
IMPLEMENTATION OF THE WEAK DECAYS METHOD IN URQMD MODEL

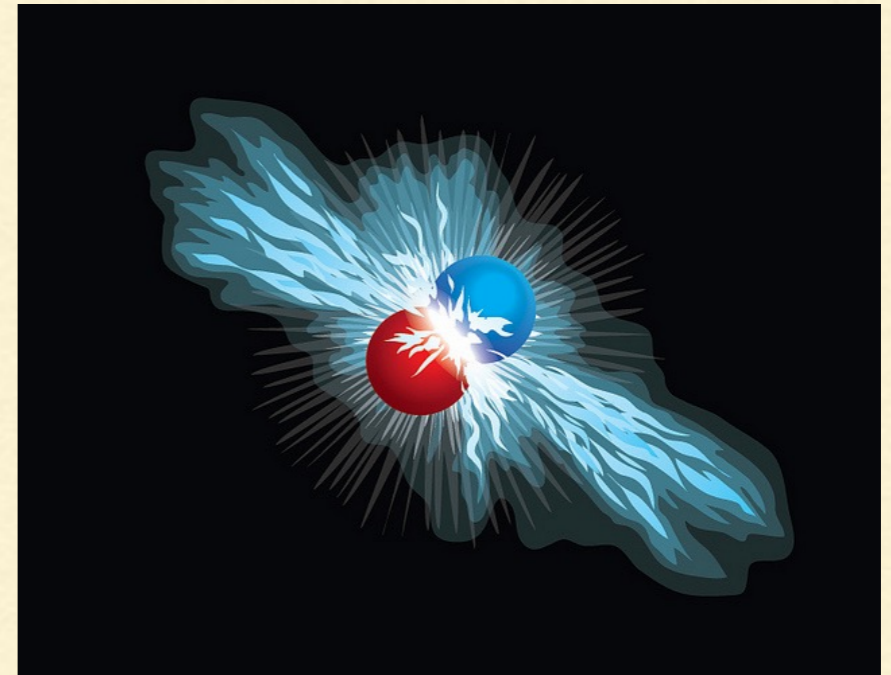
eng. Maria Stefaniak

tutor: dr eng. Hanna Zbroszczyk

GDRE 2015 Nantes

OUTLINE

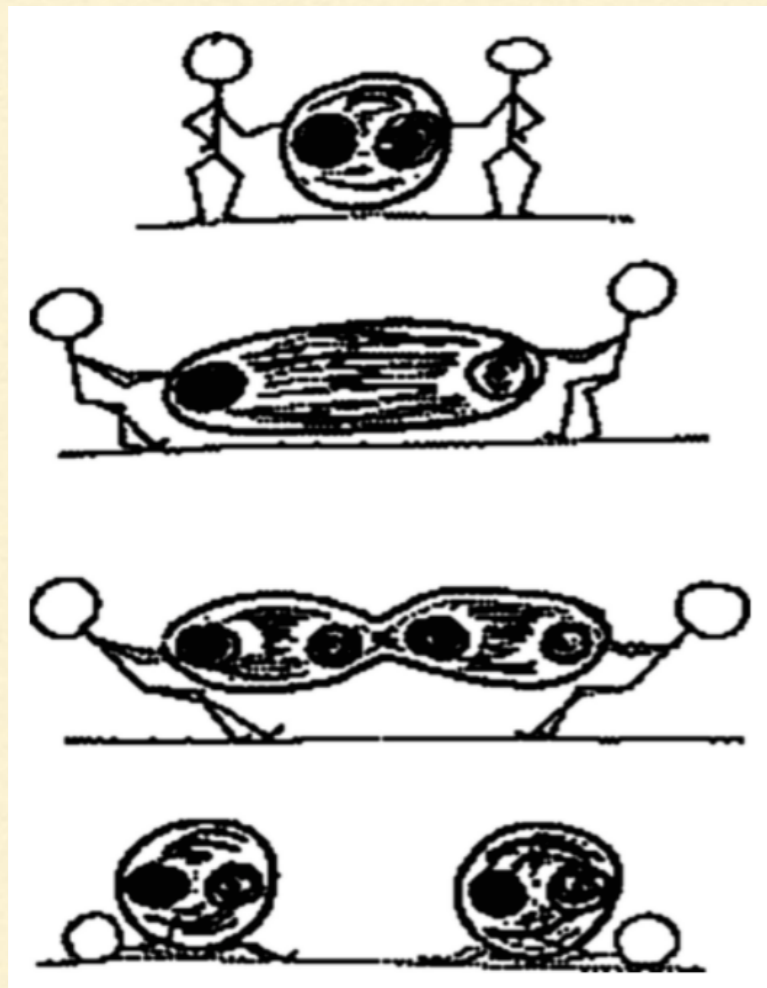
- UrQMD model
- Therminator's input files
- Weak decays method
- Results
- Conclusion and future plans



Ultra **R**elativistic **Q**uantum **M**olecular **D**ynamics

UrQMD model

- Model of hadrons transportation
- Has got implemented mechanism of modelling strong interactions using string theory



String - object fulfilled with colour field, where energy of the string is proportional to distance of quark separation

- Impossible to separate quarks as free objects
- String formation
- String fragmentation

UrQMD model

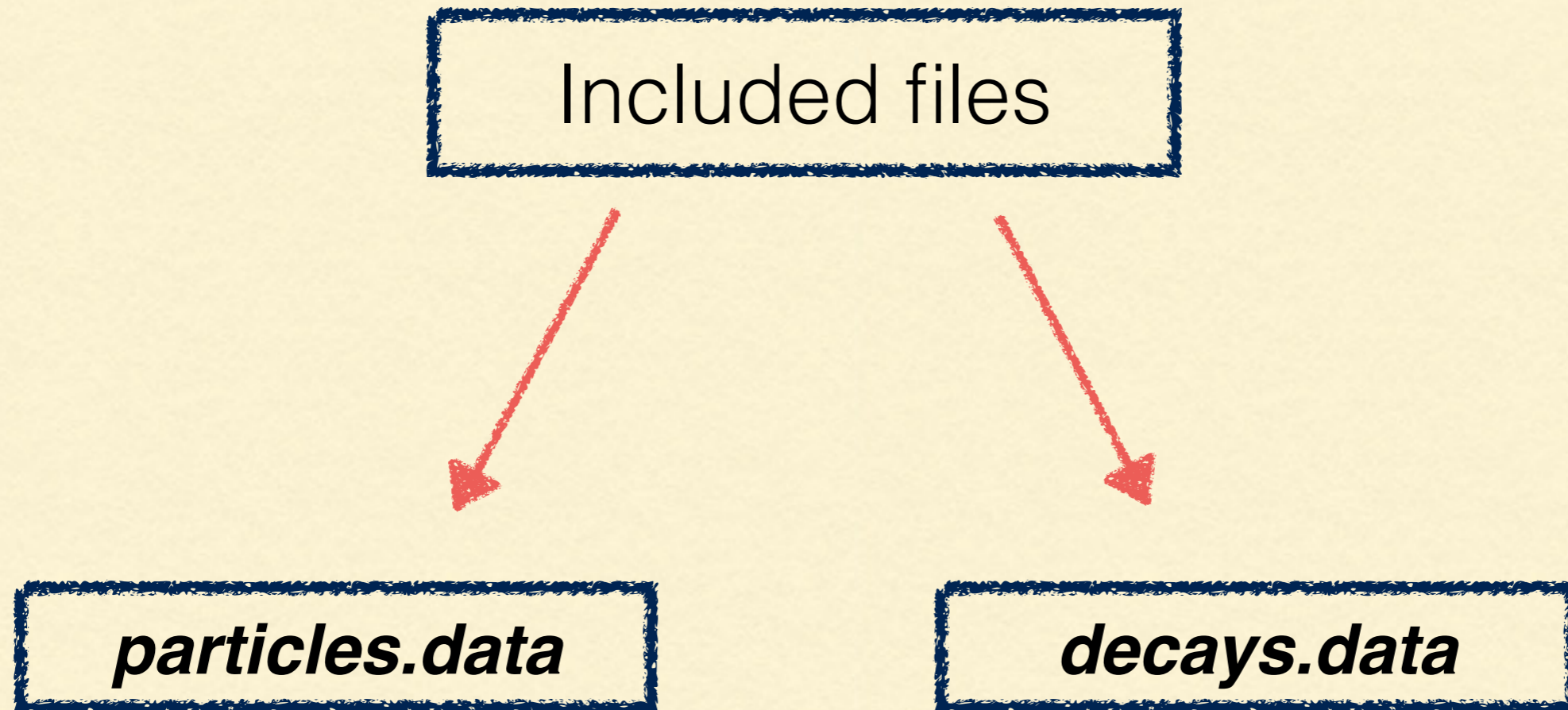
The process of generating new particles stops at 200 fm/c



