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ROOT 6

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The “6” in ROOT 6

Assessing the Past

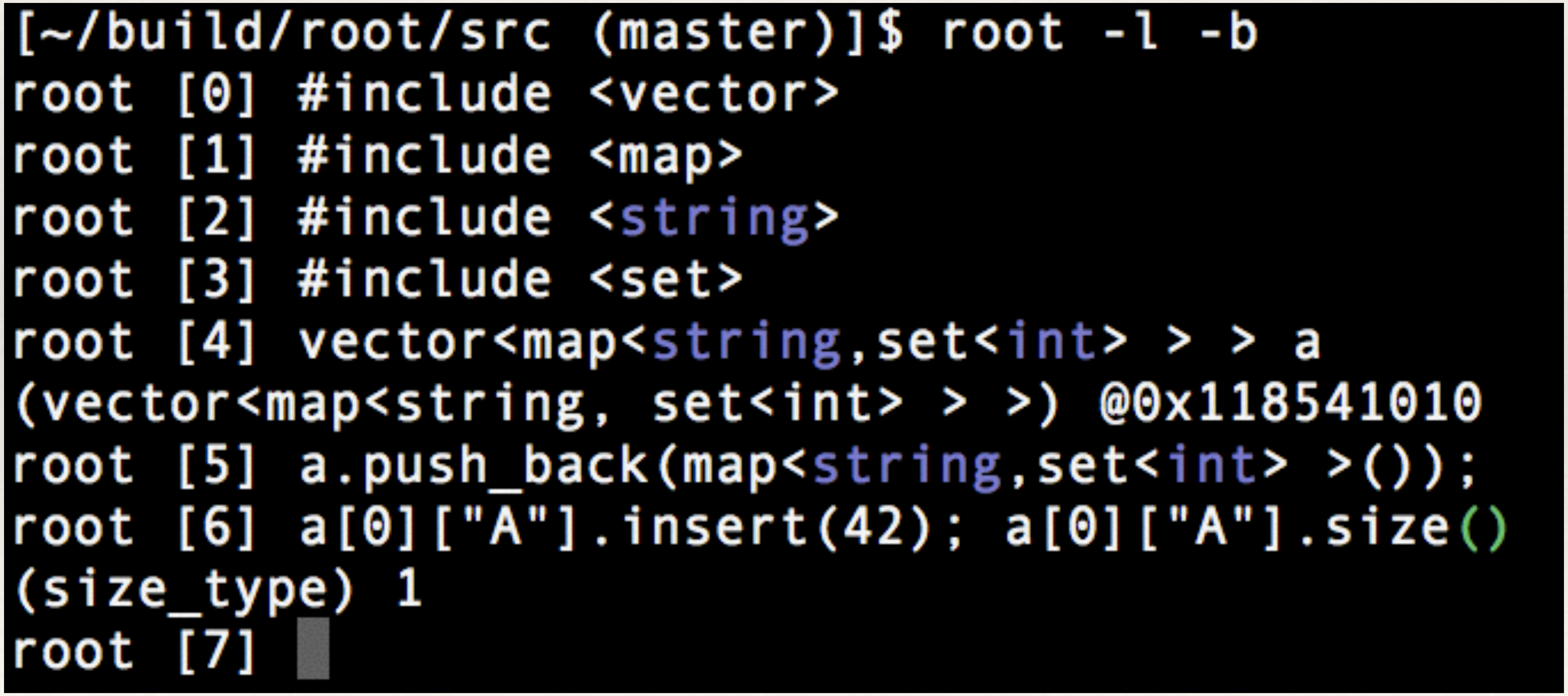
- Heart of ROOT <=5 was CINT: served amazingly well
- Limitations
    - C++ support: coverage of C++ constructs, C++11, correctness
    - scalability: too many types brought ROOT to a limit
    - robustness: seemingly simple code made ROOT crash
    - design: difficult to use in multi-threaded programs

cling clang llvm

- ROOT 6 has new interpreter cling
  - using production-grade compiler (clang+llvm) as hidden library; interpreting from #includes without dictionaries
  - just-in-time compiles to “shared library in memory”: virtual functions, function pointers - all native!
  - robust after four years of development
- ROOT now inherits C++ features from clang: diagnostics! C++14 support! correctness! speed!

