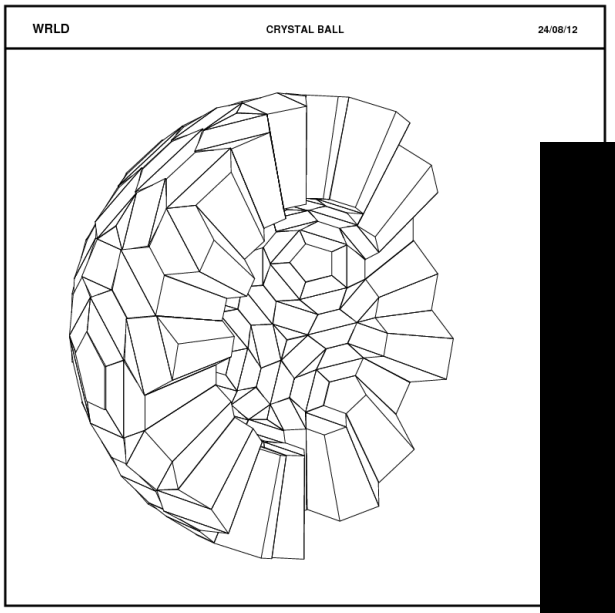
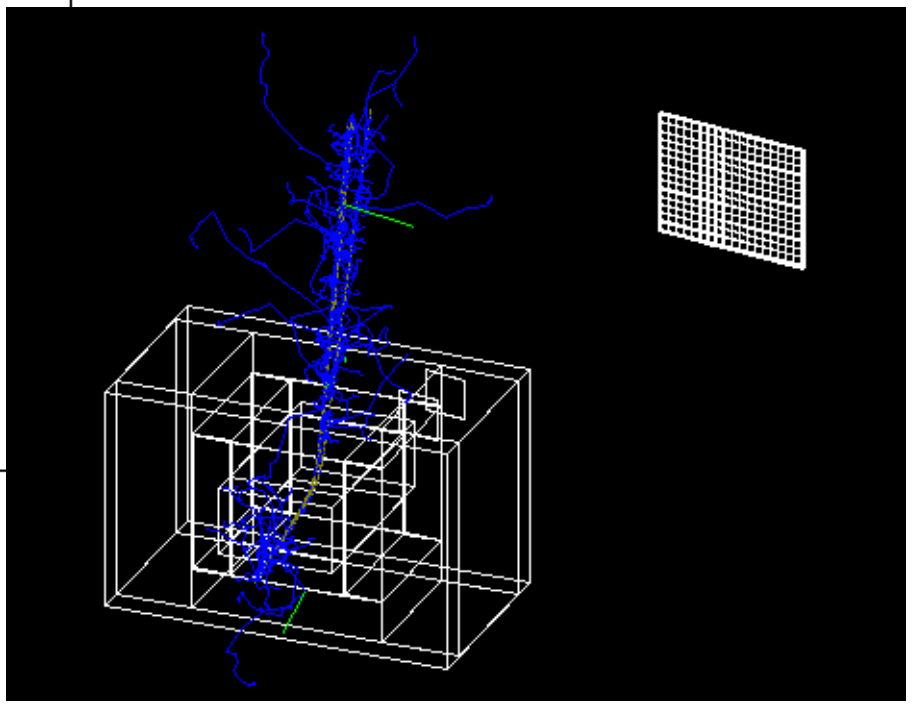
ggland NEWS

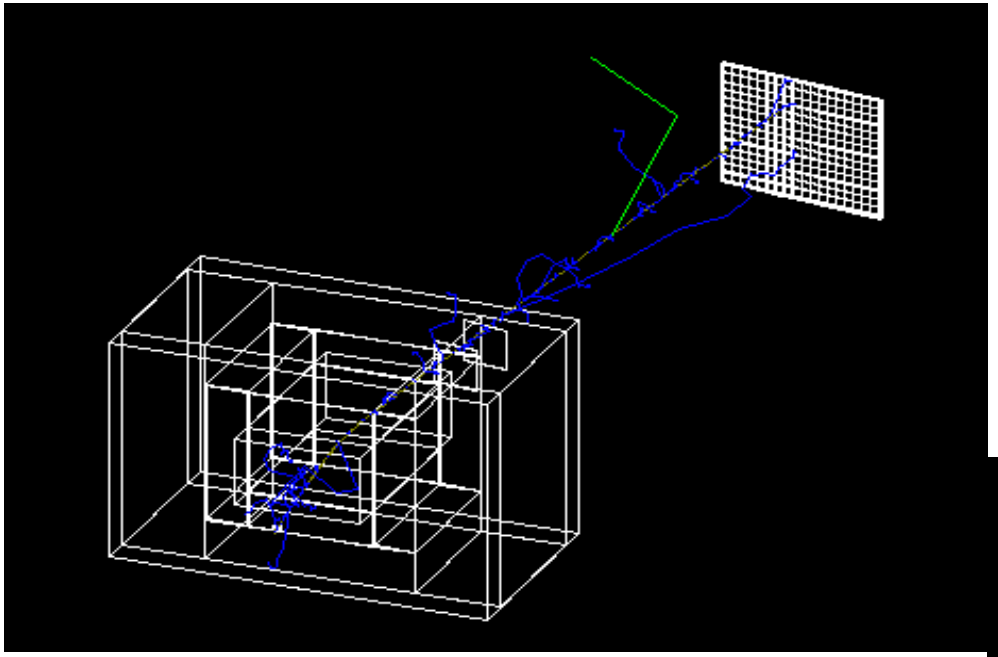




Håkan T. Johansson, Chalmers, Göteborg

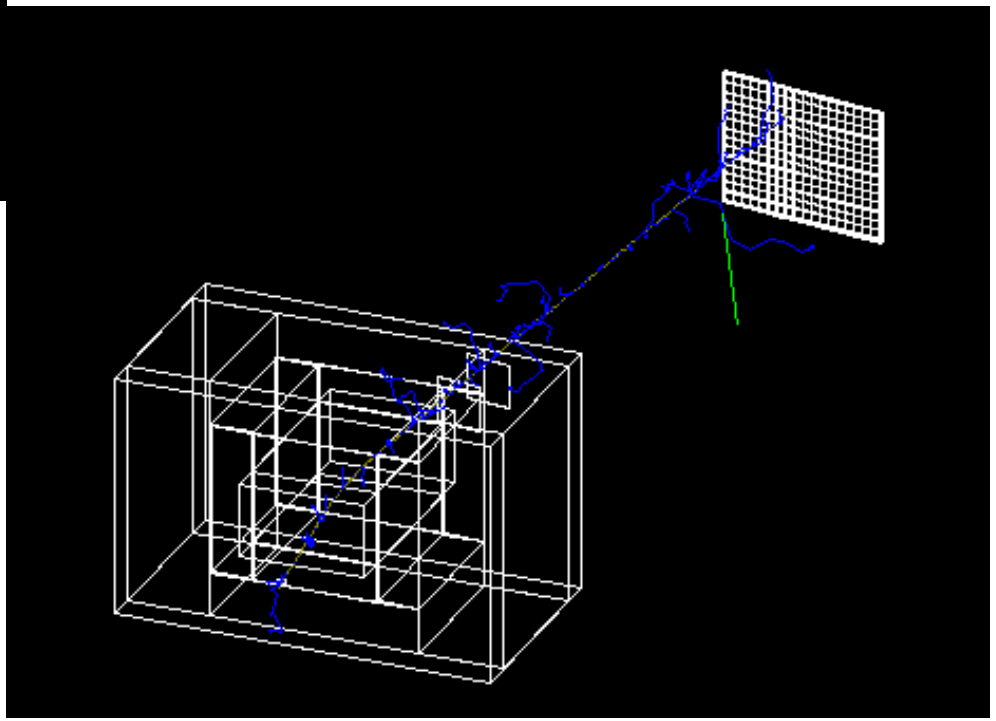
Lichtenberghaus, Darmstadt, May 2013.

