Alma Mater Studiorum - Università di Bologna

Global Tracking Analysis - MC considerations

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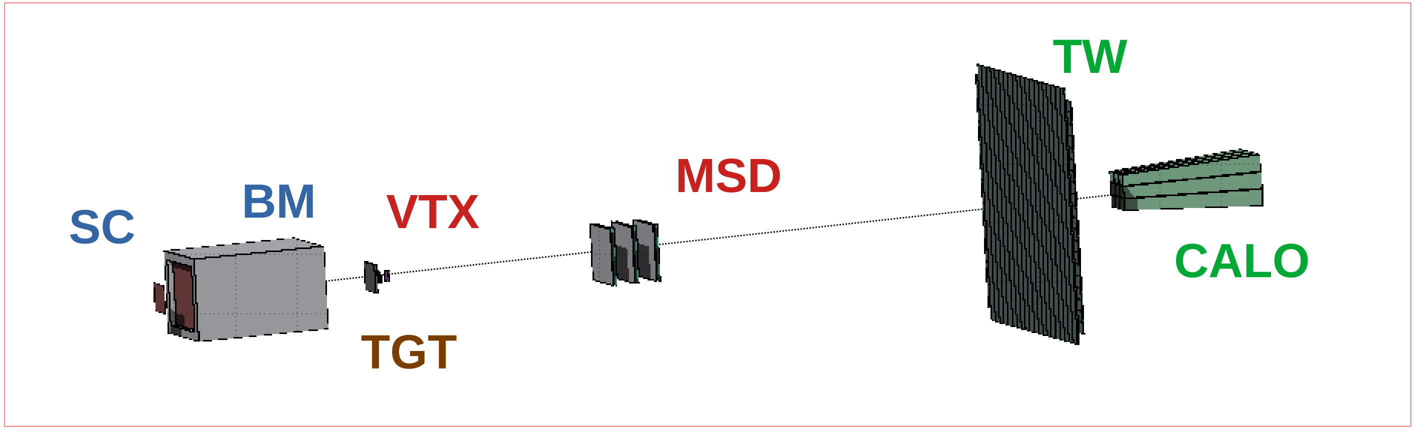
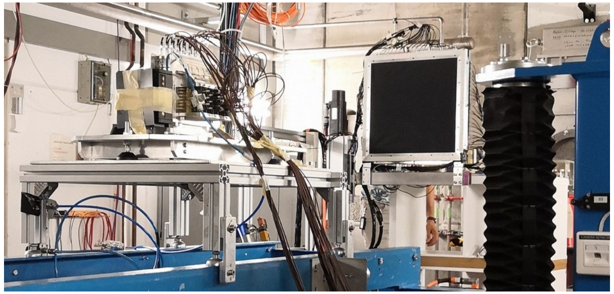
6/10/2023

GSI 2021 Analysis

- Data-taking at GSI (Darmstadt, Germany) in 2021
- **^{16}O 400 MeV/u** on 5 mm **C target**
- Partial setup: no magnet, only one module of calorimeter





MC used Dataset:

- /gpfs_data/local/foot/Simulation/GSI2021_MC/16O_C_400_**x**_shoereg.root

→ 5*10^6 events

Cross-Section formula

To compute elemental cross section and angular differential cross section:

$$\sigma(Z) = \frac{Y(Z) - \cancel{B(Z)}}{N_{beam}\, N_{target}\, \epsilon(Z)}$$

$$\frac{d\sigma}{d\theta}(Z,\theta) = \frac{Y(Z,\theta) - \cancel{B(Z,\theta)}}{N_{beam}\, N_{target}\, \Omega_\theta\, \epsilon(Z,\theta)}$$

Y:	fragment counts
~~***Bkg***~~***:***	background source counts
N_{beam}:	n° of primary events
N_{target}:	n° of scattering centers per unit area
ε:	efficiency
Ω_ϑ:	angular phase space

- We want to determine the impact of the background using global tracking and some specific MC requests

Cross-Section Yields

In the analysis, I am considering the following levels:

MC DATASET

MC TRUTH LEVEL

Cross-Section Yields

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MC DATASET

MC TRUTH LEVEL

MC Particles

N_Reference (MC)

all TAMCParticles
- primary beams
- primary fragments generated in the TG

- which cross the end of TW

(all the particles inside the geometrical acceptance of the setup without secondary fragmentation beneath the detectors)

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GENFIT Tracks

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all TAMCParticles
- primary beams
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(all the particle inside the geometrical acceptance of the setup without secondary fragmentation beneath the detectors)

N_All Reconstructed

All reconstructed tracks by GENFIT

I take the **MC_ID** of the track
(most frequent id)

N_Good Reco

(Tracks with MC_ID which satisfies MC GENERATION requests)

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(all the particle inside the geometrical acceptance of the setup without secondary fragmentation beneath the detectors)

for track ***efficiency***

Cross-Section Yields

In the analysis, I am considering the following levels:

MC DATASET

MC TRUTH LEVEL

RECO LEVEL

MC Particles

GENFIT Tracks

N_RECO

All reconstructed tracks by GENFIT

N_All Reconstructed

All reconstructed tracks by GENFIT

N_Reference (MC)

all TAMCParticles
- primary beams
- primary fragments generated in the TG
- which cross the end of TW

(all the particle inside the geometrical acceptance of the setup without secondary fragmentation beneath the detectors)

I take the **MC_ID** of the track

(most frequent id)

N_Good Reco

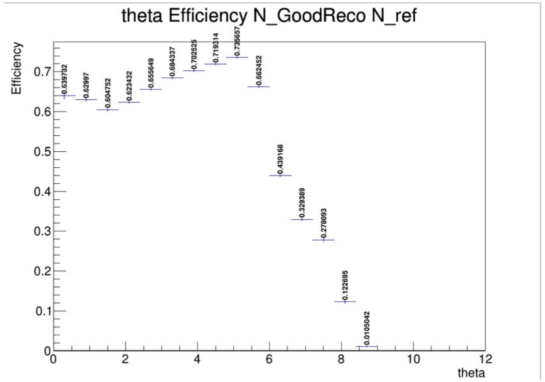
(Tracks with MC_ID which satisfies MC GENERATION requests)

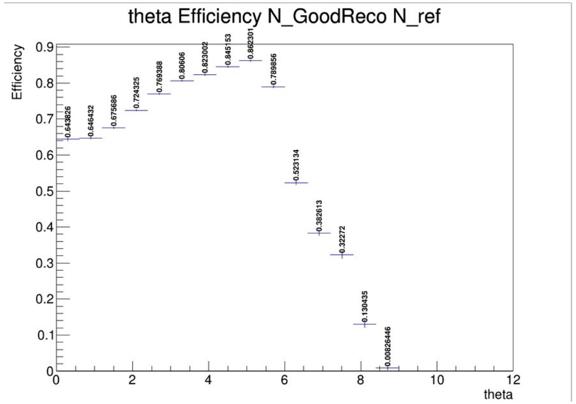
*for **yield***

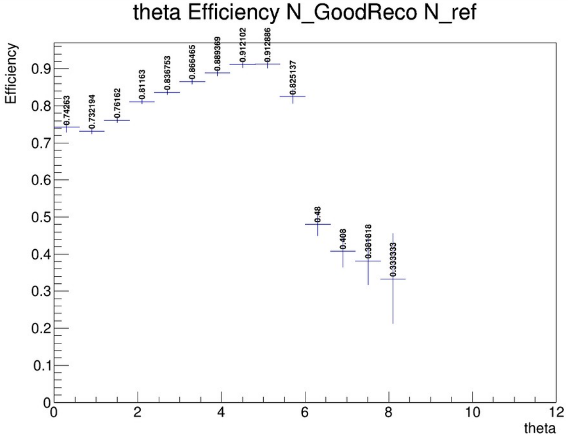
*for track **efficiency***

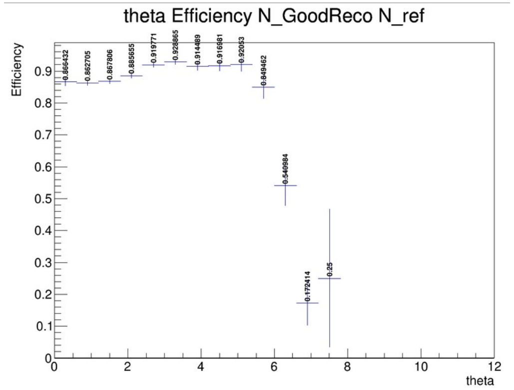
Efficiency in theta for every Z

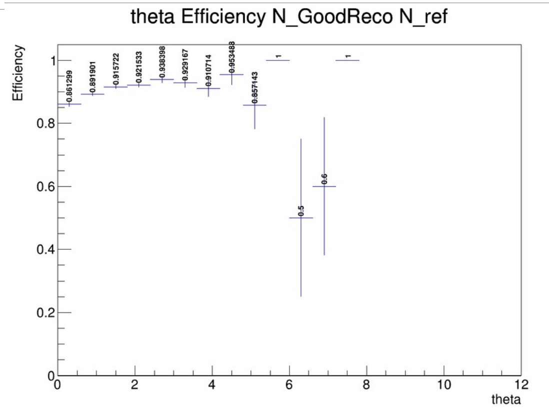
$$\varepsilon = \frac{\text{N\_Good Reco}}{\text{N\_Reference (MC)}}$$

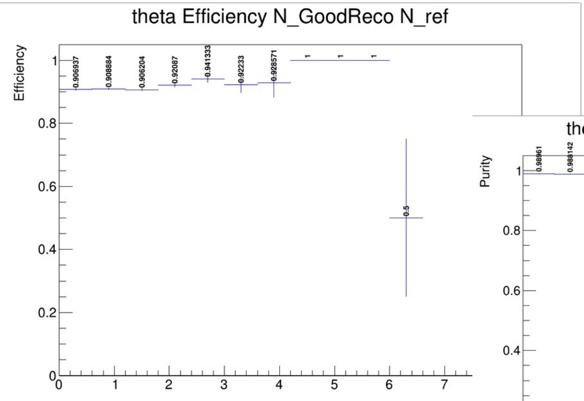


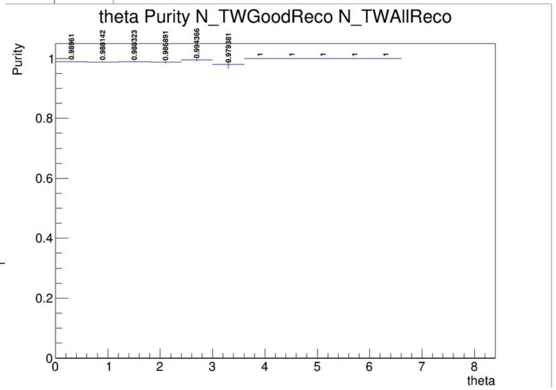












Cross section

1a) Yield is made by all reconstructed tracks (no MC cuts)

