Štúdium produkcie vektorových mezónov v rámci experimentu ALICE

Veronika Barbasová

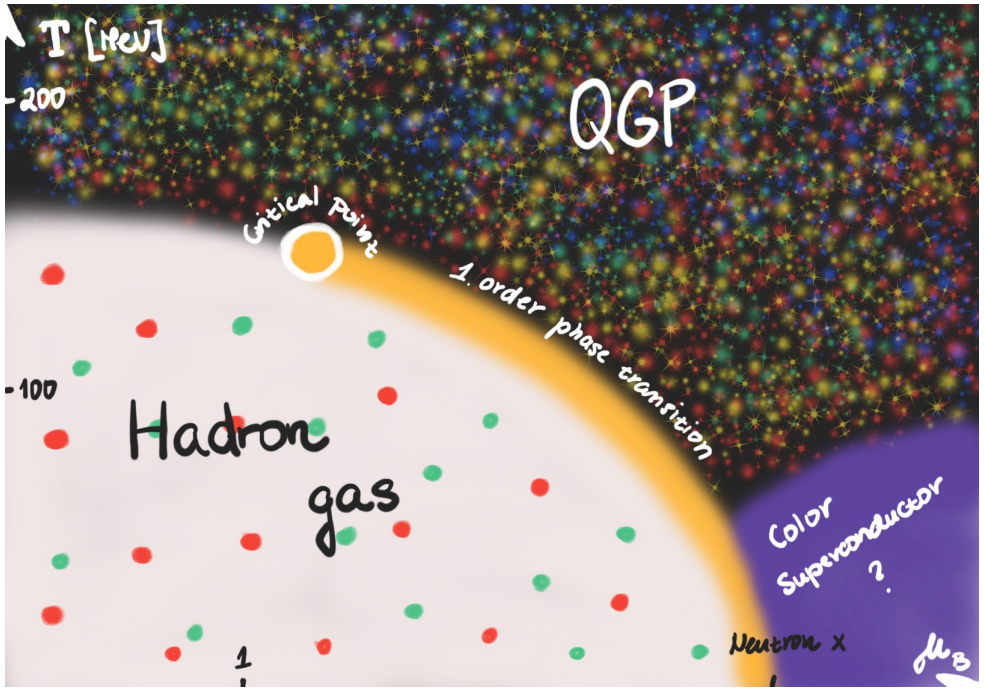
Danišovce, 24.4.2023

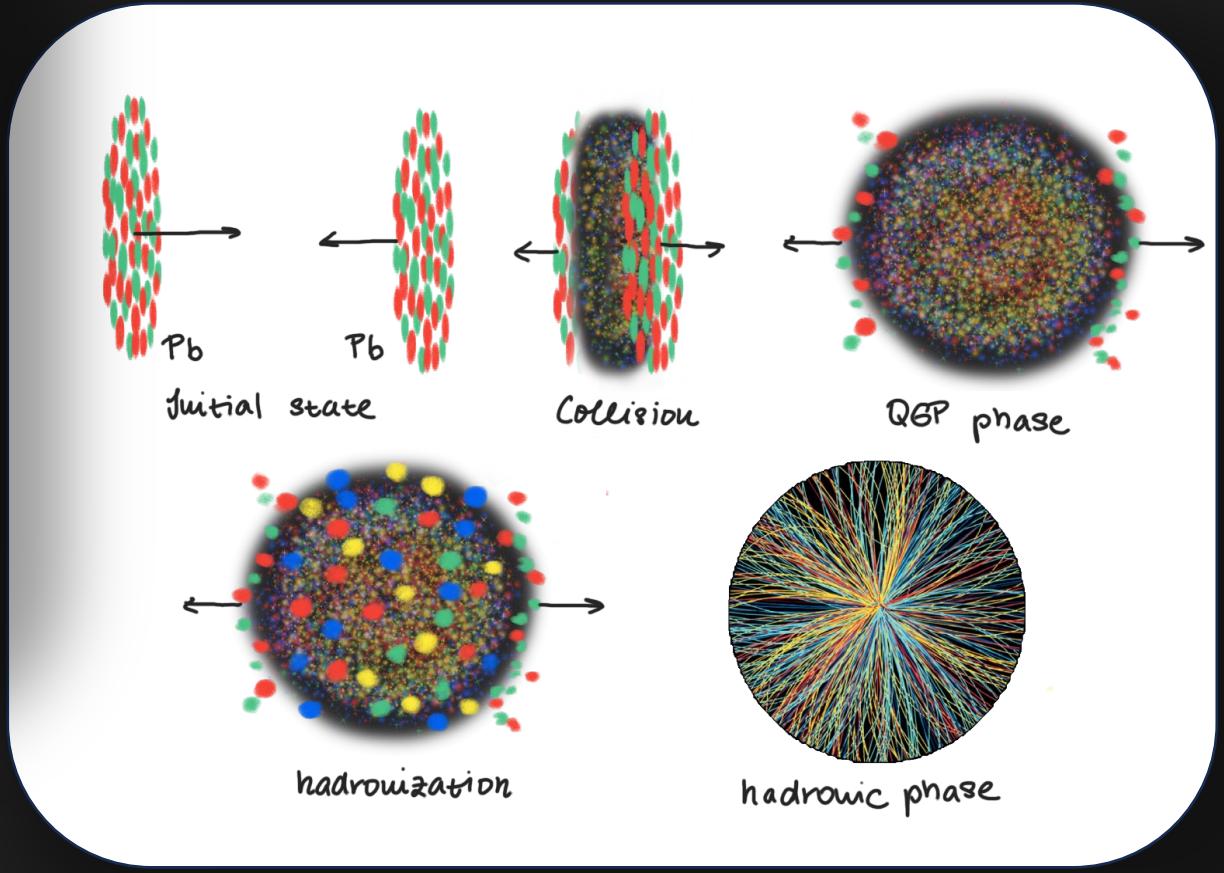
Obsah:

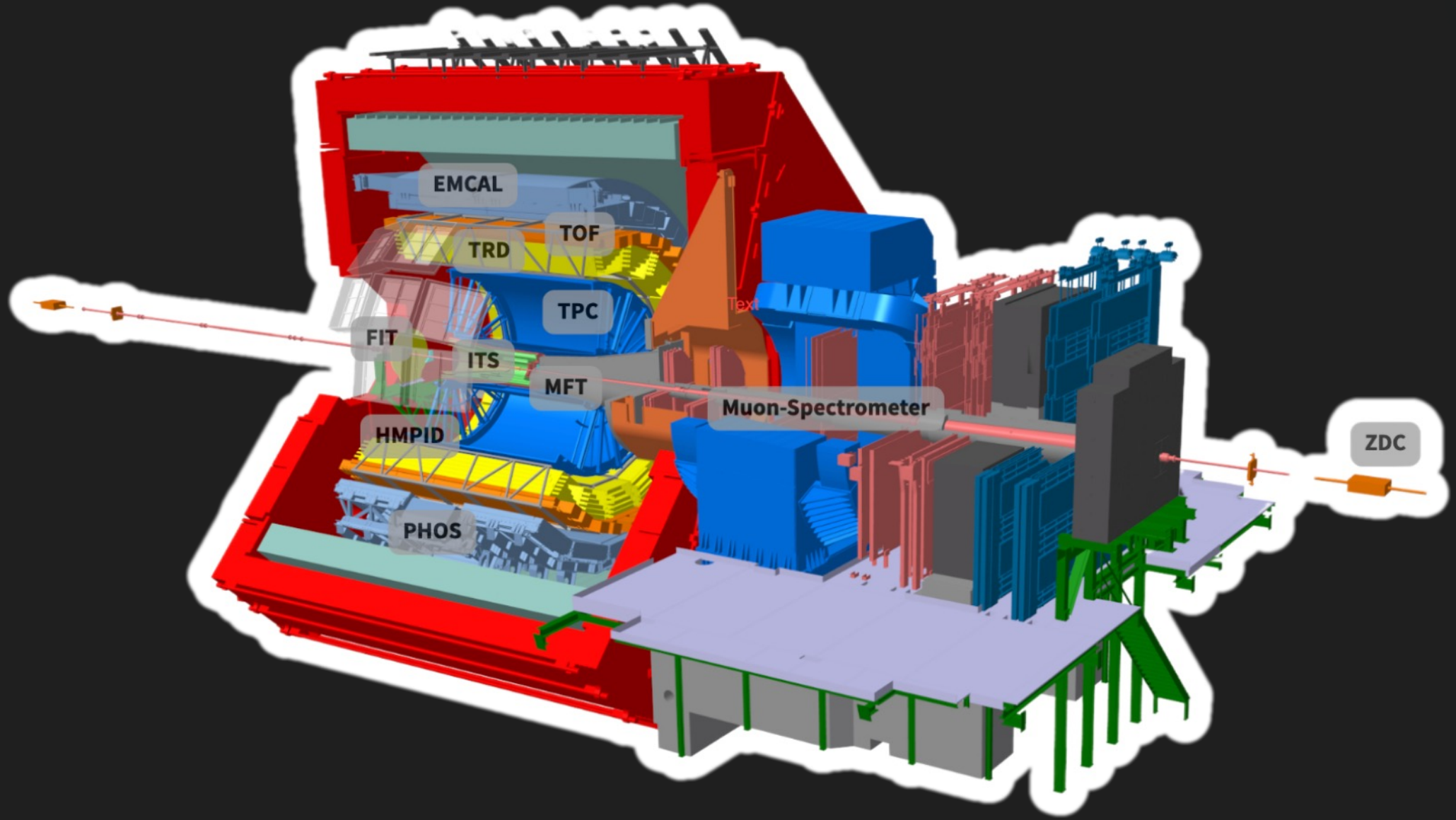
- Motivácia
- O^2 workflow
- Analyzačná metóda
- Záver
- Plány do budúcna

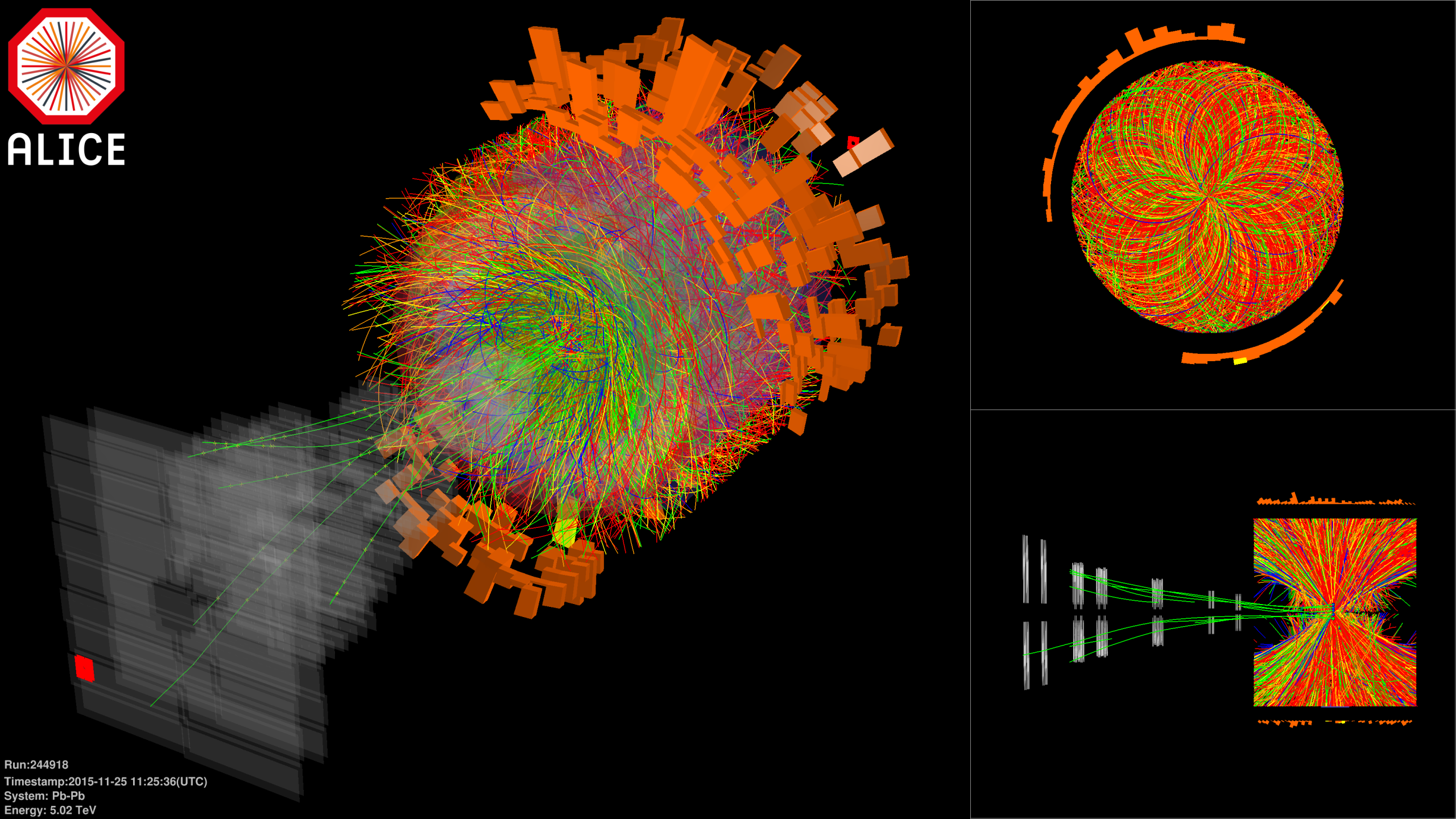
Motivácia

- Štúdium quarkovo-gluonovej plazmy (QGP)






EMCAL
TOF
TRD
TPC
FIT
ITS
MFT
Muon-Spectrometer
HMPID
ZDC
PHOS

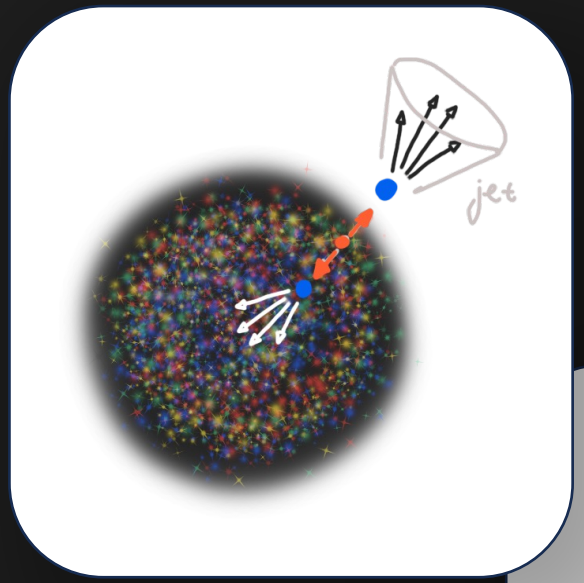

ALICE
Run:244918
Timestamp:2015-11-25 11:25:36(UTC)
System: Pb-Pb
Energy: 5.02 TeV

