JetWeb: a WWW interface and database for Monte Carlo tuning and validation

J M Butterworth, S Butterworth, B Waugh
presented by B Waugh at LCG Generator Miniworkshop, 2003-06-20

Outline of talk

- Physics motivation
- Software technology
- Object model
- Demonstration
- Example application
- Planned improvements
- Conclusion

Physics motivation

- Need to understand hadronic final state for current and future measurements.
- Some effects not calculable from first principles, e.g. hadronization.
- MC generators have many free parameters.
- Tuning to fit one data set can result in a poor description of other data.
- Better to tune to many data sets simultaneously.
- Want to:
  - automate comparisons as far as possible
  - avoid duplicating effort (and CPU usage)

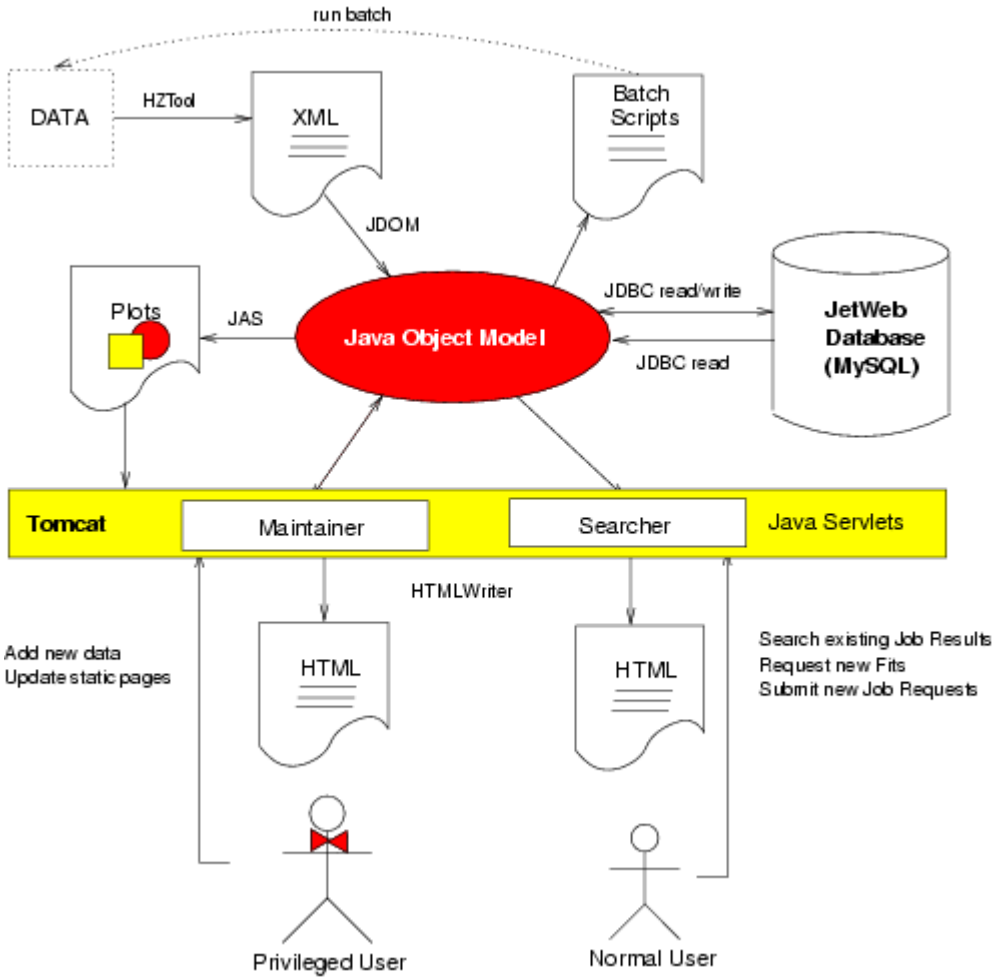
HzTool

- Fortran library: fills HBOOK histograms from generated events to compare with measurements.
- Developed in HERA Workshop:
  - J. Bromley et al., Future Physics at HERA, vol 1, 611-612
- Routine written in Fortran for each analysis.
- Range of data already included: H1, ZEUS, UA5, OPAL, CDF, D0. Contributing authors also from ATLAS and FLC. Need more!

JetWeb

- J Butterworth and S Butterworth:
  Comput. Phys. Commun. 153 (2003) 164-178.
- Adds functionality to HzTool.
- Database of measurements, predictions and fits.
- Web front end allows:
  - search database
  - submit jobs to generate MC with chosen parameters
- Uses: Java servlets, MySQL relational database, XML, Java Analysis Studio (JAS).
- HzTool jobs can be submitted to a standard batch farm or to a grid.