1b) Z purity added: it gives MC info about fragmentation out of target

$p = N(Z_{reco} = Z_{true}) / N(Z_{reco})$

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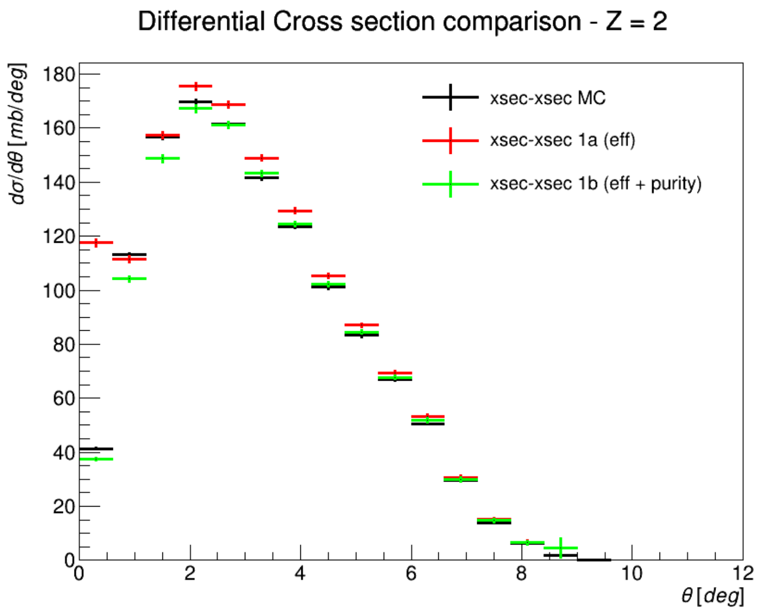
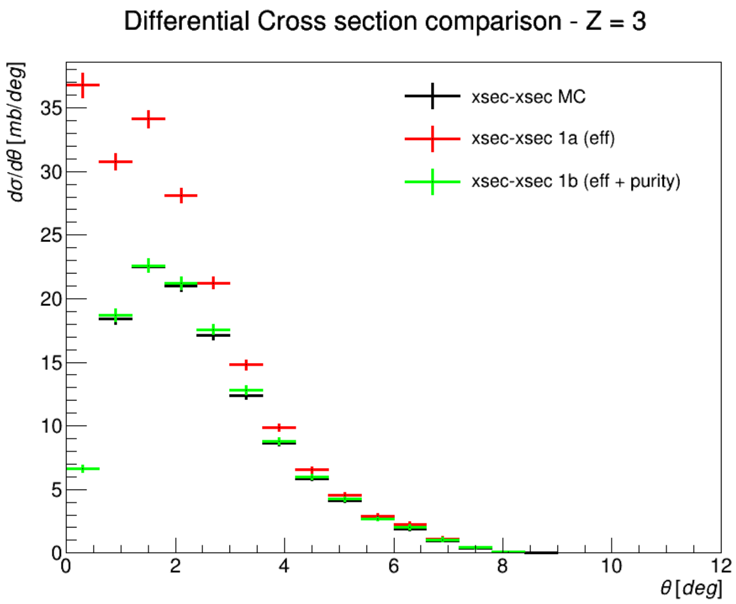
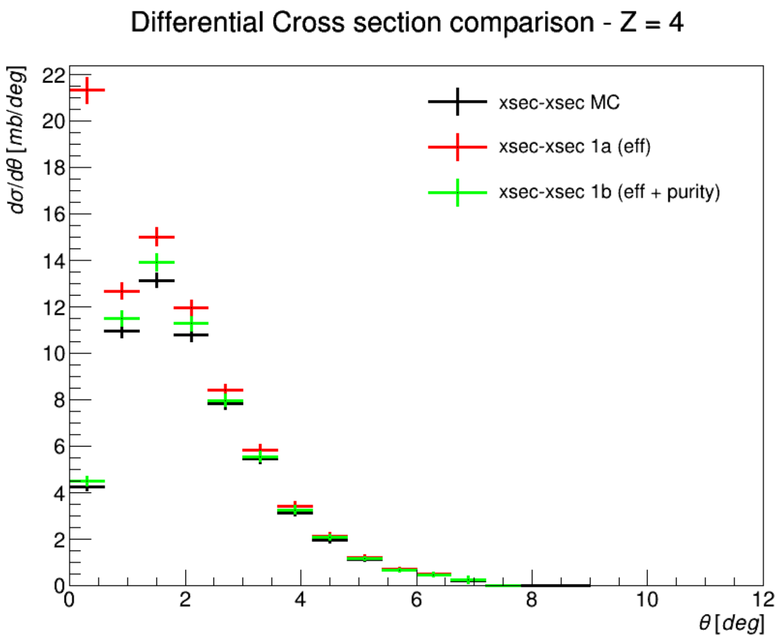


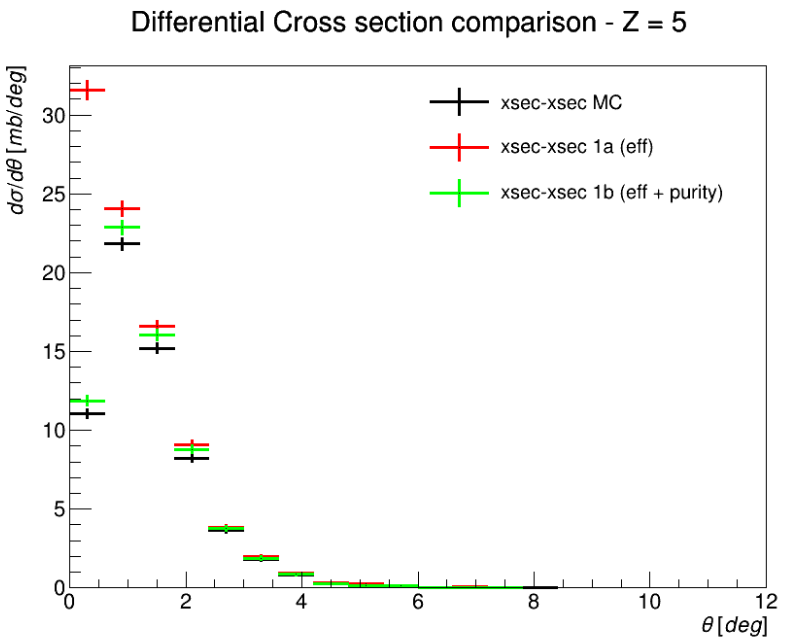


Cross section

1a) Yield is made by all reconstructed tracks (no MC cuts)
1b) + TW Z purity

p = $N(Z_{reco} = Z_{true}) / N(Z_{reco})$





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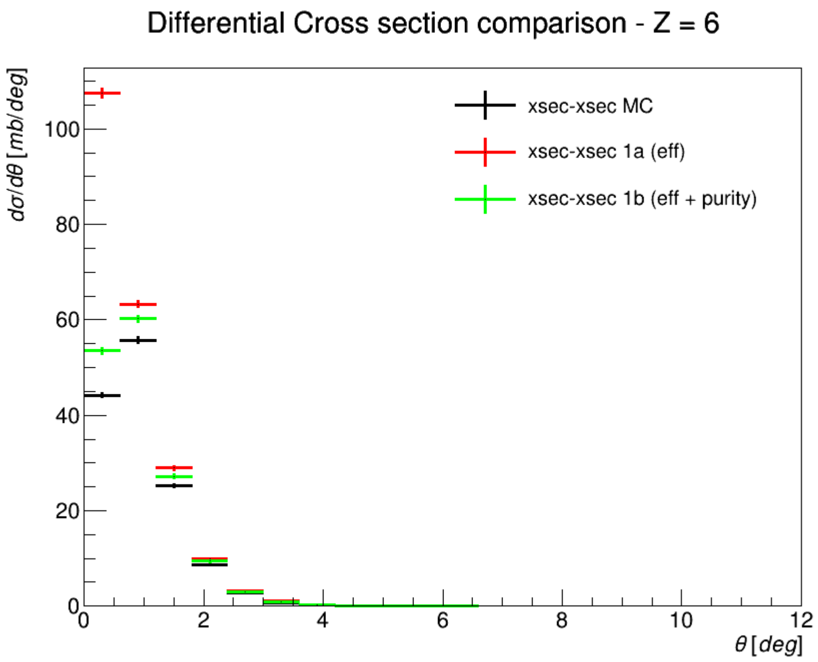

