SGV – a fast detector simulation

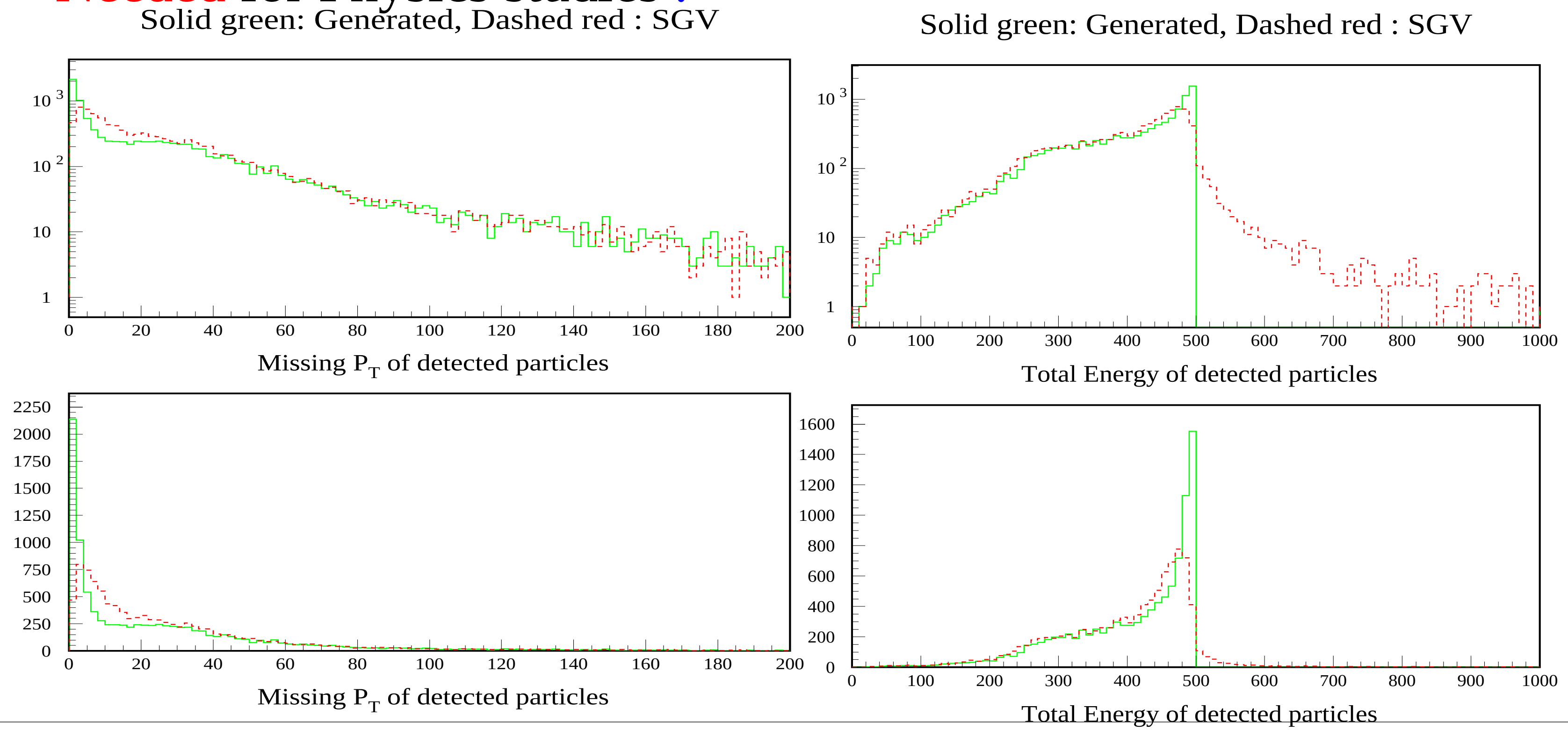
Mikael Berggren, LPNHE Paris

The *Simulation a Grande Vitesse* is:

- Simple − First events generated minutes after down−load
- General − Easy to change detector configuration
- Documented − UG and Reference manual on the Web (500+ pages in printed version)
- Much used for existing experiment − DELPHI
- Tested − Billions of events produced without problems within the DELPHI SUSY searches.
- Fault tolerant − Error−trapping and re−start
- Portable − to VMS, HP−UX, AIX, Digital UNIX, Linux,...
- Complete: Tracking with full error matrix, calorimetry with shower merging, particle identification, impact parameters,...
- Compares well with real data

And...

