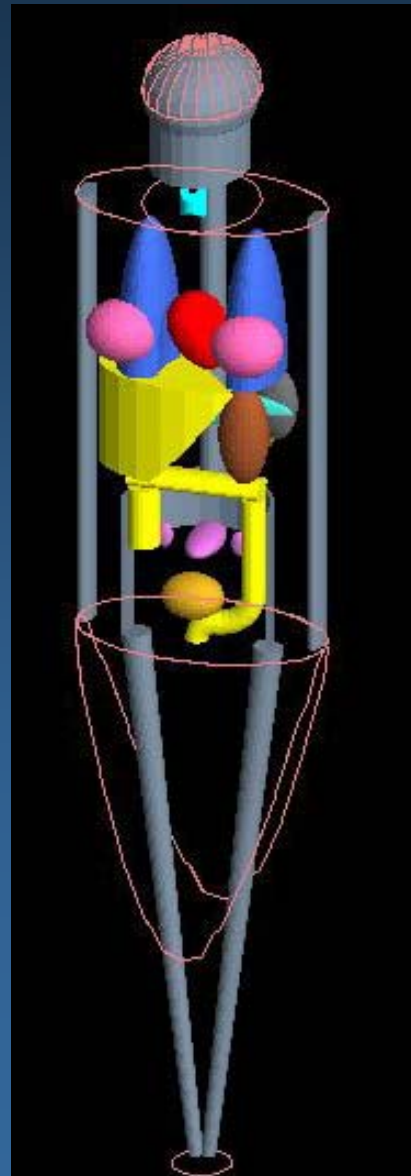
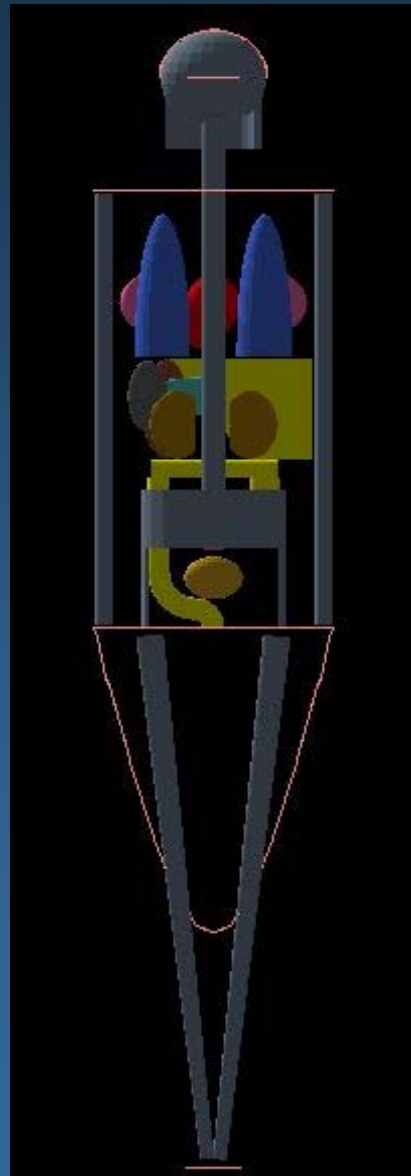
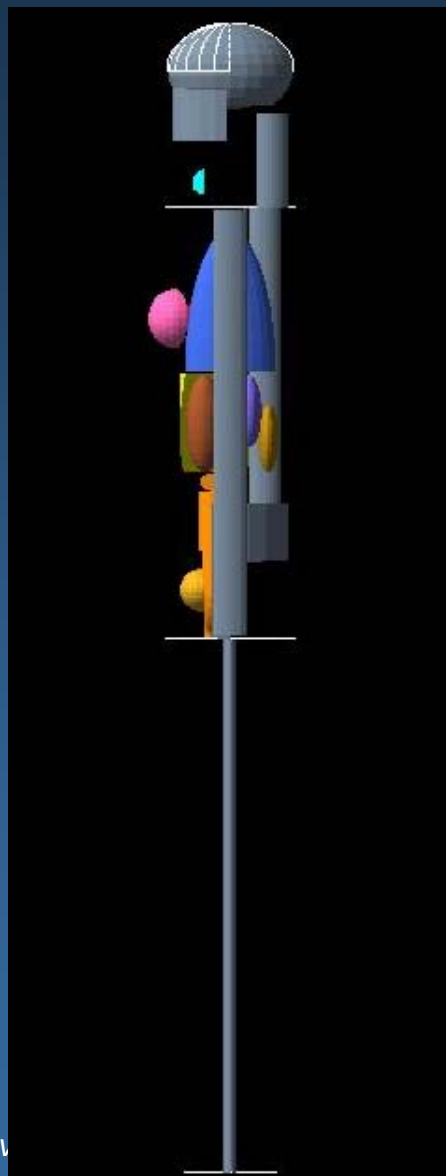
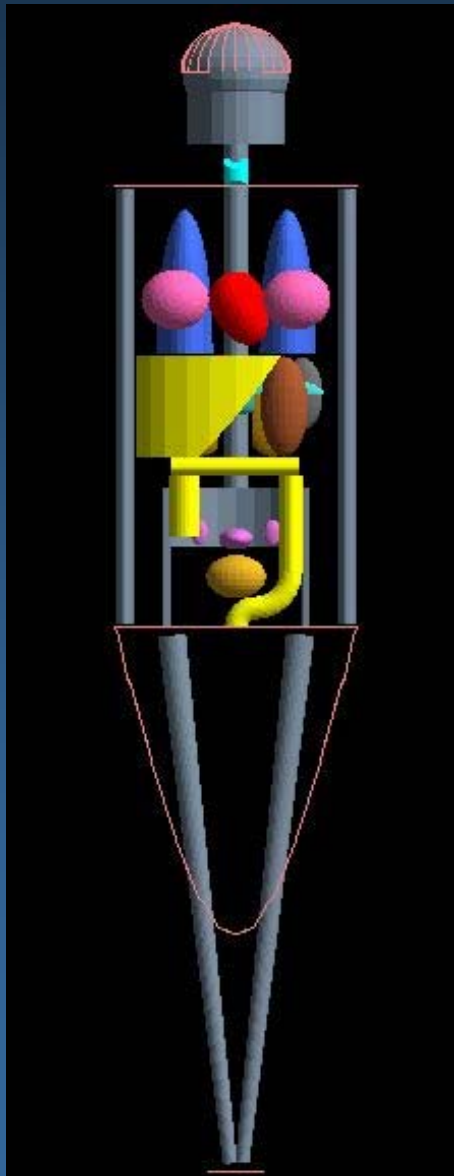


