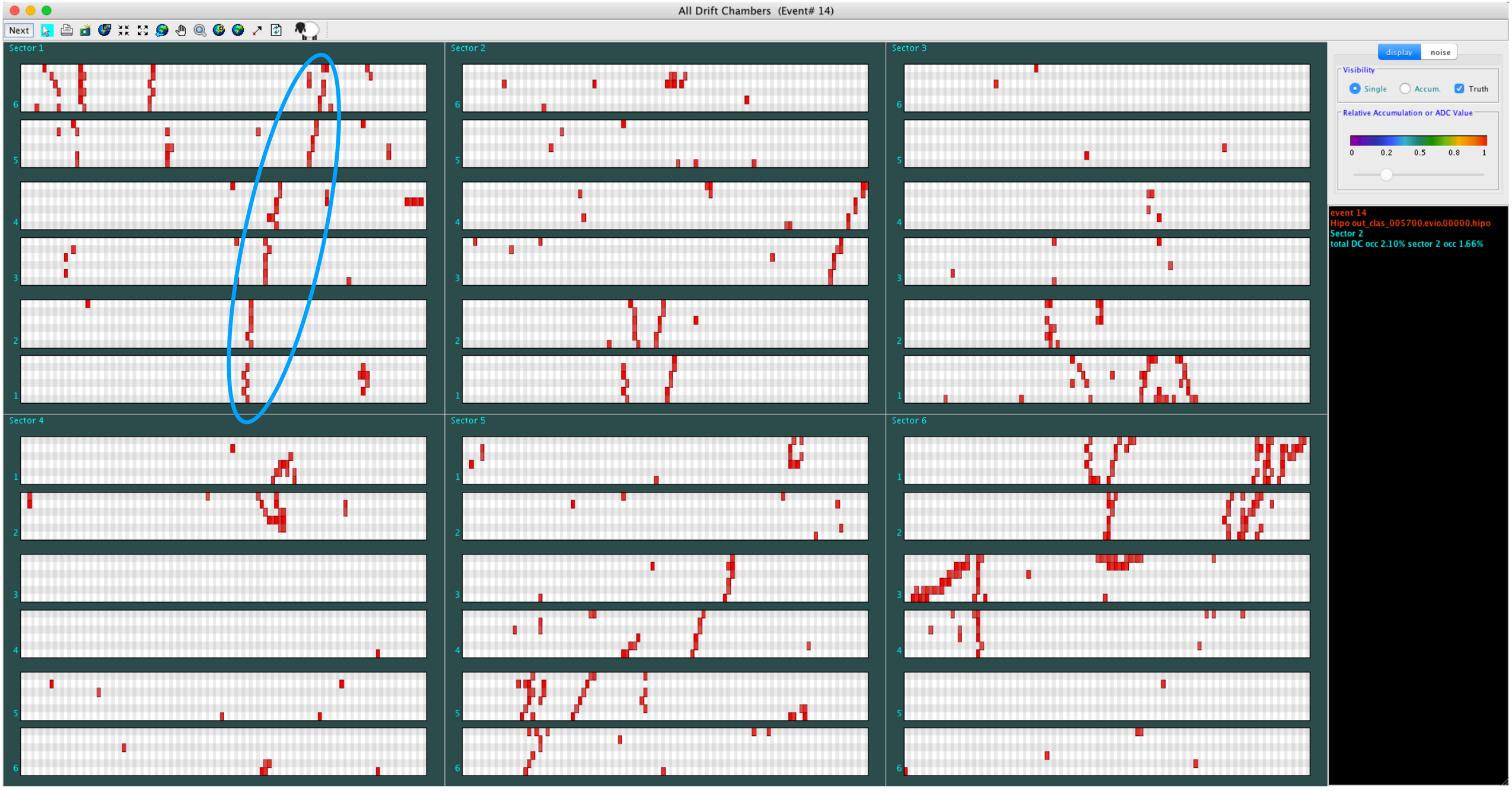