- FAST − 240 ee −> stau stau events/s at LEP200 or 20 ee−>stop stop events/s at the LC (TESLA at 500 GeV) on an Alpha.
- Fully implemented for TESLA − used for physics studies.
- Needed for Physics studies :

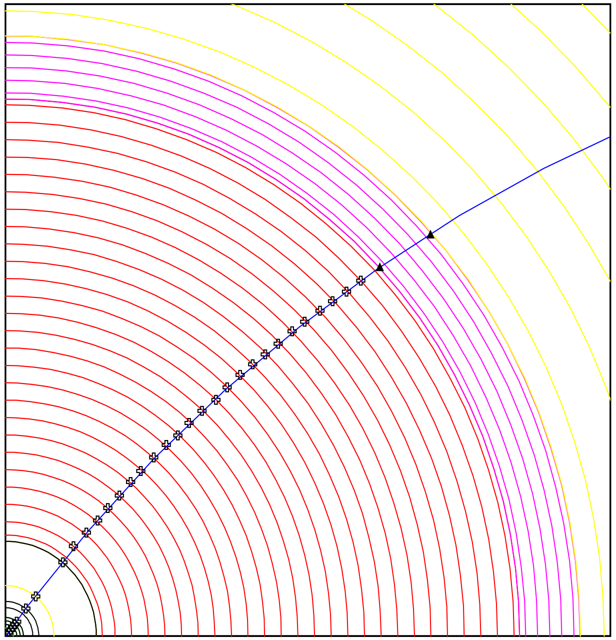


How does it work?

SGV is a *machine to calculate covariance matrices*

Tracking:

- Follow track−helix through the detector, to find what layers are hit by the particle.



- From this, calculate covariance matrix at perigee, including effects of material, measurement errors and extrapolation.
- Smear perigee parameters accordingly, with Choleski decomposition (takes all correlations into account)
- Information on hit−pattern accessible to analysis. Coordinates of hits accessible.

Calorimeters:

- Follow particle to intersection with calorimeters
- Decide how the detectors will act: MIP, EM−shower, hadronic shower, below threshold, etc.
- Simulate response from parameters.
- Merge close showers
- Easy to plug in other (more sophisticated) shower−simulation

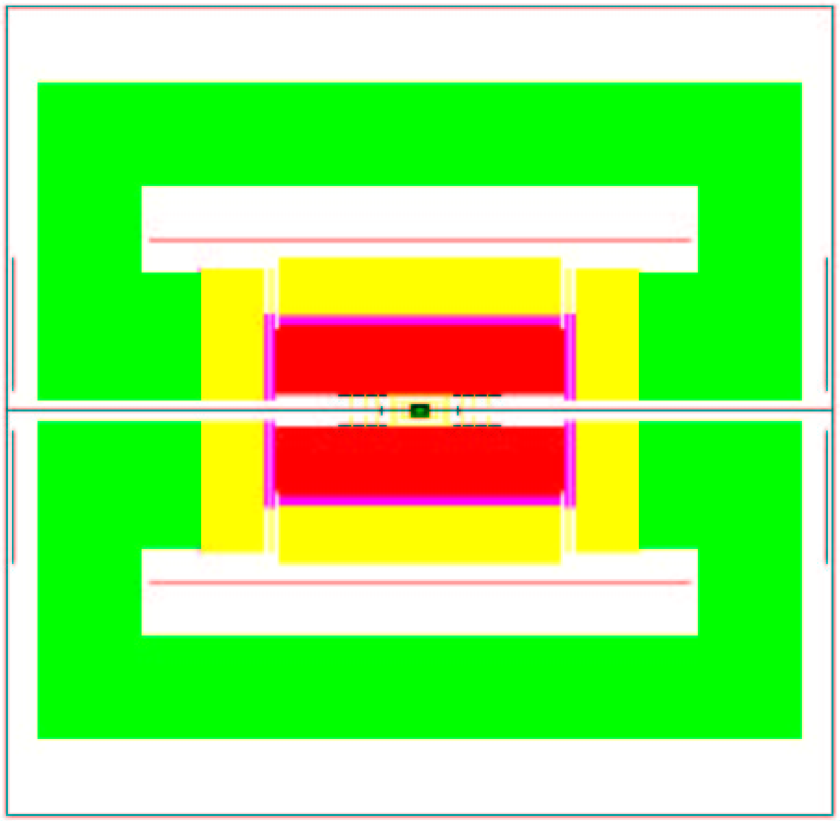
Other stuff:

- EM−interactions in detector material simulated
- Plug−ins for particle identification, track−finding efficiencies,...
- Scintilators and Taggers

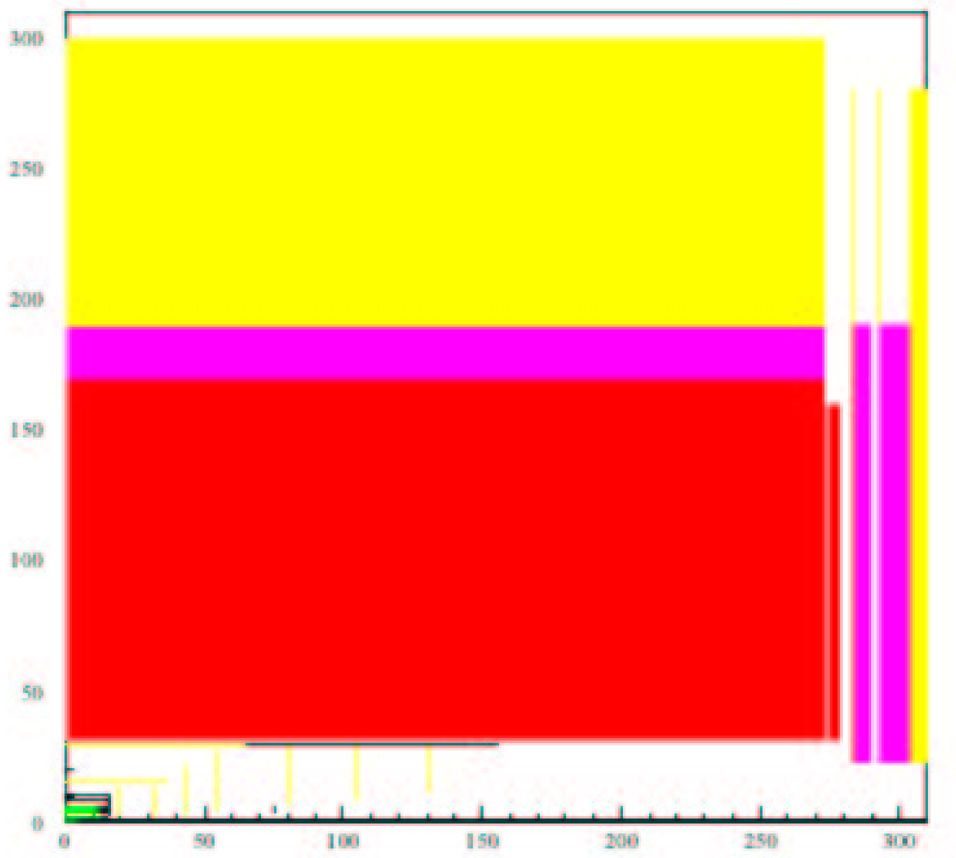
Some words on how to use SGV

- Generators: Interfaces to PYTHIA, JETSET and SUSYGEN included. Interface to PYTHIA 6 (double precission version) recently added. Easy to interface to others (but depends on how well-structured the generator is...).
- Detector geometry: Given as planes and cylinders, with attributes attached (measurement, material, names,...). Read from a human−readable ASCII−file (ex). Simple visualisation of the detector included. Up to three detectors can be loaded simultaneously, and will be looped over event by event.

