

# Libraries and Frameworks: 2015 Programme of Work

2nd February 2015, SFT Group Meeting

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# Outline

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- ❖ ROOT Plans
- ❖ External Packages and LCG Releases Plans

# ROOT Plans for 2015 and Beyond

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# ROOT Main Areas of Work

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- ❖ Development
- ❖ Documentation
- ❖ New Platforms
- ❖ Infrastructure
- ❖ User Support
- ❖ ROOT and the HEP Software Foundation

# The ROOT Core Team

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- ❖ Bertrand BELLENOT
- ❖ Philippe CANAL (FNAL)
- ❖ Oliver COUET
- ❖ Gerri GANIS
- ❖ Benedikt HEGNER
- ❖ Pere MATO
- ❖ Lorenzo MONETA
- ❖ Axel NAUMANN
- ❖ Danilo PIPARO
- ❖ David SMITH
- ❖ Eric TEJEDOR (Fellow)
- ❖ Wim WLAVRIJSEN (LBNL)

# Main Development Directions

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- ❖ Cling Interpreter consolidation and its full exploitation
- ❖ Parallelization
- ❖ Vectorization
- ❖ I/O Improvements
- ❖ Math Libraries
- ❖ New Histograms
- ❖ Python reloaded
- ❖ Packaging and modularization
- ❖ Re-thinking User Interface
- ❖ ROOT as-a-service

# Development: Cling

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Consolidation - follow closely needs from experiments  
C++11 / 14, JIT compilation opens many possibilities

- ❖ Migration to MCJIT
  - ❖ Assembler instructions, exceptions handling, proper debugging
  - ❖ Pre-requisite for using recent LLVM versions
- ❖ Introduction of PCMs
  - ❖ Essential for reducing the memory footprint
- ❖ New developments exploiting Cling / C++11 / 14
  - ❖ new TTreeFormula, automatic differentiation (if manpower available)
  - ❖ C++11 features: move constructors, ...

# Development: Parallelization

Seek for any opportunity in ROOT to do things in parallel to better exploit the new hardware

- ❖ Re-engineer Proof-Lite or develop something new for executing parallel tasks in both **multi-process** and **multi-thread**
- ❖ Prototype solution(s) for 4 use cases:
  - ❖ Histogram/ntuple filling (Rene's programs)
  - ❖ Ntuple processing (TTreeDraw)
  - ❖ I/O pipeline (serialization, compression, disk I/O)
  - ❖ Minimization/Fitting (task and data parallel)
- ❖ Solve problems for merging efficiently the output objects produced by the parallel tasks: (histograms, trees, etc....)
- ❖ Introduce thread-safety where needed (e.g. I/O)

# Development: Vectorization

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- ❖ Exploit vectorization in code which can be critical
  - ❖ Add vector signature for function evaluations (to be used for fitting)
  - ❖ Vectorization in queries of trees (TTreeFormula)
  - ❖ Computing histogram sums of histogram bin contents
  - ❖ Vectorize commonly used math and statistical functions
- ❖ Collaboration with GeantV for supporting GPUs
  - ❖ CUDA implementation of math functions (bessel, gamma,...)

# Development: I/O improvements

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- ❖ Support for new C++11 constructs / containers
  - ❖ e.g. STL collections, `std::unique_ptr`, `std::share_ptr`
- ❖ Performance (runtime, disk space, memory) improvements
  - ❖ switch to little-endian, compress each entry individually to improve random access, reduce cost of repeated [deep] hierarchies
- ❖ TTreeCache
  - ❖ New OptimizedBasket, add to FastCloning, investigate extending prefetching algorithms
- ❖ Fix outstanding issues with
  - ❖ I/O rules, thread safety

# Development: Math Libraries

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- ❖ Improve MVA tools in ROOT
  - ❖ add some new algorithm (e.g. variable importance, multi-target regression)
  - ❖ add interface for R to use MVA tools of R in TMVA
  - ❖ investigate and replace (if needed) some of the tools
  - ❖ improve kd-tree's to use for interpolation and density estimation in multi-dimensions.
- ❖ RooFit
  - ❖ improve performances looking a real case-models (e.g. Higgs combination models)
  - ❖ exploit vectorization in pdf evaluations in RooFit/HistFactory
- ❖ RooStats
  - ❖ extend support for 2D models in RooStats
  - ❖ facilitate usage of tools (e.g. command line for running RooStats limit and significance tools)
- ❖ New Random generators for concurrent environment
  - ❖ prototype work within MixMax project funded by the EU

