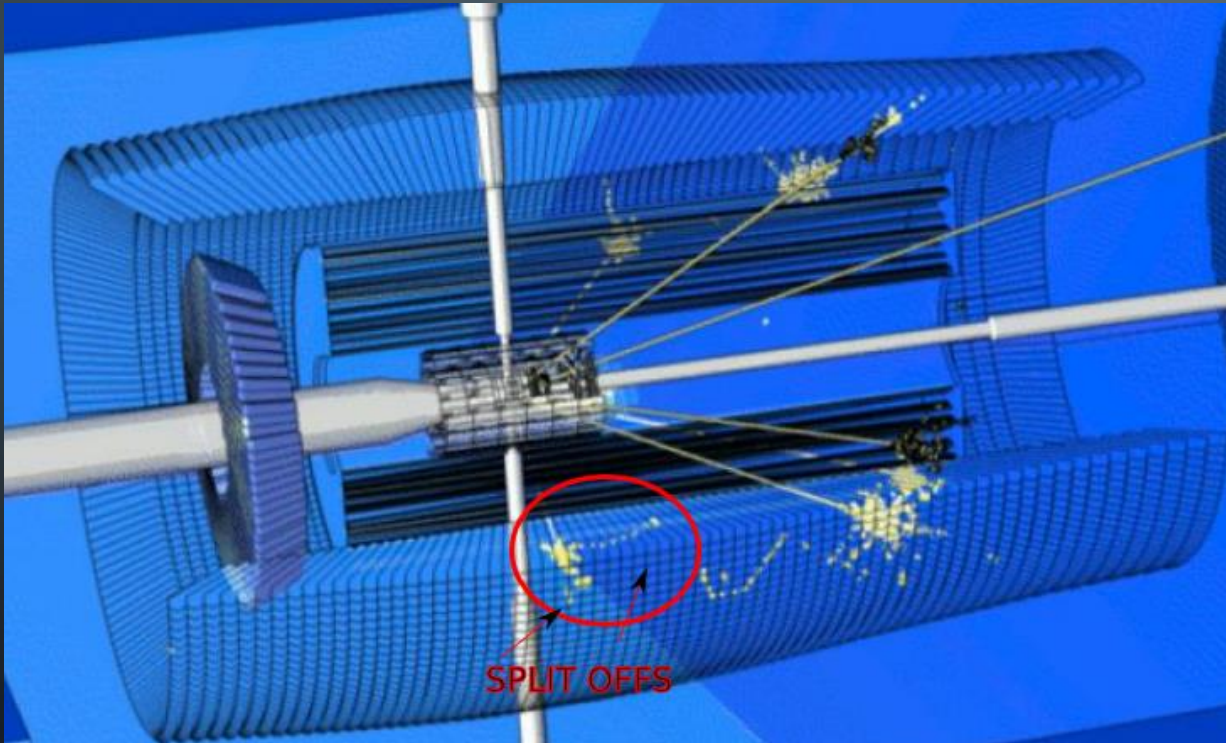




# STUDY OF SPLIT-OFF EVENTS IN PANDAROOT

ÁRON KRIPKÓ

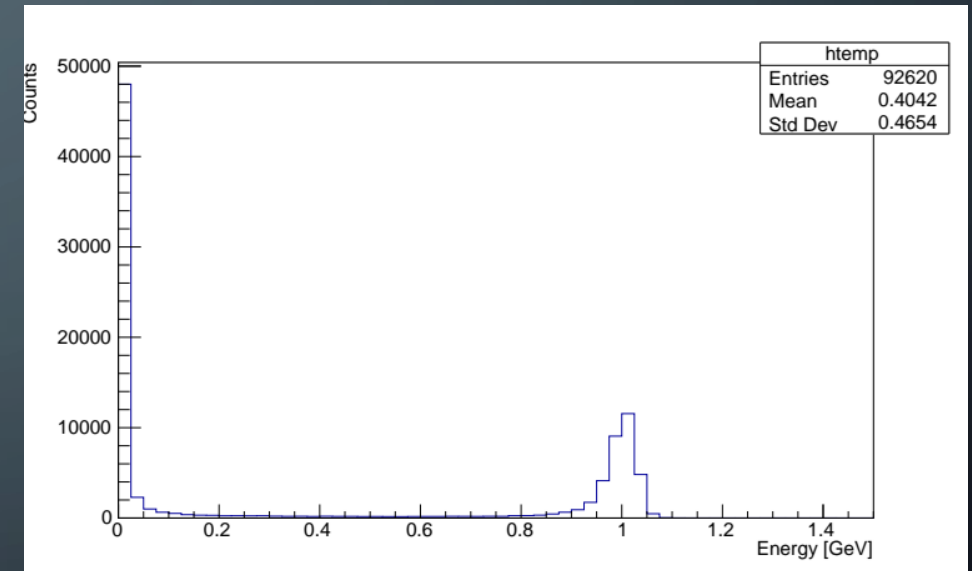
# SPLIT OFFS



- In some cases a secondary maximum is created a few crystals away from the impinging point of the primary photon
- The currently used algorithm usually reconstructs these events as individual photons - wrongly

