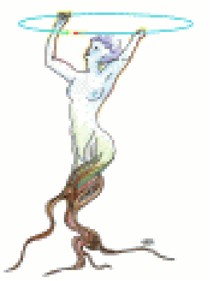


Workshop Overview
Summary of major developments

ROOT Workshop 2002 CERN

14 October

René Brun

http://root.cern.ch

Project History

- Jan 95: Thinking/writing/rewriting/???
- November 95: Public seminar, show Root 0.5
- Spring 96: decision to use CINT
- Jan 97: Root version 1.0
- Jan 98: Root version 2.0
- ☞ Mar 99: Root version 2.21/08 (1st Root workshop FNAL)
- Feb 00: Root version 2.23/12 (2nd Root workshop CERN)
- ☞ Mar 01: Root version 3.00/06
- Jun 01: Root version 3.01/05 (3rd Root workshop FNAL)
- Jan 02: Root version 3.02/07 (LCG project starts: RTAGs)
- ☞ Oct 02: Root version 3.03/09 (4th Root workshop CERN)

8 years !!

Official Support

- A very important step for the ROOT project.
- Many thanks to the people who made possible this success:
  - the EP management
  - the LCG/SC2 and in particular the LCG application area coordinator
  - the computing coordinators
  - last but not least the growing users base
- As a result new manpower in the project
- New SFT group in EP division

ROOT Team & Associates

- ROOT Team:
  - Ilka Antcheva (LCG staff) (since 1st Aug 2002)
  - Rene Brun: new SFT group and Alice part time
  - Philippe Canal (FNAL/CD) (since 1998)
  - Olivier Couet CERN (from PAW) (since 1st Jun 2002)
  - Masa Goto (Agilent technologies)
  - Valeriy Onuchin (LCG project associate) (since 1st Feb 2002)
  - Fons Rademakers: Alice and new SFT group
- Associates
  - Bertrand Bellenot (scopus) Win32gdk (since June 2000)
  - Maarten Ballintijn (MIT/Phobos) PROOF (since Sep 2001)
  - Andrei Gheata: (Alice) Geometry package (since Sep 2001)
- + see..

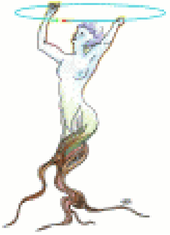
ROOT Team & Associates (2)

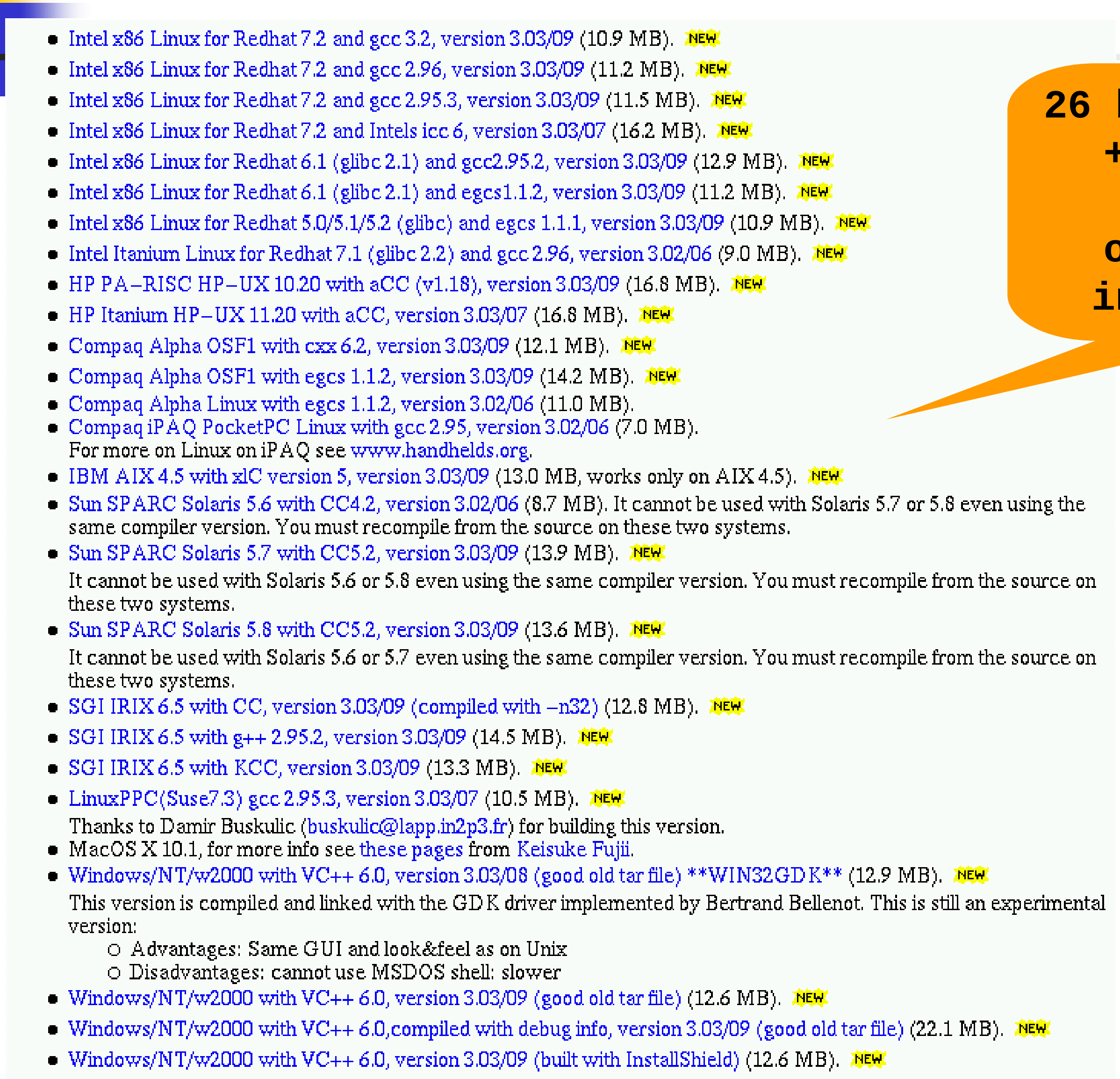
- Now in the LCG(LHC Computing GRID context)
  - Valery Fine (BNL/Atlas) I/O, TVirtualX/Qt
  - Victor Perevoztchikov (BNL/Atlas) STL, foreign classes
  - AND more than 50 important contributions from people spending a substantial fraction of their time on the project. See $ROOTSYS/README/CREDITS
- Special thanks to Suzanne Panacek who did a great job with the ROOT Users Guide, tutorials, lectures.
  - **Printed copies of the Users Guide in my office**.
- Many thanks to FNAL computing Division for the continuous support of the project since 1998.

ROOT and the LCG Project

- The “Blueprint RTAG” has recently proposed a close relationship between the LCG projects and ROOT.
- Several LCG projects may have an impact on the evolution of ROOT (eg POOL). Ongoing discussions to clarify the relationship and avoid duplication of the work.
- Feedback from users in the LHC experiments expected in the coming weeks.
- See Torre Wenaus/John Harvey talk later

Source & Binary distributions





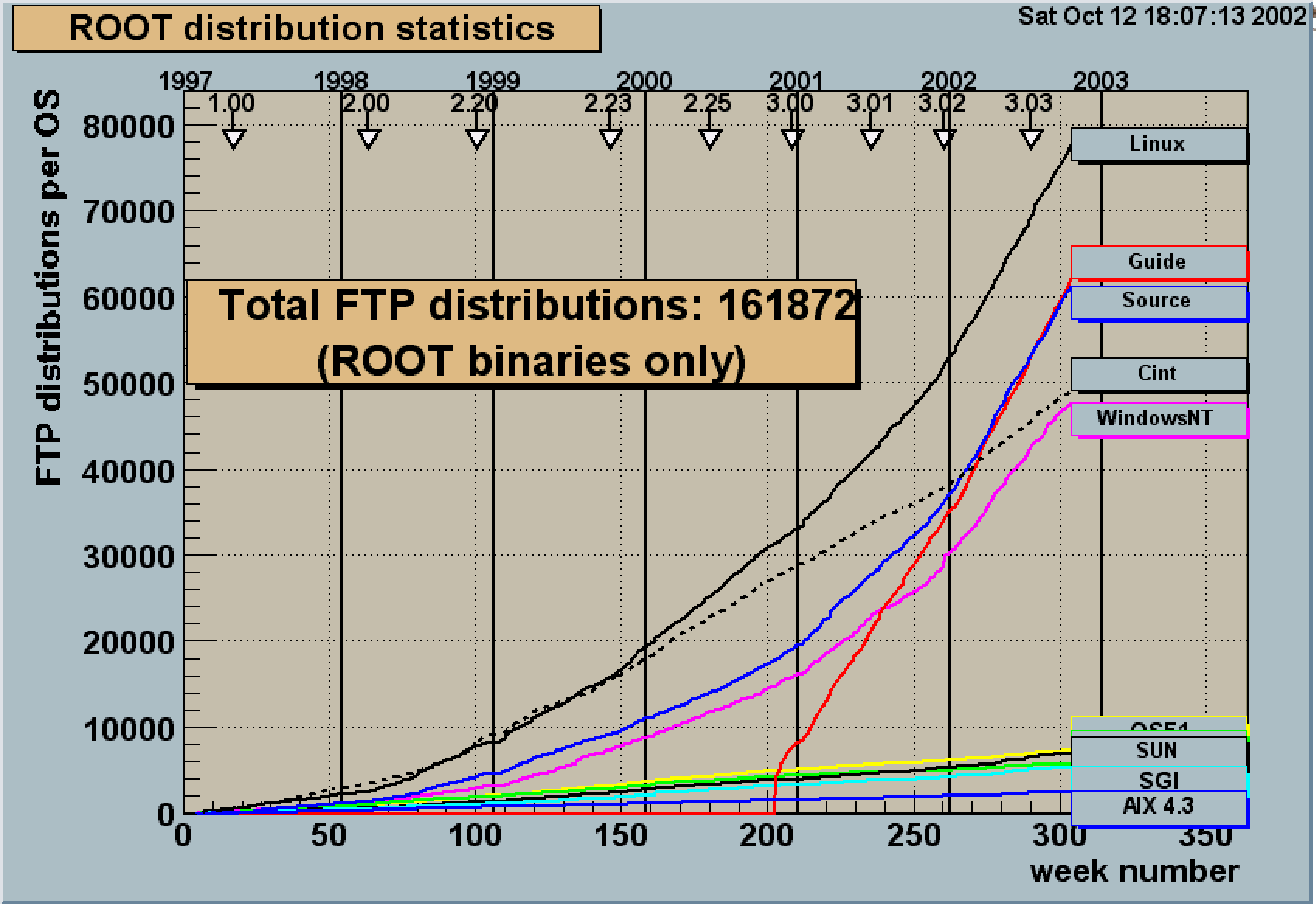
- Intel x86 Linux for Redhat 7.2 and gcc 3.2, version 3.03/09 (10.9 MB). NEW
- Intel x86 Linux for Redhat 7.2 and gcc 2.96, version 3.03/09 (11.2 MB). NEW
- Intel x86 Linux for Redhat 7.2 and gcc 2.95.3, version 3.03/09 (11.5 MB). NEW
- Intel x86 Linux for Redhat 7.2 and Intels icc 6, version 3.03/07 (16.2 MB). NEW
- Intel x86 Linux for Redhat 6.1 (glibc 2.1) and gcc2.95.2, version 3.03/09 (12.9 MB). NEW
- Intel x86 Linux for Redhat 6.1 (glibc 2.1) and egcs1.1.2, version 3.03/09 (11.2 MB). NEW
- Intel x86 Linux for Redhat 5.0/5.1/5.2 (glibc) and egcs 1.1.1, version 3.03/09 (10.9 MB). NEW
- Intel Itanium Linux for Redhat 7.1 (glibc 2.2) and gcc 2.96, version 3.02/06 (9.0 MB). NEW
- HP PA-RISC HP-UX 10.20 with aCC (v1.18), version 3.03/09 (16.8 MB). NEW
- HP Itanium HP-UX 11.20 with aCC, version 3.03/07 (16.8 MB). NEW
- Compaq Alpha OSF1 with cxx 6.2, version 3.03/09 (12.1 MB). NEW
- Compaq Alpha OSF1 with egcs 1.1.2, version 3.03/09 (14.2 MB). NEW
- Compaq Alpha Linux with egcs 1.1.2, version 3.02/06 (11.0 MB).
- Compaq iPAQ PocketPC Linux with gcc 2.95, version 3.02/06 (7.0 MB).
  For more on Linux on iPAQ see www.handhelds.org.
- IBM AIX 4.5 with xlC version 5, version 3.03/09 (13.0 MB, works only on AIX 4.5). NEW
- Sun SPARC Solaris 5.6 with CC4.2, version 3.02/06 (8.7 MB). It cannot be used with Solaris 5.7 or 5.8 even using the same compiler version. You must recompile from the source on these two systems.
- Sun SPARC Solaris 5.7 with CC5.2, version 3.03/09 (13.9 MB). NEW