No weak decays



Therminator's input files



Terminator's input files

particles.data

- Includes particles characteristics from PDG code

om0782zer	0.7825700	0.0084400	1.0	0.	0.	1.	0.	1.	0.	0.	0.	223
rho770plu	0.7693000	0.1502000	1.0	1.	1.	1.	0.	1.	0.	0.	0.	213
rho770min	0.7693000	0.1502000	1.0	1.	-1.	1.	0.	1.	0.	0.	0.	-213
rho770zer	0.7693000	0.1502000	1.0	1.	0.	1.	0.	1.	0.	0.	0.	113
f00600zer	0.8000000	0.8000000	0.0	0.	0.	1.	0.	1.	0.	0.	0.	9000221
eta547zer	0.5473000	1.2900e-6	0.0	0.	0.	0.19	0.81	0.19	0.81	0.	0.	221
Ka0492zer	0.4976720	7.335e-16	0.0	0.5	-0.5	1.	0.	0.	1.	0.	0.	311
Ka0492zrb	0.4976720	7.335e-16	0.0	0.5	0.5	0.	1.	1.	0.	0.	0.	-311
Ka0492plu	0.4936770	0.0000000	0.0	0.5	0.5	1.	0.	0.	1.	0.	0.	321
Ka0492min	0.4936770	0.0000000	0.0	0.5	-0.5	0.	1.	1.	0.	0.	0.	-321

Index Mass Width Spin I I3 q s aq as c ac PDG
PID

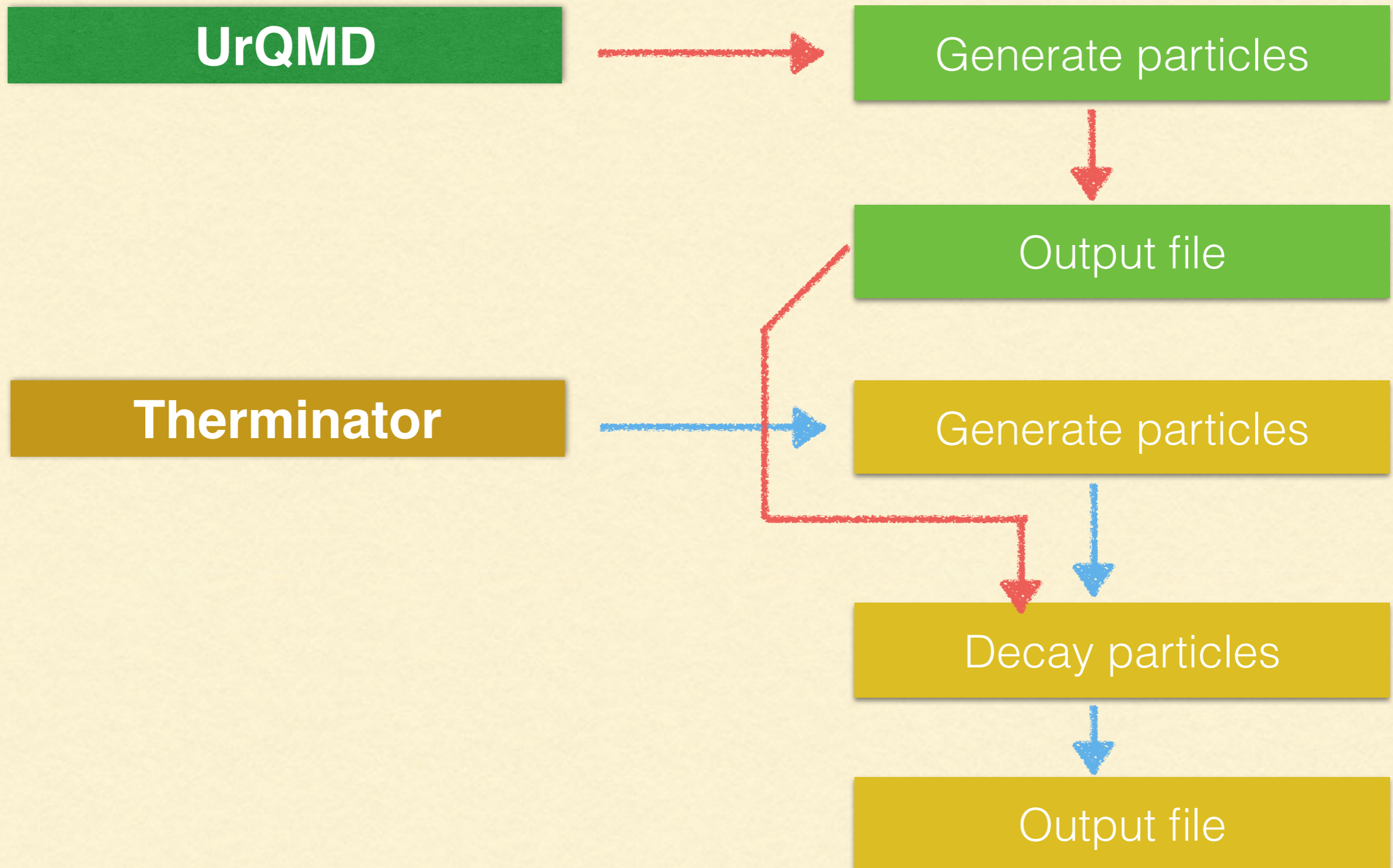
Terminator's input files

decays.data

- Created on the basis of PDG code
- Includes huge amount of particles decays

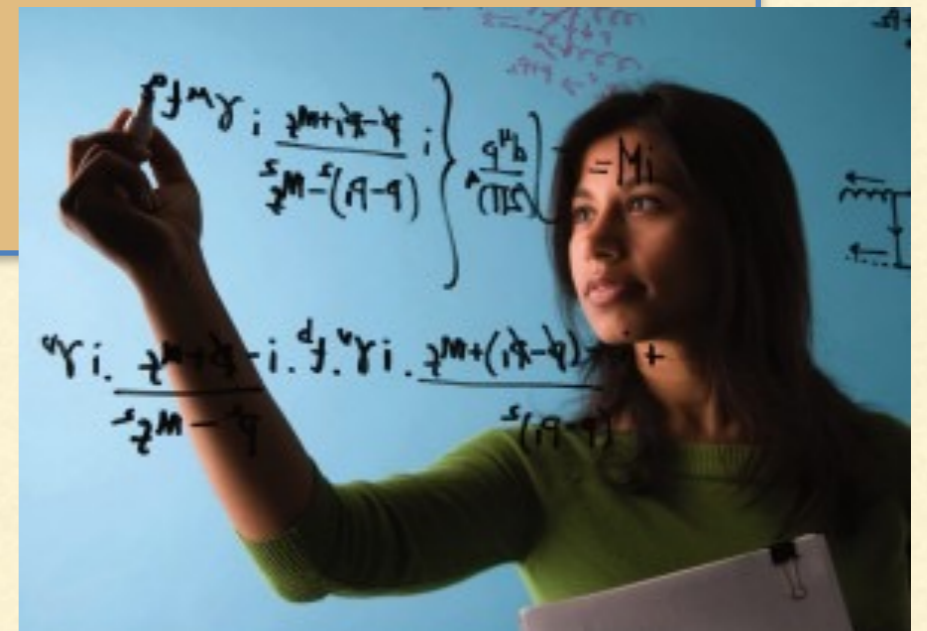
Parent	Daughters			Branching ratio
	1	2	(3)	
rho770zer	pi0139plu	pi0139min	1. 1	
rho770plu	pi0139plu	pi0135zer	1. 1	
rho770min	pi0139min	pi0135zer	1. 1	
f00600zer	pi0135zer	pi0135zer	1.0 1	
f00600zer	pi0139plu	pi0139min	1.0 1	
eta547zer	gam000zer	gam000zer	0.3943 0	
eta547zer	pi0135zer	pi0135zer	pi0135zer	0.3251 0
eta547zer	pi0139plu	pi0139min	pi0135zer	0.226 0
eta547zer	pi0139plu	pi0139min	gam000zer	0.0468 0
Ka0492zer	pi0139plu	pi0139min	0.343 0	
Ka0492zer	pi0135zer	pi0135zer	0.157 0	
Ka0492zrb	pi0139plu	pi0139min	0.343 0	
Ka0492zrb	pi0135zer	pi0135zer	0.157 0	

