



RunMC v3.1

**C++ object-oriented framework for
Monte Carlo models
(for Linux and Windows)**

S.Chekanov (ANL)

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Introduction

- A analysis framework to run most popular Monte Carlo model (PYTHIA, HERWIG, ARIADNE, CASCADE, LEPTO, AROMA)
- Good for validations, tuning, comparisons, calculations of correction factors (hadron-to-parton corrections etc.)
- Use modern C++ libraries - CLHEP
- Fully integrated with the ROOT analysis environment

(See introduction to RunMC 2.1, June 2, 2004, HERA-LHC workshop)

Plan of this presentation - discussion of new features:

- 1) Physics project (RMC) files
- 2) Histogram and steering card editors
- 3) Root Tree (Ntuple) analyzer
- 4) 2D histogram option
- 5) Platform independence

Physics project files

- Physics project (of any complicity) can be packed to a single "RMC" file

Example: "jets_LHC.rmc" - zipped "proj" directory with several files:

- 1) steering MC files - set MC parameters
- 2) user calculation functions: *user-ini*, *user-run*, *user-end*, *user-select*
- 3) jets_LHC.mc - file to update RunMC GUI & histogram definitions
- 4) a few (optional) files ..

Using the file selection dialog on RunMC GUI, a user can load this project file

RunMC automatically:

- unzips this file
- recompiles all MC models using user functions
- inserts steering parameters / MC initialization files
- updates RunMC GUI, histogram definitions etc.

in ~ 1 min, a complete analysis framework is ready

Physics project files

- After loading RMC file, a user can modify the project
 - Set different MC, parameters, histograms etc ..
- Using option "save RMC project", RunMC GUI archives the project and copies it to "archive" directory.

Presently available:

Used in the presentation by S.Magill
"Jets ET spectra at LHC" (WG2)

default.rmc	No any MC settings and physics calculations. Only dummy functions
dis_kinematics.rmc	DIS kinematic variables for HERA (Q ² ,x, etc), SC
charm_dis.rmc	Studies of D* cross sections in DIS (HERA), SC
dis_strange.rmc	Strangeness production (cross sections for K ⁰ s, Lambda's etc), SC
jets_HERA.rmc	Jets at HERA using longitudinally-invariant KT algorithm (Breit frame), SC
jets_LHC.rmc	Jets at LHC using the longitudinally-invariant KT algorithm (Lab. frame), SC
jets+charm_LHC.rmc	Jets at LHC using + charm production (Lab. frame), SC
invariant_mass.rmc	Invariant masses of two particles in e+e-, SC
event_shapes.rmc	Event shape studies, SC

<http://www.desy.de/~chekanov/runmc>

Loadable physics analysis projects (RMC)

Do you need different output, event record, MC tuning, histograms, external calculations (except for those included to RunMC)?

► Make a new RMC file and load it to RunMC

(and sent to chekanov@mail.desy.de to put on the RunMC web)

Advantages of RMC project files:

- Very easy to share complicated calculations
- Platform independents
- Small size - typically each RMC file < 22k Bytes, since main calculations (jet/event shapes algorithms etc..) are inside the RunMC
- No need to recompile the RunMC if you need to change histograms, binning, MC output, MC settings etc.

Histogram/steering cards editors

Allows to create / edit histograms or steering cards for each MC using spreadsheet-like GUI interface:

	1	2	3	4	5	6	7
1	Title	D	Min	Max	Bins	W	Comment
2	N(jets)	1	0.0	10.0	10	1.0	total number of jets
3	@ET(jets)	1	50.0	200.0	20	1.0	transverse energies of jets
4	@Eta(jets)	1	-3.0	3.0	20	1.0	pseudo-rapidity of jets
5	@Phi(jets)	1	-4.0	4.0	20	1.0	azimuthal angle of jets
6	@ET(jets)	2	50.0	200.0	50	1.0	transverse energies of jets
7	@Eta(jets)	2	-3.0	3.0	20	1.0	pseudo-rapidity of jets
8	Q2pp	1	10.0	5000.0	200	1.0	Q2, PARI(22) from PYTHIA
9	x1(hard)	1	0.0	0.5	500	1.0	x1, PARI(33) from PYTHIA
10	x2(hard)	1	0.0	0.5	500	1.0	x2, PARI(34) from PYTHIA
11	xFeynman	1	0.0	0.5	500	1.0	Feynman variable x1-x2
12	x(average)	1	0.0	0.5	500	1.0	average x: 0.5(x1+x2)