  It cannot be used with Solaris 5.6 or 5.8 even using the same compiler version. You must recompile from the source on these two systems.
- Sun SPARC Solaris 5.8 with CC5.2, version 3.03/09 (13.6 MB). NEW

  It cannot be used with Solaris 5.6 or 5.7 even using the same compiler version. You must recompile from the source on these two systems.
- SGI IRIX 6.5 with CC, version 3.03/09 (compiled with -n32) (12.8 MB). NEW
- SGI IRIX 6.5 with g++ 2.95.2, version 3.03/09 (14.5 MB). NEW
- SGI IRIX 6.5 with KCC, version 3.03/09 (13.3 MB). NEW
- LinuxPPC(Suse7.3) gcc 2.95.3, version 3.03/07 (10.5 MB). NEW
  Thanks to Damir Buskulic (buskulic@lapp.in2p3.fr) for building this version.
- MacOS X 10.1, for more info see these pages from Keisuke Fujii.
- Windows/NT/w2000 with VC++ 6.0, version 3.03/08 (good old tar file) **WIN32GDK** (12.9 MB). NEW
  This version is compiled and linked with the GDK driver implemented by Bertrand Bellenot. This is still an experimental version:
  - Advantages: Same GUI and look&feel as on Unix
  - Disadvantages: cannot use MSDOS shell: slower
- Windows/NT/w2000 with VC++ 6.0, version 3.03/09 (good old tar file) (12.6 MB). NEW
- Windows/NT/w2000 with VC++ 6.0,compiled with debug info, version 3.03/09 (good old tar file) (22.1 MB). NEW
- Windows/NT/w2000 with VC++ 6.0, version 3.03/09 (built with InstallShield) (12.6 MB). NEW

26 binary tar files + all possible combinations of OS/Compiler in the Makefile

Downloads total

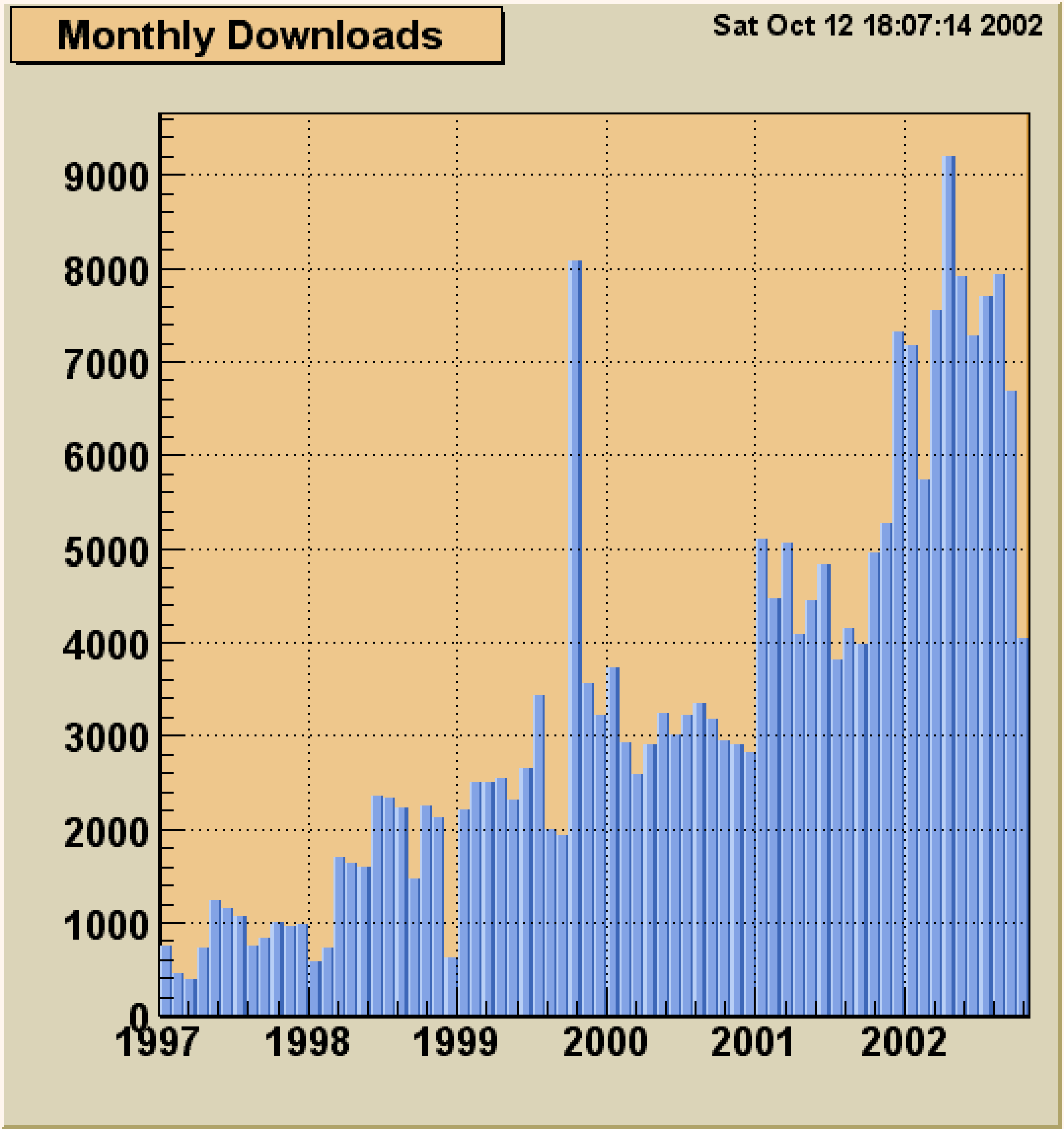


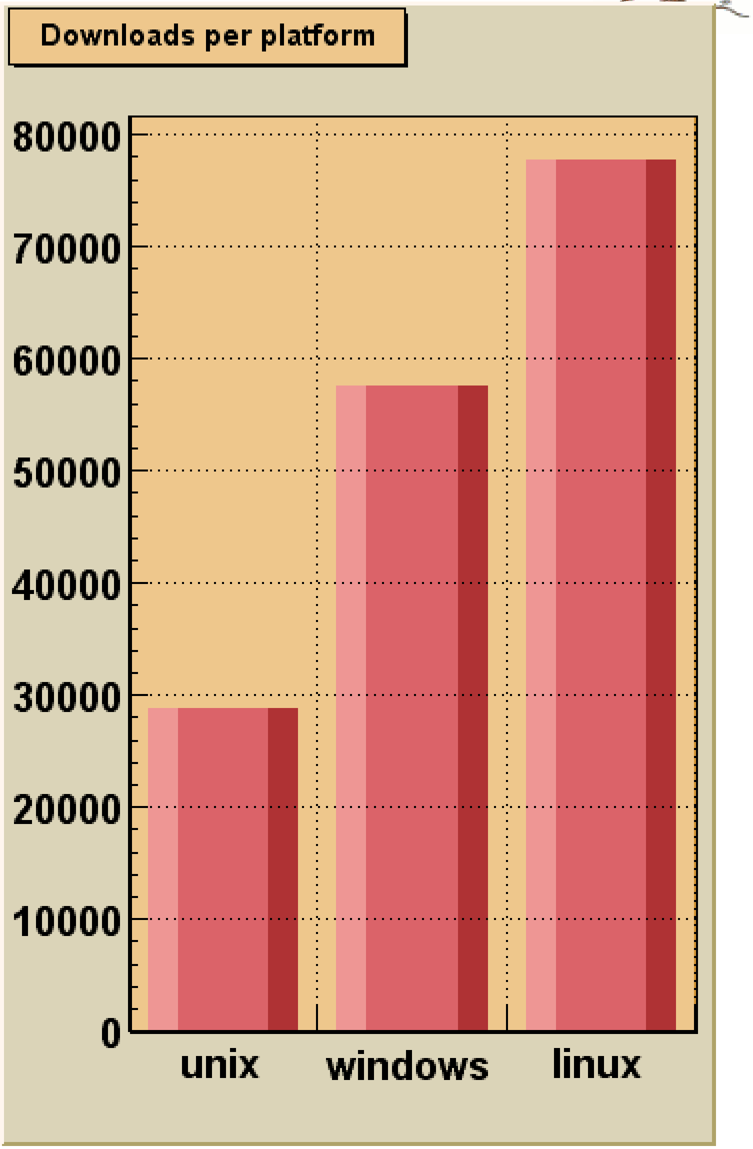
ROOT distribution statistics

Sat Oct 12 18:07:13 2002

Total FTP distributions: 161872
(ROOT binaries only)

Monthly Downloads





Short summary of main developments since FNAL2001

- Jun 2001: prerelease 3.01/05
- Jan 2002: version 3.02/07
- Sep 2002: version 3.03/09

