LARP Software

Elliott McCrory

November 23, 2005

LARP/LHC Software

- List, define and explain S/W projects
  - Define "endpoints"
    - *Especially: Inception and completion*
  - Find common issues
  - Help with common solutions
- Identify people who will do the work
- Ensure that all effort benefits LHC
  - Especially initial commissioning!

Possible LARP Software (1)

- SDA
  - E. McCrory & J. Slaughter
  - Needs to be better defined on what this means
- CHEF for linear and nonlinear analysis & diagnosis
  - L. Michelotti & J-F Ostiguy
- Passive tune control from Schottky data
  - R. Moore
- Orbit control feedback
  - V. Ranjbar

Possible LARP Software (2)

- Control of tune and chromaticity drift at injection and ramp
  - M. Martens
- Schottky monitor software
  - A. Jansson, et al.
- PLL and tune feedback
  - C-Y Tan

Other LHC Software at FNAL

- Not part of LARP mission:
  - LHC@FNAL
    - *Remote operations center, to be located, we think, in WH1*
    - *E. Gottschalk, et al.*
  - Helping with the writing of LHC applications
    - *S. Gysin starting to investigate this*
- LARP web pages
  - larp.fnal.gov
    - *My feeble attempt to make a LARP web page*
  - dms.uslarp.org
    - *A Plone-based DMS in TD*
    - *J. Konc & E. McCrory*

Summary of LARP S/W Issues

- Devise an algorithm for LHC
  - How does LHC differ from our experience?
    - *Hardware, lattices, studies, etc.*
- Implement the algorithm at CERN
  - We need an LHC "Hello World!" application
    - *How do you write, compile, test, store, release an application?*
    - *How do you get data?*
    - *Long-term support?*

LARP/Lab support: Logistics

- LARP and the lab need to decide:
  - Will we really be able to spend significant time on LARP?
  - Will we really be able to move to CERN for a year?
    - *Abandon local responsibilities?*
    - *Homes here/lodging there, taxes, schools, spouses, etc.*
- Most respondents echoed these concerns

For each piece of S/W …

- Is it a realistic project that can be completed/made useful
  - In 6 months?
  - In one year?
- If so …
  - Who is going to do it?
  - How long will it take
    - *In calendar days and in FTE effort*
  - How will it be used at LHC?
  - What, specifically, will it do?
  - Test during SPS re-commissioning in Summer 06?

SDA Acronym

- Sequenced Data Acquisition
  - Storing any data into a relation DB
  - Indexed by the "shot number"
    - *"Time" is translated to human-understandable form*
      - *Case, Set*
  - Applicable to any "big event"
- Shot Data Analysis
  - The Supertable
  - High-level summaries of Sequenced Data Acquisition "shots"
  - Includes calculations that cannot be done easily in front ends
    - *Transmission efficiencies*
    - *Emittances from beam widths*

SDA at LARP

- SDA Acronym
  - Sequenced Data Acquisition
  - Shot Data Analysis
    - *See next slide*
- LHC does not have this concept
  - Post Mortem only for failures
  - Timber
    - *Would be a crucial part of SDA*
    - *But does not have time abstraction or re-calculations*

- Probably cannot simply take our software and run it at LHC
  - M. Lamont has tentatively assigned worker(s?) to think about this idea.

CHEF

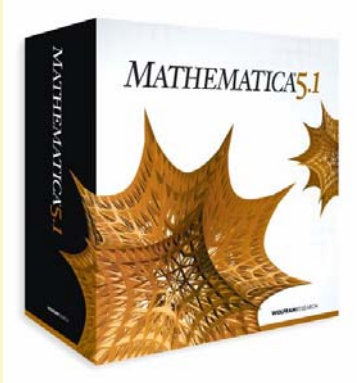
- Francois Ostiguy and Leo Michelotti
  - LM has transferred to CD
- MXYZPTLK, Beamline, etc.
  - Well established differential algebra tracking software
    - *Arbitrary order*
  - Extensive libraries
    - *Operator overloading is fundamental*
  - C++
    - *Completely rewritten in the last 3 months*
      - *E.g., "smart pointers"*
    - *60 times faster than previous version*
  - Python (PyCHEF)

CHEF: Mxyzptlk

Mister Mxyzptlk (pronounced miks-yeez-pit'l-ik) is the name used on Earth (his true name is untranslatable) by a devilish being from another plane of reality, completely different from our own, which he calls the "Fifth Dimension." A trickster whose deviousness knows no bounds or limits, he is only able to travel to our dimension once every ninety days. Once here, his only goal is to cause as much trouble as he can. His past "pranks" have included forcing Superman and the Flash to compete against each other in an around-the-world foot race, and the creation of Red Kryptonite, a variant version of the more deadly green Kryptonite which temporarily robbed Superman of his powers. Ever unpredictable, Mxyzptlk continues to plot and scheme, waiting for his next opportunity to cause mayhem and mischief.

