Event size assessment for supporting L0 DAQ scheme development

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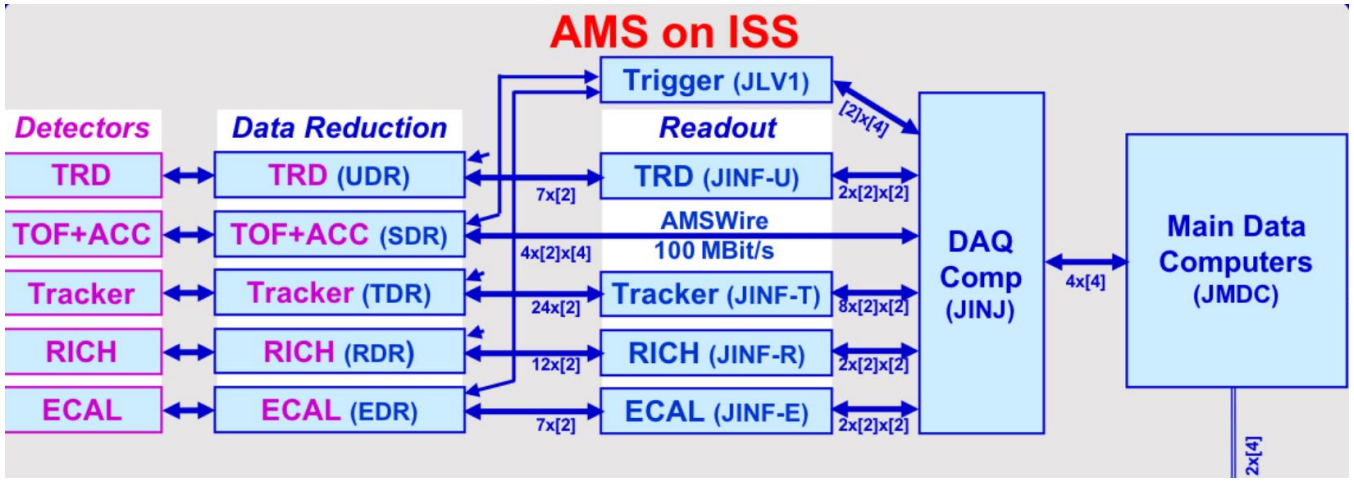
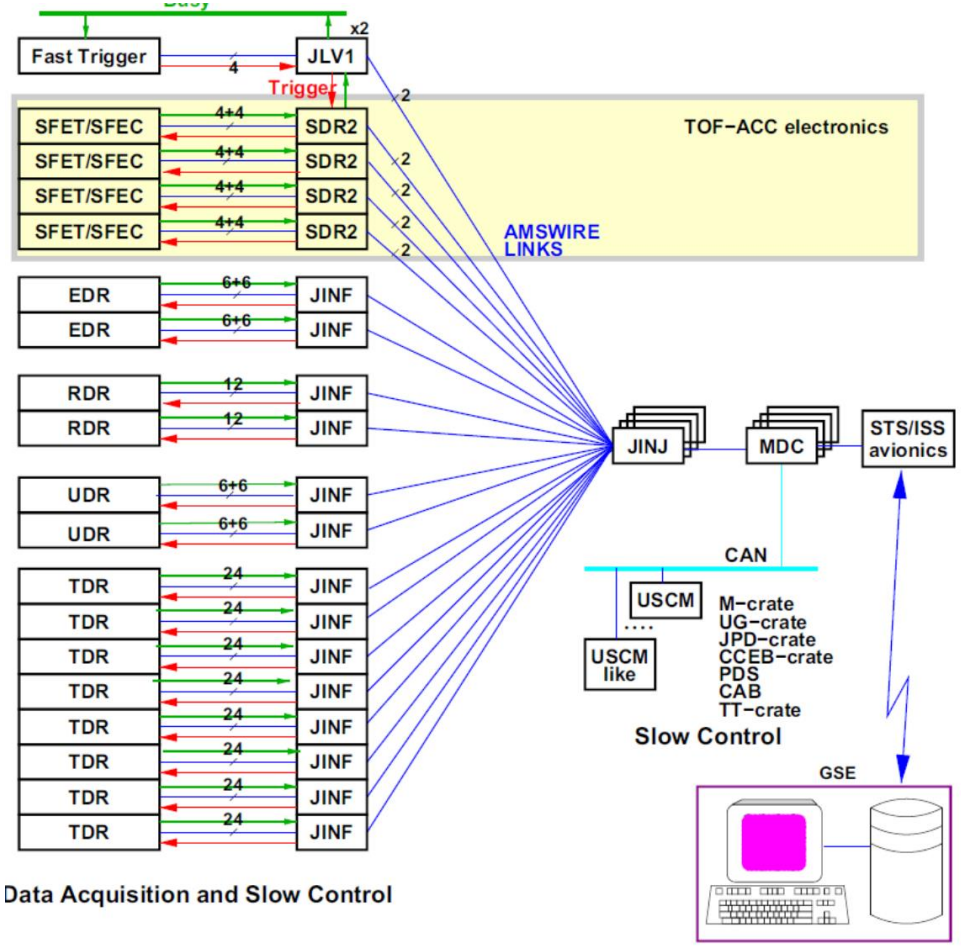
Introduction: current AMS DAQ scheme



1. Data from sub-detectors are processed by data reduction computers, and collected by readout computers.



2. After collection and reduction, the data from 24 ports (JINF, SDR, and JLV1) are combined in DAQ computers (JINJ).

Introduction: JINJ

- **JINJ buffer size: 24500 bytes.**
- **To avoid data truncation for heavy nuclei study, more than 1 JINJ are used after Feb 26, 2016:**

Run and Time Selection

Start Run	Date	Major changes of the detector configurations
1305853512	May 20/2011	1 JINJs, ACC<5 for HZ trigger
1311258168	Jul 21/2011	change Tracker DAQ: second step calibration (big efficiency increase)
1385487767	Nov 26/2013	change TOF configuration and HV: UTOF (S0,S1) to A side, LTOF (S2,S3) to B side
1456503197	Feb 26/2016	2 JINJs, ACC<8 for HZ trigger
1582034309	Feb 18/2020	4 JINJs, ACC<8 for HZ trigger
1582037855	Feb 18/2020	4 JINJs, no ACC constraint for HZ trigger
1620025528	May 03/2021	polarization-photon trigger, 4 JINJs, ACC<8 for HZ trigger
1635856717	Nov 02/2021	4 JINJs, no ACC constraint for HZ trigger
1675341999	Feb 02/2023	4 JINJs, ACC<8 for HZ trigger

+ A few runs between [1305853512, 1456503197) with 2JINJs

current	JINJ-1		JINJ-2	
new	JINJ-0	JINJ-1	JINJ-2	JINJ-3
Names	daqjlen[16] JINFT-4 daqjlen[17] JINFT-5 daqjlen[22] JINFT-6 daqjlen[23] JINFT-7	JINFR-0 [10] JINFR-1 [11] SDR-2A [18] SDR-2B [19] SDR-3A [20] SDR-3B [21] JINFU-0 [2] JLV1-A [14]	JINFE-0 [12] JINFE-1 [13] SDR-0A [4] SDR-0B [5] SDR-0A [6] SDR-0B [7] JINFU-1 [8] JLV1-B [15]	JINFT-0 daqjlen[3] JINFT-1 daqjlen[0] JINFT-2 daqjlen[2] JINFT-3 daqjlen[1]

Old (2 JINJs)	JINJ-1		JINJ-2	
Current (4 JINJs)	JINJ-0	JINJ-1	JINJ-2	JINJ-3
Names	JINFT-4 JINFT-5 JINFT-6 JINFT-7	JINFR-0 JINFR-1 SDR-2B SDR-3B JINFU-0	JINFE-0 JINFE-1 SDR-0A SDR-1A JINFU-1 JLV1-B JINFT-3	JINFT-0 JINFT-1 JINFT-2

18.02.2020

JINJ (from Jiayu Hu)

Motivation of this study:

check event size with current data for supporting L0 DAQ scheme development.

Outline

Event size check:

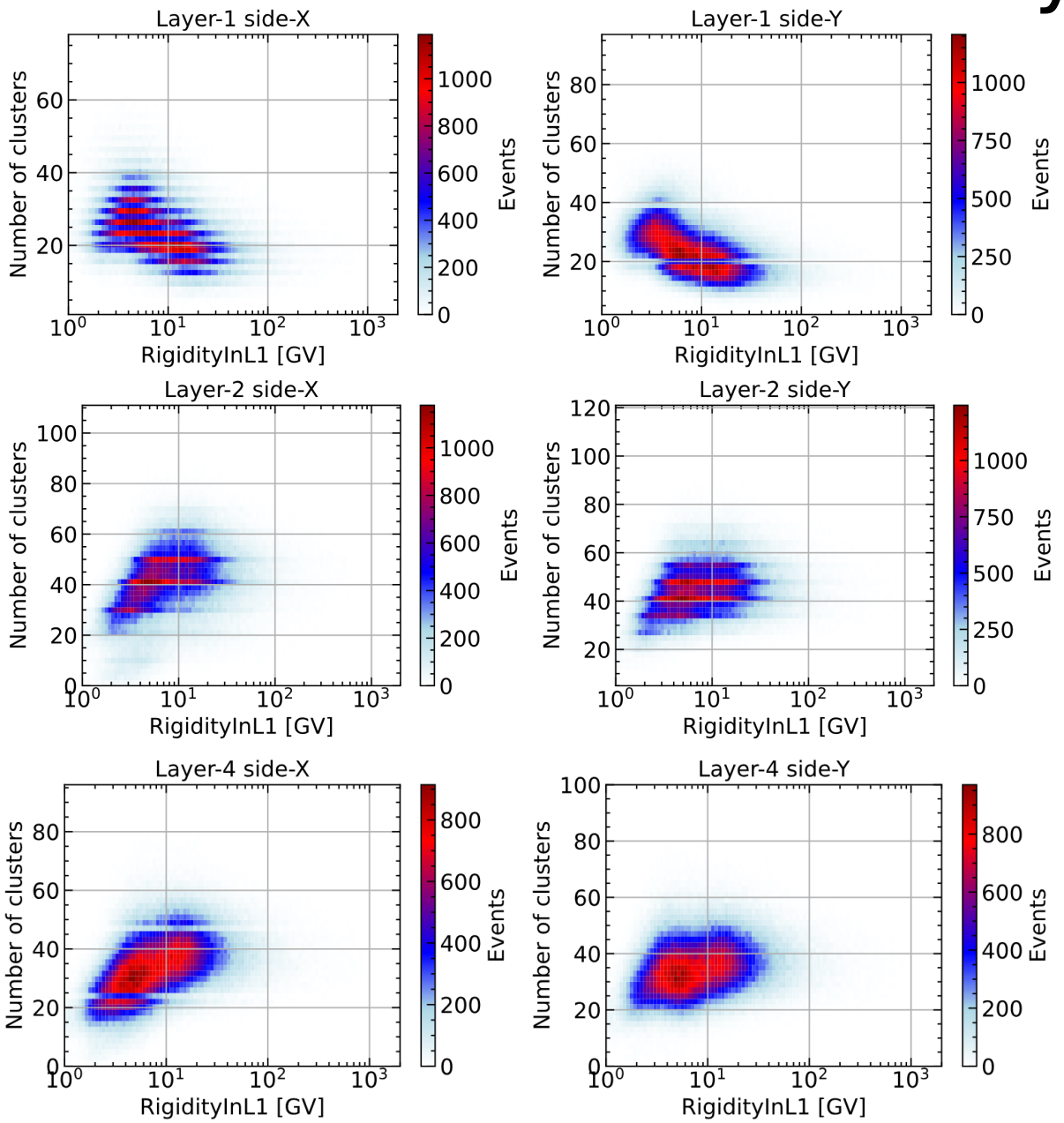
1. Tracker cluster information
2. 4 JINJ event size
3. 24 JINJ ports event size
4. Sub-Detector event size
5. Redistribute event to 3 JINJs

Part-1, Tracker Cluster information

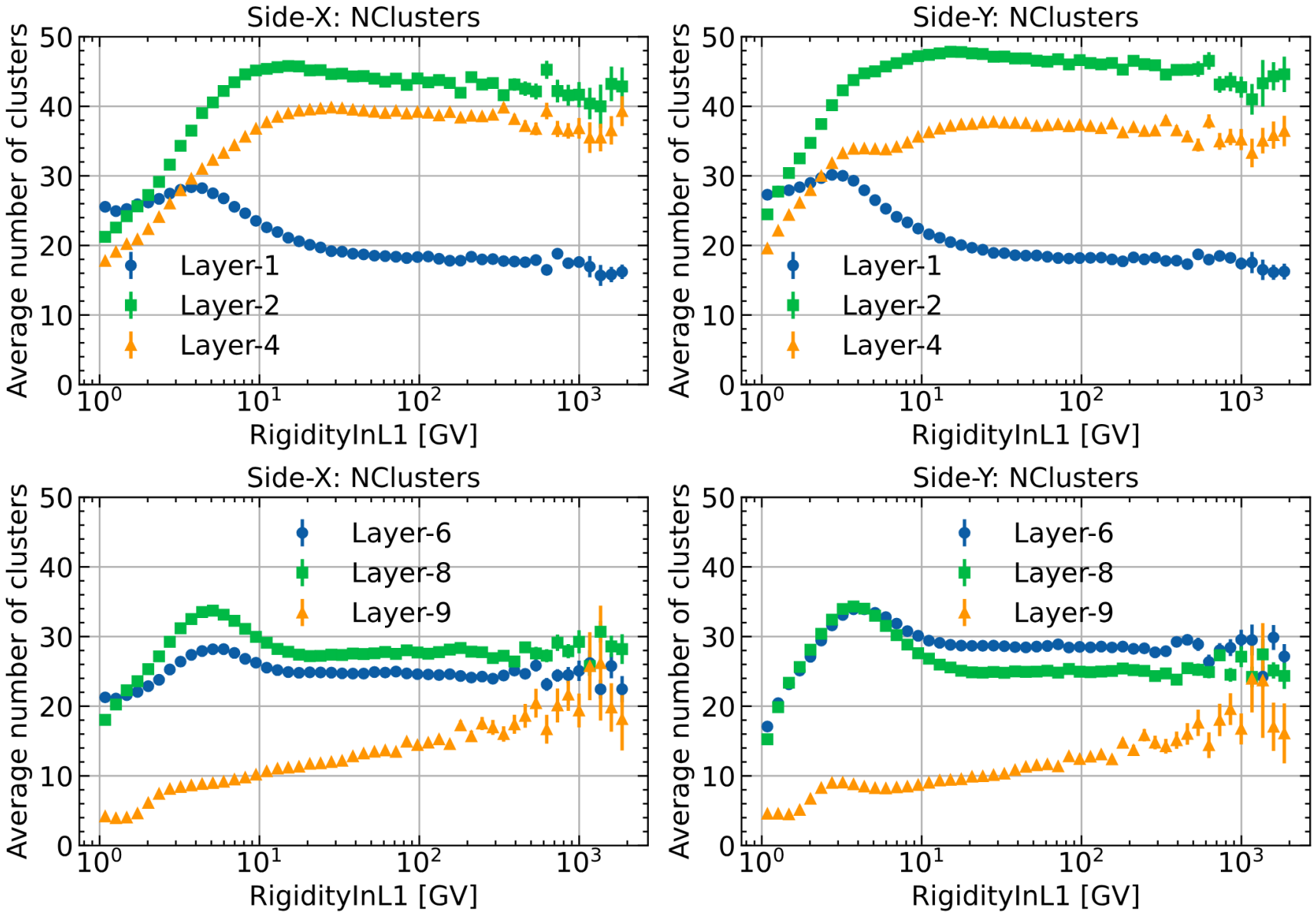
Number of clusters for different Tracker side and layer

Event selection:

1. **MIT Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5**
2. Run time: 4 JlNJs period

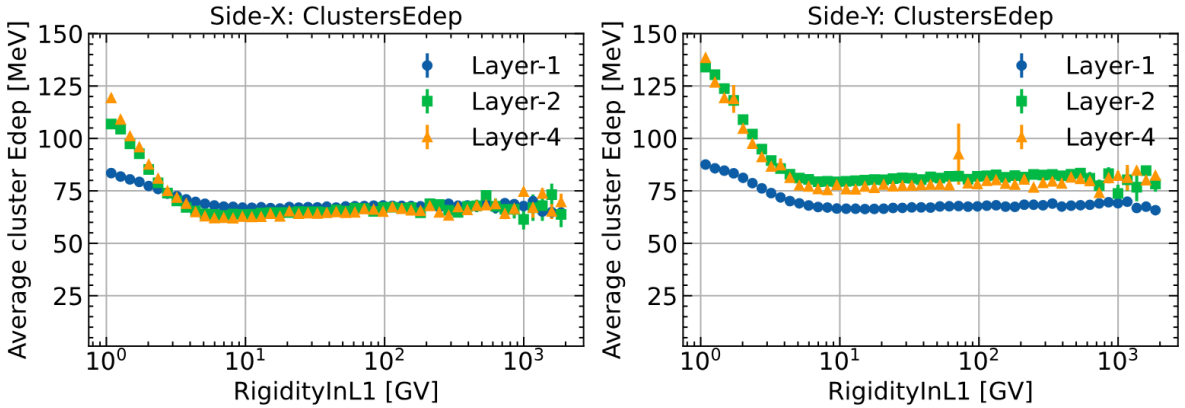


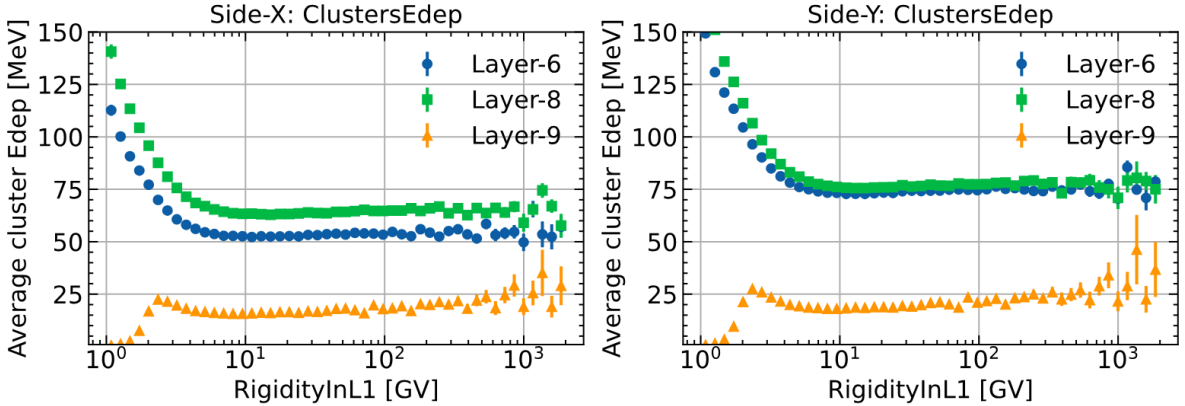
Average number of clusters on different layer and side