# Development: New Histograms

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- \* new TFormula and new TF1 are almost completed
  - \* use the occasion for changing TF1-TF2-TF3 inheritance
  - \* have a common base class (e.g TFBBase)
  - \* implement TF1,2,3 and a new TFN as derived classes of TFBBase
- \* Re-design histogram classes
  - \* new full implementation of histogram classes with completely new interfaces (not high priority)
  - \* re-design must be done together with graphics and core (ownership issues)
- \* backward compatibility in I/O
  - \* do we need to be able to read files written with very old versions (< 5) ?
  - \* could provide ad-hoc converters for these files if needed

# Developments: Python Reloaded

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- ❖ Re-factoring of PyROOT
  - ❖ Wim's ongoing work
  - ❖ Details to be discussed next week
- ❖ Better tutorials and documentation
  - ❖ e.g. tree analysis
- ❖ Better integration with other scientific modules
  - ❖ E.g. NumPy, SciPy, StatsModels,...
- ❖ Distribute **rootpy** within ROOT
  - ❖ The **rootpy** project is a community-driven initiative aiming to provide a more pythonic interface with ROOT on top of the existing PyROOT bindings

# Development: Packaging

Easy use third party packages

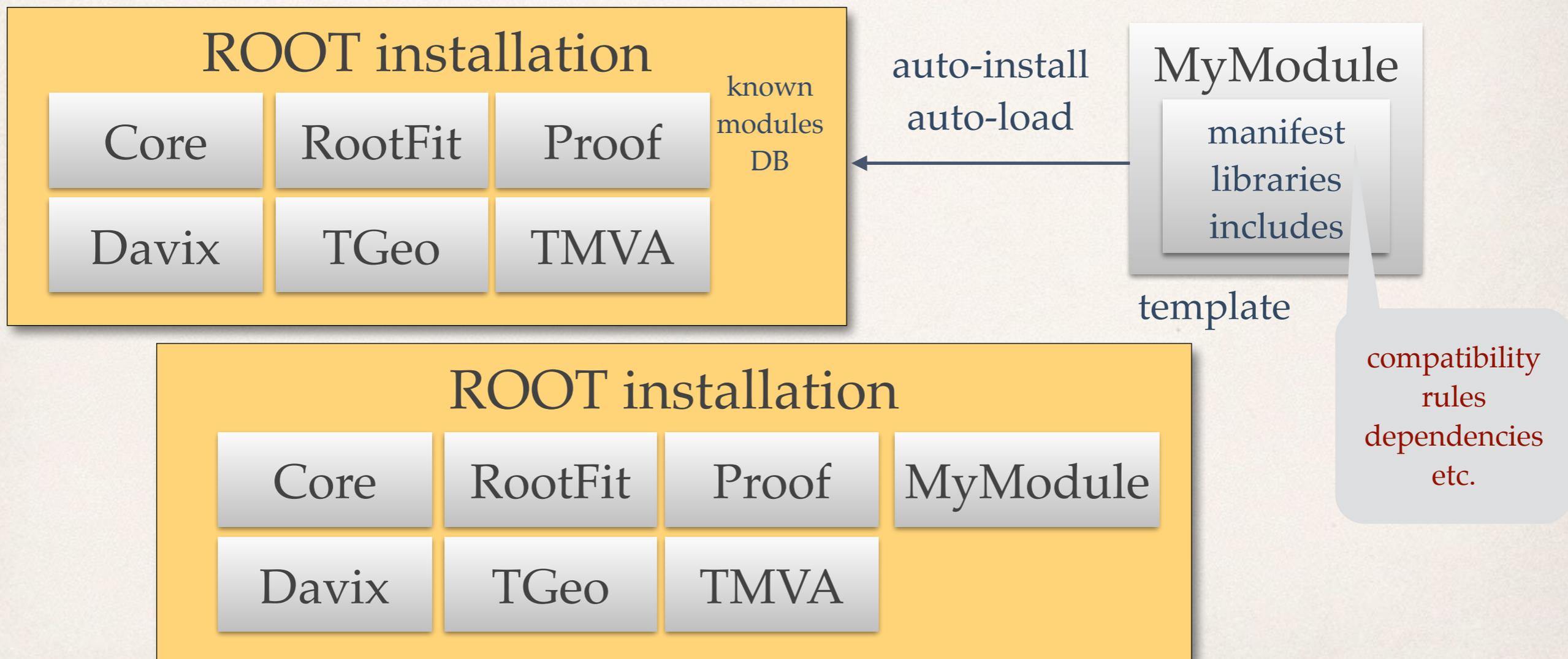
Build/install modules and plugins on demand

