

# Geant 4

## Proposal of a Space Radiation Environment Generator interfaced to Geant4

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<http://www.ge.infn.it/geant4/lowE/space>

# The experience with students at INFN Genova...

- **Alfonso** works on Bepi Colombo, X-ray fluorescence
  - he needs solar X-ray spectra as an input to his Geant4 simulation
- **Simona** works on Bepi Colombo, PIXE
  - she needs solar proton spectra as an input to her Geant4 simulation
- **Susanna** works on dosimetry for interplanetary manned missions
  - she needs Galactic Cosmic Ray and Solar Particle Event spectra as an input to her Geant4 simulation
- **Barbara** works on Geant4-DNA
  - she needs all the above (and more) for her Geant4 developments
- A lot of cut-and-paste of code exchanged among four students, working in the same room...

...how many people have similar needs?

# ...a proposal

An open-source, comprehensive  
**primary generator**  
for the space radiation environment  
in the solar system interfaced to Geant4

- A collaborative project
  - make common solutions available to common needs
- An ambitious project...
  - incremental and iterative process is mandatory!
  - complementary expertise needed: astrophysics + software

# Open source

## • Open system

- to contributions from experts from the scientific community
- to evolution of software, following the evolution of physics modeling and availability of experimental data
- to extension through new developments
- to users providing valuable feedback for improvement

## • Open source

- transparency of the models, assumptions, approximations, data sources
- the user has control of the ingredients of his/her application, contributing to the reliability of the final results from his/her software

# Comprehensive

- Variety of physics models available
- Evolution of models and data
  - Offer the user the choice among available models
- Scope to be defined through an analysis of the user requirements
  - content & capabilities
  - priorities
- Long term project
  - open to extension and evolution
  - incremental and iterative process

# Primary generator: user view

- **From the point of view of the user: functionality**
  - to pick the spectra of particles to inject into a Geant4 simulation in a given configuration (location, solar cycle etc.)
  - to select the model(s) for the spectrum generation out of a set of options
  - to select models for scaling
- **“Primary” PhysicsList approach**
  - to select the primary spectra/models to generate
  - to provide some guidance to the configuration of the generator
- **Multiple user interfaces are possible**
  - if the system is well designed
  - to fulfill requirements for different usage in different type of studies

# Physics content

- **To be thoroughly studied**
  - physics models
  - experimental data
- **Models for**
  - solar X-rays
  - solar event protons,  $\alpha$  and electrons
  - Jovian electrons and photons
  - cosmic ray protons and  $\alpha$
  - galactic X-rays and  $\gamma$ -rays
- **Local magnetospheric environment**
  - difficult to model
  - good architecture should allow adding specialised models in later development cycles
- **Specific expertise needed**

# Interfaced to Geant4

- **Not a Geant4 implementation**
  - common tool to address many use cases of Geant4-based simulation
- **Component-based architecture facilitates usage in different environments**
  - standalone
  - interfaced to Geant4
  - interfaced to other software systems
- **G4VPrimaryGeneratorAction**
  - user class
  - can **use** other components



# Key issues

- A clear vision
- A solid architecture
- State of the art physics content
- Rigorous software process

# Vision

- Current status: brainstorming, collect ideas from experts and potential users in the field
  - the purpose of this presentation...
- Input from many sources to be distilled
  - coherent picture of the project
  - clear objectives and priorities
- Identification of stakeholders

