HERA Data Preservation Plans and Activities

Report on behalf of DESY Data Preservation Group

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Outline

- The DESY Data Preservation Group
- Future HERA Analysis Models
- Virtualisation and Validation
- HERA Data for Preservation
- An Archival System for the HERA Data
- Documentation Efforts
- Using HERA Data for Education Purposes
- Summary
The DESY Data Preservation Group

➢ DESY presence within DPHEP effort strong from the start
  ▪ HERA experiments and BaBar led the initial discussions

➢ Joint enterprise started soon after 1st DPHEP workshop between the relevant groups at DESY

➢ Data preservation plans at DESY and status of individual contributors described in the document submitted to the PRC (Physics Research Committee) in April 2010
  ▪ Contributions from H1, ZEUS, DESY-IT, DESY-Library

➢ Update submitted in October with a more detailed projects proposal for data preservation at DESY, including manpower requirements

➢ Such projects crucial to ensure a long term HERA data facility at DESY
Data Preservation Models Identified by DPHEP

<table>
<thead>
<tr>
<th>Preservation Model</th>
<th>Use case</th>
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<tbody>
<tr>
<td>1. Provide additional documentation</td>
<td>Publication-related information search</td>
</tr>
<tr>
<td>2. Preserve the data in a simplified format</td>
<td>Outreach, simple training analyses</td>
</tr>
<tr>
<td>3. Preserve the analysis level software and data format</td>
<td>Full scientific analysis based on existing reconstruction</td>
</tr>
<tr>
<td>4. Preserve the reconstruction and simulation software and basic level data</td>
<td>Full potential of the experimental data</td>
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- Only with the full flexibility does the full potential of the data remain
  - Level 4 type programme was required by JADE and ALEPH re-analyses

- H1 and HERMES aim for DPHEP level 4, ZEUS between levels 3 and 4
  - Different approaches, can benefit from each other’s experiences
  - A level 2 scheme for outreach using HERA data, collaborating via DPHEP, could also be pursued
ZEUS Future Analysis Model

> Preserve Data and MC samples in Common Ntuple format

> Maintain the ability of simulation of new MC after the end of the current analysis model and the current MC mass production system

> **Standalone MC simulation package**
  - Full chain from existing MC generators or generic MC interface (like HepMC standard format) to simulation to Common Ntuple production
  - All dependencies included: calibration, condition, alignment, geometry, executables, steering card; unnecessary dependences removed
  - The core of the package is based on the current MC production scheme on GRID

> **Standalone MC simulation software package**
  - Adapted makefiles scheme – one button recompilation
  - Serving as a source of new versions of executables for MC package

> Both packages can run either on real or virtual machines (tested on VirtualBox)
  - MC mass production on real machines (given necessary resources, GRID or local farm, available)
  - Once compilation breaks: MC package frozen: Virtual images with the last working OS

> Validation done with simple tool to compare different MC simulation releases
  - Basic set of histograms for comparison
  - Need to develop validation tool for MC and software packages on the level of physics analysis
HERMES Future Analysis Model

- MC production requires a fully functional data production chain
  - Aiming to maintain the ability of new MC mass productions
  - Full software analysis chain (mDST based)
  - Complete data reproduction not foreseen, possibility not excluded, software-wise

- No external software dependencies
  - Database server part of local software (independent on network type or availability)
  - Local version of CERNLIB used
  - ROOT needed ONLY for certain analysis frameworks (not critical)

- Transition to SLD5 smooth on real and virtual machines
  - Static binaries compiled on SLD3 run flawlessly on SLD5
  - Recompilation on SLD5 requires gcc3/f77 (available on future OS, SLD6…?)

- Tests running on real SL5 batch nodes and a VirtualBox image

- Validation procedure in development phase
H1 Future Analysis Model

> H1 plans a *rolling model of preservation*, with a production timescale of say 3 months interval
  - Regular recompilation of analysis level software
  - Full data production of μODS/HAT (analysis level) data and MC

> Define a strategy for a rolling preservation model
  - Always use newest versions or freeze external software?
  - Aim to at least incorporate ROOT updates
  - Full level 4 version: Adopt changes in OS, include Fortran
  - Continue using the database / or maybe have a snapshot

> We will need good validation tools
  - Such a scheme already exists to validate the files content of the analysis level software between different releases
  - Expanding this validation to include full analysis selections, as well as the Fortran (simulation and reconstruction) code