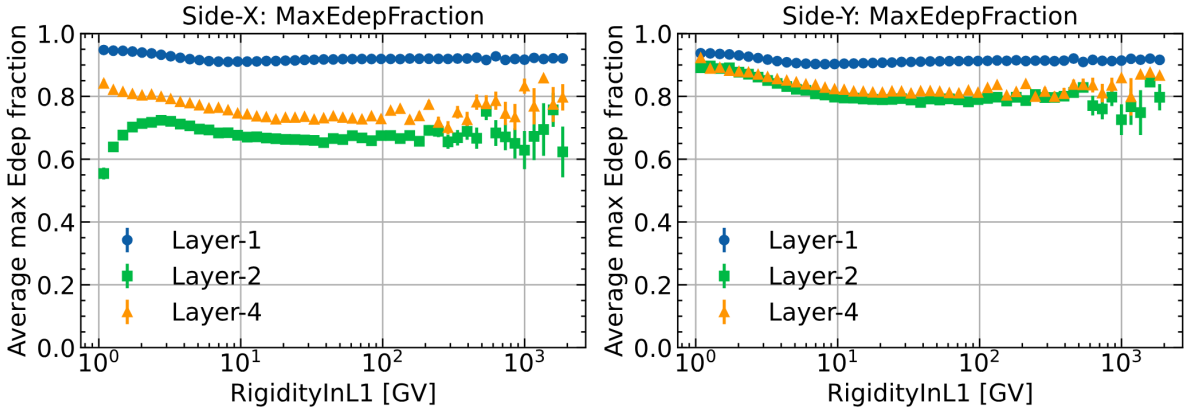
Average Edep (MeV) on different layer and side

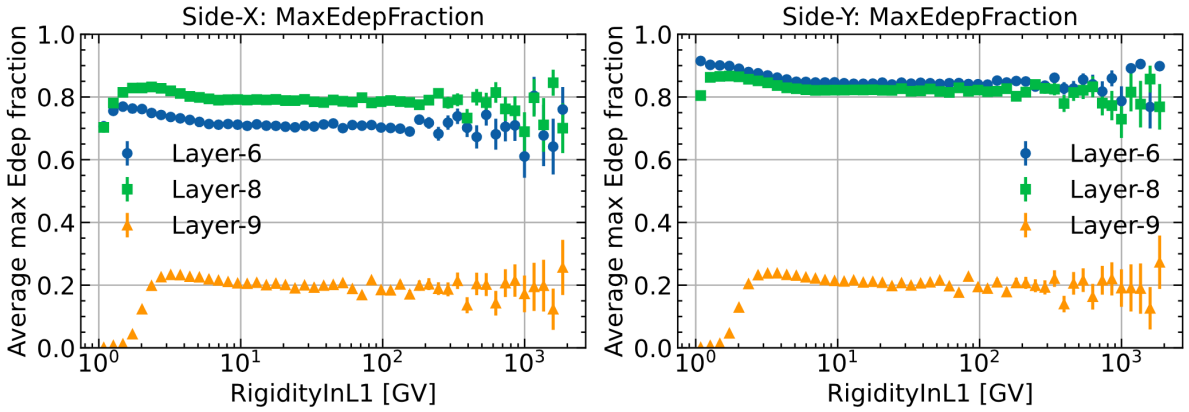
Edep of the cluster on Track
for each layer and side





Edep of the cluster on Track / Total Edep
for each layer and side

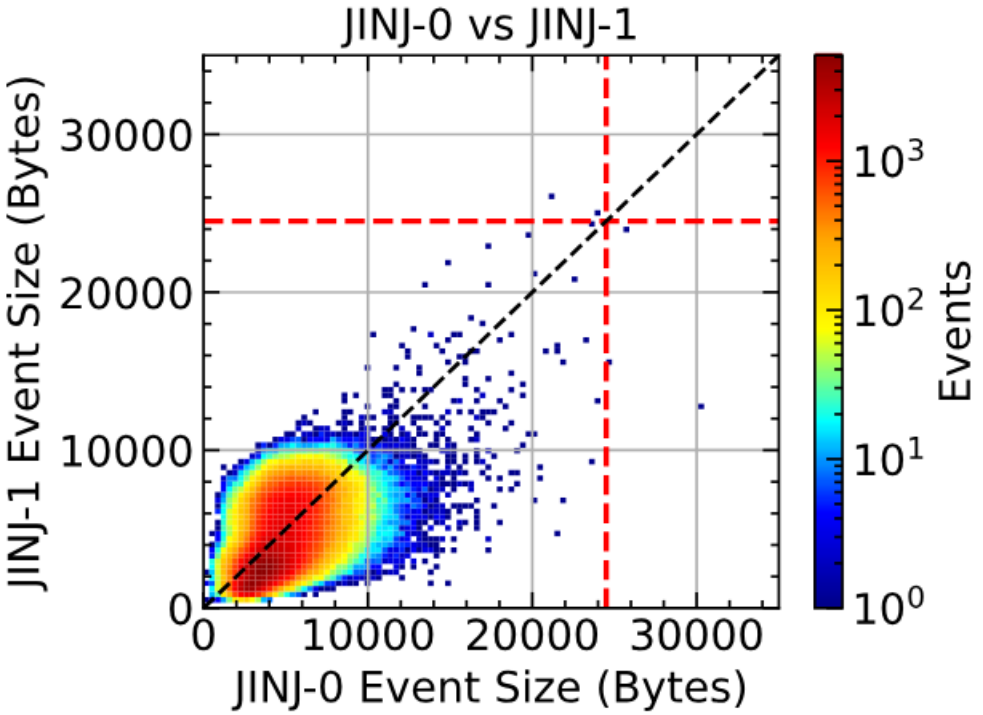


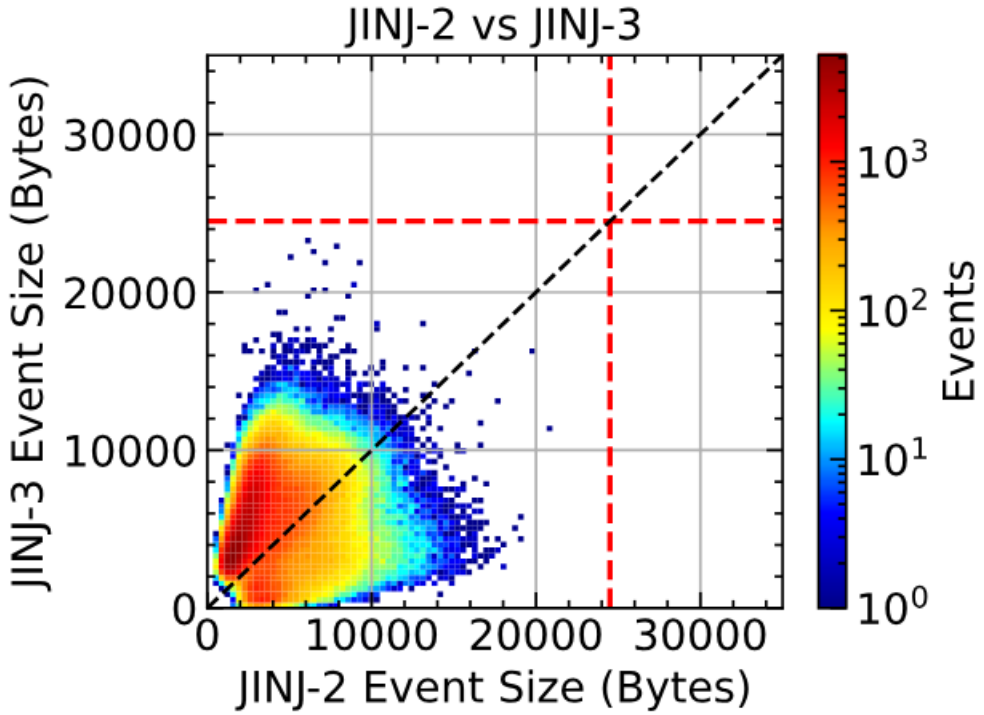


Part-2, 4 JINJ event size

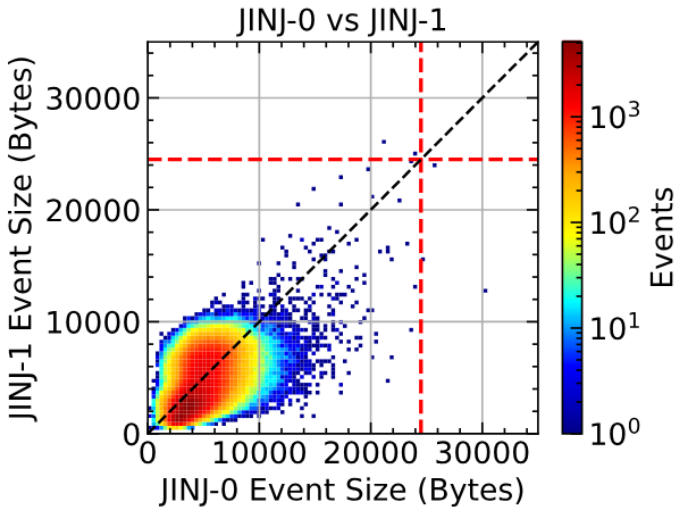
JINJ event size

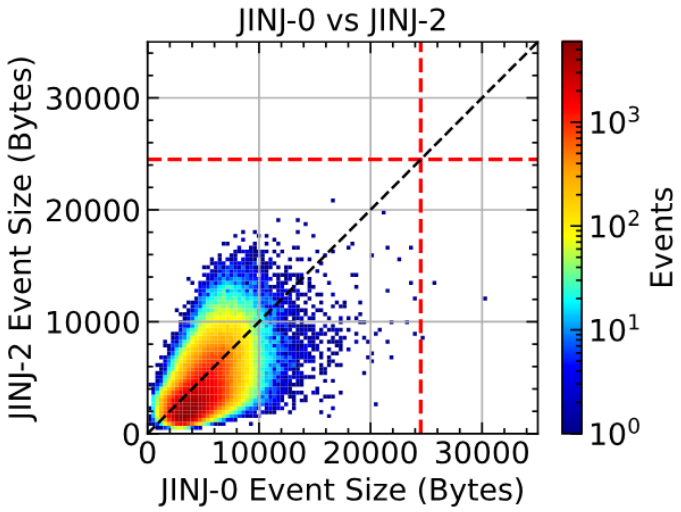
- Event selection:
  1. **With only Tracker charge selection** (L1 and Inner Tracker Charge > 25.5)
  2. Run time: 4 JINJs period

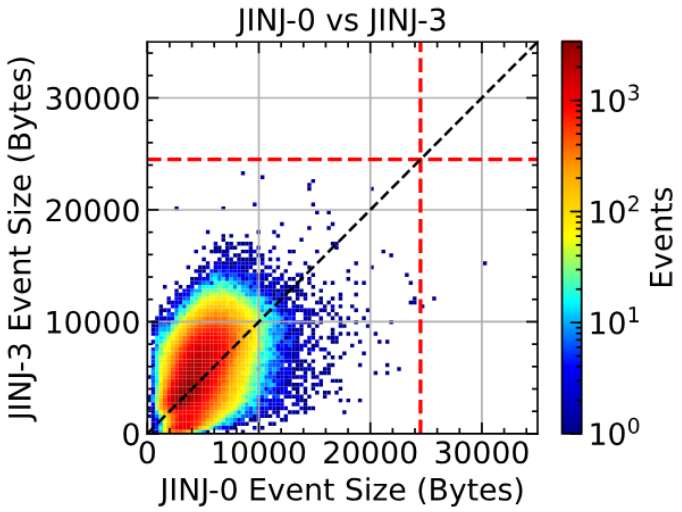


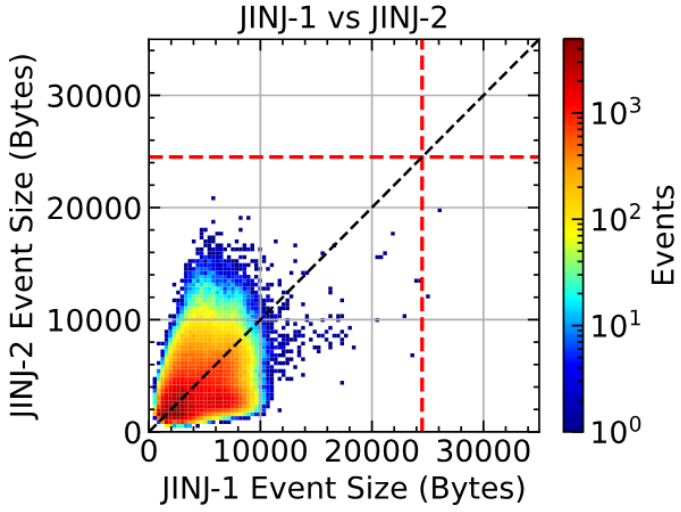


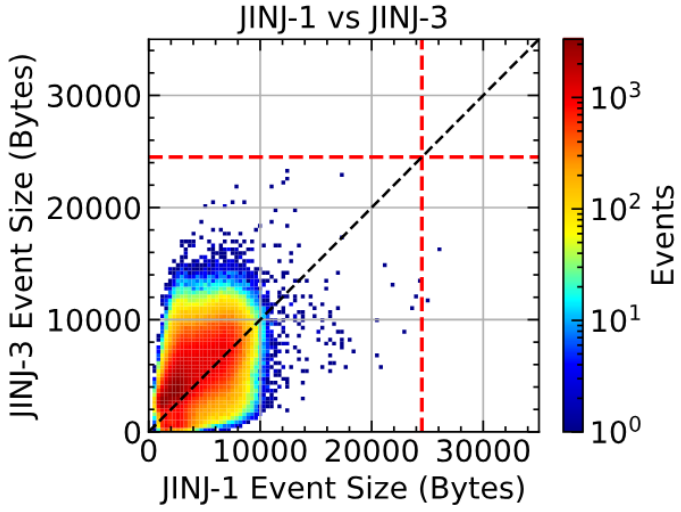
JINJ event size (L1 and Inner Tracker Charge > 25.5)

