Update on dE/dx

Tracking Meeting

Charles Hughes
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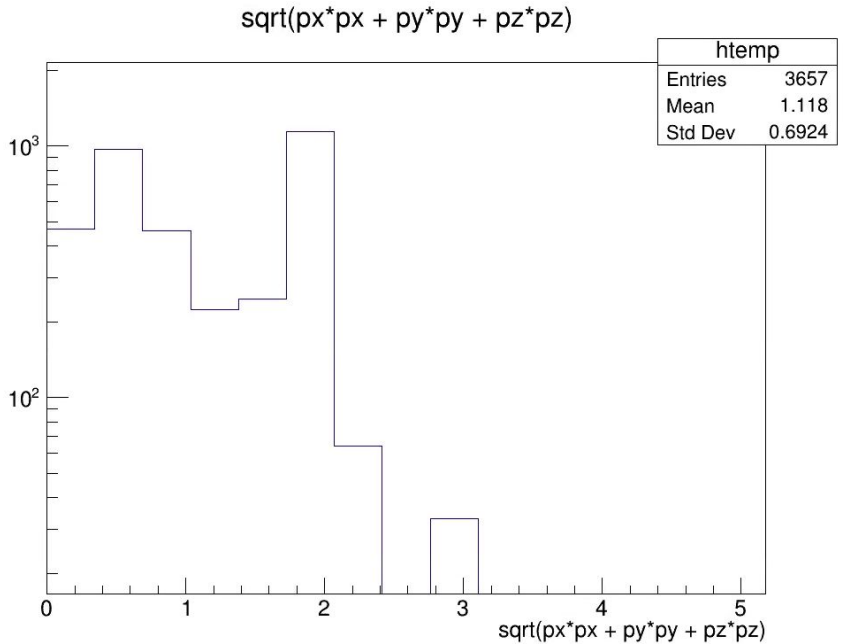
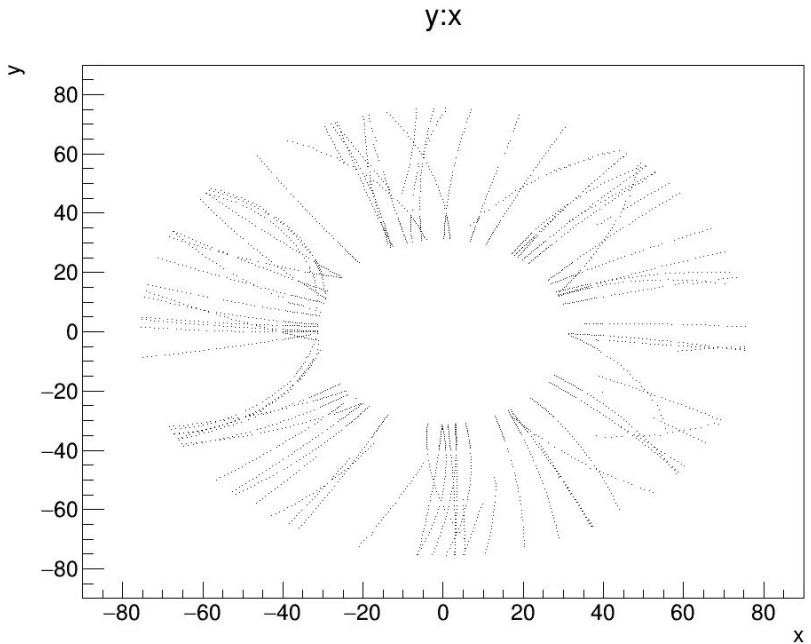
Progress Update

- (Reminder) From Workfest
  - Using [coresoftware/simulation/g4simulation/g4eval/TrackEvaluation.cc]
- From last week's meeting
  - Simulation: What is going on with momentum?
  - Reconstruction: What is going on with ADC?
- From Jin Huang: exercise (debug dE and dx)
  - Simulate light ions (just proton, He4, Li7)
  - Simulate 2 GeV pions at fixed η
- From me:
  - Simulation kaons

Progress Update

- **Simulation: What is going on with momentum ?**
  - **Lots of low momentum tracks - much lower than what I ask for**
  - **E.G. INPUTGENERATOR::SimpleEventGenerator[0]->set_p_range(2,2); (2 GeV pions)**





Progress Update

- **Reconstruction: What is going on with ADC?**
  - **Fixing issue with unreliable ADC from trk_clusv5->getAdc():**
  - **Doing the following instead (TrackEvaluation.cc):**

```
//! hit energy for a given cluster
void add_cluster_energy( TrackEvaluationContainerv1::ClusterStruct& cluster, TrkrDefs::cluskey clus_key,
  TrkrClusterHitAssoc* cluster_hit_map,
  TrkrHitSetContainer* hitsetcontainer )
{
```

```
  //std::cout<<"Charles, this is where Tony told you to look ... !!!!!!!!! 03.14.22"<<std::endl;
  for( const auto& pair:range_adaptor(range))
  {
    const auto hit = hitset->getHit( pair.second );
    if( hit )
    {
      //const auto energy = hit->getEnergy();
      const auto energy = hit->getAdc();
      cluster.energy_sum += energy;
      if( energy > cluster.energy_max ) cluster.energy_max = energy;
    }
  }
```

Progress Update

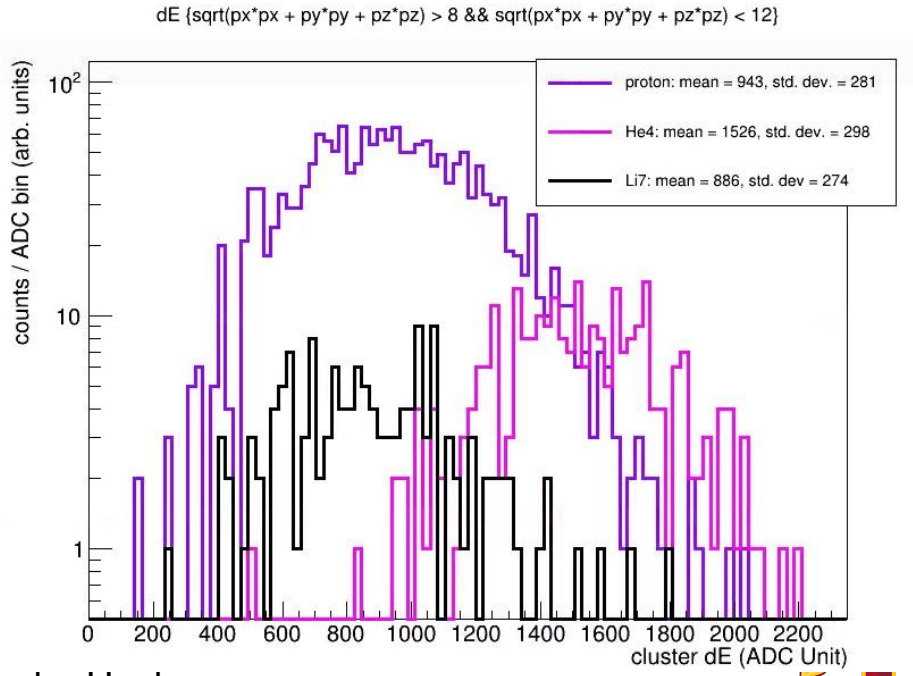
- **From Jin Huang: exercise (debug dE and dx)**
  - **Simulation light ions (proton, He4, and Li7) - looking for <ADC> per cluster scales as Z^2**

- Requesting p_tot = 10 GeV
- All TPC layers
- Looking at clusters assigned to tracks with 8 < p_tot < 12