CHEF and Python

- All Mxyzptlk classes are cast to be used in Python – PyCHEF.
  - Magic of C++ templates!
- All Python data analysis classes avail
  - FFT, signal processing, etc…
  - Same libraries used by Mathematica
- Simple examples for powerful operations
  - See J-F. Ostiguy for demonstration.



CHEF: LHC Plan

- Get Lattice Files
  - Dynamically
  - …
- Determine relevance to commissioning
  - Algorithms specified so far are simple to implement

CHEF: LHC Lattice Files

- Specified in "sequence files"
  - MAD X input scheme
    - *Drifts are implied, not specified directly*
  - Completely flat lattice description
    - *Yuck!*
  - Gigantic files!
    - *Used in the control system*

- J-F. O. will write parser for this
  - About 1 month of work
  - Can reuse a lot of existing code
    - *E.g., expressions*

CHEF: Possible Calculations

- Suggestions from T. Sen
- Linear analysis
- Nonlinear analysis

CHEF: Linear Analysis

- Using difference orbits data
  - Beta beating, dispersion beating etc
  - Find sources of error
    - *Mis-powered or misaligned quads etc*
    - *Valishev has an algorithm that uses the orbit response matrix*
- Using turn by turn orbit data, extract with high precision:
  - Beta and dispersion functions, phase advances between BPMs, coupling angles, …

CHEF: Nonlinear Analysis

- With turn by turn orbit data
  - Detuning with amplitude,
  - Resonance driving terms
    - *Frank Schmidt has algorithm*
- Linear & 2nd order chromaticity of an insertion
  - With thick quads
  - Chromatic dependence of the usual Twiss functions.
- Calculate measures of nonlinearity of a map
  - L2 measure of a map at specified amplitudes,
  - Nonlinear resonance driving terms,
  - Resonance widths,
  - Detuning with amplitude
- Algorithms for nonlinear correction of the IR
  - E.g. the one implemented in the baseline LHC optics
- Frequency map analysis and chaotic boundary with short term tracking

CHEF: Short-term plan

- Next 3 months
  - Generate sample of what CHEF can do
  - Get another person to help
- Generate an algorithm that is relevant to LHC commissioning
  - E.g., Schmidt's algorithm from 10-Nov-05 seminar
- Make this easy to use
- Demonstrate it far and wide

Schottky Monitor Software

- Collaborators
  - FNAL
    - *R. Pasquinelli, P. Lebrun, D. Sun, D. Tinsley, A. Jansson*
  - BNL
    - *P. Cameron, P. Oddo*
  - CERN
    - *F. Caspers, R. Jones*
- Porting the Fermilab Schottky analysis software to the CERN control system framework.
  - CERN provides the generic controls communications software and the platform for running the code.
  - **(FNAL, FY'06-07)**

PLL and Tune Feedback

- C-Y. Tan
- "Bar B Q"
- Will follow the same path as Schottky
  - Use vector signal analyzer?
    - *Probably just a port of existing Tevatron software*
  - Use VSA, DAQ board, etc.?
    - *Much bigger software effort*
    - *Again, rely on Schottky solution*

Passive Control from Schottky Data

- Ron Moore
  - Experienced Java programmer
  - Wants to help!
    - *User interfaces?*
    - *Bunch by bunch display*
      - *This may be our "Hello World!" example*

- Our experience
  - The pbar tunes must be adjusted throughout the store due to beam-beam tune shift
  - Have implemented an alarm to advise when to change tunes
- Will LHC be willing to run PLL/BBQ during stores?
  - If not, then this sort of passive tune data may be necessary to do a feedback.