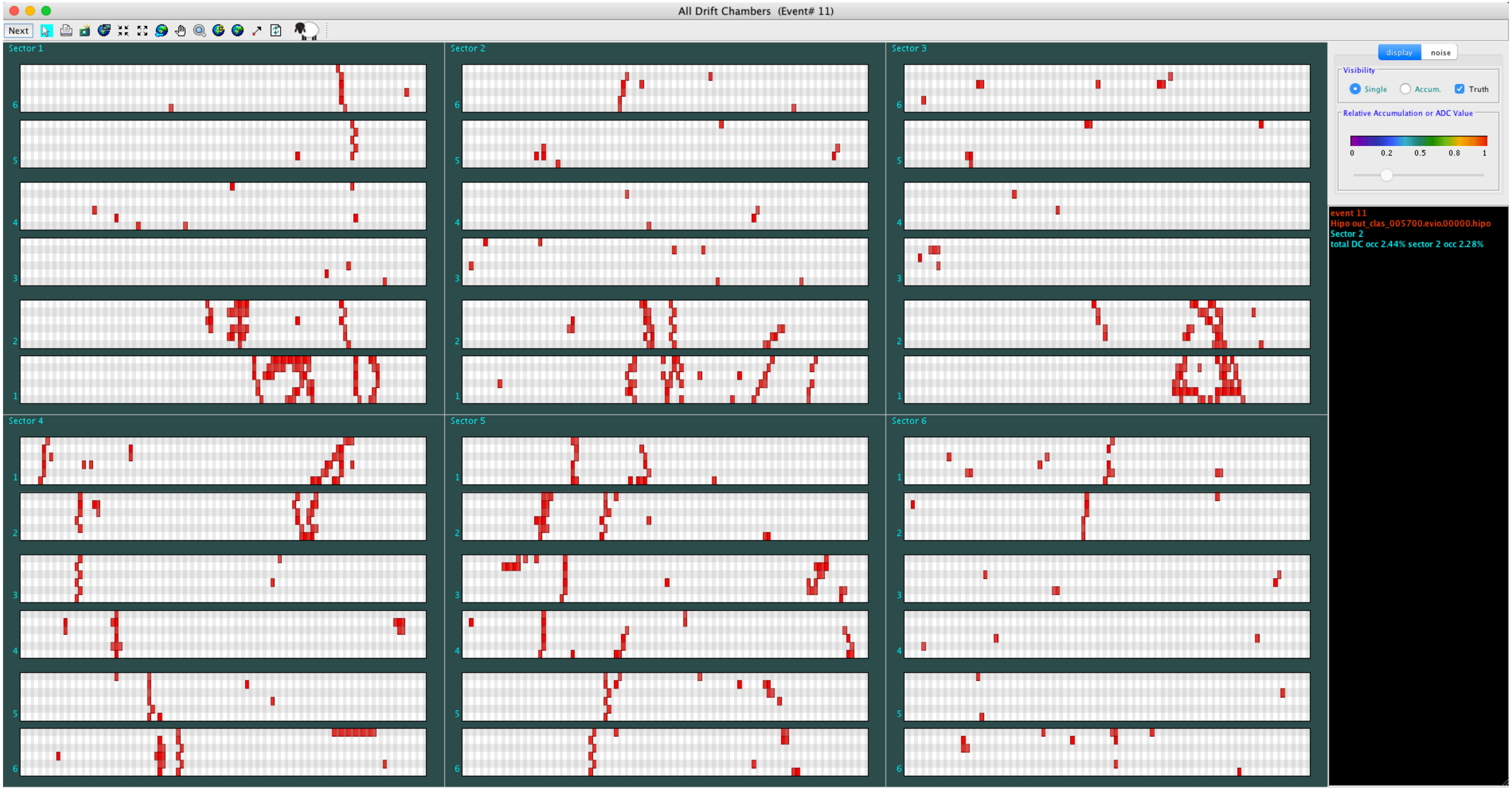