  - <ADC> per cluster does increase between proton and He4

  - Unfortunately, trend breaks with Li7, also trend is not as Z^2 for proton/He4

  - Tried asking Chris about ions - recommended ion gun - can not get to work



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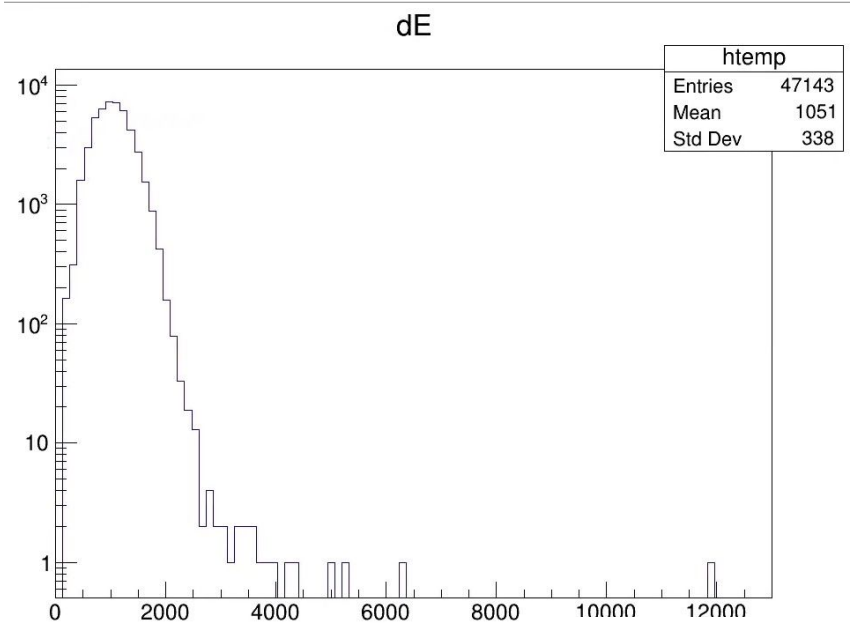
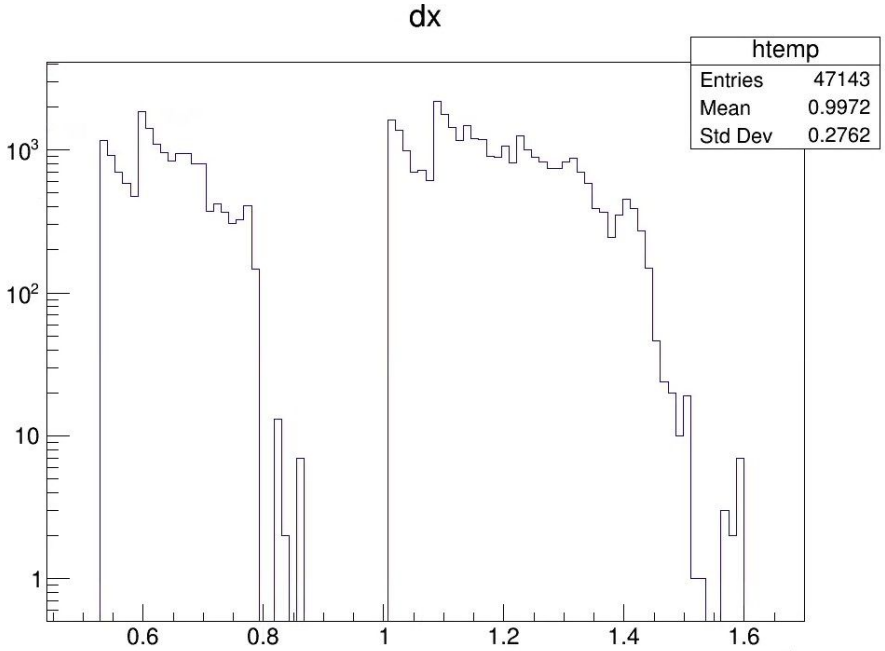
Progress Update

- From Charles: calculate a dE/dx
  - Simulation kaons: 10 kaons/event, 100 events, p_tot (0,10) GeV, φ: (-π, π), η: (-1 , 1)



Cluster dE (ADC)



Cluster dx (cm)

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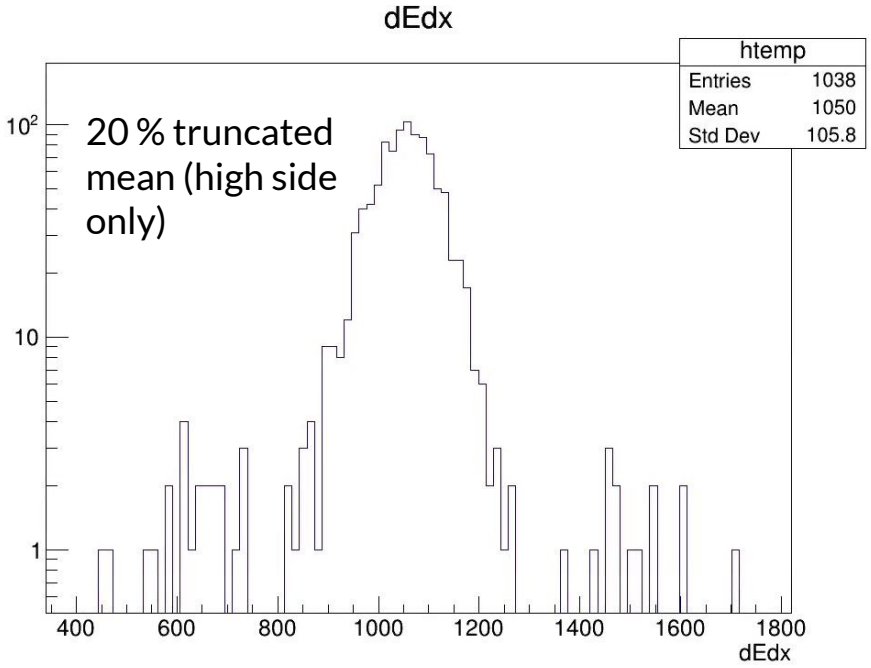