Detector example: TESLA TDR



A bit closer ...



- User data : Delivered in COMMON blocks as extended 4−vectors , track parameters with correlations, calorimetric clusters . When relevant, true values also given. Auxiliary information on particle history, detector−elements used etc.Global variables also given.
- Analysis tasks : Information on jets, event−shapes, secondary vertecies, impact parameters and b−tagging filled by calls to routines, included in SGV. Access routines give an easy interface to the detector geometry.

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General structure of SGV

- SGV is made of six loosely connected parts:

–– The Steering, which takes care of initialisation and ending, and runs the event loop.

–– In the event loop,

  –– The Event Generator

  –– The Detector Simulation

  –– The Event Dispatcher

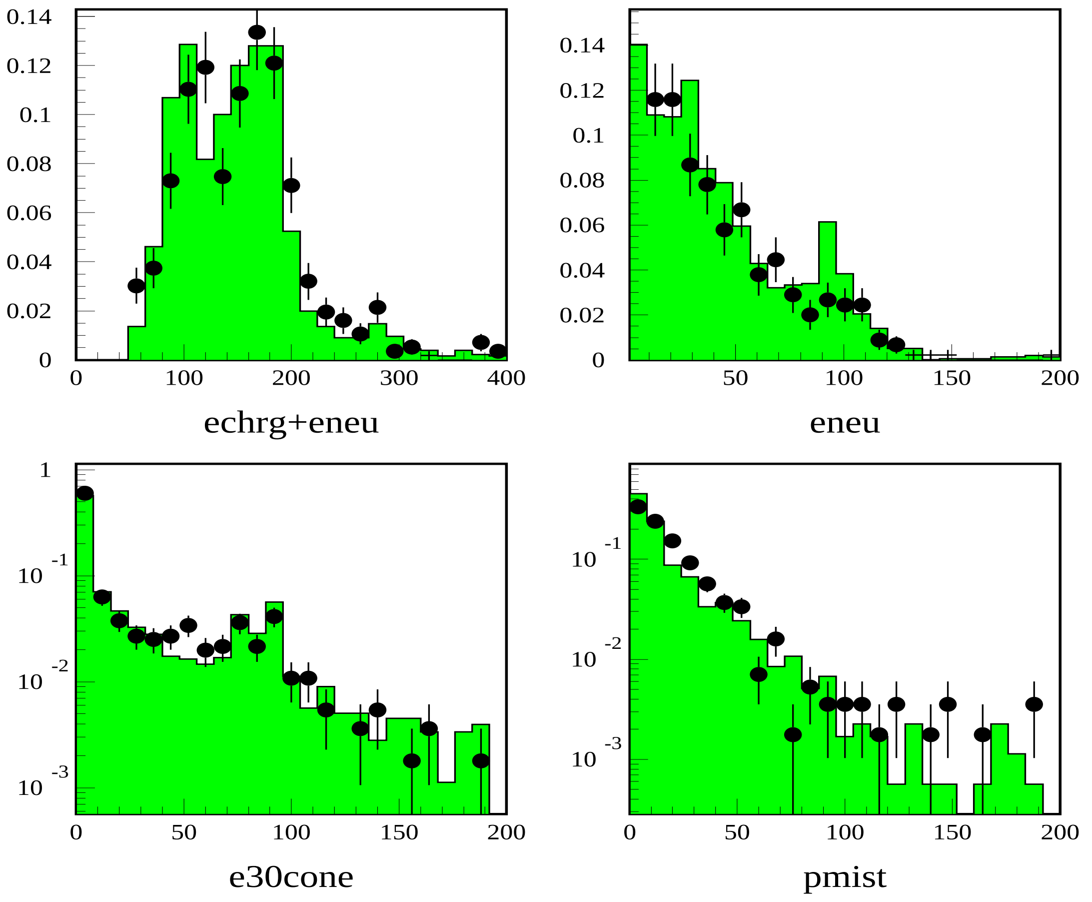
 is called.