Slimed down initial ROOT installation (BOOT)

- \* Need to incorporate new external packages in the core of ROOT
  - \* e.g. VecGeom, vc, vdt, TBB, new random lib, ...
  - \* streamline procedures for building, testing and deploying
- \* Migrate TGeom to use VecGeom
  - \* keep the same user interface if possible
- \* Develop model for building/installing modules on demand and evolve ROOT into BOOT
  - \* Essential for contributors

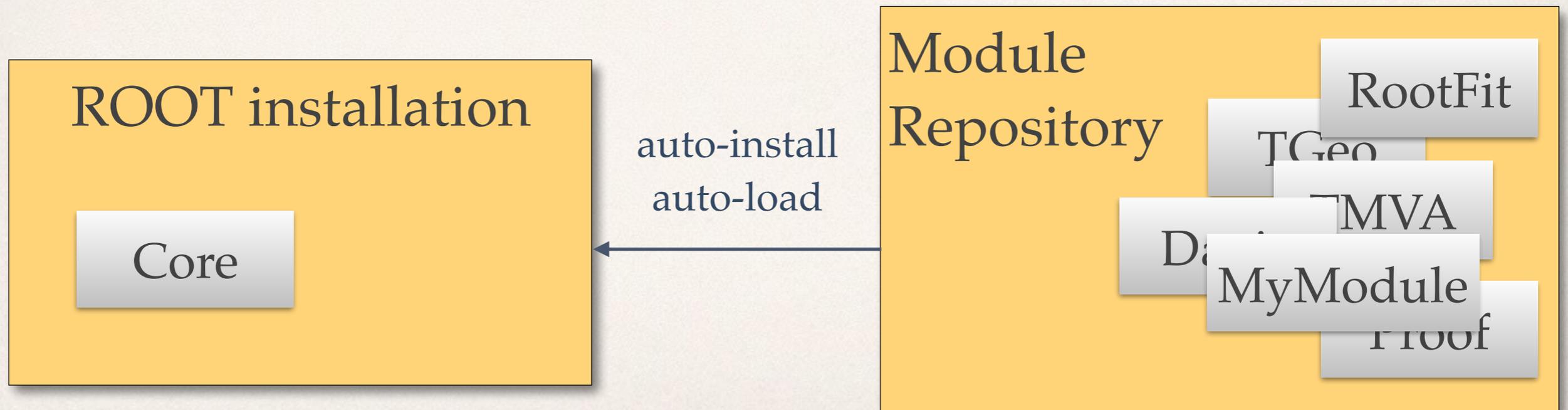
# Step 1: Auto-install

- \* Explicit or implicit installation of **known modules** when required
  - \* type/namespace  $\longleftrightarrow$  module name



# Step2: BOOT

- ❖ Once the auto-install system is well understood and working adequately we could factorize the standard ROOT installation in a number of modules
  - ❖ Minimal installation and memory requirements
- ❖ Contributors can easily provide modules



# Development: Graphics

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- ❖ Continuous improving, feedback from ROOT user's workshop, and user's requests, etc.
- ❖ In particular:
  - ❖ Improve the GUI fonts
  - ❖ TMathText (LaTeX interpreter) PDF output and reduce the space need for fonts