LAND / R^3B setup detectors



csi, dtf, gfi, land, ntf, pdc, pos, rolu, sciland, sst, test, tfw, world, xb

New during the spring, by
S. Buller, J. Magnusson, T. Rathsman.



```
$LAND_GEANT4 \
    --sst-1=z0=11cm \
    --sst-2=z0=14cm \
    --gfi-1=z0=220cm,roty=-15deg,z0=255cm \
    --gfi-2=z0=280cm,roty=-15deg,z0=255cm \
    --tfw=z0=900cm,roty=-15deg,z0=255cm \
    --aladin=I=-2500A,roty=-6.5deg,z0=255cm \
    --world=d=1200cm \
    --events=200 \
    --gun=B15,beta=0.745,dtheta=1deg \
    --tree=land02track,part,nonreduced,$OUT \
    --np=7   # --cmd=scripts/draw.mac
```

Detector defintion (POS)

(S. Buller, J. Magnusson, T. Rathsman.)

```
#include ...

struct spec_POS_t
{
  SPEC_FLOAT(_dx,              5,"cm","full width x of active volume");
  SPEC_FLOAT(_dy,              5,"cm","full width y of active volume");
  SPEC_FLOAT(_dz,           0.03,"cm","full width z of active volume");
  SPEC_MEDIA(_type,   "plastic",""  ,"POS active volume material.");
};

#include "auto_gen/spec_info_pos.hh"

gg_geom_obj *make_POS(void *vspec, uint32_t UNUSED_PARAM(mask_set),
                      const transform_matrix *loc_rot,
                      det_name_no_info *name_no)
{
  spec_POS_t *spec = (spec_POS_t *) vspec;

  gg_geom_obj *goPOS = makebox("POS", _world_media_type,
                               d_full(spec->_dx /* + ... */),
                               d_full(spec->_dy /* + ... */),
                               d_full(spec->_dz));
  gg_geom_obj *goActive = makebox("POS", spec->_media_type,
                                  d_full(spec->_dx), d_full(spec->_dy),
                                  d_full(spec->_dz));
  posvol(goActive,1,goPOS,0.,0.,0.);
  place_in_world(goPOS, loc_rot, name_no);

  collect_tree_vol_info *collect_info = register_collect_tree_id(name_no,1);
  collect_tree_reduced_vars(collect_info,
                COL_TREE_VAR_T | COL_TREE_VAR_E |
                COL_TREE_VAR_X | COL_TREE_VAR_Y);
  vect_step_copyno_path path;
  register_step(goActive, NULL, collect_info, &path);
  return goPOS;
}
```

Parameters (modifiable on command line)

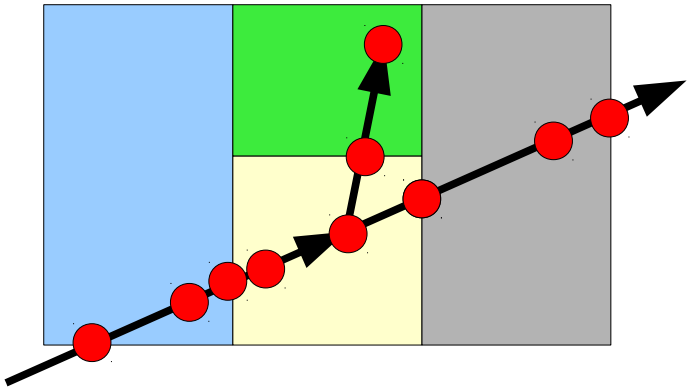
Create volumes
(lightguides omitted here)

Setup for digitiser

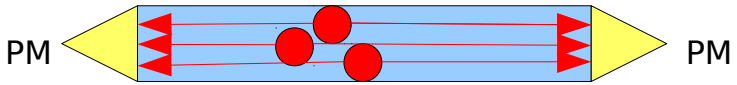
This file is all ggland knows about POS

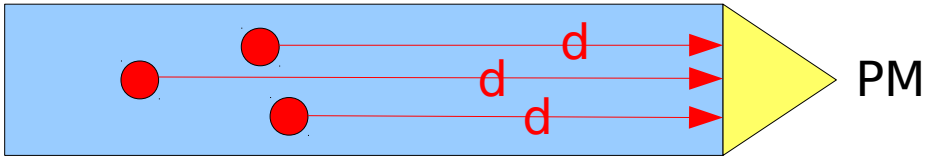
Full digitisation

GEANT: particles & tracks

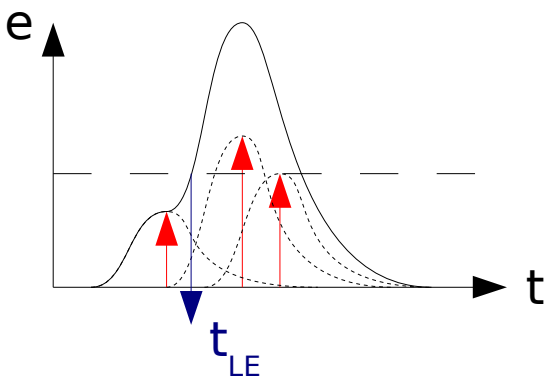


GEANT: gives 'δE-hits' (●)





Digitiser: propagate δE-signals to readout, sum & discriminate

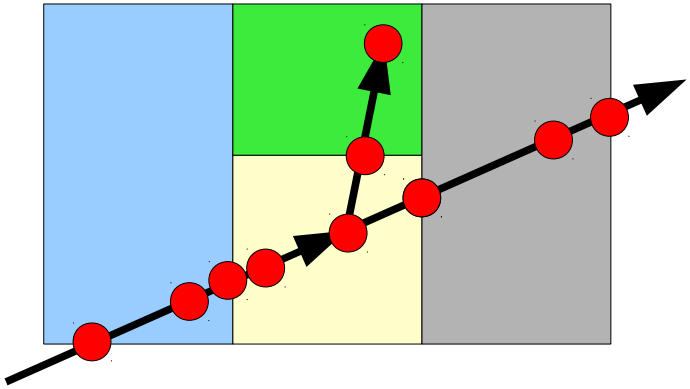


Normal reconstruction

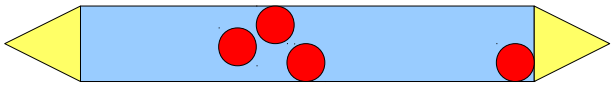
Tracking

General digitiser: introducing SHIT

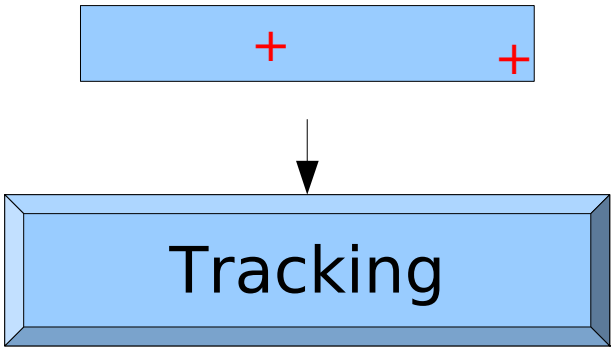
GEANT: particles & tracks



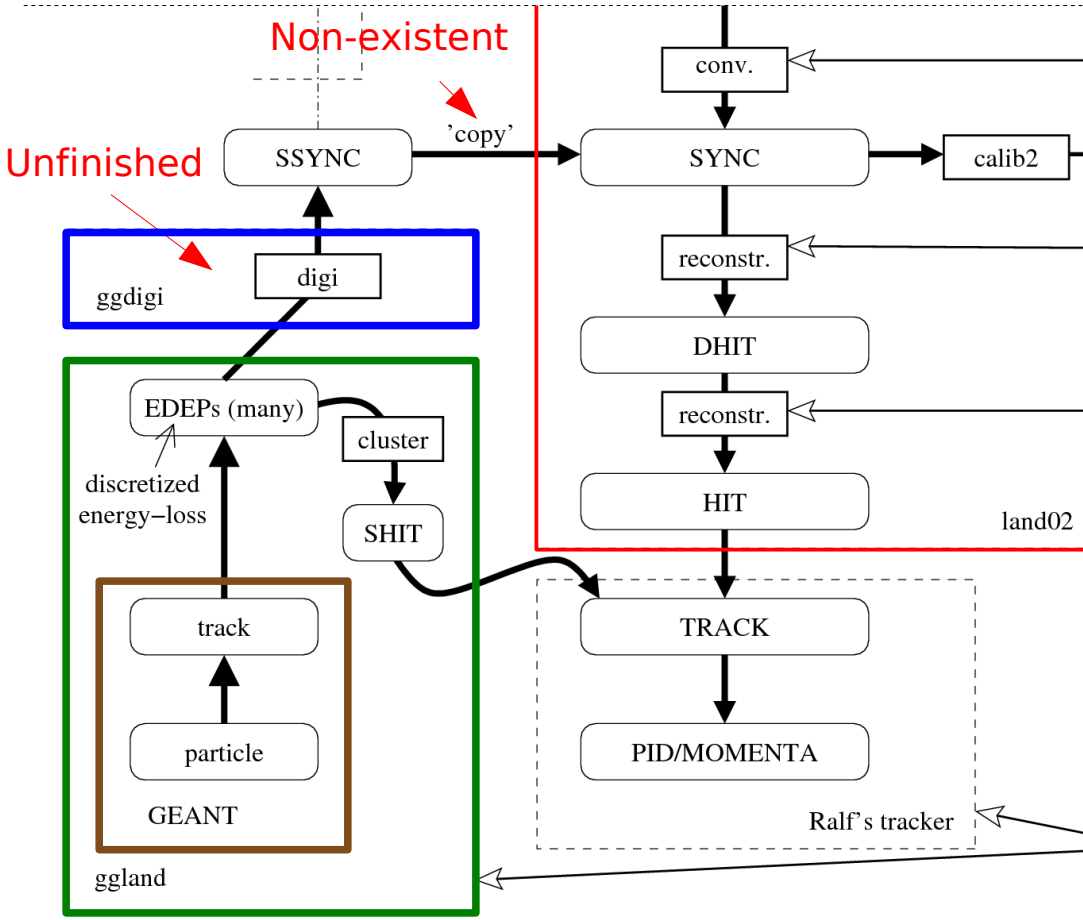
GEANT: gives 'δE-hits' (●)



For δE/track clusters in each active volume: Energy-weighted averages of `t, x, y, z, e`



Simulated HITs from general clusterisation of δE in each active volume.