–– The Detector Simulation calls

  –– The Covariance Matrix Machine

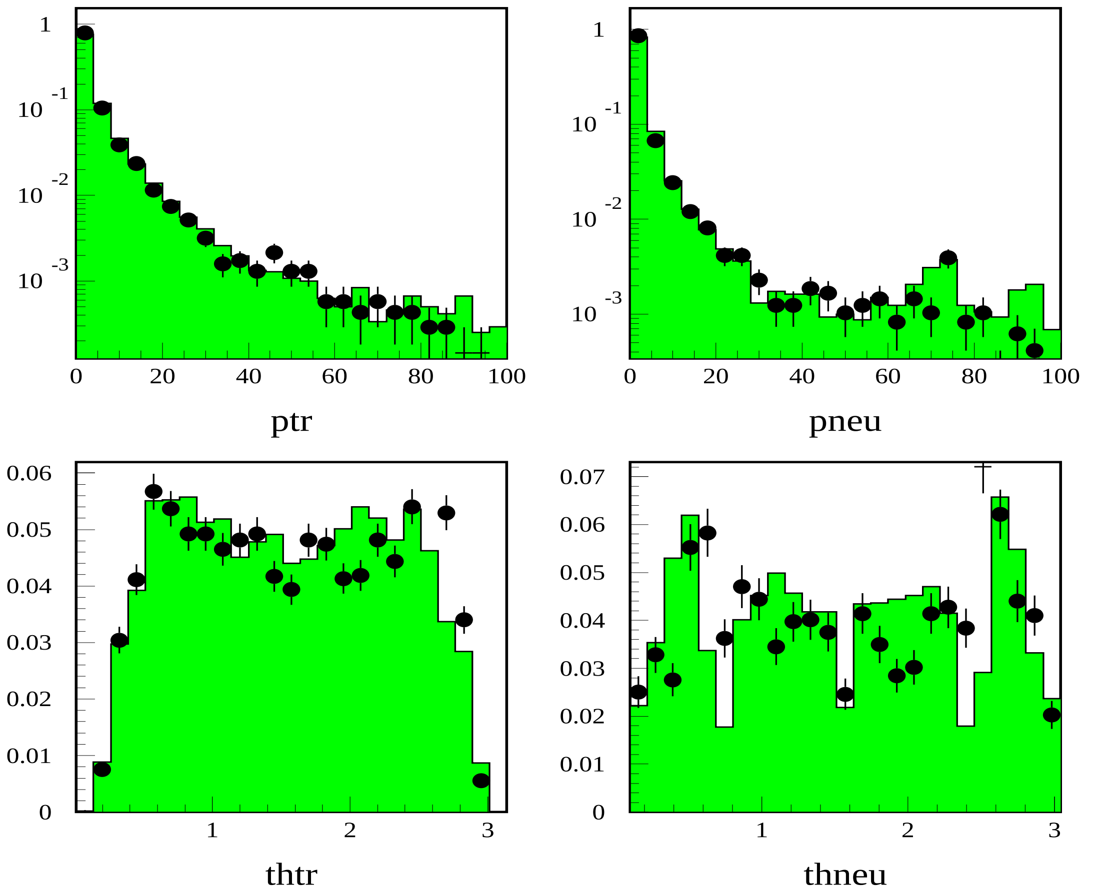
SGV compared to data: Global variables

Histogram: SGV, Points: DELPHI data



SGV compared to data: track variables

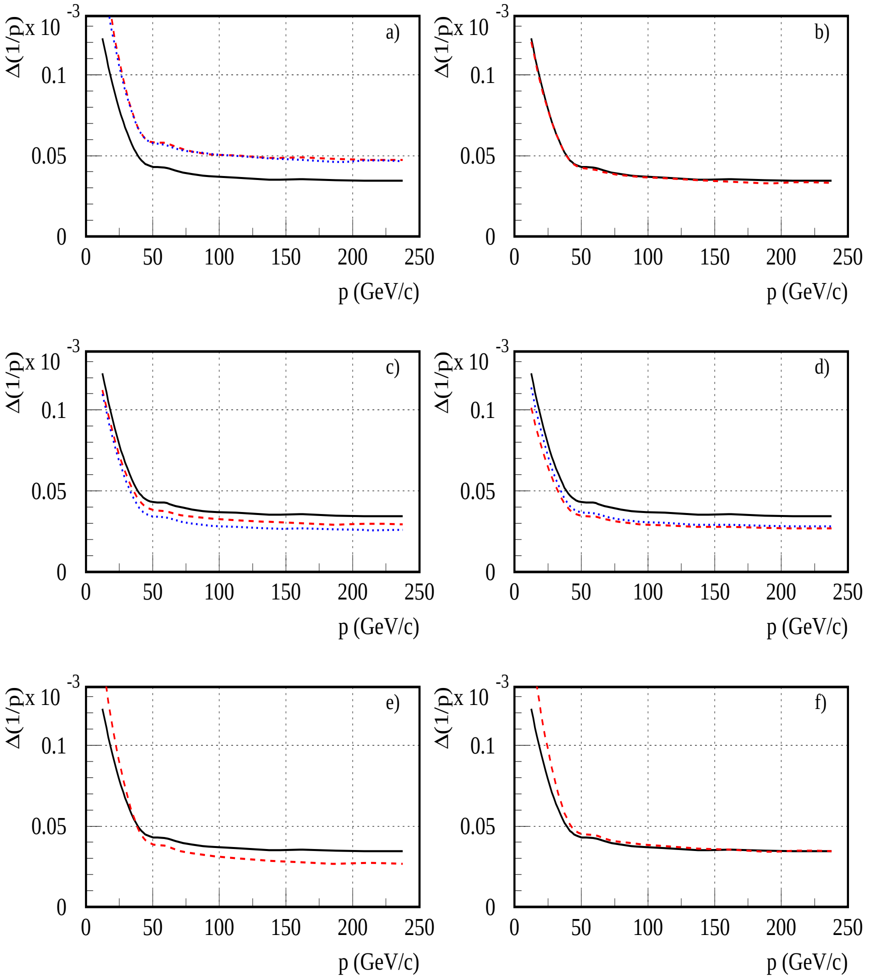
Histogram: SGV, Points: DELPHI data



SGV for detector studies: the TESLA SET

- **H**ow would the momentum resolution change if one adds an Silicon External Tracker outside the TPC? How many layers should one put? How should they be distributed?

Ask SGV !



Black is TDR, the other curves are 9 different SET options.

SGV: White paper

- **Language:** FORTRAN77
- **Code management:** PATCHY
- **Depends on** CERNLIB
- **Distributed as:** Single compressed file (Gzip)
- **Installation procedure:** Self−installing on UN*X and VMS
- **Size:** Distribution−file 230 kB. Expanded and installed, 2.9 MB is needed (including documentation, 1.1 MB). The PATCHY pam−file contains 35 000 lines.

- **Documentation:** Users Guide and Reference Manual included in distribution−file, in the form of LaTeX. The installation procedure creates the corresponding PostScript files, if requested. The source is latex2htmlable.
- **Manifestly runs on:** Linux, HP/UX, True64 (Digital UNIX), VMS, with native compilers (=g77 in the case of Linux).
- **Timing:** 114 ms/PYTHIA qq event on a Compaq 1655 notebook (266 MHz I686). About 1 000 times faster than the DELPHI full simulation for the same channel.

Getting hold of SGV

Down−load from

http://home.cern.ch/berggren/sgv.html

or use the pre−installed version in the cern.ch afs−cell (HP−UX, DigitalUnix, Aix and Linux) by executing

/afs/cern.ch/delphi/tasks/sgv/share/pam/sgvenv.sh

Summary

- SGV is about three orders of magnitude faster than a typicall full simulation.
- Both in comparision with real data and full simulation, SGV results typically differs by less than 10%.
- Many analyses at LEP have used SGV.
- Many people contribute with suggestions, fixes, new features.
- A road−map to move to a modern, OO system is in place, aiming at realeasing SGV++ before the end of the year.