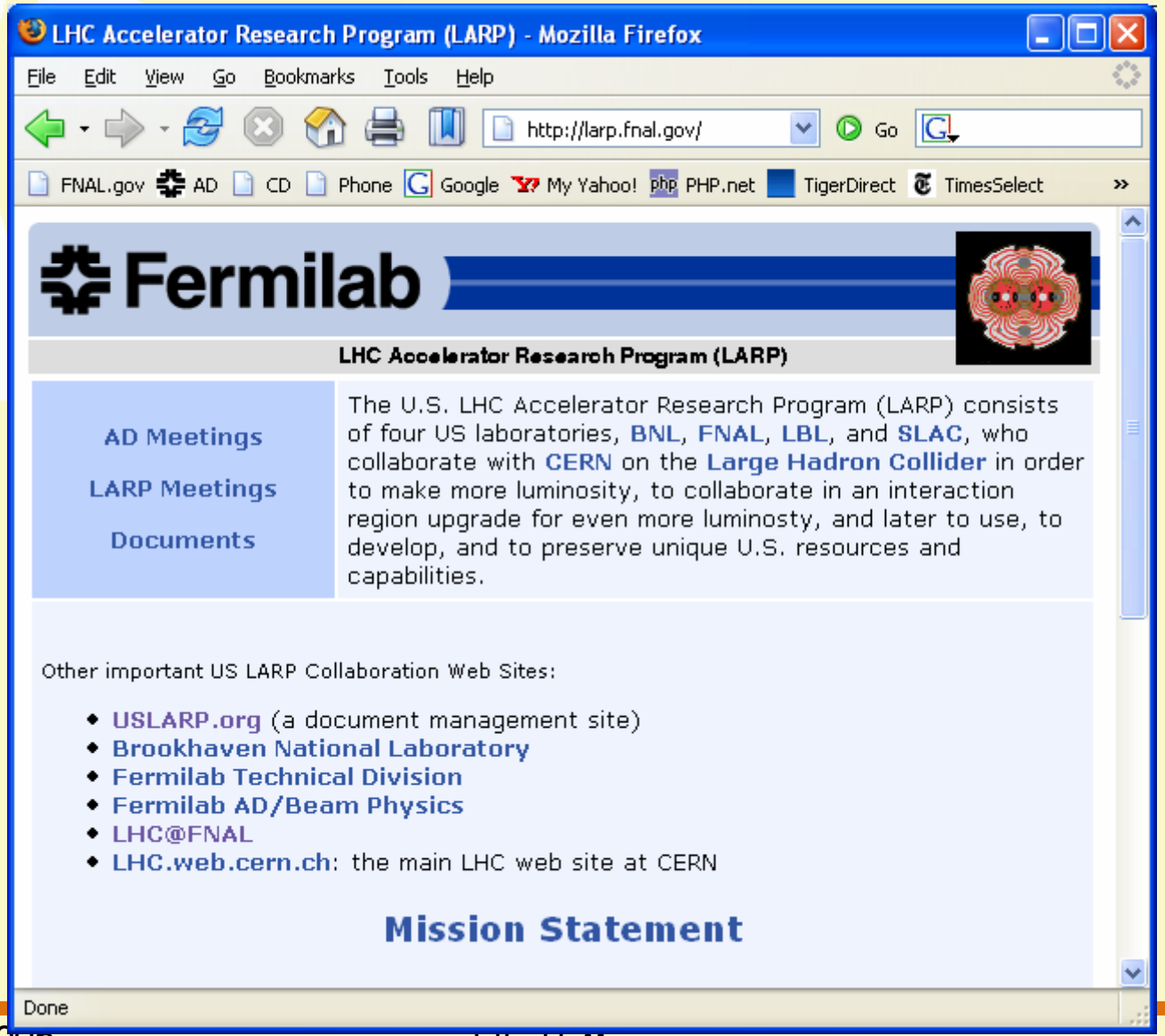
Orbit Control Feedback

- Vahid Ranjibar
  - CERN folks: Jorg Wenninger & grad student
    - *Also working on collimation*
- Our experience
  - Tevatron orbit control works now
  - Simple algorithms to enable global orbit control
  - But has been a major effort
    - *Highly iterative*

Tune/Chromaticity Drift Control

- Mike Martens
- Ordered to-do list
  - Understand the magnets
    - *Chromaticity circuits*
    - *How do they ramp?*
  - Get beam-based studies to determine
    - *Details of magnet fields*
      - *Magnet measurements are incomplete, by design*
    - *Specifics of the algorithms necessary*
  - Implement the algorithm
    - *Actually, a small amount of work, once the previous steps are completed.*