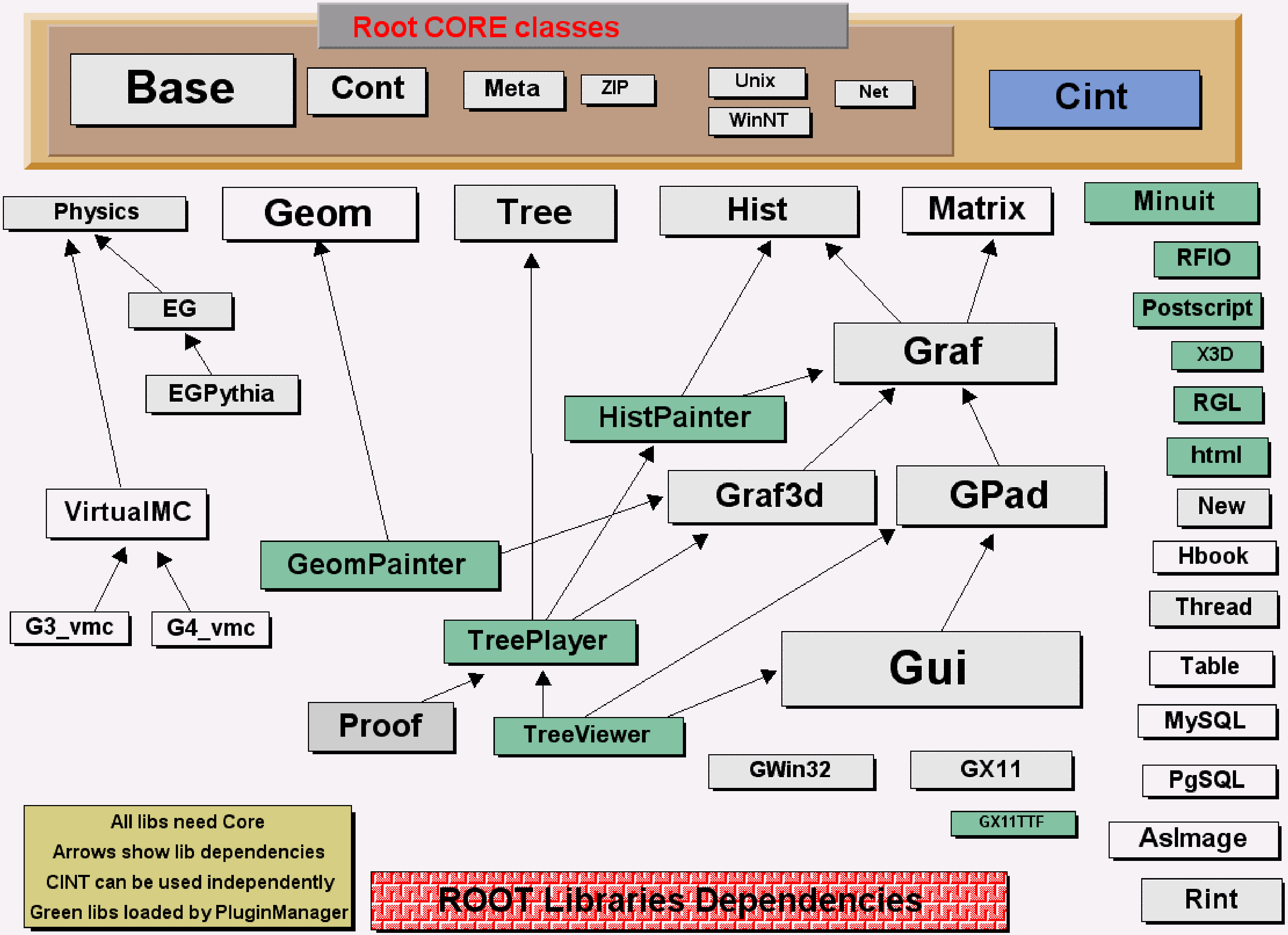
http://root.cern.ch/root/htmldoc/examples/Version302.news.html
http://root.cern.ch/root/htmldoc/examples/Version30207.news.html
http://root.cern.ch/root/htmldoc/examples/Version303.news.html
http://root.cern.ch/root/htmldoc/examples/Version30309.news.html

CINT

- Continuous and impressive list of developments by Masa (see his talk)
- towards full C++ standard ?
  - Still problems with object scope in loops
- Byte code optimisation

Library organisation

- New packages, new libraries
- Matrix moved to list in `root-config --libs`
- Many requests to move Matrix & Physics to Core
- TPluginManager developments
  - see Fons talk



Root CORE classes

Base

Cont

Meta

ZIP

Unix

WinNT

Net

Cint

Physics

Geom

Tree

Hist

Matrix

Minuit

RFIO

Postscript

X3D

RGL

html

New

Hbook

Thread

Table

MySQL

PgSQL

AsImage

Rint

EG

EGPythia

Graf

HistPainter

Graf3d

GPad

VirtualMC

GeomPainter

G3_vmc

G4_vmc

TreePlayer

Gui

Proof

TreeViewer

GWin32

GX11

GX11TTF

All libs need Core

Arrows show lib dependencies

CINT can be used independently

Green libs loaded by PluginManager

ROOT Libraries Dependencies

ROOT I/O developments

- Support for foreign (non ROOT instrumented classes with ClassDef): The SHADOW classes
- New, Simpler and more powerful versions of ClassDef: ClassImp optional
  - see Philippe talk
- TRef, TRefArray classes
  - see my talk on Wednesday
- Better support for templates and STL
  - see Victor talk

Automatic file overflow when writing Trees

New function TFile *TTree::ChangeFile(TFile *file) called by TTree::Fill when file has reached its maximum fgMaxTreeSize. Create a new file. If the original file is named "myfile.root", subsequent files are named "myfile_1.root", "myfile_2.root", etc. We expect to give more control to the user at this point in future versions via the message handler mechanism.

Returns pointer to new file. Currently, the automatic change of file is restricted to the case where the Tree is in the top level directory. The file should not contain sub-directories.

Before switching to a new file, the Tree header is written to the current file, then the current file is closed.

To process the multiple files created by ChangeFile(), one must use a TChain.

The variable fgMaxTreeSize can be set via the static function TTree::SetMaxTreeSize(). The default value of fgMaxTreeSize is 1.9 Gigabytes.

If the current file contains other objects like TH1 and TTree, these objects are automatically moved to the new file.

Rootd, GRID, PROOF

- TPluginManager services for RFIO, DCACHE,etc
- TGrid; Abstract interface to GRID services
- TAlien: an implementation of TGrid
  - see Fons talk
- PROOF: see talks by Fons and Maarten

RDBMS new interfaces

SQL interface to SAP DB (http://www.sapdb.org/)

SAP DB is an open source (GPL) RDBMS that provides full DB functionality and can be easily used instead of Oracle. These classes are based on the ODBC call interface and are provided by Mark Hemberger
(Marc.Hemberger@realtech.de).

SQL interface to PostgreSQL

PostgreSQL interface provided by Gian Paolo Ciceri.

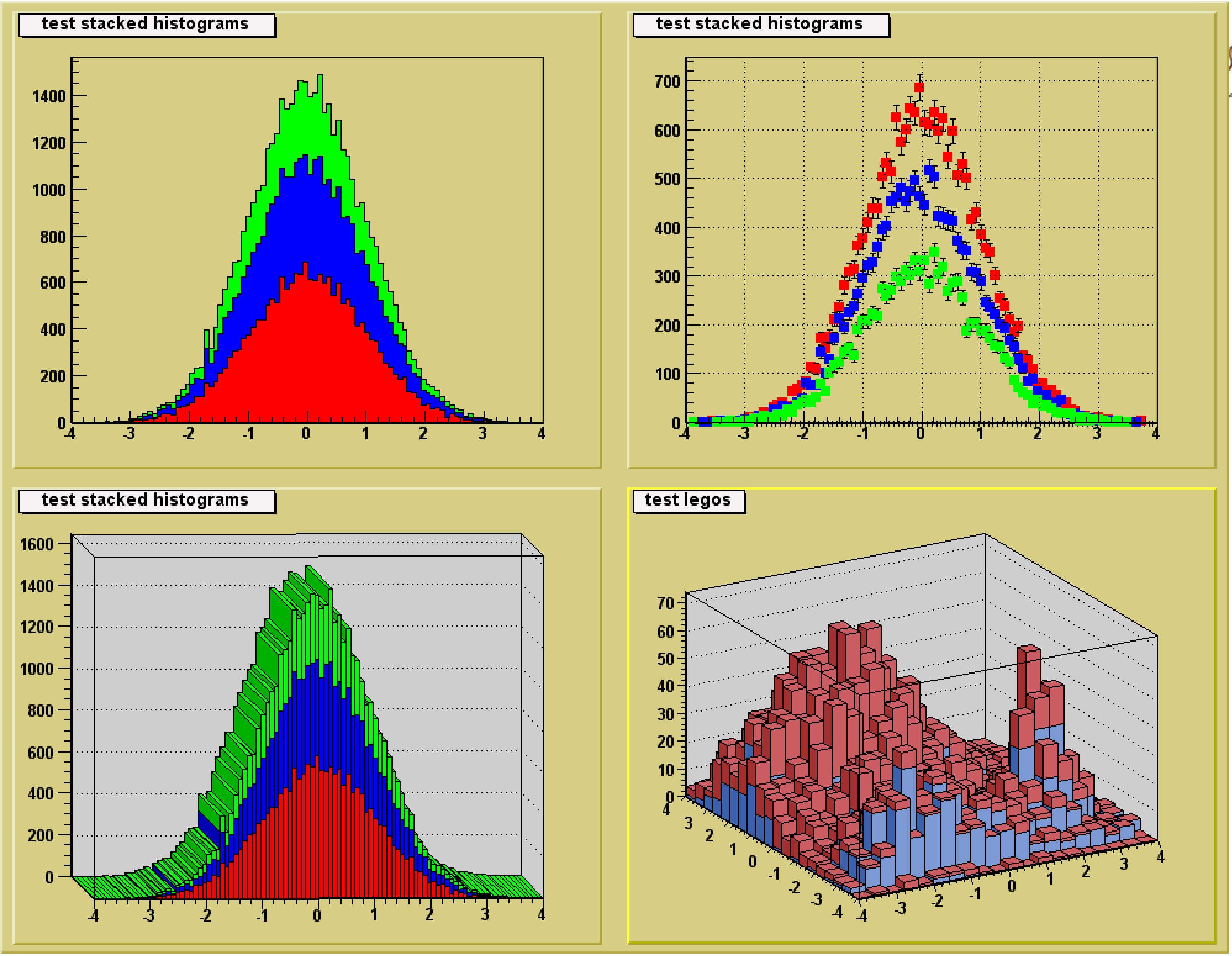
Trees

- TTree::Branch(TCollection *list,...
  - A very powerful way to build a Tree with a dynamic definition at run time
- Automatic split algorithm improved for complex cases of inheritance or composition.
- TTree::MakeClass: many extensions
- TTree/TTreeFormula queries
  - (a long list of improvements)
  - see Philippe talk