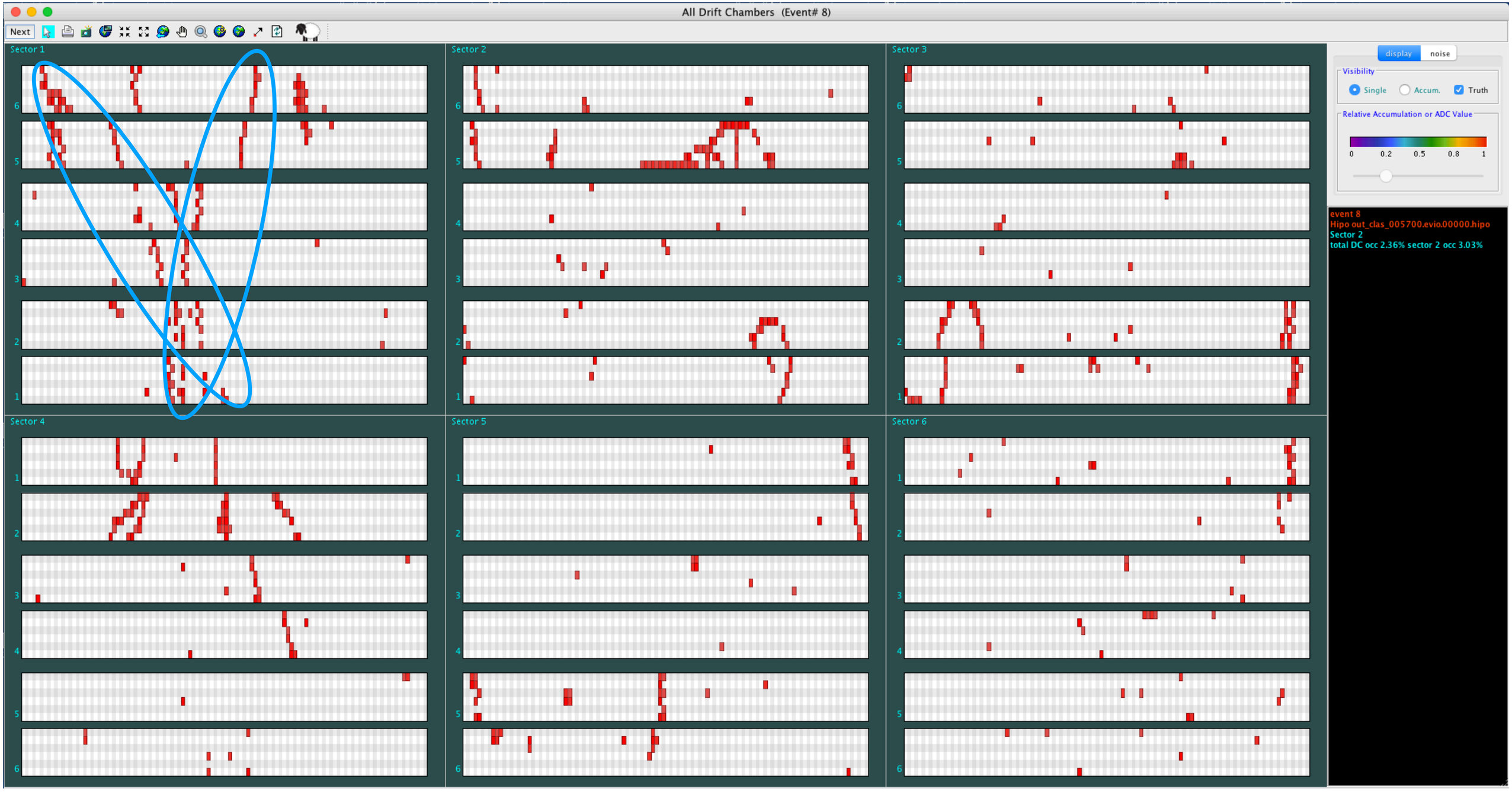
ML for tracking