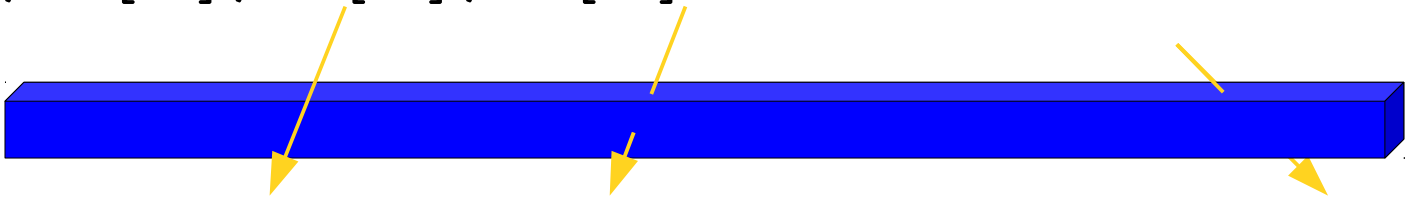
IMPROVED

Instant `.root`-file

Back-of-the-envelope simulations

Create root-file with data from active volumes: `sumE`

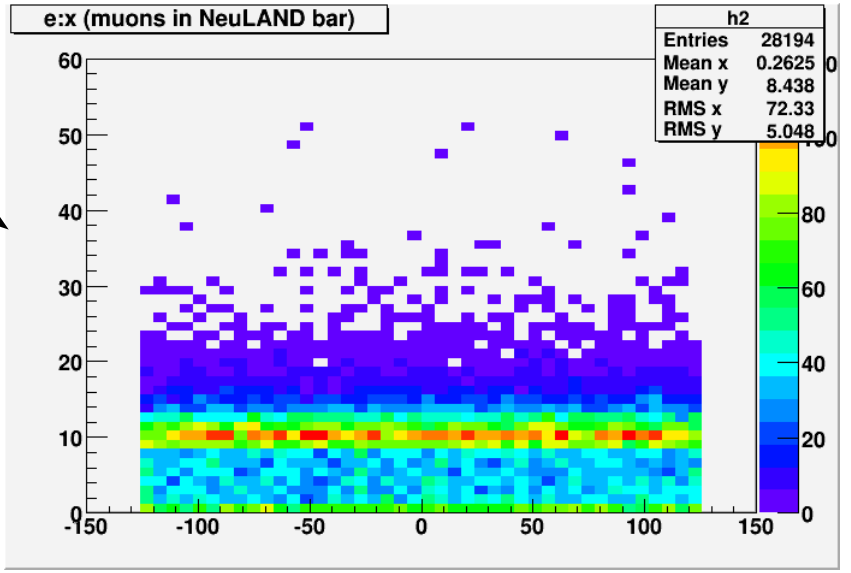
By rough 'digitizer': cluster by distance (currently sqrt(10) cm):
`n, x[n], y[n], z[n], t[n], e[n]`



```
./land_geant4 --test=dx=250cm,dy=5cm,dz=5cm,type=plastic,tree=1
   --gun=cosmmuonthetaE=250MeV,sr=130cm --tree=muons2.root
   --events=1000000
```