PYTHIA6 parameters and steering variables available to the user are stored in the following commons and can be changed as indicated below. They are explained in the PYTHIA manual.

Changing variables:
The order and the number of variables to be changed are arbitrary. In case of a one-dimensional array only the first index is used, the second index may have any value. In case of the variable CHARF, the second index and new-value are used to set the character*8 string. The basic rules (for details see the BOS manual) for writing card

	1	2	3	4	
1	Parameter	Index I	Index II	Value	Comment
2	HSTP	81	0	0	no multiple interactions
3	CKIN	3	0	40.	min. pt
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

OK Cancel

RunMC 3.1 GUI

Select MC model

Stable/partons?

ROOT canvas

1D or 2D?

Set histograms

Steering card editor

Select jets

6.5 model

Differential x-section in p

4909 events requested

4908 events generated

x-section $1.184837e+05$ pb

Luminosity $4.142341e-02$ pb⁻¹

Output histograms:

variable:	min	max	bins	
Q2	10.0	200.0	50	1D
X	0.0	0.0500000007	50	
N(jets)	0.0	7.0	7	2D
@ET(jets)	4.0	20.0	20	1D
@Eta(jets)	-2.0	3.0	20	1D
@Phi(jets)	-4.0	4.0	20	2D
@ET(jets)	4.0	10.0	20	2D
@Eta(jets)	-2.0	3.0	20	2D

Projects

MC settings

Select output

1636

HERA

Stop

Log

Histogram editor

1	2	3	4	5	6	7
Title	D	Min	Max	Bins	W	Comment
Q2	1	10.0	200.0	50	1.0	$-(q1-q2)**2$ for DIS/ppbar
X	1	0.0	0.0500000007	50	1.0	Bjorken X for DIS/ppbar
N(jets)	2	0.0	7.0	7	1.0	total number of jets
@ET(jets)	2	4.0	20.0	20	1.0	transverse energies of jets
@Eta(jets)	1	-2.0	3.0	20	1.0	pseudo-rapidity of jets
@Phi(jets)	1	-4.0	4.0	20	1.0	azimuthal angle of jets
@ET(jets)	2	4.0	10.0	20	1.0	transverse energies of jets
@Eta(jets)	2	-2.0	3.0	20	1.0	pseudo-rapidity of jets

Histogram selector

- none
- PTtot: transverse event momenta
- PZtot: longitudinal event momenta
- Etot: total event energy
- N(tot): total number of particles in event
- @Px: Px of all particles
- @Py: Py of all particles
- @pz: pz of all particles
- energy of all particles
- $Y**2$ for particles
- $2) for particles$
- angle for all particles
- le of all particles
- pidity: $-\ln(\tan(\theta/2))$
- i.e. $0.5*\ln((E+pz)/(E-pz))$

OK

Cancel

Steering card editor

lepto65.cards

RunMC card file lepto65.cards

Type of jet

Jade

Durham

KT (long. invariant)

Y(cut)