G.Gavalian Feb. 12, 2019


All Drift Chambers (Event# 14)
Next
Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Sector 6
display
noise
Visibility
Single
Accum.
Truth
Relative Accumulation or ADC Value
0
0.2
0.5
0.8
1
event 14
Hipo out_clas_005700.evio.00000.hipo
Sector 2
total DC occ 2.10% sector 2 occ 1.66%


All Drift Chambers (Event# 11)
Next
Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Sector 6
display
noise
Visibility
Single
Accum.
Truth
Relative Accumulation or ADC Value
0
0.2
0.5
0.8
1
event 11
Hipo out_clas_005700.evio.00000.hipo
Sector 2
total DC occ 2.44% sector 2 occ 2.28%


All Drift Chambers (Event# 8)
Next
Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Sector 6
display
noise
Visibility
Single
Accum.
Truth
Relative Accumulation or ADC Value
0
0.2
0.5
0.8
1
event 8
Hipo out_clas_005700.evio.00000.hipo
Sector 2
total DC occ 2.36% sector 2 occ 3.03%

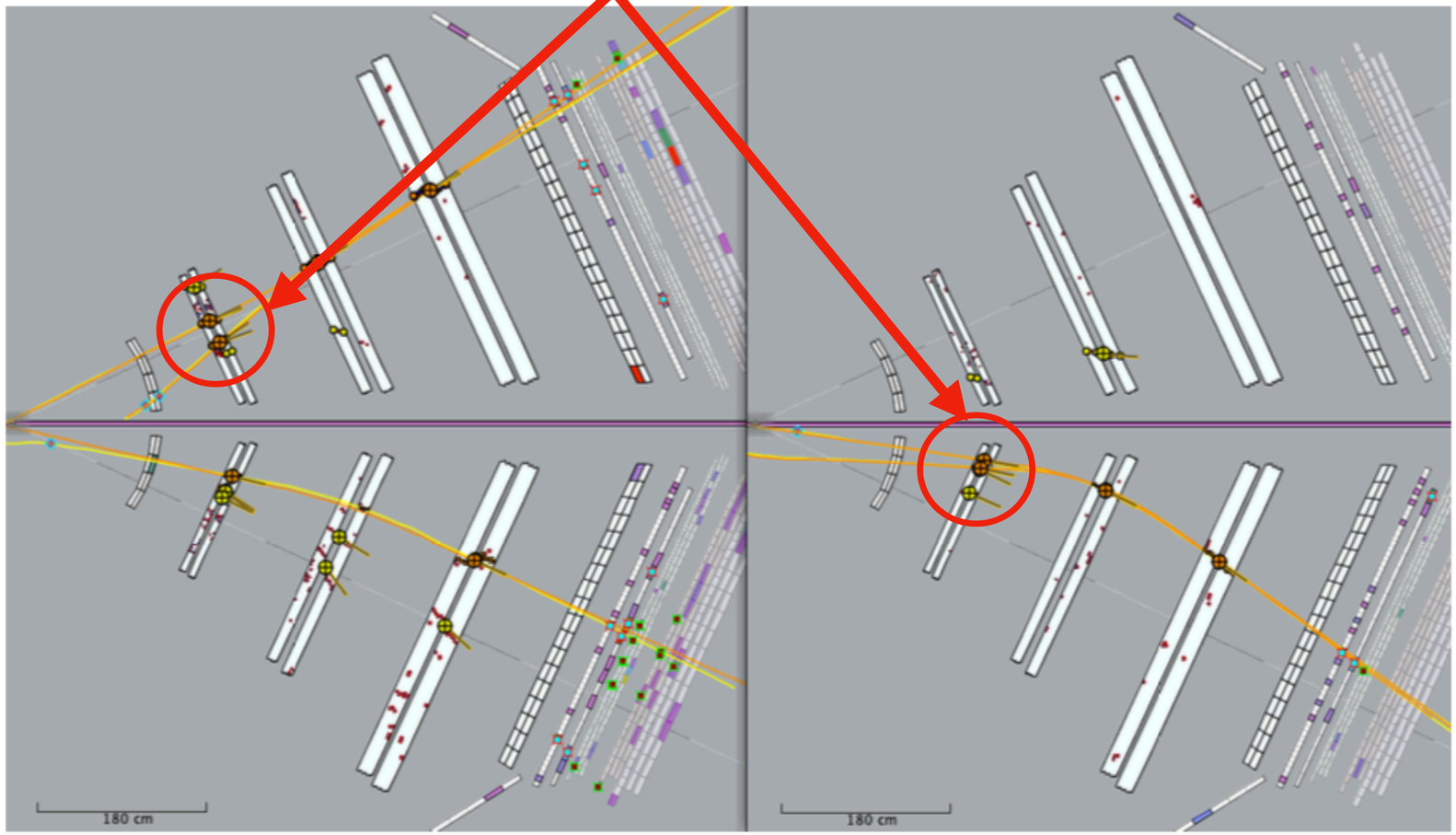
Reducing Data

- Identifying events where there are no tracks, can reduce data size by 30%.