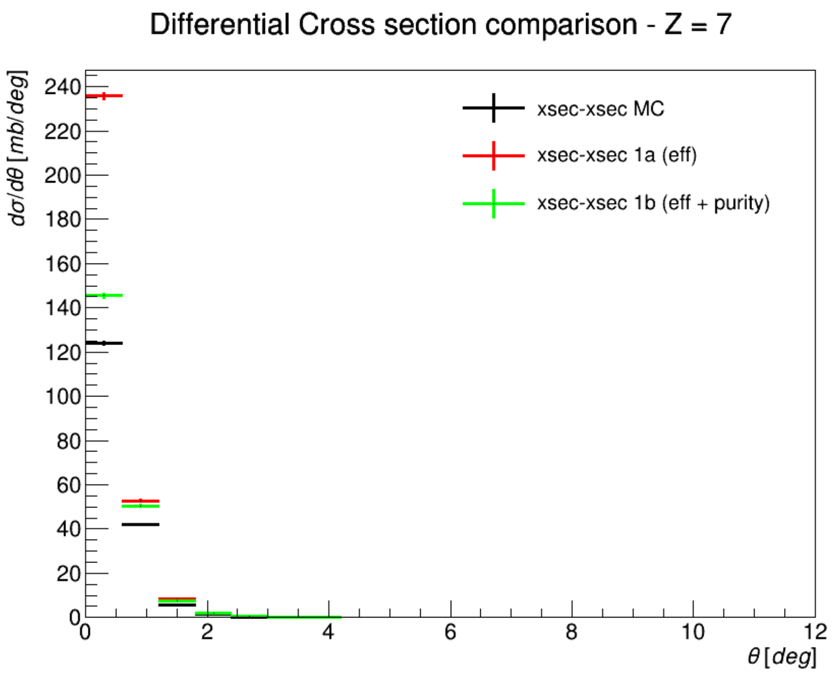

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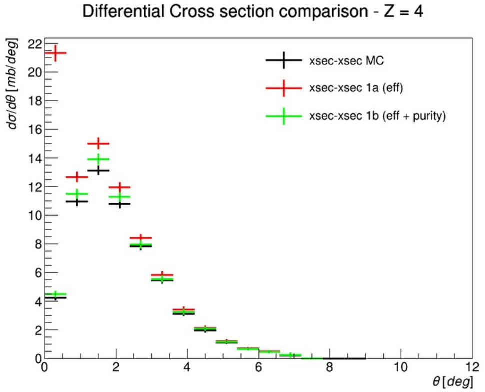
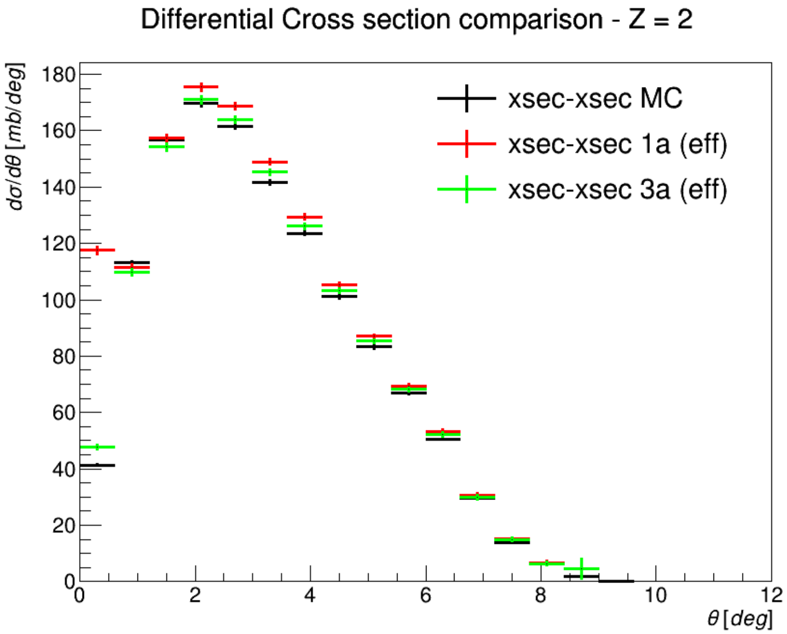
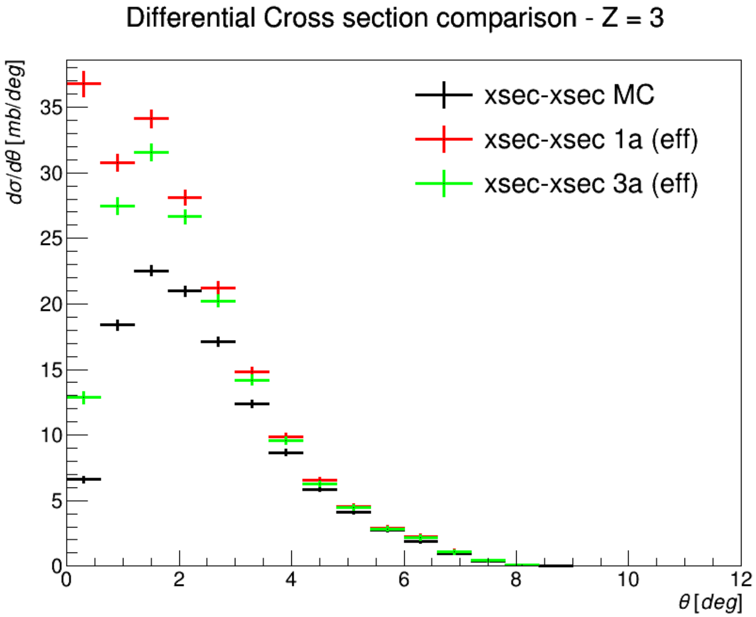


- Largest systematics in the first bins
- purity “corrects” yields of fragments out of target

Cross section

1a) Yield is made by all reconstructed tracks (no MC cuts)
3a) MC TW Match: the most frequent id of the track should be the same of the TW





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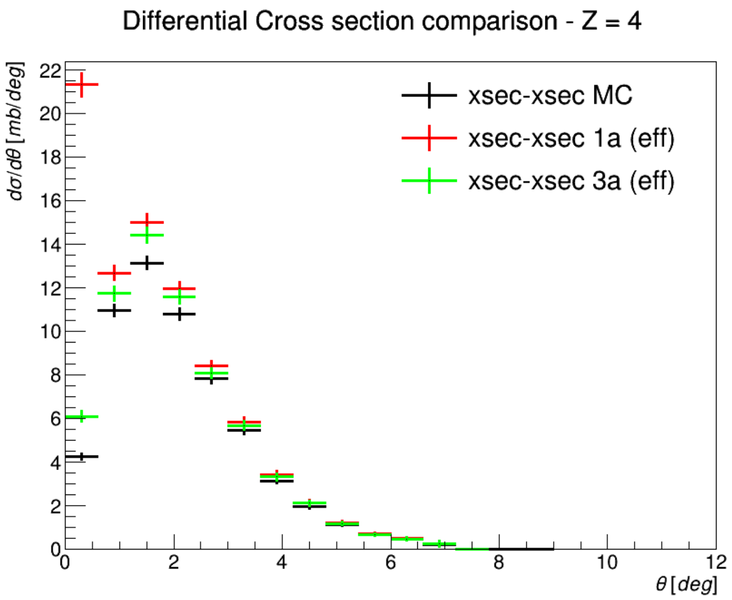

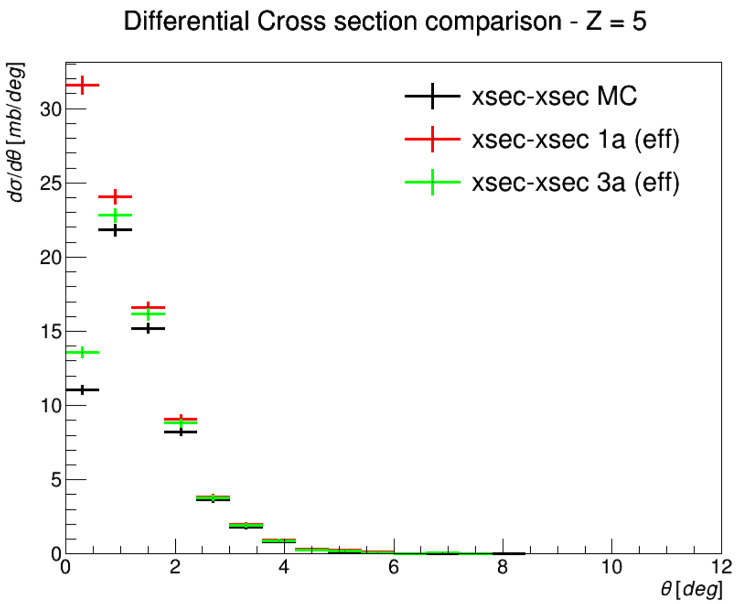

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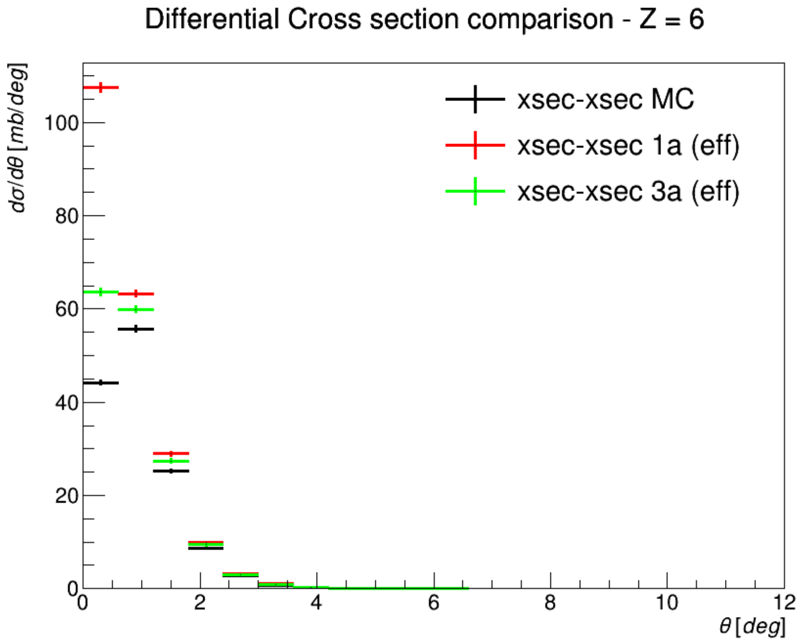