0.0020000

No jets

2 jets

2. delta R

2. recombination Pt

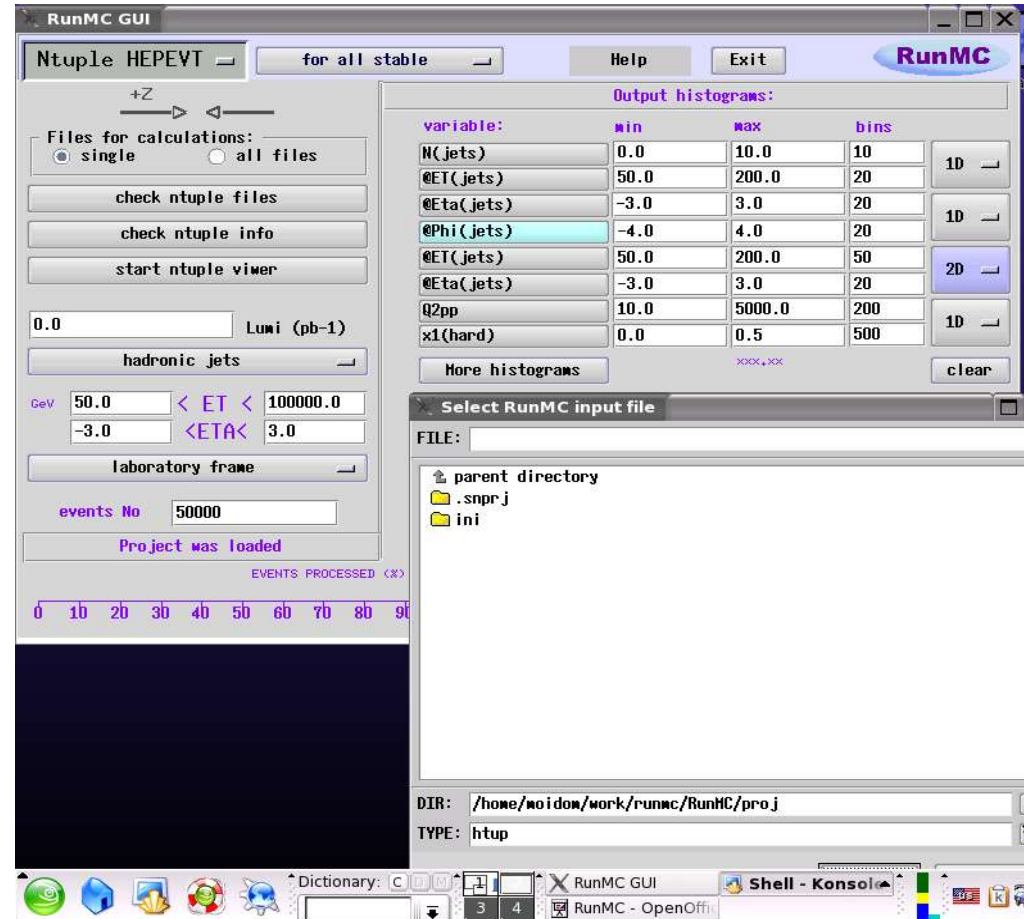
OK

Cancel

Main features (v3.1)

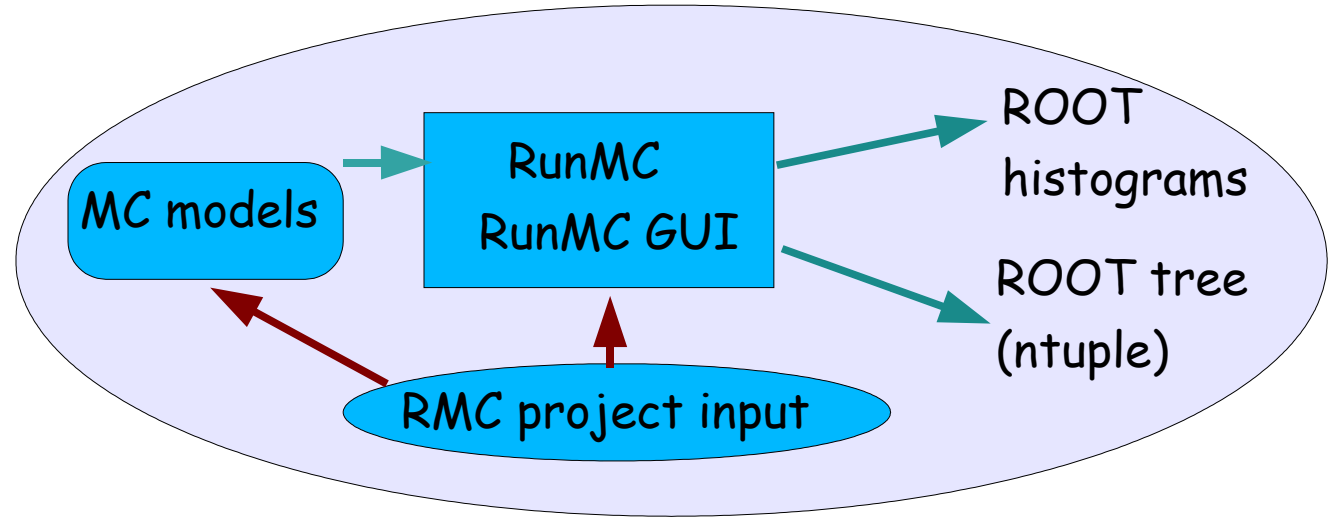
RunMC can create ROOT trees (ntuples)