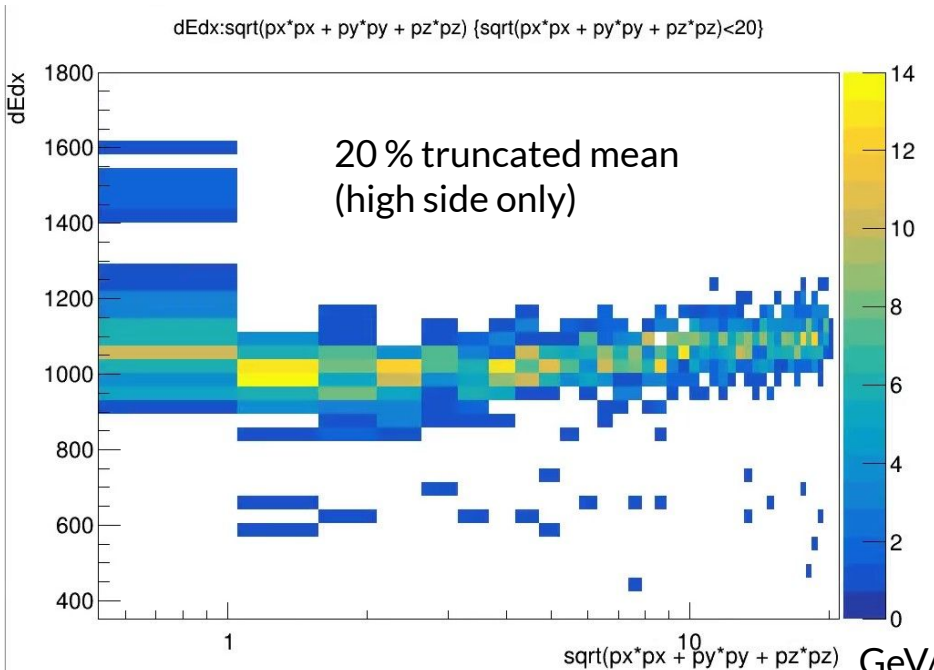

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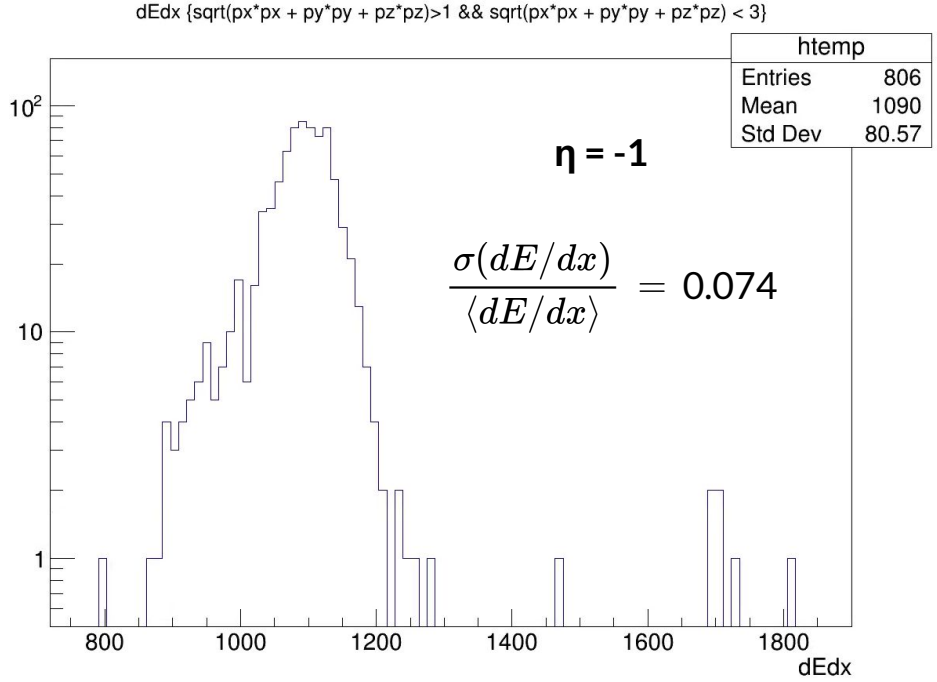
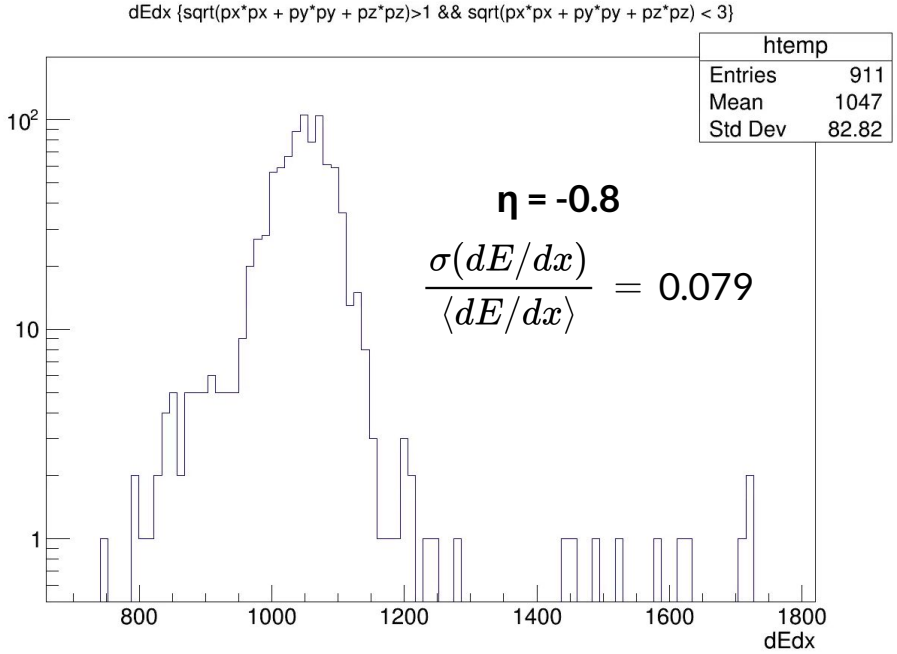
From Jin: Calculate dE/dx resolution

- dE/dx for 100 events, 10 pions/event, p_tot = 2 GeV, fixed eta
- Require reconstructed track 1 GeV < p_tot < 3 GeV
- dE/dx from 20 % truncated mean





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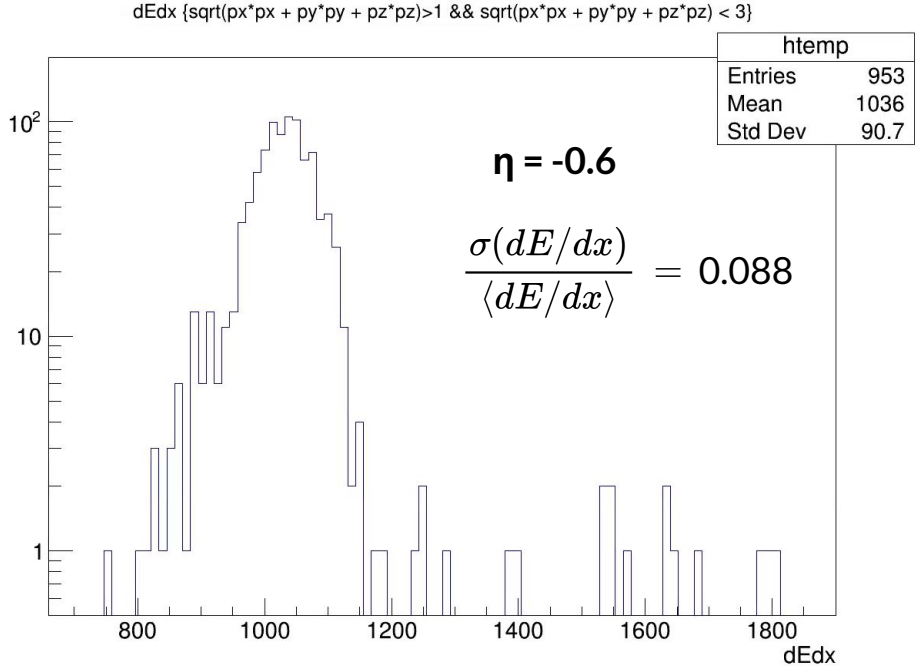

