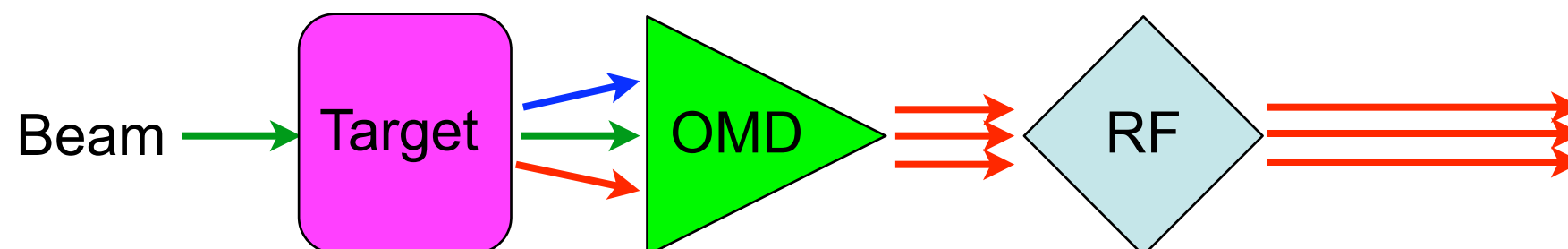


Positron Source Modelling using Geant4

S. Riemann, A. Schälicke, A. Ushakov

- Introduction
 - PPS Overview
 - Geant4 Overview
- PPS-Sim
 - Features
 - Results
- **Live Demo**
- Summary/Outlook

Polarised Positron Source (for the ILC)



- Primary beam
 - Photons from Undulator
 - Electrons (conventional source)
 - Input file (Compton photons, Crystal target)
- Target
 - Ti wheel, Liquid Lead
- Positron Capture Optics (OMD)
 - AMD, QWT, Li-Lens
 - Solenoid B-field, RF E-field



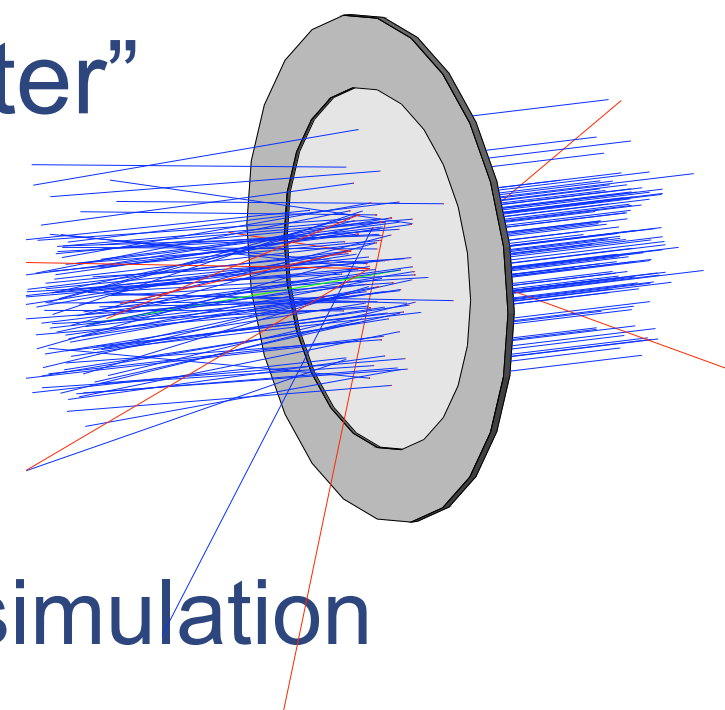
- **Geant4 Toolkit**

“a toolkit for the simulation of the passage of particles through matter”