# Development: Rethinking UI

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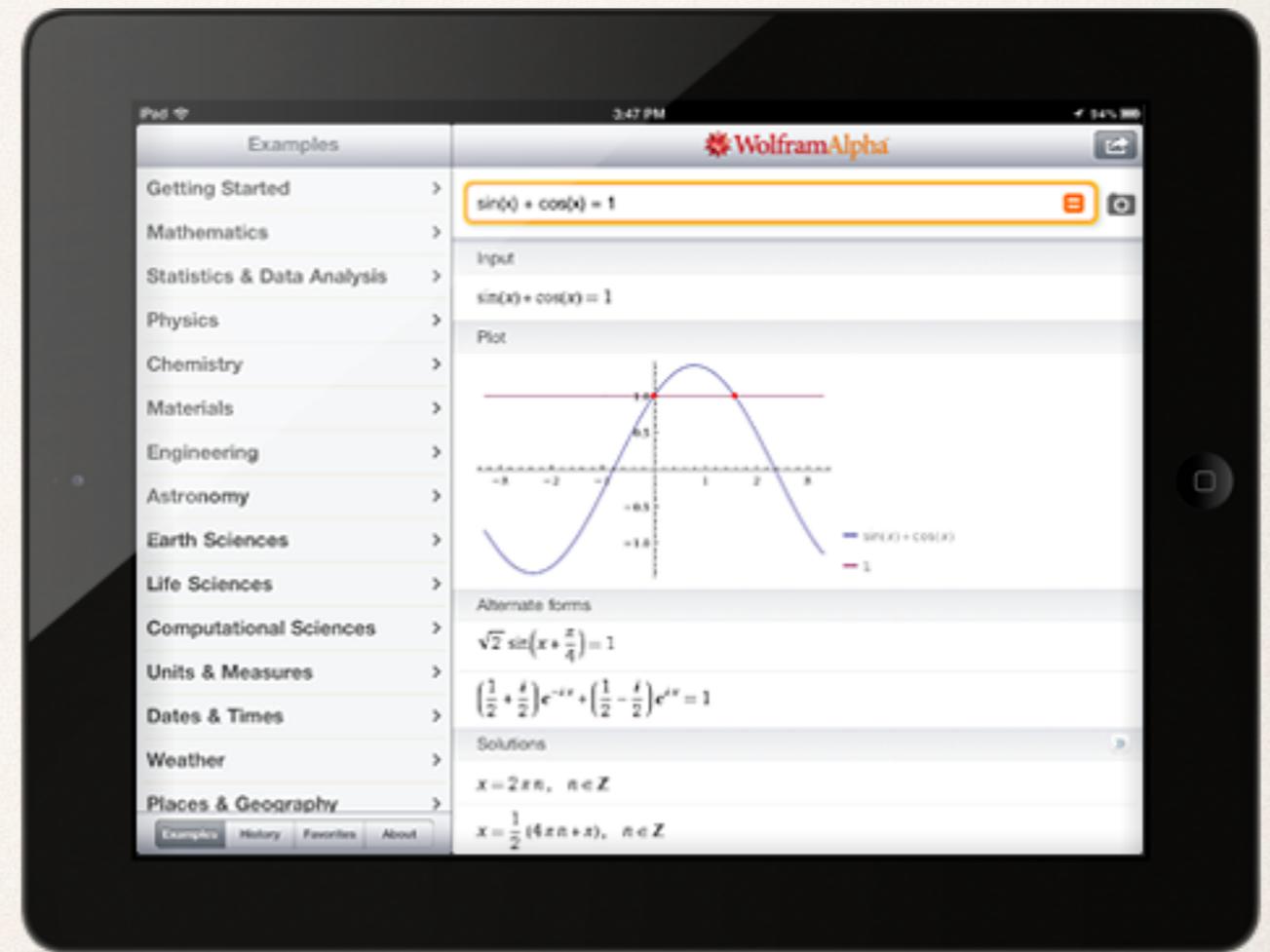
Explore new ways to provide thin-client web-based user interfaces

- ❖ Increase interactivity using modern web technology (javascript) in a client-server model
  - ❖ No need to install anything in the client side
  - ❖ Worksheet style
    - ❖ send command, display results in text or graphics form
  - ❖ 3D geometry viewer
- ❖ Built on the HttpServer of Sergey Linev
- ❖ new TTreeView

# Development: ROOT as-a-Service

Thin client plugged directly into a ROOT supercomputing cloud, computing answers quickly, efficiently, and without scalding your lap