Type of Events	Count	Percent
Events in the File	144076	100%
Events with Hit Based Tracks	119867	83%
Events with Time Based Tracks	103929	72%

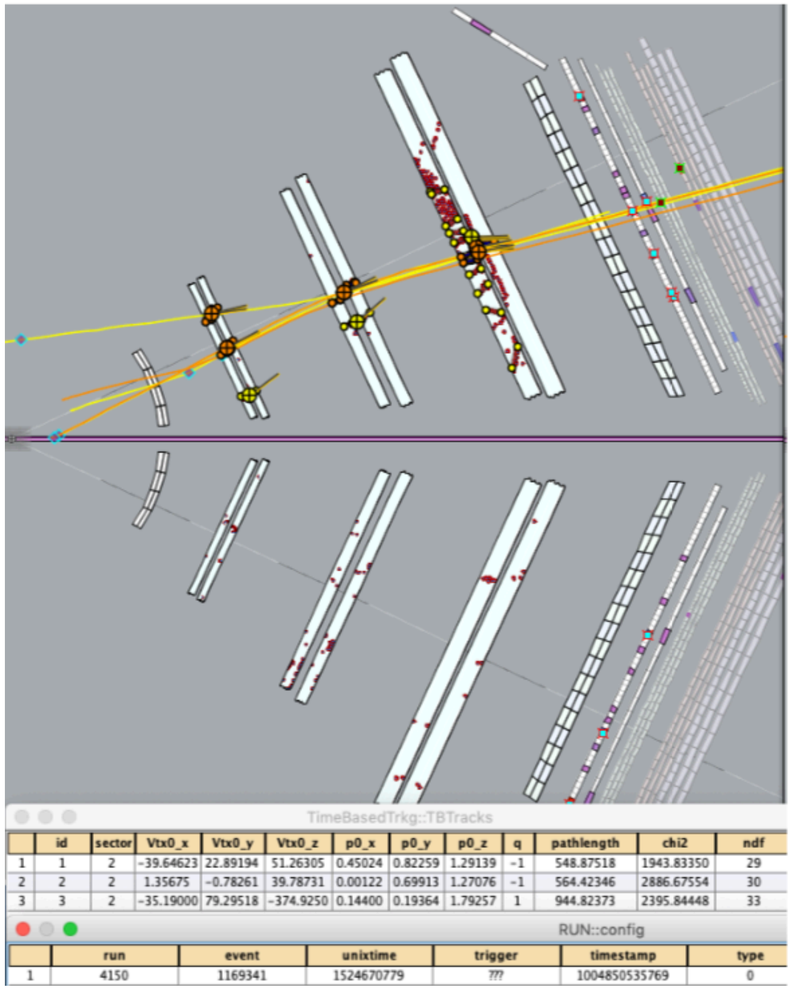
High Luminosity

Combinatorics forces tracking code to run through many tracks to find real ones



High Luminosity

Four track combinations were considered where there are none.