JetWeb overview



Object model

- Java classes correspond (more or less) to tables in database.
- Data: papers contain plots contain points.
- Model = generator/version + parameters
  - several models can be equivalent for a particular collider, e.g. proton PDF irrelevant to e+e- data, so introduce class *logparms* = *model* + *collider*
- Predicted plots/points
- Fit: comparison between data and model
  - Normalized to fit selected high-Et data
  - Chi-squared calculated for various data sets

Using JetWeb

- Start at http://jetweb.hep.ucl.ac.uk/
- Search the database: possibilities include
  - select MC generator and parameters, and compare predictions with a range of data;
  - select data set of interest and find models giving a good description of these data;
  - more generally: restrict some MC parameters while allowing others to vary, and compare predictions with all available data or a subset.
- Use ready-made searches under *Selected Results.*
- Best fit pages are automatically updated.

Searching the database

- Select generator(s) of interest
- Restrict parameters as required, or leave them free
  - Common: ptmin, underlying event model, PDFs, kt
  - Generator specific
- Choose order of results (e.g. find best fit to charm date)
- *Get results!* (May take minutes for very general search.)
- If nothing in DB matches your request, you can submit a request to generate some new MC.

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best fits, all data

- HERWIG
- PYTHIA

summaries, all fits

- HERWIG latest
- PYTHIA latest
- HERWIG all
- PYTHIA all

documentation, downloads

- Latest News
- Bibliography
- Generator Parameters
- Developer Resources

simulations

- HERWIG
- PYTHIA

experiments

- HERA(H1,ZEUS)
- LEP (OPAL)
- Tevatron (CDF, D0)
- HEPDATA

JetWeb

Automated Data Comparisons for High Energy Physics

Search the DataBase Maintenance

Selected Results

- Studies for a Future Linear Collider
- Multiparton Interactions/underlying event
- Intrinsic KT photon/proton
- PYTHIA parton showers PARP67
- Parton Distribution Functions in Photon
- HERWIG fragmentation parameters (CLMAX,PSPLT)

If you do use any results from here, please quote Comp. Phys. Comm. vol 153/2 164-178 (2003)

The current focus of this project is on jet and heavy flavour production in hadron-like collisions (which includes hadron-photon and photon-photon). There is no reason why other data shouldn't be incorporated though.

If you'd like join in, or have any comments or suggestions please contact us at jetweb@hep.ucl.ac.uk

The story so far:
4982 jobs submitted to Manchester PBS, 4297 completed
143 jobs submitted to UCL NQS, 142 completed
9 jobs submitted to UCL PBS, 2 completed
13 jobs submitted to the Grid, 9 completed