Include volume

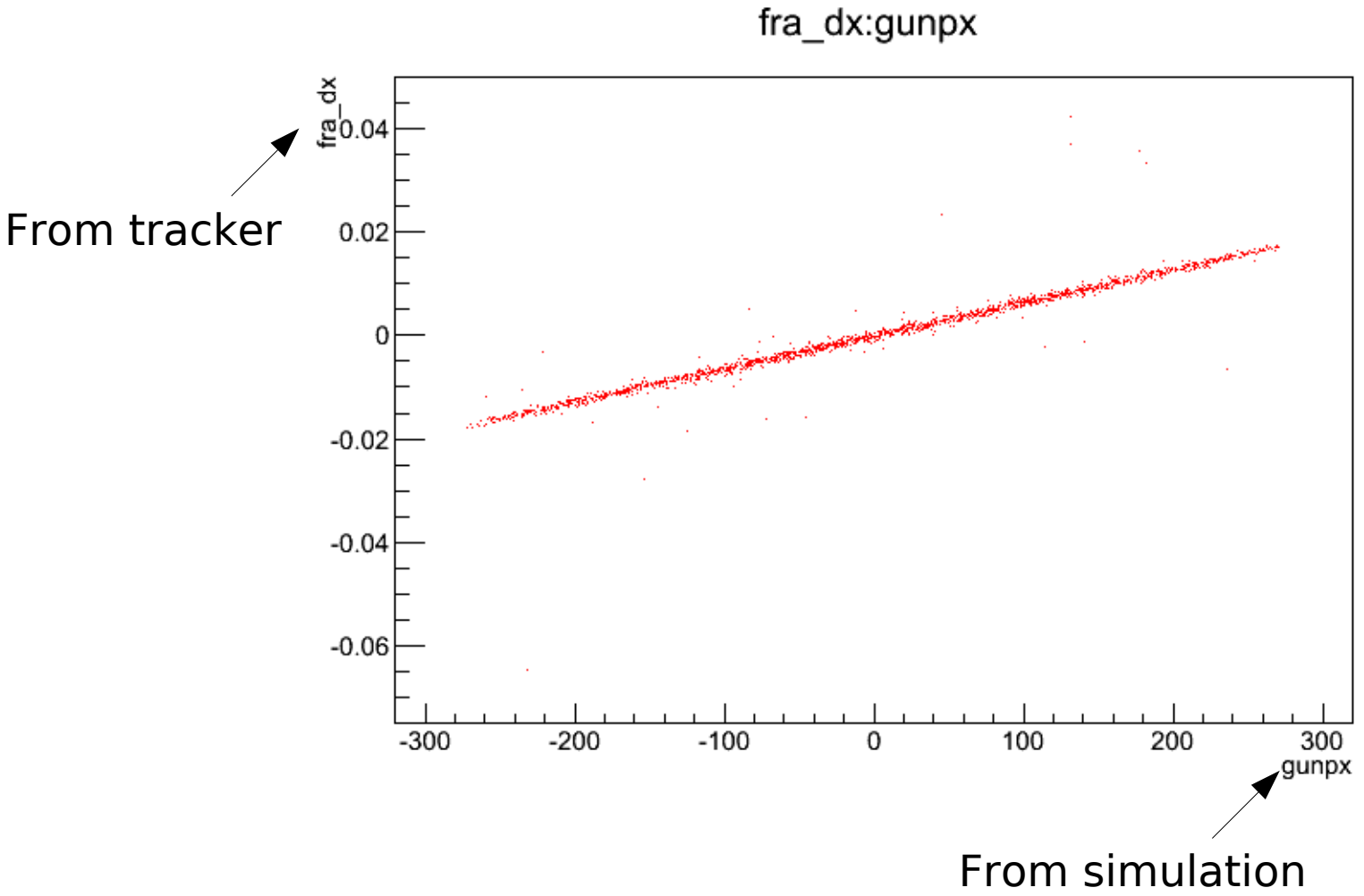
```
h102->Draw("TSTe:TSTx")
```



Now applies to active volume(s) of any detector

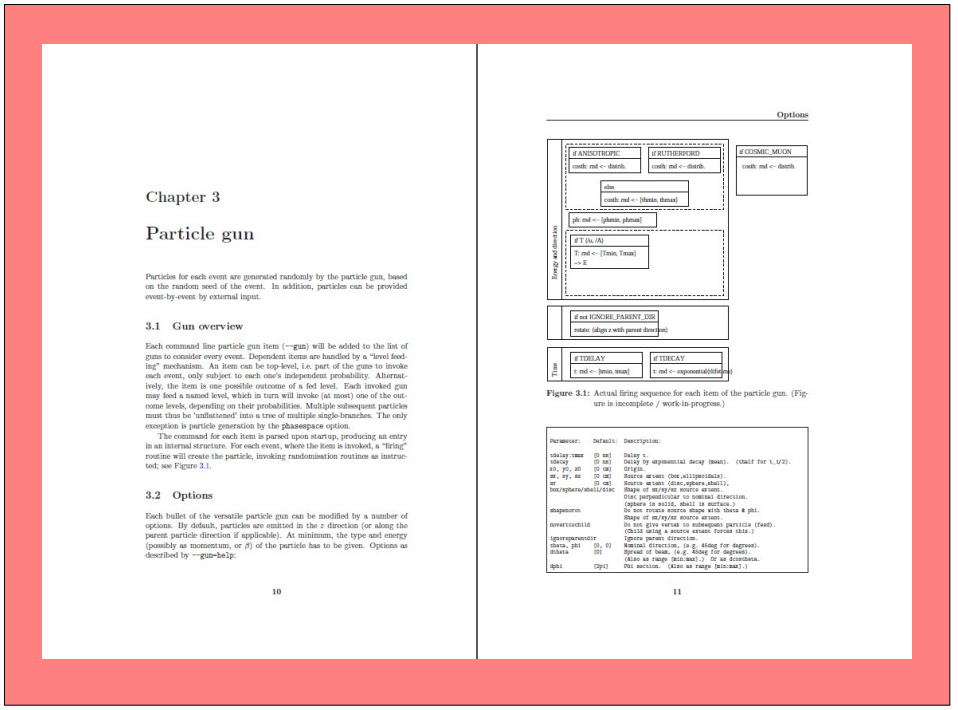
Interfacing with Ralf's tracker

With `--tree=land02track,...,$OUTFILE`,
the clusterised data is land02-like enough to be used by the tracker:



Documentation

- Webpage: http://fy.chalmers.se/~f96hajo/ggland/
- Write-up:



Chapter 3

Particle gun

Particles for each event are generated randomly by the particle gun, based on the random seed of the event. In addition, particles can be provided event-by-event by external input.

3.1 Gun overview

Each command line particle gun item (--gun) will be added to the list of guns to consider every event. Dependent items are handled by a "level feeding" mechanism. An item can be top-level, i.e. part of the guns to invoke each event, only subject to each one's independent probability. Alternatively, the item is one possible outcome of a fed level. Each invoked gun may feed a named level, which in turn will invoke (at most) one of the outcome levels, depending on their probabilities. Multiple subsequent particles must thus be 'unflattened' into a tree of multiple single-branches. The only exception is particle generation by the phasespace option.

The command for each item is parsed upon startup, producing an entry in an internal structure. For each event, where the item is invoked, a "firing" routine will create the particle, invoking randomisation routines as instructed; see Figure 3.1.

3.2 Options

Each bullet of the versatile particle gun can be modified by a number of options. By default, particles are emitted in the z direction (or along the parent particle direction if applicable). At minimum, the type and energy (possibly as momentum, or $\beta\gamma$) of the particle has to be given. Options as described by --gun-help:

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Options

Figure 3.1: Actual firing sequence for each item of the particle gun. (Figure is incomplete / work-in-progress.)

Parameter:	Default:	Description:
tdelay:tmax	[0 ns]	Delay τ.
tdecay	[0 ns]	Delay by exponential decay (mean). (thalf for τ_1/2).
x0, y0, z0	[0 cm]	Origin.
ax, ay, az	[0 cm]	Source extent (box,ellipseidals).
sr	[0 cm]	Source extent (disc,sphere,shell).
box/sphere/shell/disc		Shape of ax/ay/az source extent. Disc perpendicular to nominal direction. (sphere is solid, shell is surface.)
shapenorot		Do not rotate source shape with theta & phi.
		Shape of ax/ay/az source extent.
novertexchild		Do not give vertex to subsequent particle (feed). (Child using a source extent forces this.)
ignoreparentdir		Ignore parent direction.
theta, phi	[0, 0]	Nominal direction, (e.g. 45deg for degrees).
dtheta	[0]	Spread of beam, (e.g. 45deg for degrees). (Also an range [min:max].) Or an ecordsetca.
dphi	[2pi]	Phi section. (Also an range [min:max].)

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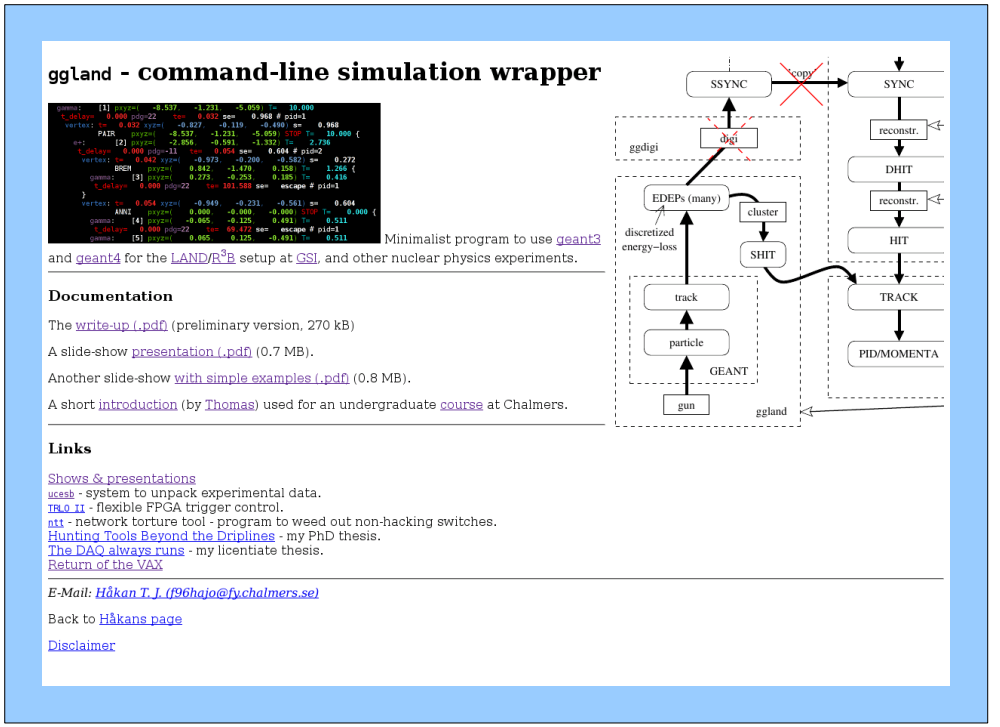
(~75 % complete)



ggland - command-line simulation wrapper

```
gamma:    [1] pxyz=(   -8.537,    -1.231,    -5.059) T=   10.000
 t_delay=   0.000 pdg=22    tot=   0.032 se=    0.968 # pid=1
 vertex: t=   0.032 xyz=(   -0.827,    -0.119,    -0.490) s=    0.968
      PAIR    pxyz=(   -8.537,    -1.231,    -5.059) STOP T=   10.000 {
  e-:    [2] pxyz=(   -2.856,    -0.591,    -1.332) T=    2.736
   t_delay=   0.000 pdg=-11   tot=   0.054 se=    0.604 # pid=2
   vertex: t=   0.042 xyz=(   -0.973,    -0.200,    -0.582) s=    0.272
        BREM    pxyz=(    0.842,    -1.479,     0.158) T=    1.266 {
     gamma:    [3] pxyz=(    0.273,    -0.253,     0.185) T=    0.416
      t_delay=   0.000 pdg=22    tot= 101.588 se=   escape # pid=1
   }
   vertex: t=   0.054 xyz=(   -0.949,    -0.231,    -0.561) s=    0.604
        ANNI    pxyz=(    0.000,    -0.000,    -0.000) STOP T=    0.000 {
     gamma:    [4] pxyz=(   -0.065,    -0.125,    -0.491) T=    0.511
      t_delay=   0.000 pdg=22    tot=  69.472 se=   escape # pid=1
     gamma:    [5] pxyz=(    0.065,     0.125,    -0.491) T=    0.511
```

Minimalist program to use geant3 and geant4 for the LAND/R^{3}B setup at GSI, and other nuclear physics experiments.

Documentation

The write-up (.pdf) (preliminary version, 270 kB)

A slide-show presentation (.pdf) (0.7 MB).

Another slide-show with simple examples (.pdf) (0.8 MB).

A short introduction (by Thomas) used for an undergraduate course at Chalmers.