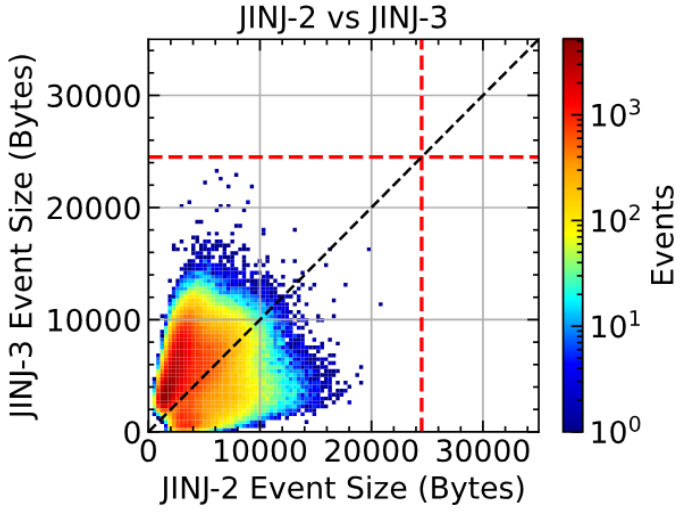






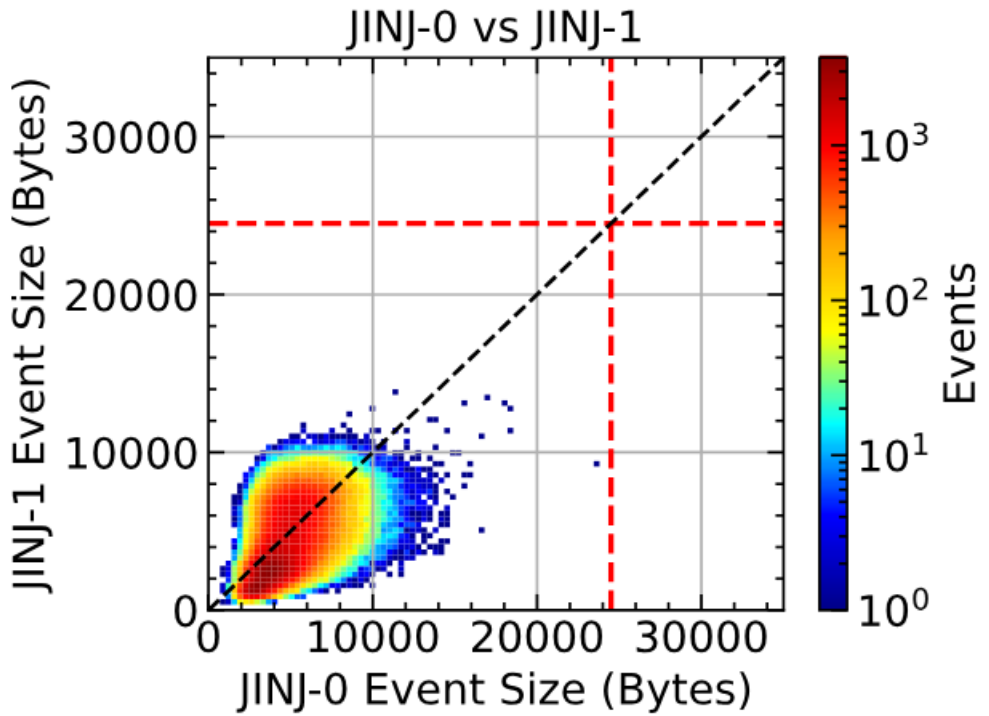


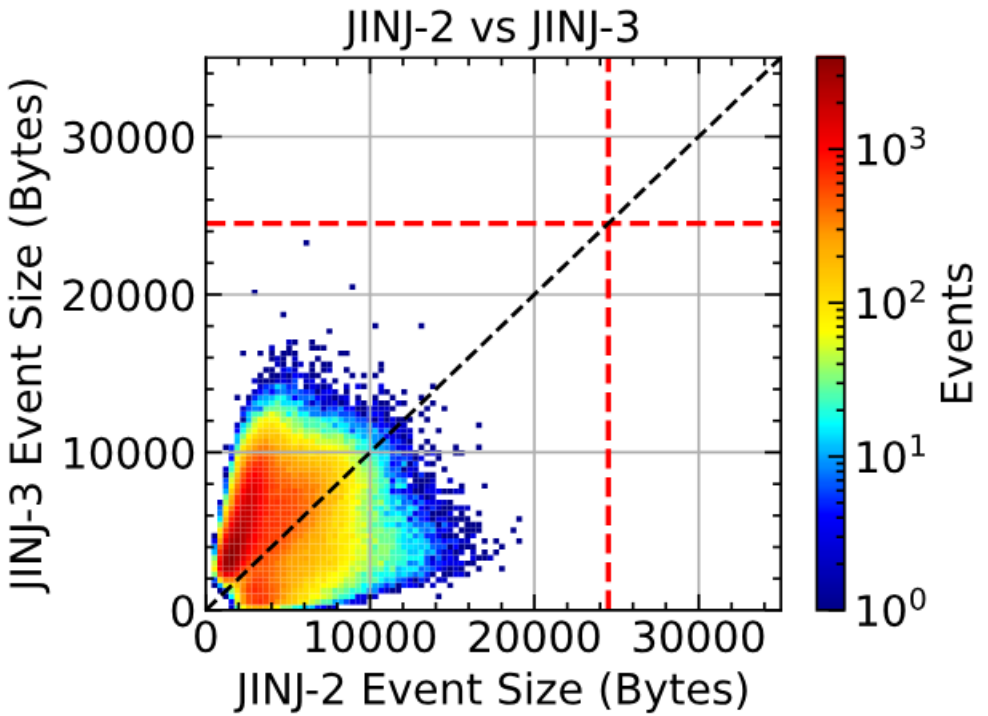




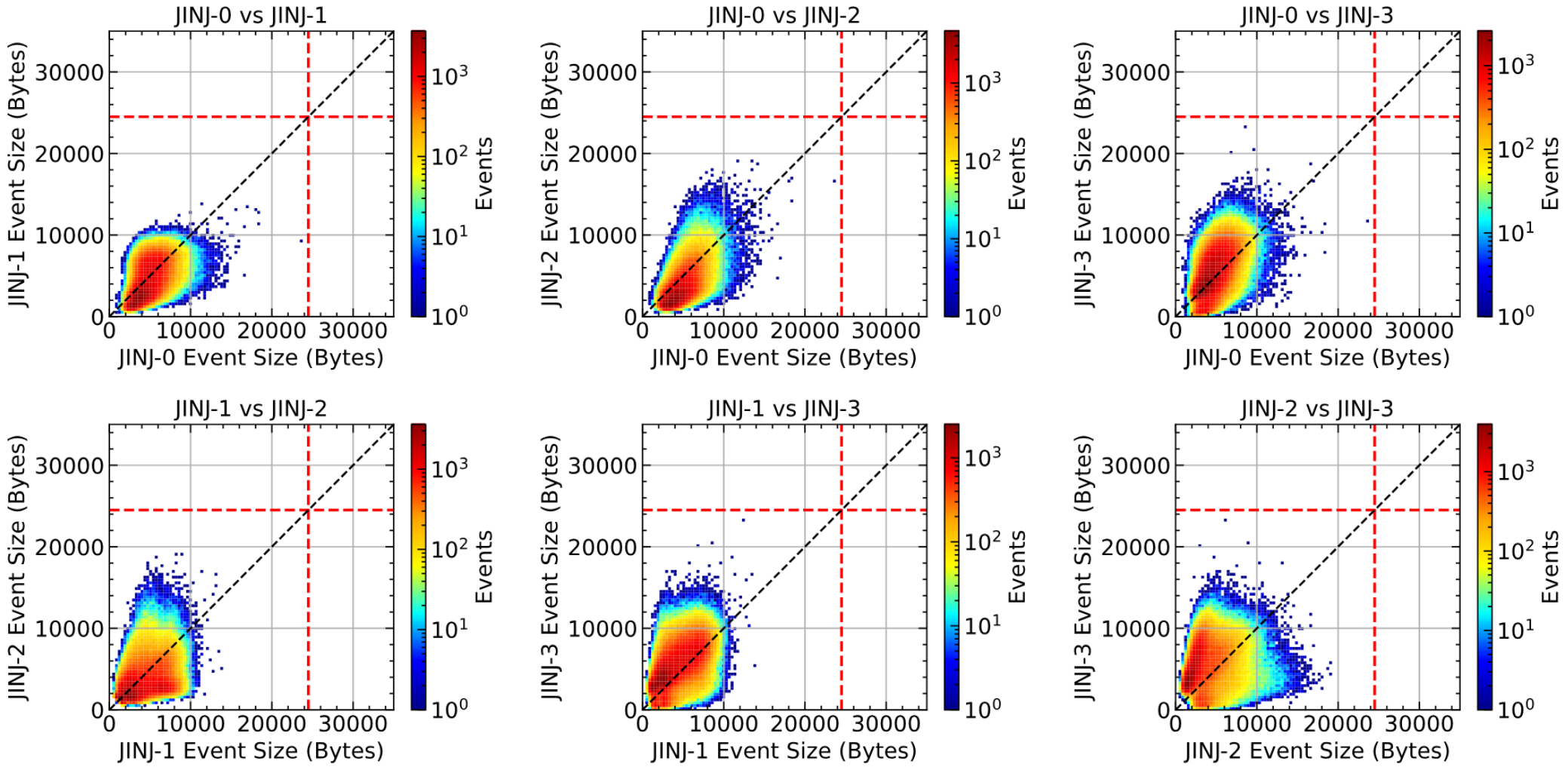
JINJ event size

- Event selection (Total events: 320K):
  1. **MIT Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5**
  2. Run time: 4 JINJs period

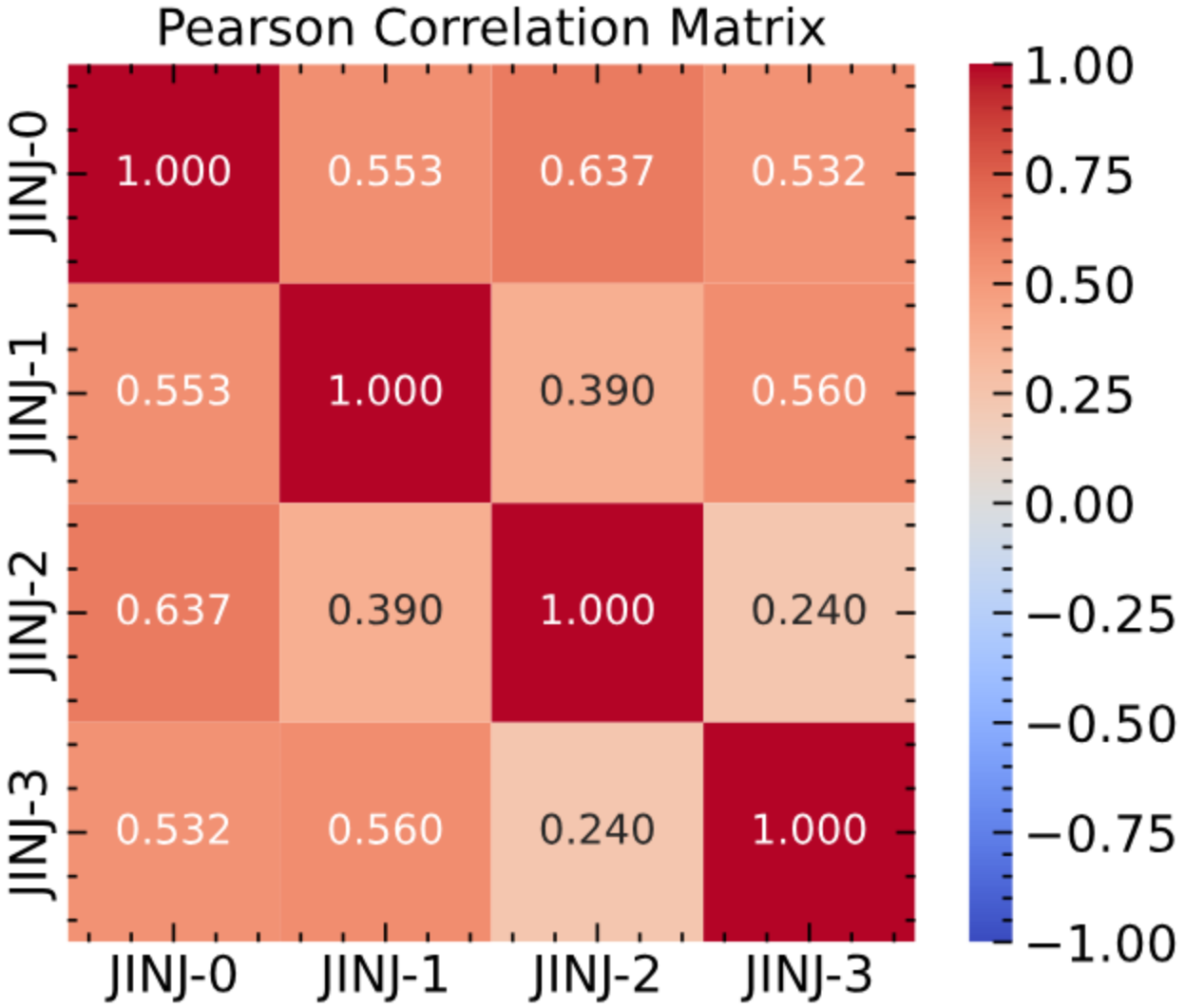




JINJ event size (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)



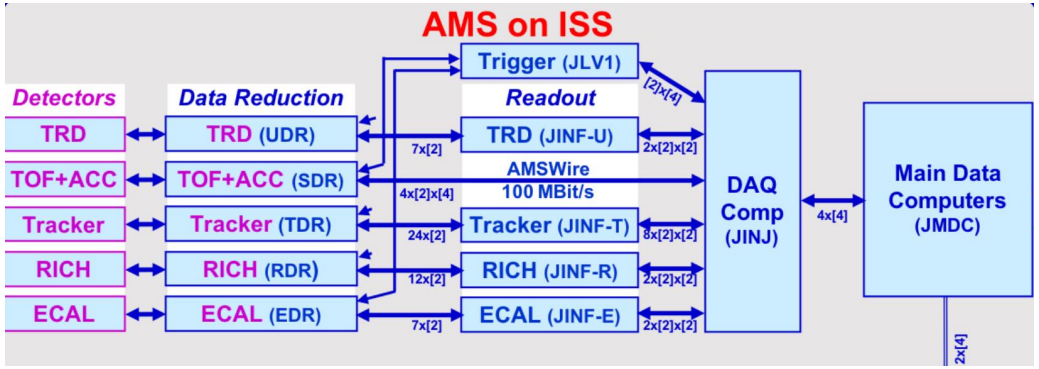
JINJ pairwise correlation (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)



Part-3, 24 ports of JlNJ

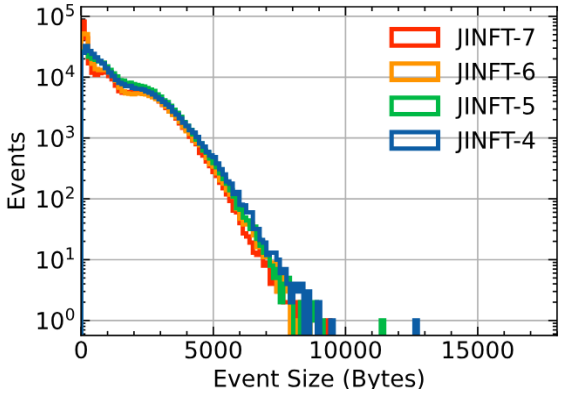
24 ports of JINJ

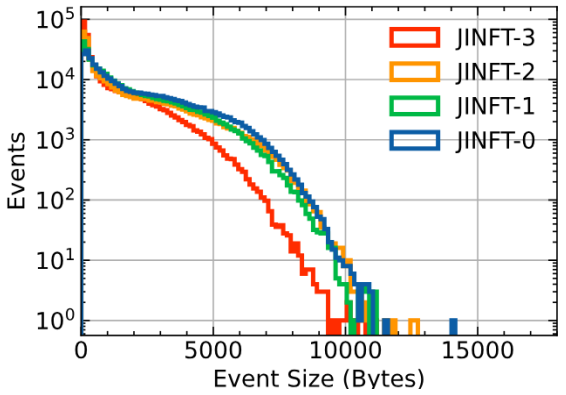
(Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)

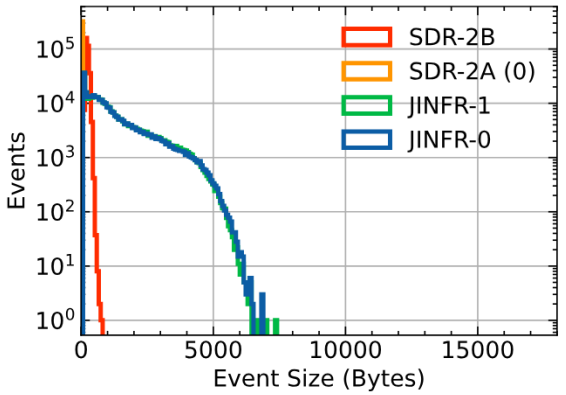


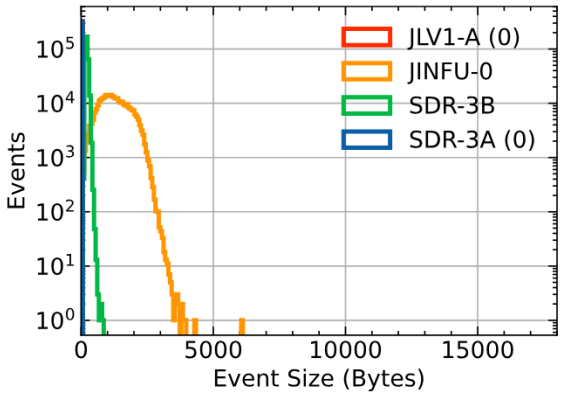
Zero values :

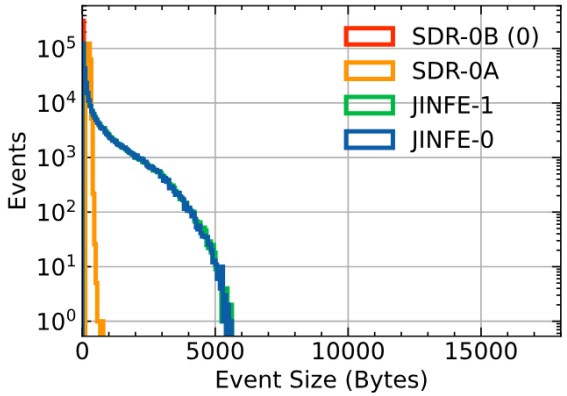
- SDR-0B
- SDR-1B
- JLV1-A
- SDR-2A
- SDR-3A