- Events can be analyzed exactly as as for usual MC runs:
 - Significantly faster
 - Use RMC project files do this



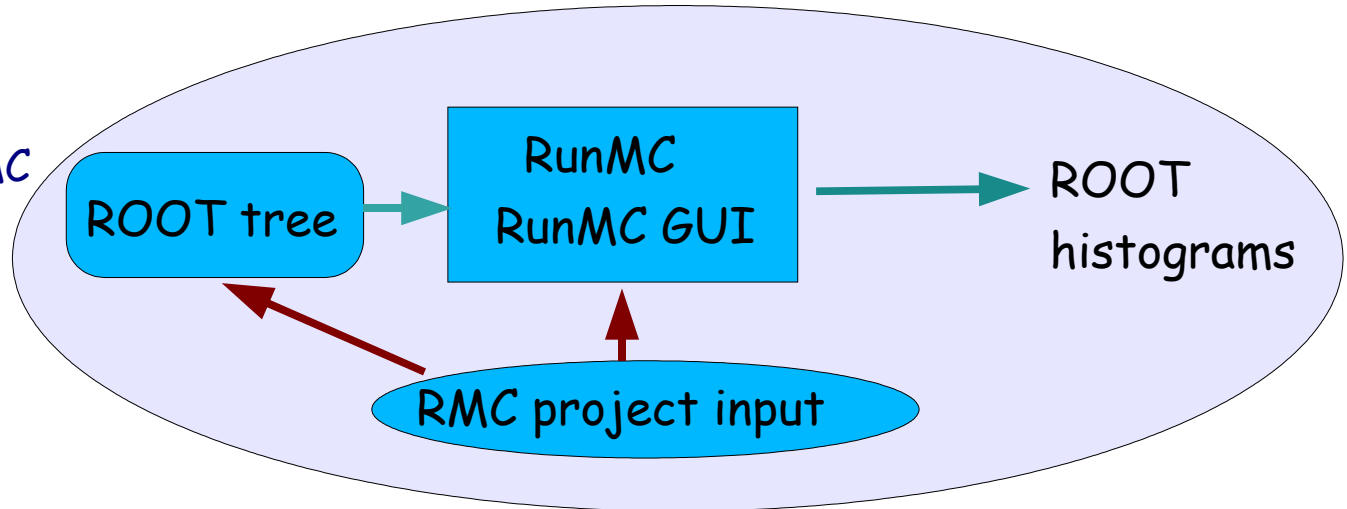
New features: 2 ways to fill histograms

1) Generate events and fill histograms (0.007 sec / event)



Alternatively:

1) Generate events and save event record in ROOT tree
2) Run over the ROOT tree using the same RMC project file (~ 17 times faster than to generate event & fill histogram)