> Aim to validate the **whole analysis chain** from RAW data to the publication plots

**Some numbers from current productions:**
* Read and copy 13.5 Tb of HERA II DST format data to Grid
* 900 Grid jobs each running on average 20 hours
* Produce 1.3 Tb of HERA II mODS/HAT format data
  * Ideally: 1 day to produce data, 1 day to download from the Grid
Software Migrations and Dependencies

> All HERA experiments are currently moving to Scientific Linux (DESY) 5

> Start with the latest OS, rather than preserving something already outdated
  - Non-default (but better) compiler gcc-4.4 needed by H1 and ZEUS
  - Problems changing from g77 to gFortran, most software now compiled; HERMES still use gcc-3/g77
  - ZEUS problem with ADAMO tools for updating calibrations, constants (ok when final versions..)

> Identify external dependencies: also many common points between experiments
  - CERNLIB, ROOT, CLHEP, ORACLE, FastJet, Neurobayes, …
  - H1 problem with GKS (event display graphics), which no longer works in SLD5, no source available

> What about a unified validation suite, which can compare different DSTs, software releases and even analyses running under different operating systems, different external software versions, different ..?
  - *Could be used by all HERA experiments, ..and experiment X!*
Towards a Generic Solution

- Validation framework using virtualisation techniques proposed by DESY-IT

- Validates experiment software and running environment, tests data access protocols
- Minimises efforts for future OS transitions, compilers changes, external software updates
- Successfully tested with 5% pilot project

Y. Kemp, D. Ozerov (DESY-IT)
Workflow: One test in detail (5% mock-up)

Experiment XYZ:
- application.sh
  - Can be precompiled executable
  - Better: Compile source code
- test.sh
  - Do something with binaries obtained in application.sh

Prepare test VM

Run VM and perform tasks within it

Extract results from VM and analyze them

IT:
- Raw VM image
- system_rpm.sh
- Preparation for automatic execution

IT:
- Run VM
- Monitor execution

IT: extract
- system.log
- app.log
- test.log
- output.root
- Put on web-server;
- Analyse errors

Experiment XYZ:
- Check extracted logs and analyse resulting files
### Validation Suite Test-Run, July 2010

<table>
<thead>
<tr>
<th></th>
<th>SL4</th>
<th>SL5</th>
<th>Fedora 13</th>
<th>Type of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROOT v5.26</strong></td>
<td>- no F77 compiler gfortran found - libX11 MUST be installed</td>
<td>Estimated ROOTMARKS: 1534.29</td>
<td>Estimated ROOTMARKS: 1512.76</td>
<td>Compilation</td>
</tr>
<tr>
<td><strong>H1 Data Analysis</strong></td>
<td>Processed 47243 events with J/Psi candidates Histogram written to jpsi_mods.root</td>
<td>Processed 47243 events with J/Psi candidates Histogram written to jpsi_mods.root</td>
<td>Processed 47243 events with J/Psi candidates Histogram written to jpsi_mods.root</td>
<td>Run pre-compiled tgz using compatlibs</td>
</tr>
<tr>
<td><strong>ZEUS MC Production</strong></td>
<td>&gt; ls -lh ZEUSMC.HFSZ627.E8954.GRAPE.Z01 4.2 MByte</td>
<td>&gt; ls -lh ZEUSMC.HFSZ627.E8954.GRAPE.Z01 4.2 MByte</td>
<td>&gt; ls -lh ZEUSMC.HFSZ627.E8954.GRAPE.Z01 4.2 MByte</td>
<td>Run pre-compiled tgz using compatlibs</td>
</tr>
<tr>
<td><strong>HERA-B Software</strong></td>
<td>Compilation OK</td>
<td>Compilation OK</td>
<td>Compilation failed – needs code change</td>
<td>Compilation</td>
</tr>
<tr>
<td></td>
<td>DB connect fails</td>
<td>DB connect fails</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(HERMES to come)

> Proof of principle shown to work, such a system would provide a powerful tool
  
  - Requires development within DESY-IT and input preparation by each participating experiment
HERA Data Formats for Preservation

> Final ZEUS data reprocessing to mDST completed in 2009
- Basic preserved data format: ROOT based “Common Ntuples” (CN) (two more iterations in 2011)
- Ultimately RAW, MDST data and MC removed from robots, keep only CN
- Reduces total amount to be preserved for ZEUS from the current 1 PB to ~ 100 TB