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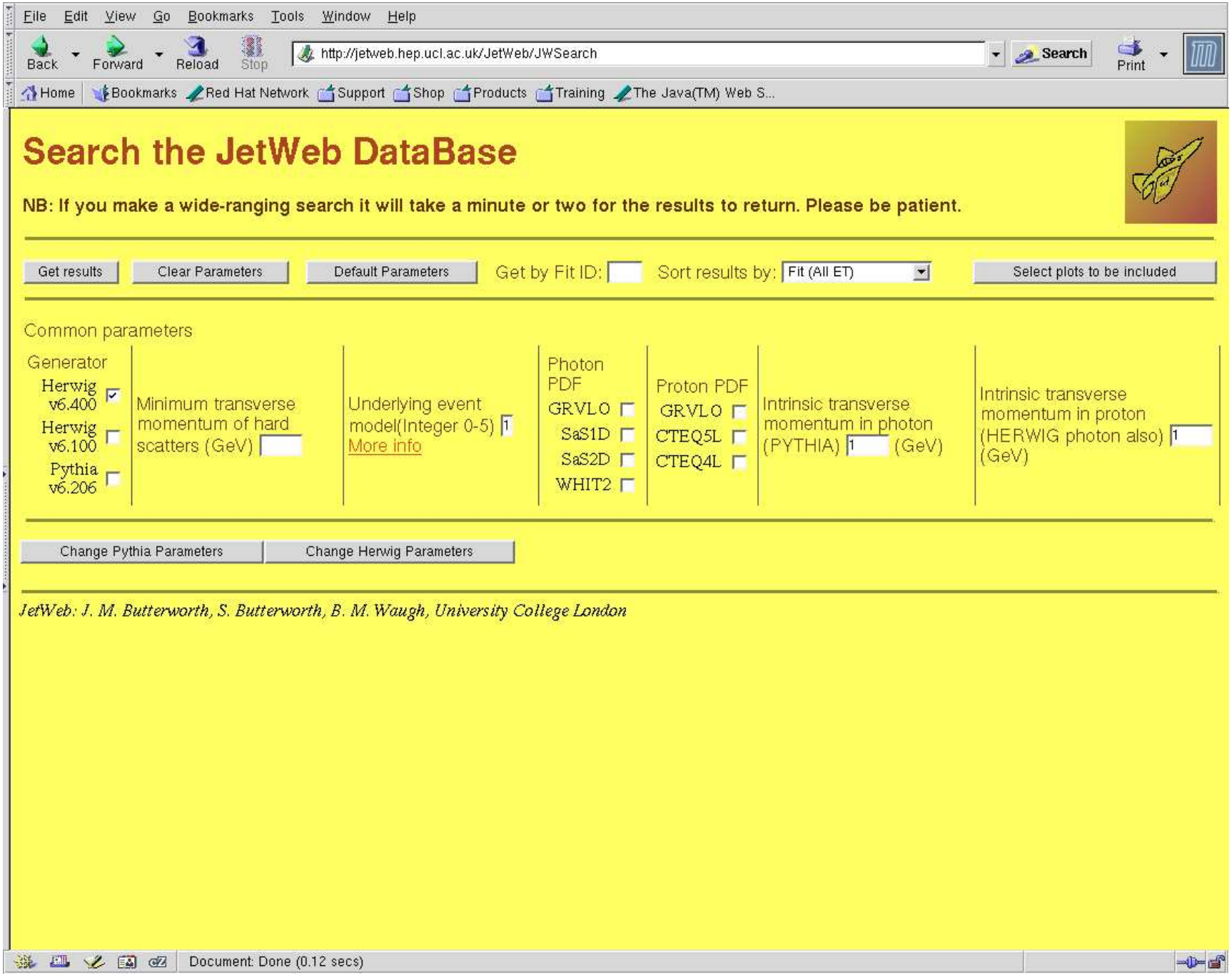
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Search the JetWeb DataBase
NB: If you make a wide-ranging search it will take a minute or two for the results to return. Please be patient.
Get results
Clear Parameters
Default Parameters
Get by Fit ID:
Sort results by: Fit (All ET)
Select plots to be included
Common parameters
Generator
Herwig v6.400
Herwig v6.100
Pythia v6.206
Minimum transverse momentum of hard scatters (GeV)
Underlying event model(Integer 0-5) 1
More info
Photon PDF
GRVLO
SaS1D
SaS2D
WHIT2
Proton PDF
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CTEQ5L
CTEQ4L
Intrinsic transverse momentum in photon (PYTHIA) 1 (GeV)
Intrinsic transverse momentum in proton (HERWIG photon also) 1 (GeV)
Change Pythia Parameters
Change Herwig Parameters
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Results sorted by Fit (All ET)

Last updated 26-May-2003 at 15:44:57

HERWIG v6.400 run 10/05/2003 PDFs: Photon GRVLO Proton CTEQ5L PTMIN 3.0GeV UE JIMMY Photon kt:1.0 Proton kt:1.0 Scale **1.65**: Fit ID **637** : Plots etc

Combined:		Chi2/Dof: All: **4.45**	High ET: **2.05**	Low ET: **3.29**	Jet Shape: **9.37**	Charm: **4.09**
EP	Lumi 54.0 pb^{-1}	Chi2/Dof: All: *4.37*	High ET: *2.05*	Low ET: *2.77*	Jet Shape: *14.2*	Charm: *4.09*
EE	Lumi 1000.0 pb^{-1}	Chi2/Dof: All: *8.34*	High ET: *?*	Low ET: *5.7*	Jet Shape: *22.87*	Charm: *?*
PP	Lumi 0.00015 pb^{-1}	Chi2/Dof: All: *1.58*	High ET: *?*	Low ET: *1.24*	Jet Shape: *1.65*	Charm: *?*

HERWIG v6.400 run 22/05/2003 PDFs: Photon SaS2D Proton CTEQ5L PTMIN 3.0GeV UE JIMMY Photon kt:1.0 Proton kt:1.0 Scale **1.65**: Fit ID **639** : Plots etc

Combined:		Chi2/Dof: All: **4.97**	High ET: **2.03**	Low ET: **3.05**	Jet Shape: **11.59**	Charm: **6.71**
EP	Lumi 56.0 pb^{-1}	Chi2/Dof: All: *4.98*	High ET: *2.03*	Low ET: *2.72*	Jet Shape: *17.49*	Charm: *6.71*
EE	Lumi 1700.0 pb^{-1}	Chi2/Dof: All: *8.82*	High ET: *?*	Low ET: *4.75*	Jet Shape: *31.21*	Charm: *?*
PP	Lumi 0.00015 pb^{-1}	Chi2/Dof: All: *1.58*	High ET: *?*	Low ET: *1.24*	Jet Shape: *1.65*	Charm: *?*