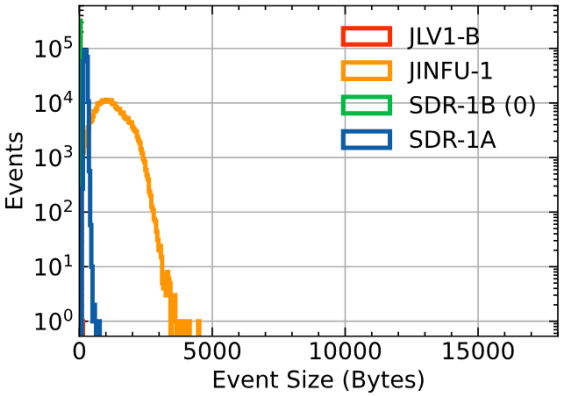




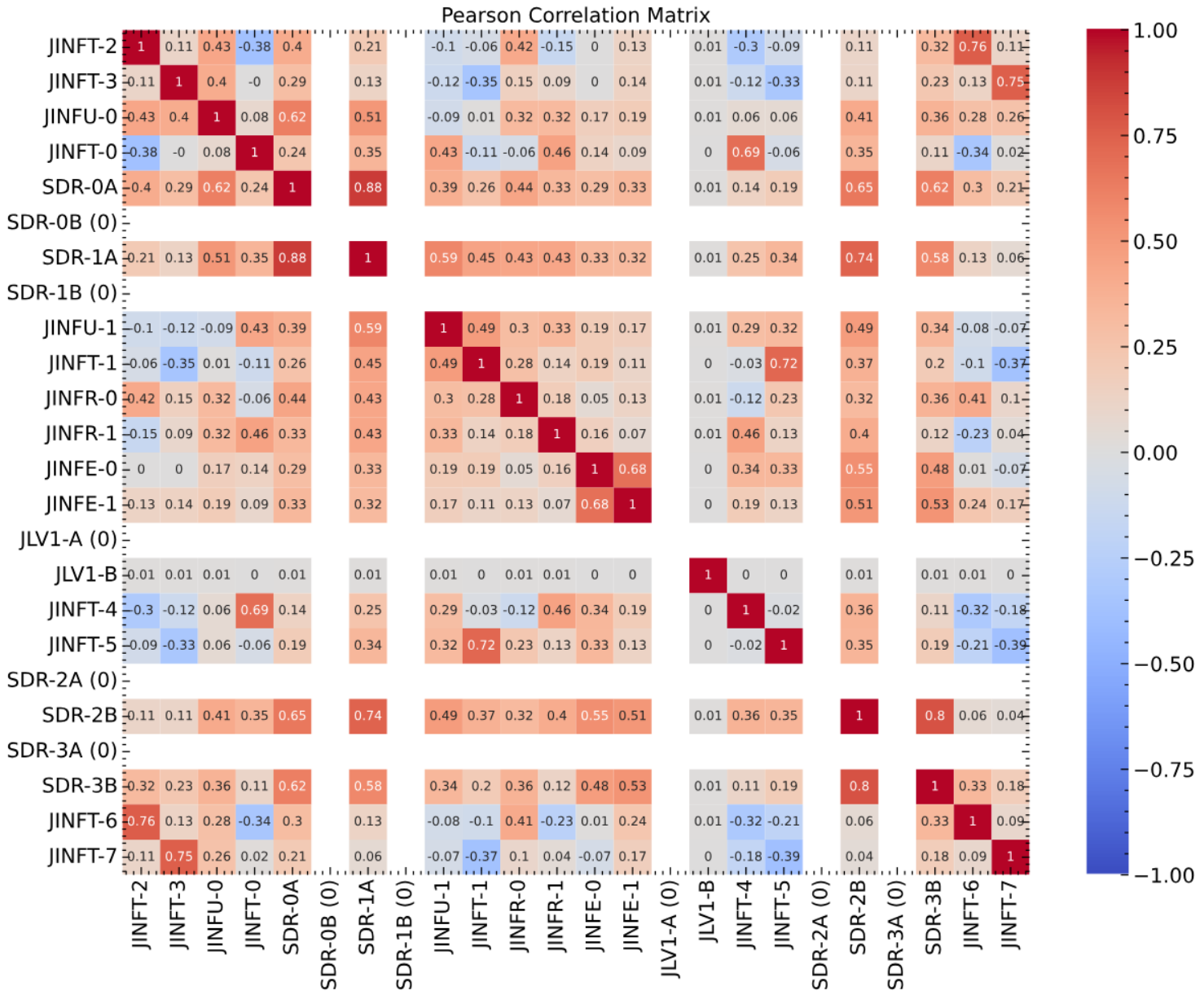








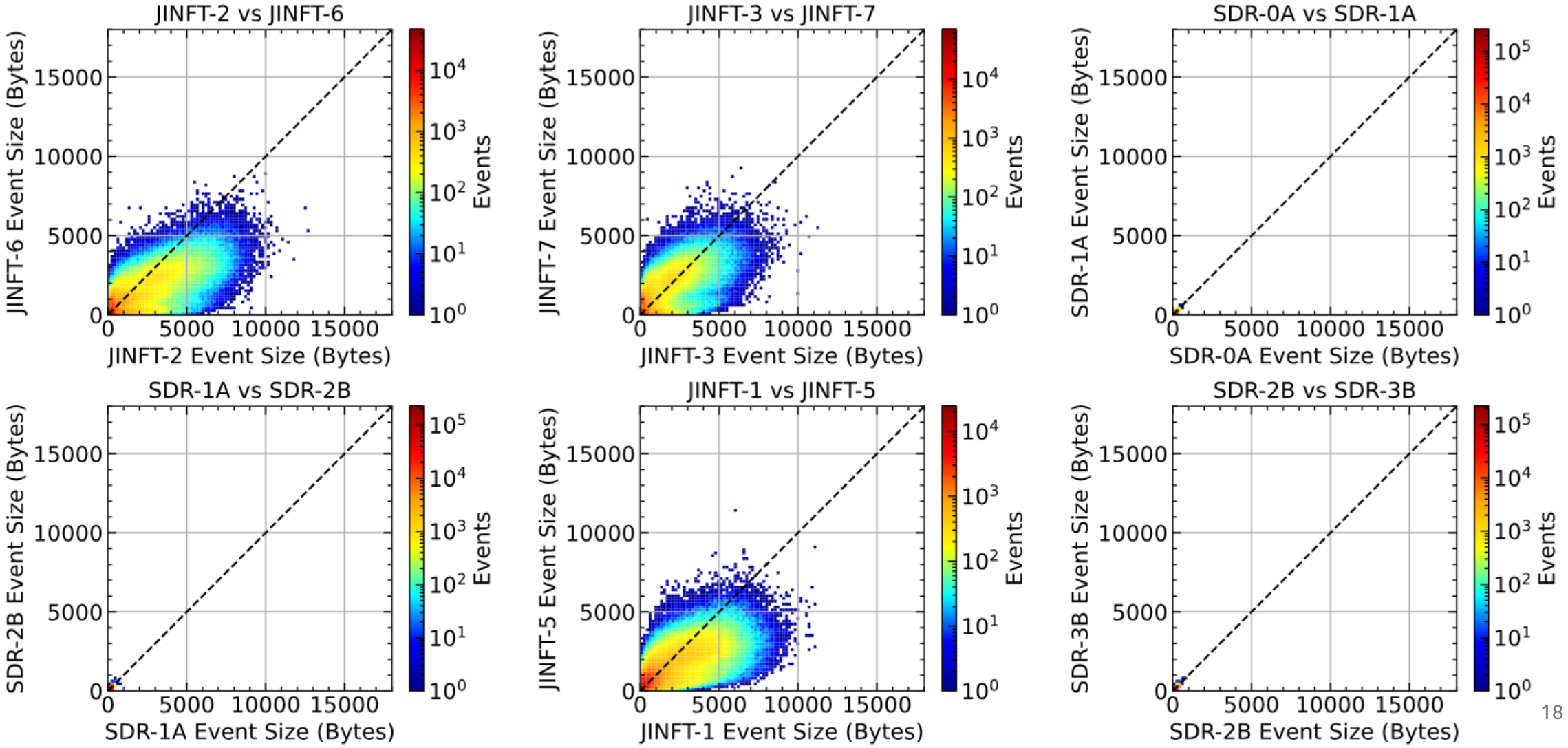
24 ports of JINJ: check pairwise correlation



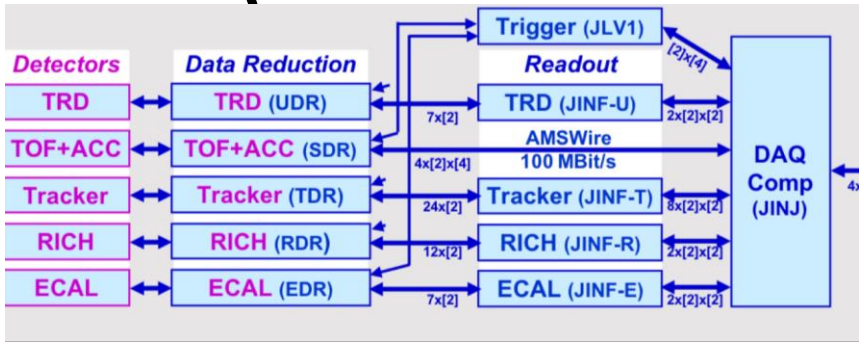
Highly correlated pairs (|correlation| > 0.7):

1. JINFT-2 and JINFT-6: Correlation = 0.76
2. JINFT-3 and JINFT-7: Correlation = 0.75
3. SDR-0A and SDR-1A: Correlation = 0.88
4. SDR-1A and SDR-2B: Correlation = 0.74
5. JINFT-1 and JINFT-5: Correlation = 0.72
6. SDR-2B and SDR-3B: Correlation = 0.80

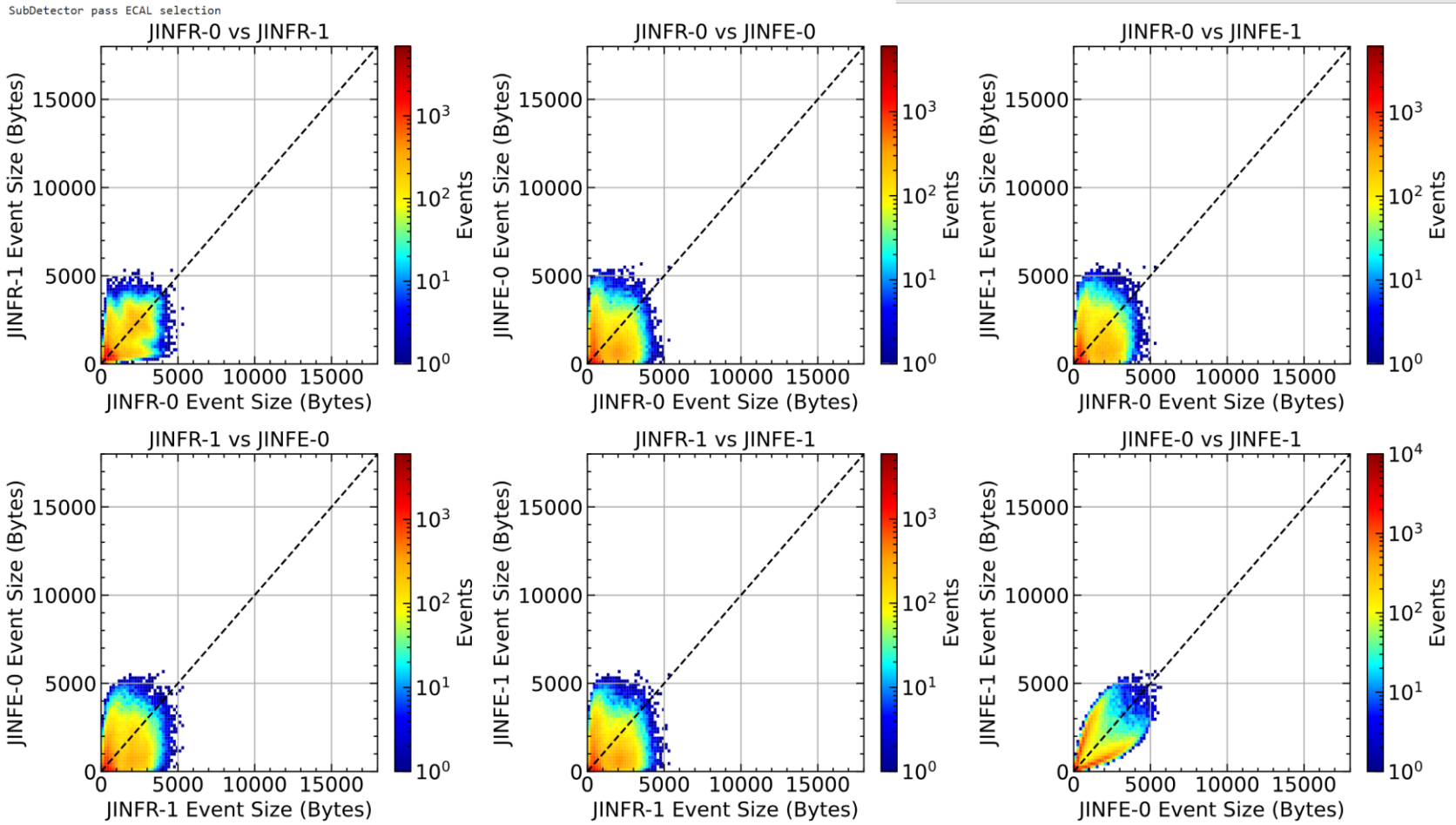
24 ports of JINJ: Highly correlated pairs (|correlation| > 0.7):



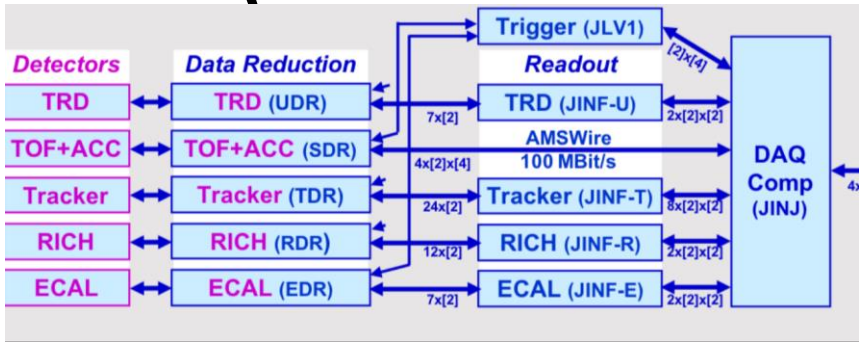
JINFR and JINFE pairwise correlation (Events inside ECAL)



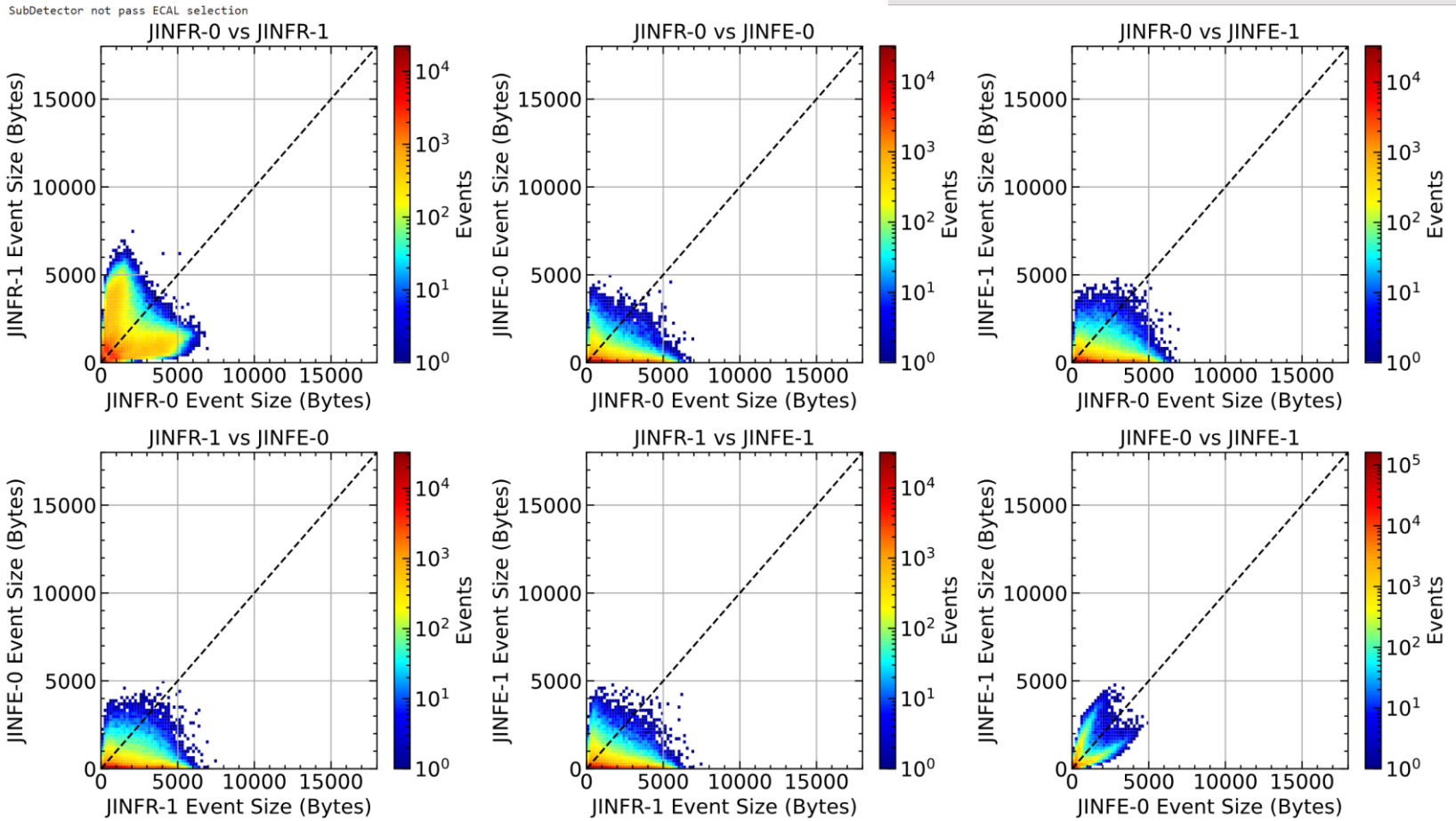
Events inside ECAL: (Tracker track extrapolation within ECAL fiducial volume)



JINFR and JINFE pairwise correlation (Events outside ECAL)



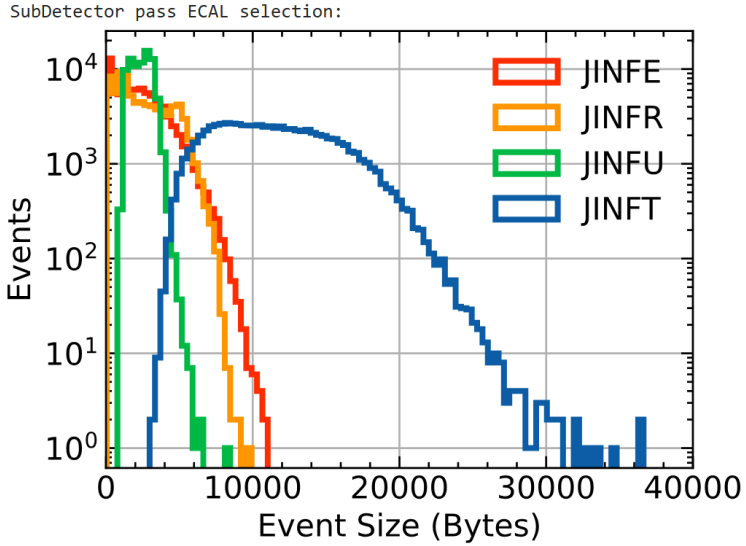
Events outside ECAL:
(Tracker track extrapolation outside ECAL fiducial volume)

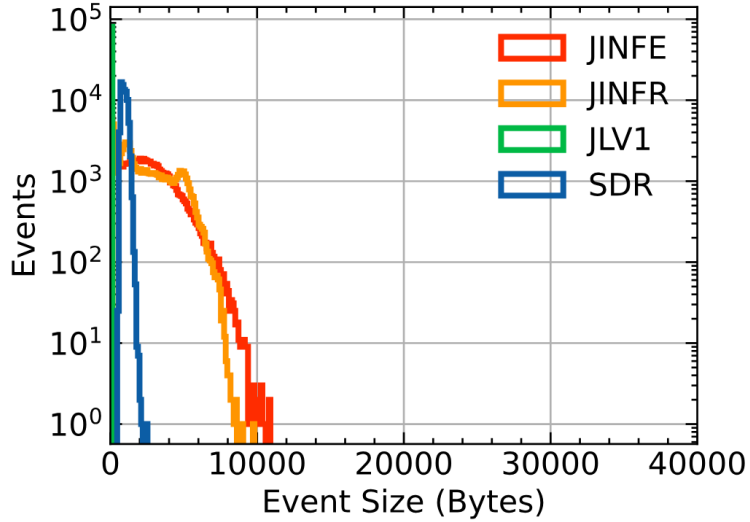


Part-4, Sub-Detector event size

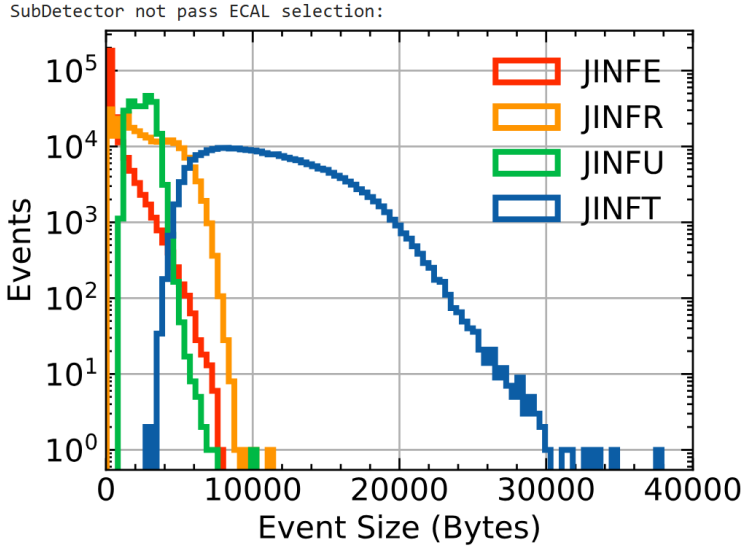
6 subdetectors (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)