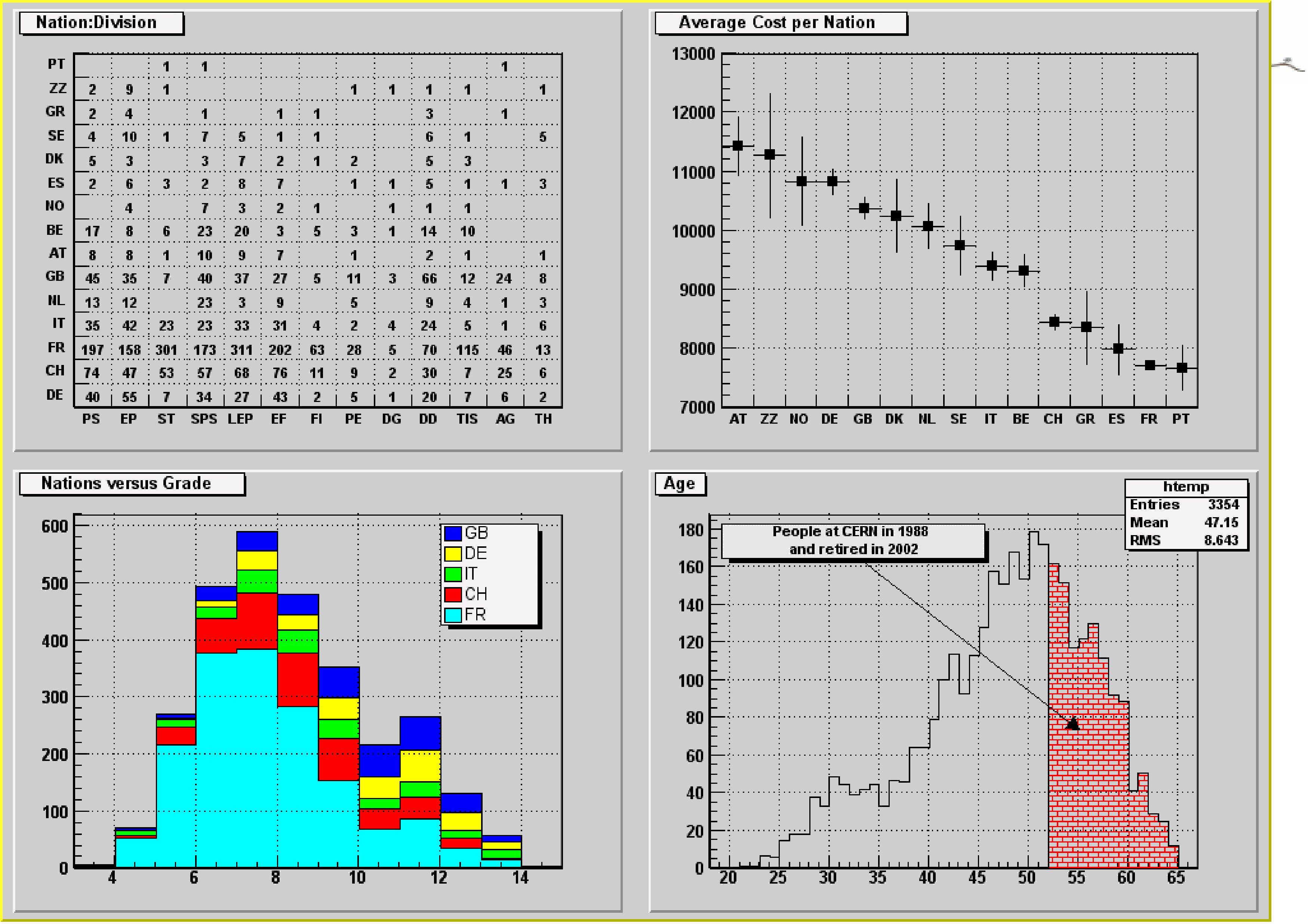
Histograms

- New class THStack
- Long list of new functions in TH1
- Plenty of new drawing options
- Filling with string variables
- TH1::Merge(TCollection *list) (for PROOF)

THStack examples



Filling with string variables



Nation:Division

	PS	EP	ST	SPS	LEP	EF	FI	PE	DG	DD	TIS	AG	TH
PT			1	1								1	
ZZ	2	9	1					1	1	1	1		1
GR	2	4		1		1	1			3		1	
SE	4	10	1	7	5	1	1			6	1		5
DK	5	3		3	7	2	1	2		5	3		
ES	2	6	3	2	8	7		1	1	5	1	1	3
NO		4		7	3	2	1		1	1	1		
BE	17	8	6	23	20	3	5	3	1	14	10		
AT	8	8	1	10	9	7		1		2	1		1
GB	45	35	7	40	37	27	5	11	3	66	12	24	8
NL	13	12		23	3	9		5		9	4	1	3
IT	35	42	23	23	33	31	4	2	4	24	5	1	6
FR	197	158	301	173	311	202	63	28	5	70	115	46	13
CH	74	47	53	57	68	76	11	9	2	30	7	25	6
DE	40	55	7	34	27	43	2	5	1	20	7	6	2

Average Cost per Nation

Nations versus Grade

Age

htemp
Entries 3354
Mean 47.15
RMS 8.643

People at CERN in 1988
and retired in 2002

HBOOK reader

A new set of classes THbookFile, THbookTree, THbookBranch has been added to a new library libHbook.so.This library provides an interface to HBOOK files and provides histogram and ntuple reading capability.

THbookFile is an interface to the Hbook objects in Hbook files.
Any Hbook object (1-D, 2-D, Profile, RWN or CWN can be read
NB: a THbookFile can only be used in READ mode. We have no plans to support writing Hbook objects from ROOT.
Use the utility in $ROOTSYS/bin/h2root to convert Hbook to ROOT.

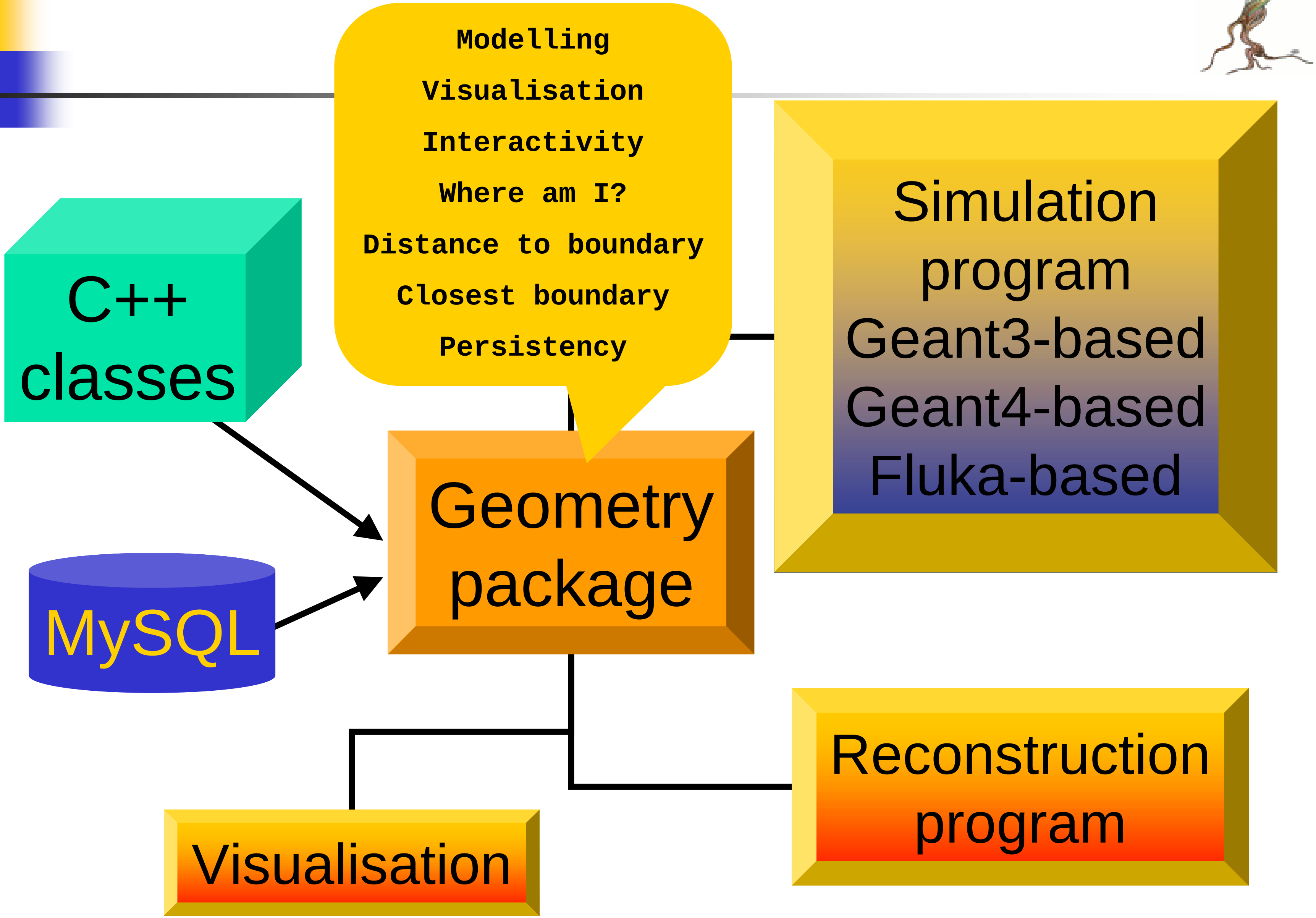
With this new version, one can:

- import automatically any 1-d, 2-d or profile histograms. The Hbook types are converted on the fly to ROOT types TH1F, TH2F and TProfile.

- import ntuple headers (Row or Column-Wise).
  A new data type THbookTree (deriving from TTree) with functions like hbookTree.Draw("x","selection") like for a normal TTree. The ntuple data are read directly from the Hbook file.

- The Tree viewer can be used directly: hbookTree.StartViewer();

New Detector Geometry



Modelling

Visualisation

Interactivity

Where am I?