- Features include

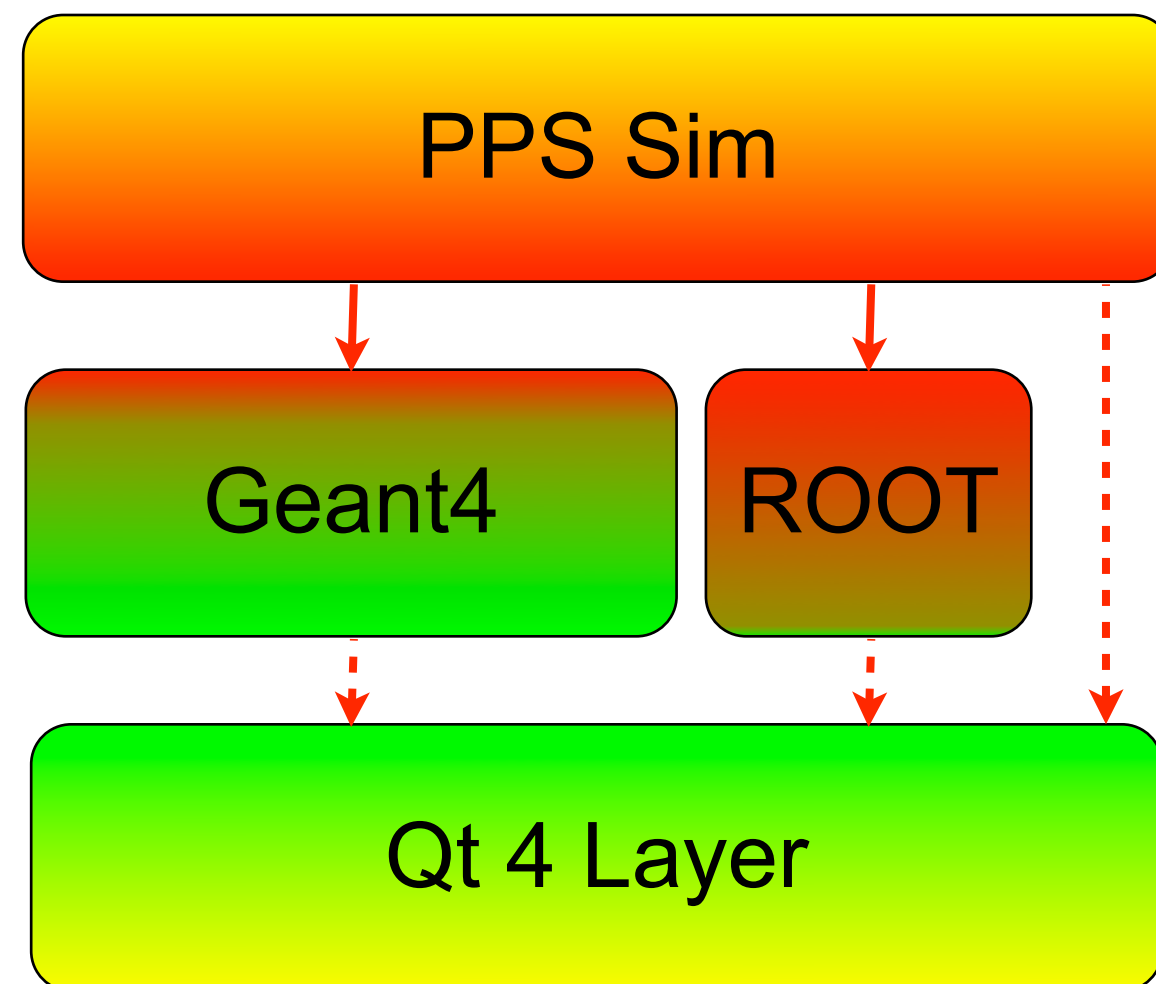
- powerful geometry package
- electromagnetic and hadronic shower simulation
- **polarisation transfer** in physics processes
- particle and **spin tracking** in electromagnetic fields
- visualisation (geometry, particles, energy deposition,...)
- GUI (XM, Qt,...)

- ...



- **Idea:** use Geant4 for modelling of PPS
 - start from positron production (target)
 - end after first accelerator structure
 - simplified geometry
 - aim: **easy usage** (also for non-G4 experts)
- graphical user interface (GUI)
 - visualisation
 - internal analysis
- allow for batch mode running
 - high statistics runs
 - configure via macro commands
 - post analysis

- Layout
 - use **Geant4** for:
geometry, physics, UI
 - use **ROOT** for:
data analysis, persistency
- Prerequisites
 - Geant4 9.2
(incl. Qt4 binding)
 - ROOT 5.22
(incl. Qt4 binding)
 - **Qt 4.2 or above**
(4.4.x recommended)



- Tested:
 - Linux SL5 and OpenSuSE
 - MacOSX 10.5.x

- Input:
 - Beam, Target & OMD (free configurable)
- Output:
 - positron yield & polarisation (incl. DR acceptance)
 - beam properties (width, emittance, energy, ...)
 - total energy deposition in components
 - ...
- User interface:
 - GUI allows for setting of simulation parameter
 - visualisation of geometry & tracks
 - semi-automatic parameter scans (e.g. RF phase)
 - output as .root, .eps,