- Configuration
 - Study of the effect of the front lid
- Rigorous quantitative analysis is needed



G4Lady

Talk at NSS 2006



Publications

- To reward the developers' efforts
- To support the credibility of the examples
- To document Geant4 usage and achievements in experimental use cases

• Goal

- all Advanced Examples associated to journal publications

Orphan
Under development

Publications

1. air_shower
2. brachytherapy
3. *cell_irradiation*
4. composite_calorimeter
5. cosmicray_charging
6. gammaray_telescope
7. hadrontherapy
8. *human_phantom*
9. IAr_calorimeter
10. medical_linac
11. microbeam
12. *nanotechnology*
13. purging_magnet
14. *radiation_monitor*
15. radioprotection
16. raredecay_calorimetry
17. Rich
18. Tiara
19. underground_physics
20. xray_fluorescence
21. xray_telescope

1. *In progress?*
2. Conference Proc. + In preparation (*medium term*)
3. In preparation (*medium term*)
- 4.
- 5.
- 6.
7. **Published in journal** + In preparation (*short term*)
8. In preparation (*short term*)
- 9.
10. Conference Proc. + In preparation (*long term*)
11. **Published in journal**
12. In preparation (*medium term*)
- 13.
14. In preparation (*short term*)
15. In preparation (*short term*)
- 16.
17. **TNS?**
- 18.
- 19.
20. In preparation (*medium term*)
21. **XMM reference?**

*Apologies for any omissions
Please let me know of other
pertinent publications*

Open issues

- **Far from optimal software quality of most examples**
 - ...but what about Geant4 code in general?
 - Education of developers to healthy software process
 - Technical background often minimal (average in the community?)
- **Orphan examples**
 - Difficult to find adoptive maintainers
 - Overworked group members
- **Last minute maintenance**
 - Tag at 11.59 pm on the deadline day for inclusion in a Geant4 release...
- **System testing**
 - Wider coverage would be helpful to ensure a higher software quality
- **Cinderella role in the Geant4 Collaboration**
 - Frustrating to many young developers
 - Strategic vision for Geant4 role in the scientific community

Wish List: domains to cover

- Neutrino experiments
- Isotope production
- Reactor physics
- Heavy ion experiments
- Cosmic ray experiments
- Molecular fluorescence
- Accelerator studies
- Medical imaging
- Hadrontherapy with ions
- Material analysis
- Gaseous tracking detectors
- Semiconductor detectors
- Detector response modeling
- Radiation effects on components
- etc.