Weak decays method



Weak decays method

- Compare input data in Therminator methods and output file in UrQMD.
- Adapt UrQMD output files to be used by Therminator.
- Create „dictionary” of particles and their necessary features (for example PDG code)
- Design method of the weak decays
- Test already generated files.



Weak decays method

Sample of particles' dictionary

Index	PDG
j p3096zer	443
Dc1800plu	1231
Dc1800min	1232
Dc1800zer	1233
Dc1800zrb	1234
Dc2010plu	4231
Dc2010min	4232
Dc2010zer	4233
Dc2010zrb	4234
Ns2600plu	9401
Ns2600zer	9400
Ns2600plb	-9401
Ns2600zrb	-9400
Dl2420plp	9297
Dl2420plu	9298
Dl2420zer	9299
Dl2420min	9300
Dl2420ppb	-9297
Dl2420plb	-9298
Dl2420zrb	-9299
Dl2420mnb	-9300
Lm2350zer	9001
Lm2350zrb	-9001
f42340zer	40225
f22300zer	30225
UM2250min	9000
UM2250mnb	-9000
Ns2250plu	5128
Ns2250zer	5218
Ns2250plb	-5128
Ns2250zrb	-5218

Weak decays method

New form of output files from UrQMD

1	2112	ne0939zer	+1.9244801e-01	+7.6656902e-01	+2.0819499e+00	+2.4164100e+00	+9.3800002e-01	+2.1229399e-02	+5.2523098e+00	+1.7842100e+01	+2.0371901e+01
+2	+2212	pr0938plu	-1.5793700e-02	+3.9549999e-02	+1.5009400e+01	+1.5036300e+01	+8.9816803e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+3	+2212	pr0938plu	-1.0835500e-01	-8.7061301e-02	+2.0119301e+01	+2.0140699e+01	+9.1940302e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+4	+2212	pr0938plu	-9.3937099e-02	-2.1037800e-02	+1.9955299e+01	+1.9976999e+01	+9.2489702e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+5	+2212	pr0938plu	-1.1277100e-01	-1.1088500e-01	+2.2059500e+01	+2.2078899e+01	+9.1087800e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+6	+2212	pr0938plu	+9.2632100e-02	-1.8839000e-01	+2.1987600e+01	+2.2007099e+01	+9.0178603e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+7	+2212	pr0938plu	+3.9902499e-01	-4.6842799e-02	+5.1345701e+00	+5.2349901e+00	+9.3800002e-01	+5.0170298e+00	-3.3896101e+00	+6.0060902e+01	+6.0908501e+01
+8	+2212	pr0938plu	+1.0536300e-01	+1.1065100e-01	+1.7736401e+01	+1.7760500e+01	+9.1201502e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+9	+2212	pr0938plu	-1.2389500e-01	+1.3654099e-01	+1.9606400e+01	+1.9628500e+01	+9.1151398e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+10	+3222	Sg1189plu	+7.7040201e-01	-2.0096800e-01	+1.1713300e+01	+1.1800700e+01	+1.1920000e+00	+3.0848200e+00	-1.9078200e+00	+3.6376701e+01	+3.7074799e+01
+11	+2212	pr0938plu	+1.8812899e-01	+4.2904800e-04	+2.7240000e+00	+2.8871200e+00	+9.3800002e-01	+3.7876999e+00	-5.2392298e-01	+4.6636902e+01	+4.8822800e+01
+12	+2212	pr0938plu	-2.5668800e-02	-1.4346600e-01	+2.0849800e+01	+2.0870501e+01	+9.1711599e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+13	+2212	pr0938plu	+1.1125000e-01	+5.4548599e-02	+1.7969400e+01	+1.7993299e+01	+9.1802102e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+14	+2212	pr0938plu	+5.7991400e-02	-6.8798102e-02	+1.5667800e+01	+1.5694100e+01	+9.0307301e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+15	+2212	pr0938plu	-2.2109200e-01	+4.7622299e-01	+2.1025000e+01	+2.1052500e+01	+9.3800002e-01	+6.5845199e+00	+1.4543500e+00	+1.5821001e+02	+1.5896001e+02
+16	+3122	Lm1115zer	-5.5290002e-01	+3.4094700e-01	+4.7382501e-01	+1.3754700e+00	+1.1160001e+00	-6.2447900e-01	-4.5220098e+00	+1.3813500e+01	+1.9339300e+01
+17	+2212	pr0938plu	+6.4961302e-01	+3.2015401e-01	-1.0508900e+01	+1.0575600e+01	+9.3800002e-01	+1.7773401e+00	+1.2896399e+00	-7.7533997e+01	+7.8434700e+01
+18	+2212	pr0938plu	+9.0762600e-02	-6.0520001e-02	+1.6378799e+01	+1.6404301e+01	+9.0863597e-01	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00	+0.0000000e+00
+19	+2212	pr0938plu	+2.2034200e-02	+3.2873300e-01	+1.9806499e+01	+1.9831400e+01	+9.3800002e-01	+1.1562500e+00	+3.2959800e+00	+4.7907398e+01	+4.8441700e+01

New Index

Weak decays method

Part of decay mechanism

Read events from UrQMD

- use data from well-prepared UrQMD output file
- implement mechanisms to decay particles (similar as in Therminator)

```
void
Event::DecayParticles()
{
    Particle *tPart1, *tPart2, *tPart3, *tFather;
    ParticleDecayer* tDecayer;
    int tCount = 0;
    tDecayer = new ParticleDecayer(mDB);
    tDecayer->SeedSet(mRandom->Integer(100000000));
    while (tFather = GetParticleOfCount(tCount)) {
        if (tFather->GetParticleType()->GetGamma() >= 0.0)
        if ((tFather->GetParticleType()->GetTable()) && (((DecayTable *)
            |tFather->GetParticleType()->GetTable()->GetChannelCount()+1 > 0))
            {tDecayer->DecayParticle(tFather, &tPart1, &tPart2, &tPart3);
#ifdef _RESCALE_CHANNELS_
            if (!tPart1) {
                tCount++;
                continue;}
#endif
#ifdef _NO_THREE_BODY_DECAYS_
            if (tPart3){
                tCount++;
                cout<<"three body: "<<tCount<<endl;
                continue;}
#endif
#ifdef _OMIT_TWO_BODY_
            if (tPart1 && tPart2 && !tPart3){
                cout<<"two body: "<<tCount<<endl;
                continue;}
#endif
            tPart1->SetFather(tFather->GetParticleType()->GetPDGCode());
            tPart2->SetFather(tFather->GetParticleType()->GetPDGCode());
            if (tPart3)
                {tPart3->SetFather(tFather->GetParticleType()->GetPDGCode());}
            AddParticle(tPart1);
            AddParticle(tPart2);
            delete tPart1;
            delete tPart2;
            if (tPart3) {
                AddParticle(tPart3);
                delete tPart3;}
        }
        else{}
        tCount++;}
    delete tDecayer;
}
```