# THE PROBLEM

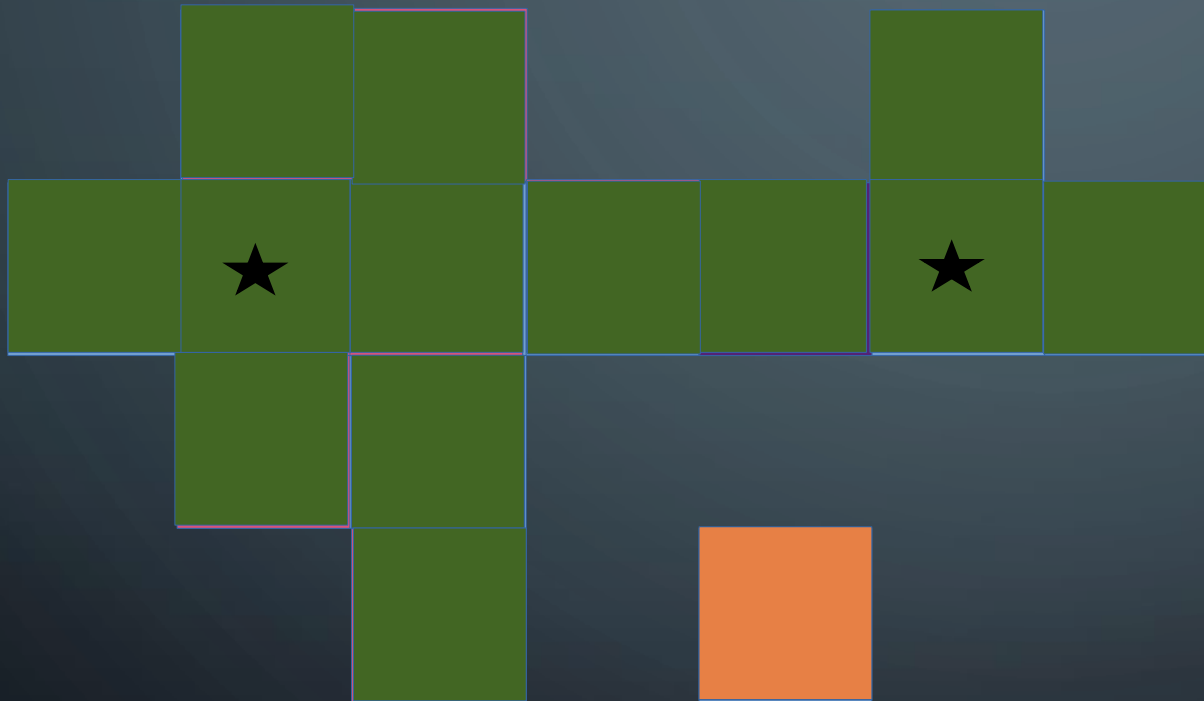
- Many low energy photons are created falsely
- In case of 10000 simulated events, more than 92000 photons are reconstructed