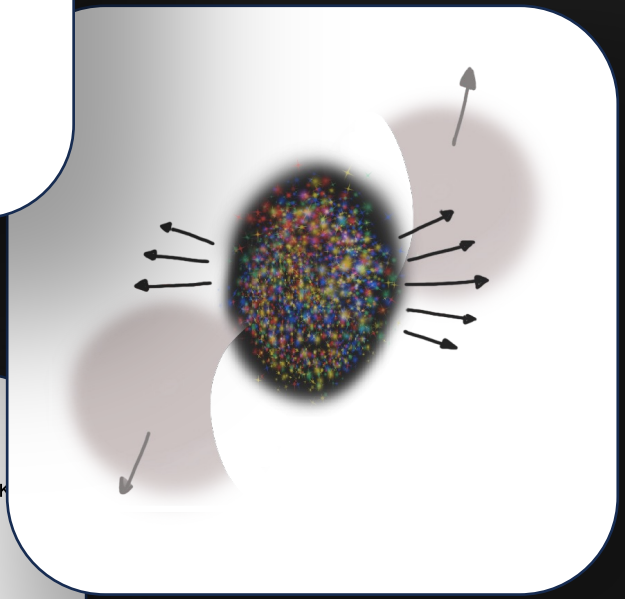
Signatúry QGP:

1. Potlačenie produkcie J/ψ mezónov
2. Zhasenie jetu (Jet Quenching)
3. Kolektívne efekty (flow) hadrónov

… atď.

x. Zmena hmotnosti a doby života vektorových mezónov



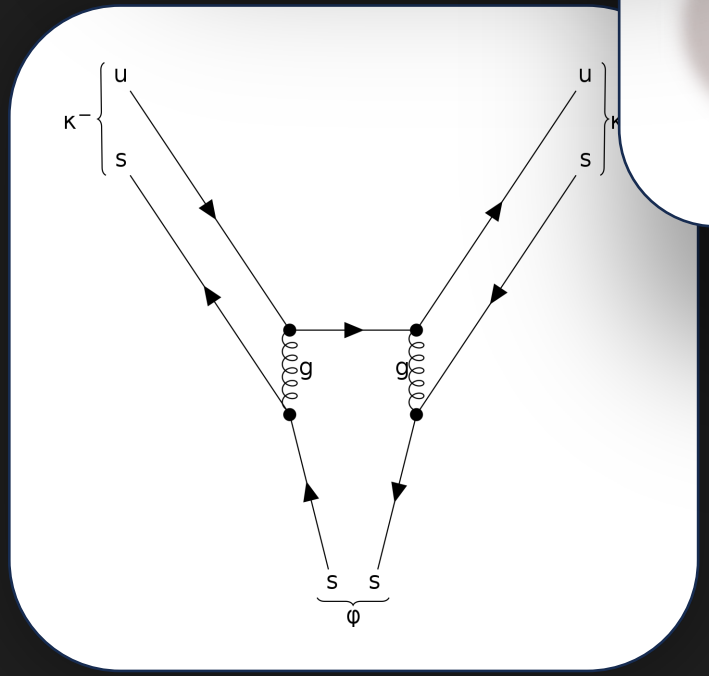


Phi meson:

- krátkožijúci vektorový mezón

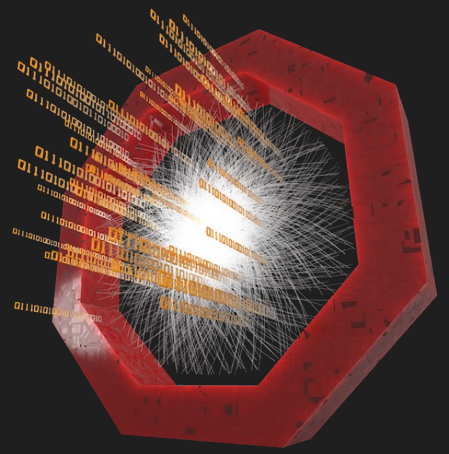
ϕ ($s\bar{s}$) – najľahší vektorový mezón (m=1.019 GeV/c^2)

$$\phi \rightarrow K^+ + K^- \ (49.2\%)$$



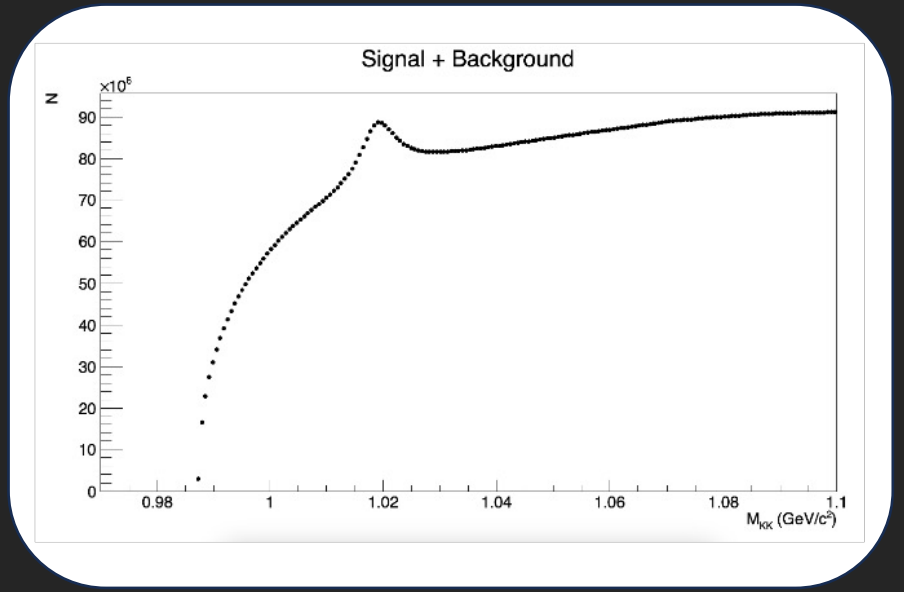
O2 WORKFLOW

```
o2-analysis-phi-analysis-thnsparse
```



(najnovšia verzia od tagu O2Physics-daily-20240508-0200-1)

EVENT and TRACK SELECTION



COMBINATIONS

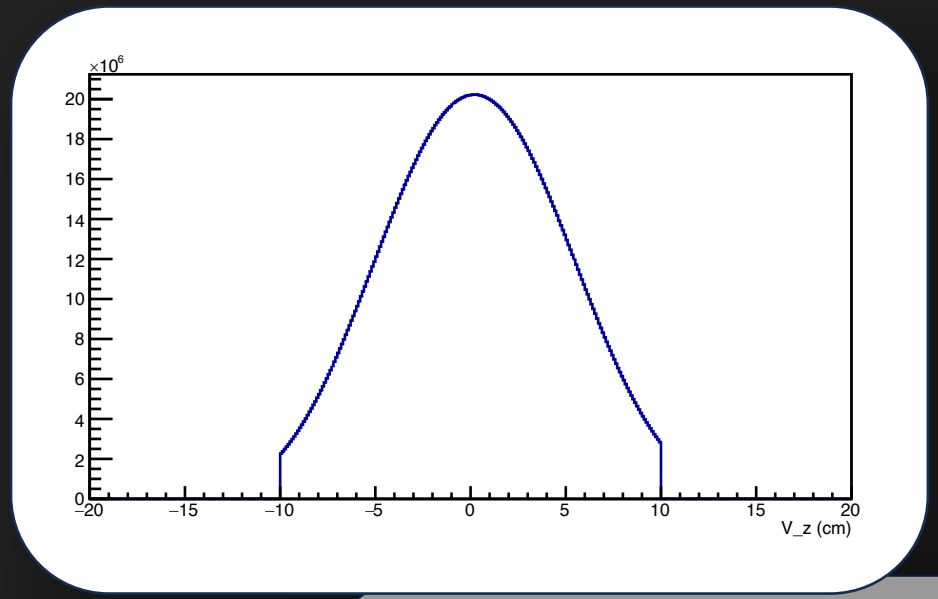
INVARIANT MASS

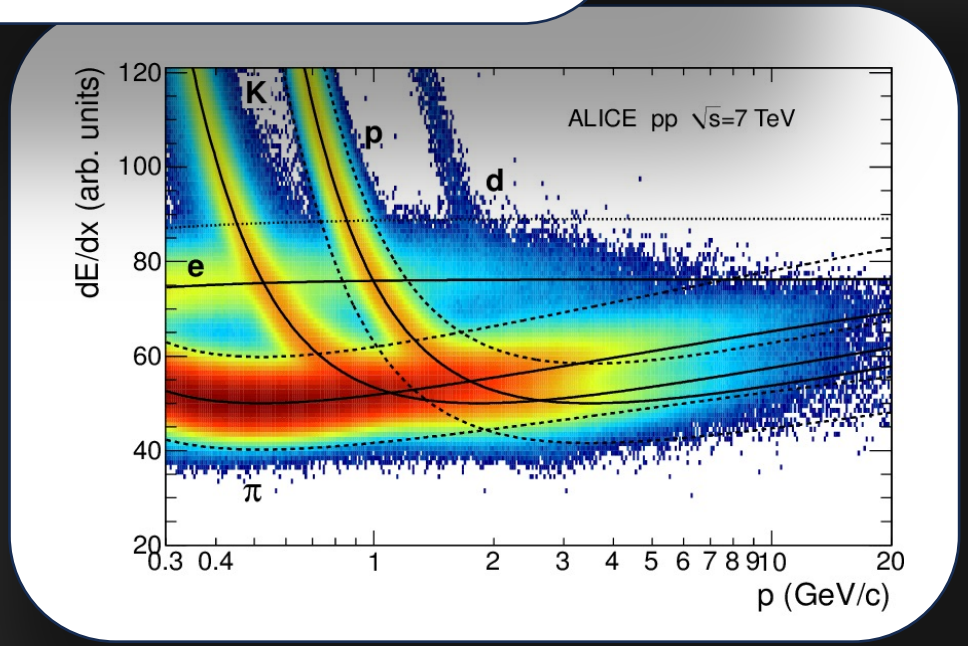
$$M_{KK}^2 = m_1^2 + m_2^2 + 2(E_1E_2 - \overrightarrow{p_1}.\overrightarrow{p_2})$$

Event & Track selection

Event: Z vertex: $|V_Z| < 10$ cm
Trigger: sel8

Track: TPC Nσ(Kaon) = 3
$|p_T| > 0{,}15$ GeV/c
$|\eta| < 0{,}5$
$|dca_{xy}| < 1$ cm
$|dca_z| < 1$ cm
NClFound > 70
isPrimaryTrack()
isPVContributor()

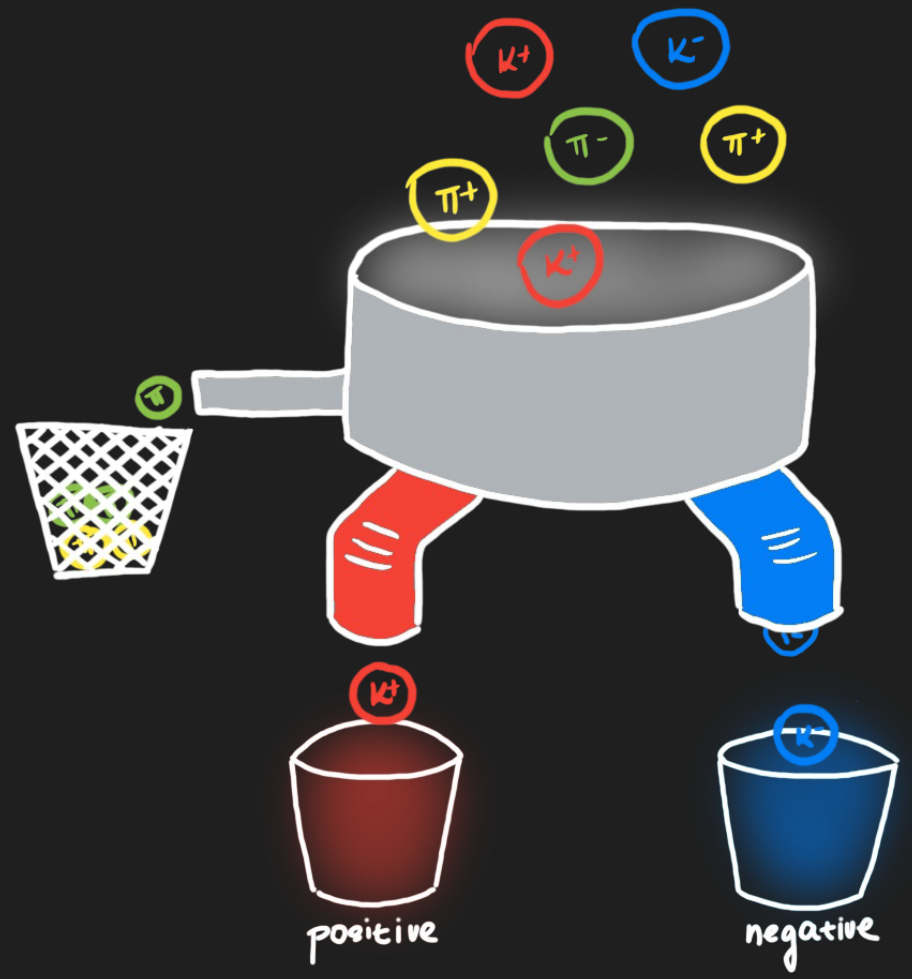




Partition

```
Partition<TrackCandidates> positive = (aod::track::signed1Pt > 0.0f) && (nabs(o2::aod::pidtpc::tpcNSigmaKa) < std::abs(static_cast<float>(cut.tpcnSigmaPos)));
Partition<TrackCandidates> negative = (aod::track::signed1Pt < 0.0f) && (nabs(o2::aod::pidtpc::tpcNSigmaKa) < std::abs(static_cast<float>(cut.tpcnSigmaNeg)));
```

$$\phi \rightarrow K^+ + K^-$$



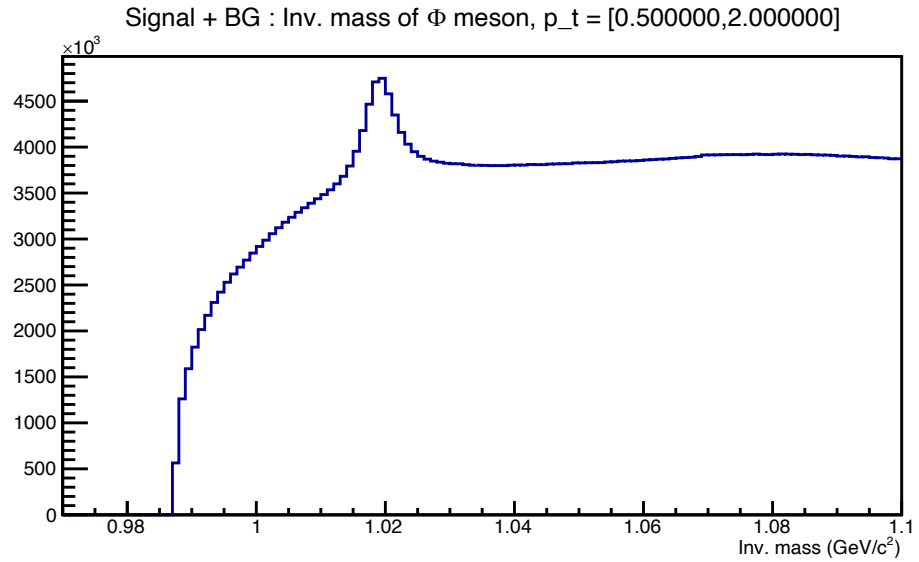
Combinations

```
auto posDauthers = positive->sliceByCached(aod::track::collisionId, collision.globalIndex(), cache);
auto negDauthers = negative->sliceByCached(aod::track::collisionId, collision.globalIndex(), cache);

for (auto& [track1, track2] : combinations(o2::soa::CombinationsFullIndexPolicy(posDauthers, negDauthers))) {
```