Weak decays method

Sample of new UrQMD output file

```
691619 2212 -5.3590260e-02 -1.5948150e-01 +3.7648510e+00 +3.8836540e+00 +9.3827200e-01 +1.8481650e+12 -4.4791980e+13 +1.3802280e+15 +1.4305630e+15 +3122 +0
+691620 -211 +5.9111570e-02 +2.5667480e-02 +3.5851890e-01 +3.9008790e-01 +1.3956990e-01 +1.8481650e+12 -4.4791980e+13 +1.3802280e+15 +1.4305630e+15 +3122 +0
+691621 +2212 -3.4252210e-01 +1.0443280e-01 +9.8381210e+00 +9.8892470e+00 +9.3827200e-01 -2.9267400e+13 +3.1702750e+13 +1.6453160e+15 +1.6539160e+15 +3222 +0
+691622 +111 +1.2879910e-01 +1.2707420e-01 +2.1766790e+00 +2.1883520e+00 +1.3497640e-01 -2.9267400e+13 +3.1702750e+13 +1.6453160e+15 +1.6539160e+15 +3222 +0
+691623 +2212 -2.6483000e-02 +5.0983810e-01 +1.2050190e+00 +1.6102990e+00 +9.3827200e-01 +5.6800000e+12 +4.3771020e+13 +1.1482000e+14 +1.5310500e+14 +3122 +0
+691624 -211 +9.6002400e-02 +2.5889850e-02 +2.0030080e-01 +2.6360370e-01 +1.3956990e-01 +5.6800000e+12 +4.3771020e+13 +1.1482000e+14 +1.5310500e+14 +3122 +0
+691625 +2212 -1.5347180e-01 +4.5349160e-02 +1.4803840e+01 +1.4834410e+01 +9.3827200e-01 -1.0847180e+13 +1.4260710e+13 +1.8270230e+15 +1.8305880e+15 +3122 +0
+691626 -211 +4.6163840e-02 +9.5727840e-02 +3.2703590e+00 +3.2750610e+00 +1.3956990e-01 -1.0847180e+13 +1.4260710e+13 +1.8270230e+15 +1.8305880e+15 +3122 +0
+691627 +2212 -1.0671300e-01 -2.5362260e-02 -7.4334980e-01 +1.2020620e+00 +9.3827200e-01 -9.9926830e+11 +1.0508490e+12 -1.4379720e+13 +2.4015210e+13 +3122 +0
+691628 -211 +4.8584800e-02 +8.6490950e-02 -9.3129230e-02 +1.9492040e-01 +1.3956990e-01 -9.9926830e+11 +1.0508490e+12 -1.4379720e+13 +2.4015210e+13 +3122 +0
+691629 +2212 -3.3330710e-01 -8.3264570e-01 +3.8698700e+00 +4.0817450e+00 +9.3827200e-01 -2.0055150e+13 -3.5794120e+13 +1.8890970e+14 +1.9732900e+14 +3222 +0
+691630 +111 -2.6880490e-01 -2.4199430e-01 +1.8017290e+00 +1.8426240e+00 +1.3497640e-01 -2.0055150e+13 -3.5794120e+13 +1.8890970e+14 +1.9732900e+14 +3222 +0
+691631 +211 +7.7098680e-02 +5.5247680e-02 -7.3091810e-02 +1.8389860e-01 +1.3956990e-01 +3.4780850e+05 +8.1866030e+04 -1.0841280e+06 +1.4264360e+06 +221 +0
+691632 -211 +3.0499770e-02 -9.5604870e-02 -2.0509820e-01 +2.6761080e-01 +1.3956990e-01 +3.4780850e+05 +8.1866030e+04 -1.0841280e+06 +1.4264360e+06 +221 +0
+691633 +111 +1.1490340e-01 +9.2727690e-02 -4.1535590e-01 +4.6102100e-01 +1.3497640e-01 +3.4780850e+05 +8.1866030e+04 -1.0841280e+06 +1.4264360e+06 +221 +0
+691634 +211 +3.9838930e-01 -4.2795820e-01 -6.6363730e-02 +6.0476950e-01 +1.3956990e-01 +8.3967470e+14 -1.1194280e+15 +2.8230000e+14 +1.6742010e+15 +311 +0
+691635 -211 +7.9359670e-02 -2.0896180e-01 +2.2698370e-01 +3.4779930e-01 +1.3956990e-01 +8.3967470e+14 -1.1194280e+15 +2.8230000e+14 +1.6742010e+15 +311 +0
```