# POSSIBLE SOLUTIONS

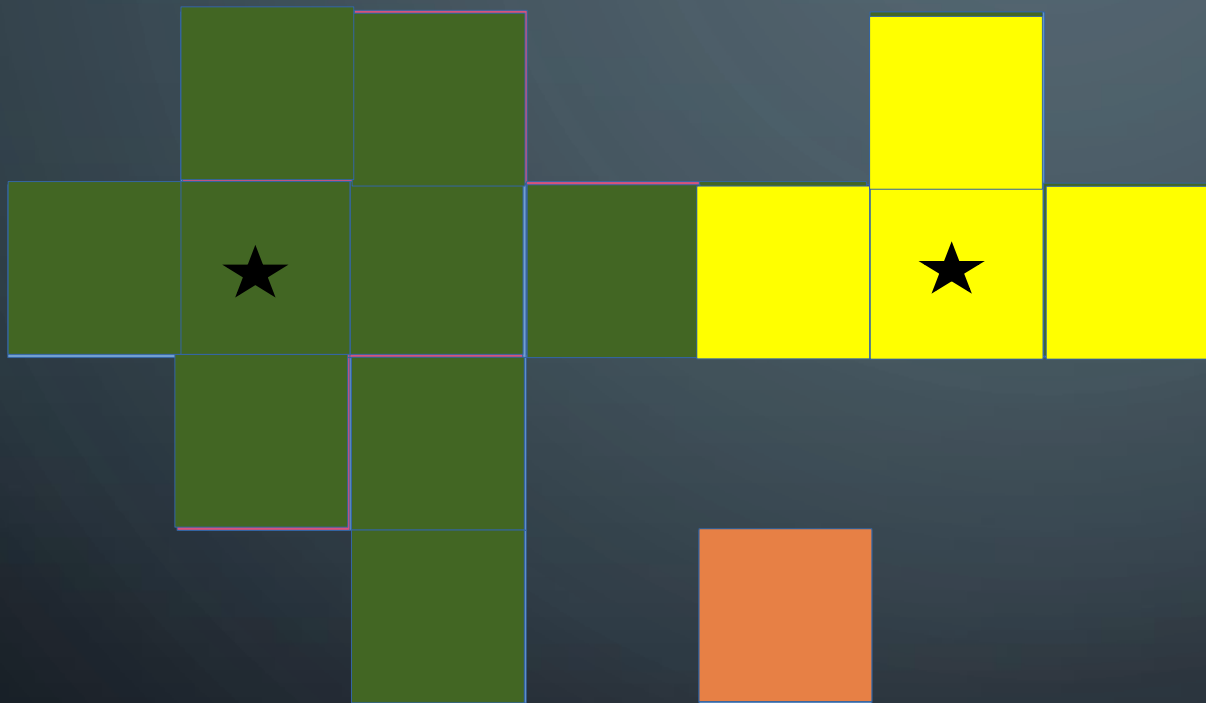
- Modify the default algorithm
  - Merging
- Try out other algorithms:
  - Island algorithm
  - Cellular automaton
- Machine learning

# DEFAULT ALGORITHM



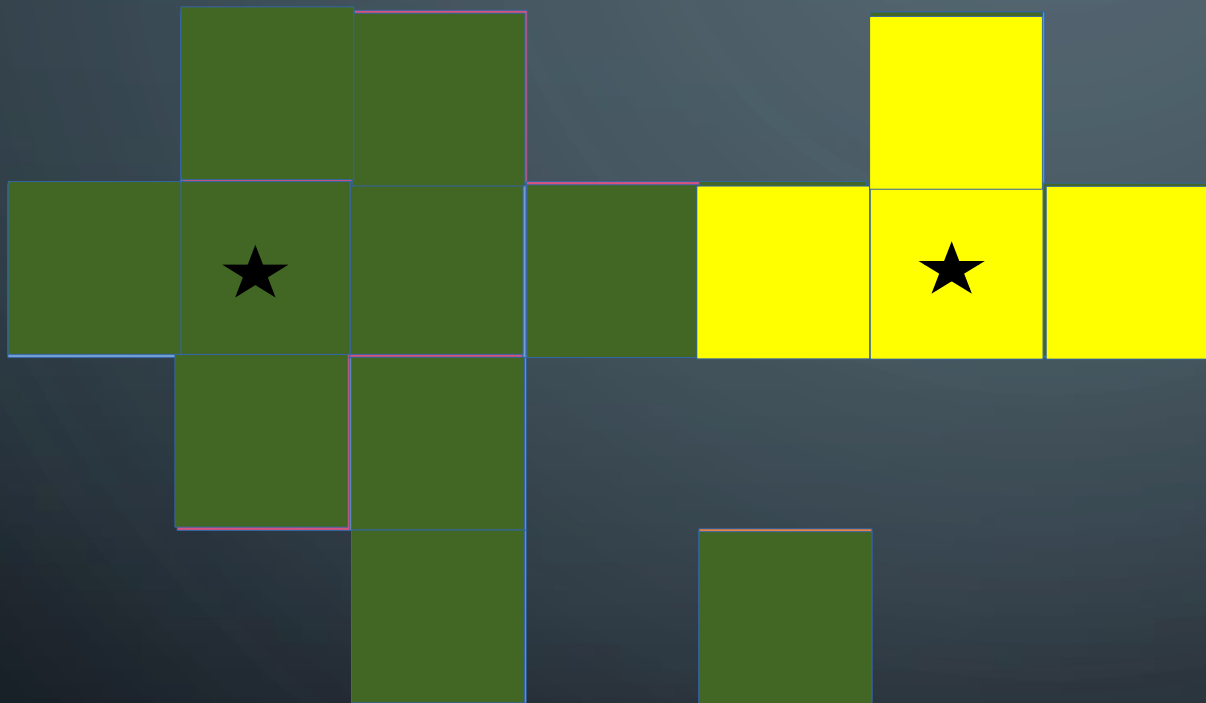
- Loops over all digis
- If one of the neighbors of the digi is in a cluster it puts it into the cluster
- If not a new cluster is created
- If a digi belongs to 2 clusters, the clusters are merged