Distance to boundary

Closest boundary

Persistency

C++ classes

MySQL

Geometry package

Simulation program Geant3-based Geant4-based Fluka-based

Visualisation

Reconstruction program

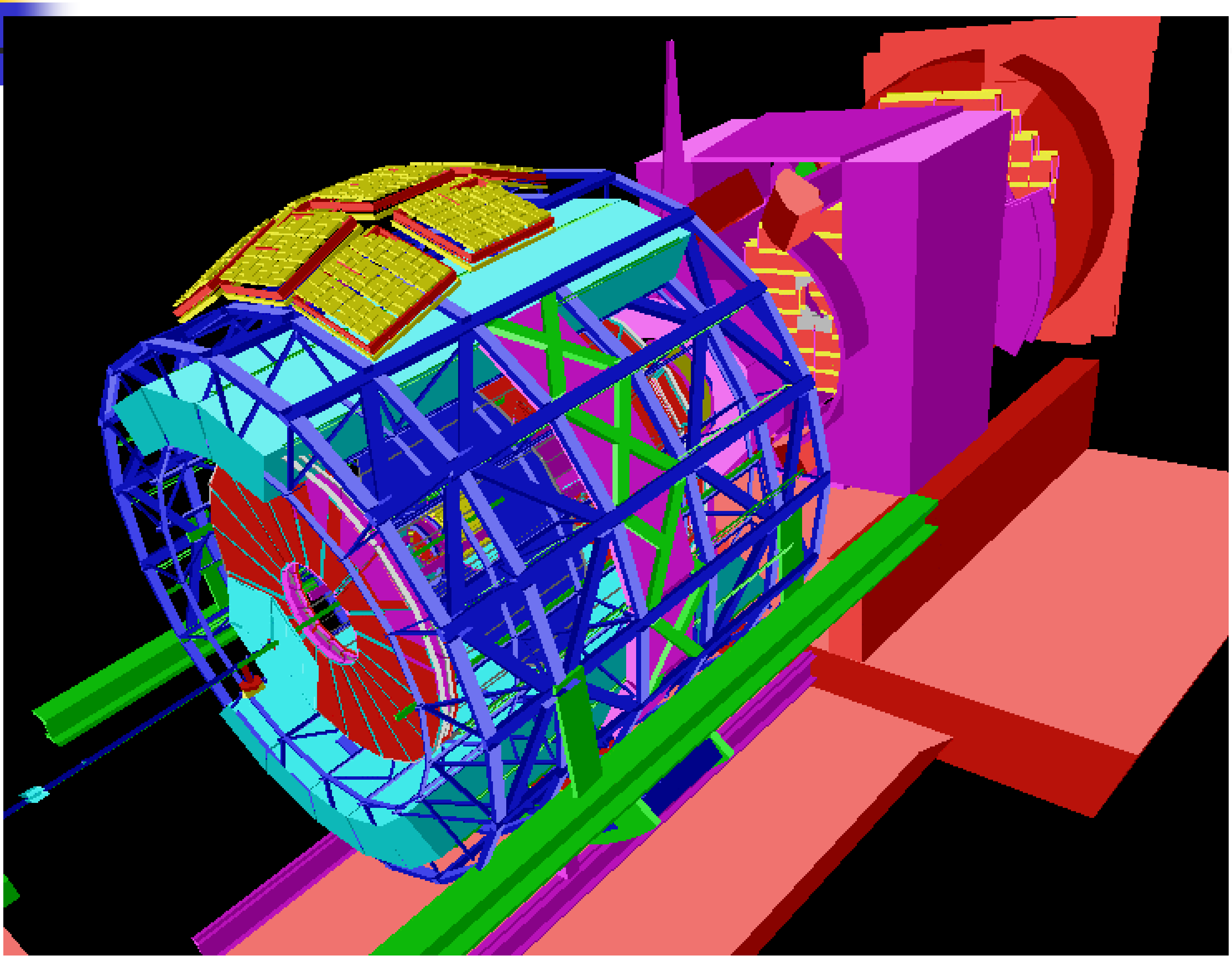
The new Geometry classes

The new ROOT geometry package is a tool designed for building, browsing, tracking and visualizing a detector geometry. The code is independent from other external MC for simulation, therefore it does not contain any constraints related to physics. However, the package defines a number of hooks for tracking, such as materials, magnetic field or track state flags,
in order to allow interfacing to tracking MC's. The final goal is to be able to use the same geometry for several purposes, such as tracking, reconstruction or visualization, taking advantage of the ROOT features related to bookkeeping, I/O, histograming, browsing and GUI's.

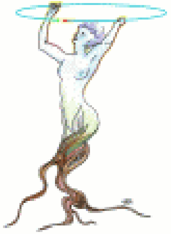
Developed in collaboration with ALICE

See Andrei Gheata talk

The TGeo classes in ALICE



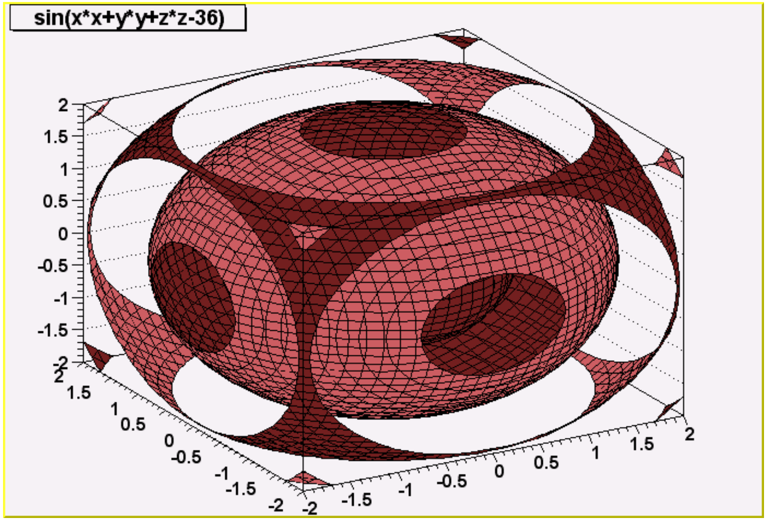
Graphics



- **TGaxis**
  - New functions SetNoExponent, SetMaxDigits, SetFunction
- **TPad / TVirtualPad**
  - added support for fixed aspect ratio (SetFixedAspectRatio)
  - Added signals RangeChanged() and RangeAxisChanged(). Basically it allows for easy monitoring of zoom events.
- **New class TGraphSmooth (Christian Stratowa)**
  - This class is a helper class to smooth TGraph, TGraphErrors or interpolate a graph at a set of given points. See new tutorial motorcycle.C
- **New class TSVG implemented by Olivier Couet.**
  - TSVG may be used like TPostScript to produce a Scalable Vector Graphics file instead of a postscript file.
  - Viewers like Internet Explorer can view directly the SVG files.

Graphics (cont)

- TF3 objects can be drawn. Example:
  - TF3 *fun3 = new TF3("fun3","sin(x*x+y*y+z*z-36)",-2,2,-2,2,-2,2);
  - fun3->Draw();



- **New Postscript interface from a pad/canvas**

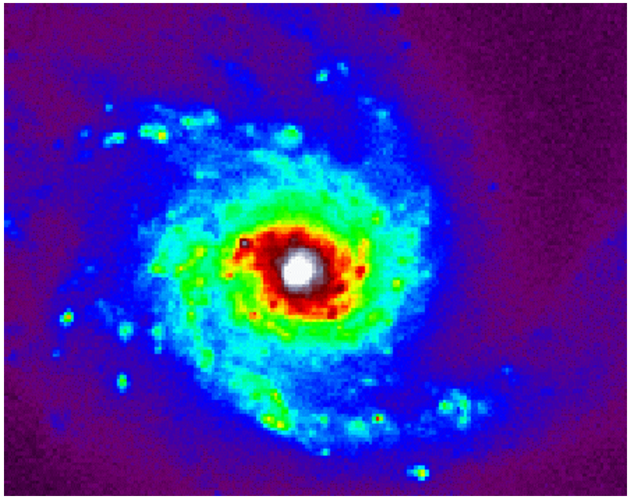
```
TCanvas c1("c1");
h1.Draw();
c1.Print("c1.ps("); //write canvas and keep the ps file open
h2.Draw();
c1.Print("c1.ps"); canvas is added to "c1.ps"
h3.Draw();
c1.Print("c1.ps)"); canvas is added to "c1.ps" and ps file is closed
```

TASImage classes

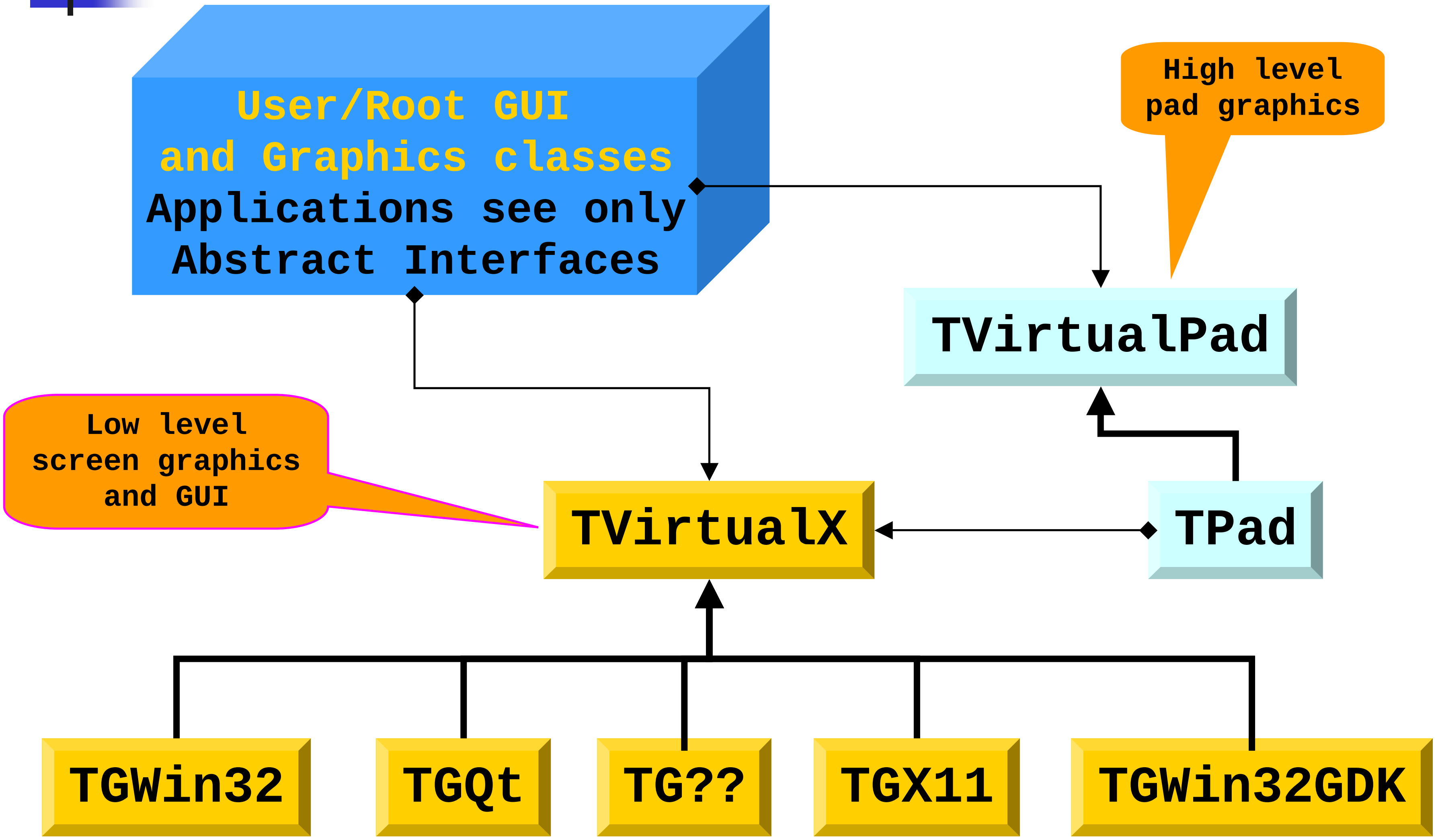
New set of image processing classes. The TImage class is the abstract image base class and TASImage is the concrete implementation using the libAfterImage imaging library of Sasha Vasko <sasha@aftercode.net>.