- positron yield & polarisation

```

G4UI Session

-----Undulator-----
N_Ph generated in Undul : 503313
N_Ph incident on Target : 250000
Mean E_Ph generated in Undul : 10.695448 MeV
Mean E_Ph incident on Target : 15.133092 MeV
HistoManagerASCII: Close Output File
-----Positrons-----
N_e+ after target: 8745
Mean e+ polarization (after target) : 0.45063314 +- 0.0033833243
N_e+ (in DR acceptance): 3174
Mean e+ polarization (in DR acc.) : 0.49165777 +- 0.014342501
-----Energy Deposition-----
mean Energy in Target : 1.1190006 MeV +- 6.2696423 keV
mean Energy in AMD : 466.01075 keV +- 4.5322635 keV
mean Energy in RF : 194.76899 keV +- 3.7425373 keV
mean Energy in Sol : 19.008334 keV +- 969.32967 eV
The run consists of 250000 gamma of 15.133 MeV through 1.48 cm of Ti6Al4V (density: 4.4925 g/cm3 )

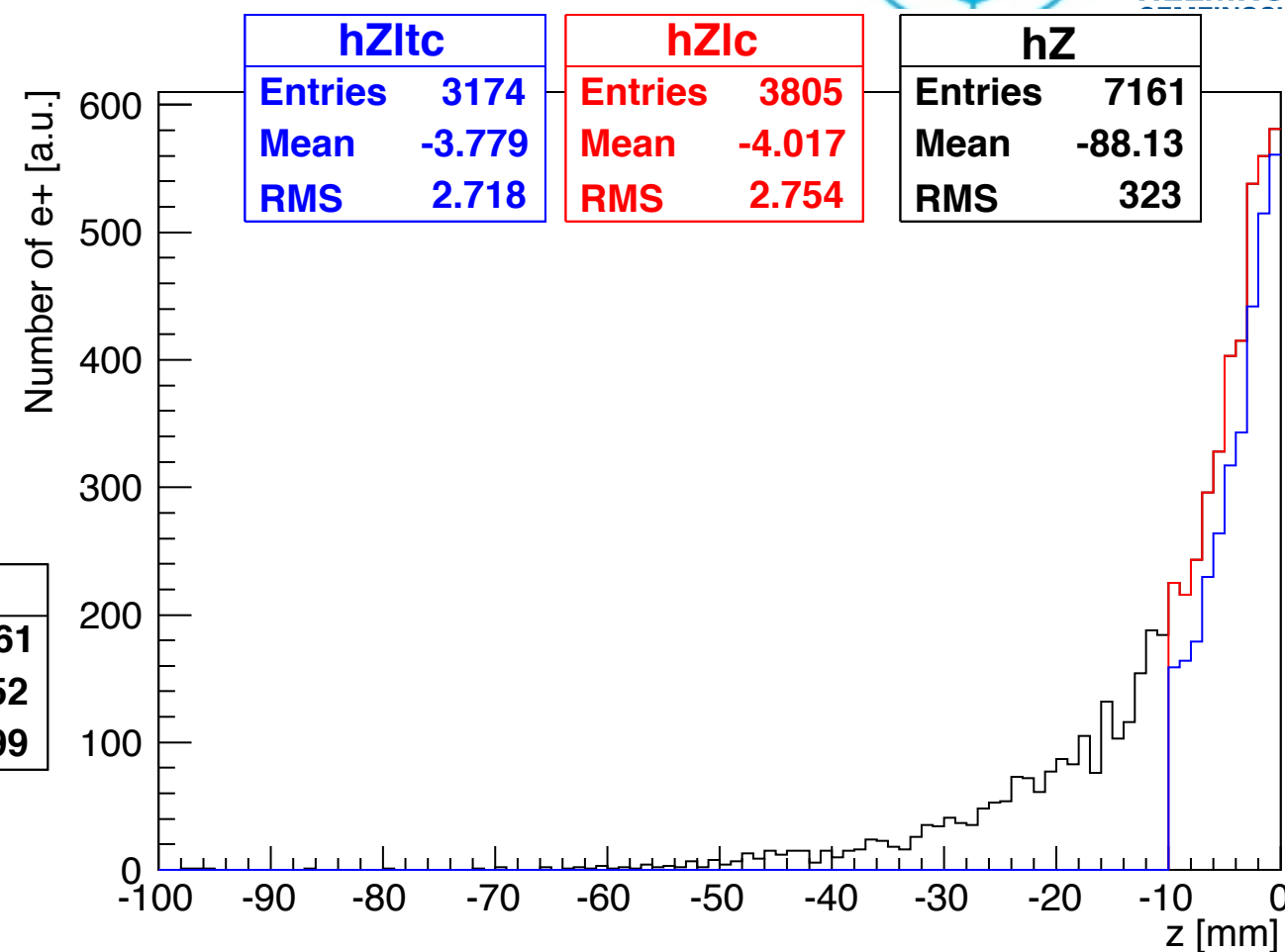
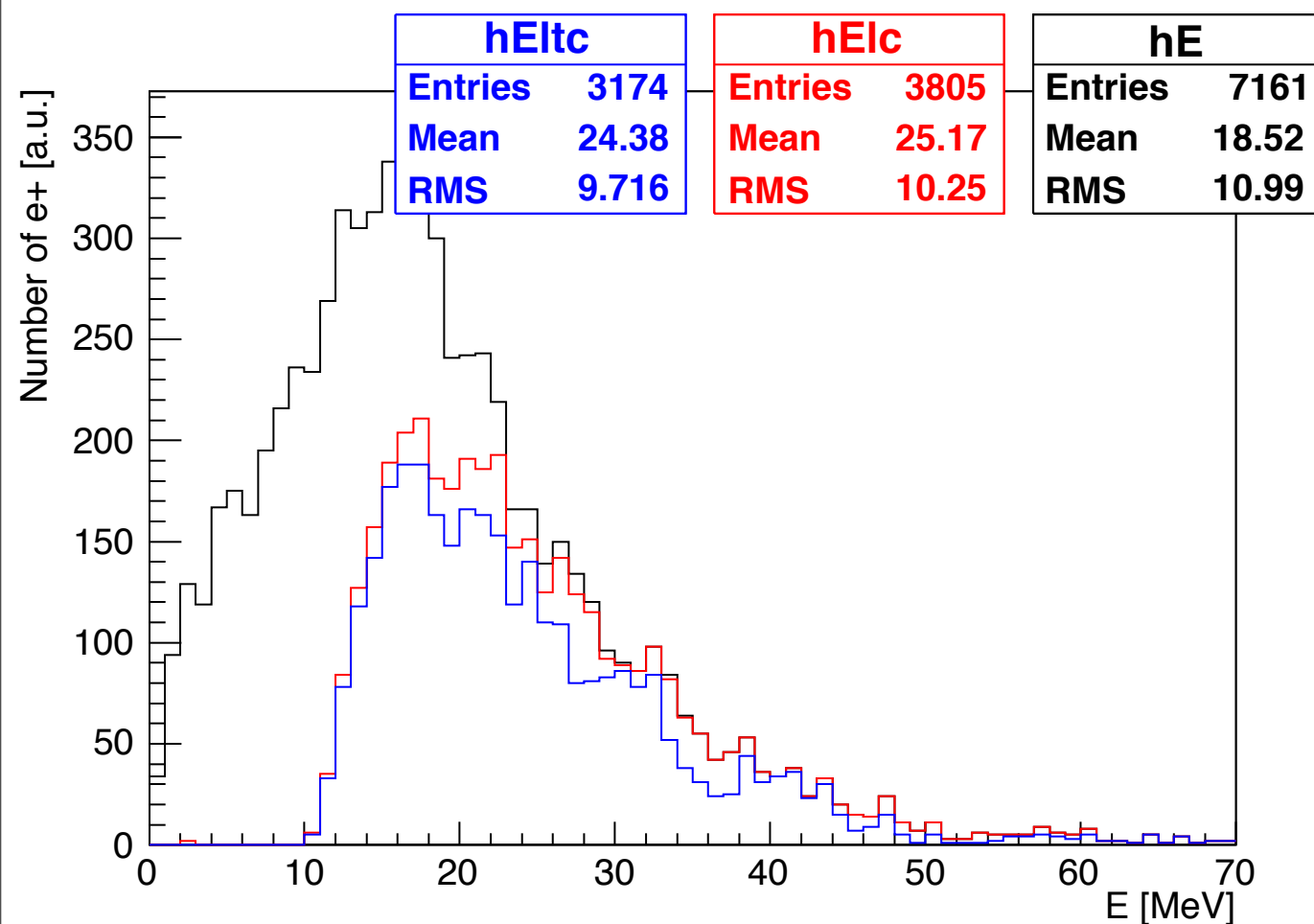
clear

session