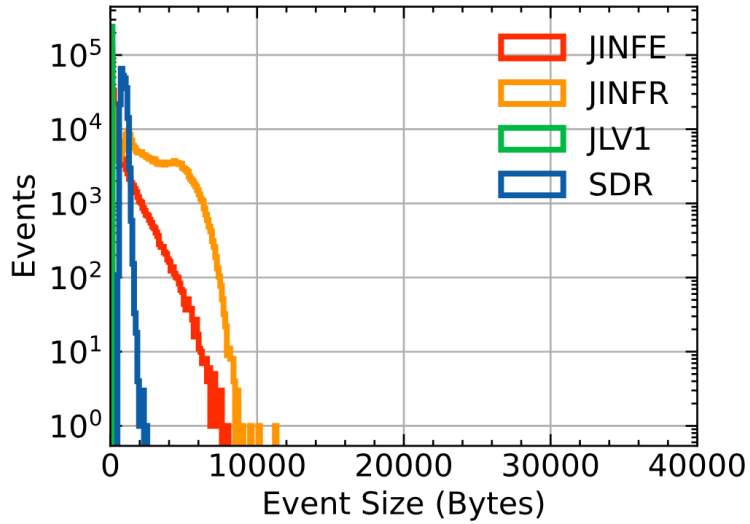
Events inside ECAL :
(Tracker track extrapolation within ECAL fiducial volume)





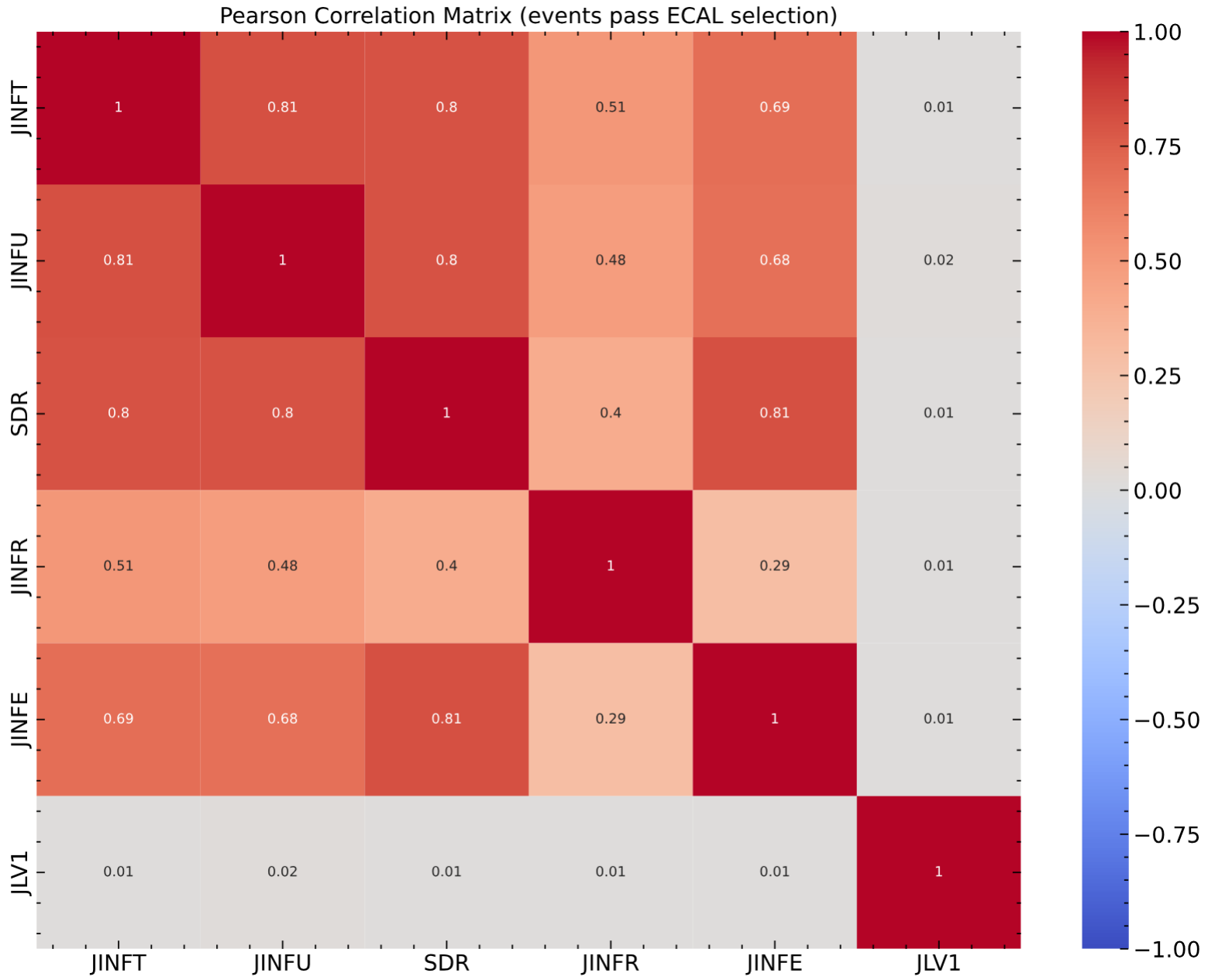
Events outside ECAL:
(Tracker track extrapolation outside ECAL fiducial volume)





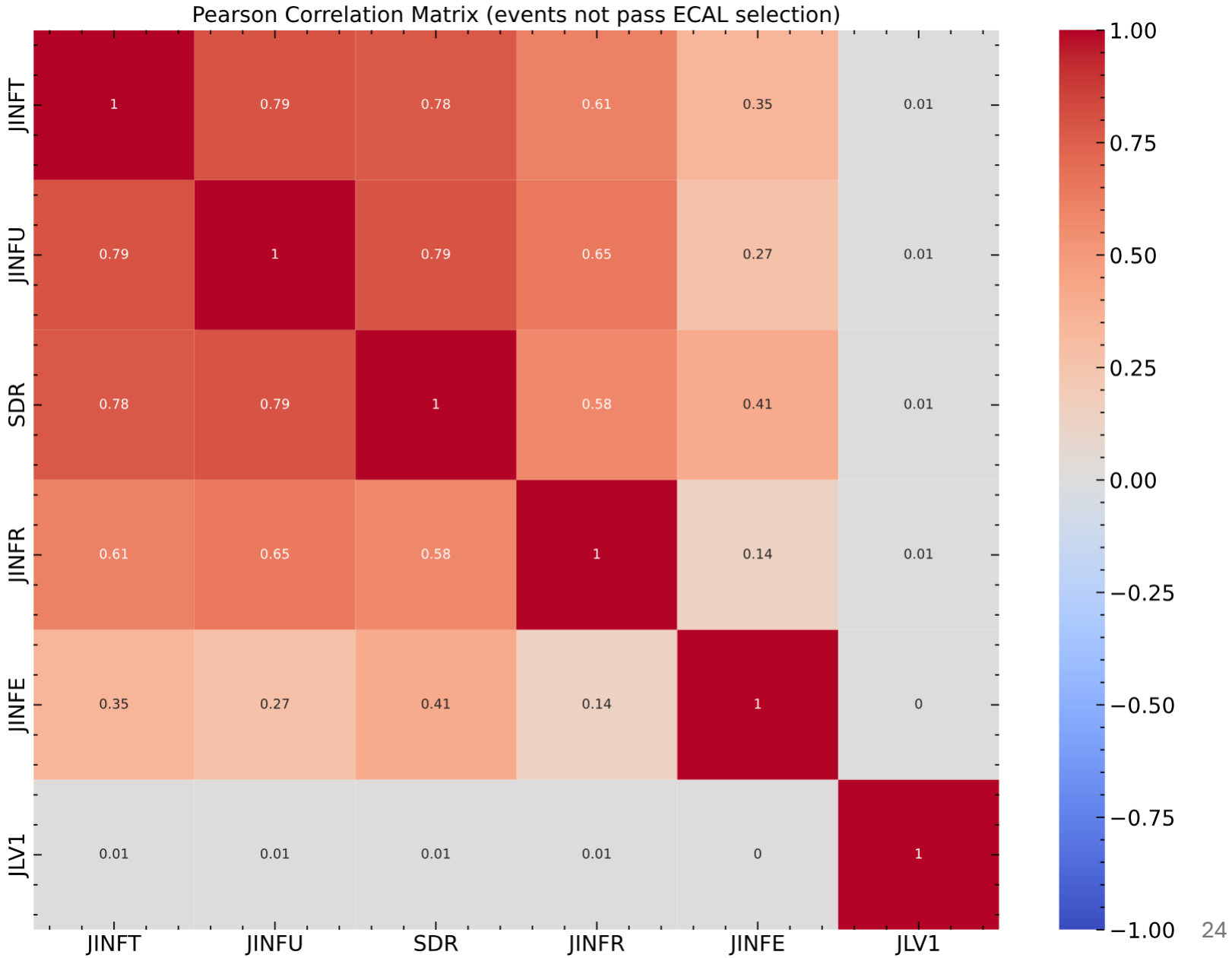
6 subdetectors

Events inside ECAL:
(Tracker track extrapolation within ECAL fiducial volume)



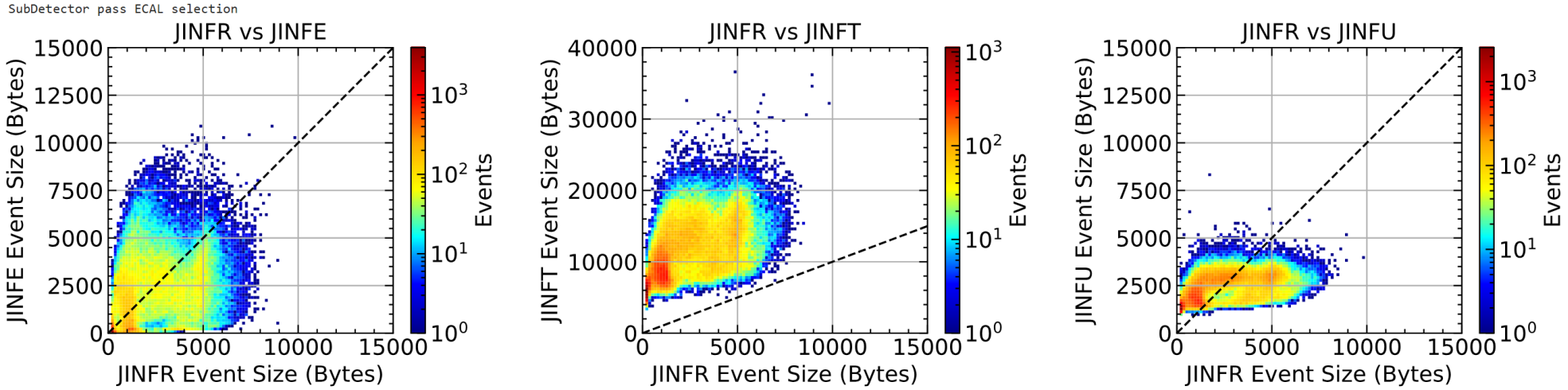
6 subdetectors

Events outside ECAL:
(Tracker track extrapolation outside ECAL fiducial volume)

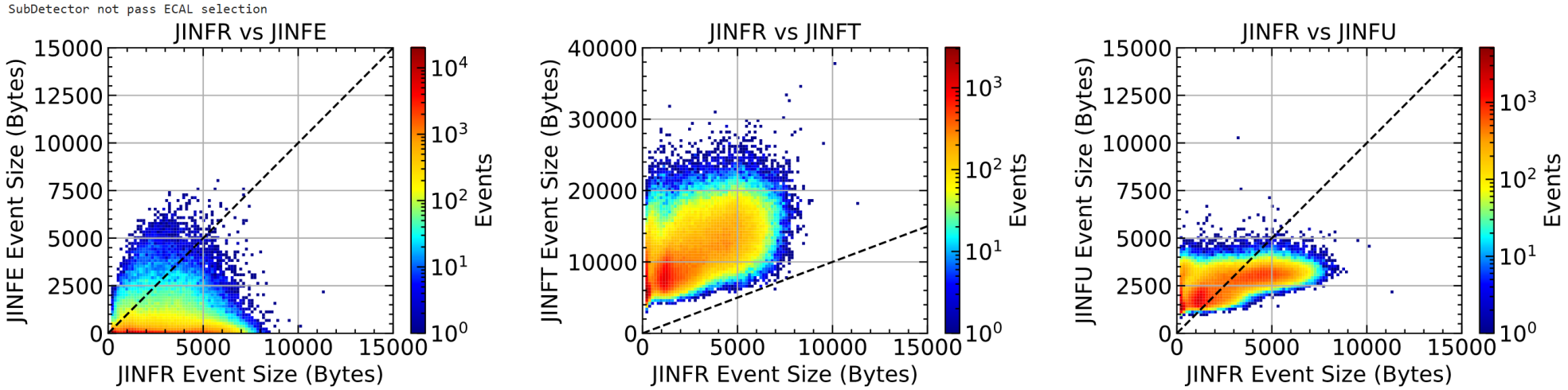


6 subdetectors: pairwise comparison (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)

Events inside ECAL:

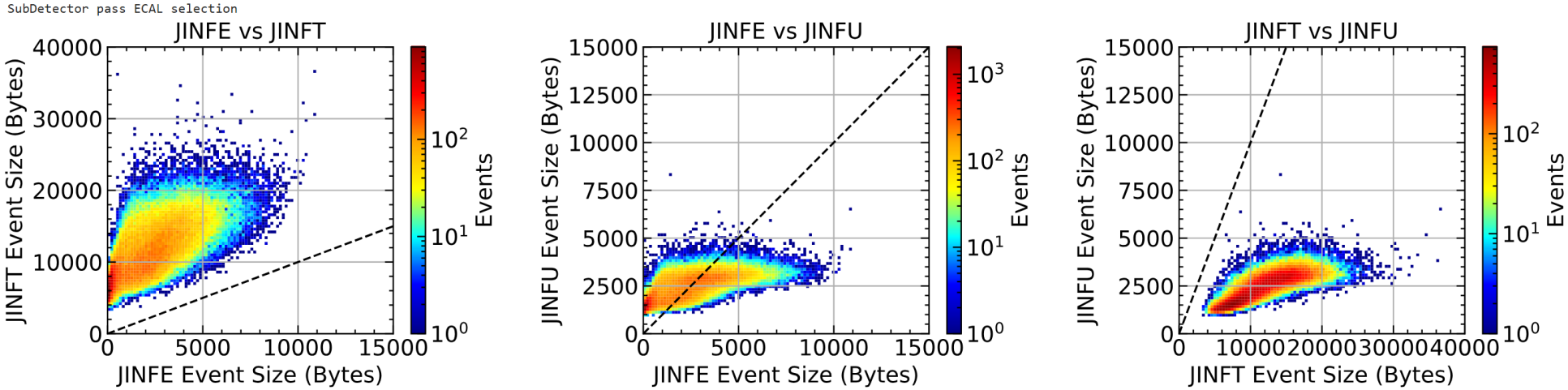


Events outside ECAL:

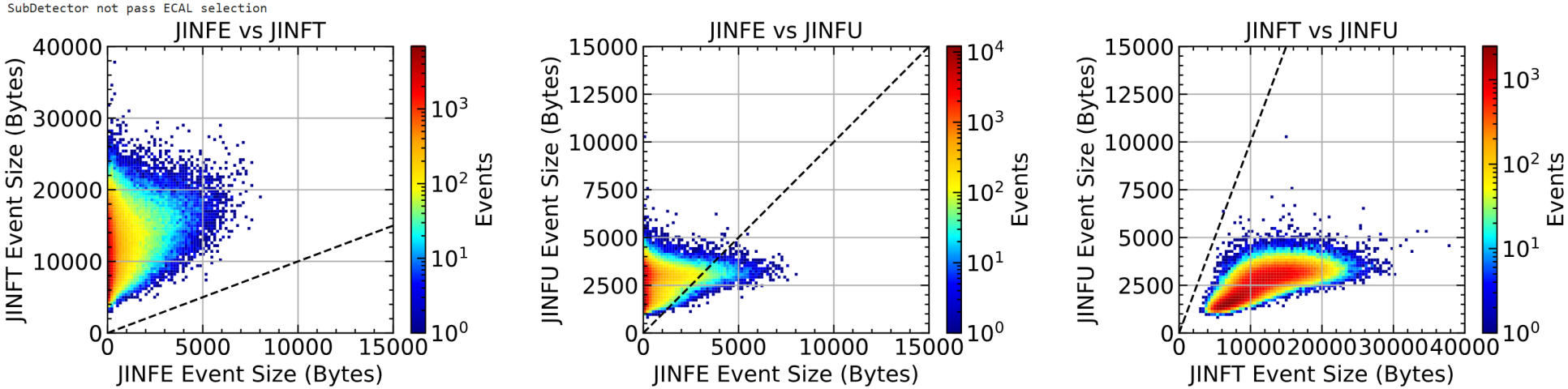


6 subdetectors: pairwise comparison (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)

Events inside ECAL:



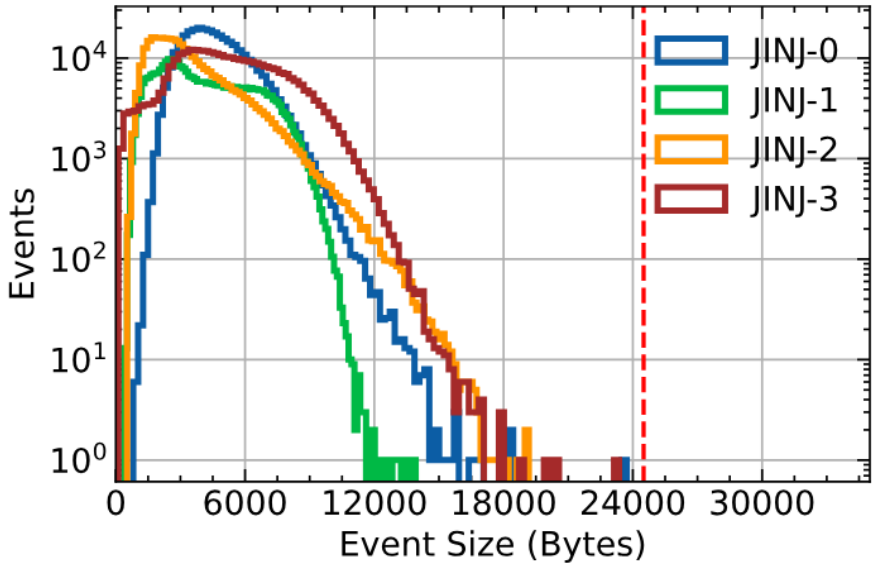
Events outside ECAL:



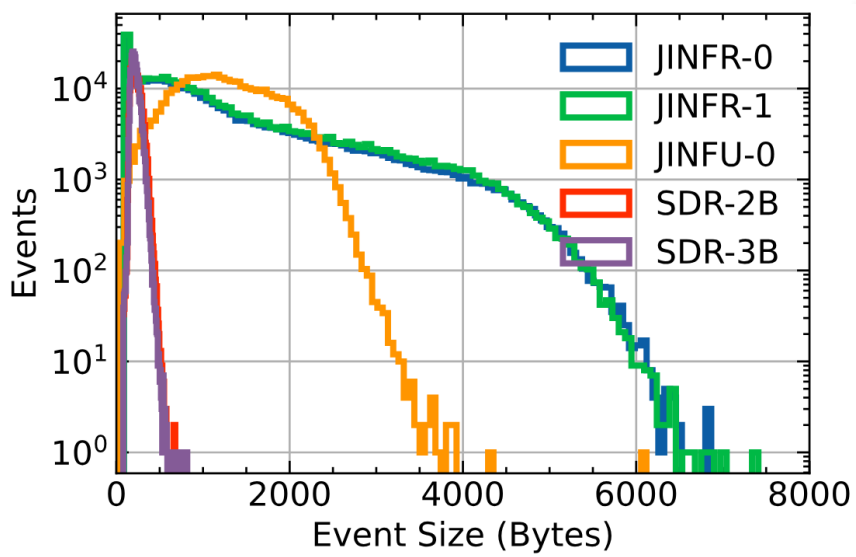
Part-5, Redistribute event to 3 JINJs

Redistribute event to 3 JINJs (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)

4 JINJs



JINJ-1 ports



JINJ (from Jiayu Hu)

current	JINJ-1		JINJ-2	
new	JINJ-0	JINJ-1	JINJ-2	JINJ-3
Names	daqjlen[16] JINFT-4 daqjlen[17] JINFT-5 daqjlen[22] JINFT-6 daqjlen[23] JINFT-7	JINFR-0 [10] JINFR-1 [11] SDR-2A [18] SDR-2B [19] SDR-3A [20] SDR-3B [21] JINFU-0 [2] JLV1-A [14]	JINFE-0 [12] JINFE-1 [13] SDR-0A [4] SDR-0B [5] SDR-0A [6] SDR-0B [7] JINFU-1 [8] JLV1-B [15]	JINFT-0 daqjlen[3] JINFT-1 daqjlen[0] JINFT-2 daqjlen[2] JINFT-3 daqjlen[1]

Old (2 JINJs)	JINJ-1		JINJ-2	
Current (4 JINJs)	JINJ-0	JINJ-1	JINJ-2	JINJ-3
Names	JINFT-4 JINFT-5 JINFT-6 JINFT-7	JINFR-0 JINFR-1 SDR-2B SDR-3B JINFU-0	JINFE-0 JINFE-1 SDR-0A SDR-1A JINFU-1 JLV1-B JINFT-3	JINFT-0 JINFT-1 JINFT-2

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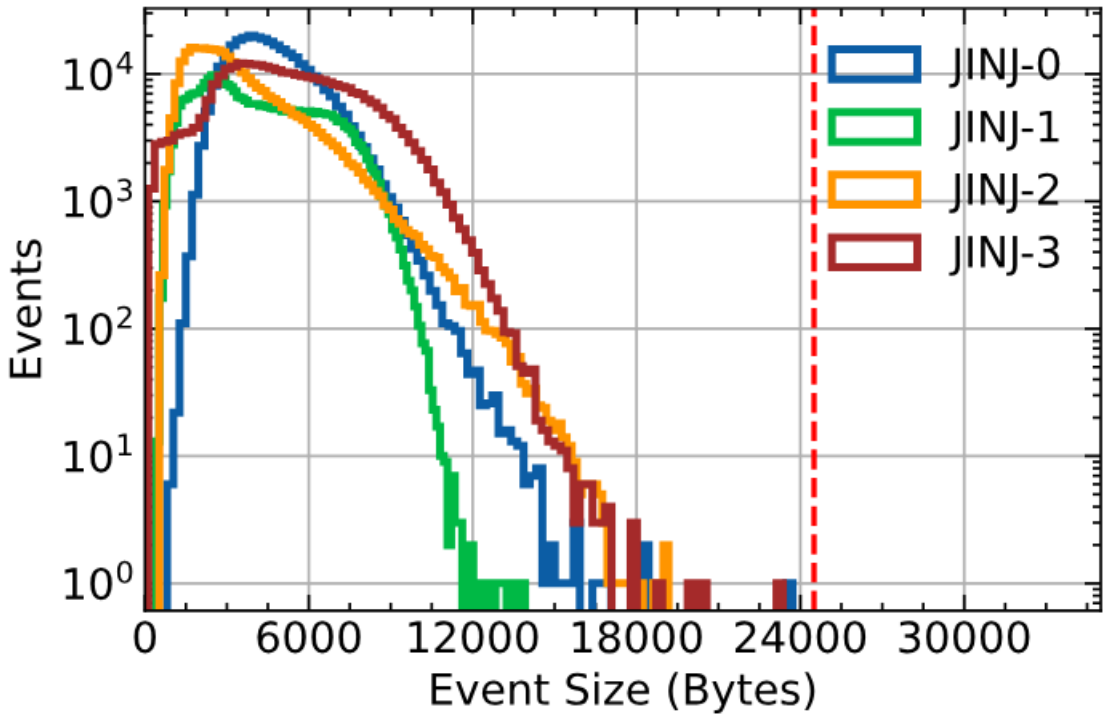
Overall event size: JINJ-1 < JINJ-0 < JINJ-2 < JINJ-3.

JINJ-1 event size is smaller, redistribute JINJ-1 event to the other 3 JINJs:

- JINFR-0 → JINJ-0
- JINFR-1 → JINJ-2
- JINFU-0 → JINJ-3
- SDR-2B, SDR-3B→ JINJ-0

Redistribute JINJ-1 events to the other 3 JINJs (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)

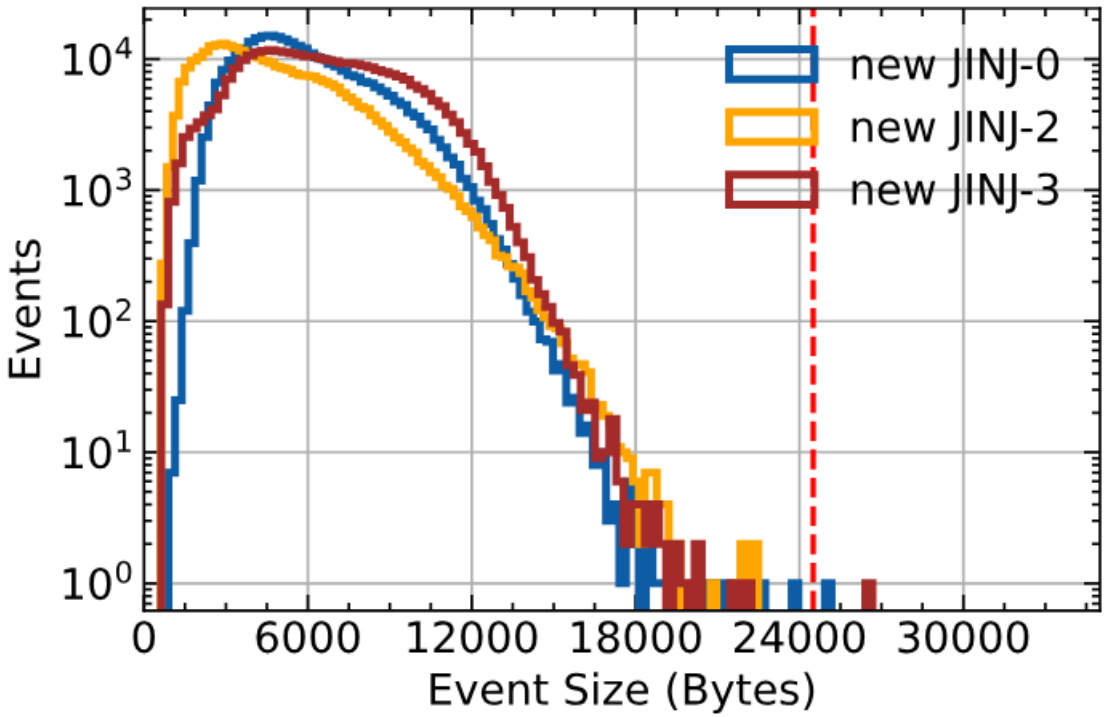
4 JINJs



(Total events: 320K)

Redistribute JINJ-1 events to the other 3 JINJs:

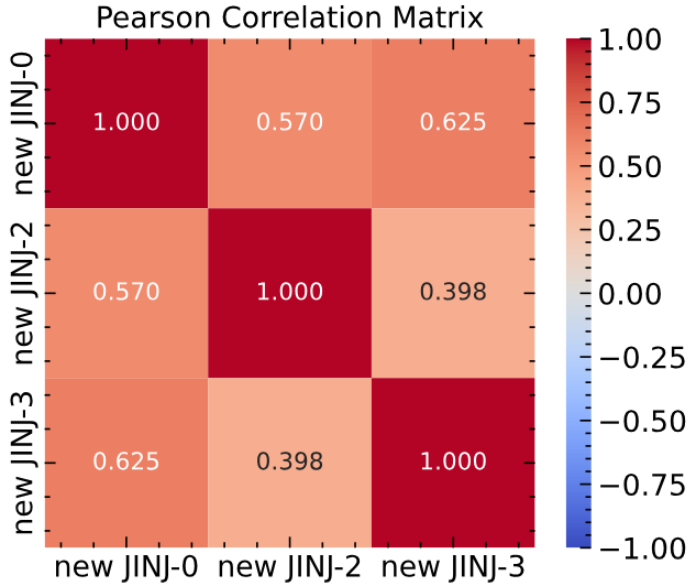
- JINFR-0 → JINJ-0
- JINFR-1 → JINJ-2
- JINFU-0 → JINJ-3
- SDR-2B, SDR-3B→ JINJ-0

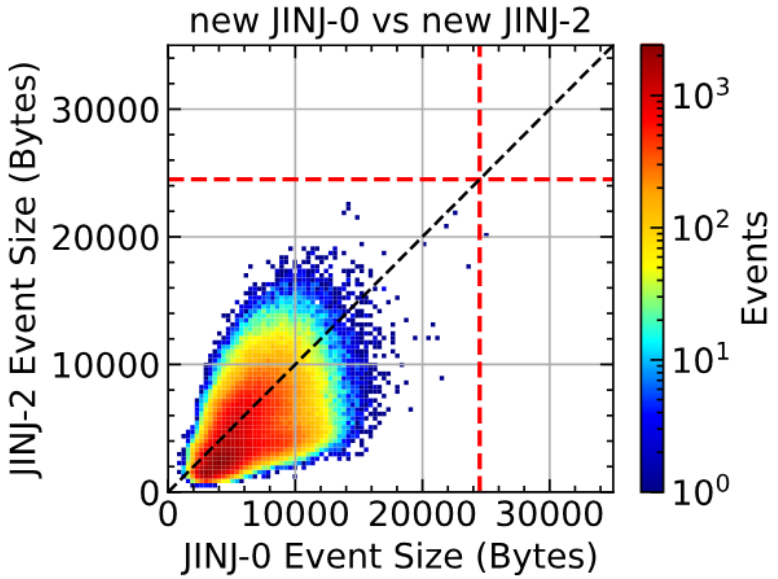


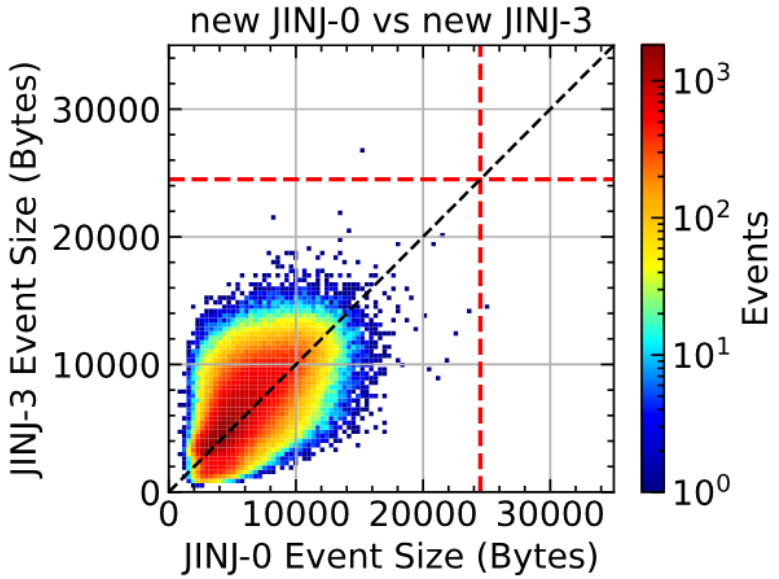
Redistribute JINJ-1 events to the other 3 JINJs

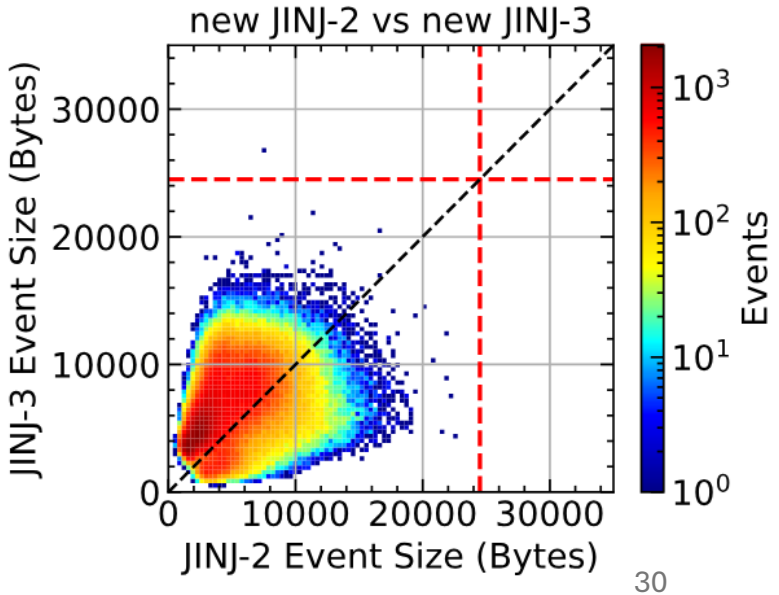
Redistribute JINJ-1 events to the other 3 JINJs:

- JINFR-0 → JINJ-0
- JINFR-1 → JINJ-2
- JINFU-0 → JINJ-3
- SDR-2B, SDR-3B→ JINJ-0









Summary

- In current data, L1 is estimated to have smaller events size than the other layers
- JINJ-1 has smaller event size
- Redistribute JINJ-1 events to the other 3 JINJs: 2 of 320k Charge > 25.5 L1Inner selected events will be truncated in the 3 JINJs

Backups

Event selection

Event selection

- L1Inner selection without charge cuts
- + L1 Charge and Inner Charge > 26-0.5
- + Run time: 4 JINJs period

Run and Time Selection

Start Run	Date	Major changes of the detector configurations
1305853512	May 20/2011	1 JINJs, ACC<5 for HZ trigger
1311258168	Jul 21/2011	change Tracker DAQ: second step calibration (big efficiency increase)
1385487767	Nov 26/2013	change TOF configuration and HV: UTOF (S0,S1) to A side, LTOF (S2,S3) to B side
1456503197	Feb 26/2016	2 JINJs, ACC<8 for HZ trigger
1582034309	Feb 18/2020	4 JINJs, ACC<8 for HZ trigger
1582037855	Feb 18/2020	4 JINJs, no ACC constraint for HZ trigger
1620025528	May 03/2021	polarization-photon trigger, 4 JINJs, ACC<8 for HZ trigger
1635856717	Nov 02/2021	4 JINJs, no ACC constraint for HZ trigger
1675341999	Feb 02/2023	4 JINJs, ACC<8 for HZ trigger

+ A few runs between [1305853512, 1456503197) with 2JINJs

JINJ (from Jiayu Hu)

current	JINJ-1		JINJ-2	
new	JINJ-0	JINJ-1	JINJ-2	JINJ-3
Names	daqjlen[16] JINFT-4	JINFR-0 [10]	JINFE-0 [12]	JINFT-0 daqjlen[5]
	daqjlen[17] JINFT-5	JINFR-1 [11]	JINFE-1 [13]	JINFT-1 daqjlen[6]
	daqjlen[22] JINFT-6	SDR-2A [18]	SDR-0A [4]	JINFT-2 daqjlen[7]
	daqjlen[23] JINFT-7	SDR-2B [19]	SDR-0B [5]	JINFT-3 daqjlen[9]
		SDR-3A [20]	SDR-0A [6]	
		SDR-3B [21]	SDR-0B [7]	
		JINFU-0 [2]	JINFU-1 [8]	
		JLV1-A [14]	JLV1-B [15]	

index_to_name = { 0: "JINFT-2", 1: "JINFT-3", 2: "JINFU-0", 3: "JINFT-0", 4: "SDR-0A", 5: "SDR-0B", 6: "SDR-1A", 7: "SDR-1B", 8: "JINFU-1", 9: "JINFT-1", 10: "JINFR-0", 11: "JINFR-1", 12: "JINFE-0", 13: "JINFE-1", 14: "JLV1-A", 15: "JLV1-B", 16: "JINFT-4", 17: "JINFT-5", 18: "SDR-2A", 19: "SDR-2B", 20: "SDR-3A", 21: "SDR-3B", 22: "JINFT-6", 23: "JINFT-7"}