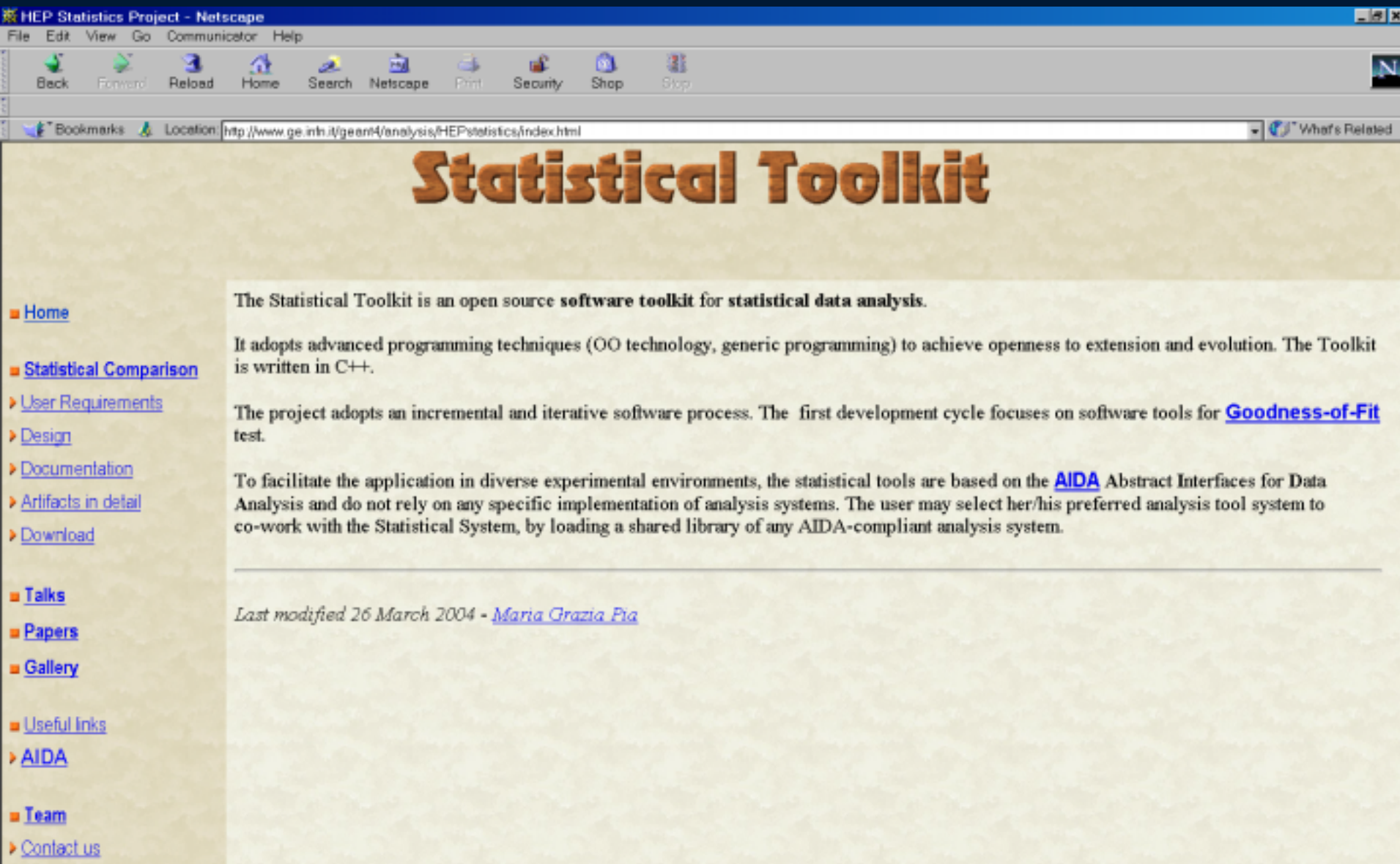
# Architecture

- Key issue to build a software system expected to evolve over a large time scale
- Use case driven
- Component-based architecture
  - easy to interchange components
  - open to extension
  - facilitates maintenance

# Software process

- **Recognized as the key to success for a software project**
  - quality of the software product
  - effective usage of the available resources
- **Iterative and incremental**
  - recommended by best practices in software development
  - essential for a project of such a broad scope, with extended time-scale and expected evolution of models and data

A similar example of a Toolkit motivated by Geant4, now living its own independent life...



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The Statistical Toolkit is an open source **software toolkit** for **statistical data analysis**.

It adopts advanced programming techniques (OO technology, generic programming) to achieve openness to extension and evolution. The Toolkit is written in C++.

The project adopts an incremental and iterative software process. The first development cycle focuses on software tools for [Goodness-of-Fit](#) test.

To facilitate the application in diverse experimental environments, the statistical tools are based on the [AIDA](#) Abstract Interfaces for Data Analysis and do not rely on any specific implementation of analysis systems. The user may select her/his preferred analysis tool system to co-work with the Statistical System, by loading a shared library of any AIDA-compliant analysis system.

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*Last modified 26 March 2004 - [Maria Grazia Pia](#)*

# Feedback form the scientific community

- Is there any interest for such a project?
  - as a potential user?
  - as contributing developer?
  - as a consulting expert on the physics models involved?
- What tools would you like?
  - User requirements to be collected from as wide as possible community
  - priorities to be evaluated
- Project open to **collaboration** from interested scientists