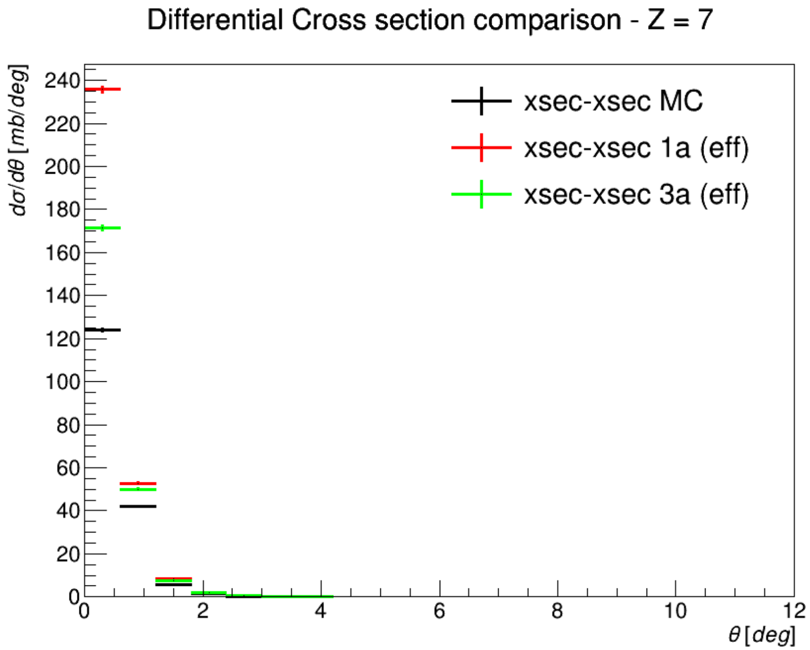

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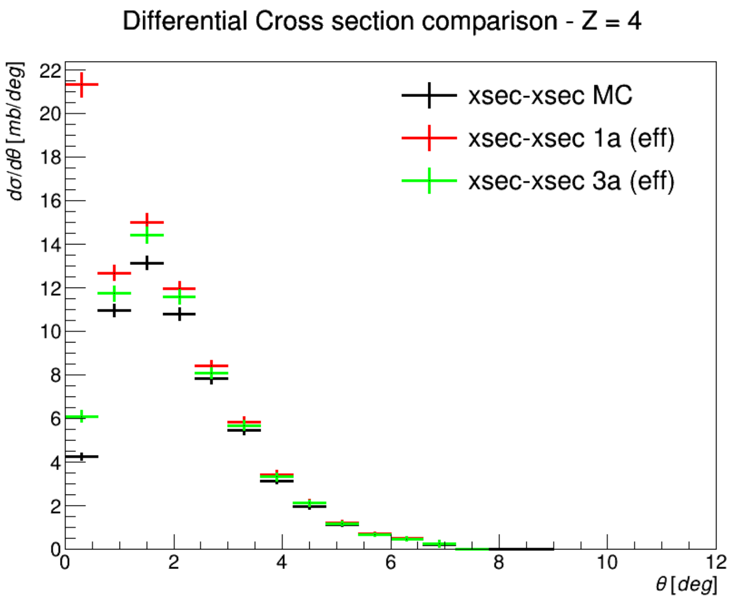
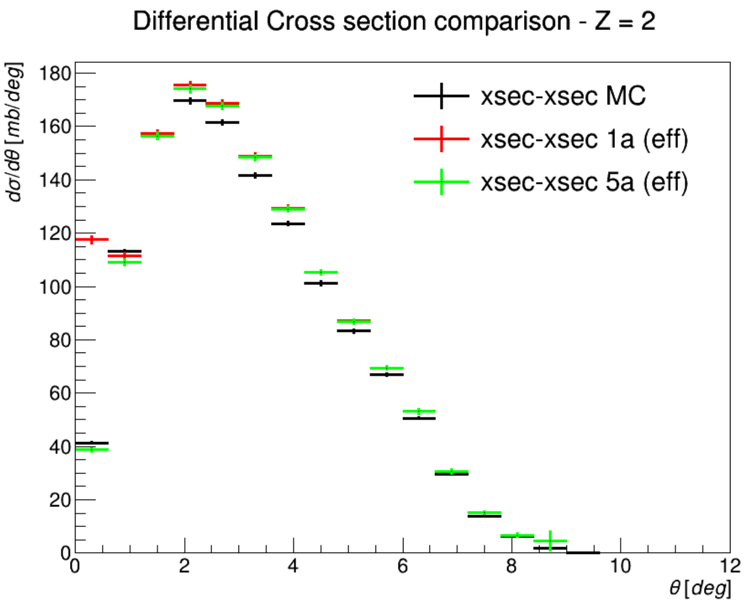
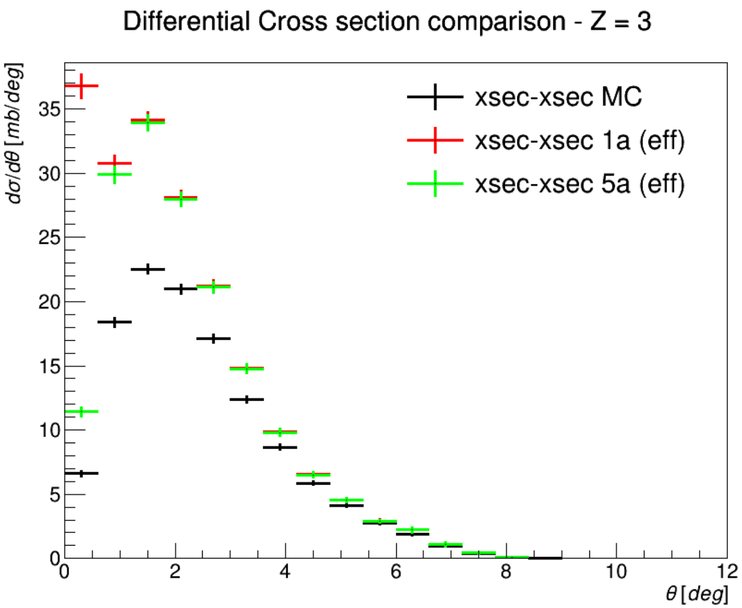


- first bin improved
- tw match “corrects” yields of fragments out of target

Cross section

1a) Yield is made by all reconstructed tracks (no MC cuts)
5a) MC VT Match
no fragmentation between the planes of the VT and good reco by TW





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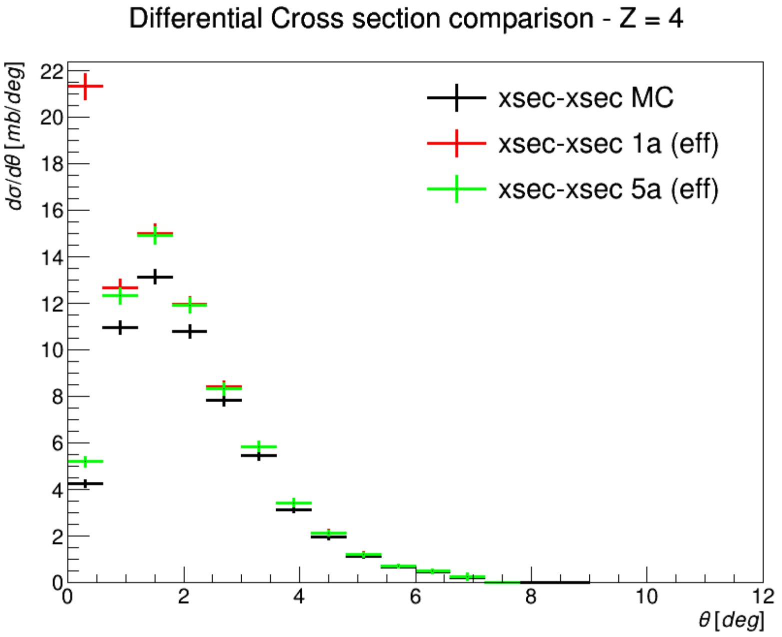

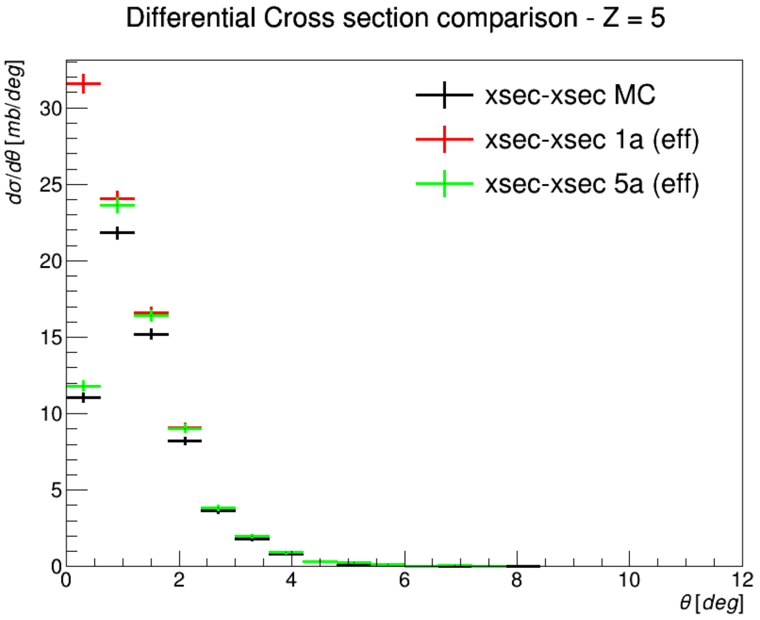

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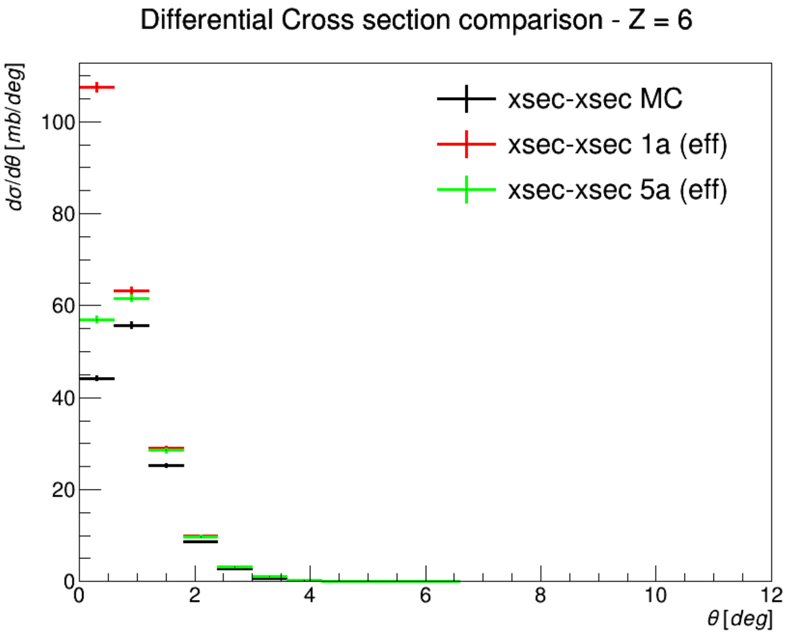