Example

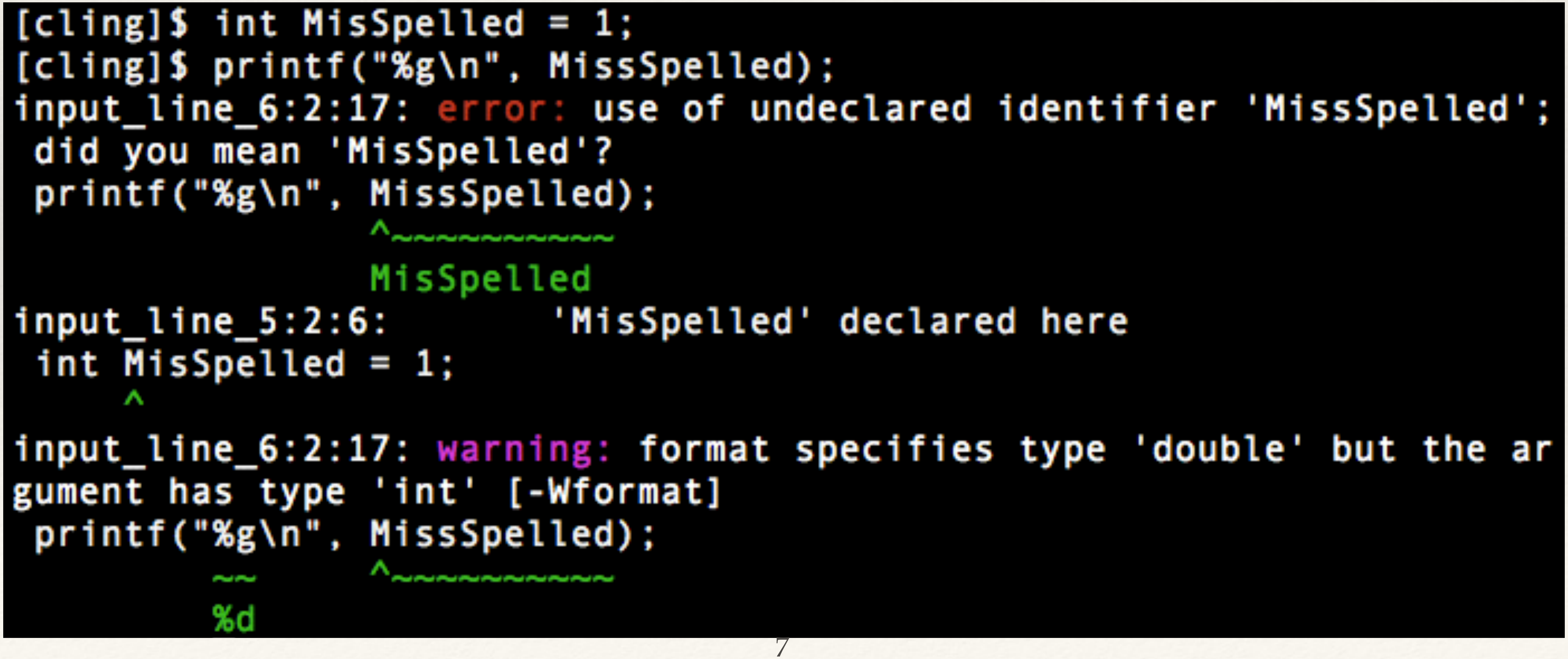
- Correctness; support of language features



```
[~/build/root/src (master)]$ root -l -b
root [0] #include <vector>
root [1] #include <map>
root [2] #include <string>
root [3] #include <set>
root [4] vector<map<string,set<int> > > a
(vector<map<string, set<int> > >) @0x118541010
root [5] a.push_back(map<string,set<int> >());
root [6] a[0]["A"].insert(42); a[0]["A"].size()
(size_type) 1
root [7]
```

Example

- Quality of diagnostics



```
[cling]$ int MisSpelled = 1;
[cling]$ printf("%g\n", MissSpelled);
input_line_6:2:17: error: use of undeclared identifier 'MissSpelled';
 did you mean 'MisSpelled'?
 printf("%g\n", MissSpelled);
                ^~~~~~~~~~~
                MisSpelled
input_line_5:2:6:       'MisSpelled' declared here
 int MisSpelled = 1;
     ^
input_line_6:2:17: warning: format specifies type 'double' but the ar
gument has type 'int' [-Wformat]
 printf("%g\n", MissSpelled);
         ~~     ^~~~~~~~~~~
         %d
```

C++ Support

C++ Standards

- C++ Standards are published at higher frequency: C++11 feels “just out”, C++14 is about to come
- C++ Standards are implemented “live”: C++14 *already* available in GCC, clang
- Experiments ask for C++11 support
- Cling gives sustainable way to adapt: rely on clang!

Why C++11?

- Increased clarity of code
- Increased robustness
- Increased performance
- Increased standard library size (a good thing!)
- Increased appeal to contributions!