# DEFAULT ALGORITHM – BUMP SPLITTING



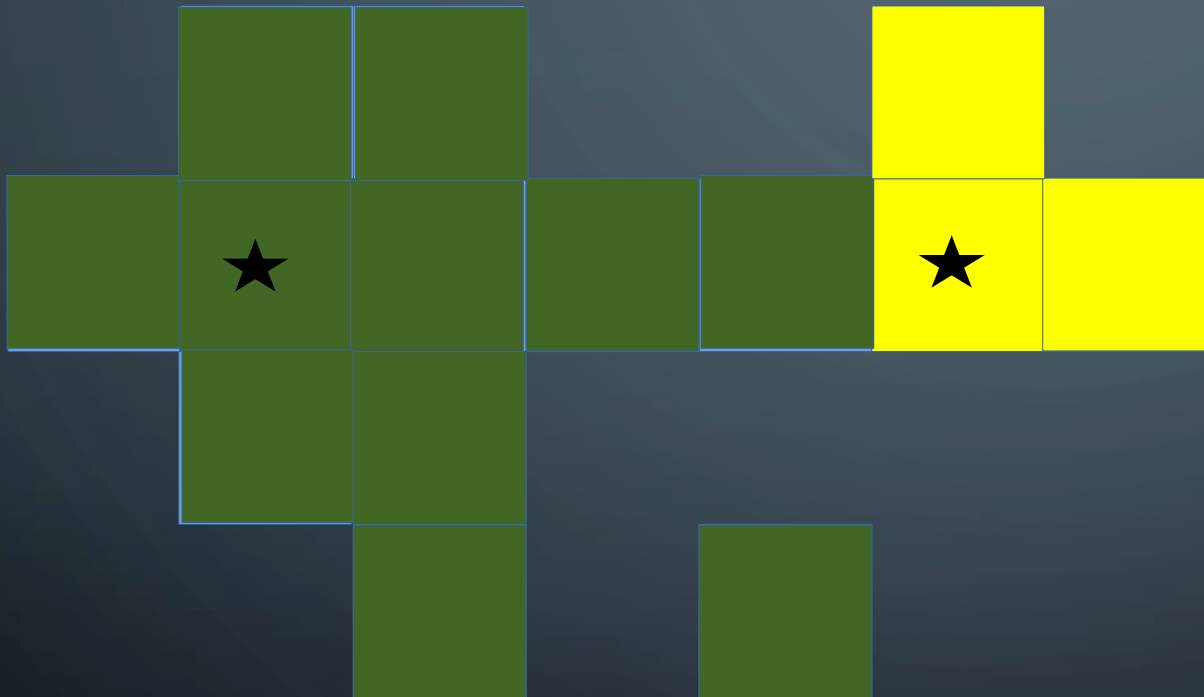
- Based on certain criteria, it splits the created clusters
- Searches for local maxima with a certain condition

# DEFAULT ALGORITHM WITH MERGING



- Before the bump splitting those clusters, which will not be split by the bump splitter are merged