HERWIG v6.400 run 22/05/2003 PDFs: Photon SaS2D Proton CTEQ5L PTMIN 3.0GeV UE JIMMY Photon kt:1.0 Proton kt:1.0 Scale **1.7**: Fit ID **395** : Plots etc

Combined:		Chi2/Dof: All: **7.03**	High ET: **1.88**	Low ET: **3.03**	Jet Shape: **22.27**	Charm: **4.57**
EP	Lumi 50.0 pb^{-1}	Chi2/Dof: All: *6.94*	High ET: *1.88*	Low ET: *2.93*	Jet Shape: *30.49*	Charm: *4.57*
EE	Lumi 1700.0 pb^{-1}	Chi2/Dof: All: *9.3*	High ET: *?*	Low ET: *5.32*	Jet Shape: *31.21*	Charm: *?*
PP	Lumi 0.00006 pb^{-1}	Chi2/Dof: All: *5.8*	High ET: *?*	Low ET: *0.08*	Jet Shape: *9.62*	Charm: *?*

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JetWeb Fit No:639

HERWIG v6.400 run . Model ID:302. Normalisation determined using default high ET data.

Date of last fit:26/05/2003
Examine the fitted papers
EP fit
EE fit
PP fit

Request higher statistics for EP Submit
Request similar data Get form
Search for similar data Get form
Maintenance Get form
Compare to fit : OK

Combined this for all fitted experiments: Chi2/Dof at an overall scale factor of 1.65)

- All: **4.7792265**
- High ET: **2.0317302**
- Low ET: **2.7966687**
- Jet Shape: **11.592832**
- Charm: **6.7092739**

Parton distribution functions: Photon SaS2D Proton CTEQ5L
PTMIN (Minimum transverse momentum for hard scatters) 3GeV
Underlying Event Model JIMMY
Intrinsic KT in the photon is:1.0
Intrinsic KT in the proton is:1.0
Parton shower cutoff is:2.5
Photon radius:1.0
Proton radius:3.0
PHad:300
Fragmentation parameters CLMAX,PSPLT(1),(2):3.35,1,1
PRSOF:0
QCDLAM:0.18
VQCUT:0.48
BTCLM:1
IOPREM:1

Fitted Papers:

Chi2 Total	Per Dof	Title
2242.5762049	12.2545148	Minimum bias SPS data at 900 GeV
2462.3046603	17.4631536	Minimum Bias SPS data at 546 GeV
1304.6661754	11.6488051	Minimum Bias SPS data at 200 GeV
3.2427762	0.1351157	THE INCLUSIVE JET CROSS-SECTION IN ANTI-P P COLLISIONS AT S**(1/2) = 1.8-TEV

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Minimum bias SPS data at 900 GeV

Z. Phys. C 43, 357 (1989)

Code author(s): Arthur Moraes
Contact: php00amm@sheffield.ac.uk

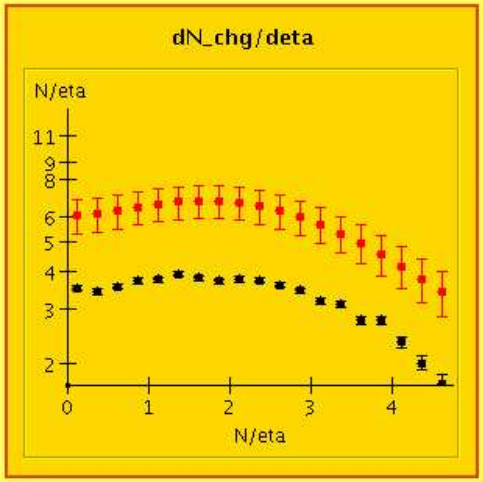
dN_chg/deta

Chi2 Contribution: (chi2 / DoF): 199.691 / 19

Data (black) was scaled by: 1.0
The model (red) was scaled by 1

This data is relevant for : Jet Shapes

Pull for each point:
{10.362} {11.782} {11.502} {11.29} {12.057} {11.55} {12.766} {13.565} {12.405} {11.576} {11.229} {10.623} {10.646} {8.798} {9.212} {6.762} {7.607} {7.934} {8.025}
(this plot not included in the fit)