> Final H1 reprocessing of HERA II data 2009, equivalent HERA I repro ongoing
- Common analysis software H1OO started 2000, uses a ROOT based data format, used by all H1
- In addition, a monthly MC production of up to 1/4 billion events
- H1 to preserve RAW data, as well as at least one DST and analysis level versions
- Estimate total amount to be preserved for H1 to be ~ 200-500 TB

> Main format for HERMES analyses is the mDST
- New production planned before final freeze
- Last years of data taking with recoil detector, still need improved calibrations
- MC productions on Grid for ongoing analyses
- Total amount to preserve on tapes ~ 150-200 TB

> Preservation of HERA-B data under investigation within DESY-IT
- Total amount of data currently ~ 250 TB, will decrease once a preservation model is established
- See: D. Ozerov (PS53-4-290)
The scope of the validation framework does not foresee an examination of the condition of complete HERA data sets.

The present storage system at DESY-IT is not suitable for the archive storage of the HERA data:

- Discovery of problems with file integrity depends on user activity (only read files are checked..)
- There is too much manual work involved (tape migrations, database consistency)
- Weak connection between the user-end system and the storage back-end

Proposal to develop a system needed for long term preservation at DESY:

- End-to-end data integrity checks, periodic inventory of whole archive with file fingerprint (checksum)
- Verification that the file content is not damaged
- File recovery in a reasonable amount of time (from second copy or via media recovery)
- Possibility to store and retrieve large amounts of data
- Ease the migration to newer storage technology
Other Virtualisation Related Projects

Studies of virtualisation ideas using H1OO within the CERN VM

- Nice example of running an analysis using a virtual image of the H1 environment
- Access to the [large scale] data remains an outstanding problem

Tests of Cloud Computing and Storage System Features for Use in the H1 Collaboration Data Preservation Model – see B. Lobodzinski (PS44-2-346)
ZEUS and HERMES Documentation Efforts

> ZEUS non-digital documentation: notes, transparencies, technical drawings
  - Stored in documentation room in basement of main lab building – will be moved due to renovation
  - Consolidation, creation of electronic catalogue, handing over custody to DESY library is planned
  - Also digitalisation of old notes, theses is considered

> ZEUS digital documentation: mostly reside on the main ZEUS web server
  - Specific technical documentation (detectors, trigger) and electronic log book distributed over different machines
  - Consolidation of all relevant digital documentation on the main web server is planned
  - Migration of the main web server to newer hardware foreseen
  - Revision of personal web pages containing analysis details

> HERMES documentation wiki
  - Large effort to move all important documentation, technical notes to a wikipedia structure
  - Revisions performed by corresponding experts
  - Old web server now redundant, long preservation of wiki only (via INSPIRE?)
  - Electronic logbook running on separate box; image created, virtualisation possible future option
H1 Documentation Efforts

- Non-digital documentation initiative begun at DESY with dedicated manpower
  - Cataloguing, organisation and digitisation where appropriate of H1 papers, notes, drawings, talks..
  - Particularly timely due to building one renovation and relocation of documentation room
  - The DESY Library will eventually take over

- Digital documentation also investigated, but further resources are needed
  - Old online shift tools, detector files may be vulnerable, mostly not updated since July 2007
  - Electronic logbooks: H1, trigger, components, detailed run information
  - Migration of H1 web-server to DESY-IT virtual environment (migration to SLD5 completed)
  - Move the H1 documentation to external resources like INSPIRE
  - Streamline the content of the H1 web, rescue dead links, increase performance and attractiveness
Project between H1 and INSPIRE

> Start test project with INSPIRE to host H1 paper histories

- From preliminary results, through draft version, up to published paper
- Referee’s report, additional material (requested checks, figures etc.)

Some other ideas like H1 internal notes, collaboration meetings presentations, H1-wiki, …?
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Using HERA Data for Educational Purposes

> Example of interactive exercises with Viewpoint NASA using real HERA data
  

> Great potential, which needs to be pursued but needs additional effort
Summary

- The $e^\pm p$ collisions collected at HERA are a unique data set worth to be preserved

- There is a strong participation of the DESY groups in the DPHEP initiative, guiding the future direction of data preservation in HEP
  - Data preservation effort at DESY unified between the different contributors

- Data preservation projects now identified, including:
  - In collaboration with DESY-IT: Validation and Data Archival, safeguarding the future of the HERA data
  - Together with the DESY Library: INSPIRE and future electronic documentation
  - Global initiatives via DPHEP: Education and Outreach