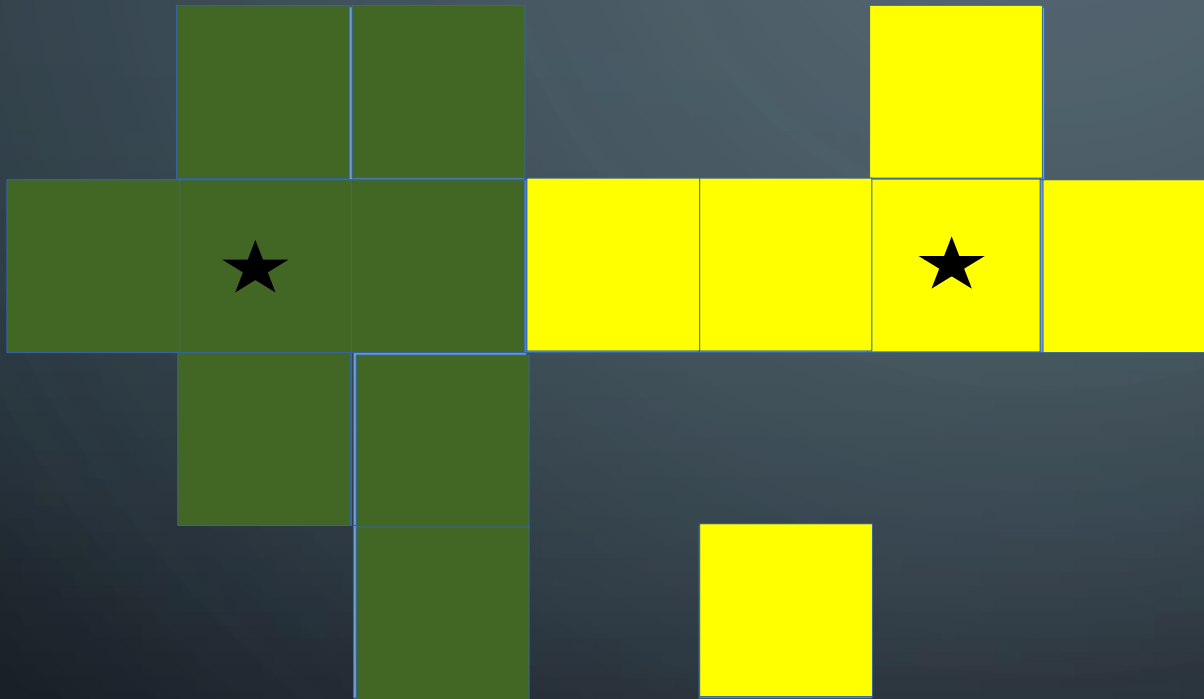
# ISLAND ALGORITHM



- Searches for seeds: local maxima with sufficiently high energy
- Puts digis to the cluster while moving in phi and theta until a rise in energy ( $>5\%$ ) or a hole is found
- The remaining digis are put into the closest cluster



# CELLULAR AUTOMATON



- Searches for seeds as previously
- The cells “infect” their neighbors with their seed-number
- Cells with the same number go to the same cluster
- Unmarked cells in the end are assigned to clusters as previously

# MEASURES OF THE RECONSTRUCTION

- Number of events in the peak – not accurate, depends on the window
- Use the MC information for cluster definition: if a track created a digi, then all digis created by this track or its daughter tracks should be in one cluster and no other digis
- Count the number of digis with the same ID to determine the clusters ID
- Measures:
  - The difference between the numbers of created and reconstructed clusters - event
  - Purity: number of digis with other IDs in the cluster - cluster
  - Completeness: number of digis with the same ID in other clusters - cluster
  - Uniqueness: number of clusters with same ID - event

# RESULTS – 100 EVENTS, 5 GAMMAS/EVT, 5 GEV

Default	Merging	Island	Cellular	
1028	396	381	377	Cluster difference
4915	5484	4669	4214	Purity
39087	9649	8658	8257	Completeness
1123	178	204	177	Uniqueness
393	381	380	392	Counts in 4.7-5.2

## Measures:

The difference between the numbers of created and reconstructed clusters - event

Purity: number of digis with other IDs in the cluster - cluster

Completeness: number of digis with the same ID in other clusters - cluster

Uniqueness: number of clusters with same ID - event

# RESULTS – 100 EVENTS, 5 GAMMAS/EVT, 1 GEV

Default	Merging	Island	Cellular	
448	215	191	189	Cluster difference
1408	1931	2027	1538	Purity
7878	2530	2891	1929	Completeness
563	112	139	94	Uniqueness
356	374	368	372	Counts in 0.95-1.05