Links

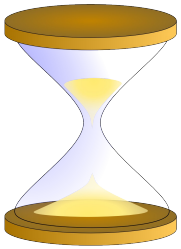
Shows & presentations
ucesb - system to unpack experimental data.
TRLO II - flexible FPGA trigger control.
ntt - network torture tool - program to weed out non-hacking switches.
Hunting Tools Beyond the Driplines - my PhD thesis.
The DAQ always runs - my licentiate thesis.
Return of the VAX

E-Mail: Håkan T. J. (f96hajo@fy.chalmers.se)

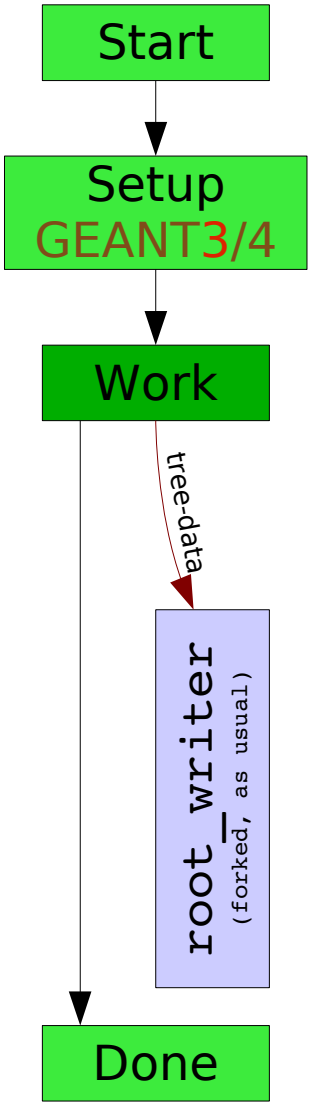
Back to Håkans page

Disclaimer

- Presentations.
- Getting-started guides.
- Listserv: ggland@gsi.de



Parallelisation



- Through process duplication:

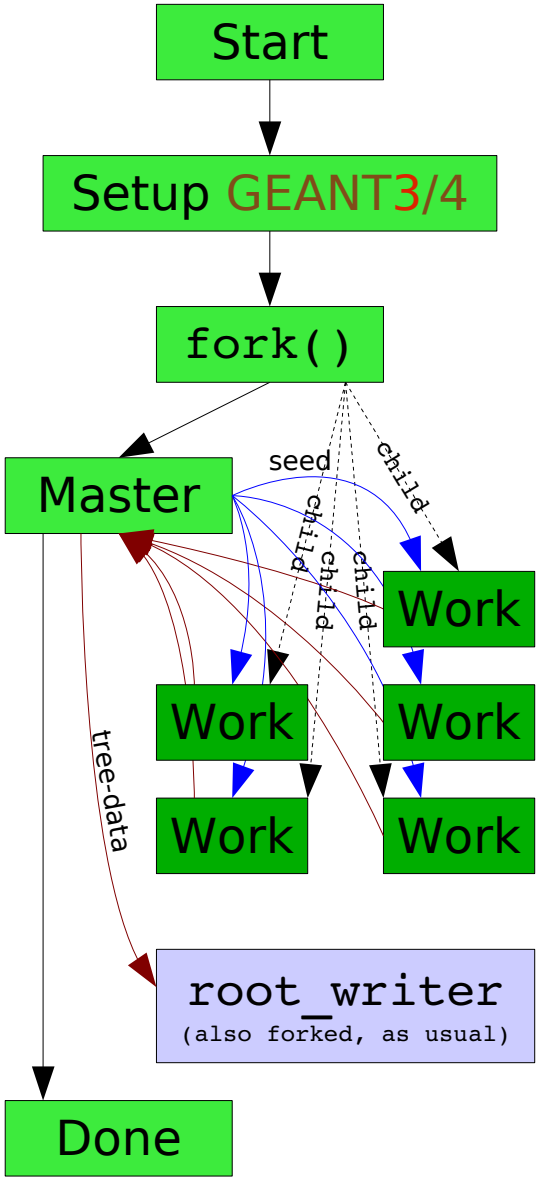
  `fork()`

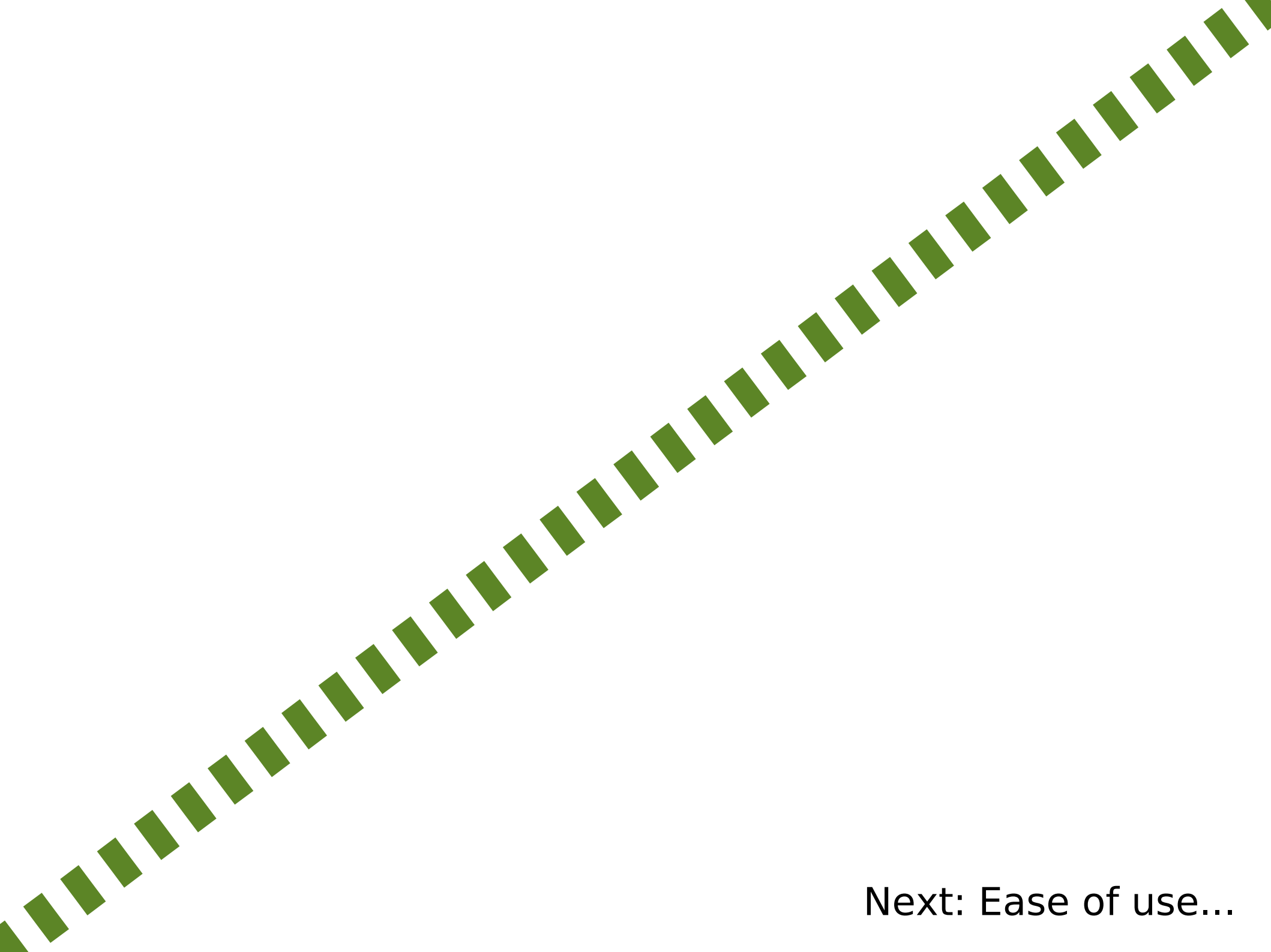
  (no threads:
  GEANT3/4 need not know!)

- Master process distributes event seeds
- Combine & sort output data (event “retirement”)

TODO:

- “Farm-forking” using `MPI` / `ssh`





Next: Ease of use...

