URQMD in SPDROOT: status and prospect

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Current status

The Ultra Relativistic Quantum Molecular Dynamics (UrQMD) model is a transport model for simulating heavy ion collisions in the energy range from SIS to RHIC. UrQMD is designed as multipurpose tool for studying a wide variety of heavy ion related effects ranging from multifragmentation and collective flow to particle production and correlations.[1]

- UrQMD can be installed in the the same docker container alongside SPDROOT for easy distribution.
- Current version of SPDROOT includes possibility to read .f14 event output format of UrQMD. The reader is checked to be working with the TestUrqmd.C script (the script doesn’t work from scratch, needs to be updated)
- SPDROOT also has possibility to convert files from .f14 format to a TTree format and write it in the .root file

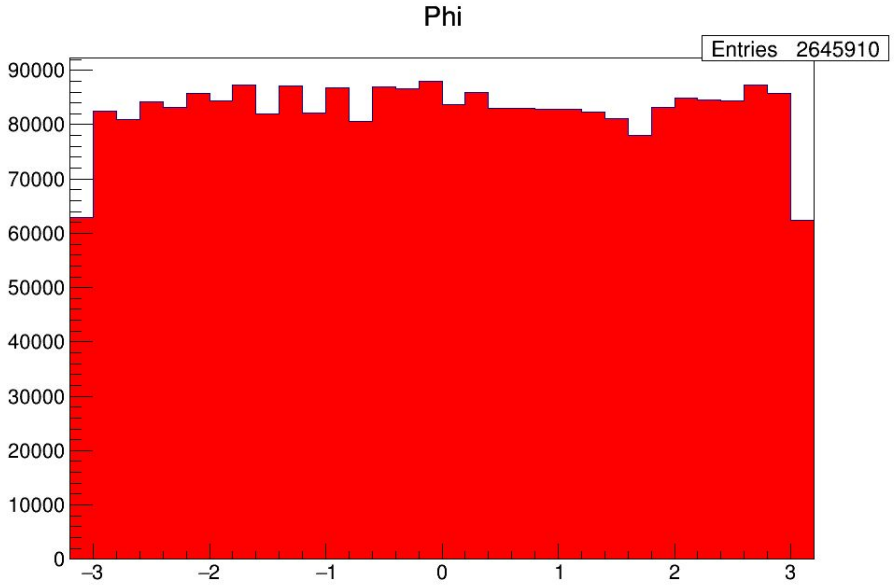
Current status

- However, some scientific groups use .f13 output, which contains more information such as freeze-out time and coordinates (see table with comparison of UrQMD output files on the right).
- Corresponding method SpdUrqmdGenerator::ReadEvent(FairPrimary Generator* primGen) in SPDROOT can be easily updated to read multiple types of UrQMD output files
- FairRoot [2] also uses .f14 output as input
- TTree output is not yet checked to be correct