## Measures:

The difference between the numbers of created and reconstructed clusters - event

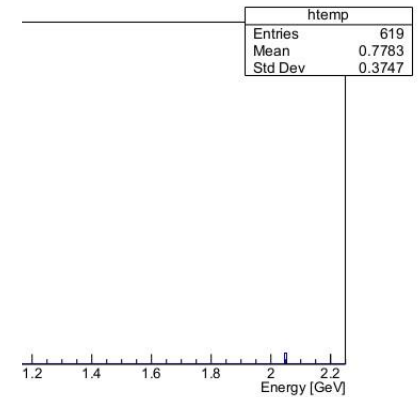
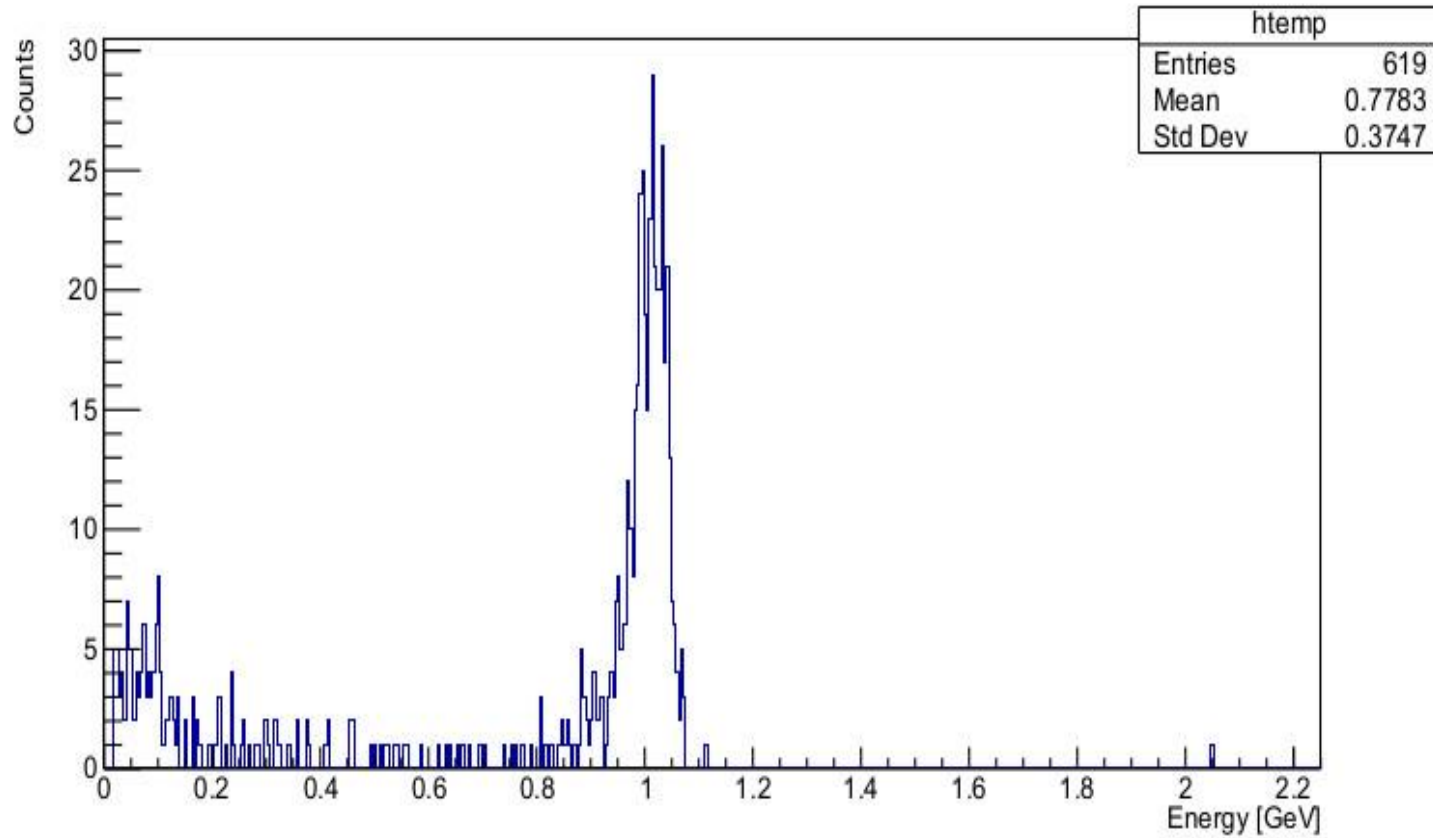
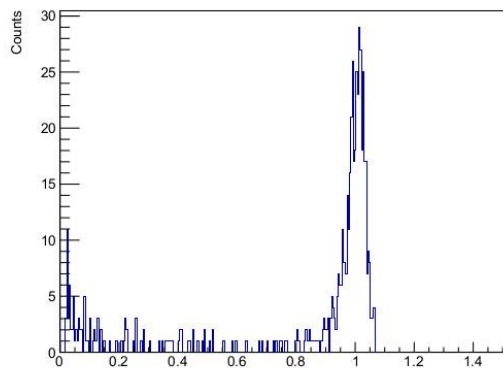
Purity: number of digis with other IDs in the cluster - cluster