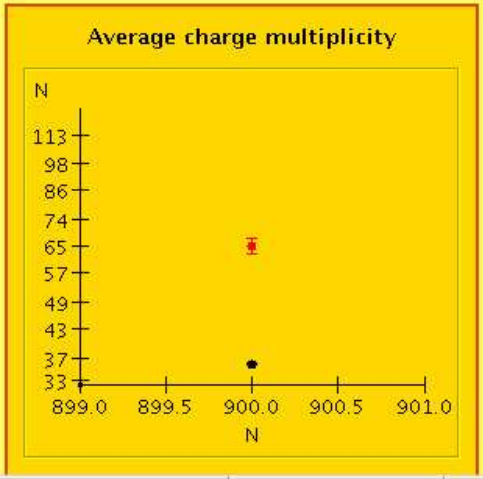
Average charge multiplicity

Chi2 Contribution: (chi2 / DoF): 128.049 / 1

Data (black) was scaled by: 1.0
The model (red) was scaled by 1

This data is relevant for : Jet Shapes

Pull for each point:
{128.049}
(this plot not included in the fit)



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Comparison of Fit 639 and Fit 637

Last updated 27-May-2003 at 07:49:52

The Following Parameters Differ Between the 2 Models

Parameter	**Fit 639**	**Fit 637**
Photon PDF	SaS2D	GRVLO

Plot Comparison

Minimum bias SPS data at 900 GeV	*639* Chi^2/DOF	*637* Chi^2/DOF
dN_chg/deta	10.51	10.51
Average charge multiplicity	128.05	128.05
dN_chg/deta	10.0	10.0
KNO distribution	16.13	16.13
KNO distribution	3.01	3.01
KNO distribution	16.13	16.13
Minimum Bias SPS data at 546 GeV	*639* Chi^2/DOF	*637* Chi^2/DOF
average charged multiplicity	93.85	93.85
dN_chg/deta	7.41	7.41
KNO distribution	23.64	23.64
KNO distribution	3.95	3.95
KNO distribution	23.64	23.64
Minimum Bias SPS data at 200 GeV	*639* Chi^2/DOF	*637* Chi^2/DOF
KNO Distribution	4.08	4.08
KNO Distribution	17.36	17.36
dN_chg/deta	4.11	4.11
Average charged multiplicity	53.93	53.93

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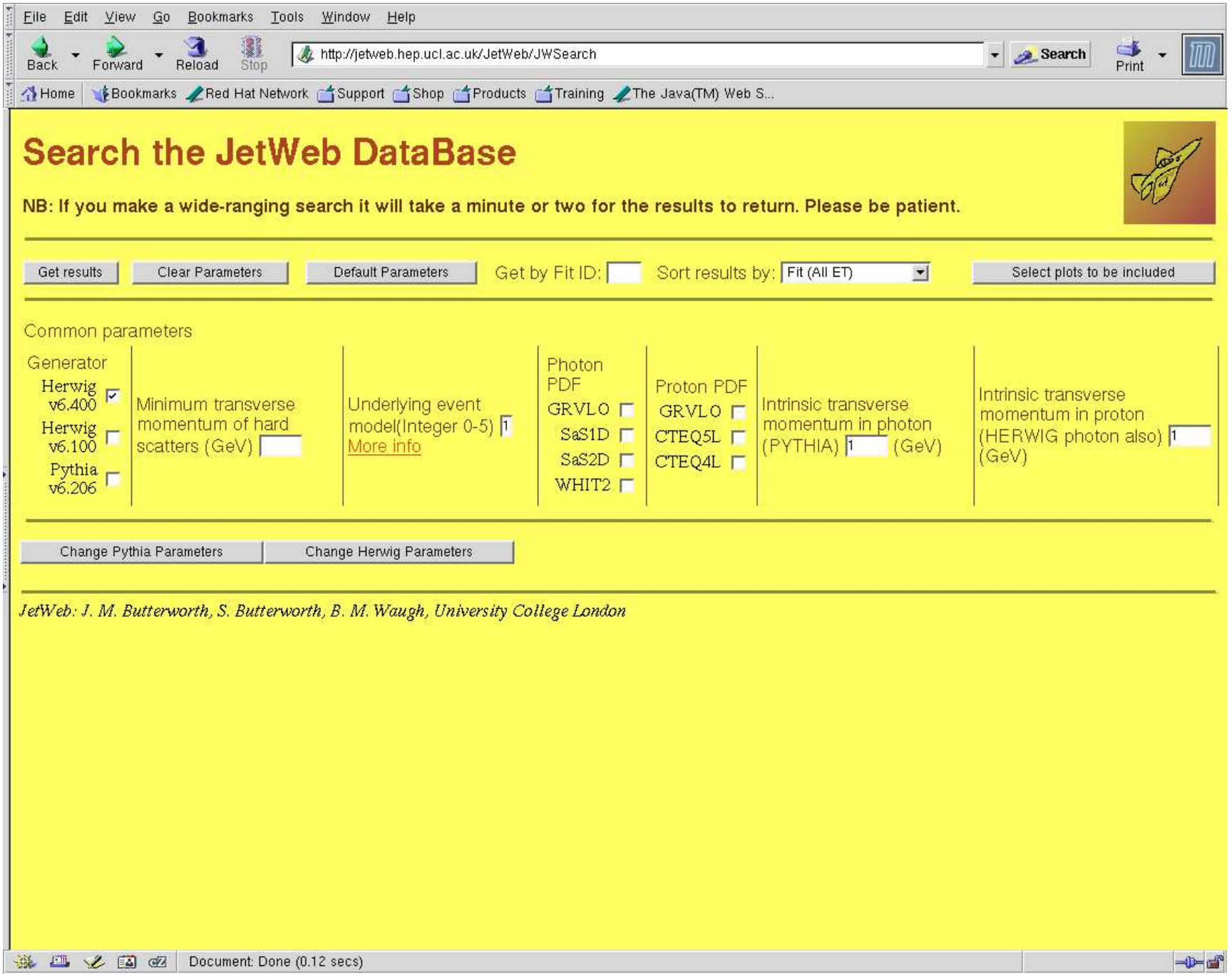
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Get results
Clear Parameters
Default Parameters
Get by Fit ID:
Sort results by: Fit (All ET)
Select plots to be included
Common parameters
Generator
Herwig v6.400
Herwig v6.100
Pythia v6.206
Minimum transverse momentum of hard scatters (GeV)
Underlying event model(Integer 0-5) 1
More info
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CTEQ5L
CTEQ4L
Intrinsic transverse momentum in photon (PYTHIA) 1 (GeV)
Intrinsic transverse momentum in proton (HERWIG photon also) 1 (GeV)
Change Pythia Parameters
Change Herwig Parameters
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JetWeb data request form