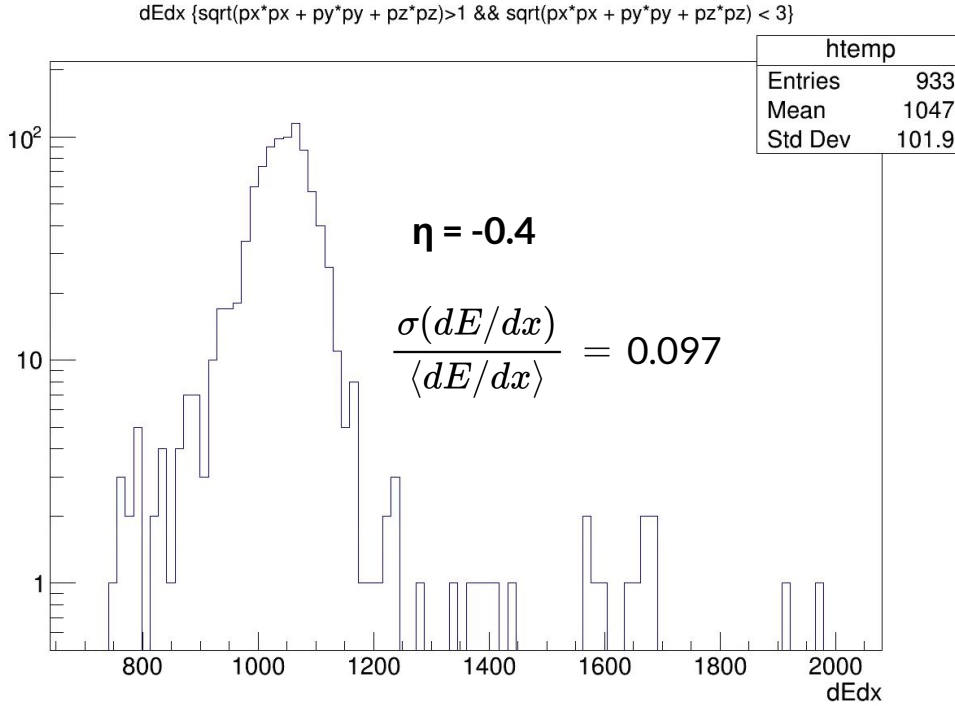

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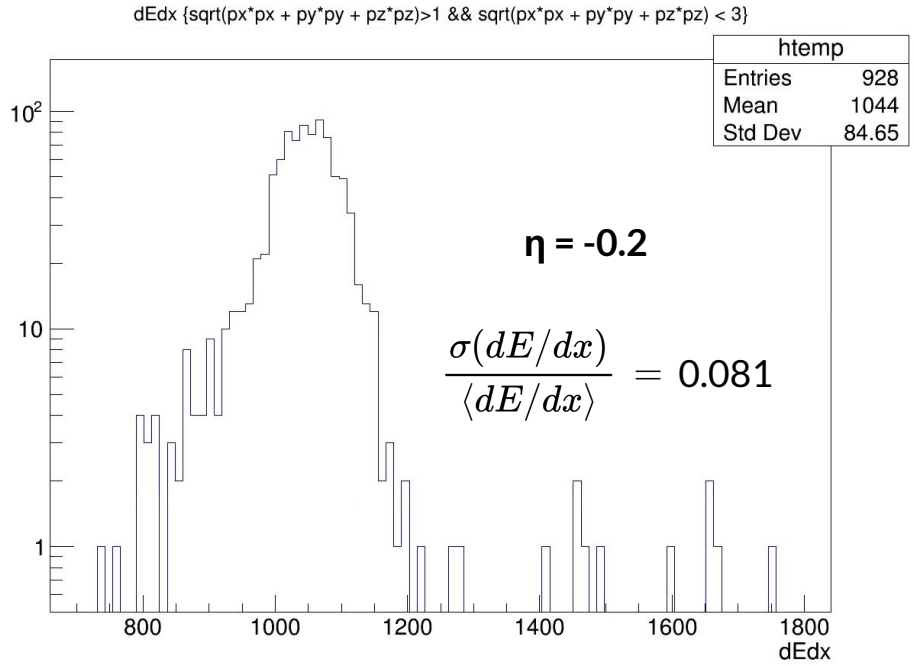

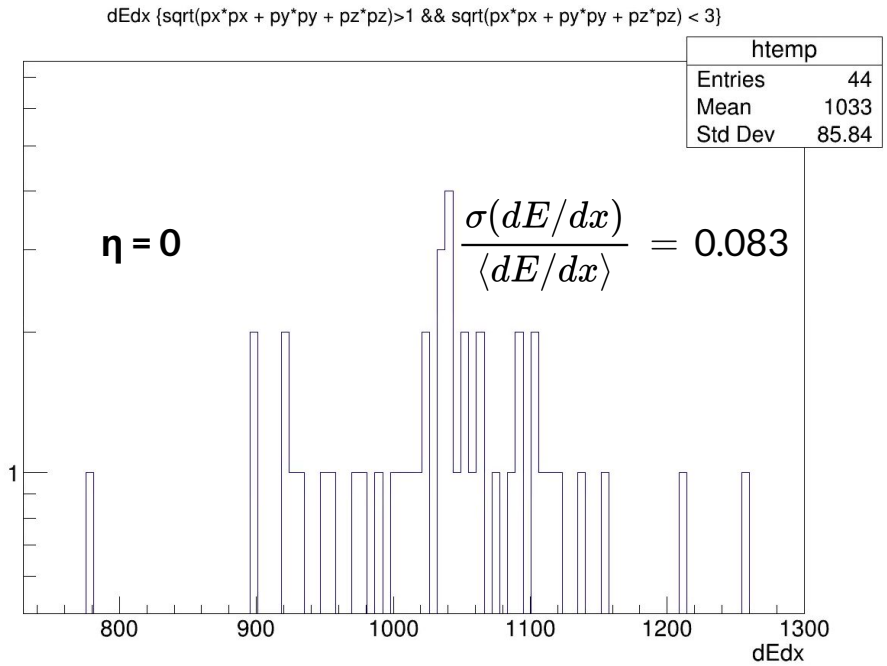

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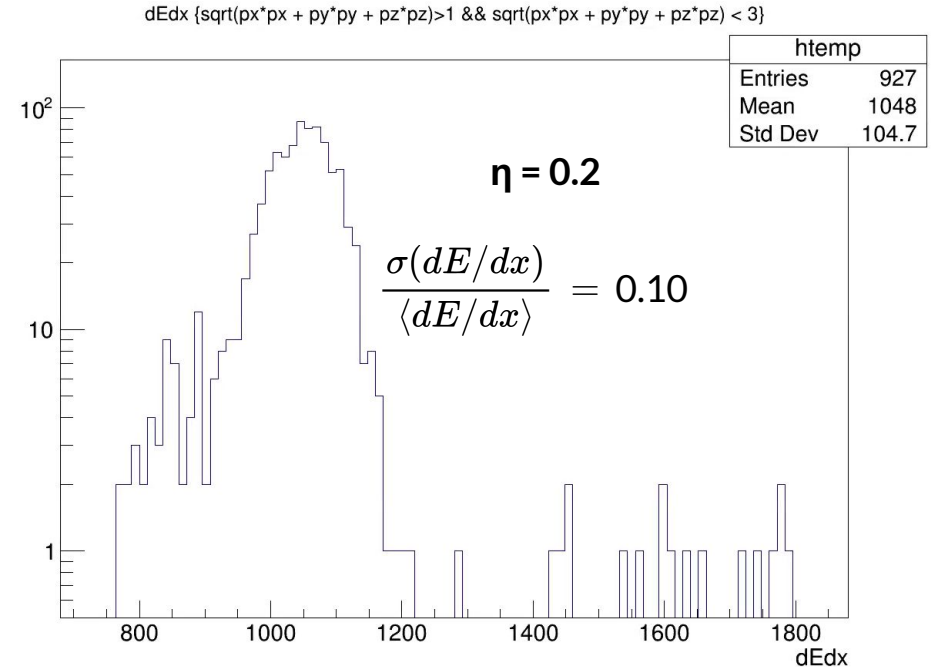