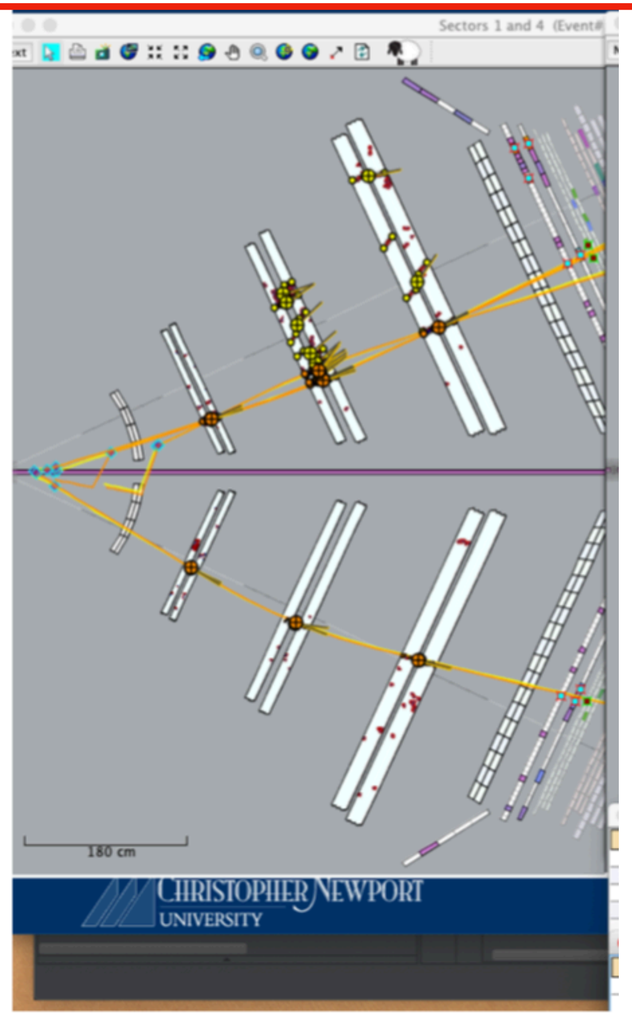
TimeBasedTrkg::TBTracks

	id	sector	Vtx0_x	Vtx0_y	Vtx0_z	p0_x	p0_y	p0_z	q	pathlength	chi2	ndf
1	1	2	-39.64623	22.89194	51.26305	0.45024	0.82259	1.29139	-1	548.87518	1943.83350	29
2	2	2	1.35675	-0.78261	39.78731	0.00122	0.69913	1.27076	-1	564.42346	2886.67554	30
3	3	2	-35.19000	79.29518	-374.9250	0.14400	0.19364	1.79257	1	944.82373	2395.84448	33

RUN::config

	run	event	unixtime	trigger	timestamp	type
1	4150	1169341	1524670779	???	1004850535769	0

Four track combinations were considered where there is one.



Benefits of ML

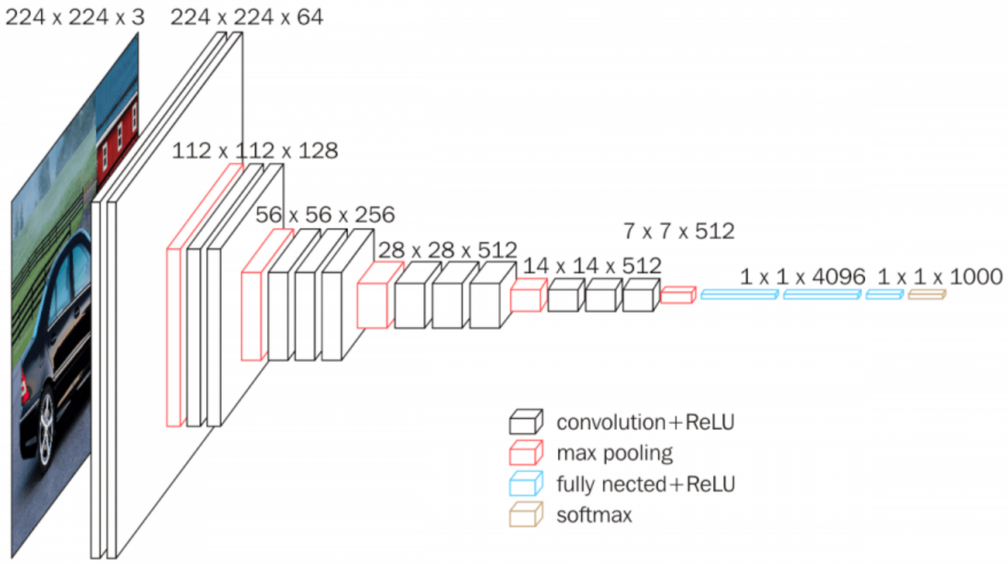
- **Data Reduction:**
  - If the events with no tracks are identified during writing of the data, the data volume will be reduced significantly.
- **Tracking Speed:**
  - If we can match crosses to the right tracks, it will eliminate need for combinatorics.
  - Especially for high luminosity runs this will reduce tracking time for up to 40%.
- **Tracking Speed (more):**
  - If we can calculate state vectors from the pattern in the drift chamber, this will reduce number of iterations needed for Kalman-Filter.
  - Potentially very big gain in speed (don’t have estimates yet)