No data currently exist in the database matching the parameters you specified. If you would like to submit a request for data to be generated, submit the form below. You may modify the parameters before submission if you wish.

Submit the request | Clear Parameters | Generate data for: EP | Weighted events?

Common parameters

Generator
- Herwig v6.400
- Herwig v6.100
- Pythia v6.206

Minimum transverse momentum of hard scatters (GeV) 3.0

Underlying event model(Integer 0-5) 1
More info

Photon PDF
- GRVLO
- SaS1D
- SaS2D
- WHIT2

Proton PDF
- GRVLO
- CTEQ5L
- CTEQ4L

Intrinsic transverse momentum in photon (PYTHIA) 1.0 (GeV)

Intrinsic transverse momentum in proton (HERWIG photon also) 1.0 (GeV)

Herwig Parameters

PHAD	300.0	PHRAD	1.0	PRRAD	3.0	QSPAC	2.5	PRSOF	0.0	IOPREM	1
BTCLM	1.0	QCDLAM	0.18	VQCUT	0.46	CLMAX	3.35	PSPLT1	1.0	PSPLT2	1.0

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Search the JetWeb DataBase

Job submission successful
Job name : /home/jetweb/JetWeb/run/series5/n00000012859
Generator : herwig
version : v6.400
Photon PDF : GRVLO
Proton radius : 3.0
Photon radius : 1.0
Underlying event model : 1
PT RMS (Photon,proton) : 1.0,1.0
proton PDF : GRVLO
PTMIN : 3.0
QSPAC =2.5CLMAX =3.35QCDLAM =0.18VQCUT =0.48PRSOF =0.0IOPREM =1BTCLM =1.0PHAD =300.0PSPLT1 =1.0PSPLT2 =1.0

Get results | Clear Parameters | Default Parameters | Get by Fit ID: | Sort results by: Fit (All ET) | Select plots to be included

Common parameters

Generator
- Herwig v6.400 [x]
- Herwig v6.100 [ ]
- Pythia v6.206 [ ]

Minimum transverse momentum of hard scatters (GeV) 3.0

Underlying event model(Integer 0-5) 1
More info

Photon PDF
- GRVLO [x]
- SaS1D [ ]
- SaS2D [ ]
- WHIT2 [ ]

Proton PDF
- GRVLO [x]
- CTEQ5L [ ]
- CTEQ4L [ ]

Intrinsic transverse momentum in photon (PYTHIA) 1.0 (GeV)

Intrinsic transverse momentum in proton (HERWIG photon also) 1.0 (GeV)

Herwig Parameters

PHAD	300.0	PHRAD	1.0	PRRAD	3.0	QSPAC	2.5	PRSOF	0.0	IOPREM	1
BTCLM	1.0	QCDLAM	0.18	VQCUT	0.48	CLMAX	3.35	PSPLT1	1.0	PSPLT2	1.0

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Applications

- Tune and validate MC models.
- Select suitable parameters for use in measurements at existing colliders.
- Predict QCD background at Future Linear Collider (J Butterworth and M Wing).
- Work on LHC (Atlas tuning) underway.