np PDG px py pz E m x y z t HasFather /
HasDecayed



NEW

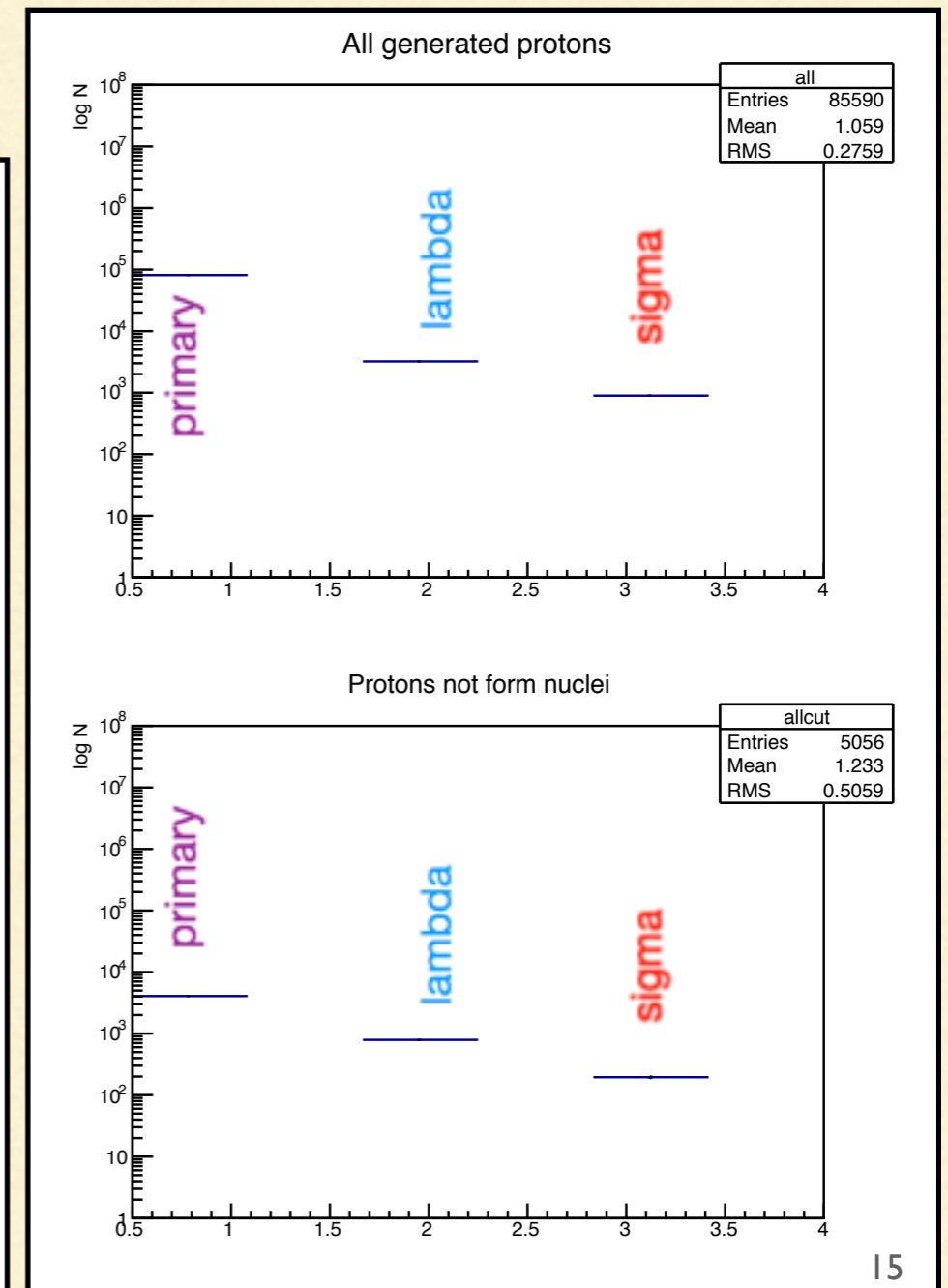
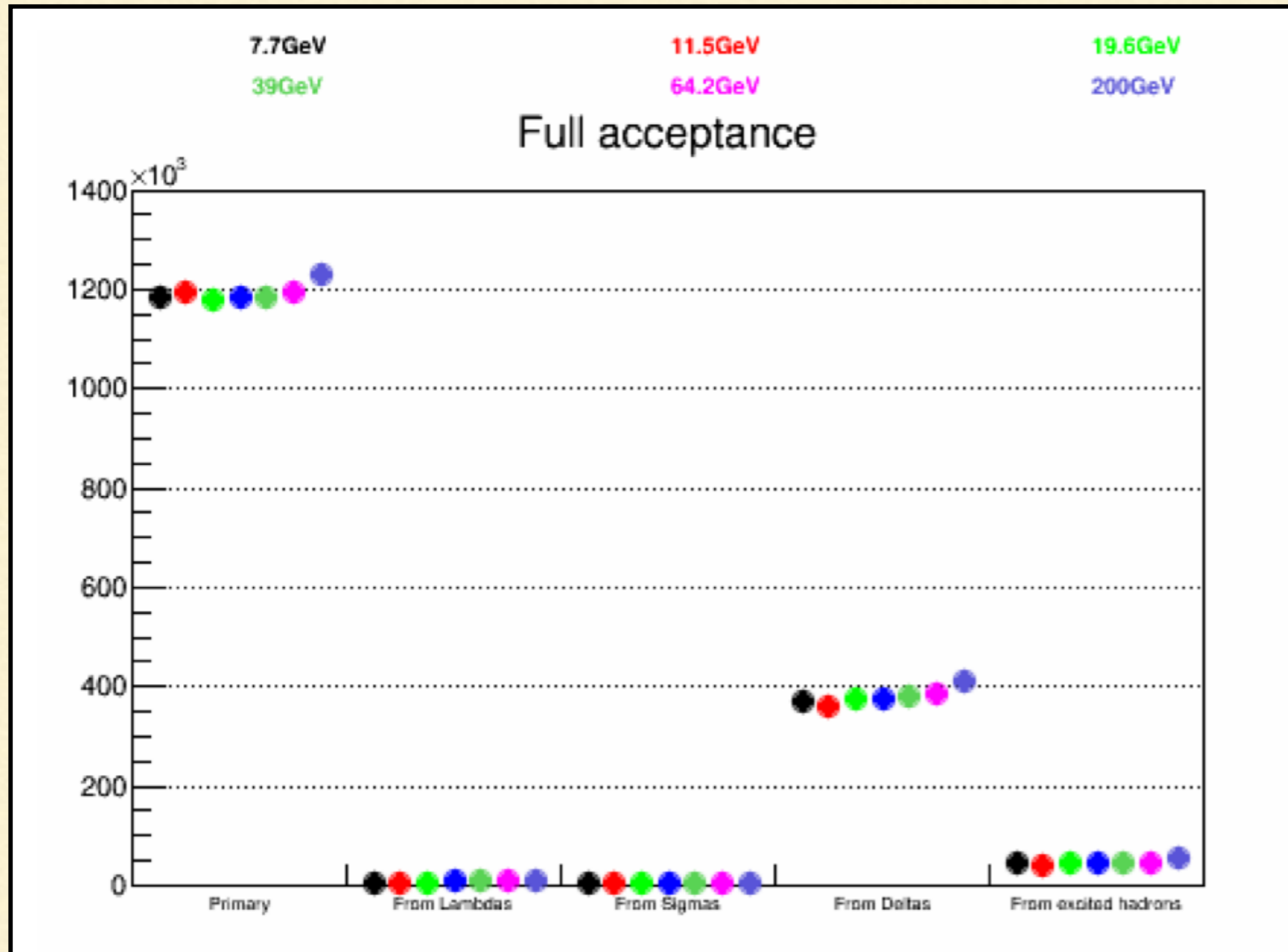
Results