A large part of the development was done by Reiner Rohlfs from the ISDC based on a set of astrophysics user requirements.

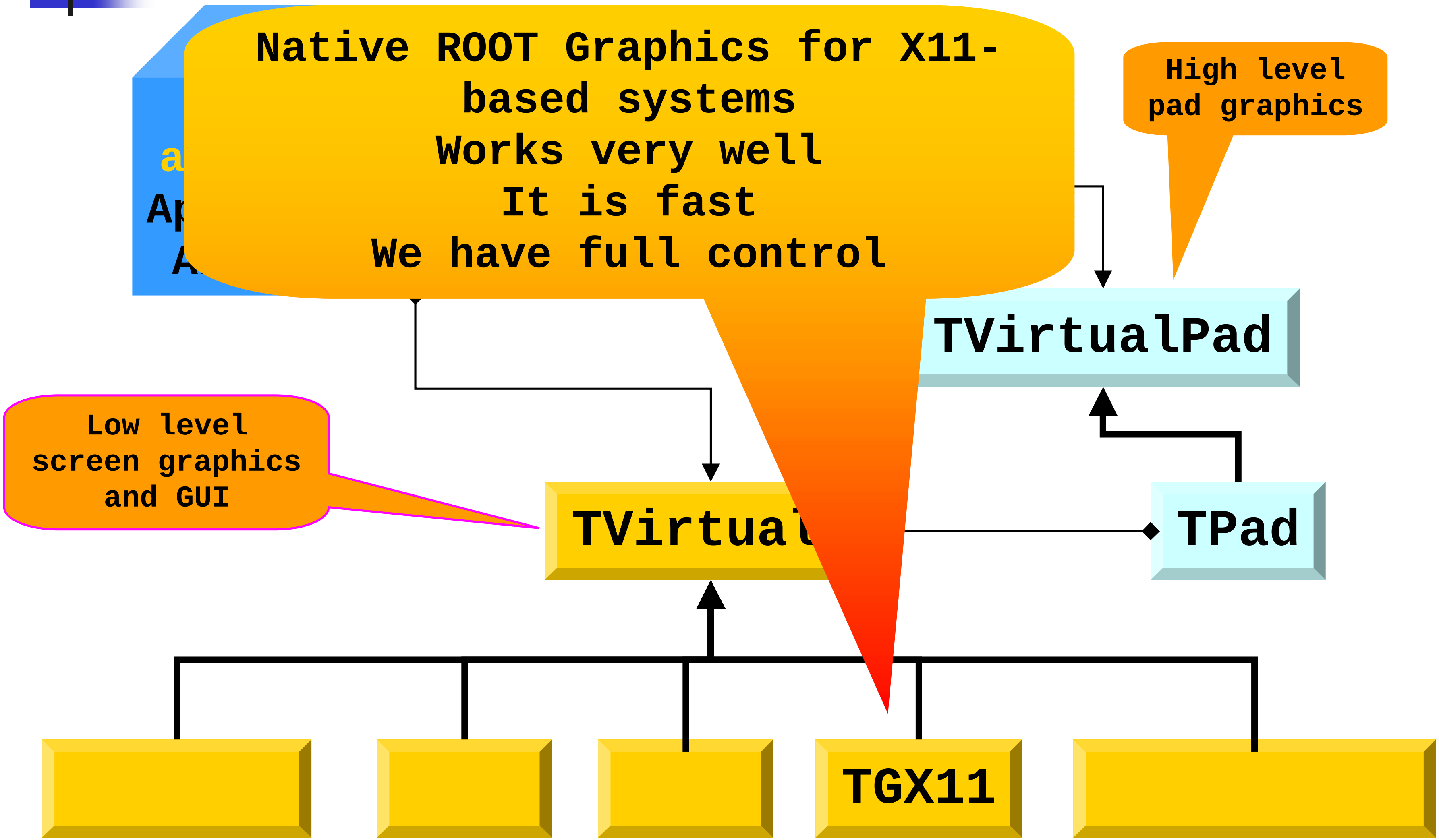
The image class allows for the reading and writing of images in different formats, several image manipulations (scaling, tiling, merging, etc.) and displaying in pads. The size of the image on the screen does not depend on the original size of the image but on the size of the pad.Therefore it is very easy to resize the image on the screen by resizing the pad.



Gui/Graphics strategy



Gui/Graphics strategy: TGX11

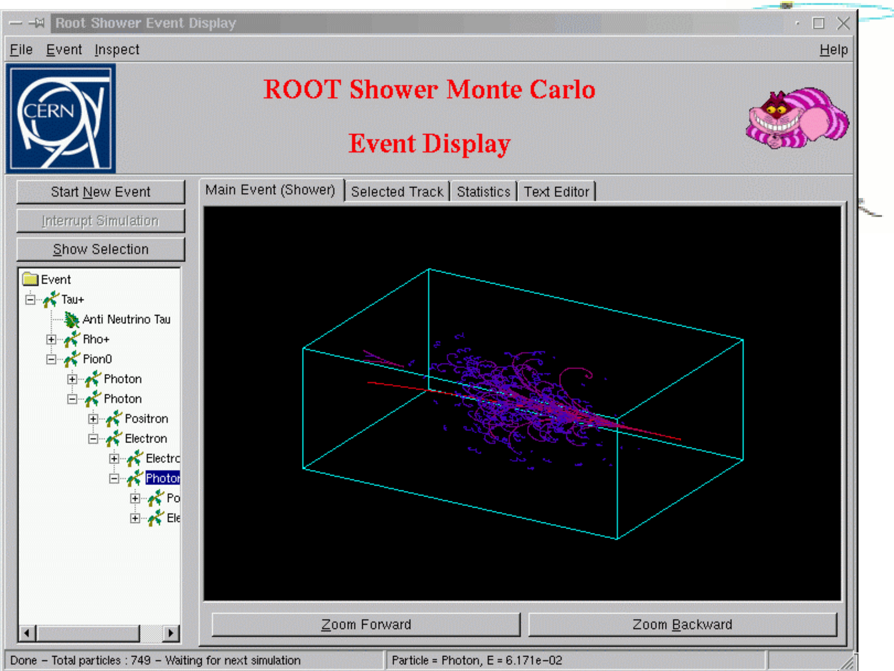


Native ROOT Graphics for X11-based systems
Works very well
It is fast
We have full control