LARP Web Pages: larp.fnal.gov

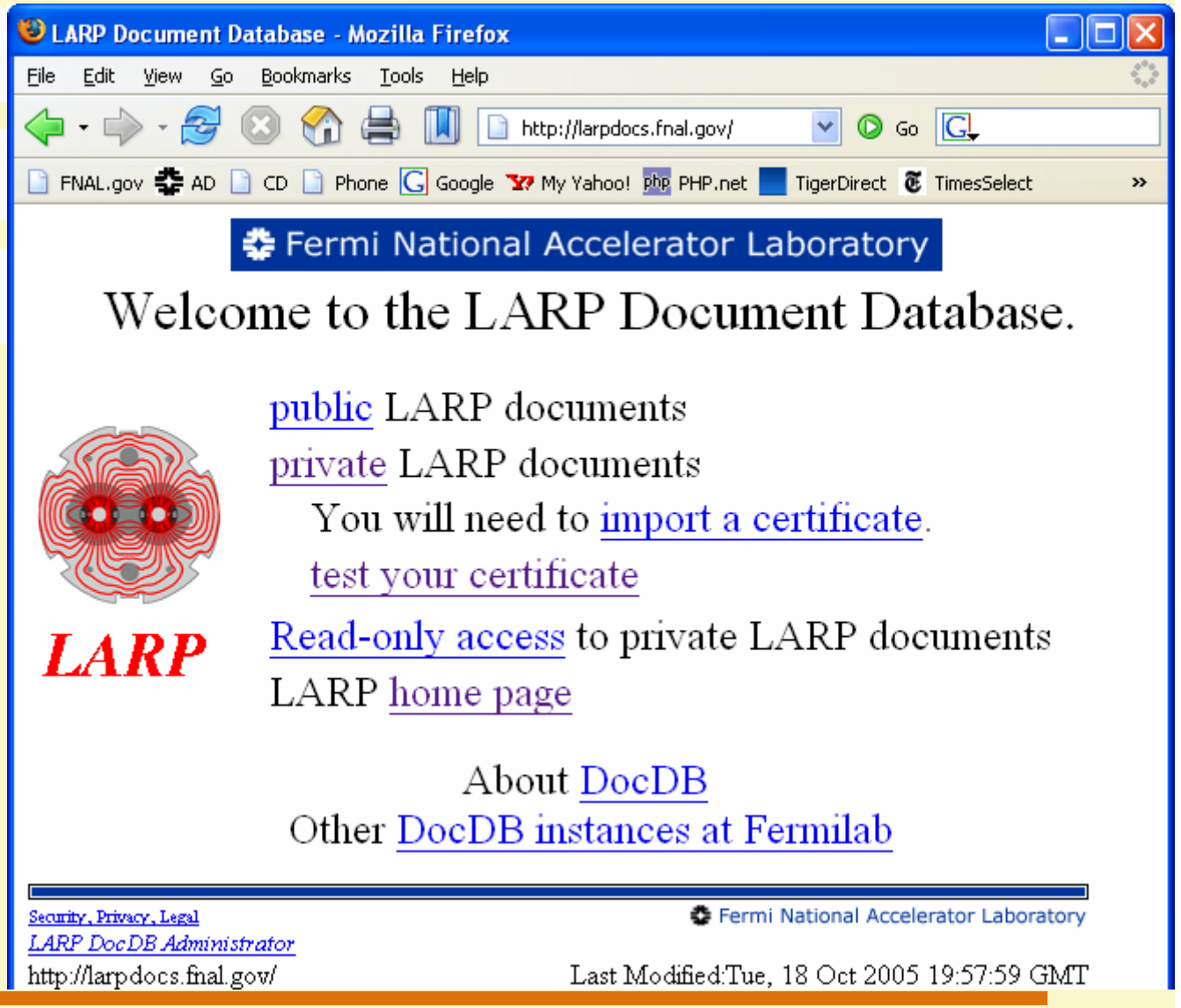


USLARP.org Plone Site

LARP = Live Action Role Playing

Larpdocs.fnal.gov

- No longer needs certificate
  - Hurray!!



LHC@FNAL To Exist in WH1

- Or maybe on the West Side…

Summary

- Everyone in the same boat for writing software for LHC
- Need a practical understanding of how to do this
  - S. Gysin (CD)
  - "Hello, World!" controls application