Pair cut: $|\eta| < 0.8$

$$M_{KK}^2 = m_1^2 + m_2^2 + 2(E_1 E_2 - \overrightarrow{p_1}.\overrightarrow{p_2})$$

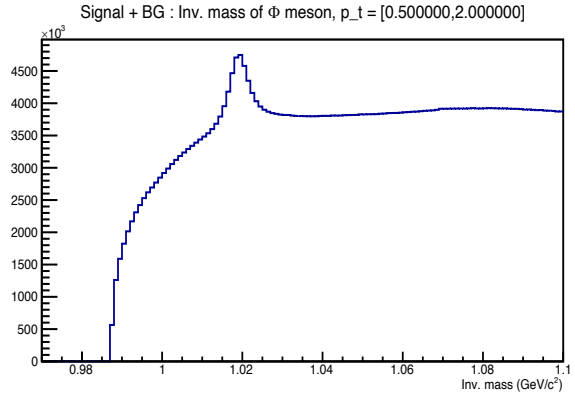


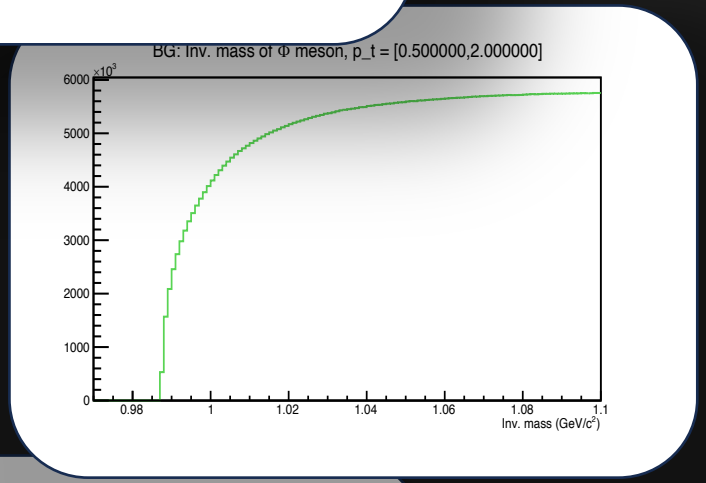
C rsnOutput.h 3 ×

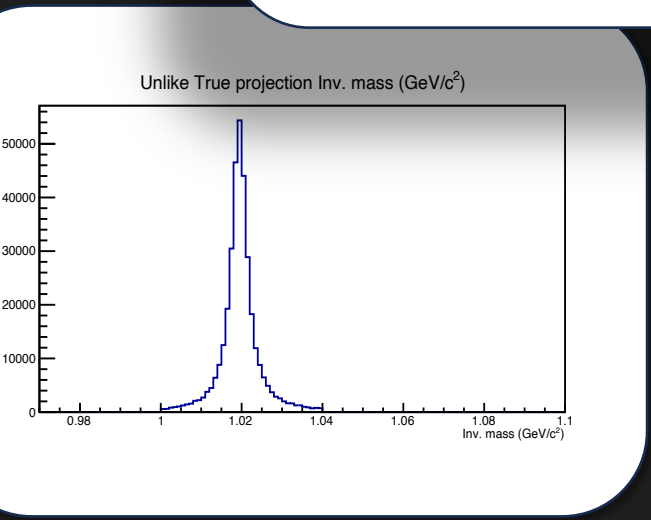
PWGLF > Utils > C rsnOutput.h > ...

```
27  namespace o2::analysis
28  {
    Veronika Barbasova, last week | 2 authors (Veronika Barbasova and others)
29  namespace rsn
30  {
31  enum class EventType {
32    zvertex,
33    all
34  };
35
36  enum class TrackType {
37    px,
38    py,
39    pz,
40    all
41  };
42
43  enum class PairType {
44    unlikepm,
45    unlikemp,
46    likepp,
47    likemm,
48    unliketrue,
49    unlikegen,
50    mixingpm,
51    mixingpp,
52    mixingmm,
53    mixingmp,
54    all
55  };
56
57  enum class PairAxisType {
58    im,
59    pt,
60    mu,
61    ns1,
62    ns2,
63    eta,
64    y,
65    vz,
66    mum,
67    vzm,
68    unknown
69  };
70
71  enum class SystematicsAxisType {
72    ncl,
73    unknown
74  };
```

```
43  enum class PairType {
44    unlikepm,
45    unlikemp,
46    likepp,
47    likemm,
48    unliketrue,
49    unlikegen,
50    mixingpm,
51    mixingpp,
52    mixingmm,
53    mixingmp,
54    all
55  };
```



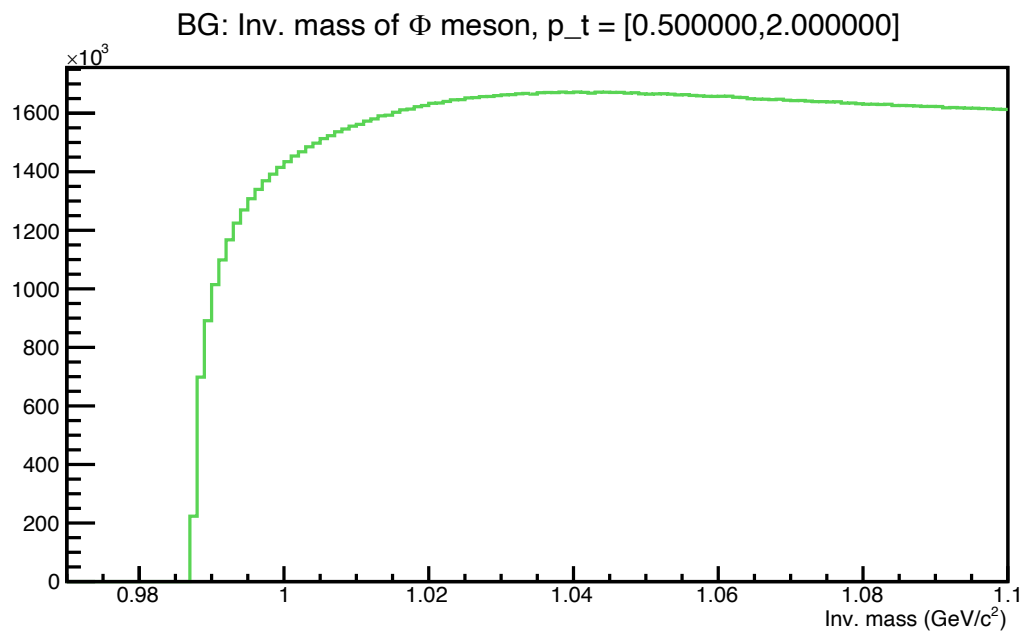




Kombinatorické pozadie

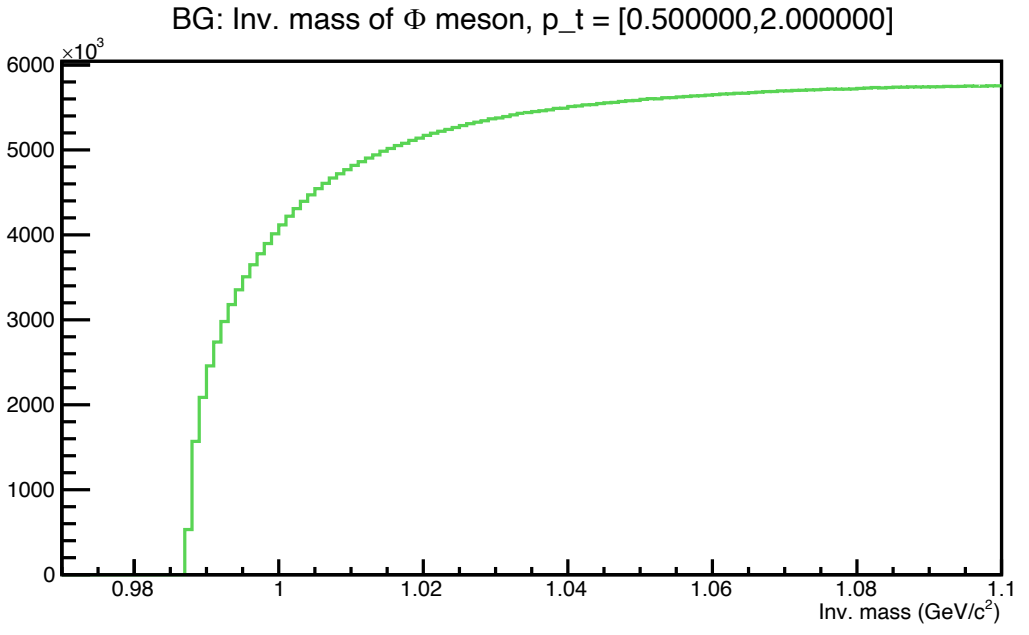
Likesign background

- Z kombinácií K^+
- Z kombinácií K^-



Event Mixing background

- Z kombinácií kaónov z rôznych ale podobných eventov *(mu, vz)*



OUTPUT

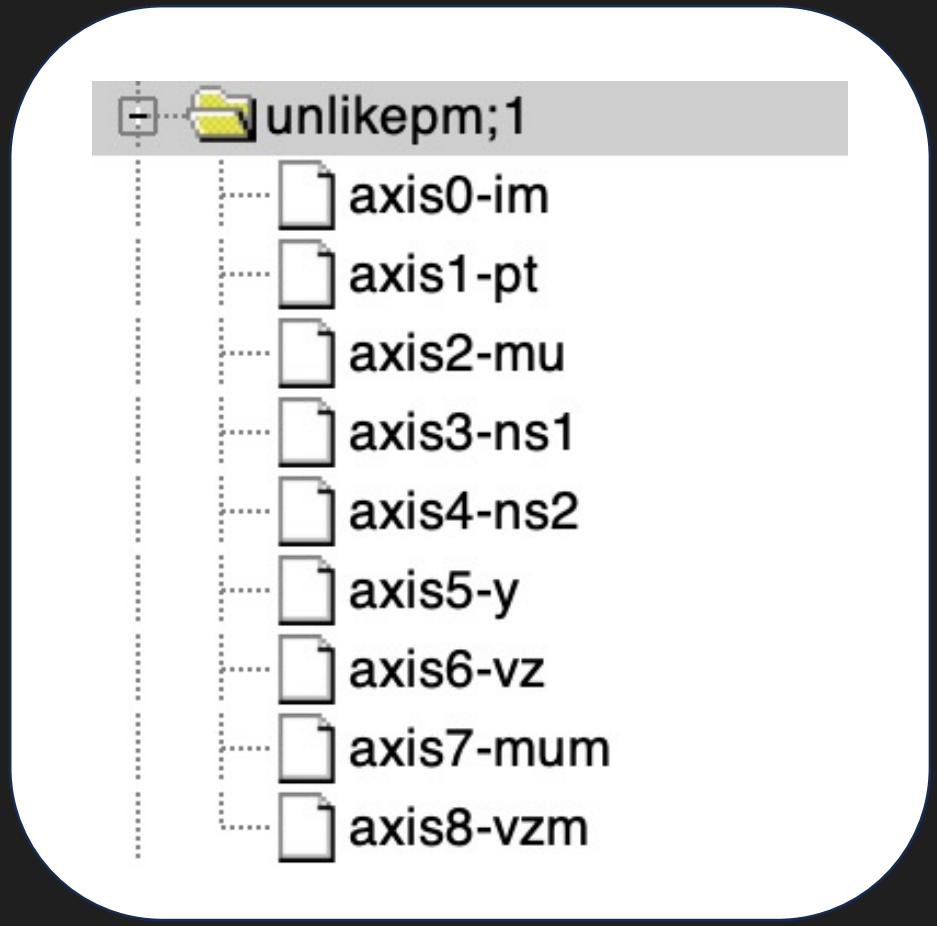
THnSparse – s možnosťou kofigurácie počtu osí

- *Invariantná hnotnosť*
- *Priečna hybnosť*
- *Multiplicita*
- *nSigma 1. častice*
- *nSigma 2. častice*
- *Rapidita*
- *Pseudorapidita*
- *Z vertex*

Pre event mixing:

- *Multiplicita 2. eventu*
- *Z vertex 2. eventu*

+ všetky osi sú konfigurovateľné.



C rsnOutput.h 3

PWGLF > Utils > C rsnOutput.h > ...