TTreeReader

Accessing TTree Data in the Past

- Many TTree interfaces are fragile (void*& etc)
- Painful to extract data from existing TTree
  - painful to teach!
- Several key TTree improvements disabled by default
- Needed fast, robust, usable interface

Using the TTreeReader

```
TTreeReader myReader("ntuple", myFile);
TTreeReaderValue<Float_t> myPx(myReader, "px");
TTreeReaderValue<Float_t> myPy(myReader, "py");
while (myReader.Next())
  myHist->Fill(*myPx + *myPy);
```

- TTreeReaderArray<Jet> for collection access
- Diagnoses type mismatch
- Now the recommended way to access data for mere humans

TFormula 2.0

We have a Compiler-Library!

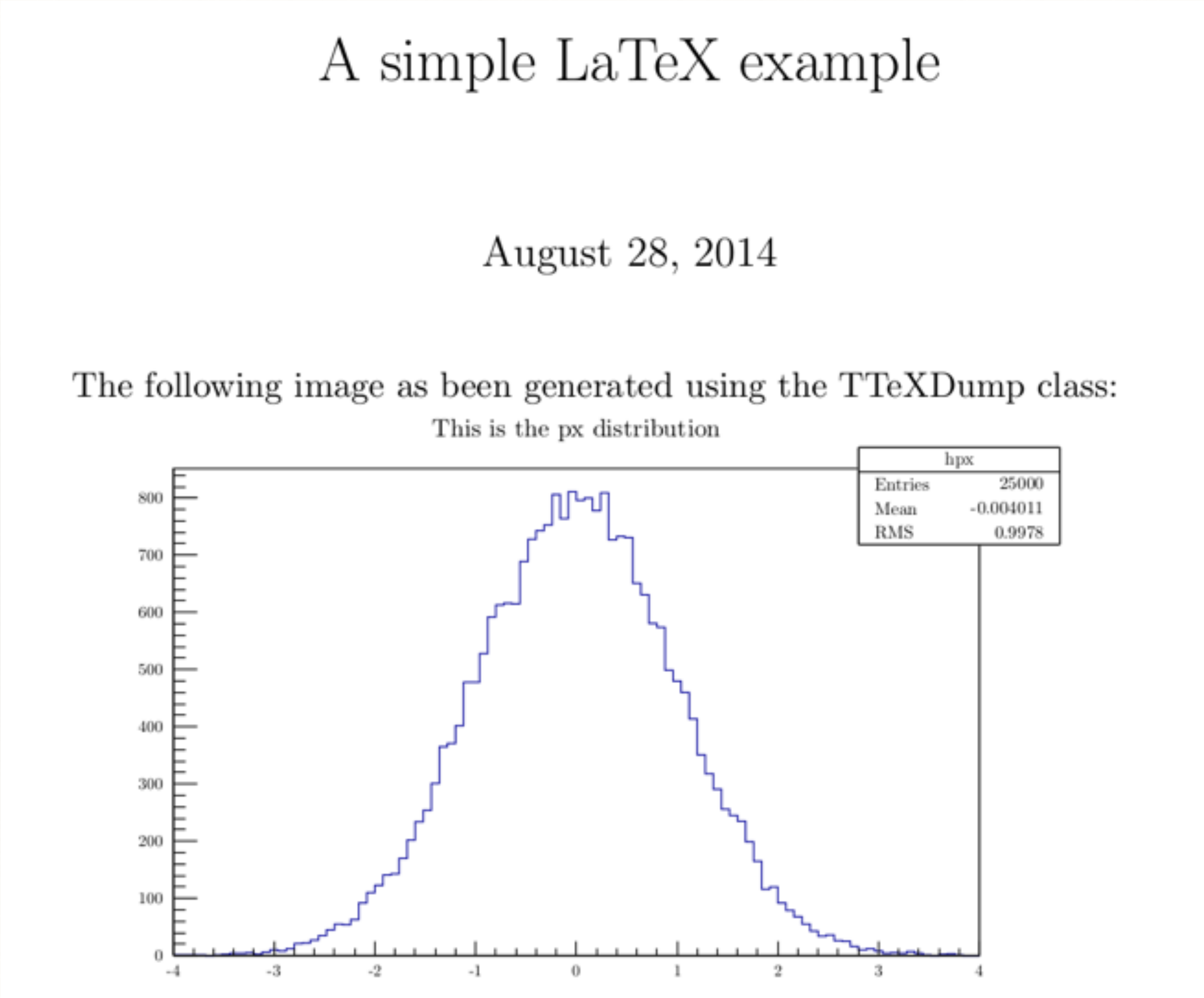
- Why not use it? Thus: the all new TFormula; part of ROOT 6.04
  - based on cling / clang / llvm
  - compiles code - speed! diagnostics!
- ROOT 6 (with current TFormula) enables full-fledged C++ in TFormula / TF1
  - TF1(“CosICan”,
    [](double* x, double*p) { return p[0]*cos(x[0]); },
    0., 1., 1)