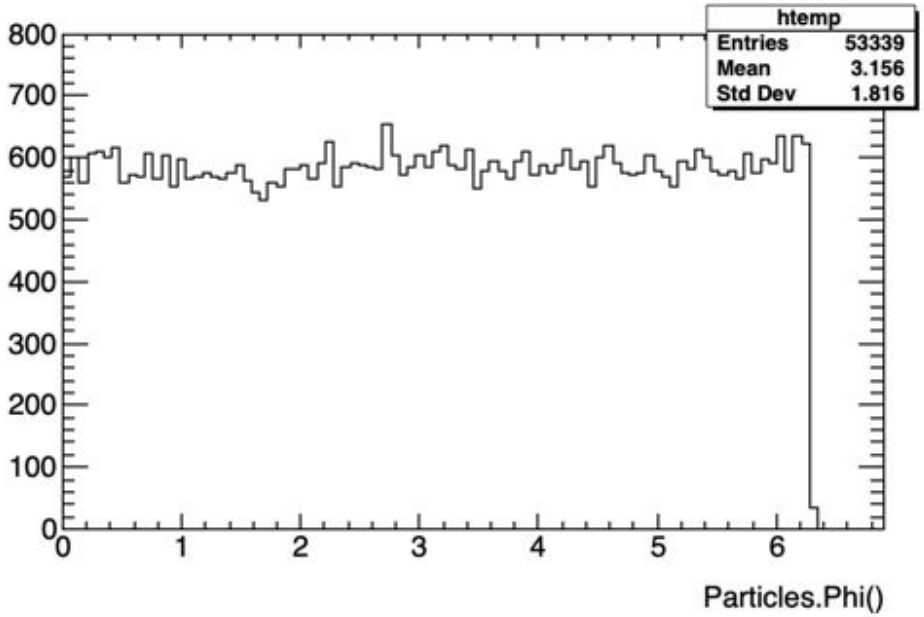
o13	o14	o15	o16	contents
		1		ind: index of particle (see `CTOption(56)`)
1	1	2	1	t: time of particle
2	2	3	2	r_x: x coordinate
3	3	4	3	r_y: y coordinate
4	4	5	4	r_z: z coordinate
5	5	6	5	E: energy of particle
6	6	7	6	p_x: x momentum component
7	7	8	7	p_y: y momentum component
8	8	9	8	p_z: z momentum component
9	9	10	9	m: mass of particle
10	10	11	10	ityp: particle-ID
11	11	12	11	iso3: $2 \cdot I_3$ (see Section 1.2)
12	12	13	12	ch : charge of particle
13	13	14	13	parent collision number (see Table 10)
14	14	15	14	N_{coll} number of collisions
		16		S : strangeness
15	15		15	parent process type (see Table 11)
		17		history information (debugging only)
16				t^{fr} : freeze-out time of particle
17				r_x^{fr} : freeze-out x coordinate
18				r_y^{fr} : freeze-out y coordinate
19				r_z^{fr} : freeze-out z coordinate
20				E^{fr} : freeze-out energy of particle
21				p_x^{fr} : freeze-out momentum x component
22				p_y^{fr} : freeze-out momentum y component
23				p_z^{fr} : freeze-out momentum z component
	16*			τ_{dec} decay time of particle
	17*			τ_{form} formation time of particle
	18*			R_σ cross section reduction factor
	19*			unique particle number (not ID!)
			16*	$\mathrm{ityp}_1^{\mathrm{old}}$: particle-ID of parent particle # 1
			17*	$\mathrm{ityp}_2^{\mathrm{old}}$: particle-ID of parent particle # 2

Current status: examples of output

histogram filled with particle φ



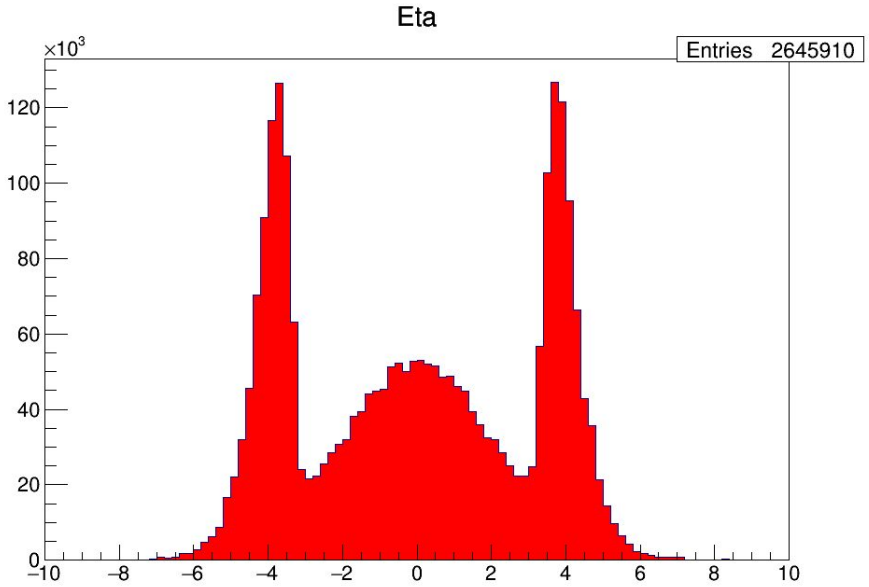
histogram filled with particle φ from TTree