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    Veronika Barbasova, last week | 2 authors (Veronika
29  namespace rsn
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42
43  enum class PairType {
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45    unlikemp,
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47    likemm,
48    unliketrue,
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50    mixingpm,
51    mixingpp,
52    mixingmm,
53    mixingmp,
54    all
55  };
56
57  enum class PairAxisType {
58    im,
59    pt,
60    mu,
61    ns1,
62    ns2,
63    eta,
64    y,
65    vz,
66    mum,
67    vzm,
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69  };
70
71  enum class SystematicsAxisType {
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74  };
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```
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59    pt,
60    mu,
61    ns1,
62    ns2,
63    eta,
64    y,
65    vz,
66    mum,
67    vzm,
68    unknown
69  };
```

My Analyses | All Analyses | Dashboard | AliHyperloop | Train Submission | Train Runs | Datasets | DPG Runlists

pp-run2-phi-data

sparse-axes

im	−
pt	−
mu	−
ns1	−
ns2	−
eta	−
y	−
vz	−
mum	−
vzm	− +

Save

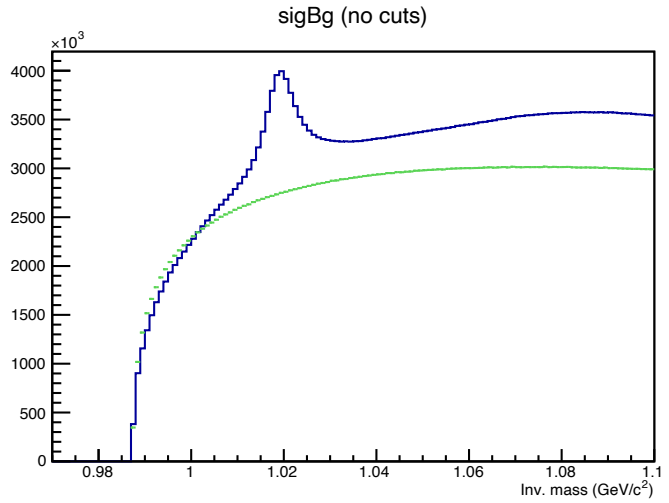
phianalysisTHnSparse.cxx

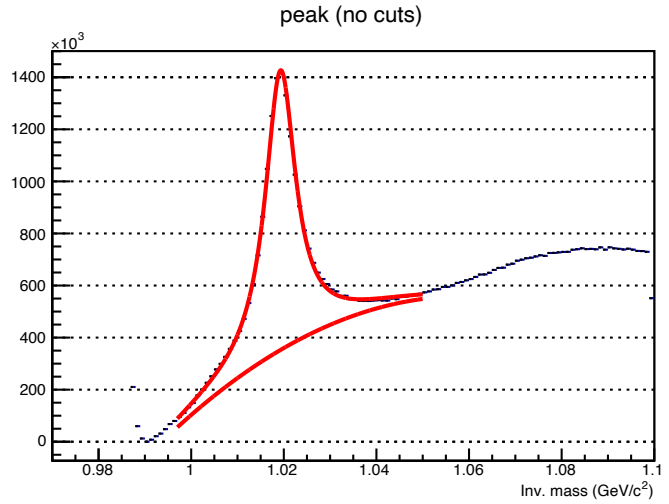
```
225  double* FillPointPair(double im, double pt, double mu, double ns1, double ns2, double eta, double y, double vz, double mum, double vzm)
226  {
227    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::im)] = im;
228    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::pt)] = pt;
229    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::mu)] = mu;
230    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::ns1)] = ns1;
231    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::ns2)] = ns2;
232    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::eta)] = eta;
233    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::y)] = y;
234    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::vz)] = vz;
235    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::mum)] = mum;
236    pointPair[static_cast<int>(o2::analysis::rsn::PairAxisType::vzm)] = vzm;
237
238    return pointPair;
239  }
```