Graphics 2.0

Graphics to Latex

- Can store graphics as Latex document
  - simply canvas->Print(“plot.tex”)
- Resulting file can be included in Latex documents, matching fonts and styles
- Uses PGF/TikZ

Graphics to Latex

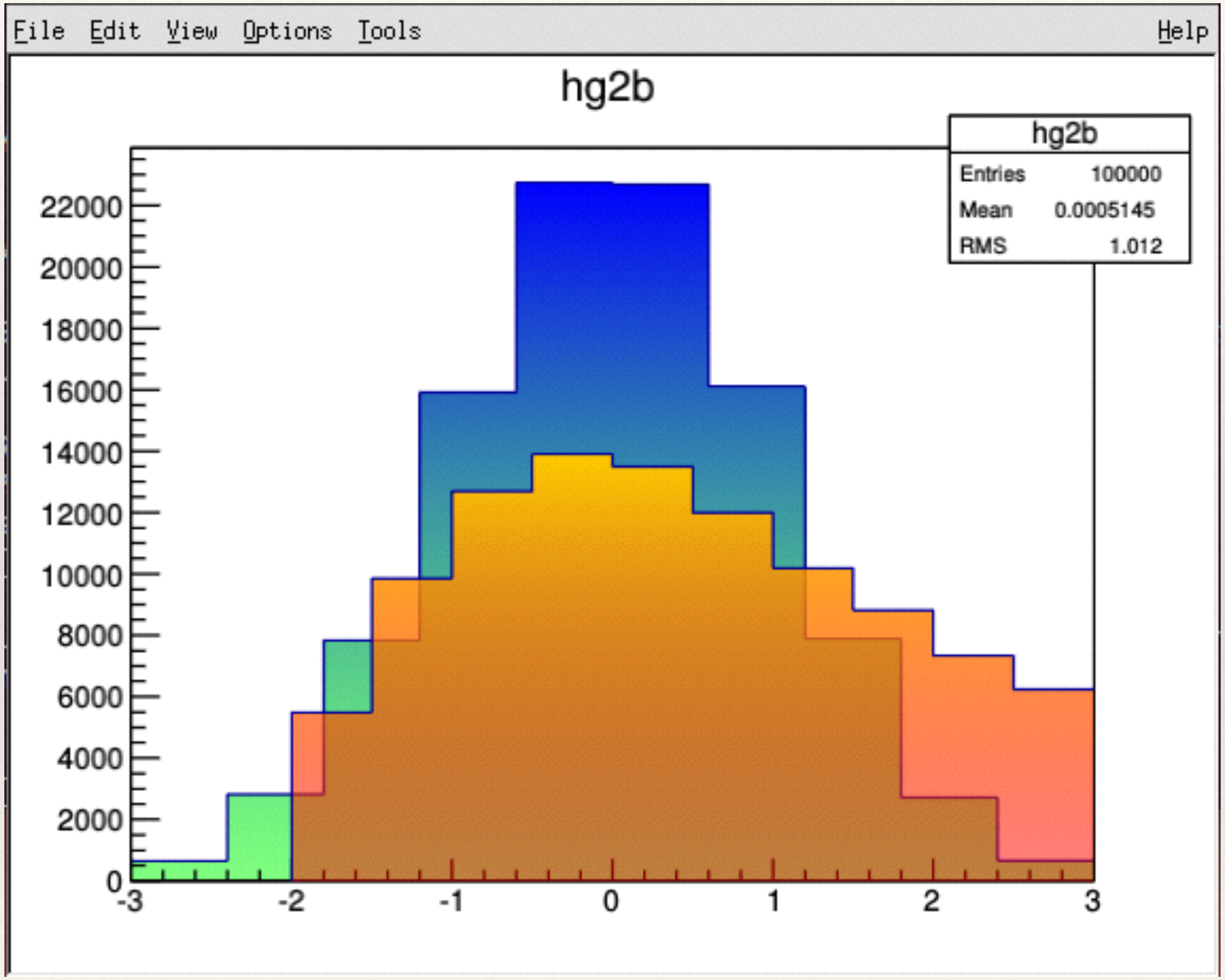


A simple LaTeX example

August 28, 2014

The following image as been generated using the TTeXDump class:

Transparency and Shading

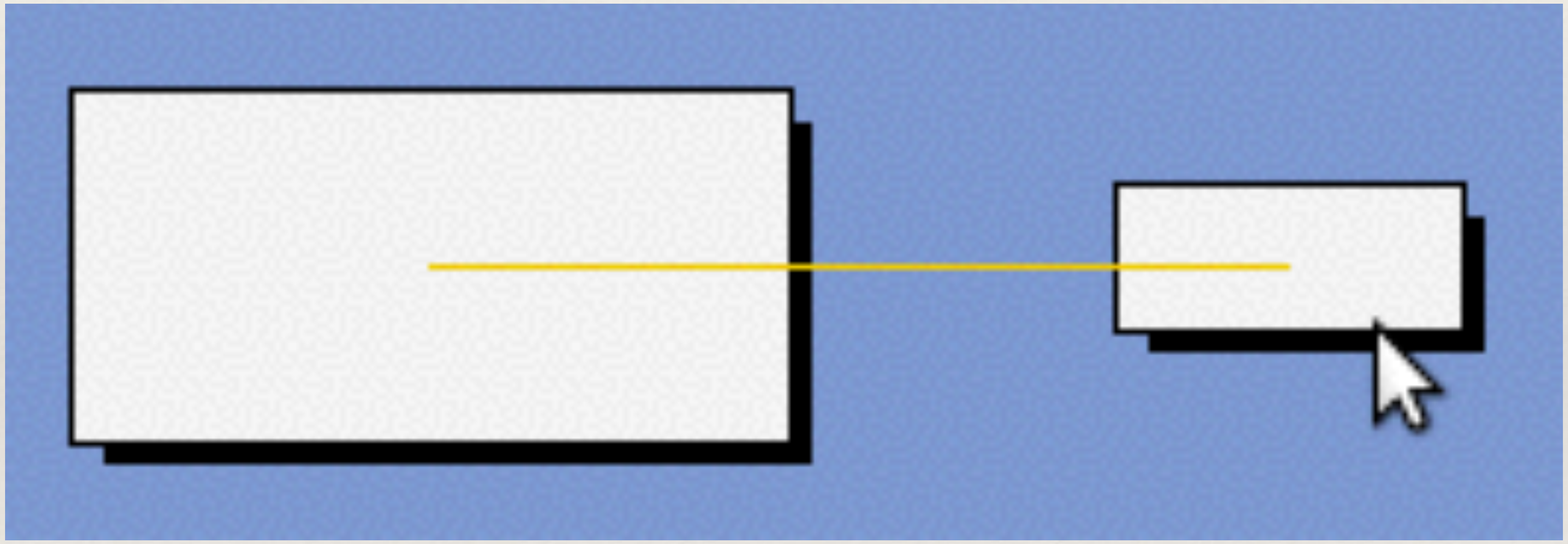


Transparency and Shading

- Requires support from graphics engine
  - currently implemented for OSX / Cocoa, OpenGL
  - planning to make OpenGL default - at least in ROOT 6
- Also currently no proper PDF export yet

Graphics UI

- Implemented current interactivity features:
  - guides for object placement



  - smooth axis zoom

Current Plans

New Interface Jargon

- TObject*-based interfaces causes several problems
  - C++ has evolved past that
  - ownership, type safety, lack of interface clarity cause crashes in user code instead of compile time errors
  - little information on threading; difficult to optimize
- Current C++(14): more precise and expressive interfaces
- Plan: start with new histogram interfaces, old will use new behind the scenes

Old and New Interfaces

- Will allow for transition period
- First time for ROOT, many open questions:
  - how do we deprecate?
  - how do we smooth, encourage, and track migration?
  - how important is write old, read new?And vice versa?
- We need discussions and feedback - else we just do what we want! ;-)

Releases

- ROOT 6.00 published May 30, 2014
  ROOT requires C++11 from here on!
- ROOT 6.02 scheduled for mid September; targeted to LHC frameworks for Run 2
- ROOT 6.04 scheduled for early 2015, plans:
  - new JIT engine for exceptions, inline asm
  - hopefully better (CPU, memory) dictionaries / type database (utilizing clang's "C++ modules")

In Related News…

More!

- You just saw Vassil's clad which we hope to make available in ROOT soon!
- More ROOT in track 1 on Tuesday:
    - Vectorization libraries VDT, VC (Danilo)
    - Investigating alternative analysis approaches (Vassil)

Conclusion

- ROOT 6 is here!
  - wealth of new features due to new interpreter
  - still limitations, most notably in unloading
- ROOT 6 opens new doors, also for ROOT
  - interface modernization just starting
  - needs your feedback!