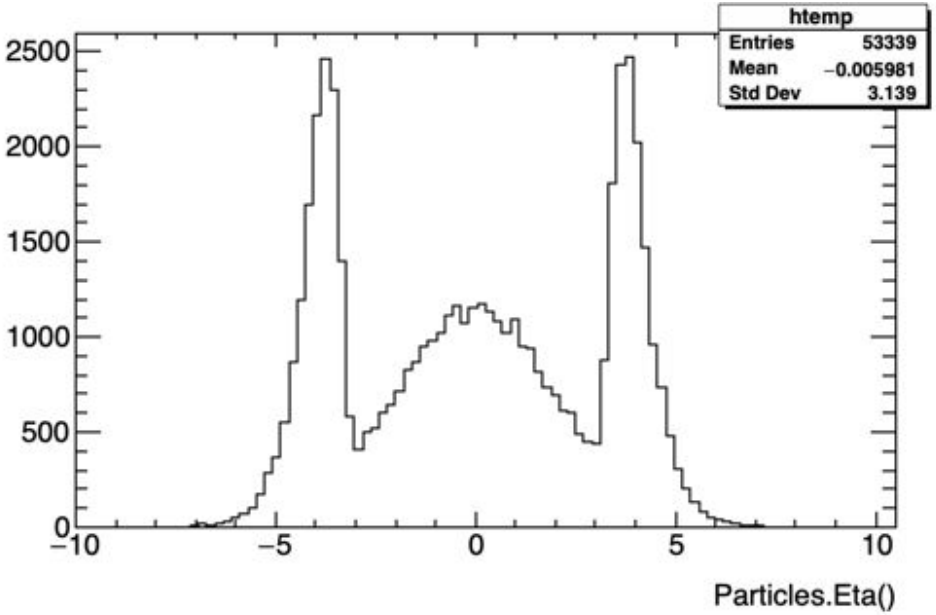
Number of entries is different. No filters for filling TTree is found yet.

Current status: examples of output

histogram filled with particle η

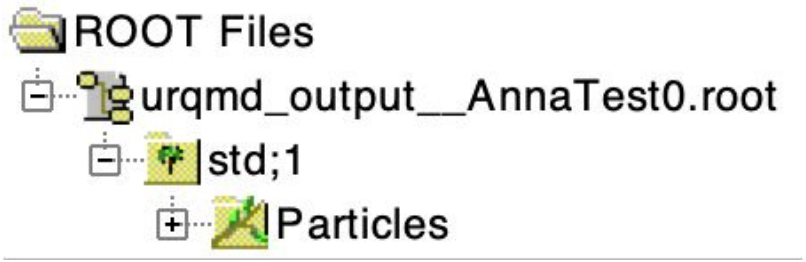


histogram filled with particle η from TTree

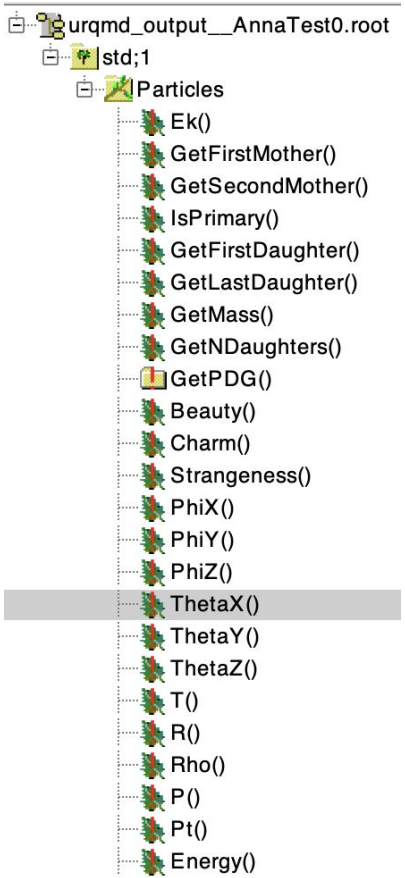


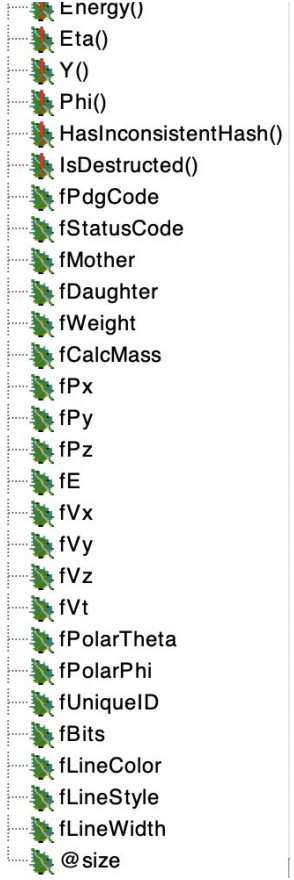
Number of entries is different. No filters for filling TTree is found yet.