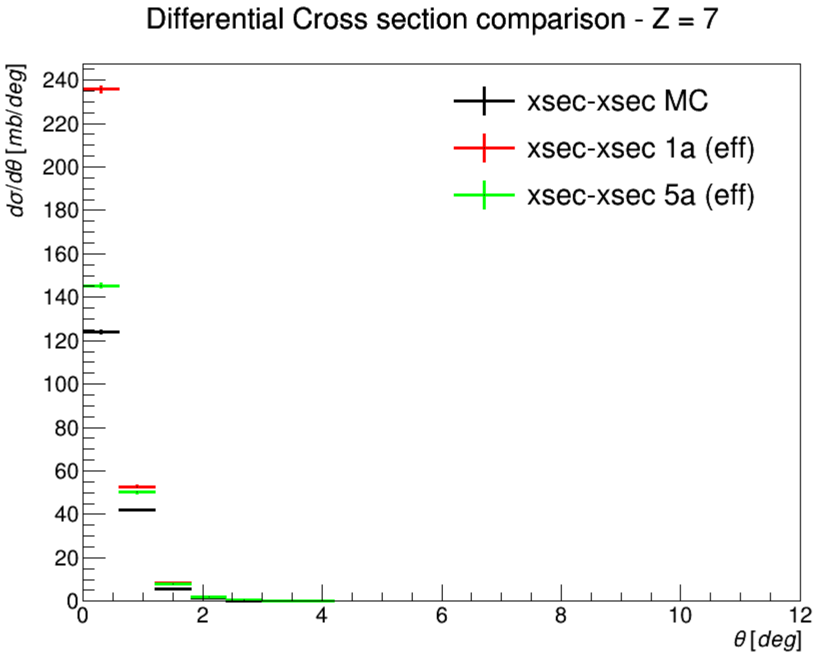

Cross section

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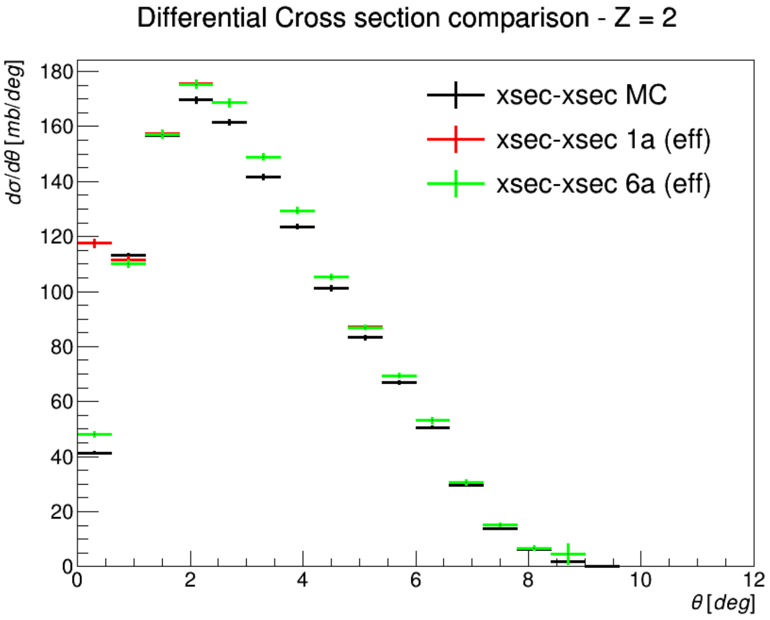
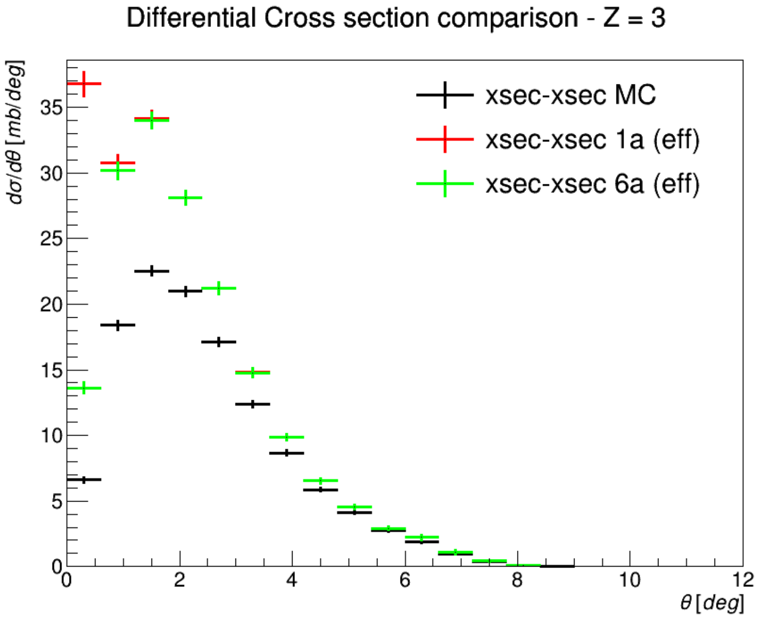
no fragmentation between the planes of the VT and good reco by TW

- fragments on vt have a high impact on first bin

Cross section

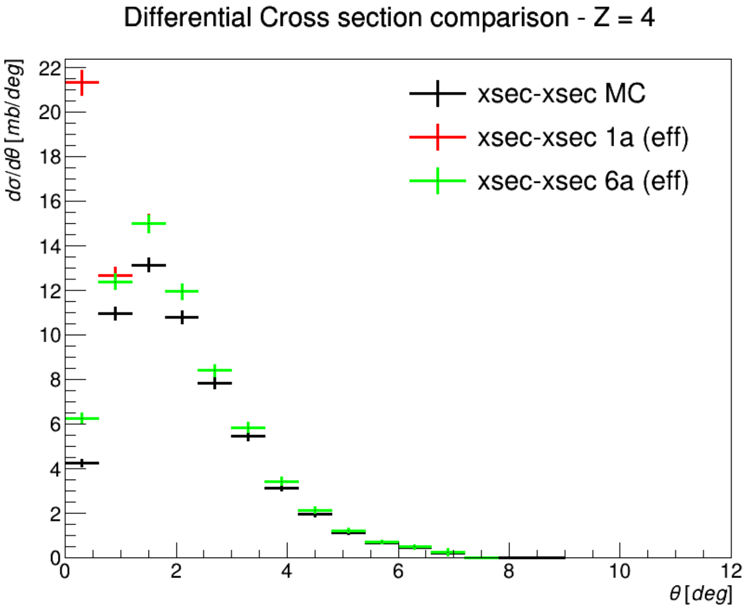
1a) Yield is made by all reconstructed tracks (no MC cuts)
6a) MC MSD Match
    no fragmentation between the planes of the MSD and good reco by TW

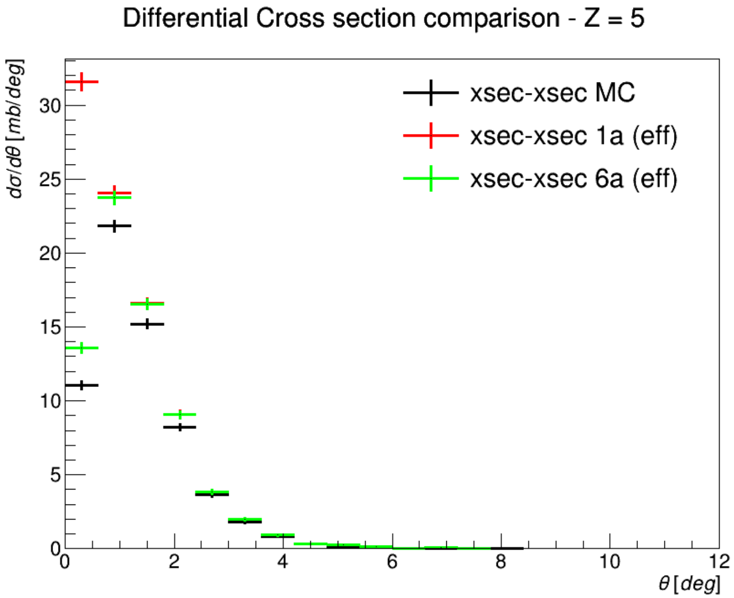




Cross section

1a) Yield is made by all reconstructed tracks (no MC cuts)
6a) MC MSD Match
no fragmentation between the planes of the MSD and good reco by TW





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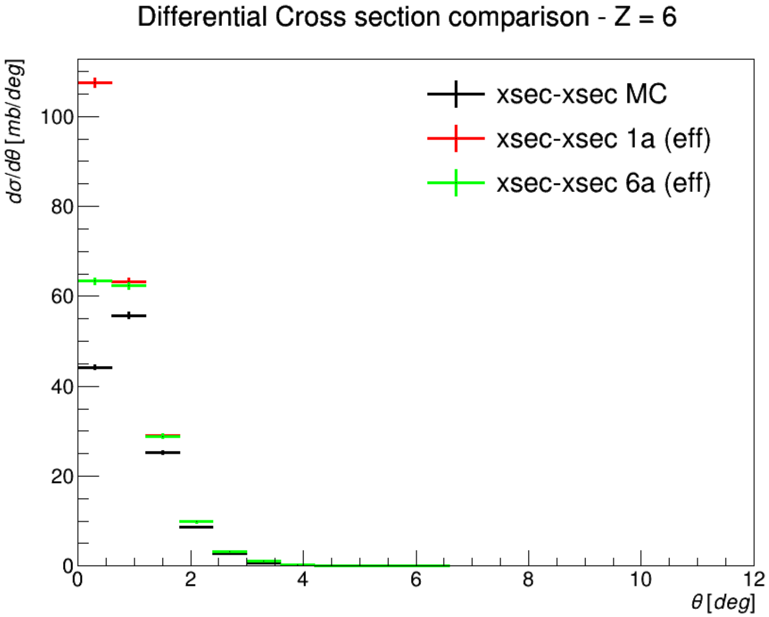
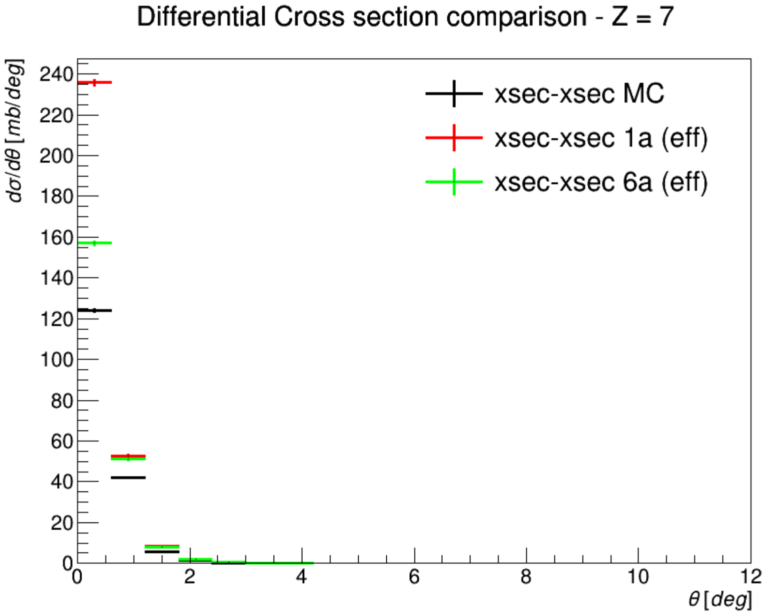
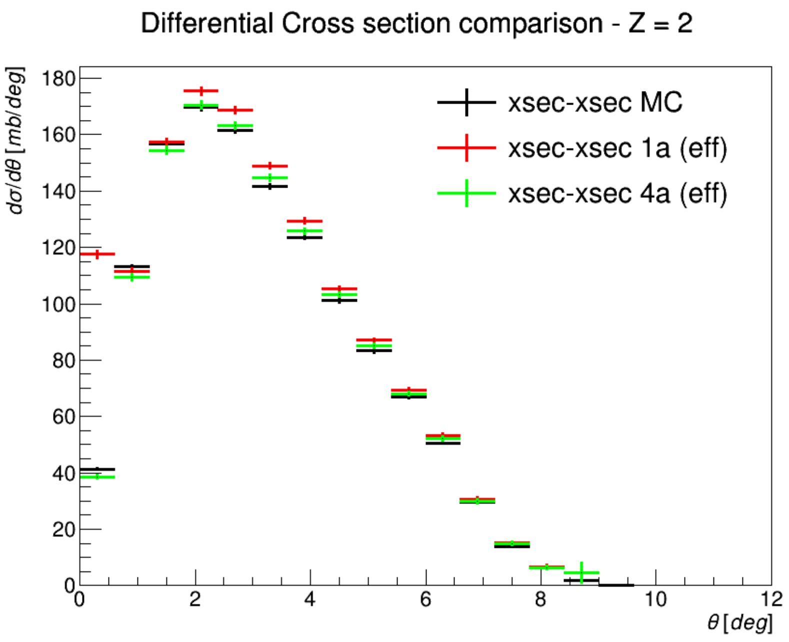
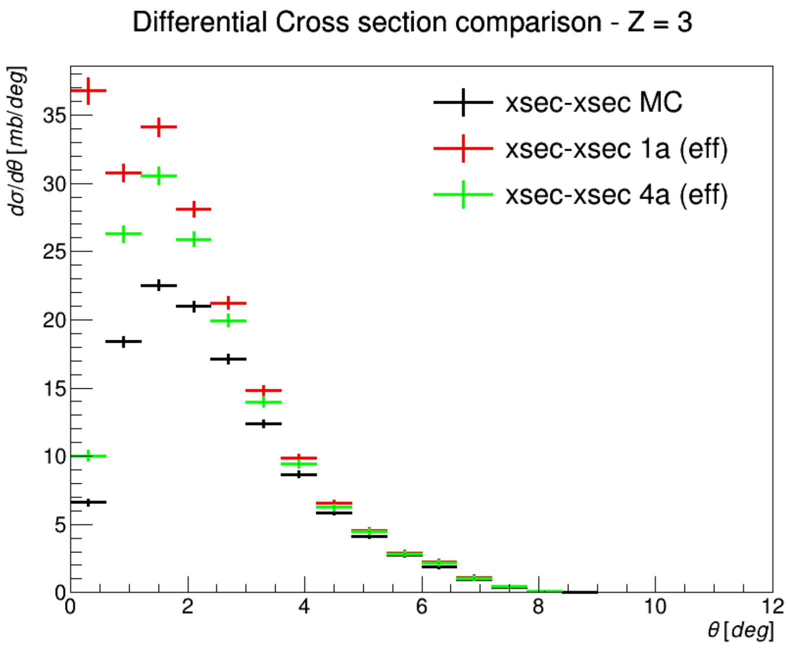