```
288        pointPair = FillPointPair(mother.Mag(),
289                                  mother.Pt(),
290                                  GetMultiplicity(collision),
291                                  (tpcnSigmaPos > 0) ? std::abs(track1.tpcNSigmaKa()) : track1.tpcNSigmaKa(),
292                                  (tpcnSigmaNeg > 0) ? std::abs(track2.tpcNSigmaKa()) : track2.tpcNSigmaKa(),
293                                  mother.Eta(),
294                                  mother.Rapidity(),
295                                  collision.posZ(),
296                                  0,
297                                  0);
298        rsnOutput->fillUnlikepm(pointPair);
299      }
```

Likesign background

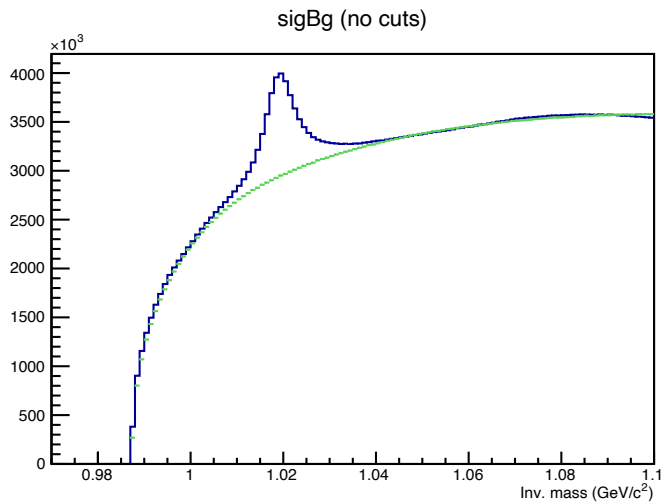
Normovací interval:
(0.99 , 1.01)

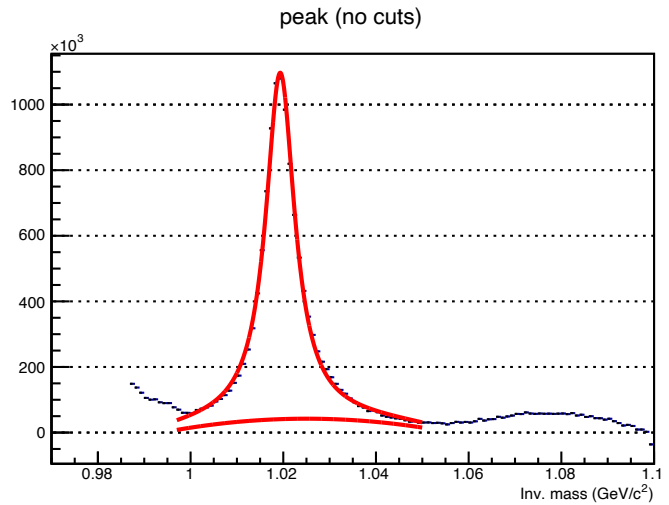




Mixing background

Normovací interval:
(1.04 , 1.06)