Example from FairRoot

Simulation Example: Rutherford Experiment

10

- Scattering of 5MeV alpha particles at a 2 μ m gold foil
- Unexpected large scattering angles observed
- Implementation using FairRoot needs
  - 600 lines of C++ source code created mostly automatically (copied from a template)
  - 60 lines of code for the build system
  - 200 lines of code for the steering macros
  - 70 lines of code for the geometry and media definition

Simulation Example: Rutherford Experiment

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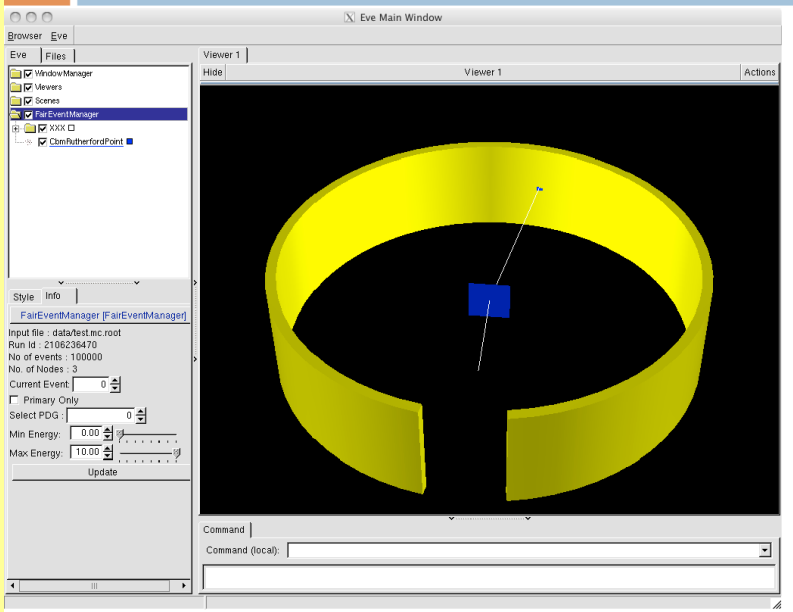
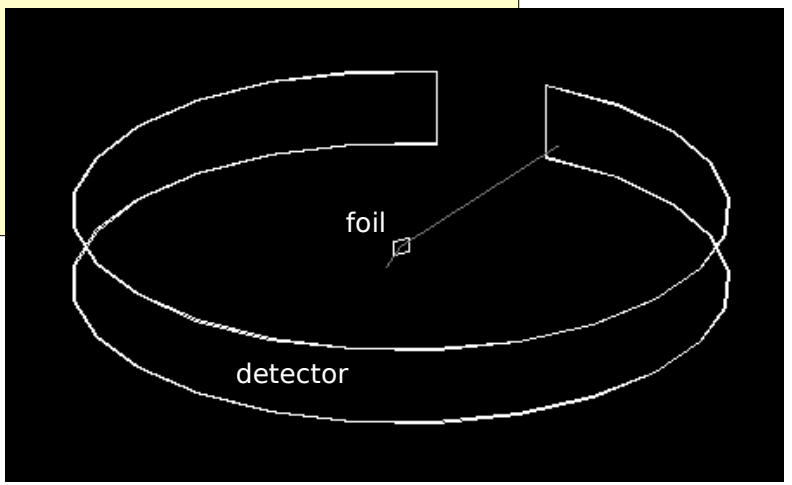


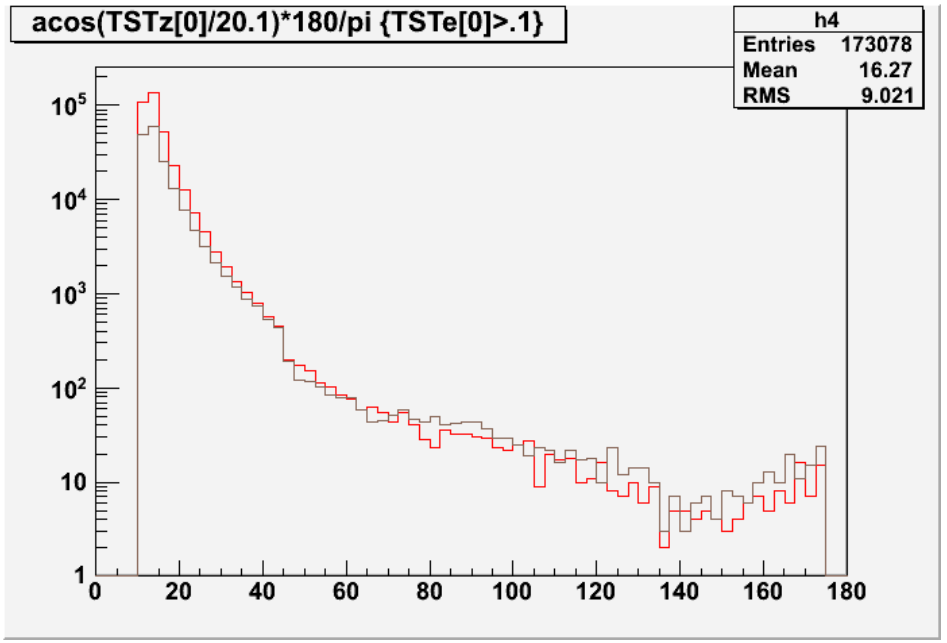
- Change experimental setup
- Change material properties
- Change simulation engine
- Change physical processes

From FairRoot talk at ROOT Users Workshop 2013, By Florian Uhlig

ggland: ... → 7 arguments

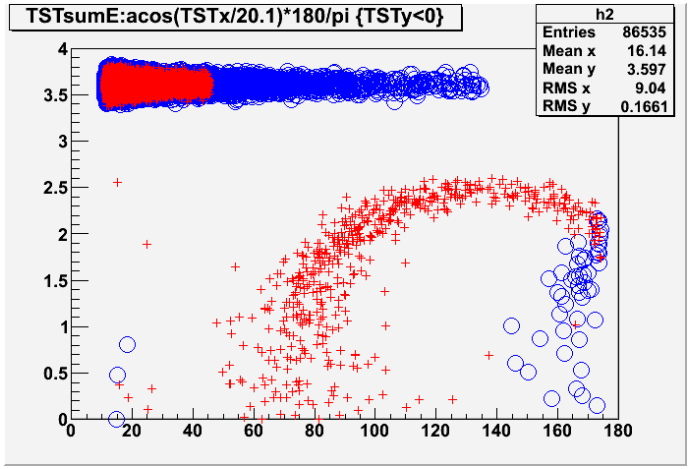
```
./land_geant4 \
    --test-1=type=Au,dx=1cm,dy=1cm,dz=0.0002cm,roty=45deg \
    --test=type=Si,ir=20cm,r=20.1cm,dz=5cm,\
phi1=10deg,phi2=350deg,rotx=90deg,roty=-90deg,tree=1 \
    --world=type=vacuum \
    --gun=alpha,T=5MeV,z0=-3cm \
    --tree=rutherford4.root \
    --events=10000000 --np=3
```

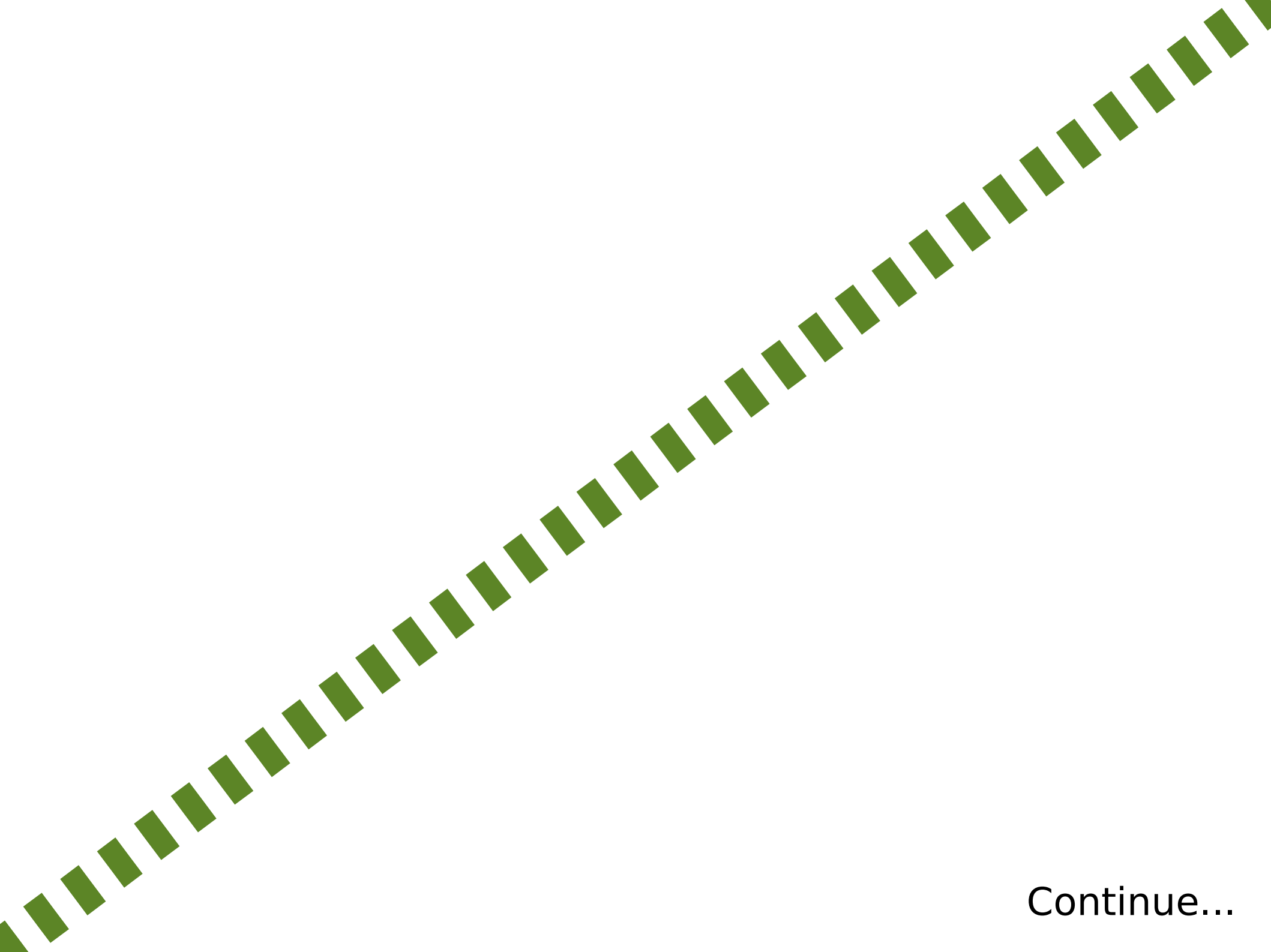




Foil tilted by 45° .