VGG16

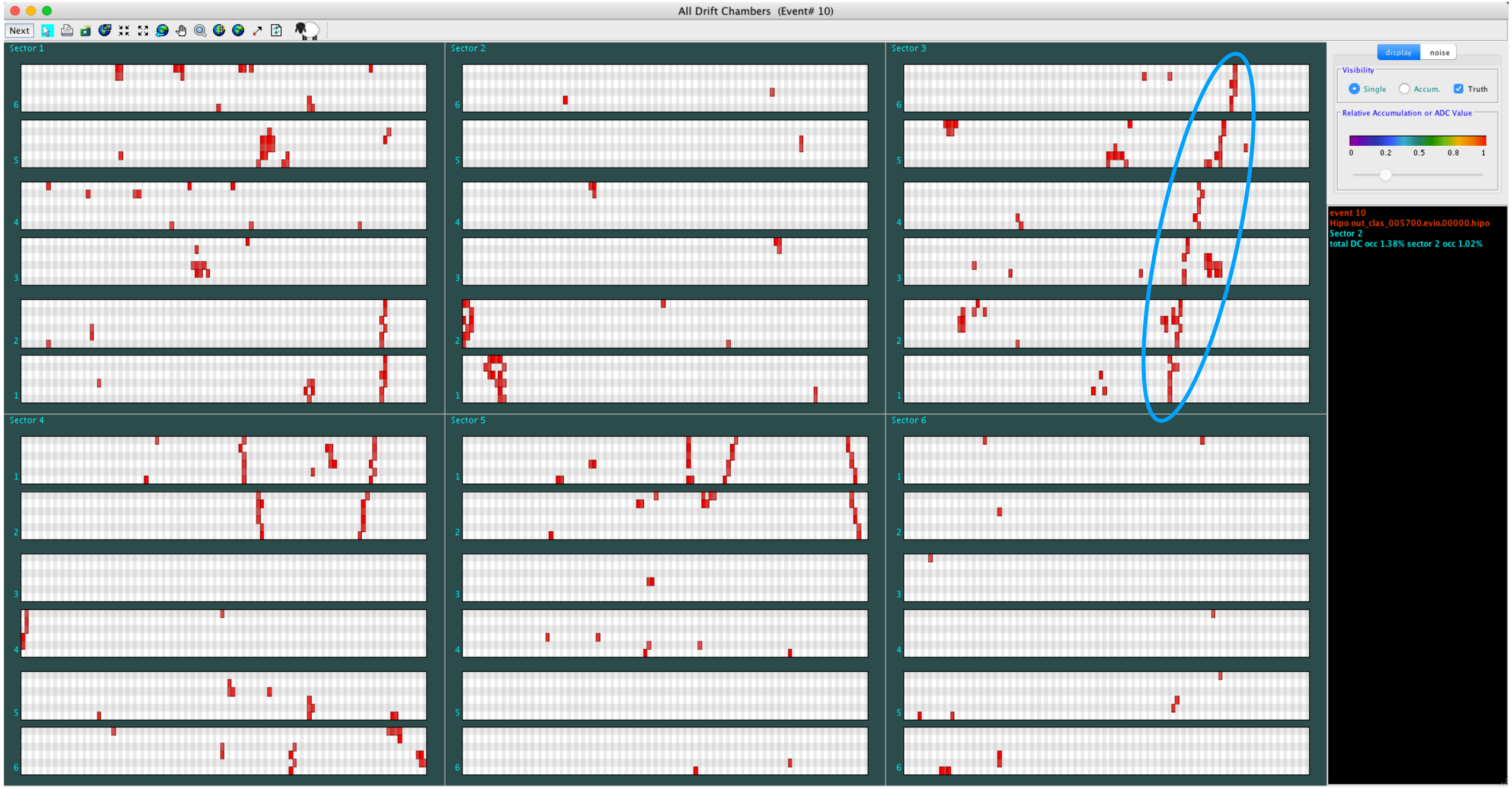
- **Pilot project**
  - We can start with pre-trained VGG16 architecture to identify tracks in our drift chambers.
  - reduce the data sample that tracking has to work with.
  - Using Adversarial Neural Network we can clean up the hits that belong to the tracks:
  - reducing number of combinatorics.