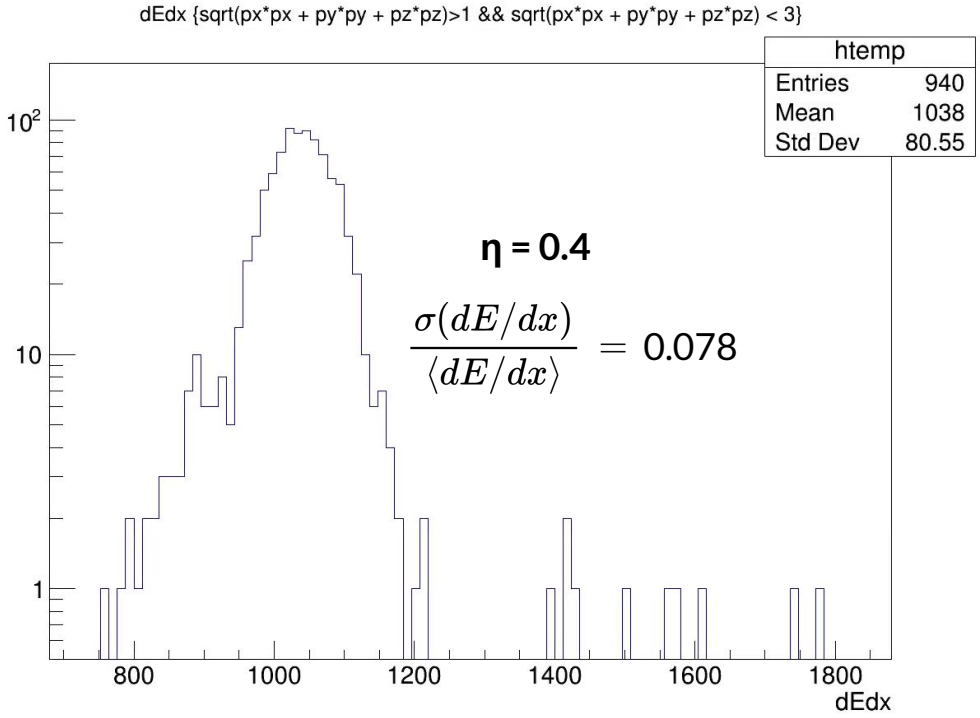

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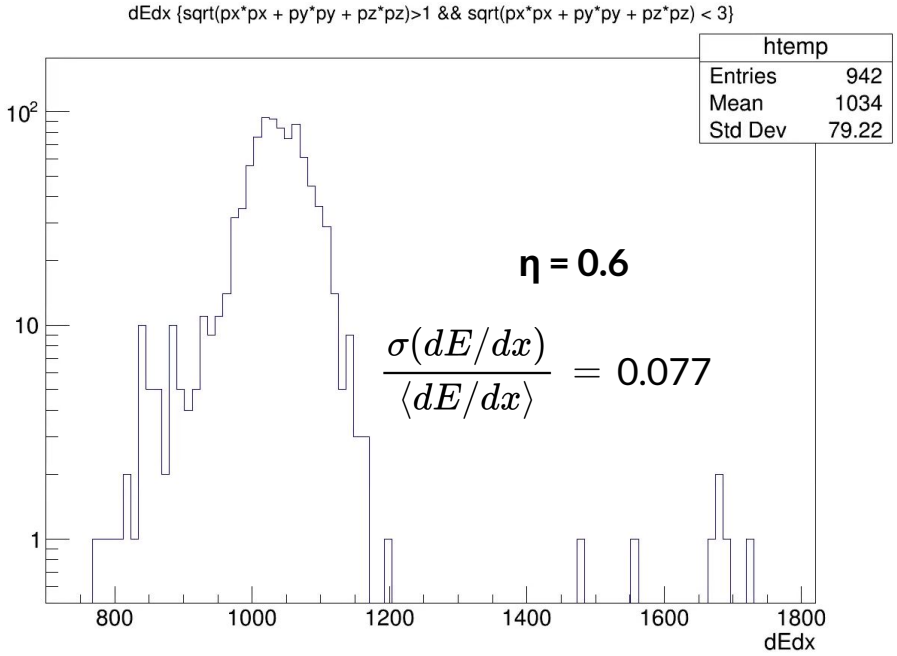

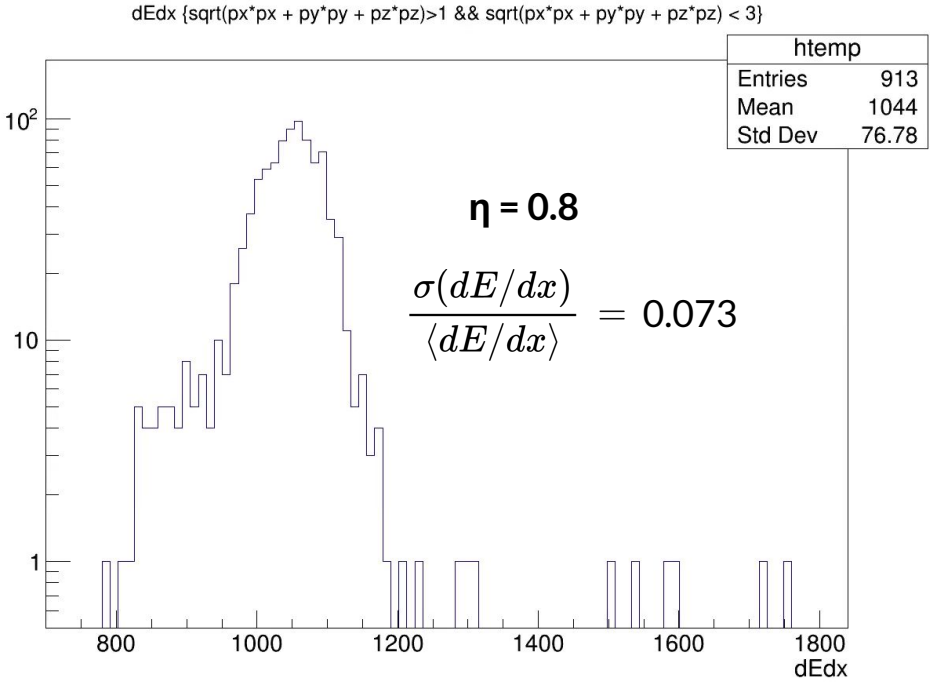

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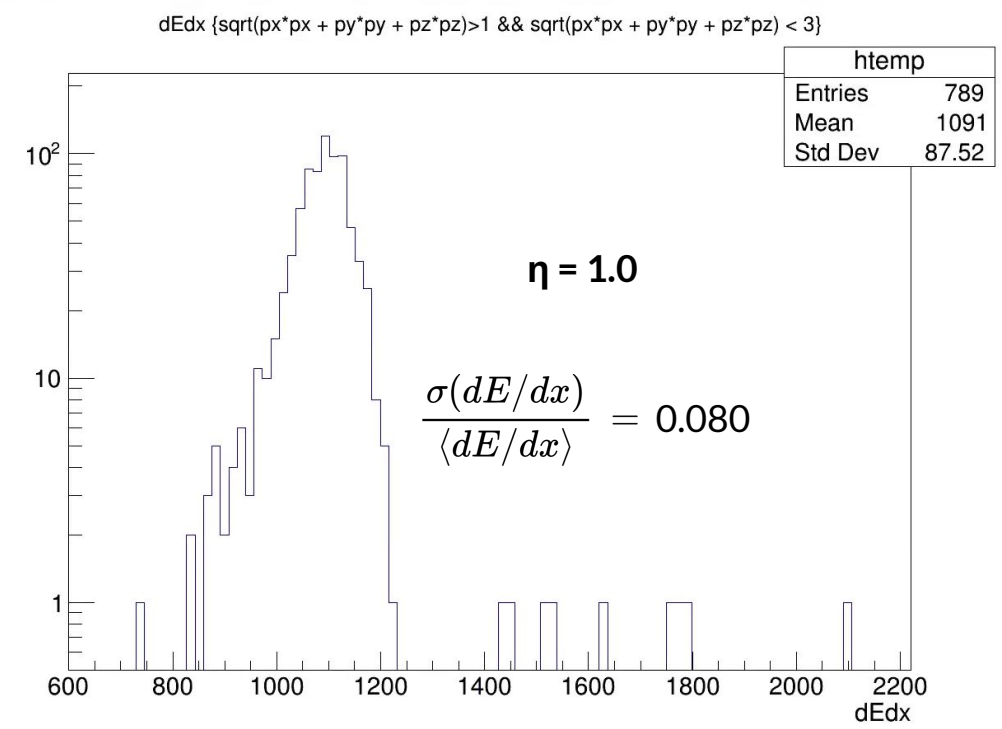