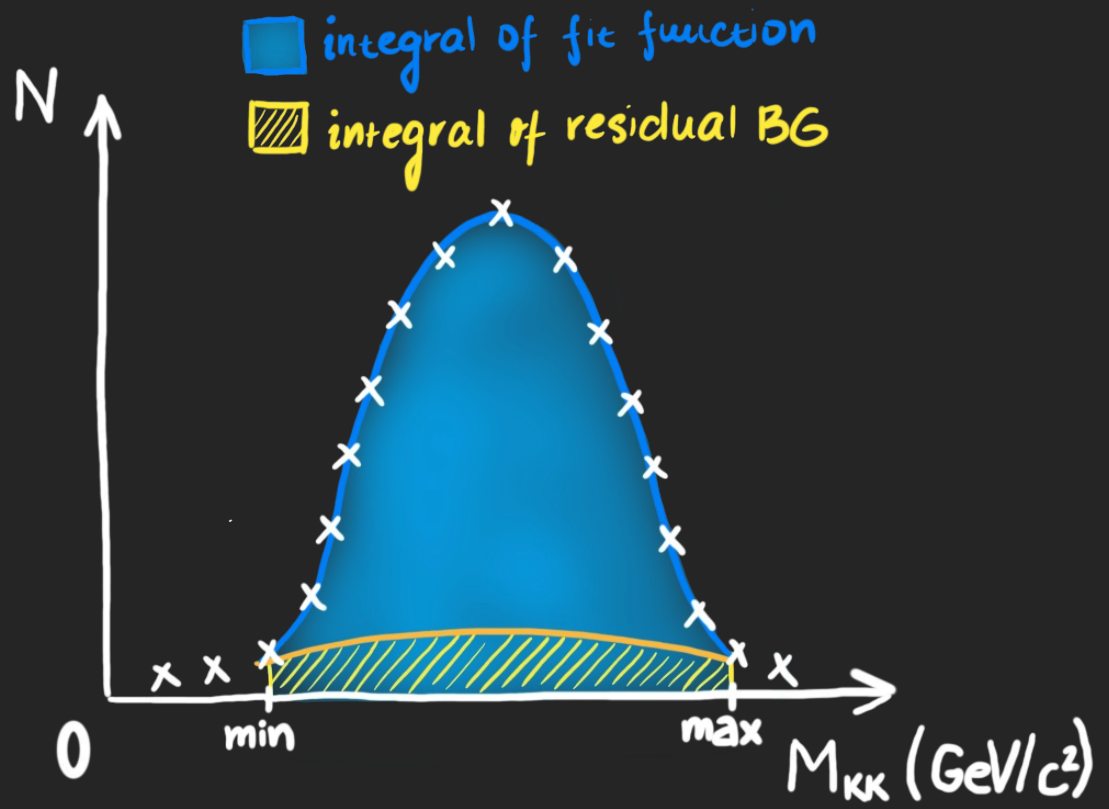
Fitovacia funkcia:

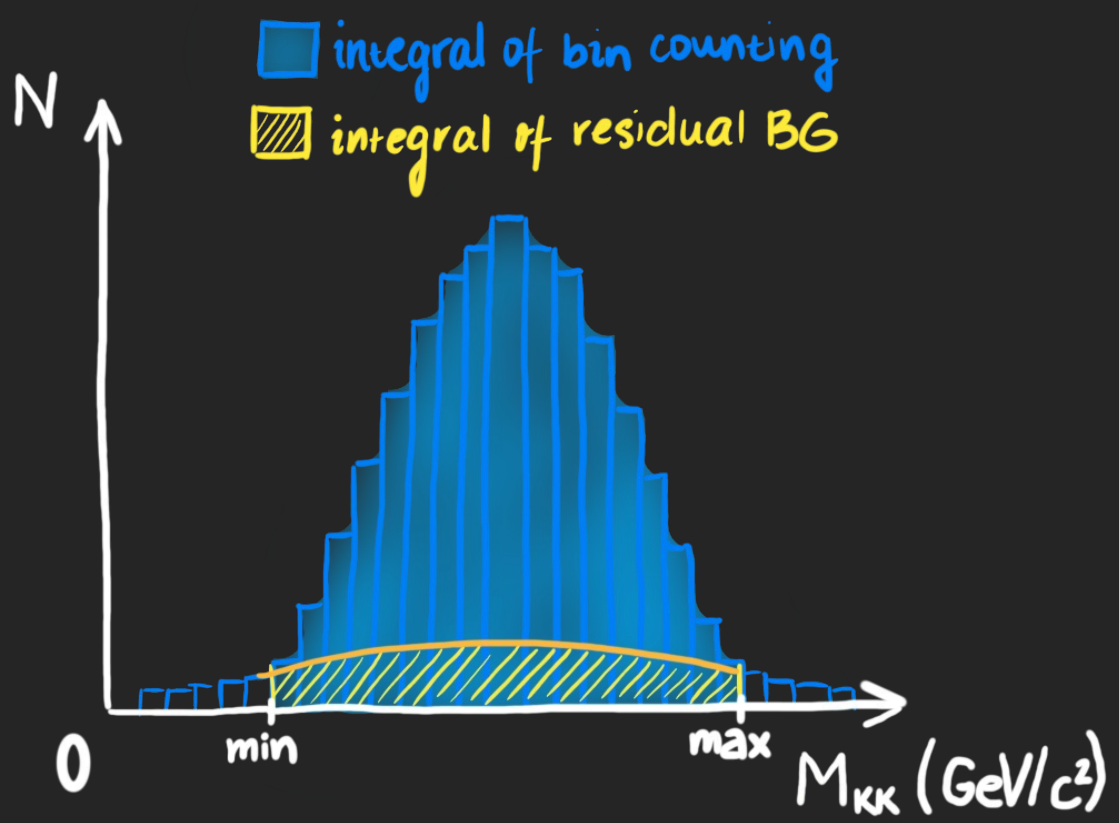
- Voigt + pol2

Fitovací interval:

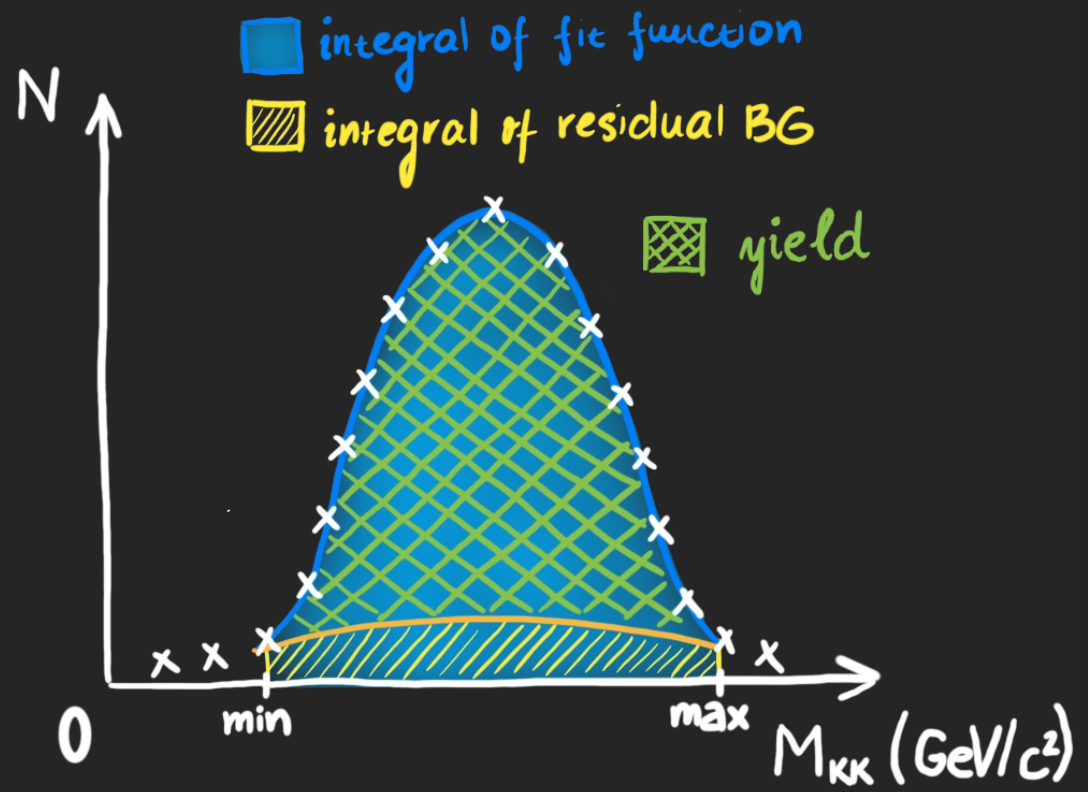
- *(0.997, 1.050)*

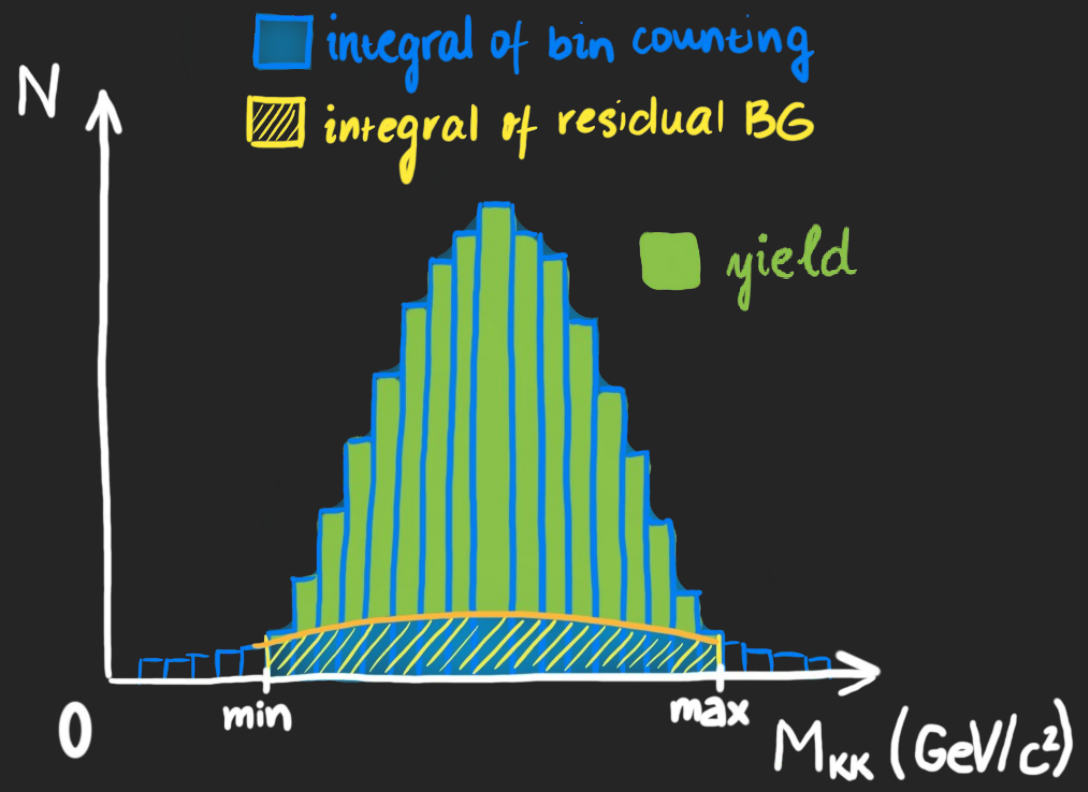
Fit function vs. Bin Counting



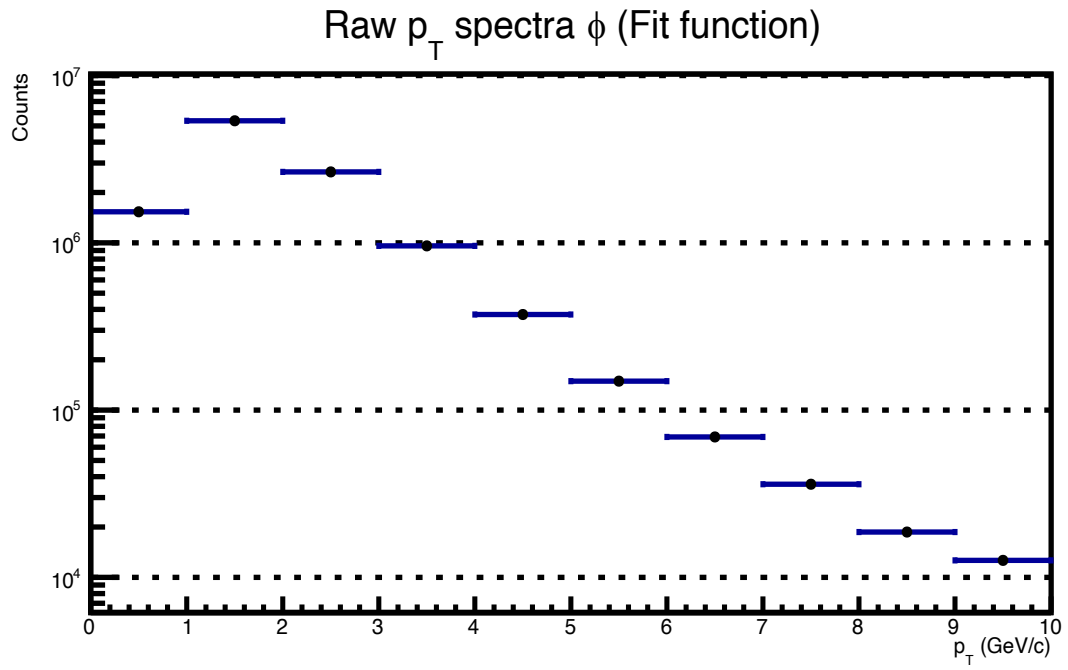


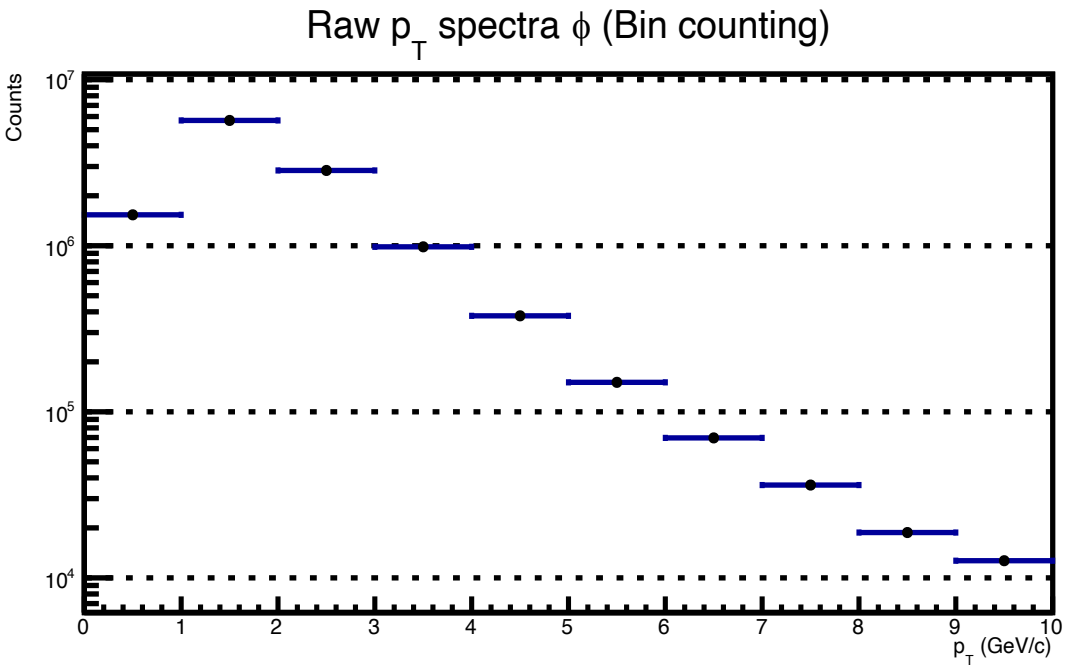
Fit function vs. Bin Counting





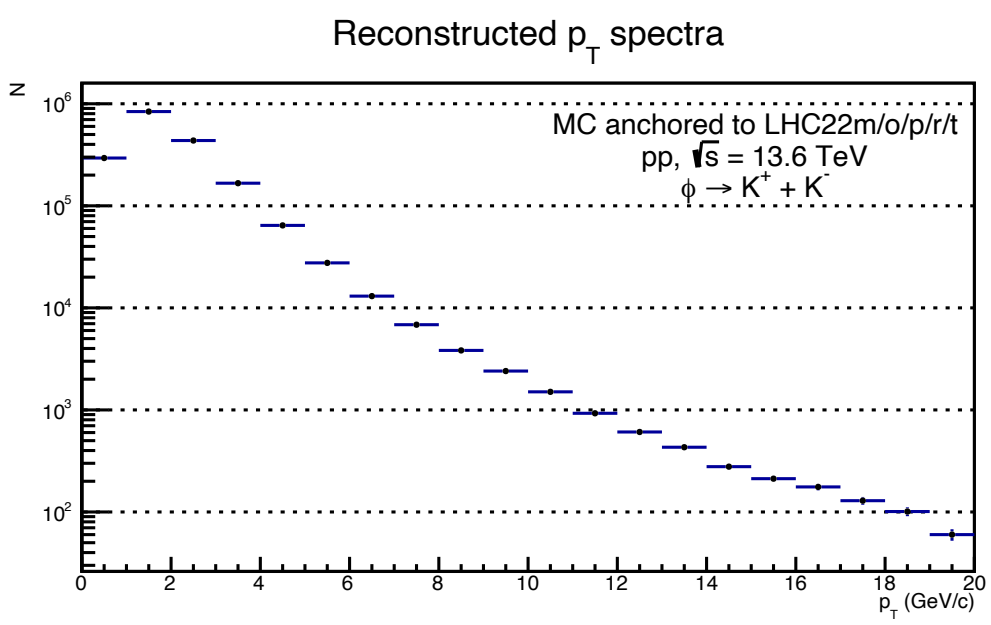
Fit function vs. Bin Counting

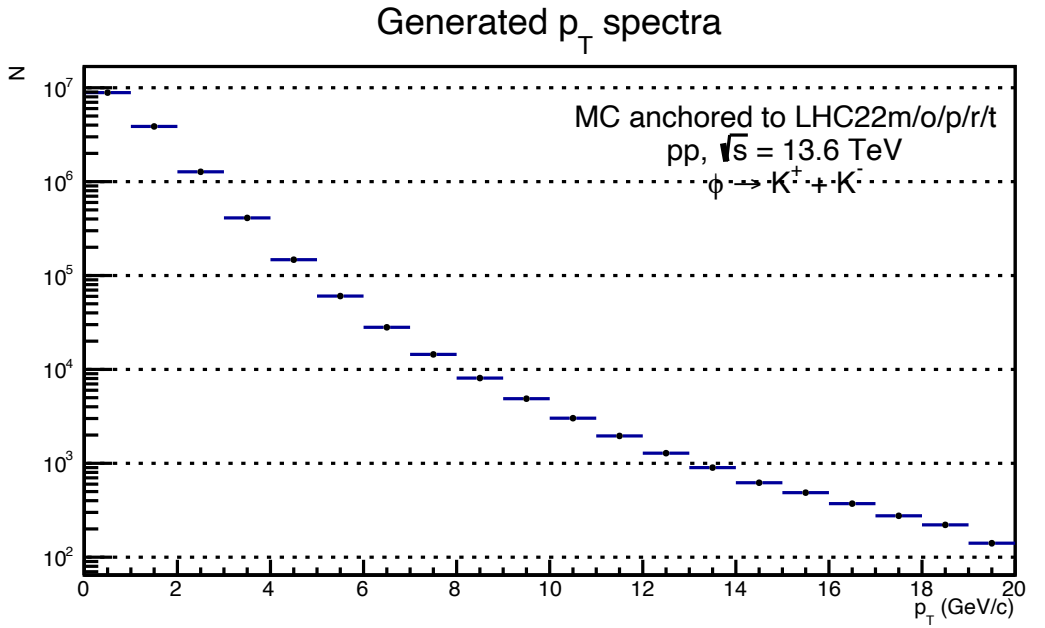




Efektivita rekonštrukcie

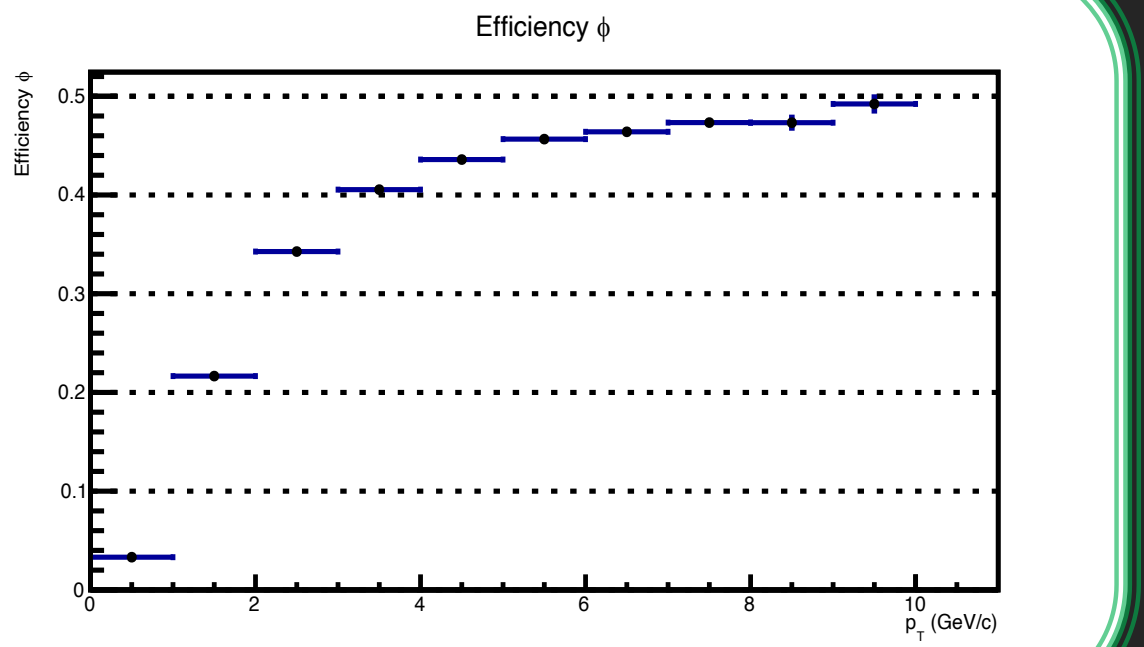
$$Efficiency = \frac{Reconstructed}{Generated}$$





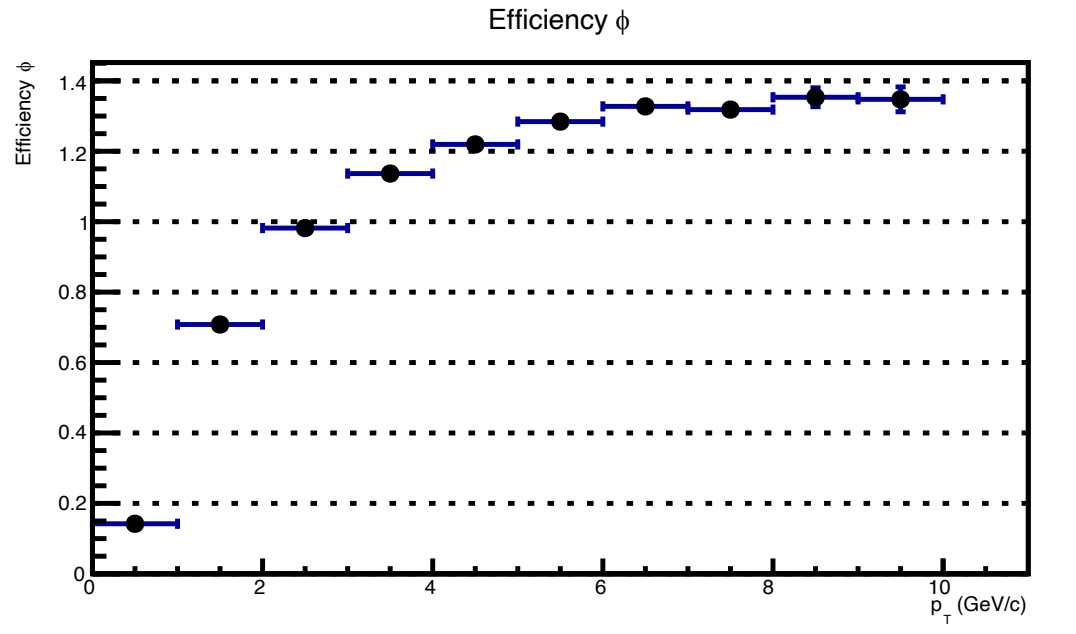
LHC23k2f

- Anchored to LHC22m/o/p/r/t_pass4

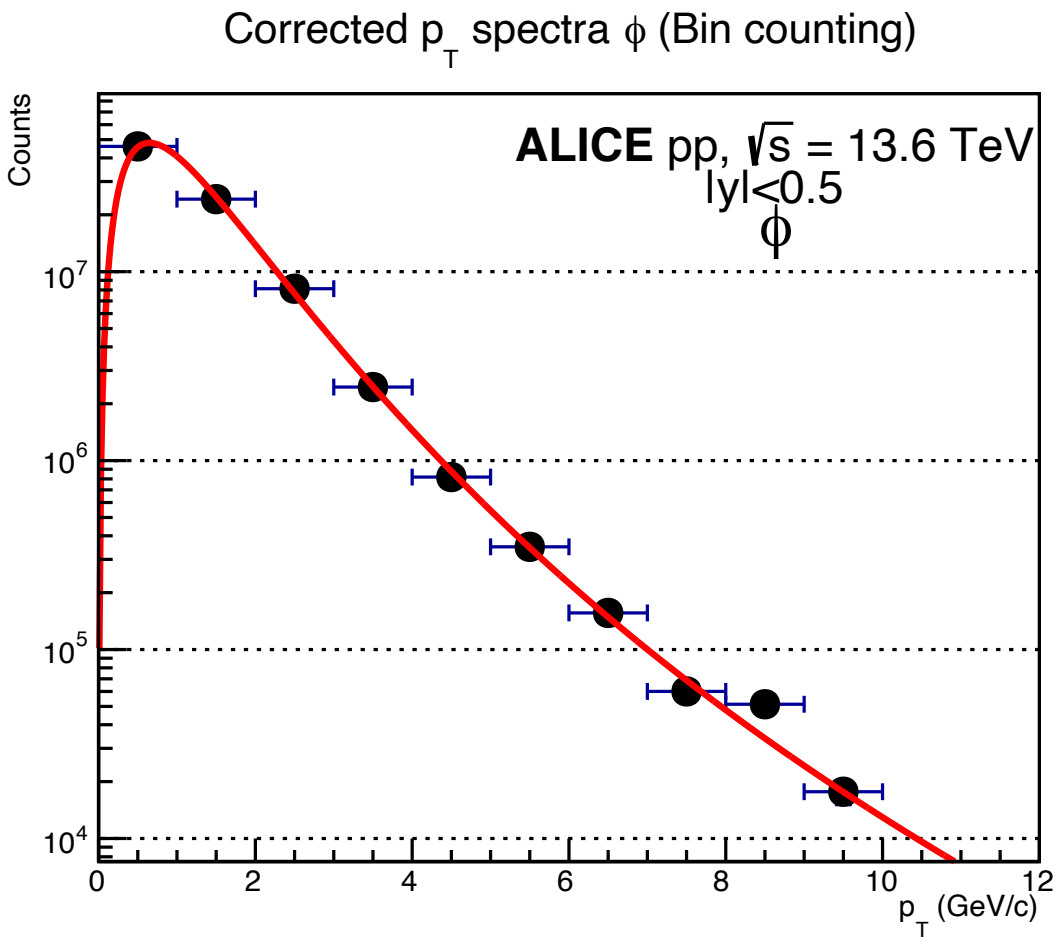


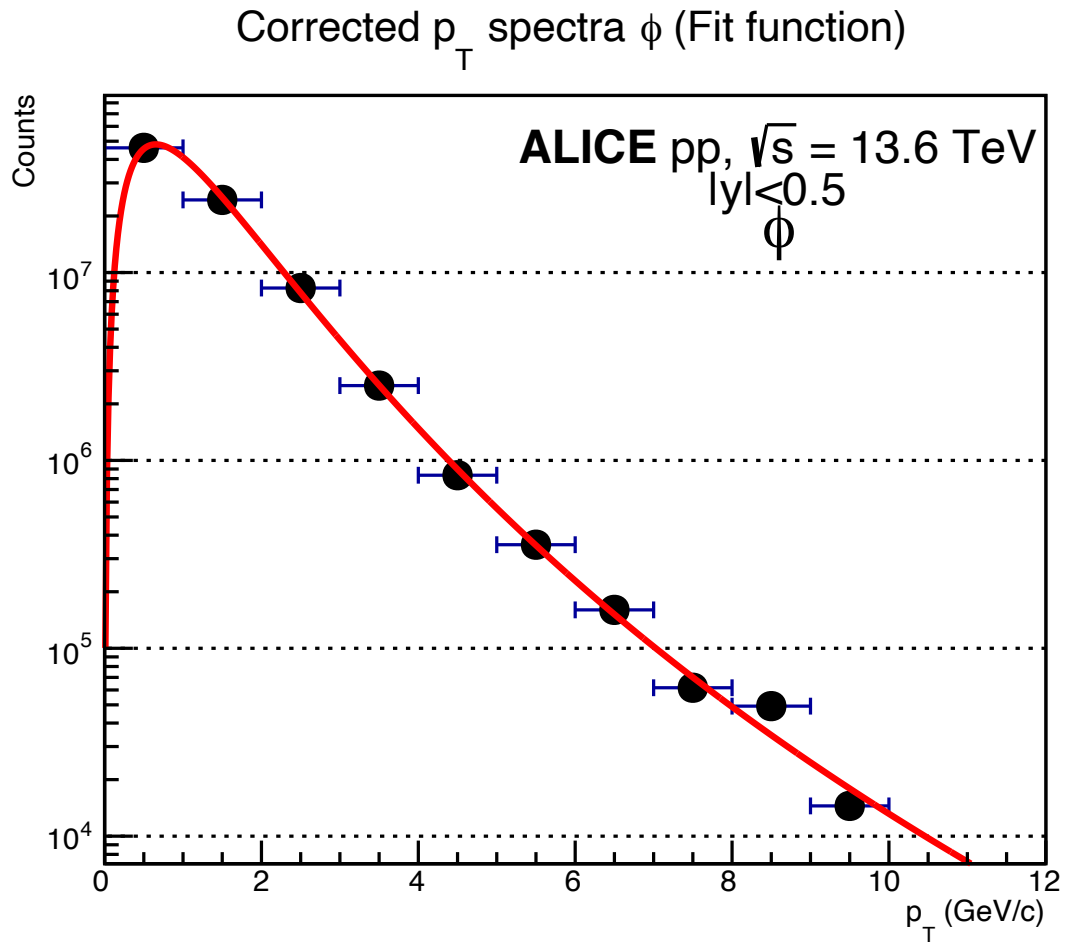
LHC24b1b

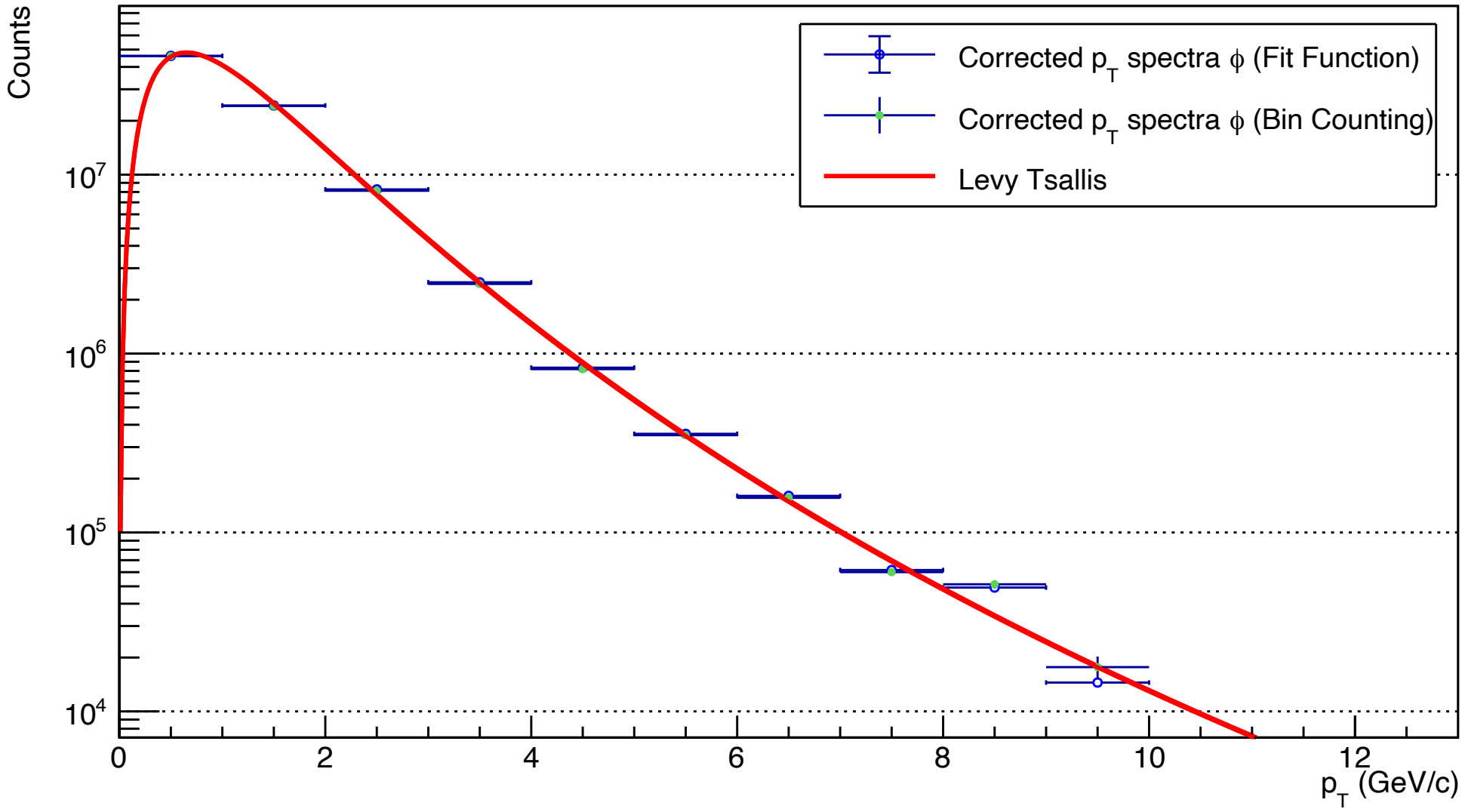
- Anchored to LHC22o_pass6
- Efektivita rekonštrukcie väčšia ako 1