Protons' origin

Au-Au 39 GeV

After

Before

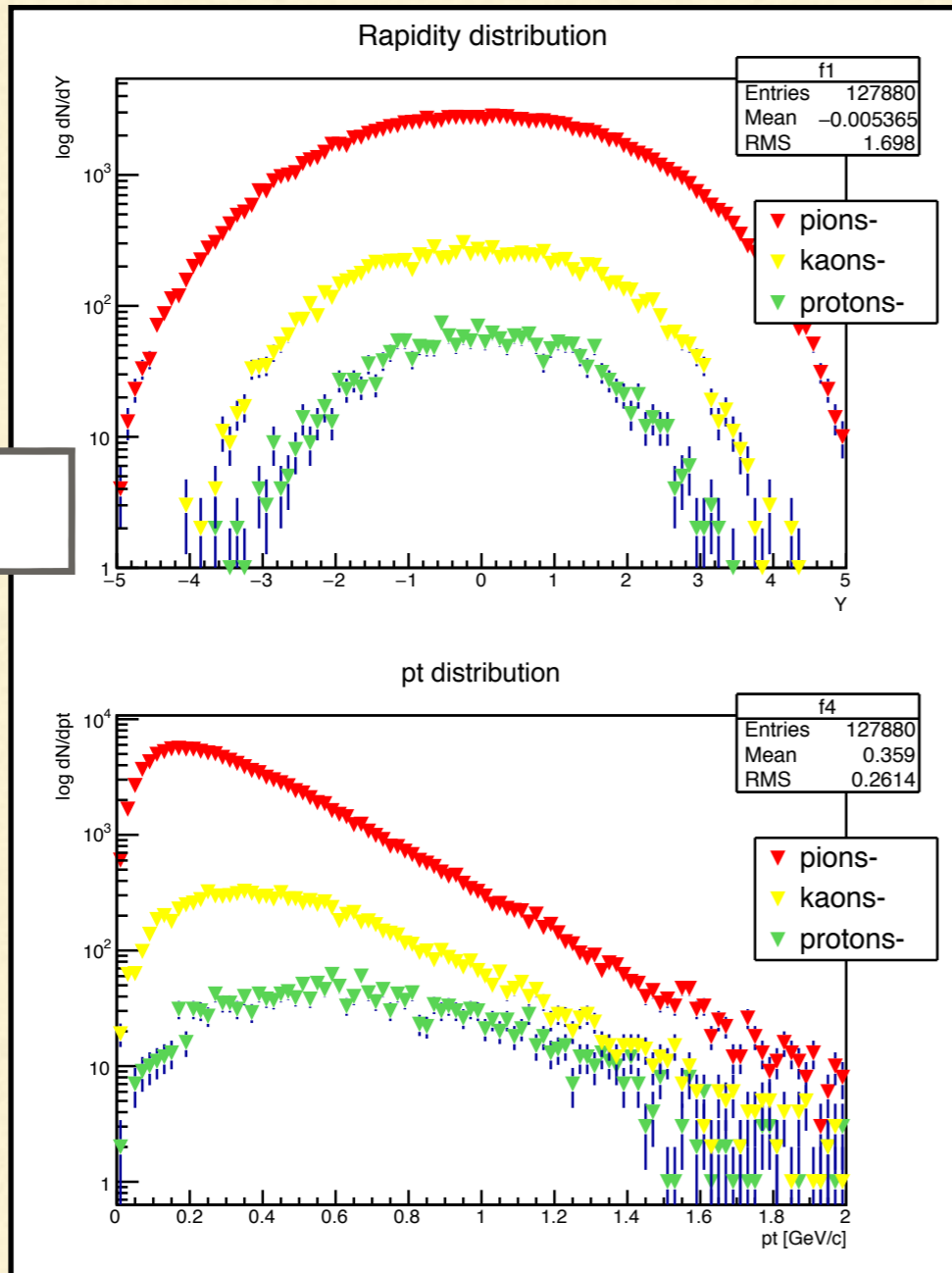


Results

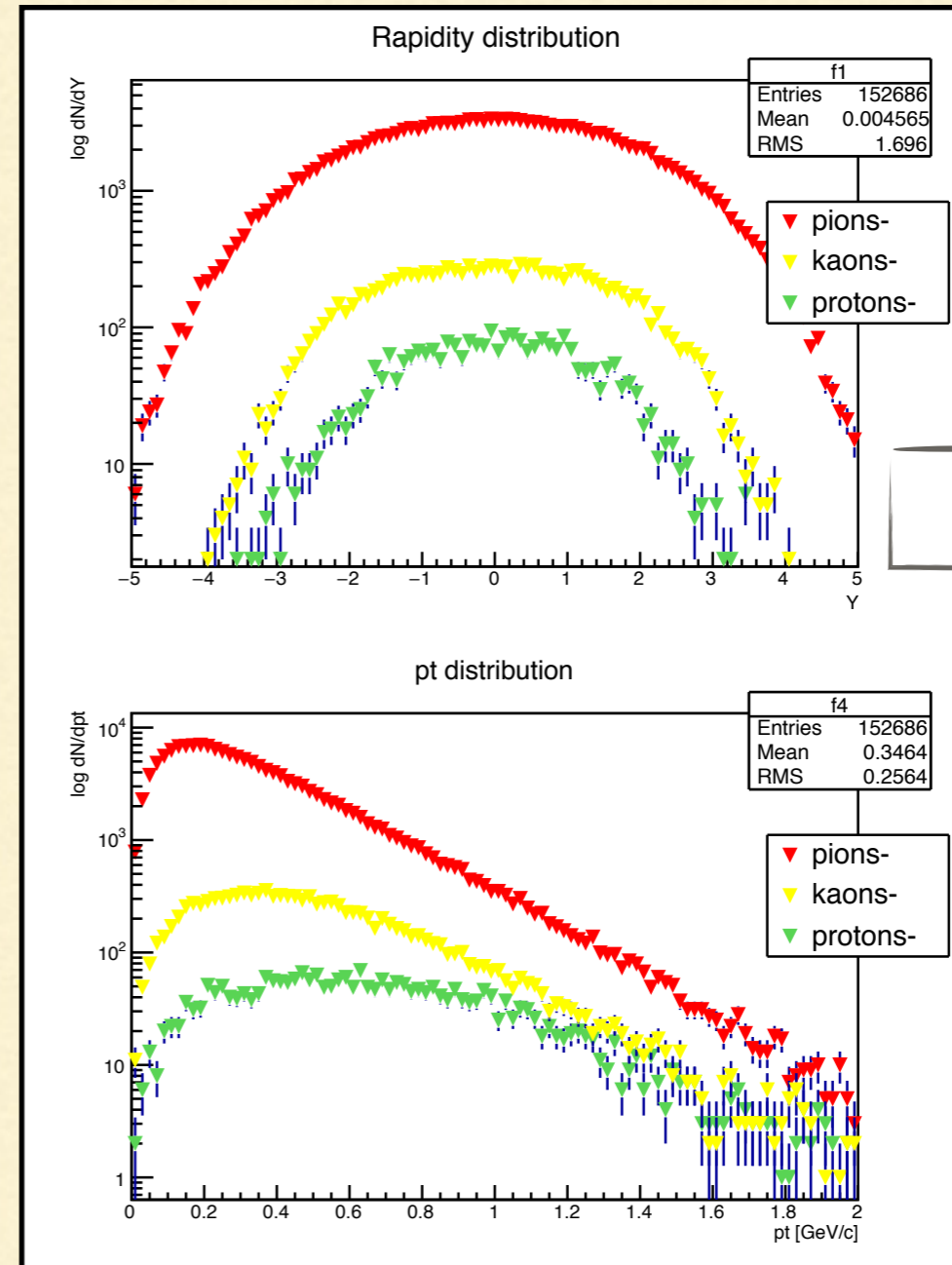
Rapidity and p_t

Au-Au 39 GeV

Before



After

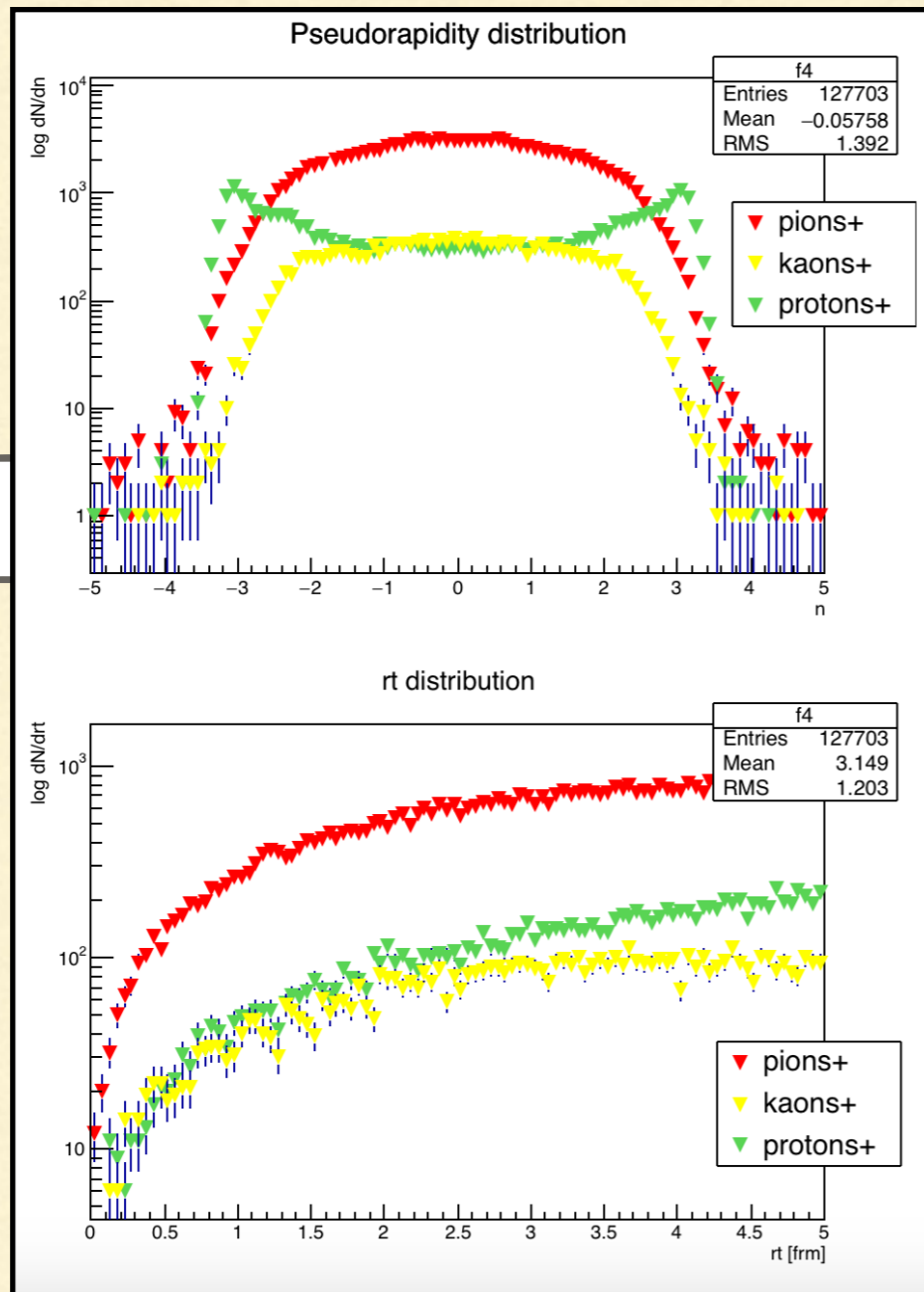


Results

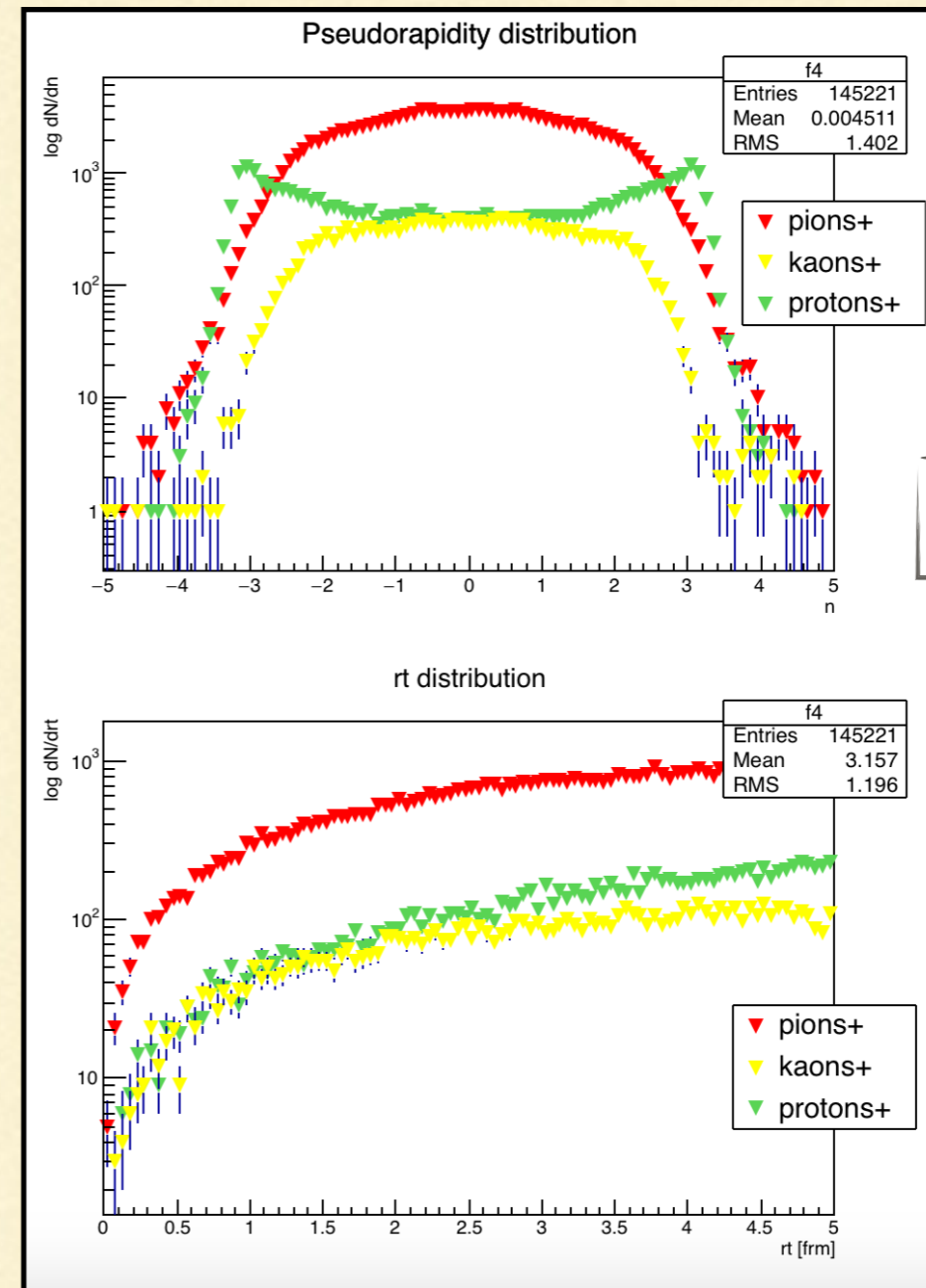
Pseudorapidity and r_t