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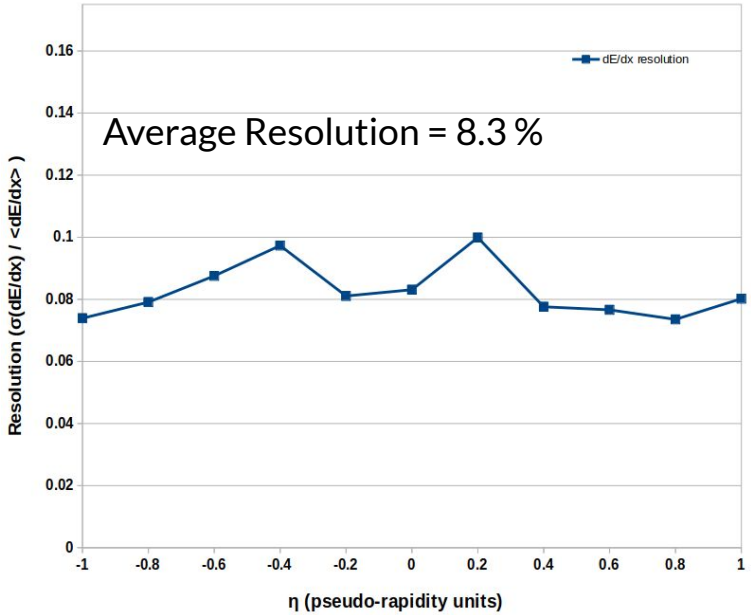
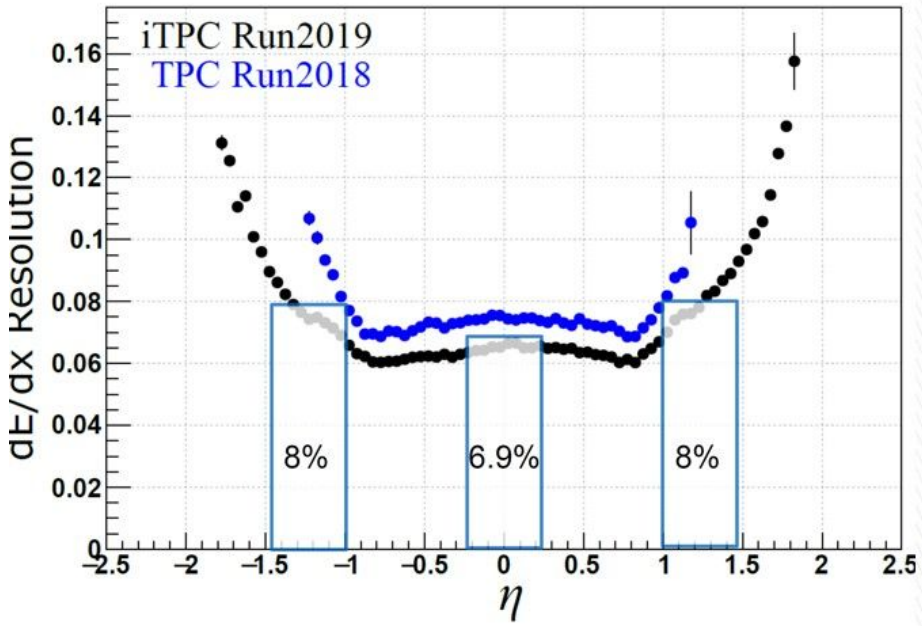
From 2023 sPHENIX simulations (previous slides)



2019 Test beam data projected to STAR iTPC (black)

Improved dE/dx resolution



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Summary

Agenda for Next Time:

- Need to understand what needs to be fixed in simulation/reconstruction
    - Simulation: What is going on with momentum? (still don't understand)
    - Do we have good dE/dx resolution?
        - Could improve with tighter track momentum cuts (used +/- 50 %)
        - Could improve with optimizing mean truncation
          (Jin found 30 % was best in test beam data)

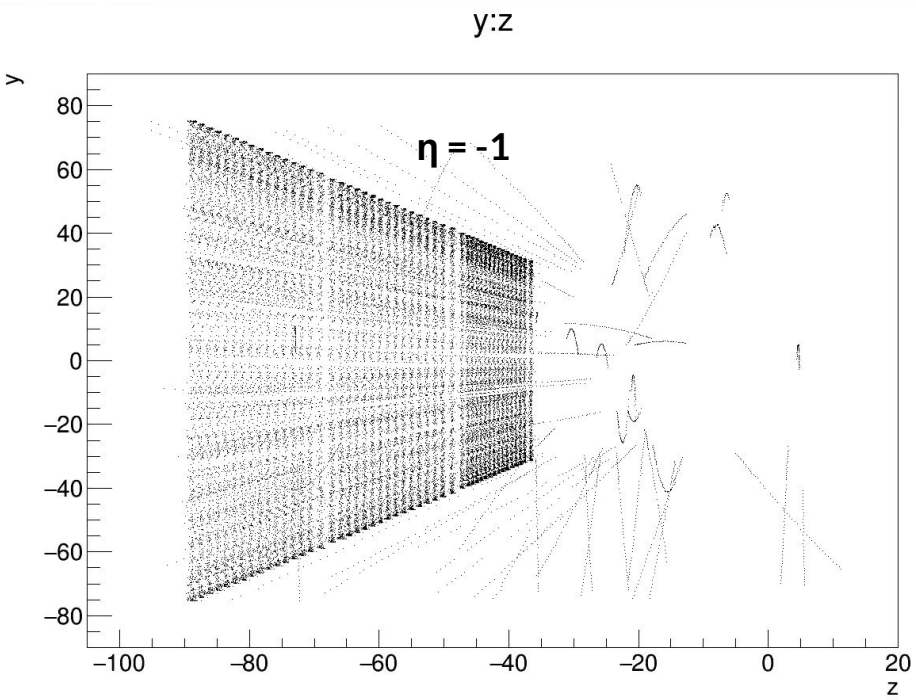
Agenda Further Ahead:

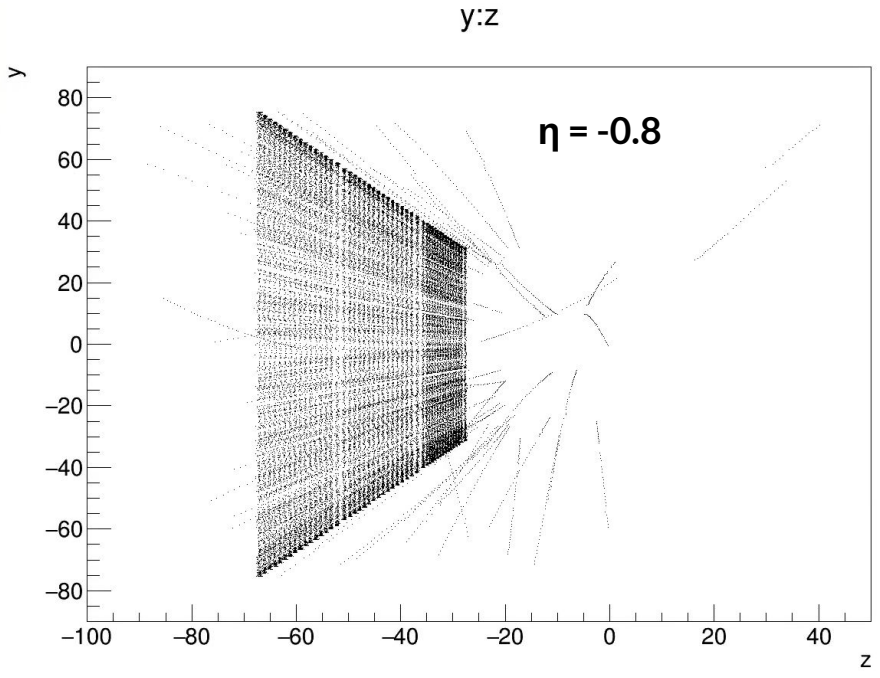
- Agree on how to get most probable dE/dx (truncated mean, template fit, … ?)
- Create utility for end user to get dE/dx for reconstructed track
- More realistic gains/looking toward data reconstruction (Evgeny gain maps)

Backup

sigma(dE/dx) (p > 1 && p < 3)	<dE/dx> (p > 1 && p < 3)	eta	dE/dx resolution
80.57	1090	-1	0.073917431192661
82.82	1047	-0.8	0.079102196752627
90.7	1036	-0.6	0.087548262548263
101.9	1047	-0.4	0.097325692454632
84.65	1044	-0.2	0.081082375478927
85.84	1033	0	0.083097773475315
104.7	1048	0.2	0.099904580152672
80.55	1038	0.4	0.077601156069364
79.22	1034	0.6	0.076615087040619
76.78	1044	0.8	0.073544061302682
87.52	1091	1	0.080219981668194
		Mean	0.082723508921451