High level pad graphics

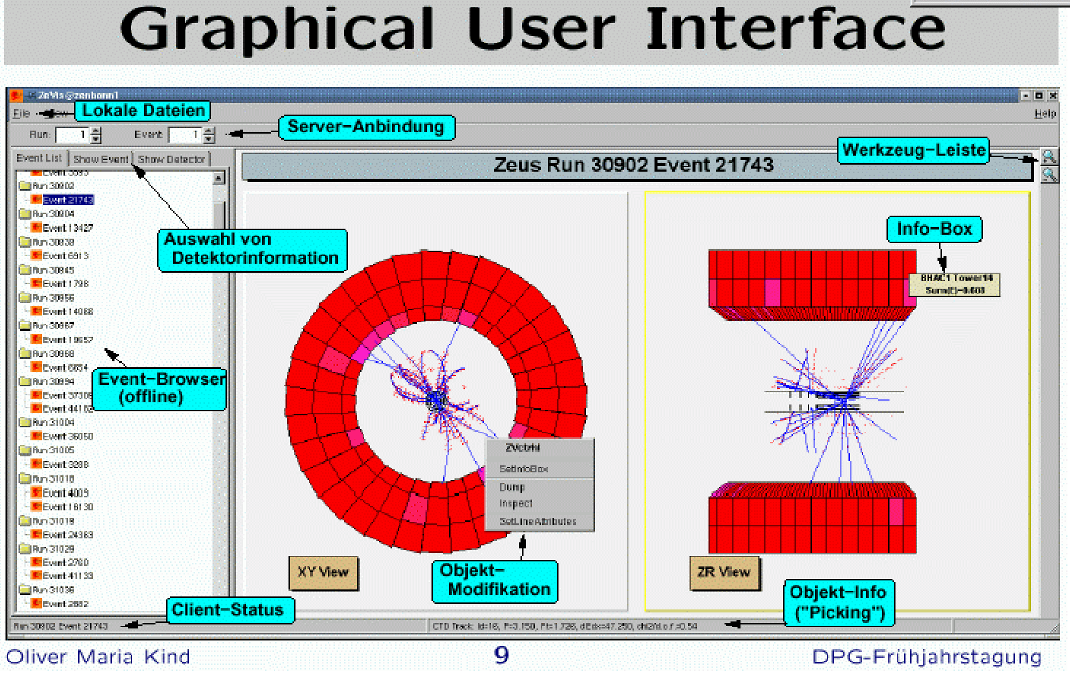
Low level screen graphics and GUI

Event Displays



Done – Total particles : 749 – Waiting for next simulation

Particle = Photon, E = 6.171e-02

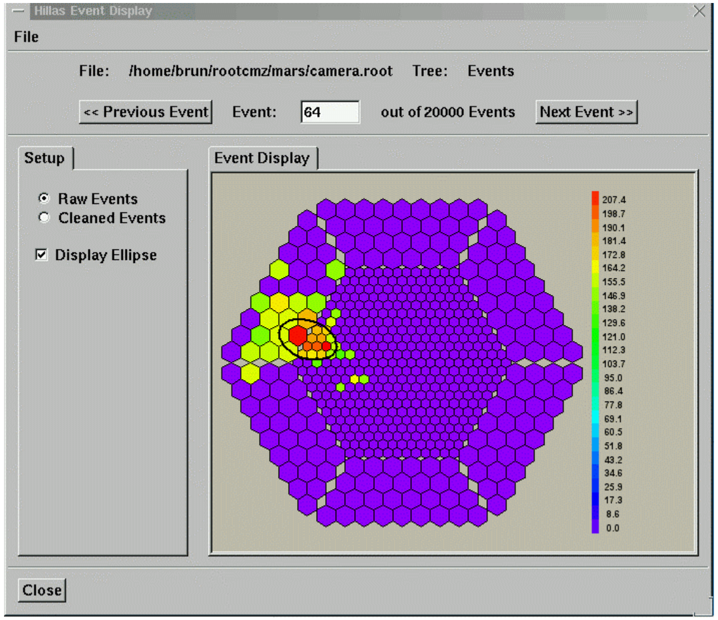


Graphical User Interface

Run 30902 Event 21743

CTD Track: Id=16, P=3.150, Pt=1.726, dEdx=47.250, chi2/d.o.f.=0.54

Oliver Maria Kind 9 DPG-Frühjahrstagung



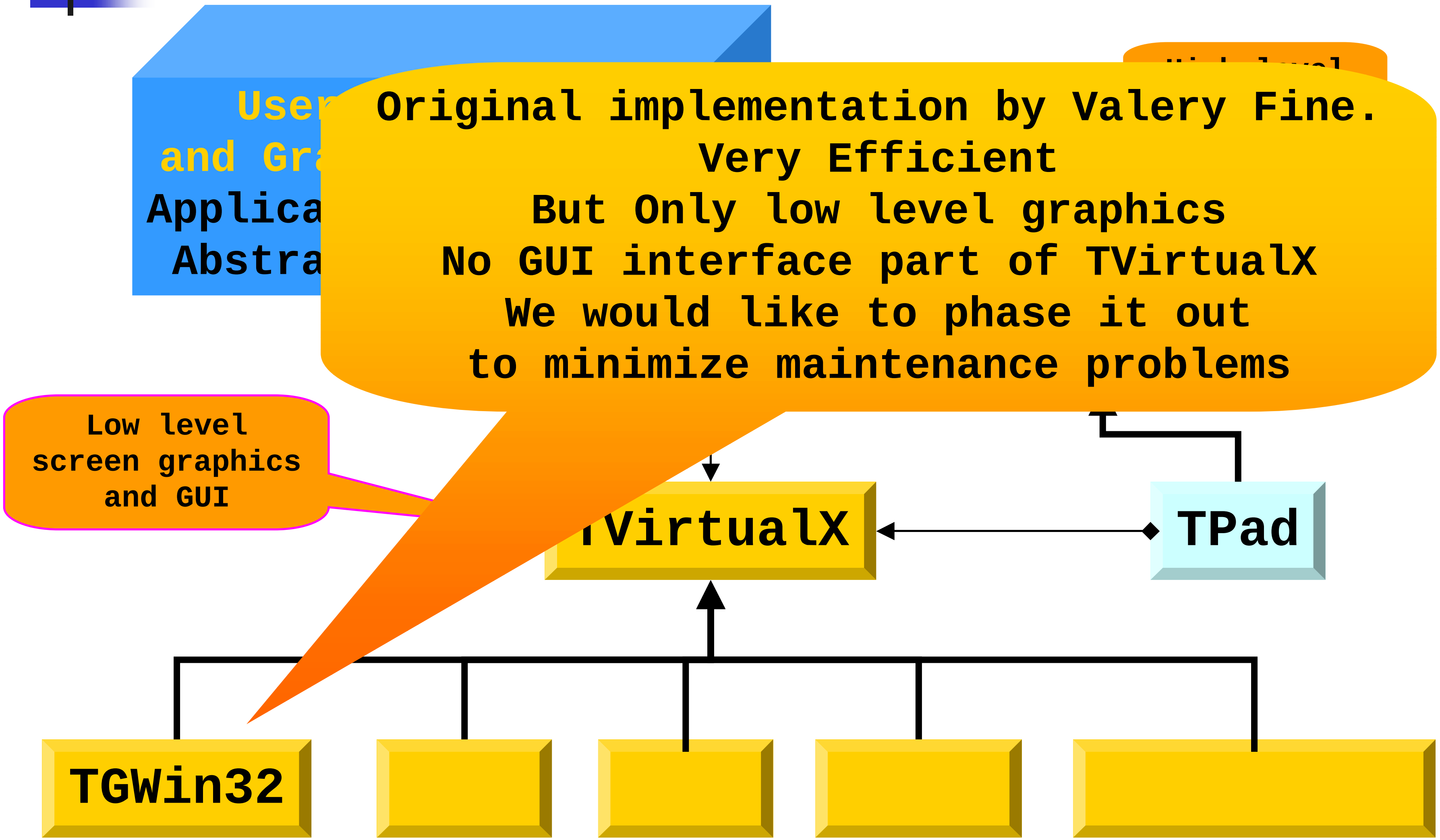
File: /home/brun/rootcmz/mars/camera.root Tree: Events

Event: 64 out of 20000 Events

● Raw Events
○ Cleaned Events

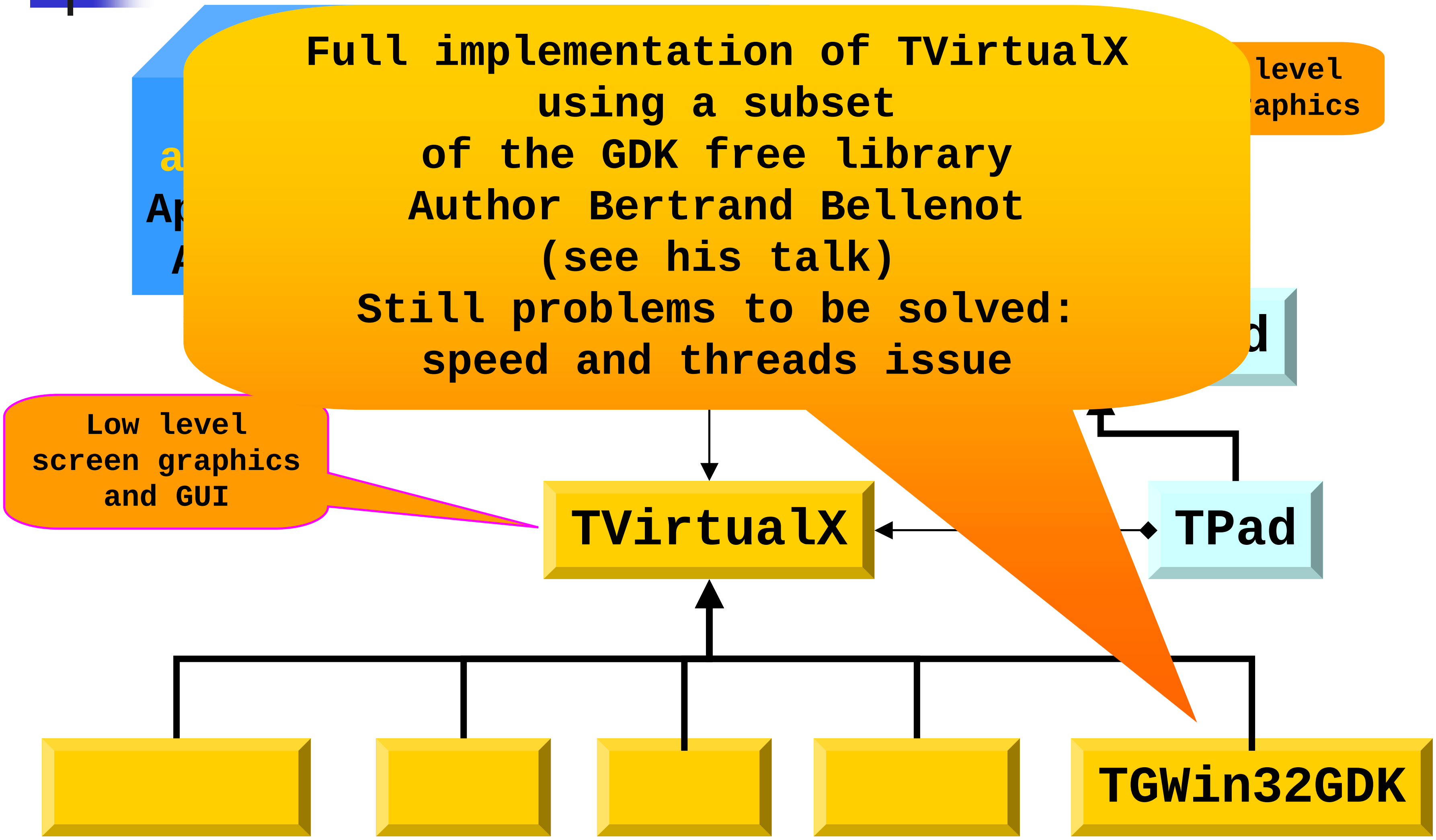
☑ Display Ellipse

Gui/Graphics strategy:TGWin32



Original implementation by Valery Fine.
Very Efficient
But Only low level graphics
No GUI interface part of TVirtualX
We would like to phase it out
to minimize maintenance problems

Gui/Graphics strategy:TGWin32GDK

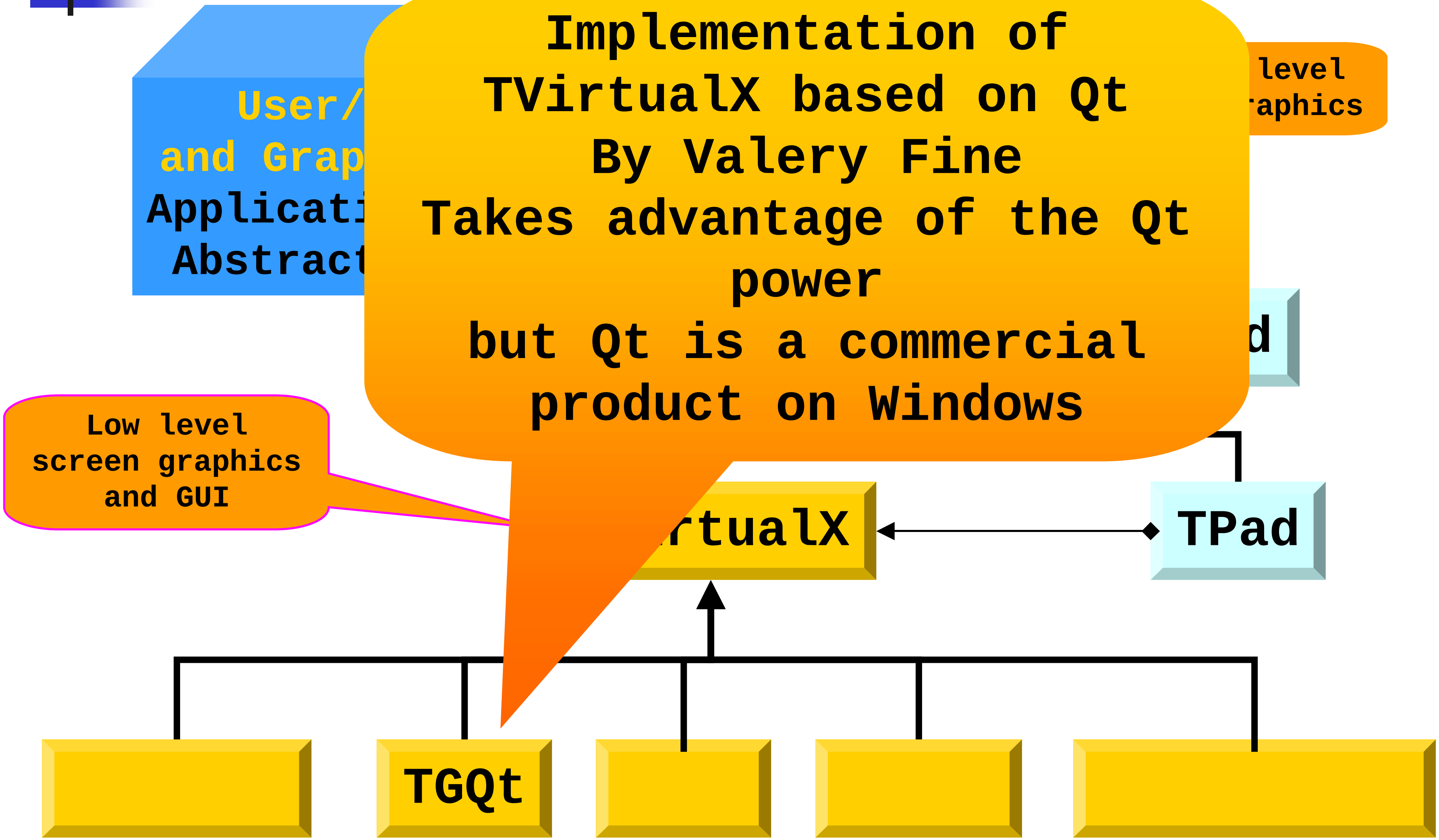


Full implementation of TVirtualX
using a subset
of the GDK free library
Author Bertrand Bellenot
(see his talk)
Still problems to be solved:
speed and threads issue