right/left



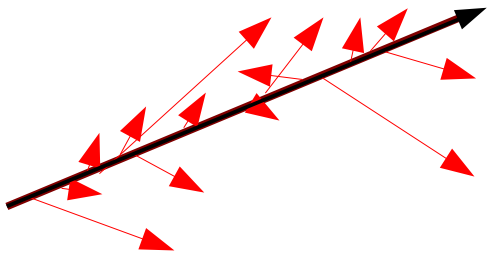


Continue...

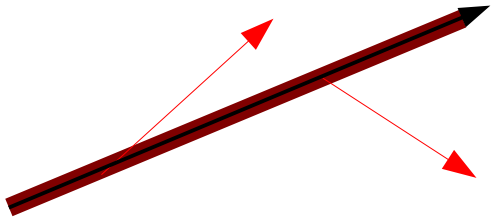
Range cut (GEANT4) – simulation speed

Same particle:

a) Short range cut:



b) Long range cut:



Difference is in gases (thin materials)!

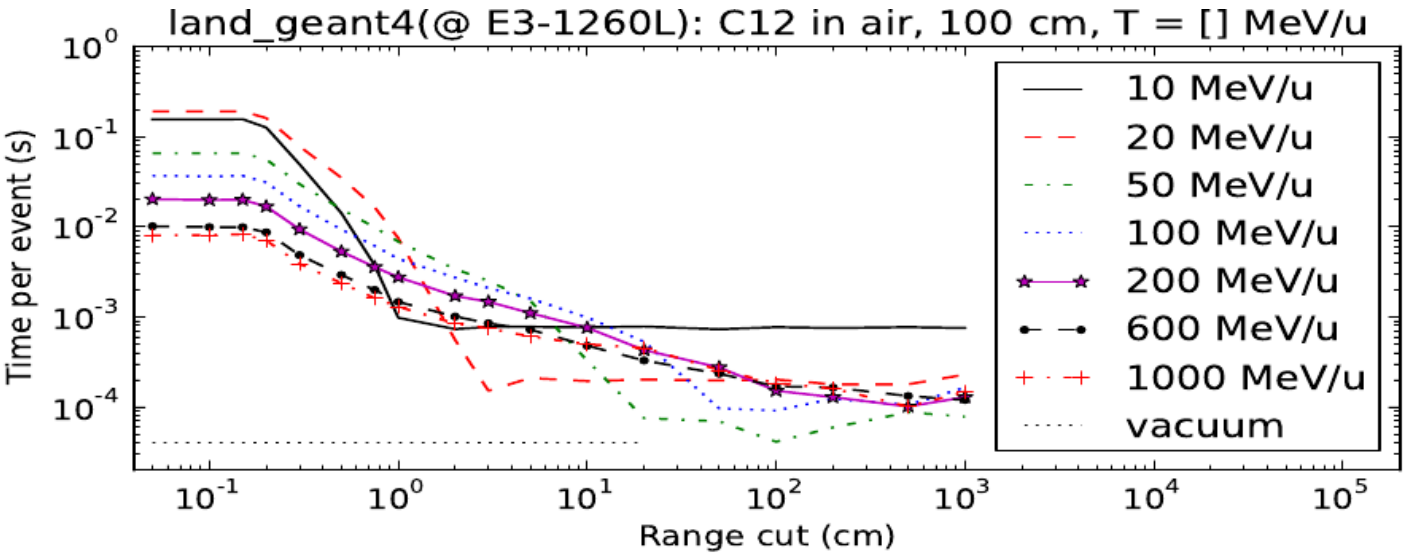
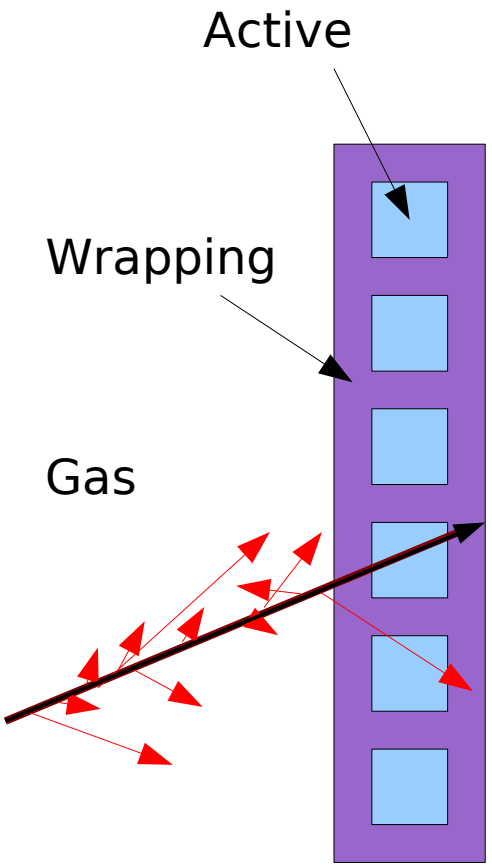


Figure 6.1: Simulation speed of ^{12}C at different energies in 100 cm air, as a function of the range cut, i.e. threshold for explicit particle generation. With range cuts between 0.1 cm – 100 cm, the simulation speed of heavy ion propagation in air can be affected by about two orders of magnitude. (The ordinate might as well have been normalised to the simulation speed in vacuum.)

Range cut (GEANT4) – effects on results



What matters is energy deposited in active volumes!