Cross section

1a) Yield is made by all reconstructed tracks (no MC cuts)
4a) Track quality = 1





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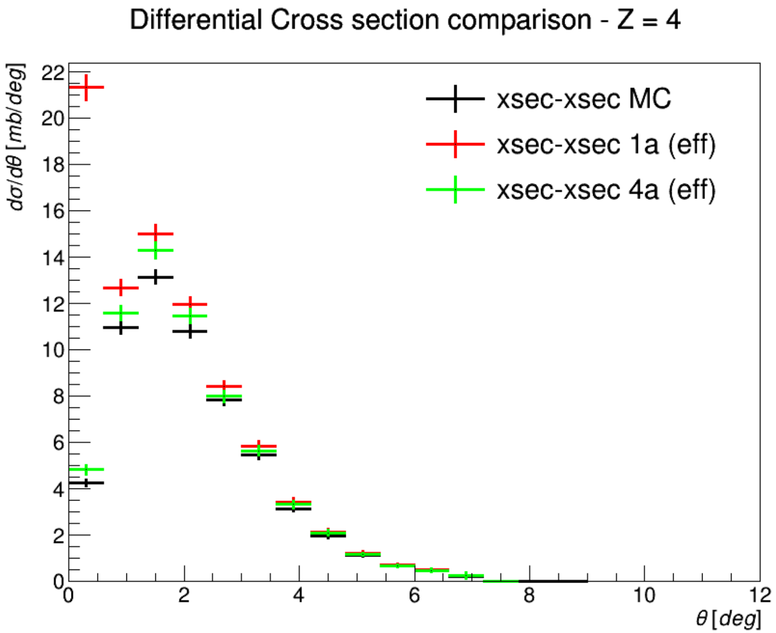

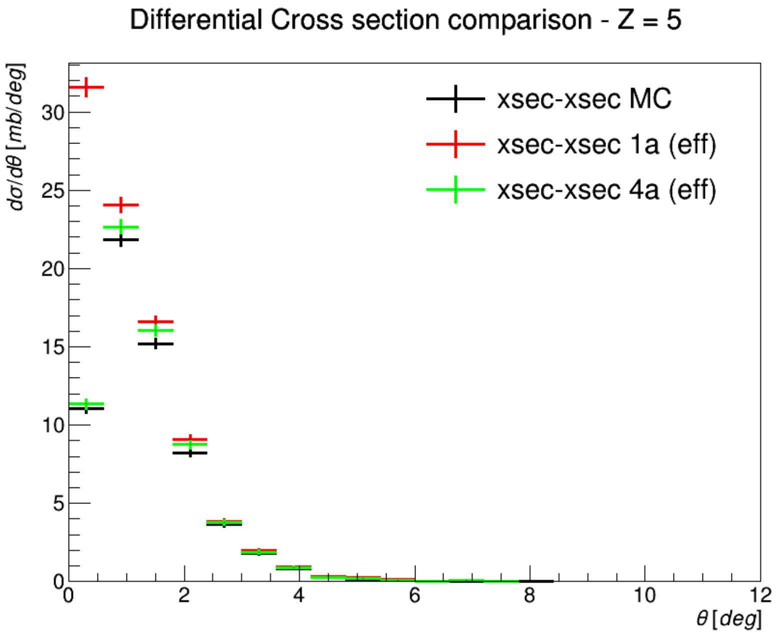

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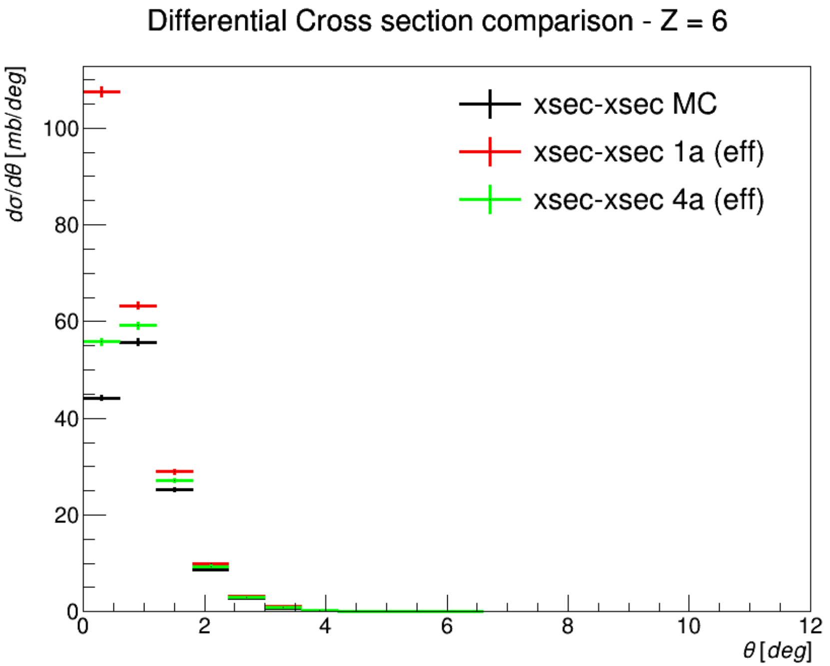
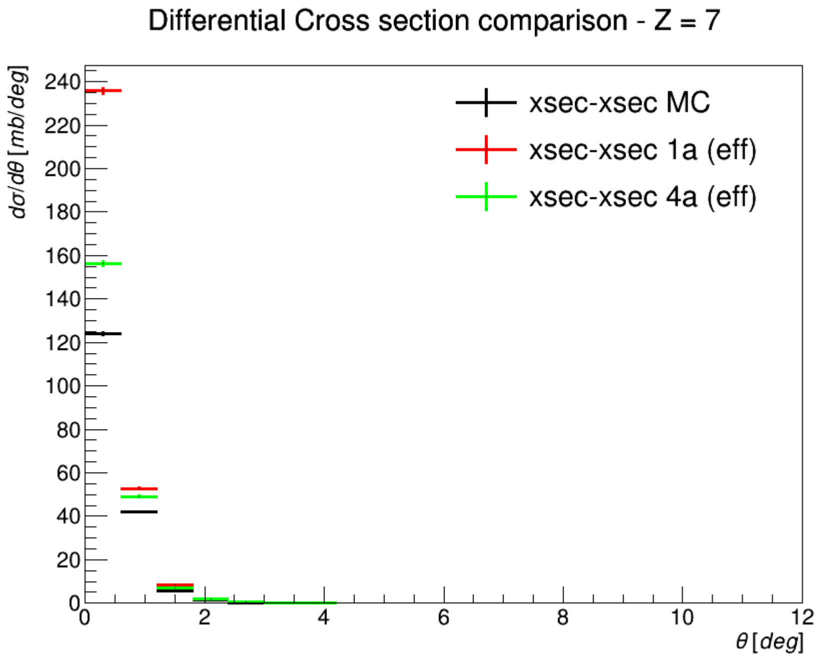
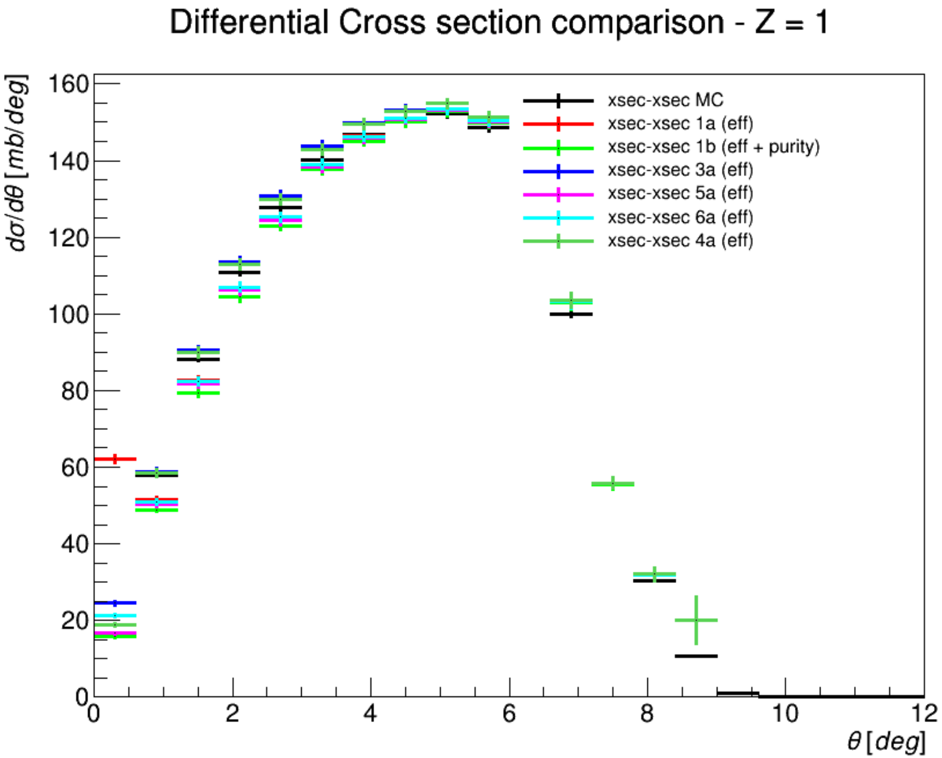