Useful to validate physics project files

New features: 2D histograms

Example: typical MC run - two 1D histograms

Rapidity distribution

Multiplicity distribution

The screenshot shows the RunMC GUI interface. At the top, there are buttons for 'PYTHIA', 'for all stable', 'Help', and 'Exit'. Below these are input fields for 'p' (set to 7000.) and 'CTEQ'. The main window is titled 'RunMC' and contains a table for 'Output histograms!'. The table has columns for 'variable:', 'min', 'max', 'bins', and a dropdown menu. The first two rows are: '@Rapidity' (min: 10.0, max: 10.0, bins: 20) and 'N(tot)' (min: 0.0, max: 500.0, bins: 20). Below the table are buttons for 'More histograms', 'View outputs', 'Projects', 'MC settings', 'Select output', and '1000'. At the bottom are 'Cancel', 'Options', 'Start', 'Stop', and 'Log' buttons. On the left side, there are two histograms: the top one is labeled 'Rapidity' and the bottom one is labeled 'Multiplicity'. Both histograms show a distribution of values. A red arrow points from the text 'Rapidity distribution' to the '@Rapidity' row in the table. A green arrow points from the text 'Multiplicity distribution' to the 'N(tot)' row in the table. A blue arrow points from the text 'Click here to create one 2D histogram from two 1D histograms' to the dropdown menu in the table.

variable:	min	max	bins	
@Rapidity	10.0	10.0	20	1D
N(tot)	0.0	500.0	20	1D
	0.0	0.0	0	1D
	0.0	0.0	0	1D
	0.0	0.0	0	1D
	0.0	0.0	0	1D
	0.0	0.0	0	1D

Click here to create one 2D histogram from two 1D histograms

New features: 2D histograms

Example: typical MC run - 2D histograms

Rapidity distribution

Multiplicity distribution

The screenshot shows the RunMC GUI interface. On the left, a 3D histogram displays the distribution of Rapidity (x-axis, ranging from -10 to 10) versus Multiplicity N(tot) (y-axis, ranging from 0 to 1000). The z-axis represents the frequency of events. A data table is overlaid on the histogram:

Rapidity-N(tot)	
Entries	223950
Mean x	0.03368
Mean y	237.2
RMS x	3.708
RMS y	56.15

On the right, the 'Output histograms' configuration table is shown:

variable:	min	max	bins	
@Rapidity	-10.0	10.0	20	2D
N(tot)	0.0	500.0	20	1D
	0.0	0.0	0	1D
	0.0	0.0	0	1D
	0.0	0.0	0	1D
	0.0	0.0	0	1D

Red arrows point from the text labels to the '2D' dropdown menu in the configuration table and the 'N(tot)' row. A green arrow points from the text 'Click here to create one 2D histogram from two 1D histograms' to the '2D' dropdown menu.

Click here to create one 2D histogram from two 1D histograms

RunMC for Windows/Cygwin

RunMC consists of 2 independent parts:

- ROOT/C++ -based executables (combined with FORTRAN MC)
- RunMC GUI - presently based on Wstudio C++ classes, but can be written in JAVA, QT, GTK etc..or ROOT GUI classes
 - ▶ Does not depend on the core of the RunMC

Presently, in addition to Linux, RUNMC is available under Windows/Cygwin:

Cygwin is necessary to have necessary working environment for ROOT & FORTRAN MC (bash, X11, g++, g77, make)

However, RunMC GUI is completely independent of Cygwin and X11 since it uses Wstudio DDL libraries

Comparison with JetWeb

Main difference:

JetWeb - like PowerPoint running on a remote server, user can load/upload files ppt files, but do not have a full control over calculations:

- current focus - jets and heavy flavor production (RunMC - no restriction)
- only PYTHIA and HERWIG (6 models in RunMC)
- includes data for tunings (RunMC has no experimental data)

RunMC - is designed to run on every desktop, but loadable RMC files with physics calculations can be easily shared between users:

- ANY calculations
- flexibility and full control over program
- no heavy maintenance (but RMC files should be "certified" by someone!)
- No data - less power compared to JetWeb for MC tuning



Summary

RunMC version (v3.1) and user manual (v1.4):

<http://www.desy.de/~chekanov/runmc>

Can be done in future:

- add RAPGAP model
- HzTOOL can be converted to use with RunMC
(as RMC project modules)