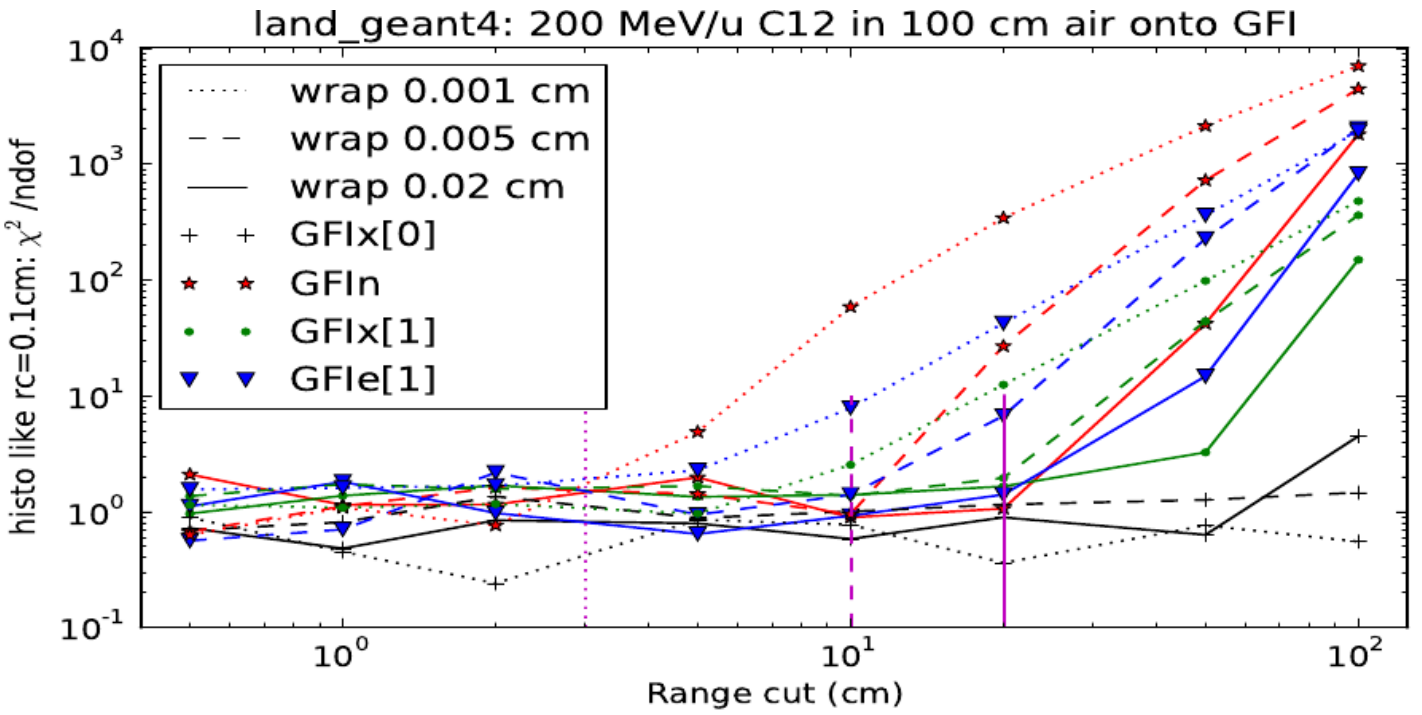


Figure 6.2: Effect on data recorded in active volumes of the GFI detector, as a function of the range cut in air, for three different values of the inactive plastic wrapping thickness. The effect is measured as the similarity of histograms of a few variables to those collected with a low range-cut (0.1 cm). The histograms deviate when $\chi^2/n_{dof} \gg 1$, as indicated by the vertical lines. Effects are seen in the secondary hits (`[1]`), and the number of hits, and not appreciably in the primary hits (`[0]`).

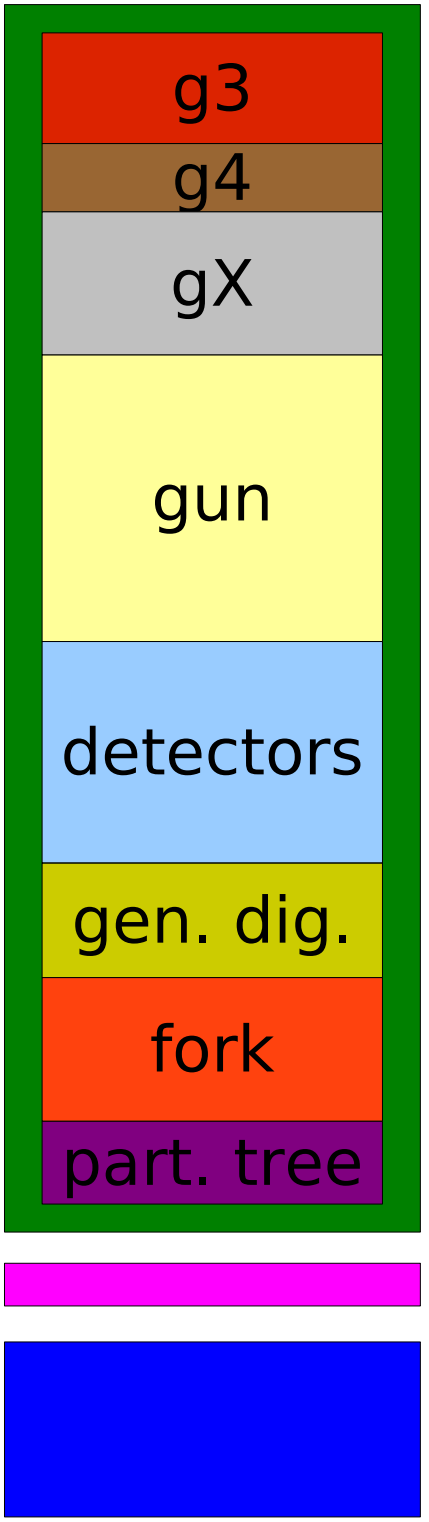
Fun-facts

`ggland:` 22,1 klines

land02-core: ~111 klines

ucesb-core: ~47 klines

Sorry: ca 20 % blank lines
included in all numbers



GEANT3 interface.

GEANT4 interface.

GEANT interface.

Particle gun.

Detector geometry.

Clusteriser (`--tree`).

Multi-process

Vertex dump.

`ggmark:` 0,7 klines

Vertex dump markup.

`ggdigi:` 3,2 klines

Digitizer.

ggland - TODO

More detectors (POS, SST, GFI, NTF, PDC, TFW). S. Buller, J. Magnusson, T. Rathsman

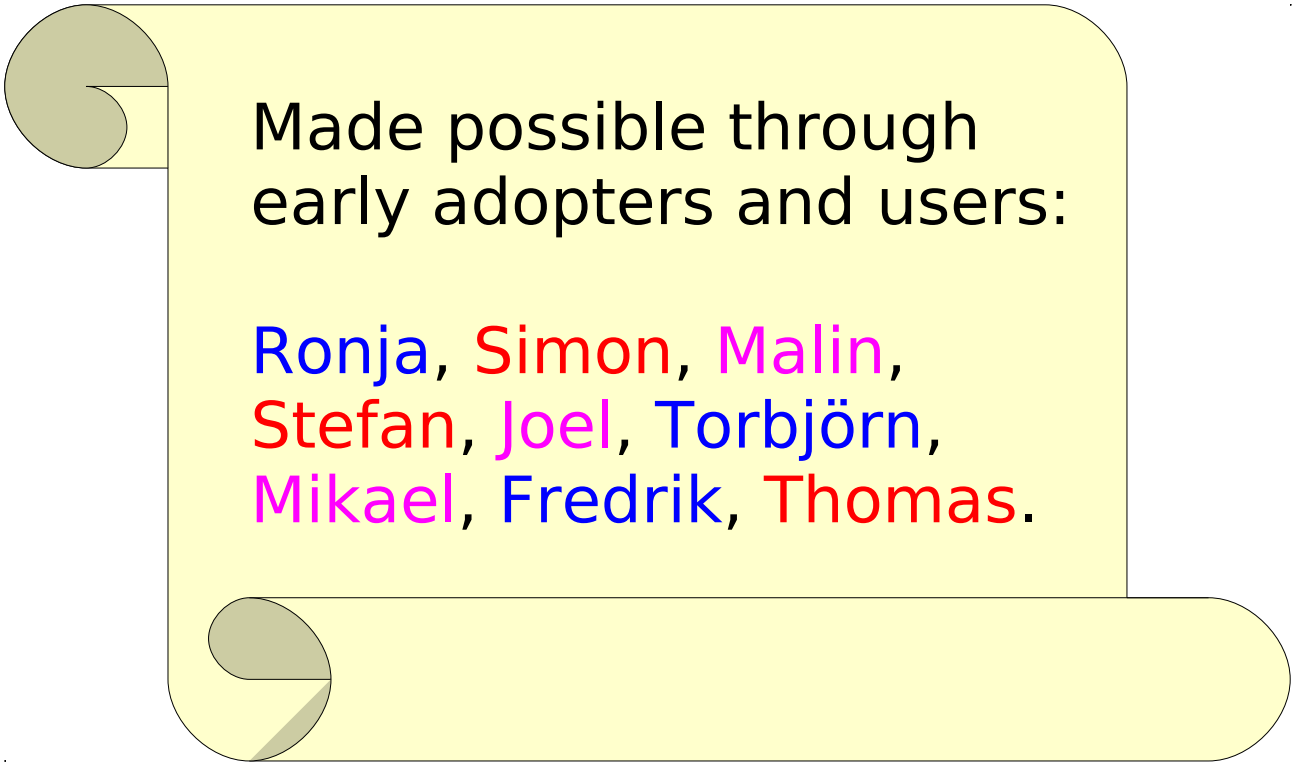
Quick-n-dirty digitizer/tree writer for detectors.

Magnetic field (ALADiN).

Gun from file (bullets).

- Passive materials around detectors (supports).
- Magnetic-free media (where B=0).
- Generation of vacuum vessels / beam pipes.
- Mimic of QFS - (p,2p) / (p,np) – in particle gun. (Works now with gun-file.)
- Record particles entering volumes for `--tree`.
- Auto-plot of visualisation around (interesting) vertices.
- Full digitiser (`ggdigi`).
- ???

Finale!



Thank you!

mini-scripting

Command line becoming long?

```
./land_geant3
  --test-0=d=0.5cm,z0=1cm,type=plastic,out_col=0
  --test-1=d=0.5cm,z0=2cm,type=plastic,out_col=1
  --test-2=d=0.5cm,z0=3cm,type=plastic,out_col=2
  --gun=gamma,T=10MeV,dtheta=0.5pi --events=1000000 |
  grep TSTDMP | sed -e "s/.*://" > 3vols.txt
```

Shell script:

Got a problem?
Odds against you?
Call the Equalizer.