FLC study (from talk by M Wing)

(Default) predictions at 500 GeV

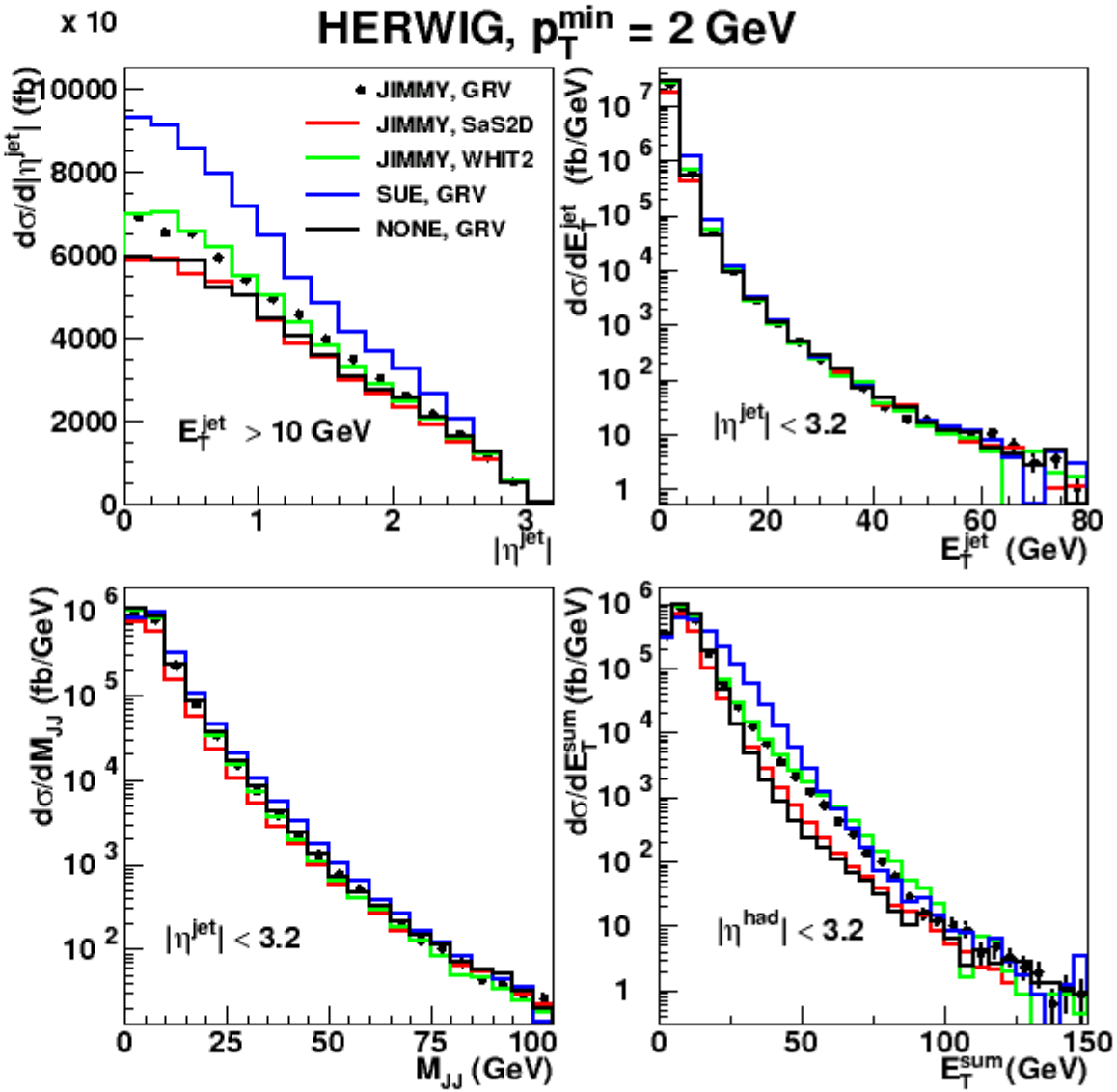
Default HERWIG prediction used with changes in underlying event and photon PDF.

All "reasonable" parameter settings.