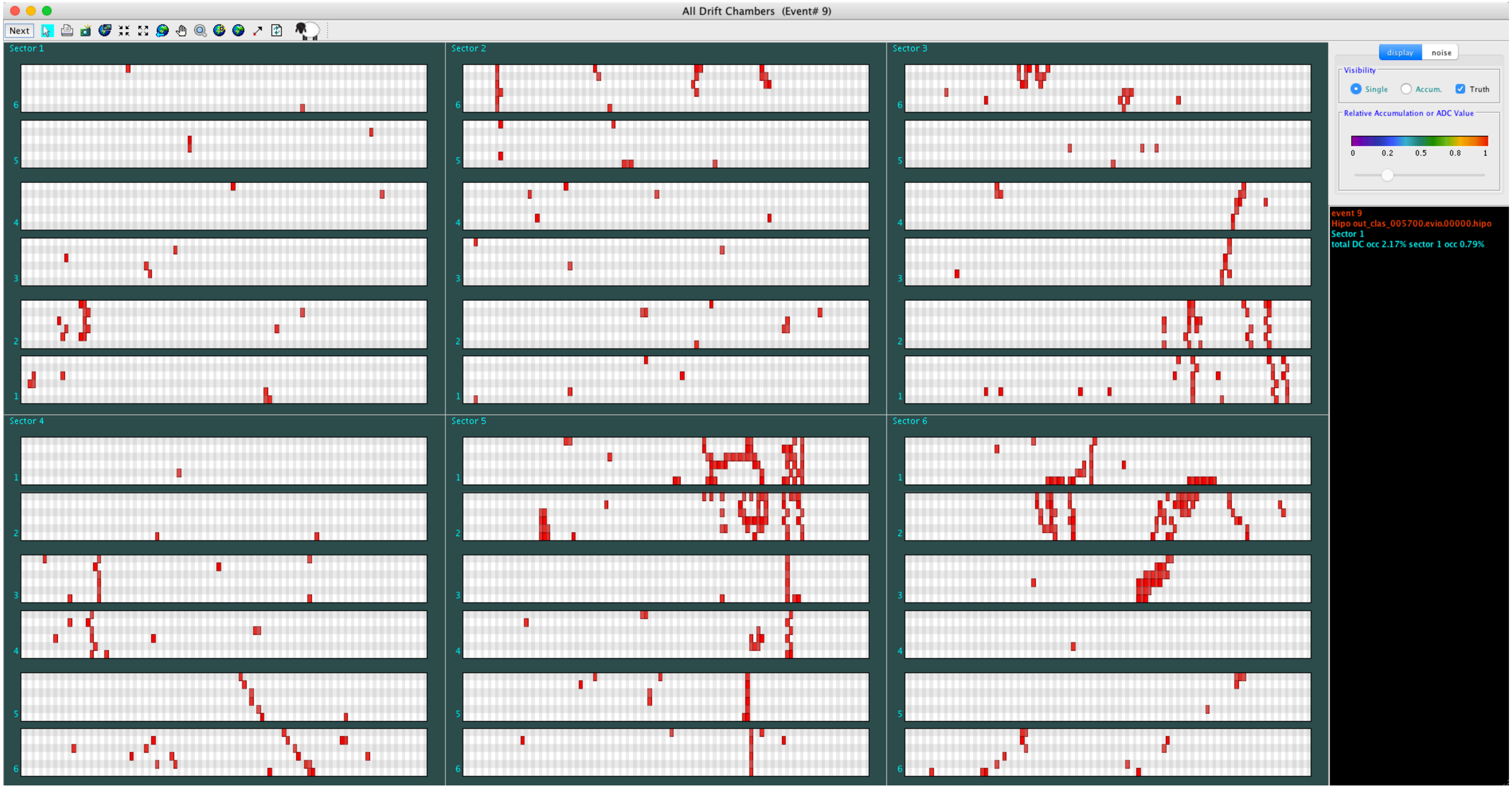
- **Extension:**

  - Use regression network on the top to calculate track parameters and pass it to tracking code to minimize Kalman-Filter iterations.



BACKUP SLIDES


All Drift Chambers (Event# 10)
Next
Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Sector 6
display
noise
Visibility
Single
Accum.
Truth
Relative Accumulation or ADC Value
0
0.2
0.5
0.8
1
event 10
Hipo out_clas_005700.evio.00000.hipo
Sector 2
total DC occ 1.38% sector 2 occ 1.02%


All Drift Chambers (Event# 9)
Next
Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Sector 6
display
noise
Visibility
Single
Accum.
Truth
Relative Accumulation or ADC Value
0
0.2
0.5
0.8
1
event 9
Hipo out_clas_005700.evio.00000.hipo
Sector 1
total DC occ 2.17% sector 1 occ 0.79%

2	2	116	1	156.2157	-1.35287	485.472(	-0.38321	-8.90391	-0.92366	189.232)	-1.27585	564.9657	0.38371	8.97201E	0.92345	38.51637	-1.75740	180.6514	3.83077	0.01798	10.52544	-7.9672(	-1.91219	74.86762	3.83555	-0.0104(	10.52371	4	5	-1	1
3	3	116	1	156.4636	0.43488	485.3563	-0.39738	3.13278E	-0.91765	190.7437	0.40754	564.2606	0.39893	-3.2032:	0.91698	49.4042(	0.62181	175.5732	0.98819	-0.0010(	3.51879	0.00145	0.84441	-0.4255:	0.97792	-0.1436:	3.51873	6	7	-1	1