- ❖ Natural evolution of modern applications
- ❖ Combine the work on **parallelization** to exploit many cores and nodes in a virtualized computing cloud
- ❖ Together with the new **web-based interface** to provide a modern and satisfying user experience



# Documentation

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- ❖ Migrate the Reference documentation to Doxygen
  - ❖ convert the ROOT comments to Doxygen style
  - ❖ tools and scripts to automate the generation of figures, etc.
    - ❖ in collaboration with ALICE
- ❖ Update and revise the Reference Guide
  - ❖ Ensure that the documentation is useful to developers and users
  - ❖ Homogenization of quality level and style
- ❖ Improve web documentation and usability
  - ❖ Use the occasion of the Drupal migration
- ❖ Update the User's Guide (and collection of topical Guides)
  - ❖ Missing chapters (e.g. cling interpreter)

# Support for New Platforms

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- ❖ Windows
  - ❖ win-64 bit
  - ❖ Davix
  - ❖ Multi-screen support
- ❖ PowerPC-64
- ❖ ARM-64
- ❖ Xeon-Phi
- ❖ CUDA ? (parts of ROOT)

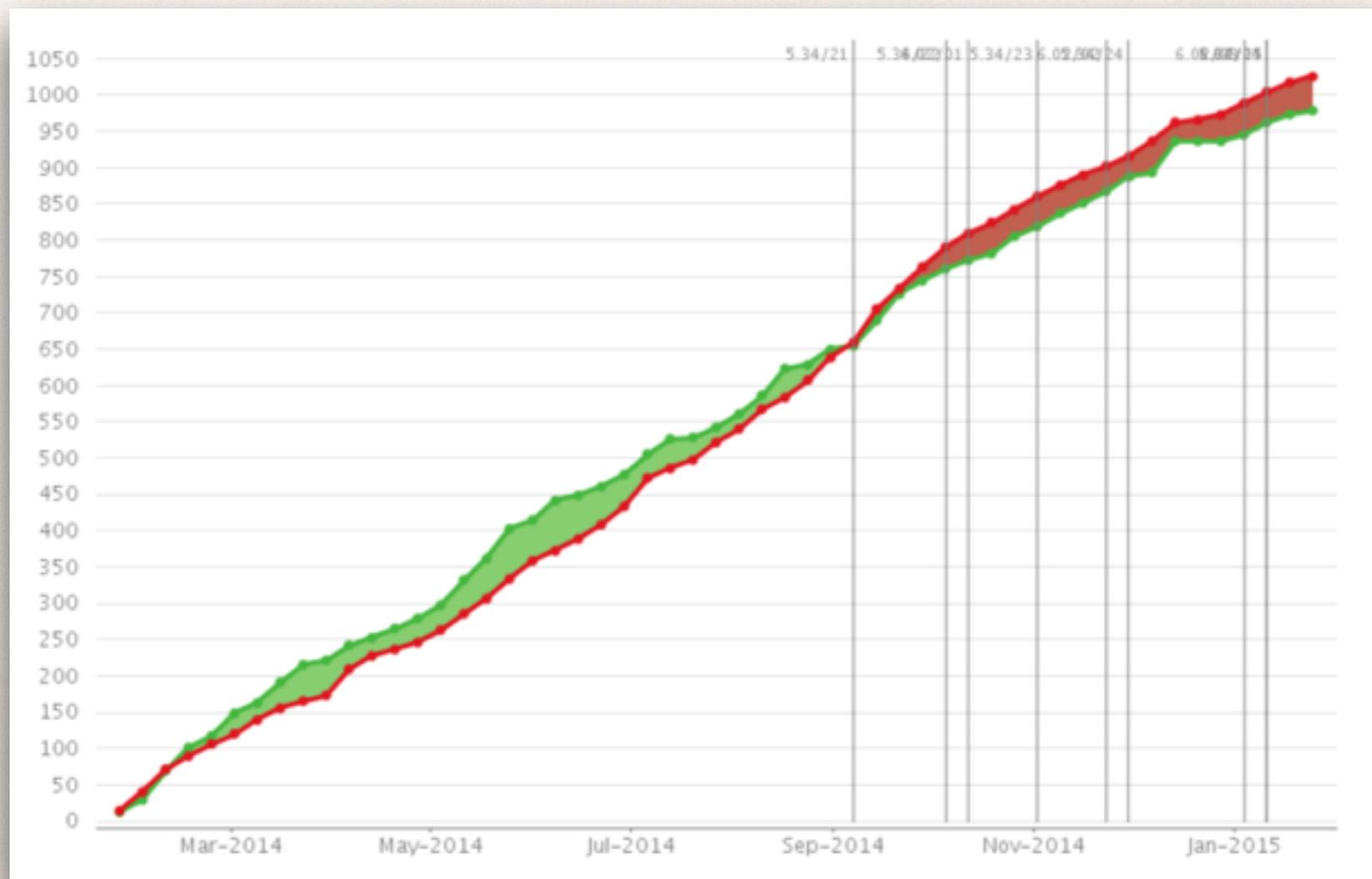
# Infrastructure

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- ❖ Migration of the ROOT project infrastructure services to IT
  - ❖ Drupal 7
  - ❖ GIT
  - ❖ File servers
  - ❖ Forum (RootTalk)
- ❖ Ensure proper backup, sustainable infrastructure, ...
- ❖ Build servers
  - ❖ Shared with all SFT projects (Macs, Linux, Windows, etc.)
- ❖ Jenkins
  - ❖ All procedures will be available in Jenkins (tagging new versions, building releases, building documentation, etc.)

# User Support: JIRA

- ❖ Issues: 1025 created and 978 resolved
  - ❖ backlog increased by 47 issues (of total about 580)
  - ❖ ~5 new issues / working day



# User Support: RootTalk

- ❖ In addition to JIRA we have the RootTalk Forum:
  - ❖ Total posts 80953
  - ❖ Total topics 18775
  - ❖ ~ 20 posts / day
  - ❖ ~ 5 new topics / day
- ❖ Setup weekly shifts to ensure that no post gets unanswered