Completeness: number of digis with the same ID in other clusters - cluster

Uniqueness: number of clusters with same ID - event

# PEAK SH

## Merging



# RESULTS – 10000 EVENTS, 5 GAMMAS/EVT, 5 GEV

Default	Merging	Island	Cellular	
106919	36593	35585	36049	Cluster difference
491221	549496	455822	428613	Purity
3831232	916144	889954	876243	Completeness
114508	18550	20927	19483	Uniqueness

## Measures:

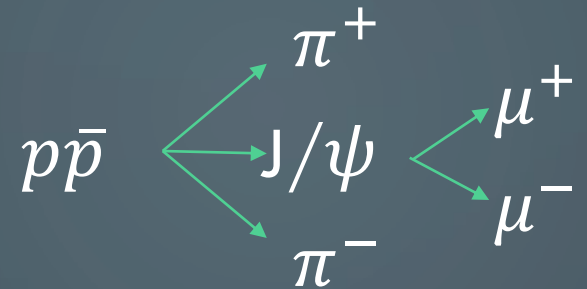
The difference between the numbers of created and reconstructed clusters - event

Purity: number of digis with other IDs in the cluster - cluster

Completeness: number of digis with the same ID in other clusters - cluster

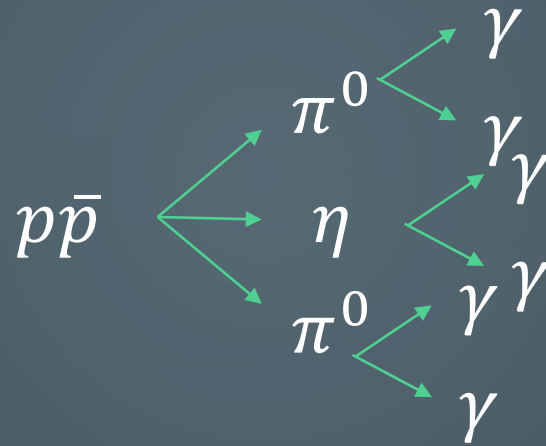
Uniqueness: number of clusters with same ID - event

# DECAYS



Default	Merging	Island	Cellular	
387	128	160	160	Cluster difference
62	234	475	333	Purity
4721	1499	2760	2162	Completeness
388	161	202	159	Uniqueness

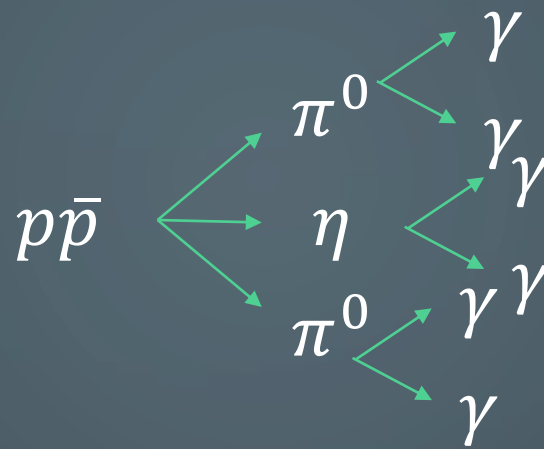
# DECAYS



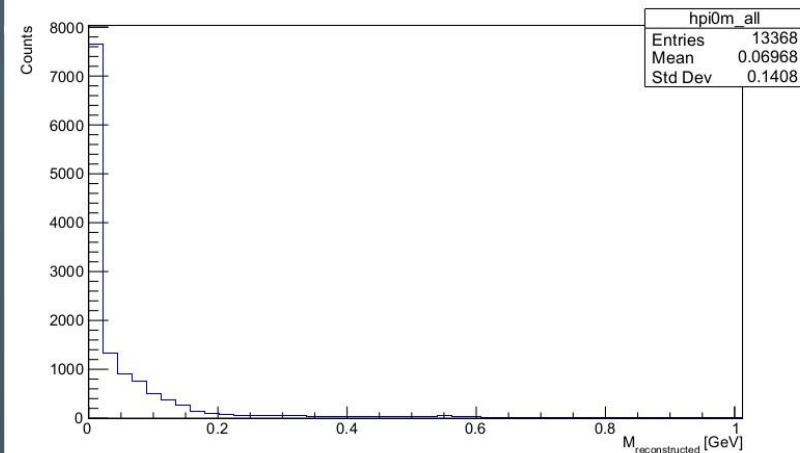
Default	Merging	Island	Cellular	
655	425	428	427	Cluster difference
2062	2603	2380	1680	Purity
13271	4163	6523	5042	Completeness
787	207	317	231	Uniqueness