Au-Au 39 GeV

Before



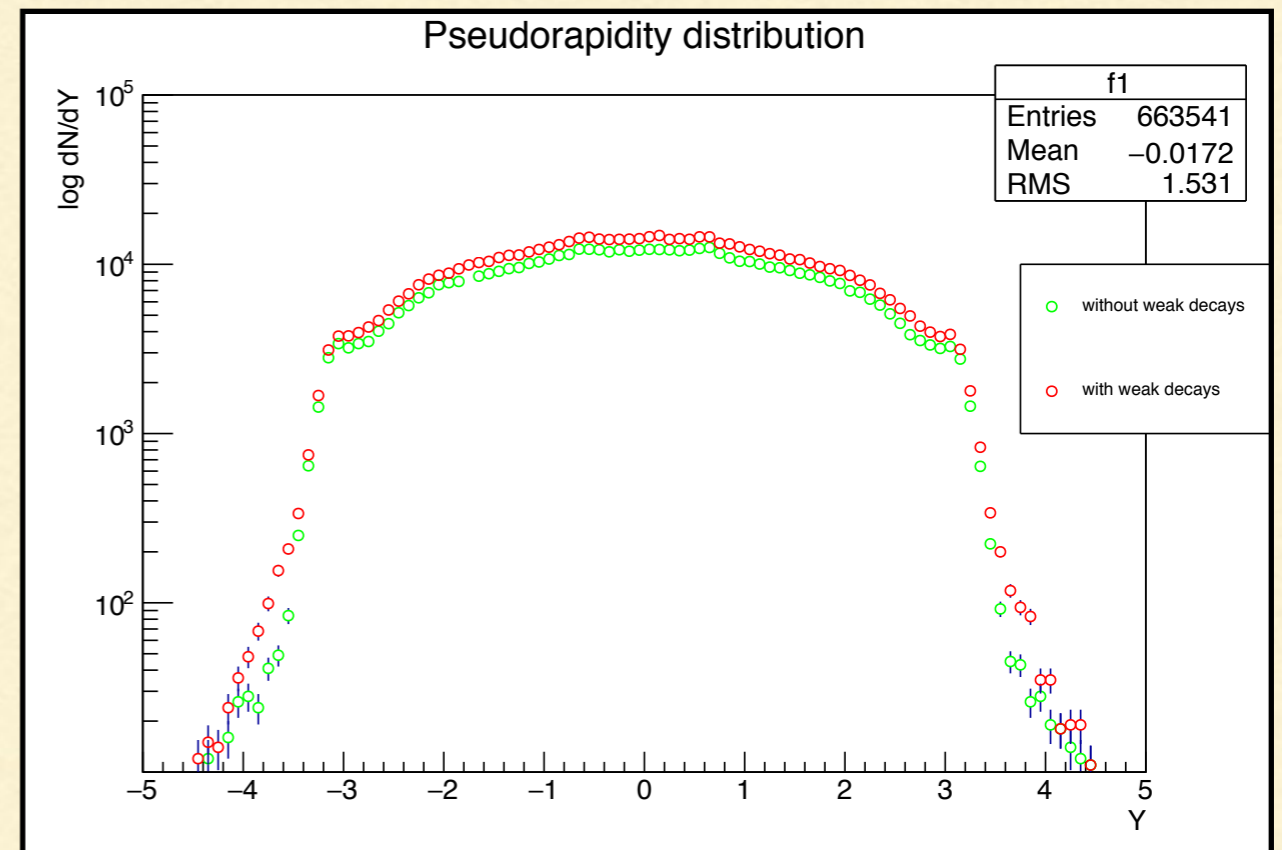
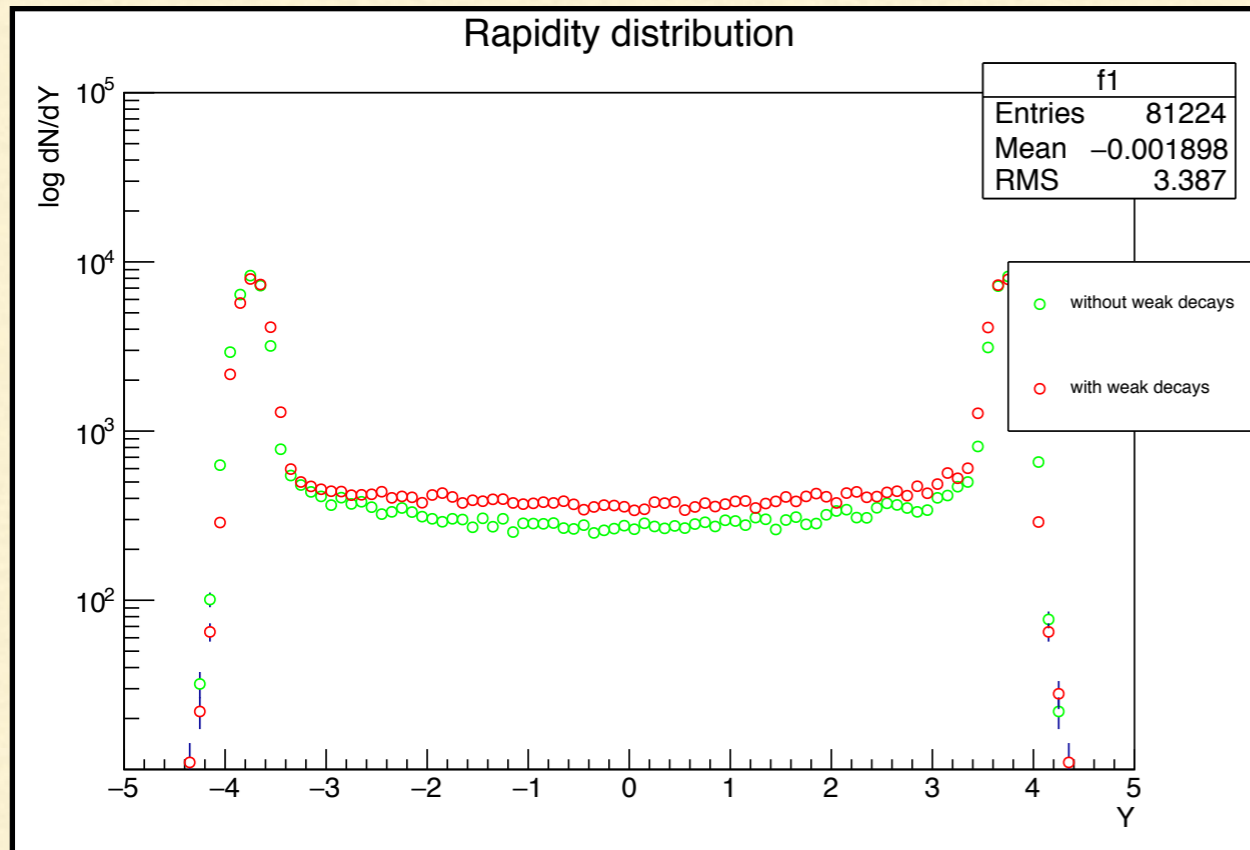
After



Results

Au-Au 39 GeV

Rapidity and pseudorapidity protons



Conclusion and plans

- The weak decays method increases possible number of applications of the UrQMD model by:
 - providing a way to get information about protons' origin
 - more precise description of results for ion collision

- Studies of heavy ion collisions for BES program using EPOS model

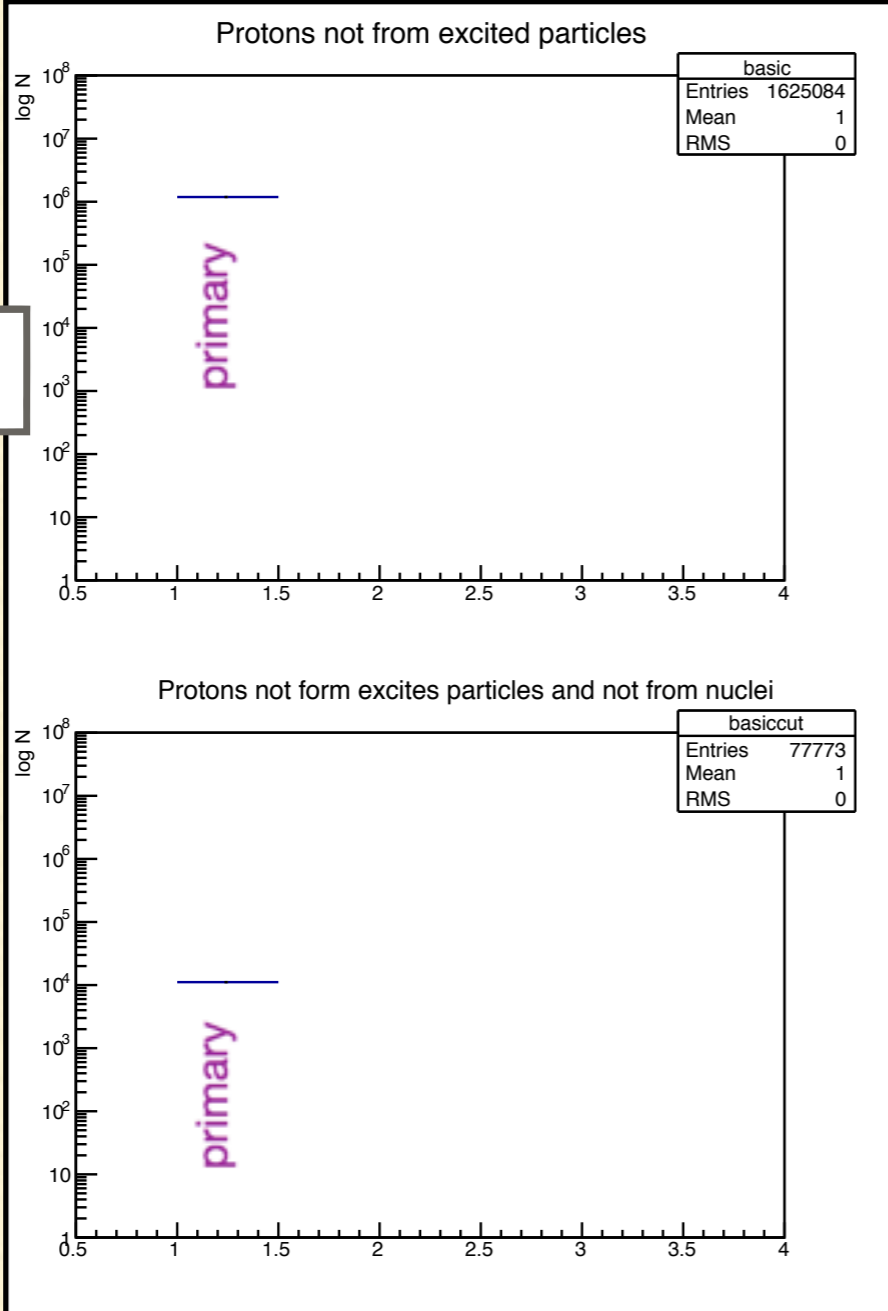
Thank you for your attention

Back up

Au-Au 39 GeV

Protons' origin

Before



After