Large spread in predictions, even at high energies.

How accurately do we know QCD production?

Not very well!



FLC study (from talk by M Wing)

(Fitted) predictions at 500 GeV

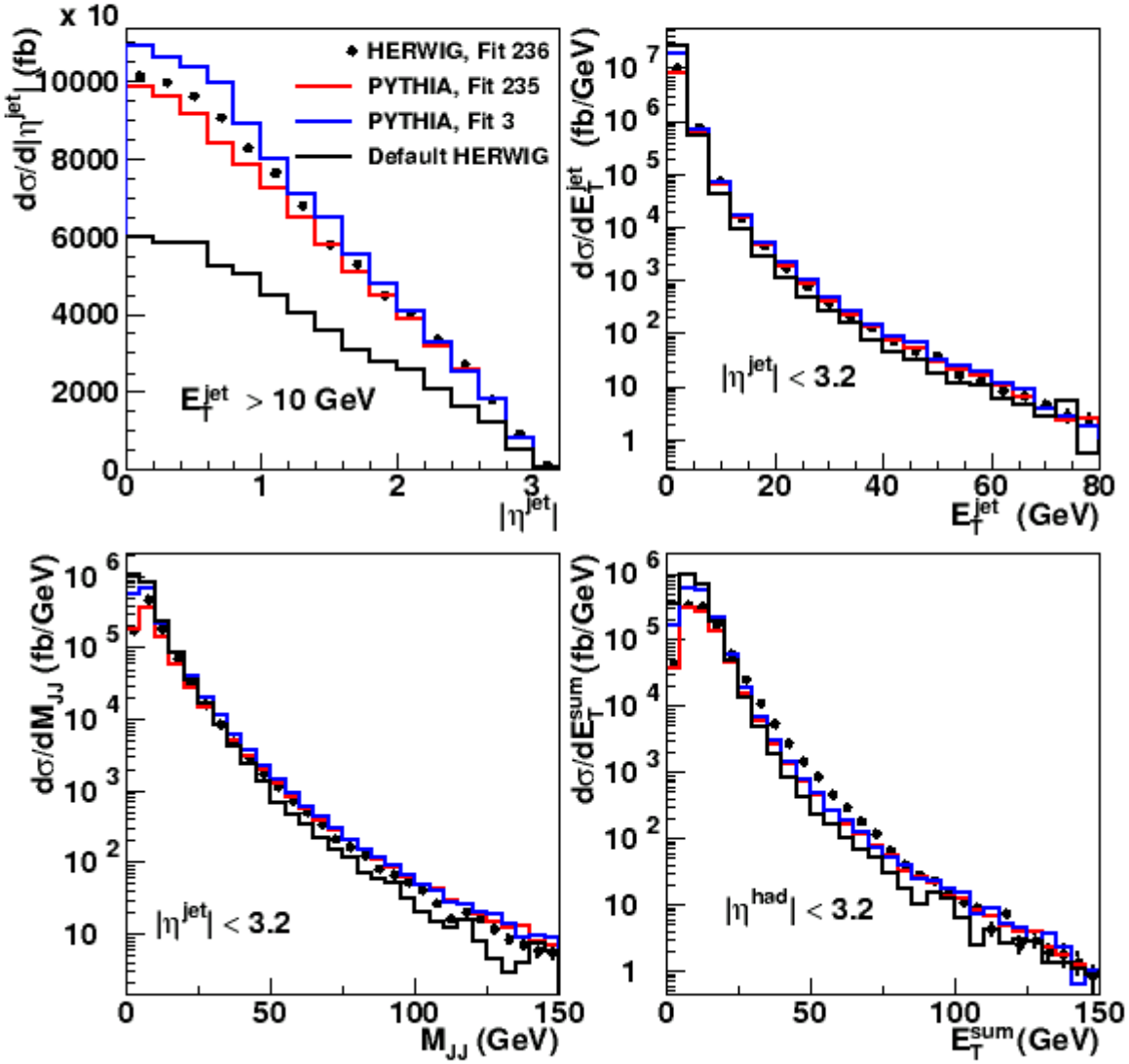
Again fits give similar results.

Spread is also reduced,
NB. predictions from two MCs

Significant differences to "default" prediction.

Predictions of QCD background known to much better accuracy.

These MC settings should be used in QCD background estimates for and colliders.



Planned improvements

- Add NLO calculations
- Integrate with HEPDATA database
- More use of Grid technologies for job submission and data access
- More data!

Conclusion

- Already a usable (and used) tool.
- Need more data, i.e. more HzTool routines.
- User feedback is also appreciated (+ and -).
- Please help us to improve and expand JetWeb!