```

- total energy deposition in components

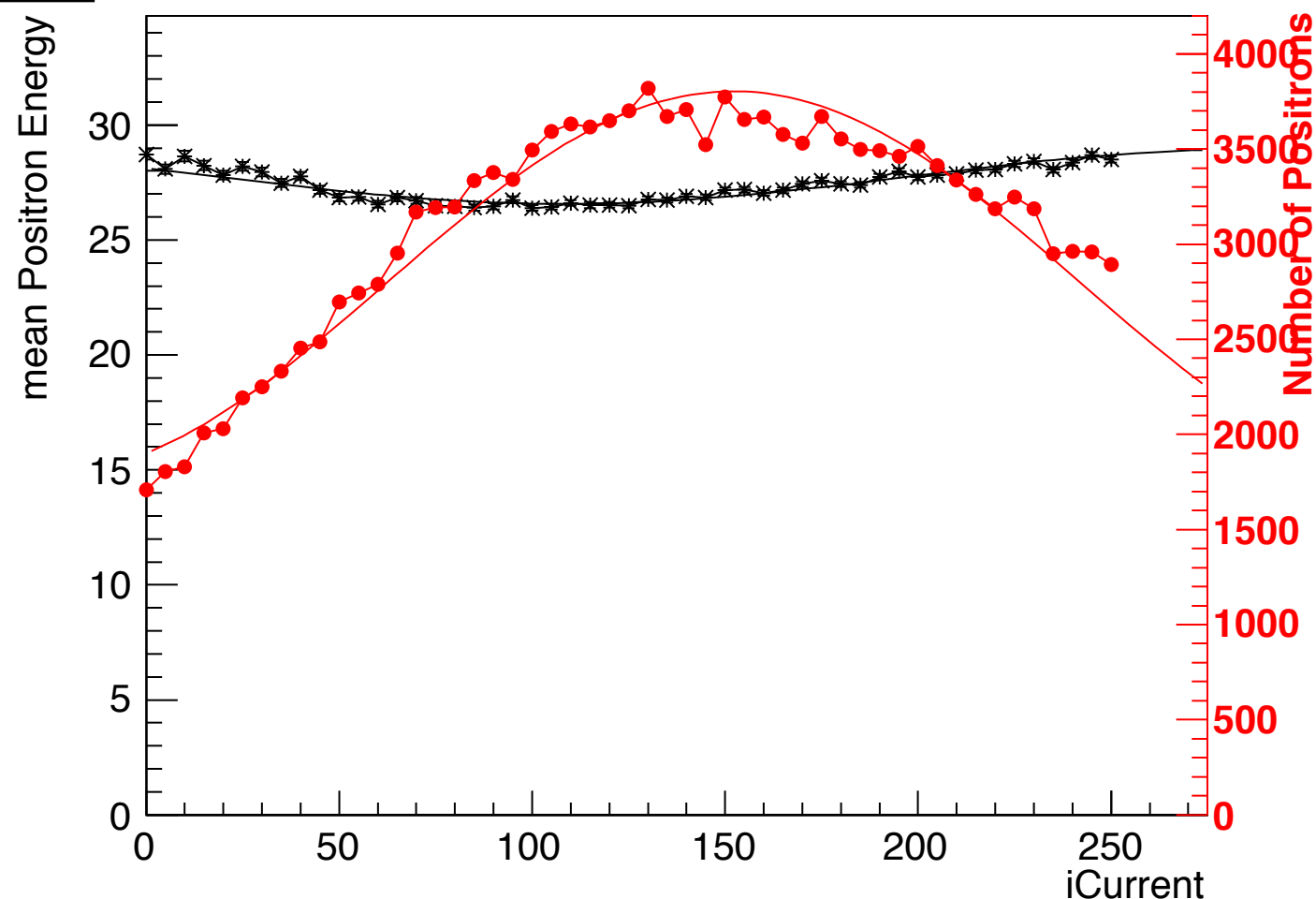
- Energy distribution
- Phase space

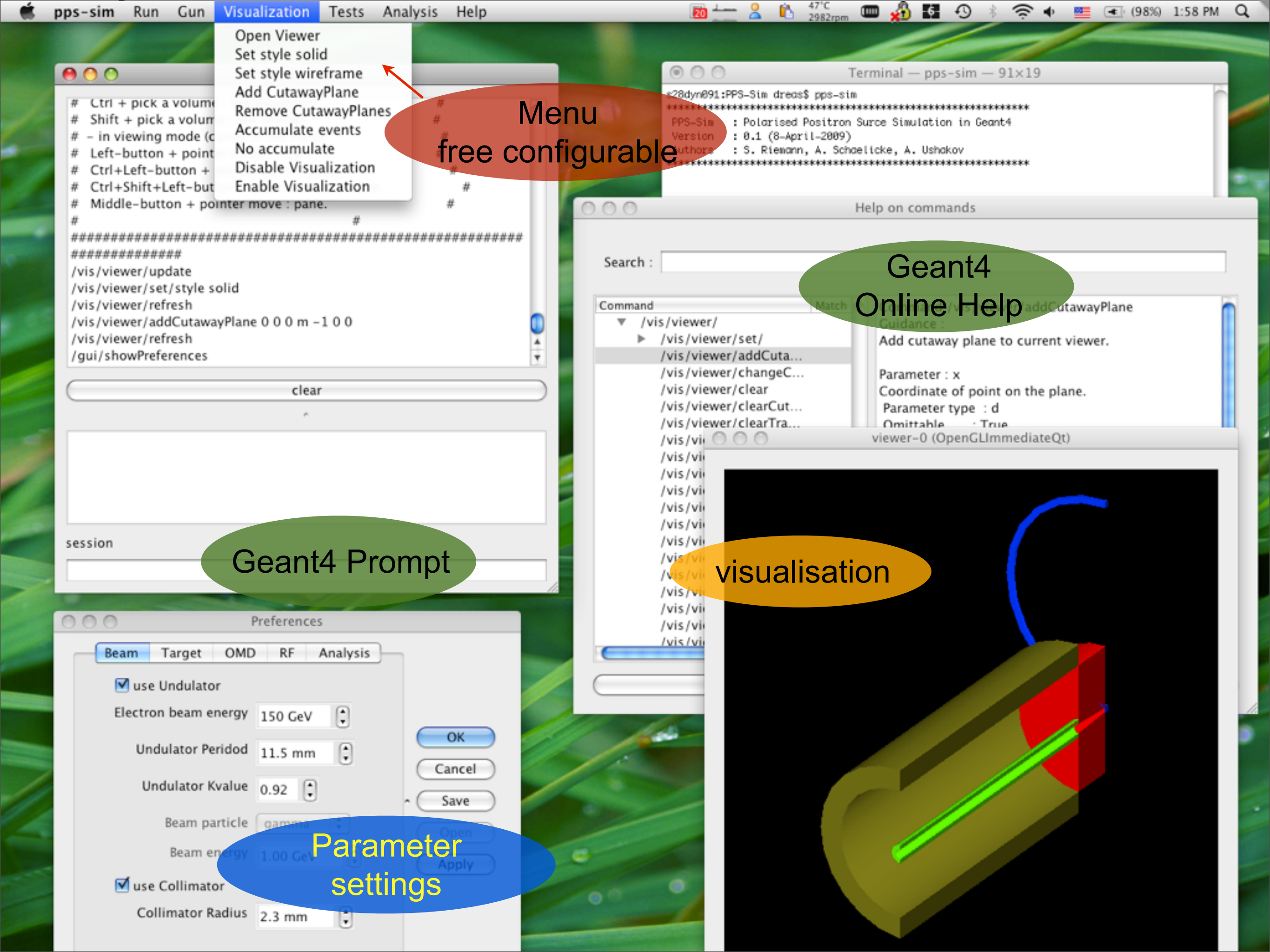


- (almost) arbitrary scans, e.g.