  - ❖ A lot of effort ~1 FTE



GENERAL	TOPICS	POSTS	LAST POST
 <b>Announcements</b> General Announcements. Moderator: rootdev	100	128	by Axel  Wed Jan 28, 2015 12:39
ROOT	TOPICS	POSTS	LAST POST
 <b>ROOT Support</b> Discuss installing and running ROOT here. Please post bug reports <a href="#">here</a> . Moderator: rootdev	14895	66328	by moneta  Thu Jan 29, 2015 17:03
 <b>ROOT Documentation</b> Discuss the ROOT documentation here. Moderator: rootdev	240	730	by couet  Tue Dec 02, 2014 11:12
 <b>Users' Contributions</b> Some general interest ROOT macros and programs provided by ROOT users. If you have such macros or programs you can put them here. Moderator: rootdev	5	18	by schiteur  Mon Dec 08, 2014 18:10
 <b>PROOF Support</b> Discuss PROOF, the Parallel ROOT Facility, here. Moderator: rootdev	455	2148	by DmytroS  Thu Jan 29, 2015 11:54
 <b>Stat and Math Tool Support</b> Discuss RooFit, TMVA and other statistical and mathematical tools here. Please post bug reports <a href="#">here</a> . Moderators: cranmer, rootdev	1542	4416	by noam  Thu Jan 29, 2015 9:36
 <b>PyROOT Support</b> Discuss PyROOT, the Python ROOT language binding, here. Moderators: wlav, rootdev	775	3795	by joelvoigt  Fri Jan 16, 2015 11:40
 <b>My ROOT App</b> Discuss your own ROOT application. Moderator: rootdev	124	358	by dpiparo  Mon Jan 26, 2015 8:17

# ROOT and HSF

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# ROOT should be part of HSF

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- \* ROOT has played the role of 'hosting' contributions that are useful to the HEP community
  - \* Providing build & testing infrastructure, integration, distribution, licensing, support infrastructure, etc.  
**==> makes the life easier to users**
- \* HSF should just generalize what ROOT has been doing so far
- \* ROOT can benefit from some of the services provided by HSF
  - \* E.g. software repositories, computing resources, development tools, training coordination, IP and licensing issues, etc.