Corrected p_T spectra






Counts
10^7
10^6
10^5
10^4
0
2
4
6
8
10
12
p_T (GeV/c)
Corrected p_T spectra ϕ (Fit Function)
Corrected p_T spectra ϕ (Bin Counting)
Levy Tsallis

Záver a plány do budúcna

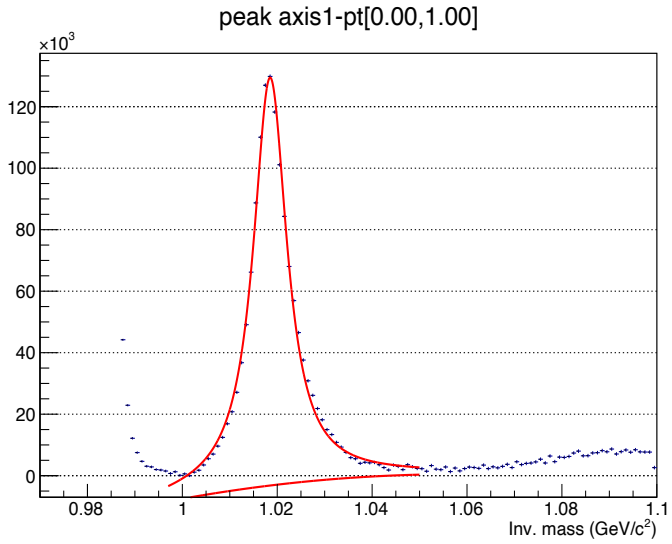
- Metodika analýzy zvládnutá
- p_T sprektrum upravené vzhľadom na efektivitu rekonštrukcie phi mesónu
- Header rsnOutput.h (možnosť konfigurácie počtu osí v sparse)

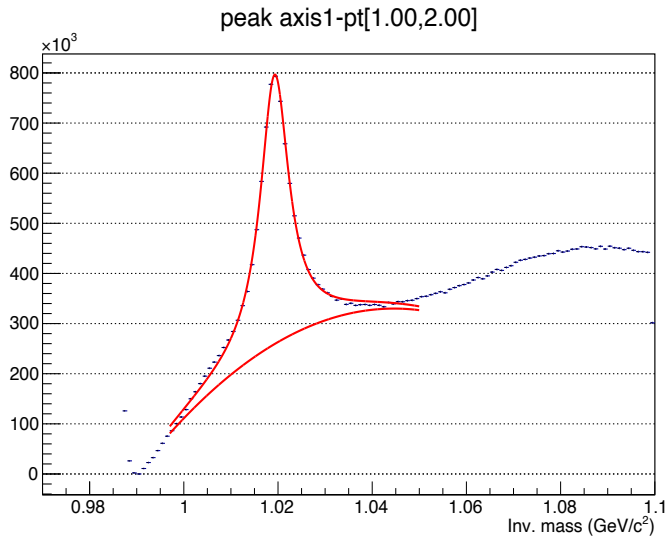
- pass6 MC – problém s efektivitou
- Malá štatistika pre mixing background pri veľkom p_T

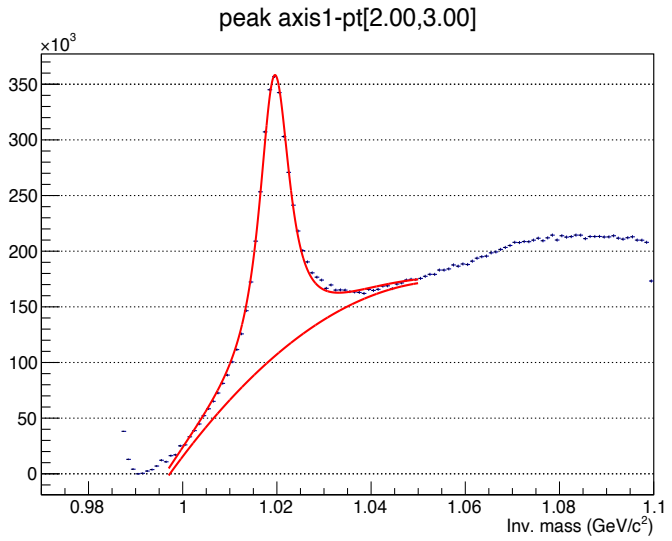
Ďakujem za pozornosť!

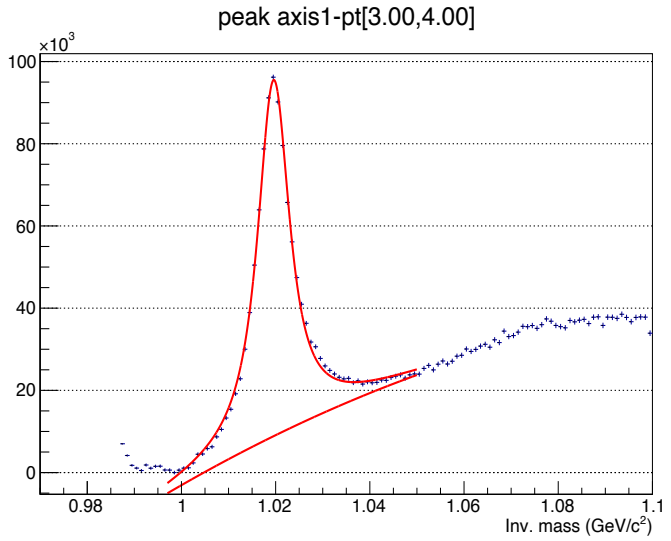
Backup slides

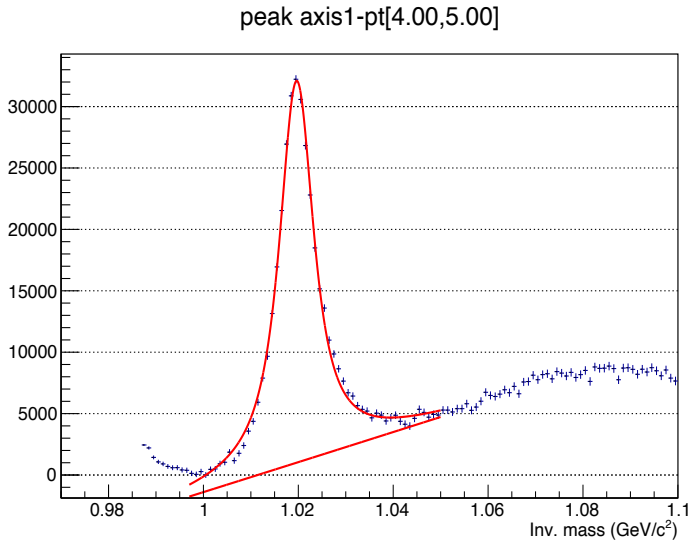
Likesign background, *Normovací interval: (0.99 , 1.01)*

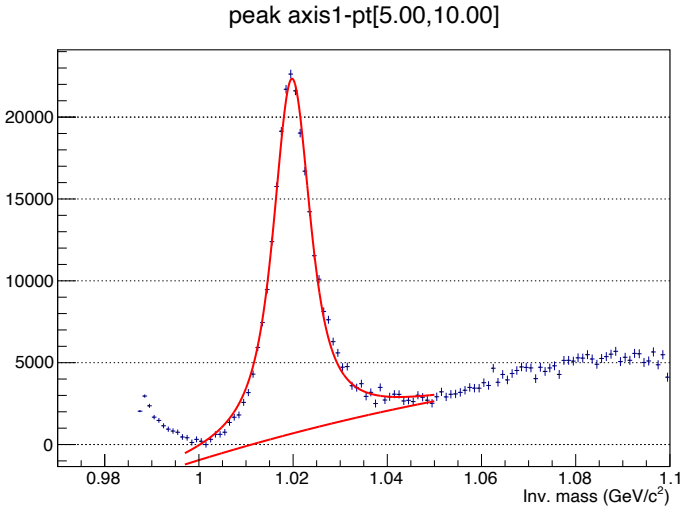


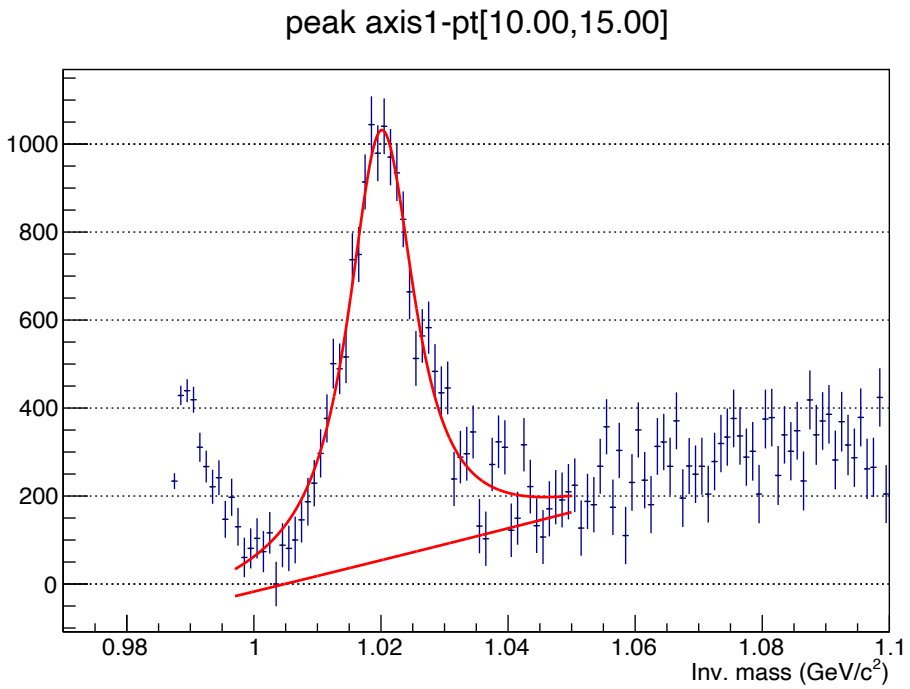


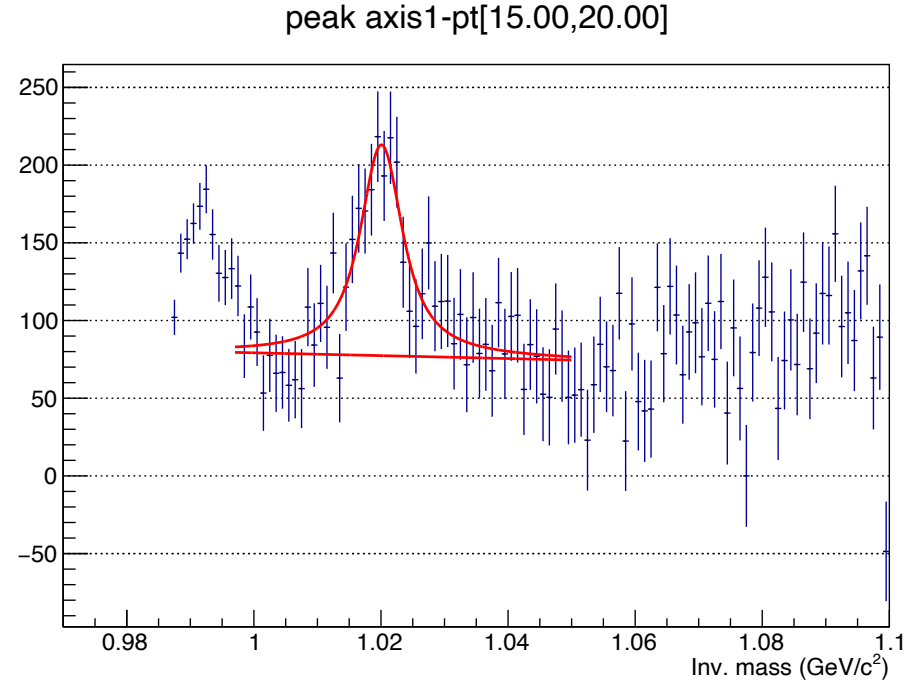






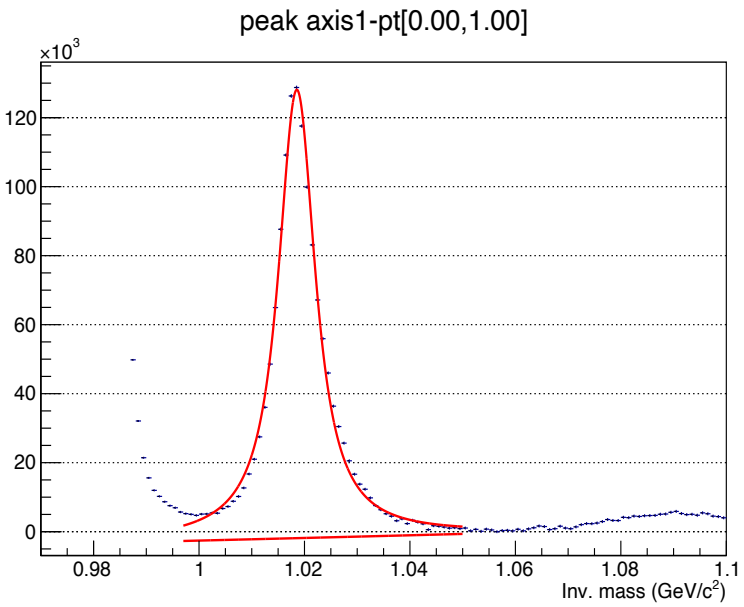