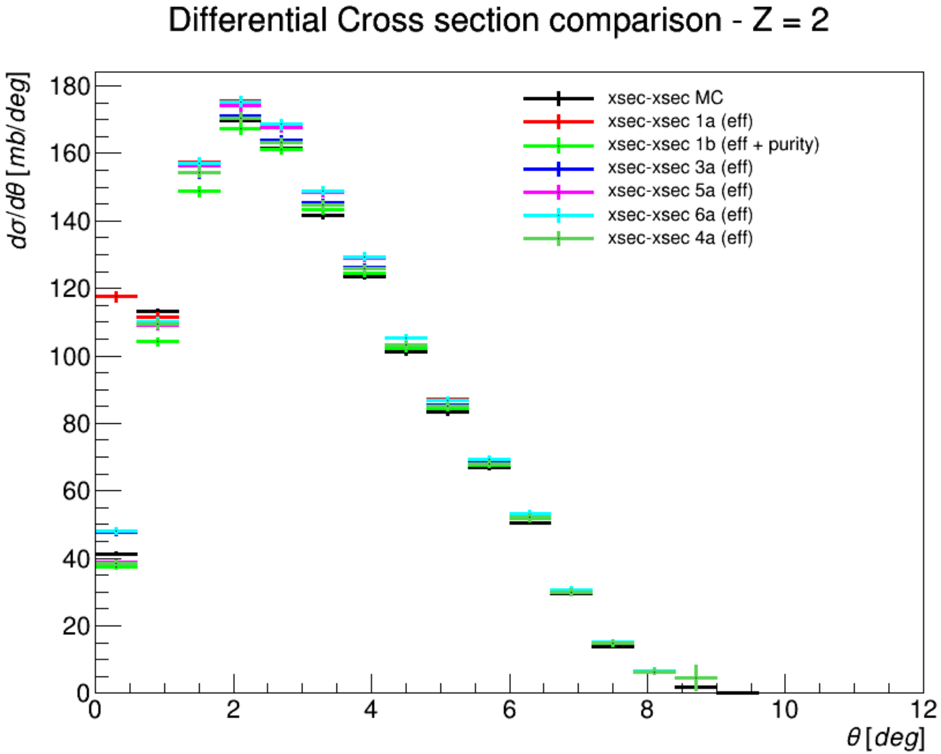


Conclusions

- MC evaluations of Glb Traking for cross section measurements
- Agreement between MC and Reco for **high angles**
- Lower agreement for low angles:
  high contribution from fragmentation out of target
  charge bad reconstruction (purity)
- From MC point of view it is possible to see improvements if inspecting VT and MSD stations
  → **detector reconstruction cuts**
  → **global tracking reconstruction cuts**

Cross section – recap





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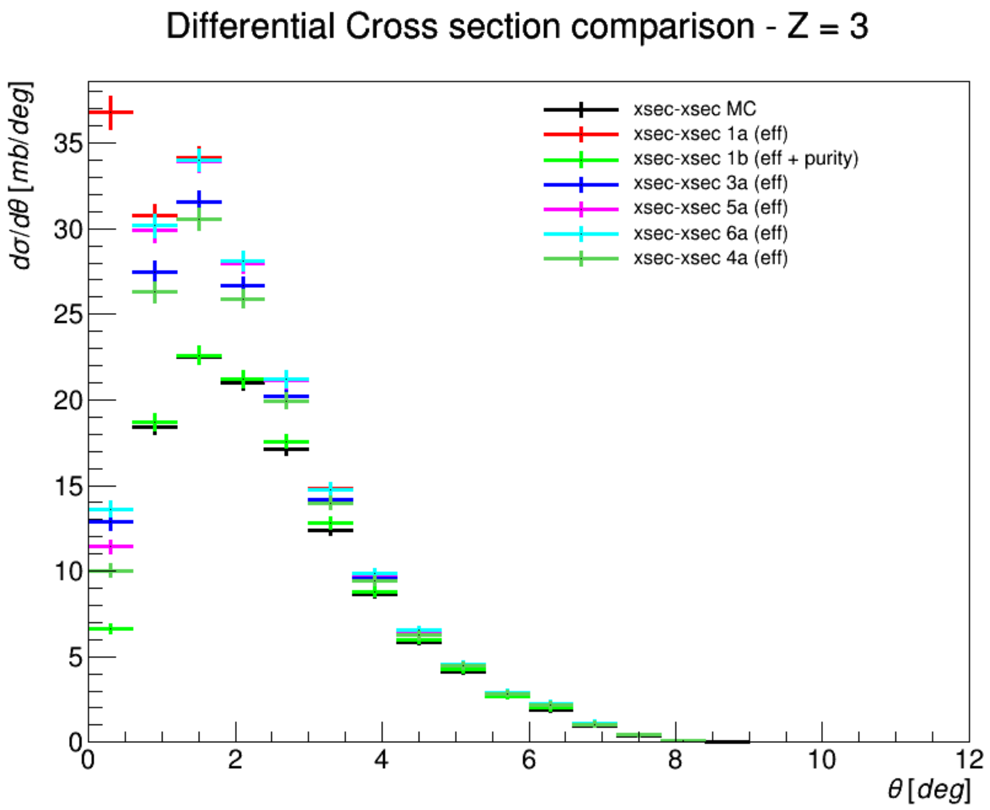

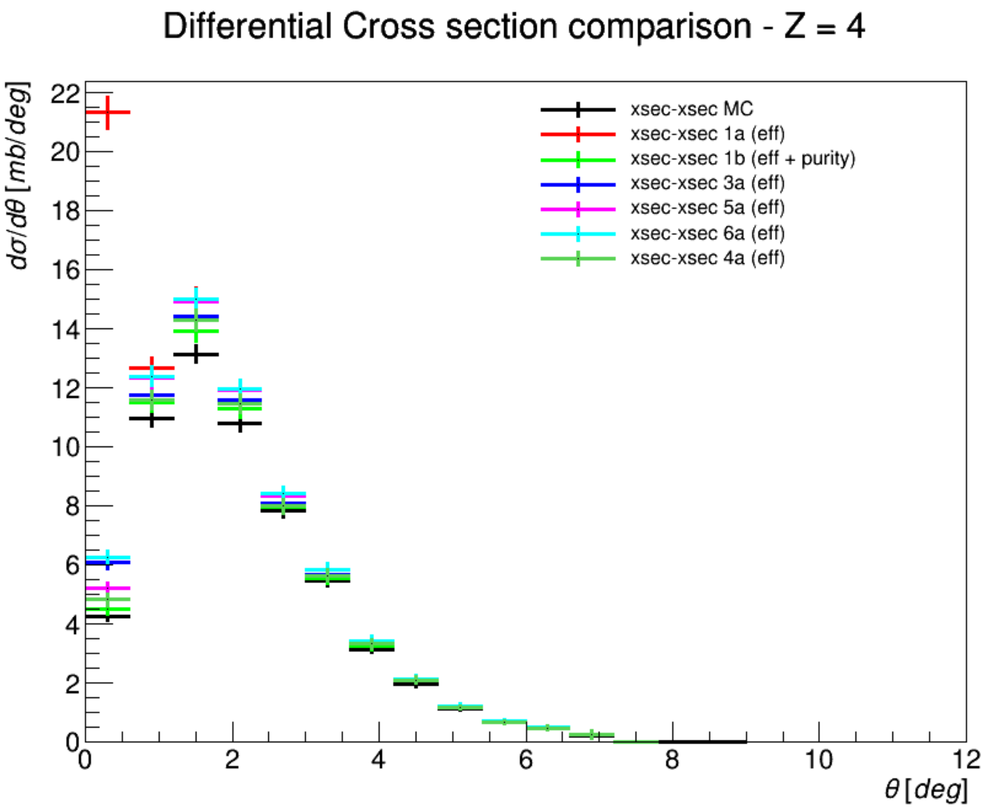

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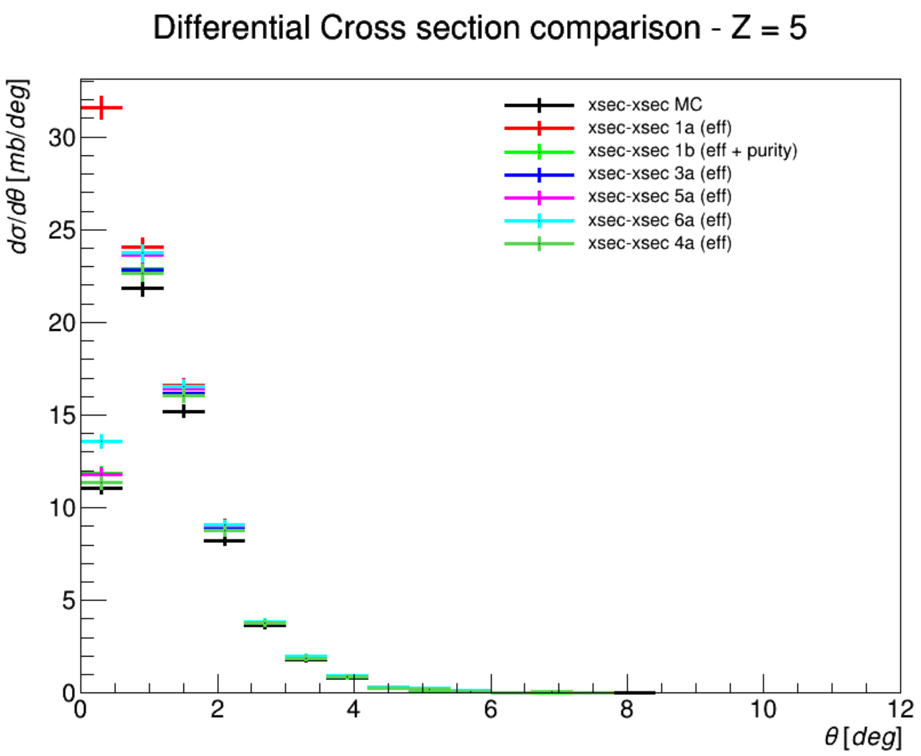