Old (2 JINJs)	JINJ-1		JINJ-2	
Current (4 JINJs)	JINJ-0	JINJ-1	JINJ-2	JINJ-3
Names	JINFT-4	JINFR-0	JINFE-0	JINFT-0
	JINFT-5	JINFR-1	JINFE-1	JINFT-1
	JINFT-6	SDR-2B	SDR-0A	JINFT-2
	JINFT-7	SDR-3B	SDR-1A	
		JINFU-0	JINFU-1	
			JLV1-B	
			JINFT-3	

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Sub-Detectors

From AMSsoftware: cc/root.C
https://ams.cern.ch/AMS/Analysis/hpl3itp1/root02_v5/html/B1300_patches/html/classDaqEventR.html

```
1864 // JINJ slaves for each subdetect.:  JINFT     JINFU      SDR      JINFR     JINFE      JLV1
1865 unsigned int DaqEventR::slaves[6]={ 0xc3020b, 0x000104, 0x3c00f0, 0x000c00, 0x003000, 0x00c000 };

12831 unsigned int DaqEventR::SDLengthU(int i){
12832   unsigned int length=0;
12833   if (i<0||i>=6) return length;
12834   for(int k=0;k<24;k++)
12835     if (slaves[i]>>k&1)
12836       length += JLength[k];
12837   return length;
12838 }
```

SD_id_to_name = { 0: "JINFT", 1: "JINFU", 2: "SDR", 3: "JINFR", 4: "JINFE", 5: "JLV1"}

Cluster information in NAIA

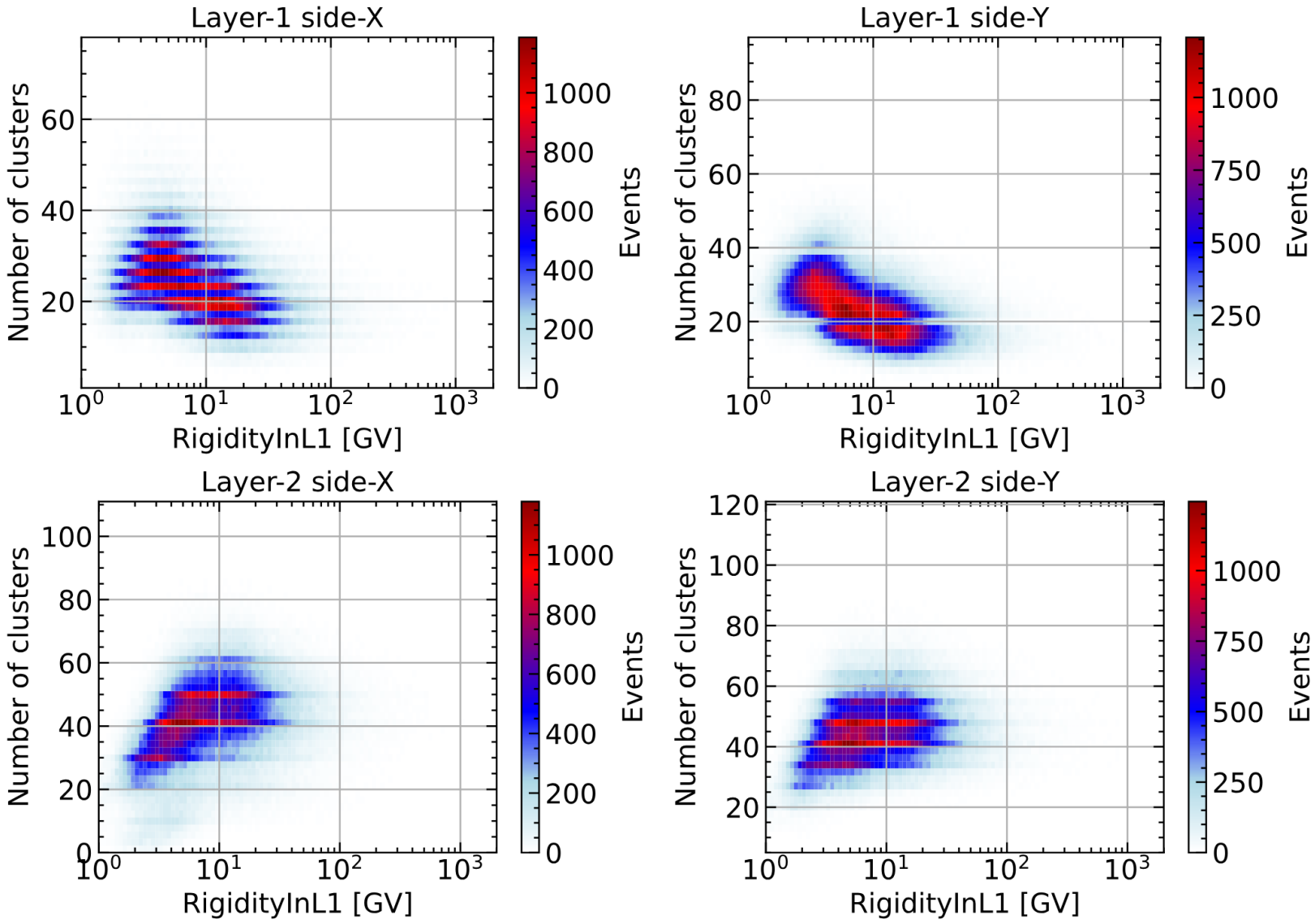
NAIA::TrTrackPlusData::Nclusters
Total number of tracker clusters for each layer, within a given distance from the track, for each side.

Nclusters[layer][DistanceFromTrack::OnTrack][side]
Nclusters[layer][DistanceFromTrack::AllLayer][side]

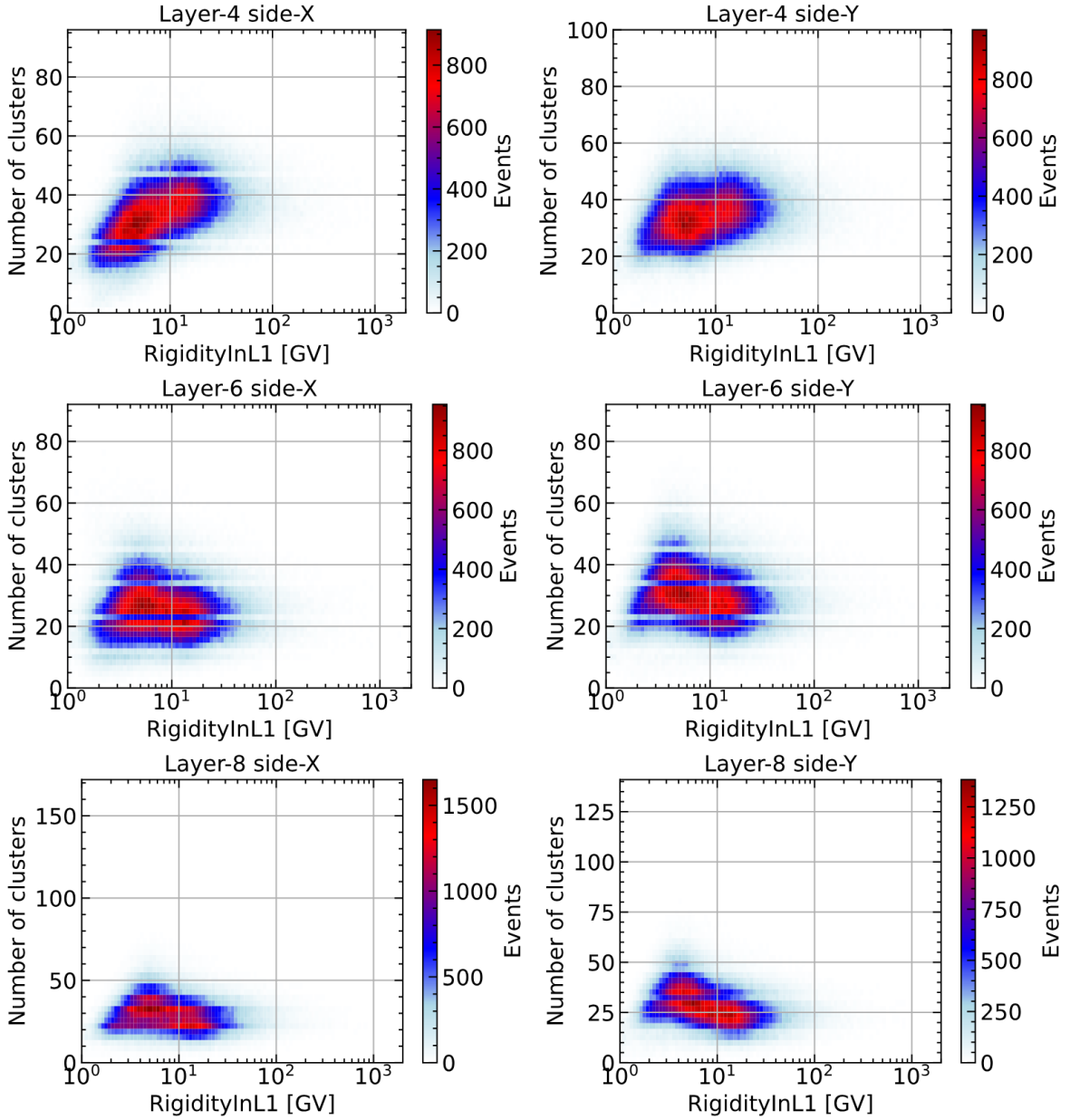
https://gitlab.cern.ch/ams-italy/naia/-/blob/master/src/Containers/TrTrackFill.cpp

```
if (!cluster || cluster->GetLayerJ() != jLayer)
  continue;

float edep = 1000 * cluster->GetEdep();
if (cluster == trackClusterPtrX) {
  NClusters[jLayer - 1][DistanceFromTrack::OnTrack][Side::X]++;
  ClustersEdep[jLayer - 1][DistanceFromTrack::OnTrack][Side::X] += edep;
  continue;
}
if (cluster == trackClusterPtrY) {
  NClusters[jLayer - 1][DistanceFromTrack::OnTrack][Side::Y]++;
  ClustersEdep[jLayer - 1][DistanceFromTrack::OnTrack][Side::Y] += edep;
  continue;
}

if (edep < noiseThreshold)
  continue; // apply a threshold to account for noise

// Deal with multiplicities: Choose closest to track
float clusterDistanceToTrack = std::numeric_limits<float>::max();
for (int im = 0; im < cluster->GetMultiplicity(); im++) {
  AMSPlaneM pl_mult = cluster->GetGCoordN(im);
  TVector3 mglob_mult = pl_mult.getMGlobal();

  clusterDistanceToTrack =
      std::min(clusterDistanceToTrack,
               fabs(static_cast<float>(fitcoo[cluster->GetSide()] - mglob_mult[cluster->GetSide()])));
}

Side side = cluster->GetSide() == 0 ? Side::X : Side::Y;

NClusters[jLayer - 1][DistanceFromTrack::AllLayer][side]++;
ClustersEdep[jLayer - 1][DistanceFromTrack::AllLayer][side] += edep;
if (edep > MaxClusterEdep[jLayer - 1][side]) {
  MaxClusterEdep[jLayer - 1][side] = edep;
  MaxClusterDistance[jLayer - 1][side] = clusterDistanceToTrack;
}
```

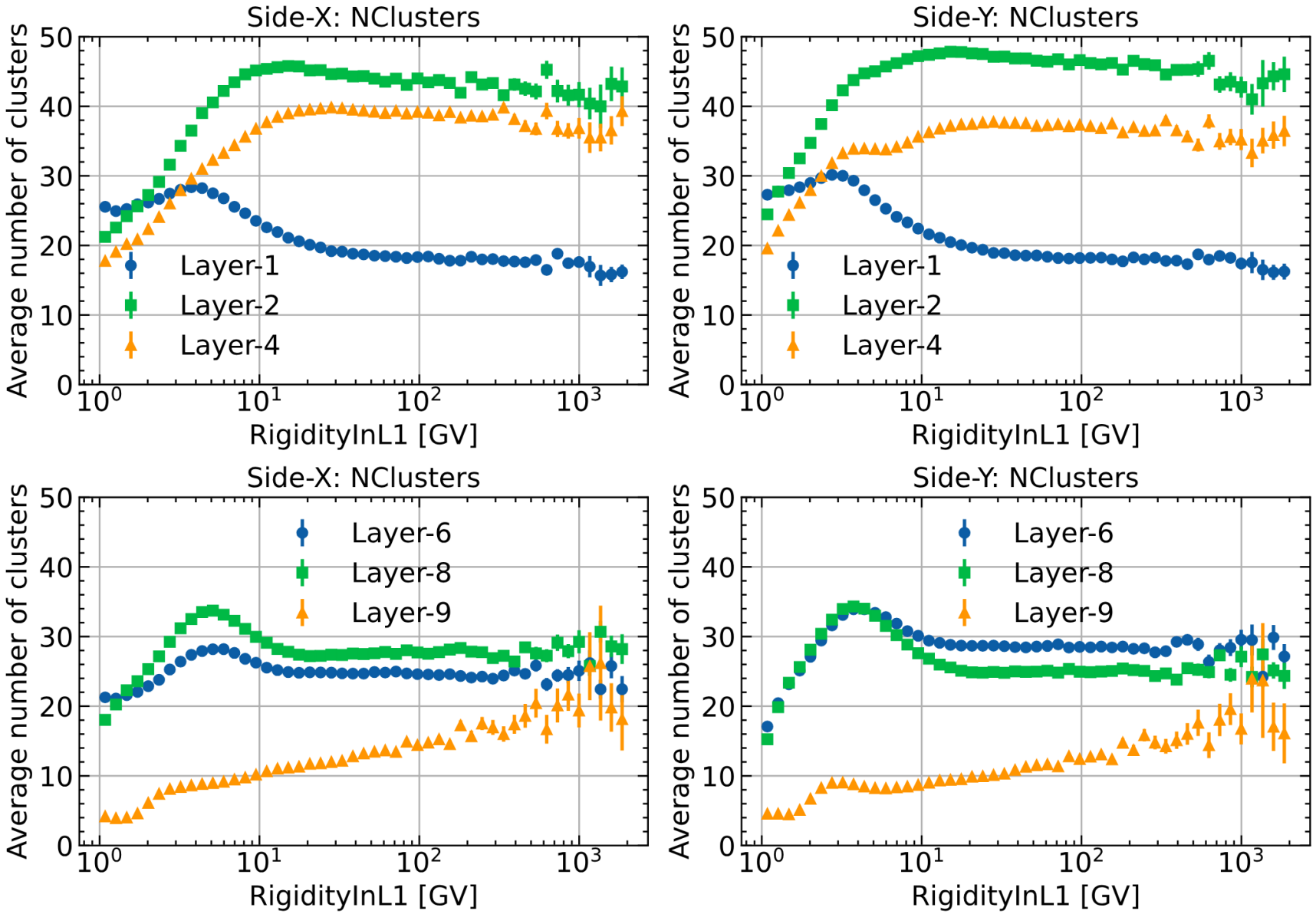
Number of clusters (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)



Number of clusters (Fe L1Inner selection with L1 and Inner Tracker Charge > 25.5)

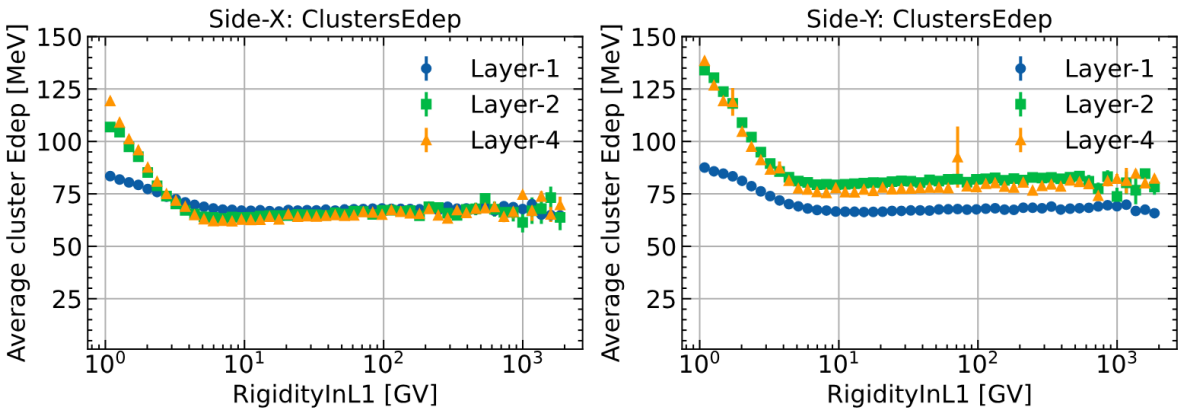


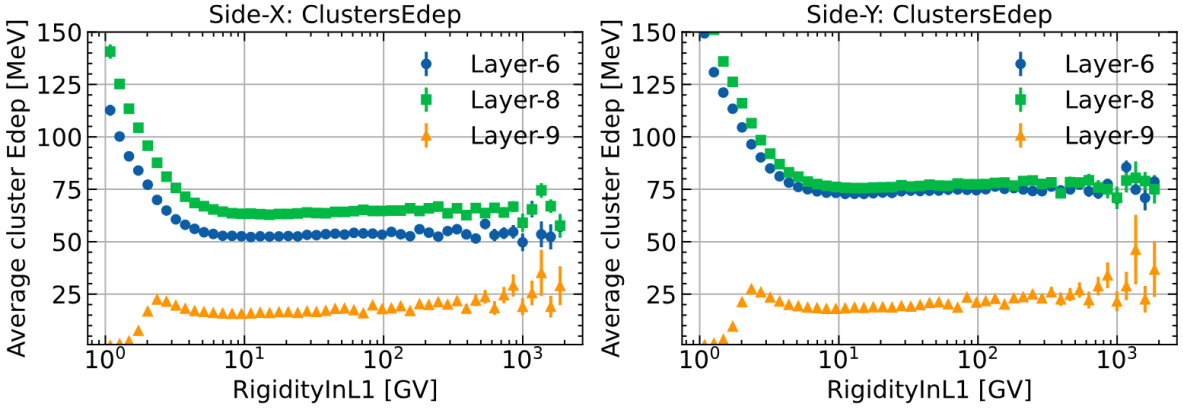
Average number of clusters on each layer