Backup





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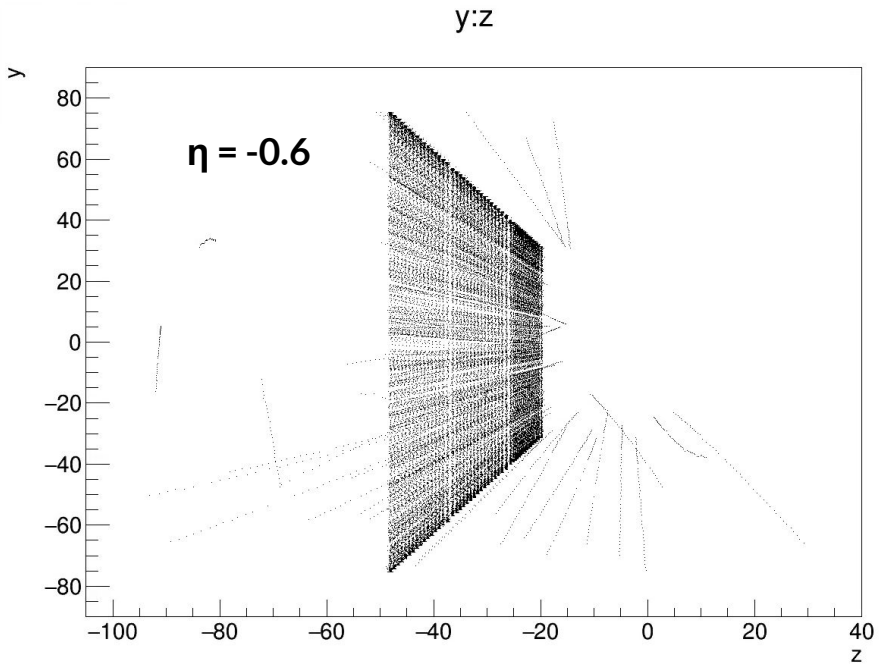
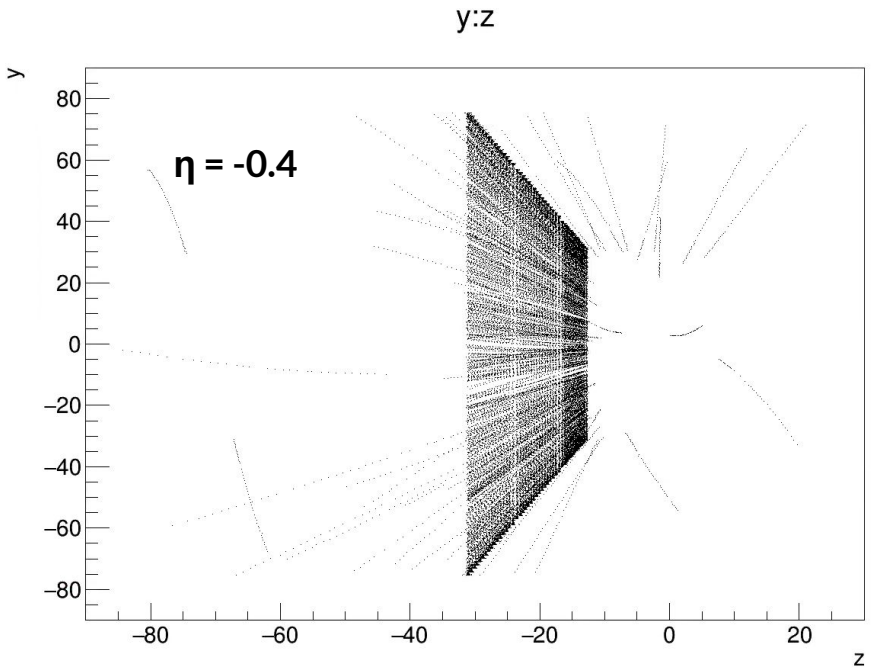

y:z
η = -0.6
y
z
80
60
40
20
0
−20
−40
−60
−80
−100
−80
−60
−40
−20
0
20
40


y:z
η = -0.4
y
z
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−40
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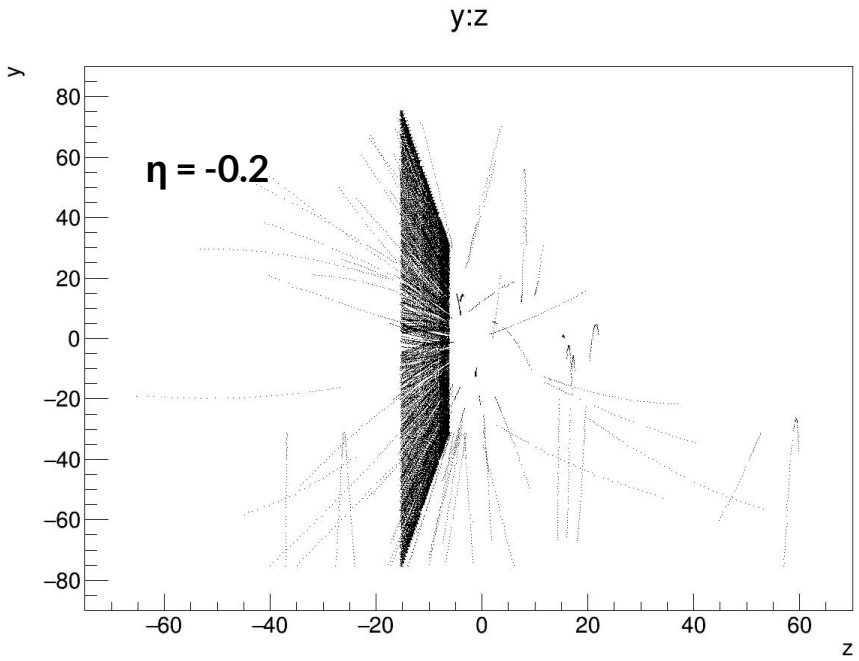
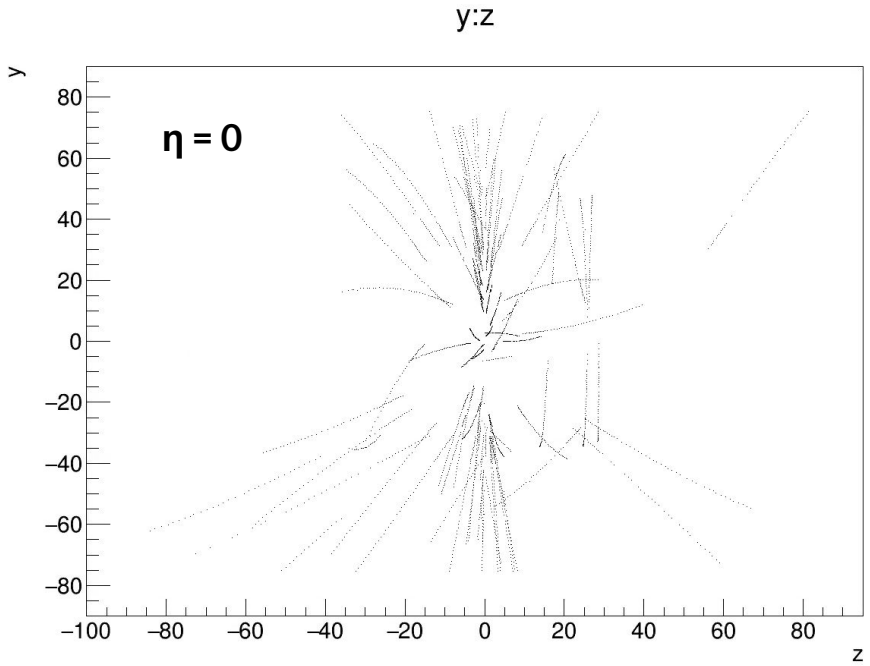
−80
−80
−60
−40
−20
0
20