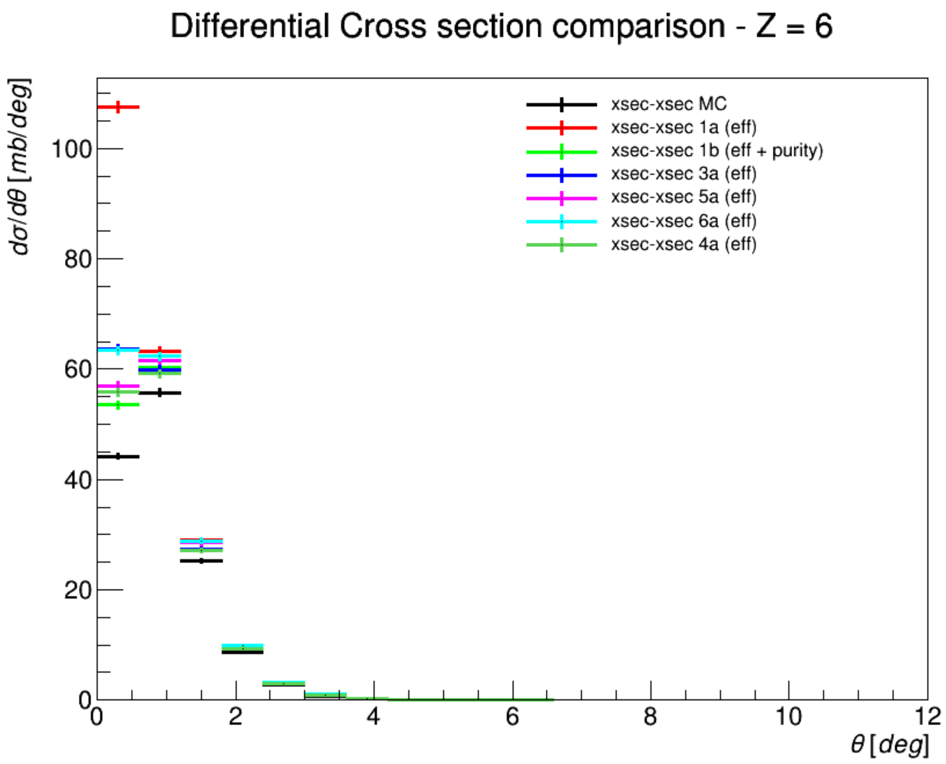

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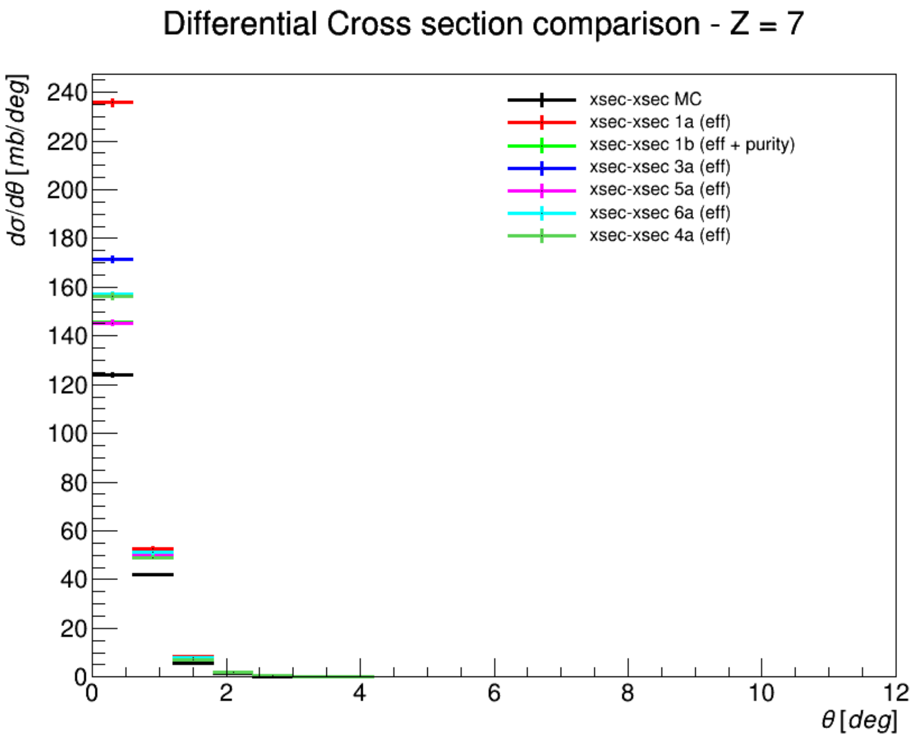

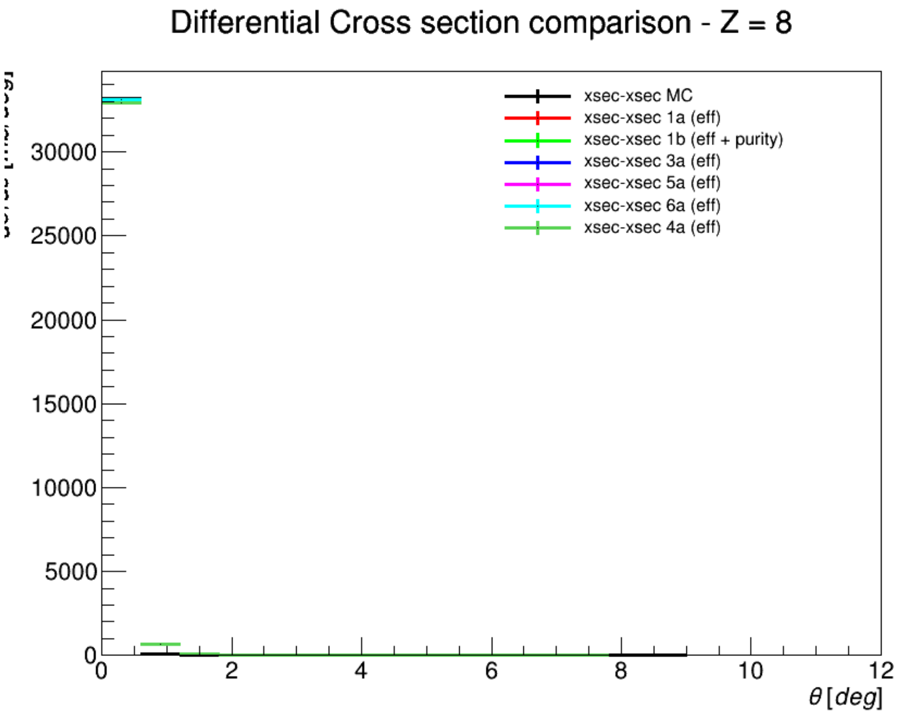

- **Cross section 1a**: yield + efficienza “GoodReco” / Nref

good reco:

```
if (
    (particle_ID == 0                         // if the particle is a primary OR
     || (Mid == 0 && Reg == target_region) // if the particle is a primary fragment born in the target
     ) &&
    particle->GetCharge() > 0 &&
    particle->GetCharge() <= primary_charge && // with reasonable charge
    // Ek_true > 100 &&                         // with enough initial energy to go beyond the vtx    //! is it true?
    // theta_tr <= 30. && // inside the angular acceptance of the vtxt   //!hard coded for GSI2021_MC
    (OldReg >= GetParGeoTw()->GetRegStrip(0, 0) &&
    OldReg <= GetParGeoTw()->GetRegStrip(1, GetParGeoTw()->GetNBars() - 1)) &&
     NewReg == AirAfterTW_region // it crosses the two planes of the TW and go beyond  (one of the bar of the two layers - region from 81 to 120)
)
  return true;
```

- **Cross section 1b:** yield + efficienza “GoodReco” + purity Z TW

```
supersig.Write_Purity("Z_/theta_",["N_Z_measEqualTrue_Th_True","N_Z_meas_Th_True"])
```

- **Cross section 3:** TW match

```
// ==================TWMATCH
TAMCpart *particle = myMcNtuPart->GetTrack(TrkIdMC);
if ((std::find(vecTwTrkId.begin(), vecTwTrkId.end(), TrkIdMC) != vecTwTrkId.end()) // if main track id in twpoint id
```

3a: efficiency

3b: efficiency + purity

- **Cross section 5**: VT MATCH

```
// // ===================VT MATCH
bool VTMatch = true;
bool VTZ8Match = true;

for (int i = 0; i < vecVtZMC.size(); i++)
{
  if (std::find(vecVtZMC.at(i).begin(), vecVtZMC.at(i).end(), 8) != vecVtZMC.at(i).end()) // if the cluster of the VTX contains Z=8
    VTZ8Match = VTZ8Match && true;
  else
    VTZ8Match = VTZ8Match && false;
}

if (VTZ8Match == true) {   // if a primary entered the first layer of the msd and did not fragmented up to its last plane...
  if (Z_meas > 7)    // ... and the charge reconstructed in TW is higher than 7
    VTMatch = true;  // --> it means there is no fragmentation between VTX and up to TW
  else
    VTMatch = false;
}

if ((std::find(vecVtZMC.at(0).begin(), vecVtZMC.at(0).end(), 8) != vecVtZMC.at(0).end()) && (VTZ8Match == false))
// if the first cluster was a Z=8 but then some fragmentation happened...
{
  VTMatch = false;
}
```

5a: efficiency
5b: efficiency + purity

- **Cross section 5**: VT MATCH

```
vecVtZMC.clear();
vecMsdZMC.clear();
for (int i = 0; i < fGlbTrack->GetPointsN(); i++) // for all the points of a track...
{
point  = fGlbTrack->GetPoint(i);

if ((string) point -> GetDevName() == "VT") { //... i take the vt cluster
  vector<Int_t> vecVT_z; // vector of all Z of a cluster of the vtx
  vecVT_z.clear();
  for (int j = 0; j < point->GetMcTracksN(); j++)
  {

    TAMCpart *particleMC = GetNtuMcTrk()->GetTrack(point->GetMcTrackIdx(j));
    vecVT_z.push_back(particleMC->GetCharge());     // i take all the charges of a cluster
  }
  vecVtZMC.push_back(vecVT_z); // and i put all in a vector
}
```

5a: efficiency
5b: efficiency + purity

- **Cross section 6**: MSD MATCH

```
// // ===================MSD MATCH
bool MSDMatch = true;
bool MsdZ8Match = true;

for (int i = 0; i < vecMsdZMC.size(); i++)
{
  if (std::find(vecMsdZMC.at(i).begin(), vecMsdZMC.at(i).end(), 8) != vecMsdZMC.at(i).end()) // if the cluster of the MSD contains Z=8
    MsdZ8Match = MsdZ8Match && true;
  else
    MsdZ8Match = MsdZ8Match && false;
}

if (MsdZ8Match == true ){  // if a primary entered the first layer of the msd and did not fragmented up to its last plane...
    if (Z_meas > 7)   // ... and the charge reconstructed in TW is higher than 7
      MSDMatch = true; // --> it means there is no fragmentation between VTX and up to TW
    else
      MSDMatch = false;
  }

  if ((std::find(vecMsdZMC.at(0).begin(), vecMsdZMC.at(0).end(), 8) != vecMsdZMC.at(0).end()) && (MsdZ8Match == false)) // if the first cl
  {
    MSDMatch = false;
  }

    if (MSDMatch == true)
    {
```

6a: efficiency
6b: efficiency + purity

- **Cross section 6**: MSD MATCH

```
if ((string)point->GetDevName() == "MSD")
{
  //cout << " it is a MSD" << endl;
  vector<Int_t> vecMSD_z; // vector of all Z of a cluster of the vtx
  vecMSD_z.clear();
  for (int j = 0; j < point->GetMcTracksN(); j++)
  {

    TAMCpart *particleMC = GetNtuMcTrk()->GetTrack(point->GetMcTrackIdx(j));
    vecMSD_z.push_back(particleMC->GetCharge());
  }
  vecMsdZMC.push_back(vecMSD_z);
}
```

6a: efficiency
6b: efficiency + purity