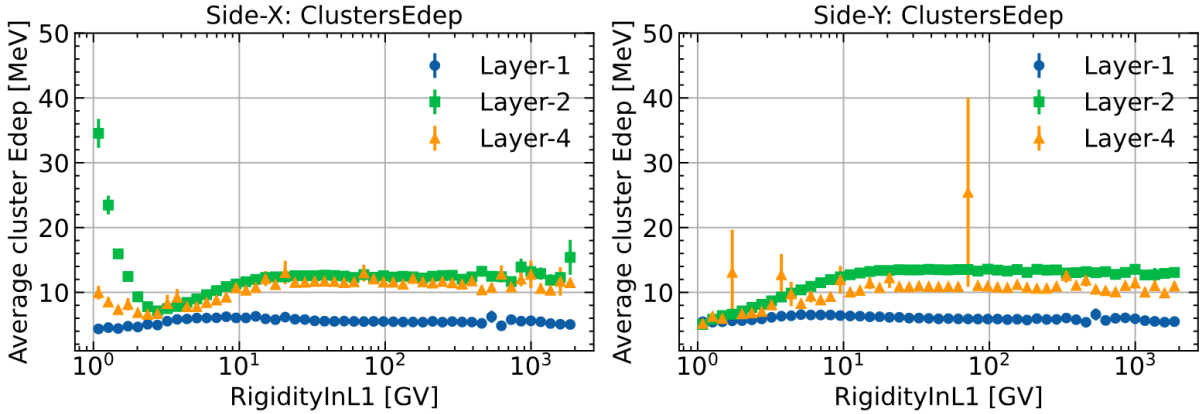
Average Edep (MeV) on different layer and side

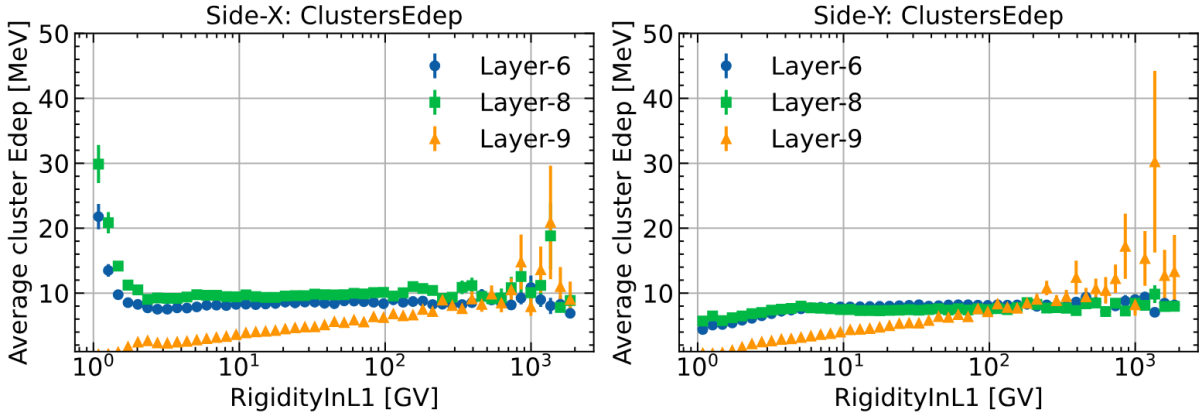
Edep of the cluster on Track
for each layer and side





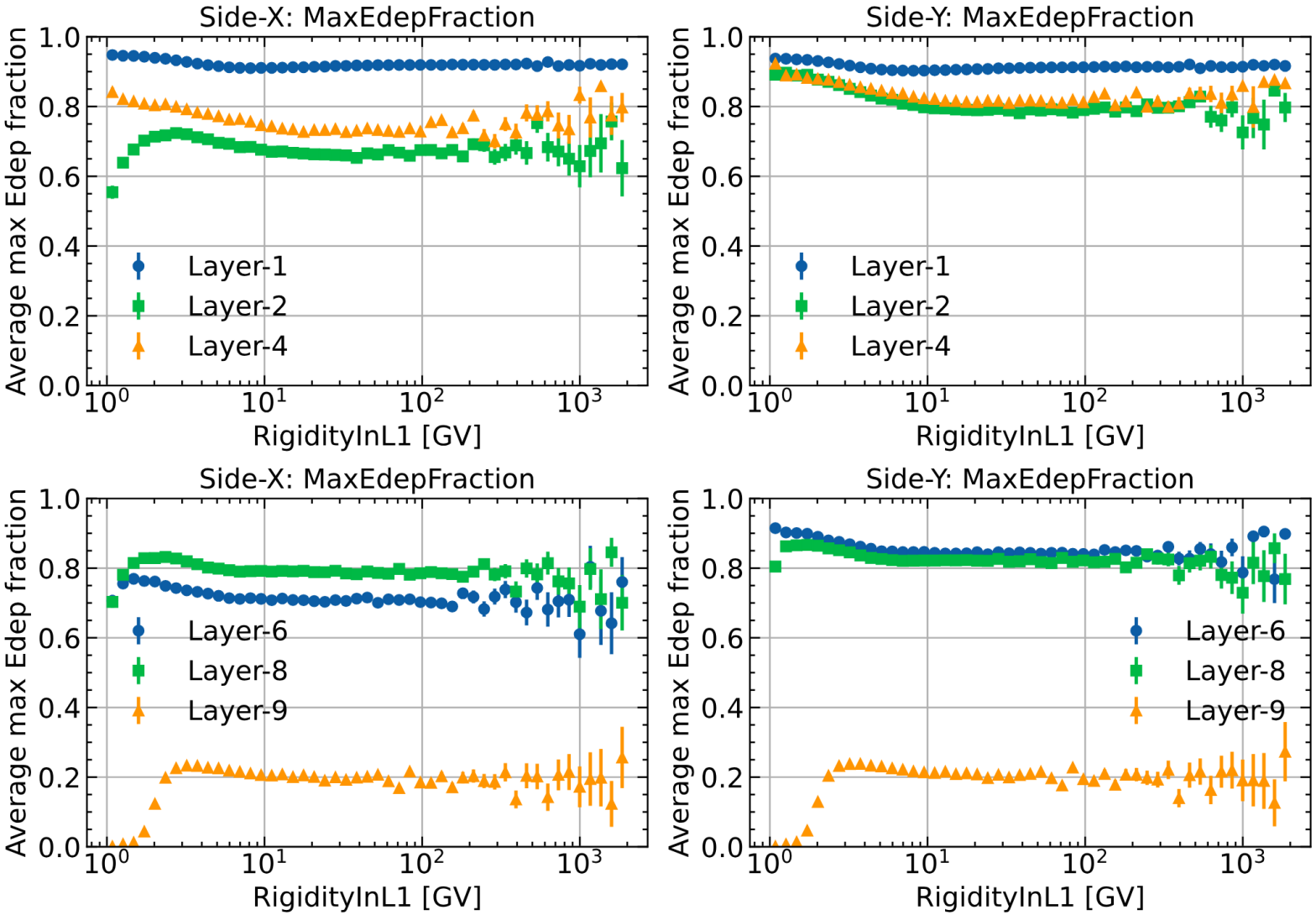
Total Edep of all clusters except the cluster on Track
for each layer and side





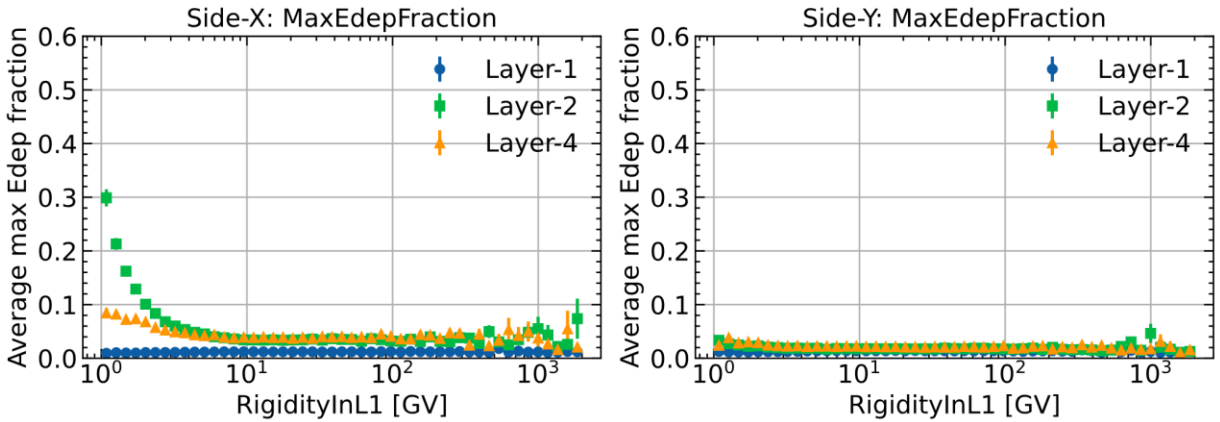
Average (max_Edep / total_Edep) fraction

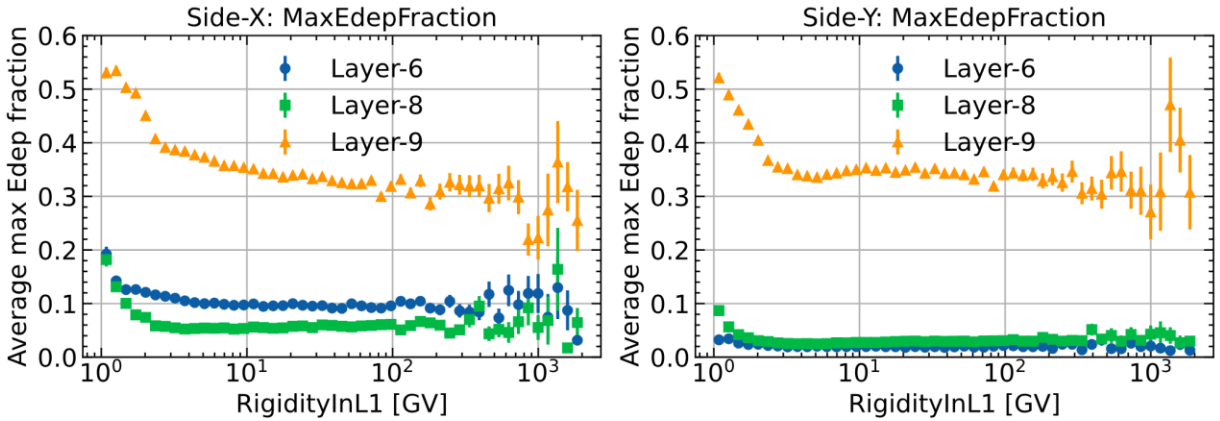
Edep of the cluster on Track / Total Edep
for each layer and side



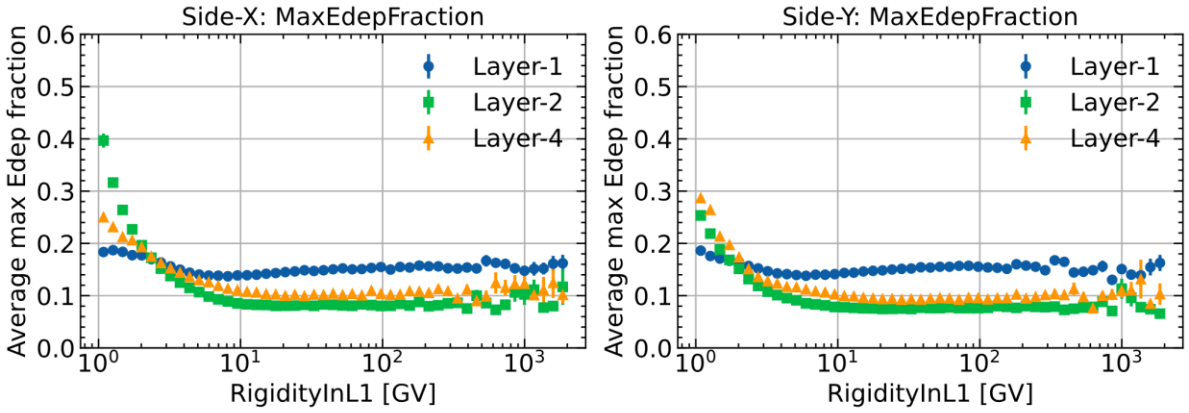
Average Edep fraction

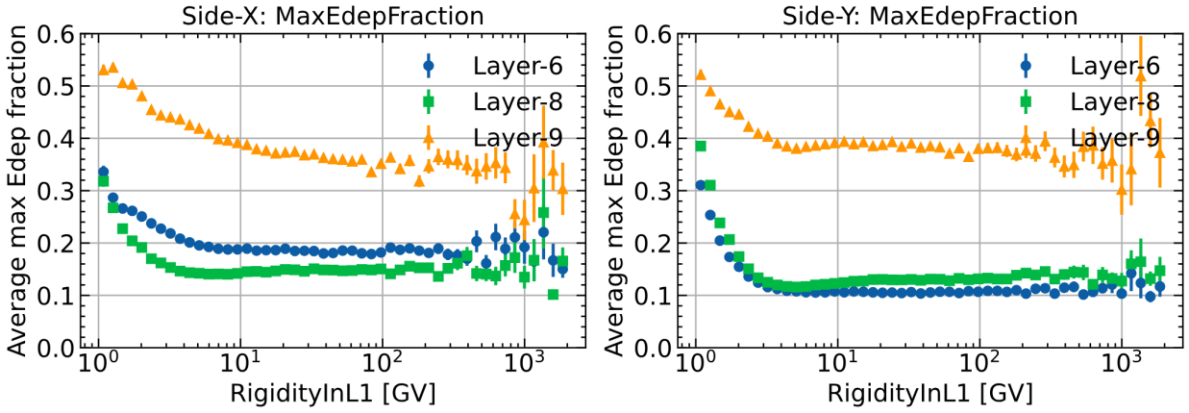
Second Max Edep / Total Edep of all clusters for each layer and side





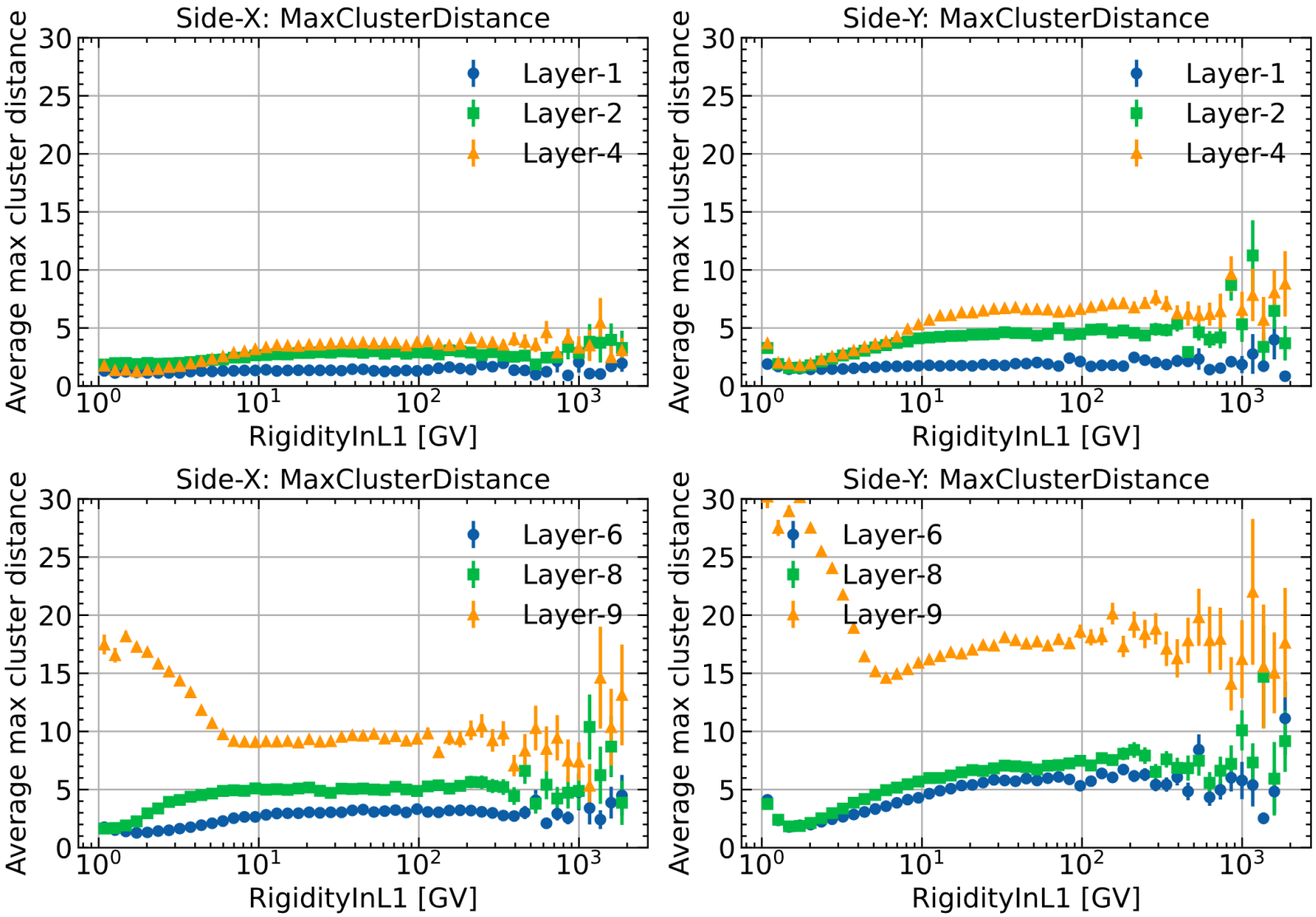
Second Max Edep / Total Edep of all clusters except the cluster on Track for each layer and side





Average max cluster to track distance (cm)

(All clusters except the cluster on Track for each layer and side)



24 ports of JINJ: pairwise comparison (6 of 171 plots)