Backup





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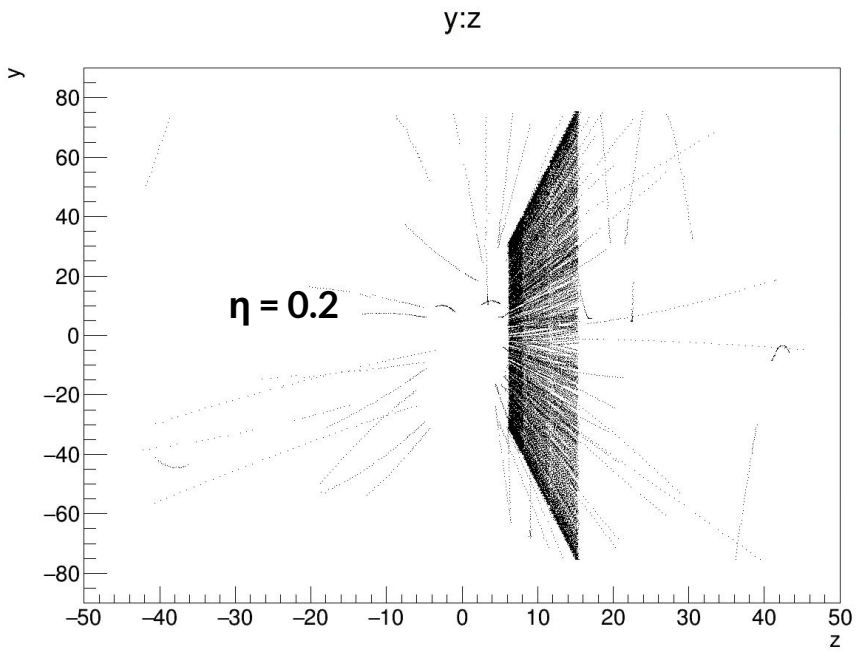

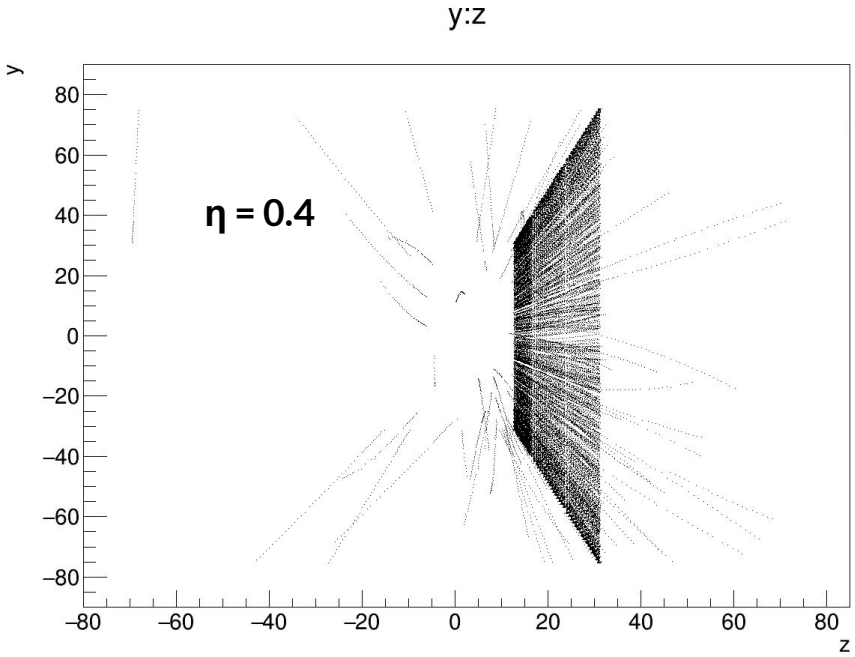

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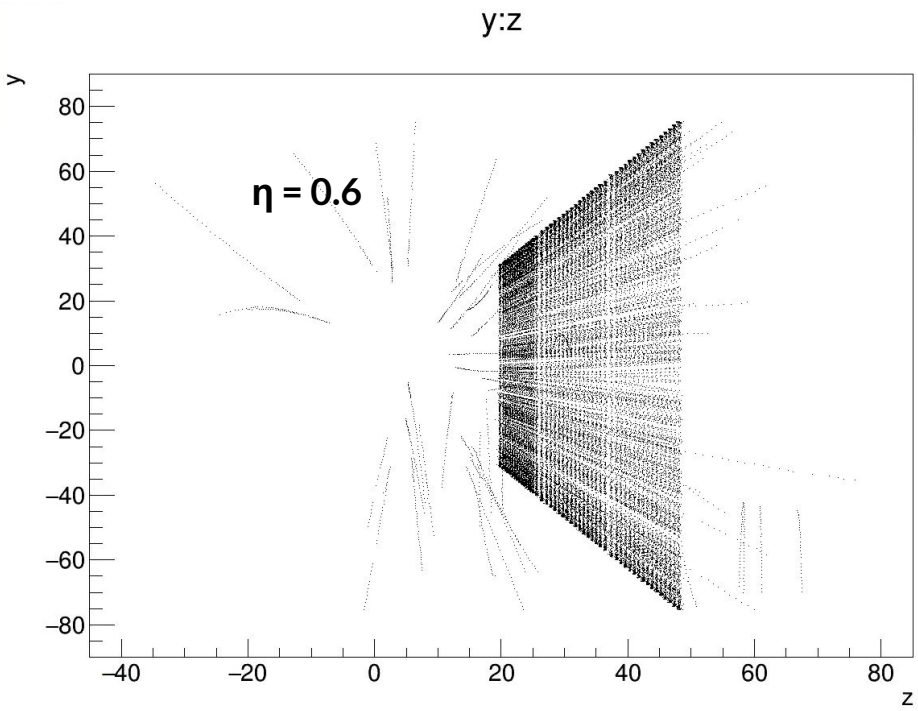
y:z
η = 0.6
y
z
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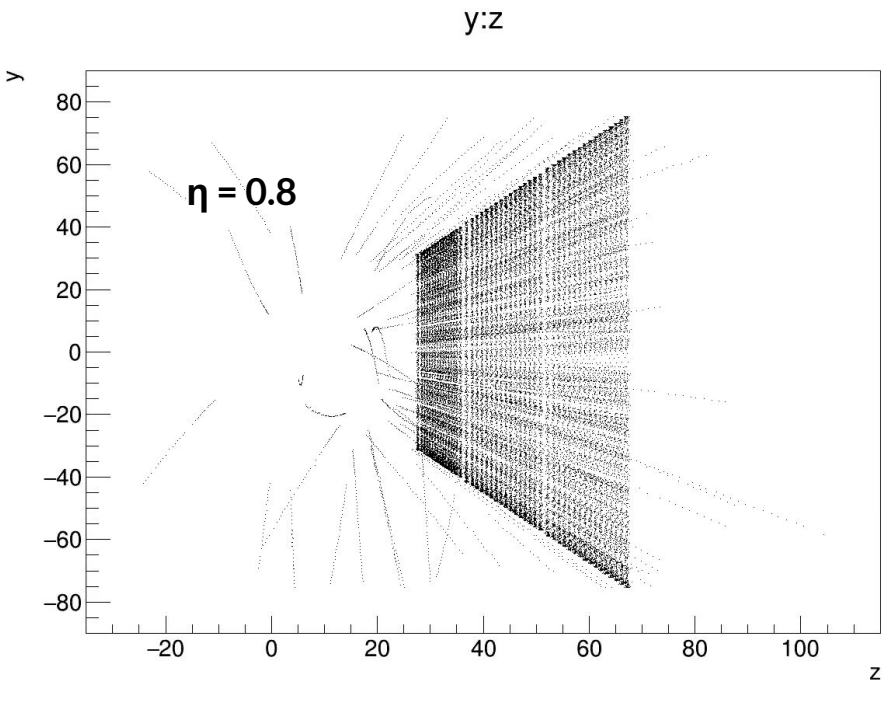
80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40
60
80
100

Backup