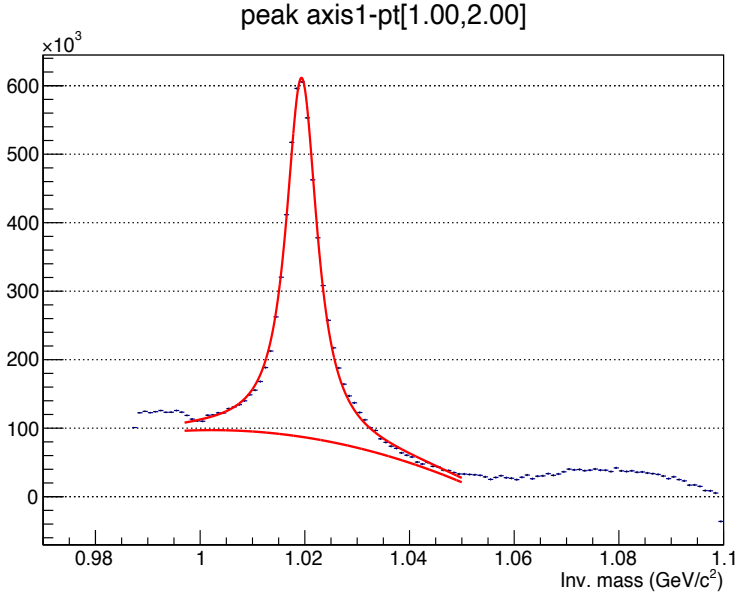


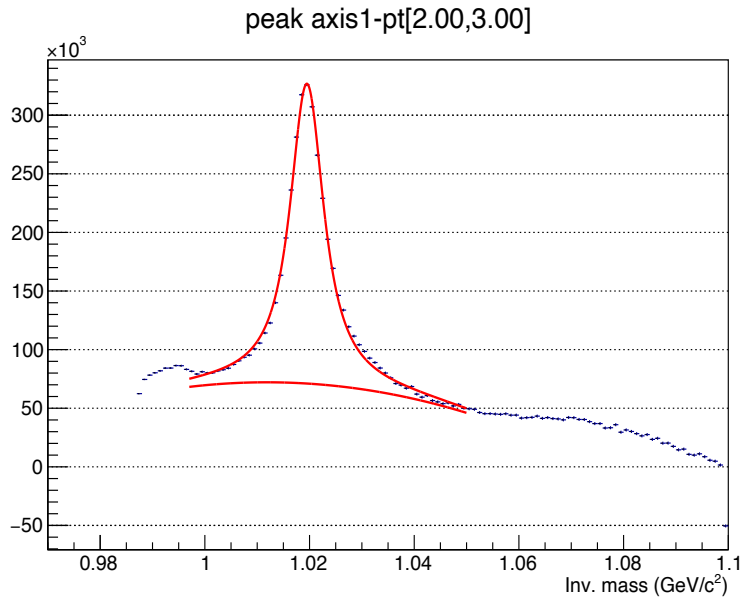


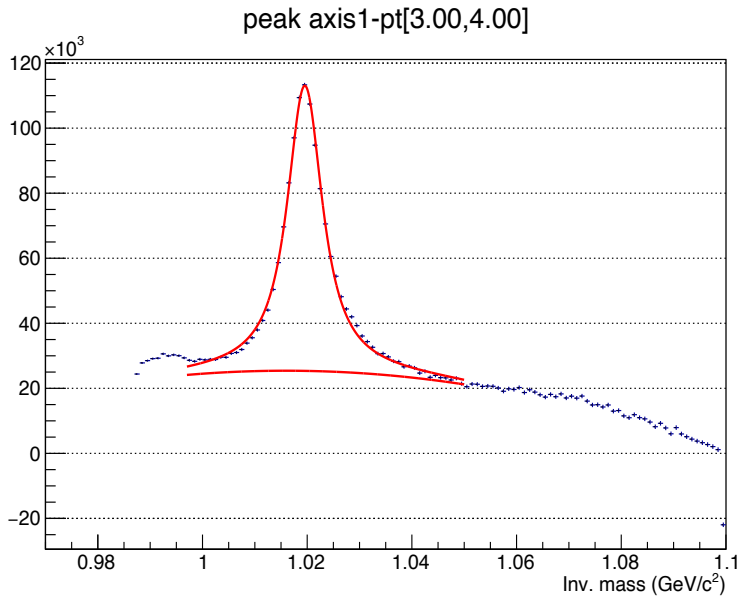
- Likesign background neopisuje tvar pozadia úplne dokonale
- pri pT > 10 GeV/c2 – problém so štatistikou

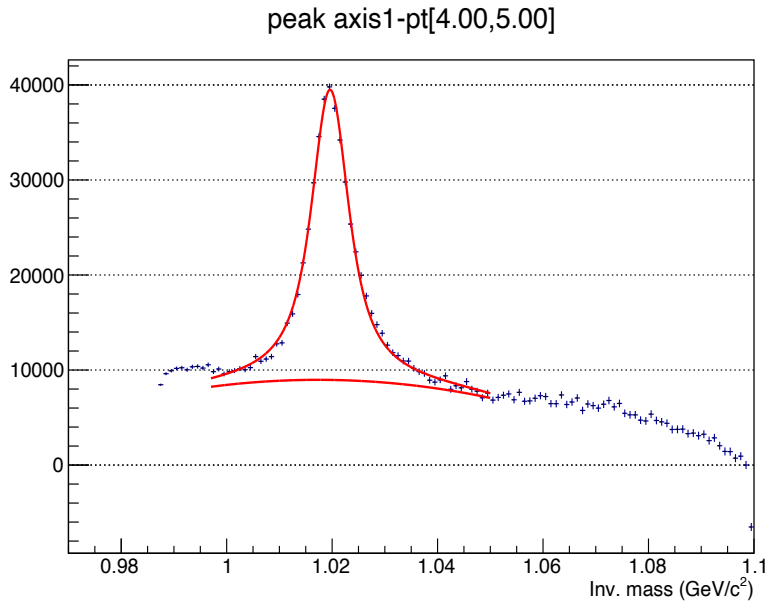
Mixing background *Normovací interval: (1.04 , 1.06)*

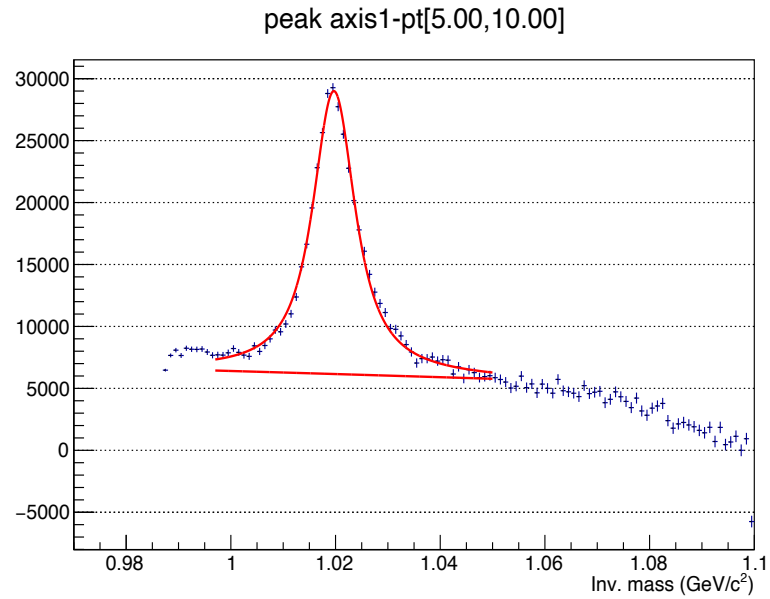


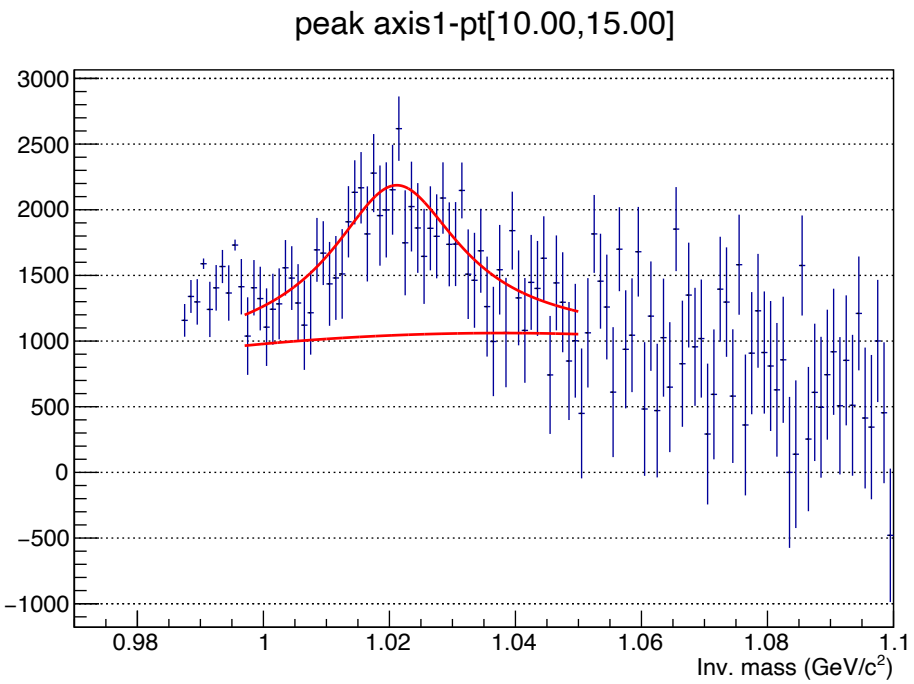


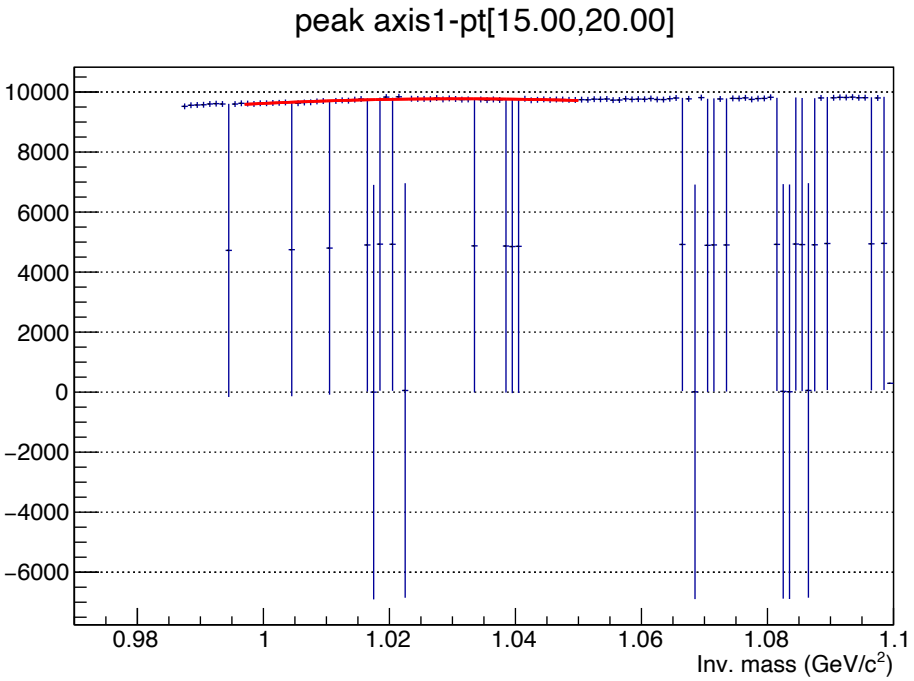










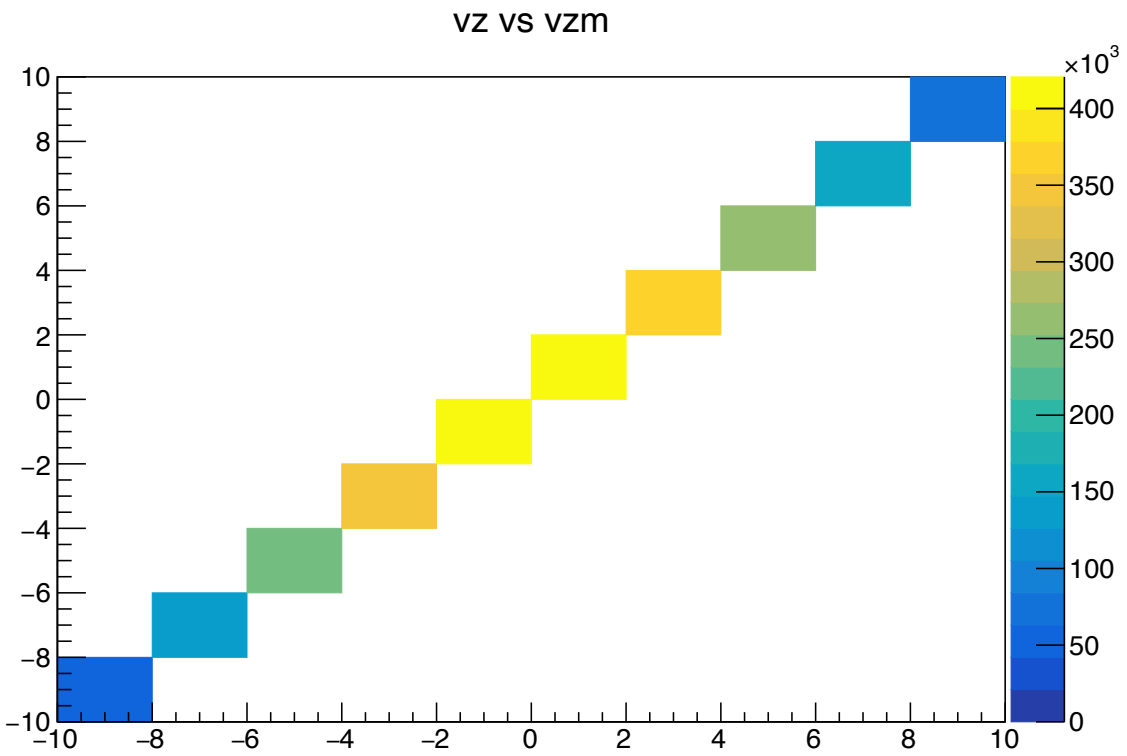


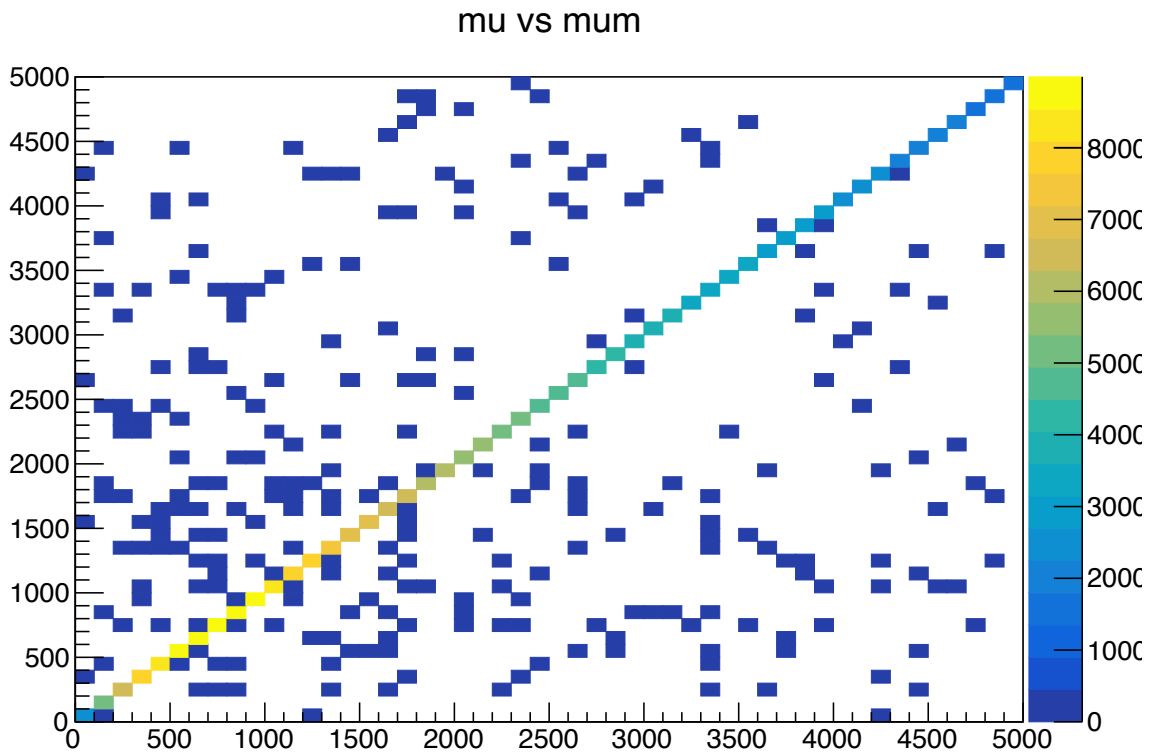
- Mixing background dobre popisuje líniu pozadia pri sumárnom pT

- pri pT > 10 GeV/c2 – problém so štatistikou
- Pri pT > 15 GeV/c2 - extrémne málo prípadov

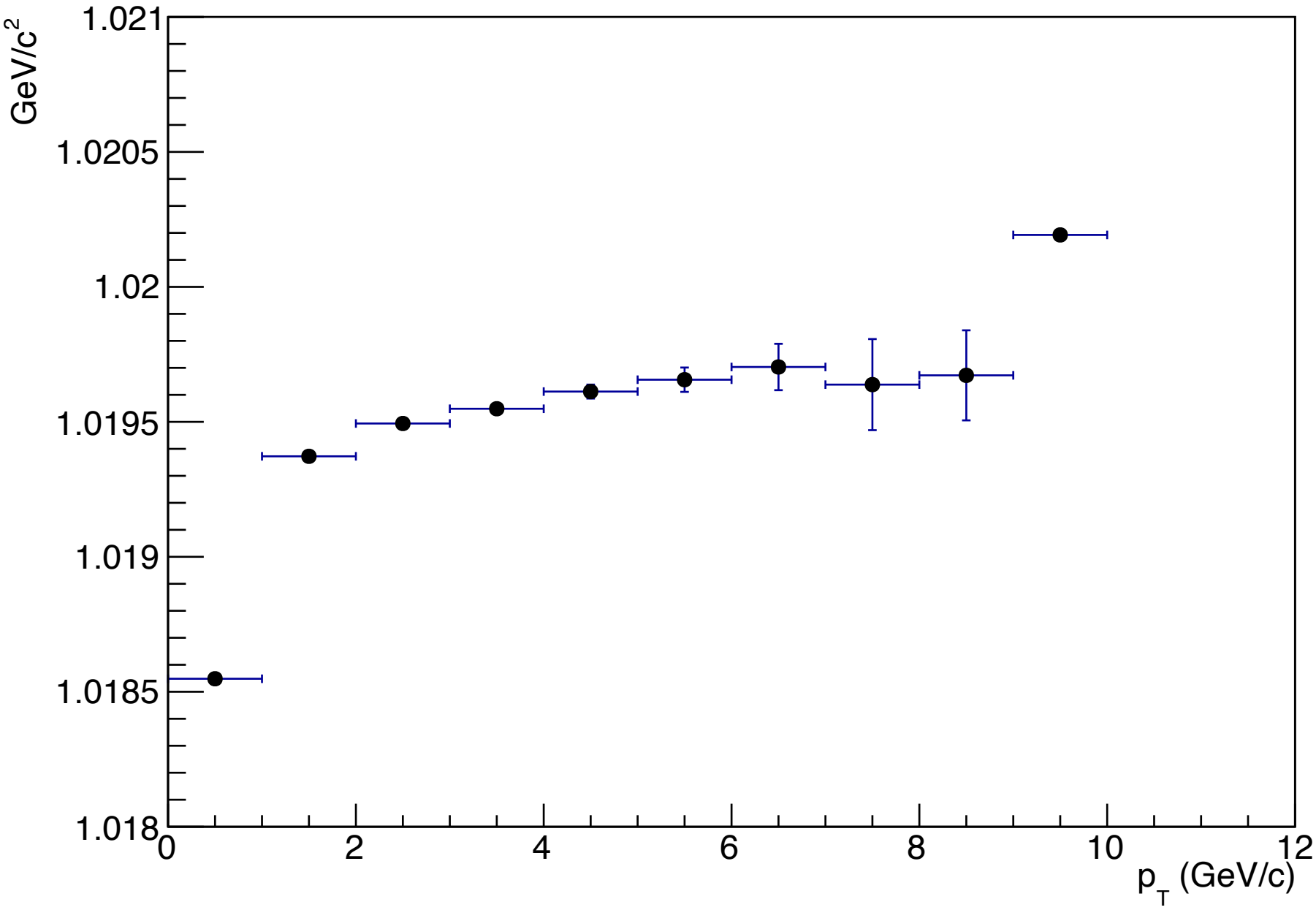
…Ešte je treba na tom popracovať…

Event mixing properties





Mass of ϕ


GeV/c^2
1.021
1.0205
1.02
1.0195
1.019
1.0185
1.018
0
2
4
6
8
10
12
p_T (GeV/c)