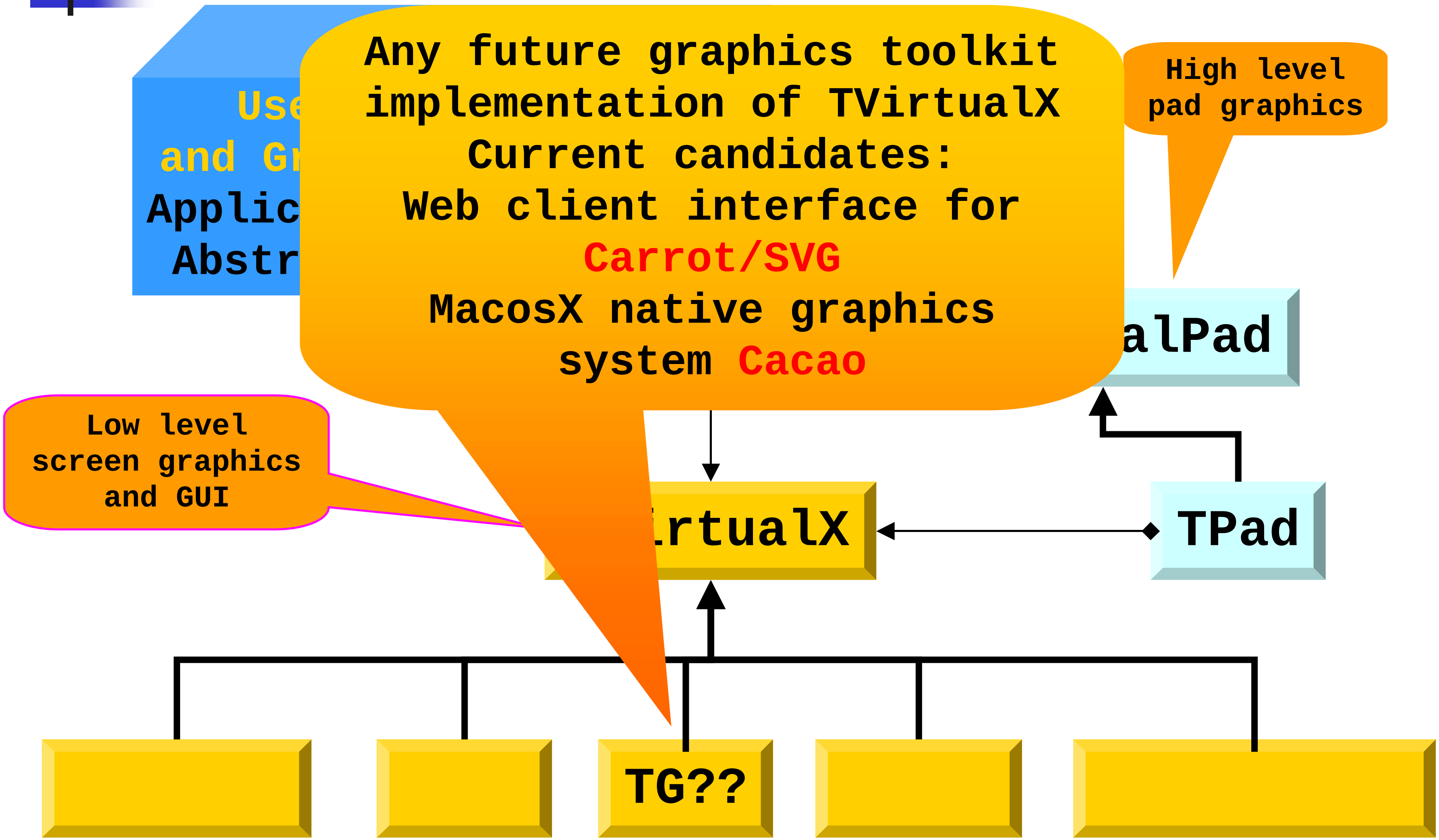
Low level
screen graphics
and GUI

Gui/Graphics strategy: TGQt

Implementation of
TVirtualX based on Qt
By Valery Fine
Takes advantage of the Qt power
but Qt is a commercial product on Windows



Gui/Graphics strategy: TG??



Any future graphics toolkit implementation of TVirtualX
Current candidates:
Web client interface for
Carrot/SVG
MacosX native graphics system Cacao

High level pad graphics

Low level screen graphics and GUI

Other Developments

- TMatrix:
  - Many enhancements by Eddy Offermann
  - see Eddy talk
  - Alternative to TMatrix: GSL ?
- THtml
  - Consolidation by Axel Naumann
  - Considering an interface to Doxygen
  - see my talk on Future Root on Wednesday

New class TFractionFitter
Frank Filthaut

Fits MC fractions to data histogram (a la HMCMLL, see R. Barlow and C. Beeston, Comp. Phys. Comm. 77 (1993) 219-228, and http://www.hep.man.ac.uk/~roger/hfrac.f).

The virtue of this fit is that it takes into account both data and Monte Carlo statistical uncertainties. The way in which this is done is through a standard likelihood fit using Poisson statistics; however, the template (MC) predictions are also varied within statistics, leading to additional contributions to the overall likelihood. This leads to many more fit parameters (one per bin per template), but the minimization with respect to these additional parameters is done analytically rather than introducing them as formal fit parameters.

New "Confidence Level" classes from Christophe Delaere

class TLimit

Algorithm to compute 95% C.L. limits using the Likelihood ratio semi-bayesian method. It takes signal, background and data histograms wrapped in a TLimitDataSource as input and runs a set of Monte Carlo experiments inorder to compute the limits. If needed, inputs are fluctuated according to systematics. The output is a TConfidenceLevel.

class TLimitDataSource

Takes the signal, background and data histograms as well as differentsystematics sources to form the TLimit input.

class TConfidenceLevel

Final result of the TLimit algorithm. It is created just after thetime-consuming part and can be stored in a TFile for further processing. It contains light methods to return CLs, CLb and other interesting quantities.

A new tutorial limit.C illustrates the use of these new classes.

New class TFeldmanCousins
Adrian Bevan

Class to calculate the CL upper limit using the Feldman-Cousins method

The default confidence interval calculated using this method is 90%. This is set either by having a default the constructor, or using the appropriate fraction when instantiating an object of this class (e.g. 0.9).

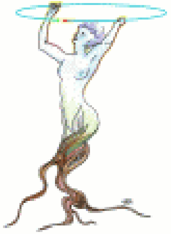
See also the TerraFerma package from Sherry Towers

Presented by Philippe

TMath

- New fundamental mathematical and physical constants
  - (thanks to Tony Colley).
- New functions:
  - Double_t TMath::Voigt()
    - Convolution of Gaus and Lorentz functions. (thanks to Miha D. Puc)
  - Double_t TMath::BreitWigner()
    - Calculate a Breit Wigner function with mean and gamma
- Add two new sorting functions:
  - void BubbleHigh(Int_t Narr, Double_t *arr1, Int_t *arr2)
  - void BubbleLow (Int_t Narr, Double_t *arr1, Int_t *arr2)
  - Thanks to Adrian Bevan, Liverpool University
- Add functions TMath::IsInside
- Add new Bessel functions and the Struve function:
  - Double_t BesselJ0(Double_t x); // Bessel function J0(x) for any real x
  - Double_t BesselJ1(Double_t x); // Bessel function J1(x) for any real x
  - Double_t BesselY0(Double_t x); // Bessel function Y0(x) for positive x
  - Double_t BesselY1(Double_t x); // Bessel function Y1(x) for positive x
  - Double_t Struve(Int_t n, Double_t x);// Struve functions of order 0 and 1

Many new tutorials



quantiles.C to illustrate the use of TH1::GetQuantiles().

hstack.C to illustrate the use of the new class THStack.

motorcycle.C to illustratre the new class TGraphSmooth.

Worldmap.C New GUI demo by Valeriy Onuchin.

PhaseSpace.C illustrating the use of the class TGenPhaseSpace by Valerio Filippini.

graphApply.C to demonstrate the functionality of TGraphX::Apply() method by Miro Helbich.

waves.C illustrating the use of color palettes (Otto Schaile)

greyscale.C showing the use of TColor::GetColor() and how to set a pad to the exact same color as the GUI.

DynamicSlice.C Improved quality of graphics

FittingDemo.C idem

first.C idem

second.C idem

crown.C illustrating new class TCrown.

rose_image.C showing an image (TASImage) in a ROOT canvas.

galaxy_image.C illustrating the new TASImage class and an image editor.

hsumanim.C illustrating how to make an animated gif file and view it. The animated gif is generated using the gifsicle tool. see comments in the tutorial.

rootgeom example illustrating the new geometry package.

hadd.C tutorial modified by Anne-Sylvie Nicollerat to automatically add Trees (via a chain of trees).

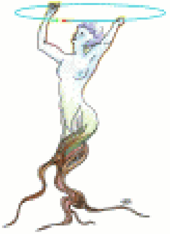
fitExclude.C illustrating how to exclude a range of bins from a fit.

alien.C illustrating the use of the new GRID class TAlien.

Many new tutorials

FeldmanCousins.C	illustrating the use of TFeldmanCousins class.
spy.C, spyserv.C	demo showing how to snoop objects from a server.
pythiaExample.C	illustrating the use of Pythia6 with ROOT.
customContextMenu.C	illustrating how to customize a custom menu.
customTH1Fmenu.C	another example with TH1F.
img2pad.C	to show how to display an image in a pad/canvas
imgconv.C	save an image in various formats: .png, .gif, .xpm and tiff.
pad2png.C	create a canvas and save as png.
langaus.C	convoluted Landau and Gaussian Fitting example.
exec3.C	simple example showing the GUI signal/slots mechanism.
bill.C	benchmark comparing write/read to/from keys or trees.
exec3.C	show the use of signal/slots to process TCanvas events.

Roottalk



Mails to roottalk

1323 in 1997
2515 in 1998
3004 in 1999
3567 in 2000
4686 in 2001
4349 in 2002 (Jan->Sep)

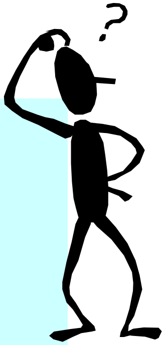
+ mails to rootdev and root-bugs

PLEASE:

-Always indicate a mail subject

-Always indicate which version of ROOT and which OS

-Send a x.tar.gz file instead of many files in attachement



Enjoy this workshop

Do not miss

the Wednesday evening session