- RF phase
- target thickness
- lens current (liquid Lithium)
- field strength, OMD length (quarter wave trans.)
-

Graph





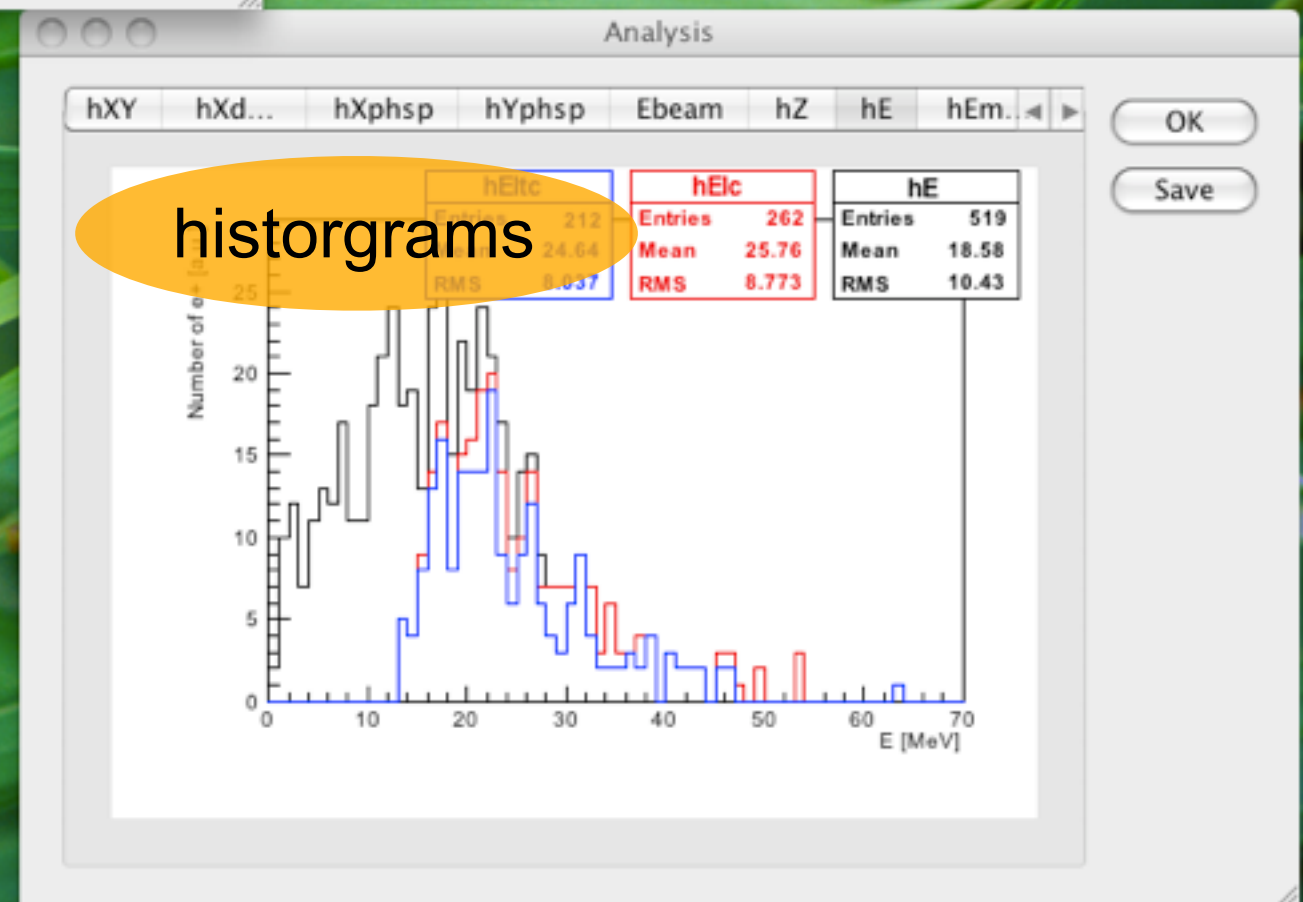
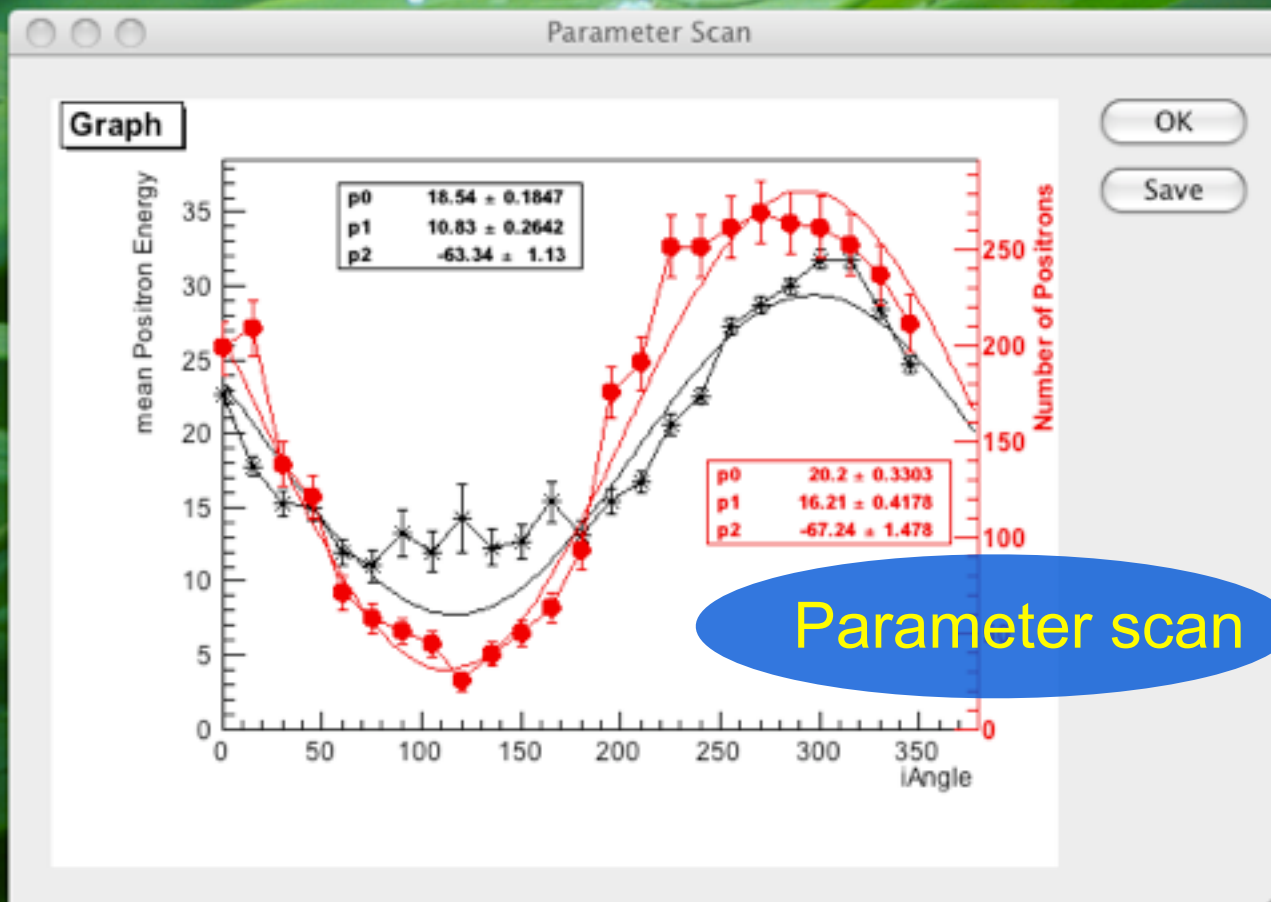
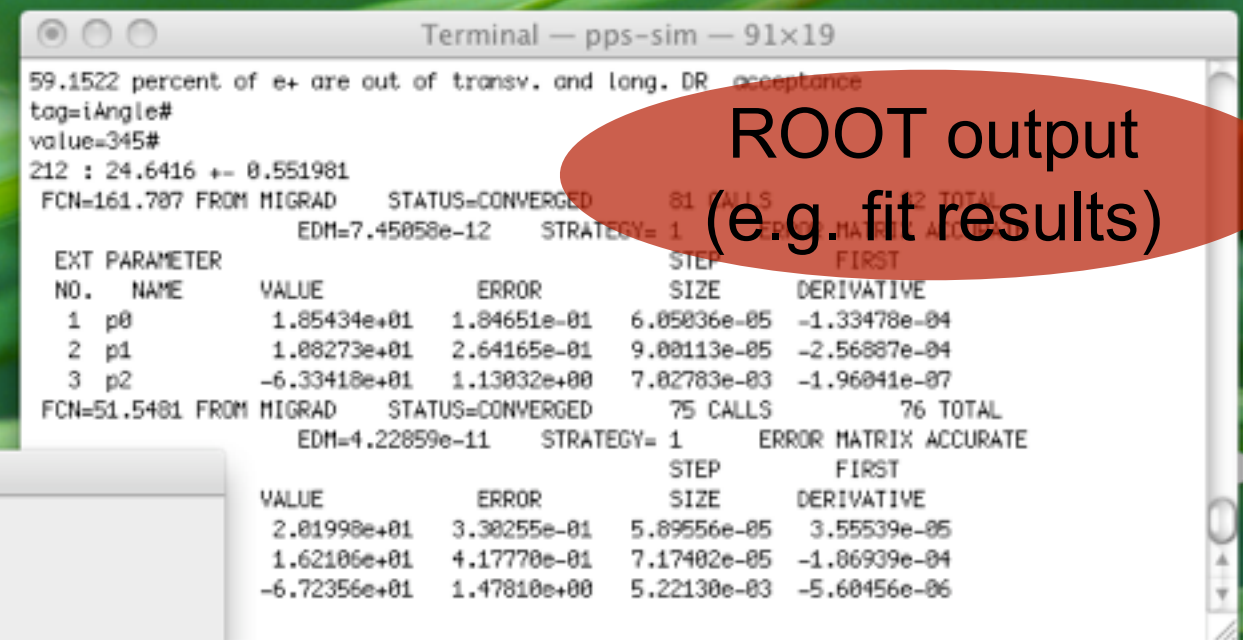
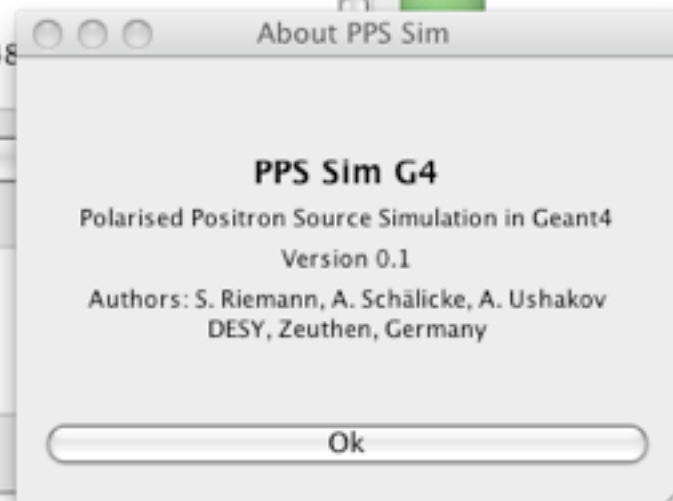
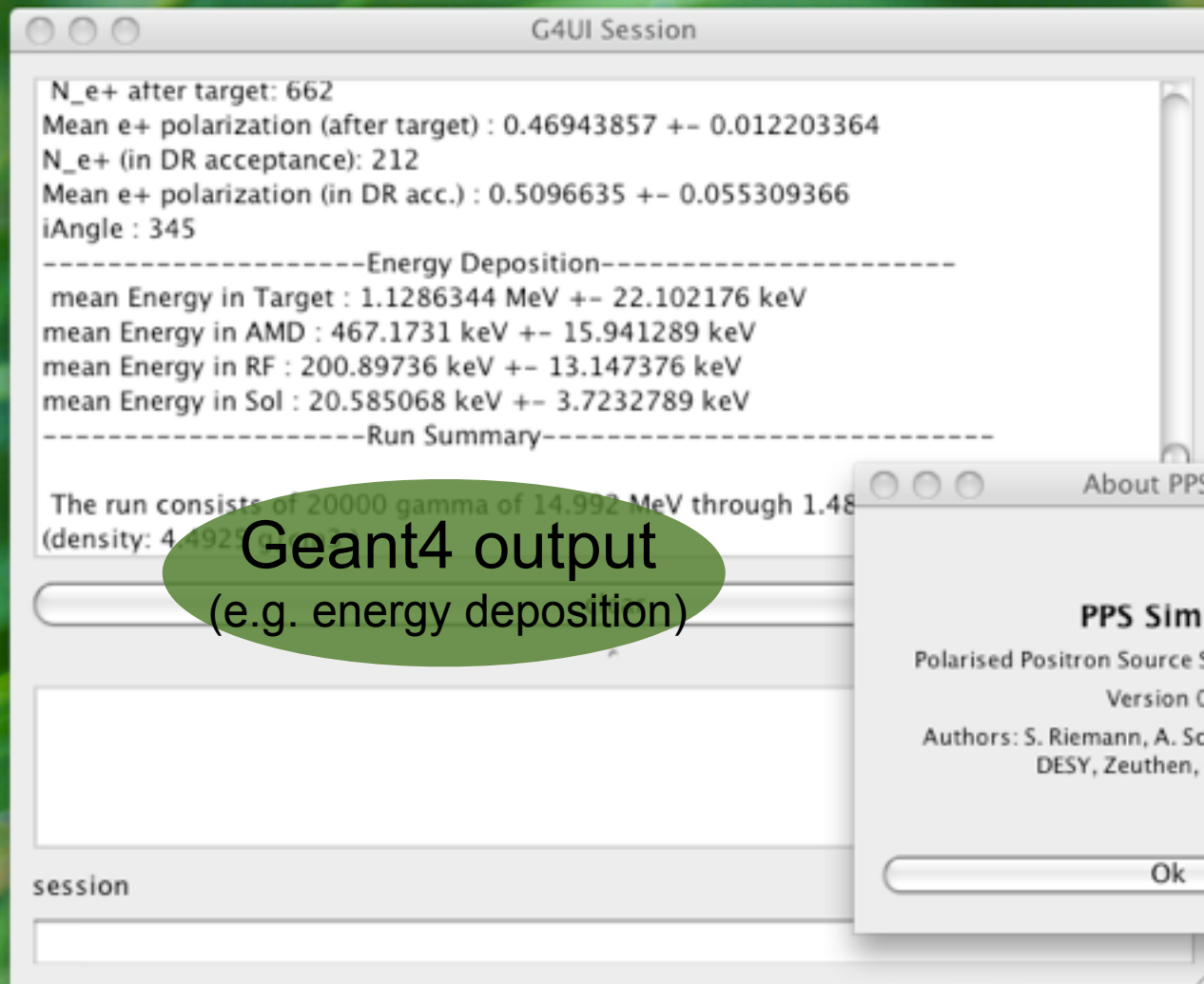
Menu
free configurable

Geant4
Online Help

Geant4 Prompt

visualisation

Parameter
settings



- **PPS-Sim**
 - exploitation of the Geant4 toolkit
 - provides Qt GUI for easy usage
 - allows batch runs for high statistics accumulation
 - uses ROOT for data analysis and persistency
- **Features**
 - e⁺ production: Undulator, Conventional
 - capture: AMD, QWT, Li-Lens
 - acceleration: RF & solenoid incl. spin tracking
- **Public available**
 - web page : pps-sim.desy.de

- **model improvements**
 - extend beyond 1st accelerator section
 - include detailed energy deposition (scoring)
 - add alternative e^+ production mechanism (e.g. Compton, CBS) (help welcome)
- **UI improvements**
 - simplify physics settings
 - allow speed improvements (e.g. no tracking of lost particles)
- **other program improvements**
 - multi processor (core) support
 - reduce dependencies on Qt