Suggestions are welcome

Synergy with other Geant4 WGs
is desirable

Contributions are welcome

Wish List: Software Process Improvement

- Documented Vision
- Documented User Requirements
- Design model
- Documented Test Mission and Test Plan
- User Documentation (*mea culpa in some cases...*)

- Peer reviews: design, code

- Geometry overlap check
- Memory leak checking
- Profiling for performance evaluation

- Inclusion in System Testing

- etc.

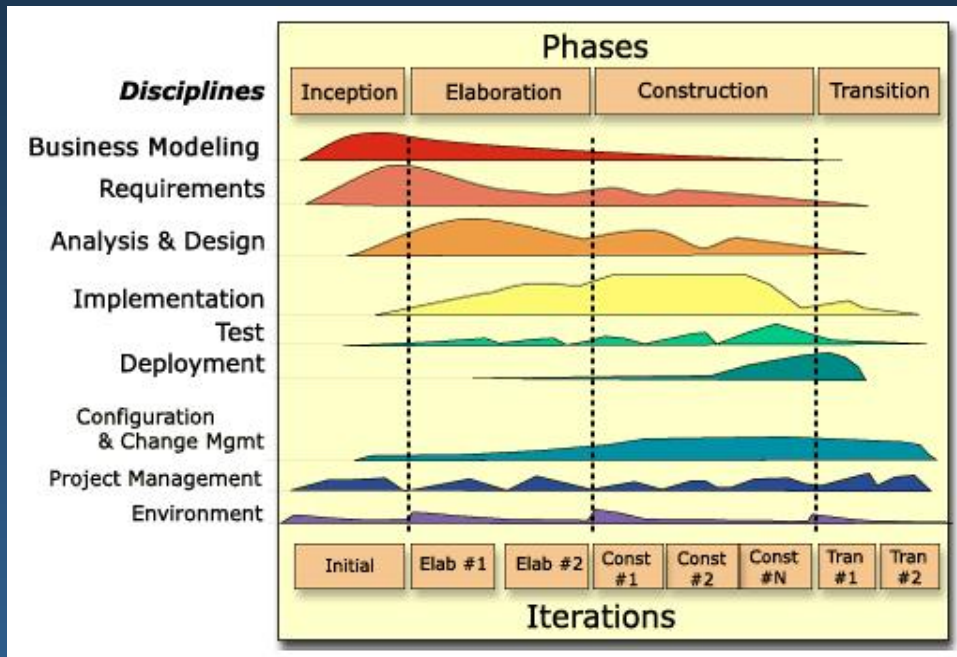
Suggestions are welcome

Volunteer reviewers are welcome

Collaboration-wide support for
SPI would be helpful

Internal OOAD training would be
beneficial

...not yet behind everything



Unified Process



A rigorous software process is still a dream for many examples

Team

Stéphane Chauvie
Pablo Cirrone
Giacomo Cuttone
Francesco Di Rosa
Susanna Guatelli
Alex Howard
Sébastien Incerti
Mikhail Kossov
Anton Lechner (new)
Alfonso Mantero
Barbara Mascialino
Luciano Pandola
MG Pia
Michela Piergentili
Alberto Ribon
Giorgio Russo
Giovanni Santin
Bernardo Tomé
Jakub Moscicki
Andreas Pfeiffer
Witold Pokorski

Maria Grazia Pia, *INFN Genova*

Our young collaborators

Bright, enthusiastic, hard-working

Most group members:

- age < 35
- temporary positions
- low (or zero) salary

**These young colleagues invest
their hopes for their future careers in
*Geant 4***

**We should feel our responsibility towards
our younger colleagues**

High scientific and technical profile of the Collaboration
Serene, collaborative work environment
Education to sound research methods
Publications for their CVs
Opportunities for conference presentations
Support to their activities