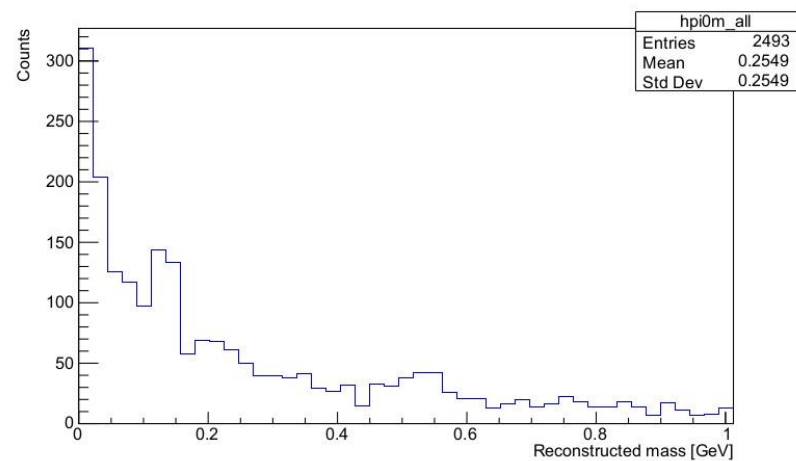
# DECAYS



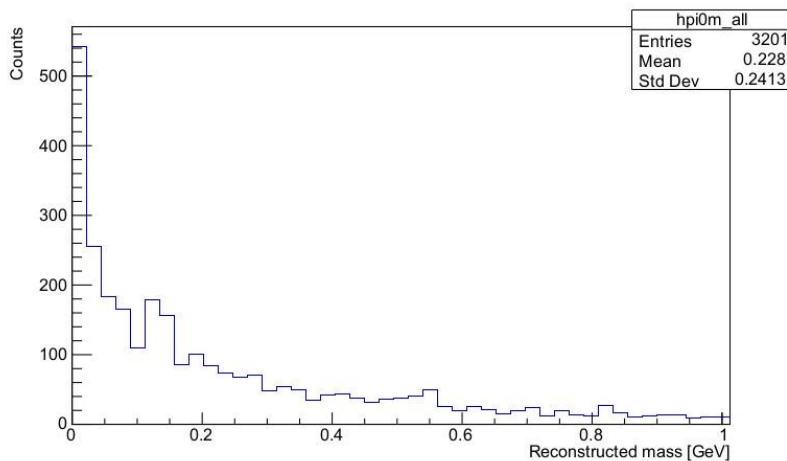
## Default



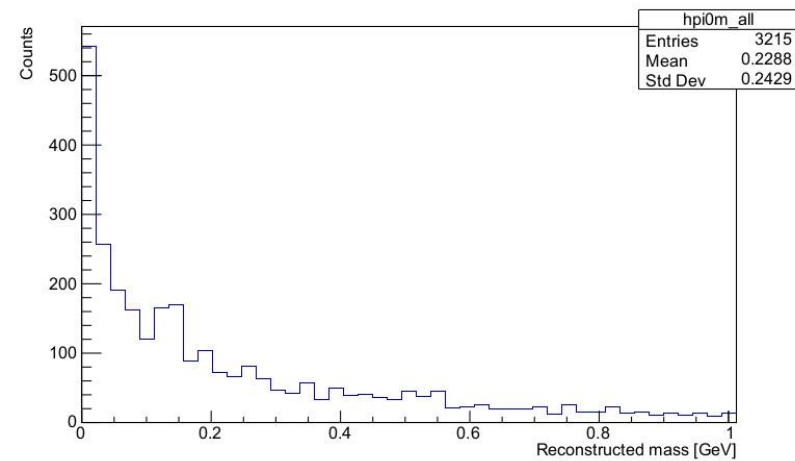
## Merging



## Island



## Cellular



# CONCLUSIONS

- Split off events create high combinatorial background
- All newly implemented algorithms are better than the default one
- They perform almost the same – the user should decide which to use
- Further studies are needed

# PLANS

- Currently working on machine learning
- Algorithms:
  - Benchmarking
  - Optimization
  - A wrapper class for all
- Try other algorithms
- Experiment with other neighbor definitions