# Opportunity for Contributors

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- \* We would like to facilitate contributions to ROOT without engaging our responsibility in the maintenance and user support
  - \* modules or plugins that can bring new functionality to users
  - \* e.g. systems like Jenkins / Drupal / R provides a platform for developers to contribute in an easy manner
- \* ROOT is 20 years old, and some parts requires re-engineering
  - \* Exploit modern hardware (many-core, GPU, etc.) to boost performance
  - \* Modernize implementations (C++11 constructs, use existing libraries, etc.)
  - \* Need to solve the backward compatibility
- \* Need to produce the “How to Contribute Page”

# LCG Releases

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# LCGCMake

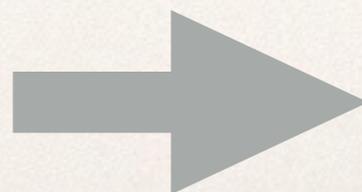
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- ❖ Development of LCGCMake system is completed
  - ❖ Operational from LCG\_68 (June 2014)
  - ❖ It includes all MC generators + all external libraries
- ❖ Need to complete the LCGSoft web interface
  - ❖ <http://lcgsoft.web.cern.ch/lcgsoft>
- ❖ Evolve LCGCMake to produce releases in the HepSoft layout
  - ❖ all packages installed into a single \$PREFIX
- ❖ The new platforms in the pipeline will be a reality check for the new system
  - ❖ CC7, MacOSX 10.9/10, clang 3.5

# From EC to Jenkins

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- ❖ Evaluation of Jenkins successful - No limit in the licenses
  - ❖ LCG Releases, ROOT, CernVM,...
- ❖ Moving the remaining projects: Geant4 (already started), GeantV, CORAL/COOL, ...
- ❖ Tried to have a CERN Jenkins service (provided by IT)
  - ❖ Not successful - IT not flexible enough
- ❖ Move remaining of build machines from EC to Jenkins
- ❖ New plugins being investigated (mailer, better reporting,...)



# Jenkins



# Infrastructure and Services

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- ❖ The project's team will participate to the maintenance and the running of the updated set of services
  - ❖ Benedikt's presentation at later time
- ❖ Prepare and produce new **LCG releases** (aiming for a rotation role)
  - ❖ Driven by LIM / AF decisions
  - ❖ Use the automated procedures and scripts developed by the project
  - ❖ Check and validate acceptance tests
- ❖ Prepare and produce new **HepSoft releases**
  - ❖ Driven by the needs of the Theory Community
  - ❖ Use the procedures and scripts developed by the project
  - ❖ Check and validate acceptance tests

# More during 2015 ...

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- ❖ Automation of more procedures to support life-cycle of projects
  - ❖ ROOT tagging, doc generation, binaries, ...
  - ❖ Synchronizing installations to CVMFS
  - ❖ LCG releases for LHC experiments
    - ❖ Full and partial (e.g. adding new versions of generators)
  - ❖ External dependencies packages releases (for ROOT, GeantV,...)
  - ❖ HepSoft releases
- ❖ Better Jenkins and CDash integration
- ❖ Static analysis triggered by Jenkins

# Meetings

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- ❖ The project participates to the following meetings:
  - ❖ C5 - CERN Computer Centre Coordination Committee
  - ❖ AF/LIM - LCG Application Area Meetings
  - ❖ ITUM - IT Technical Users Meeting
  - ❖ Concurrency Forum
- ❖ In addition, members of the team participate from time to time
  - ❖ LHCb Core software meetings
  - ❖ CMS Statistics meetings
  - ❖ CMS Core-SW meetings
  - ❖ ATLAS software meetings

# Conferences/Workshops

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- ❖ CHEP
  - ❖ 13-17 April, Okinawa
- ❖ ROOT Users' Workshop
  - ❖ 15-18 September, Saas-Fee
- ❖ ROOT I/O Workshops
  - ❖ Not yet fixed (end of May)
- ❖ Annual Concurrency Forum Meeting
  - ❖ Not yet fixed
- ❖ SAAGAS - Keynote by Axel
  - ❖ 23-25 February 2015, in Aachen

# Tutorials and Courses

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- ❖ tCSC
  - ❖ Danilo
- ❖ CSC
  - ❖ Danilo, Benedikt
- ❖ GridKA School
  - ❖ Benedikt?, Axel?
- ❖ Summer Student's Tutorial
  - ❖ Axel, Bertrand
- ❖ School Statistics DESY
  - ❖ Lorenzo