Current status: structure of output TTree



- No event information is recorded, only particles and their properties.
- Possibly not optimal output.
- A lot of info is not used.
- Probably needs to be modified.





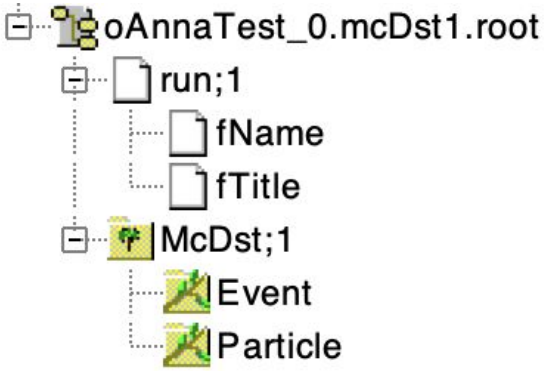
Prospect: McDst converter

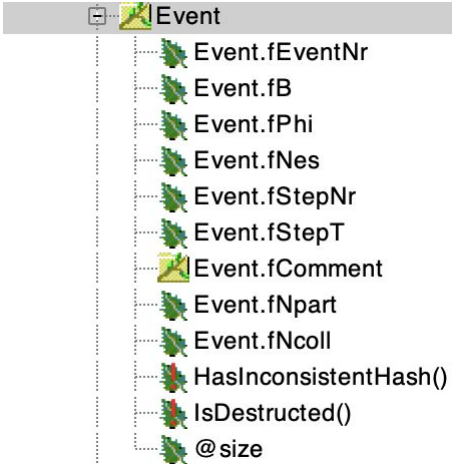
Another way to convert .f13 format to TTree .root is using McDst converter [3] made by Grigori Nigmatkulov

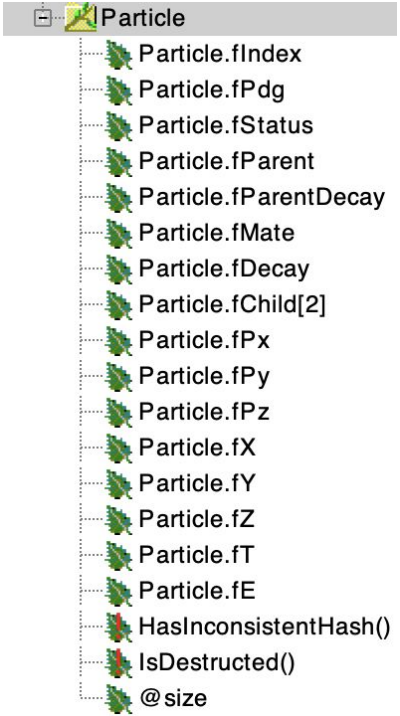
Advantages:

- Has possibility to filter events with elastic collisions and filter spectator particles
- Has information both about event and particles
- Already successfully tested
- Already implemented in MPDroot [4]: can use their experience
- Can convert output from other generators

File structure







Intermediate conclusion

For the reasons listed on the previous slide it was decided at SPD meeting of MEPhI group to move towards integration of McDst converter in SPDROOT.

Further steps

- gather information about which particle and event characteristics are necessary for simulation in Geant4
- figure out how these data are fed to Geant4 in MPDroot from McDst
- compare integration of UrQMD in MPDroot and in FairRoot
- implement UrQMD via McDst in SPD root analysis chain

References

[1] https://itp.uni-frankfurt.de/~bleicher/userguide.pdf

[2] https://github.com/FairRootGroup/FairRoot/tree/master

[3] https://github.com/nigmatkulov/McDst/tree/master

[4] https://git.jinr.ru/nica/mpdroot/-/tree/dev?ref_type=heads