Gamma bg and pileup

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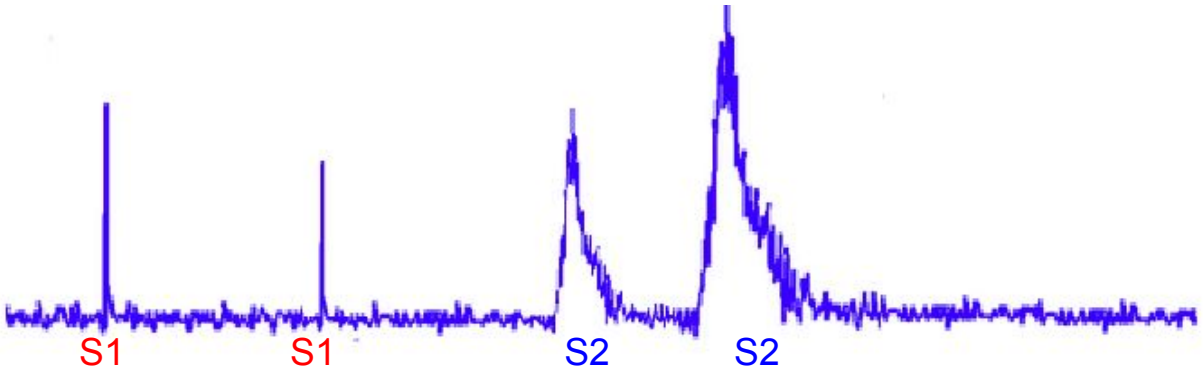
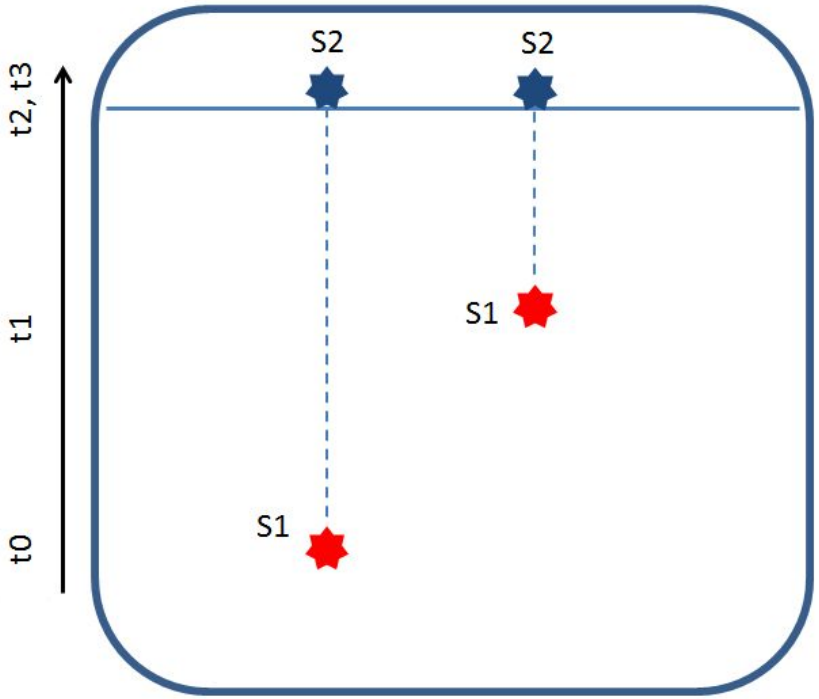
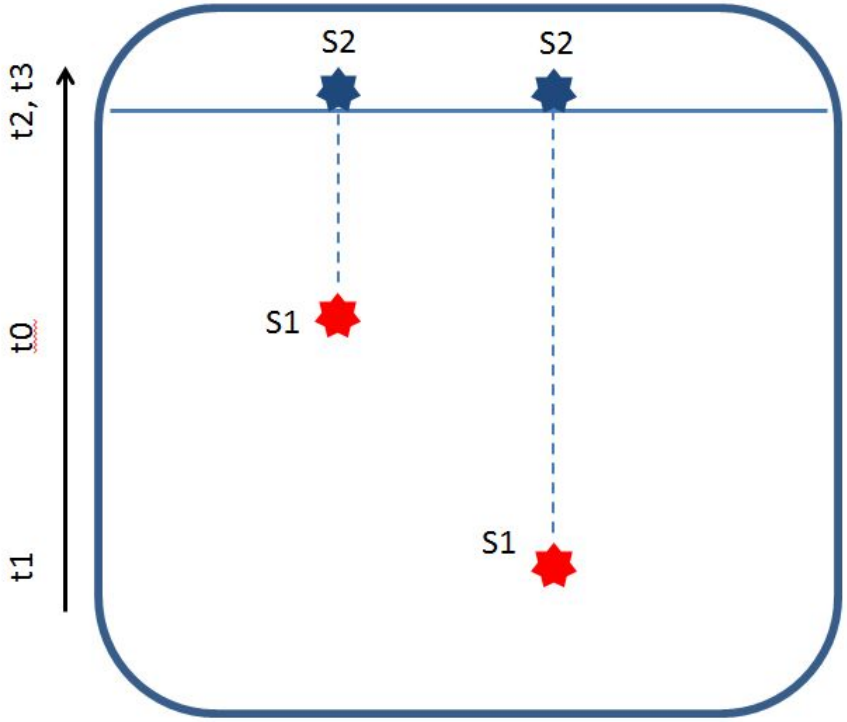
Linking the S2 charge signal to the right S1







Quick facts:

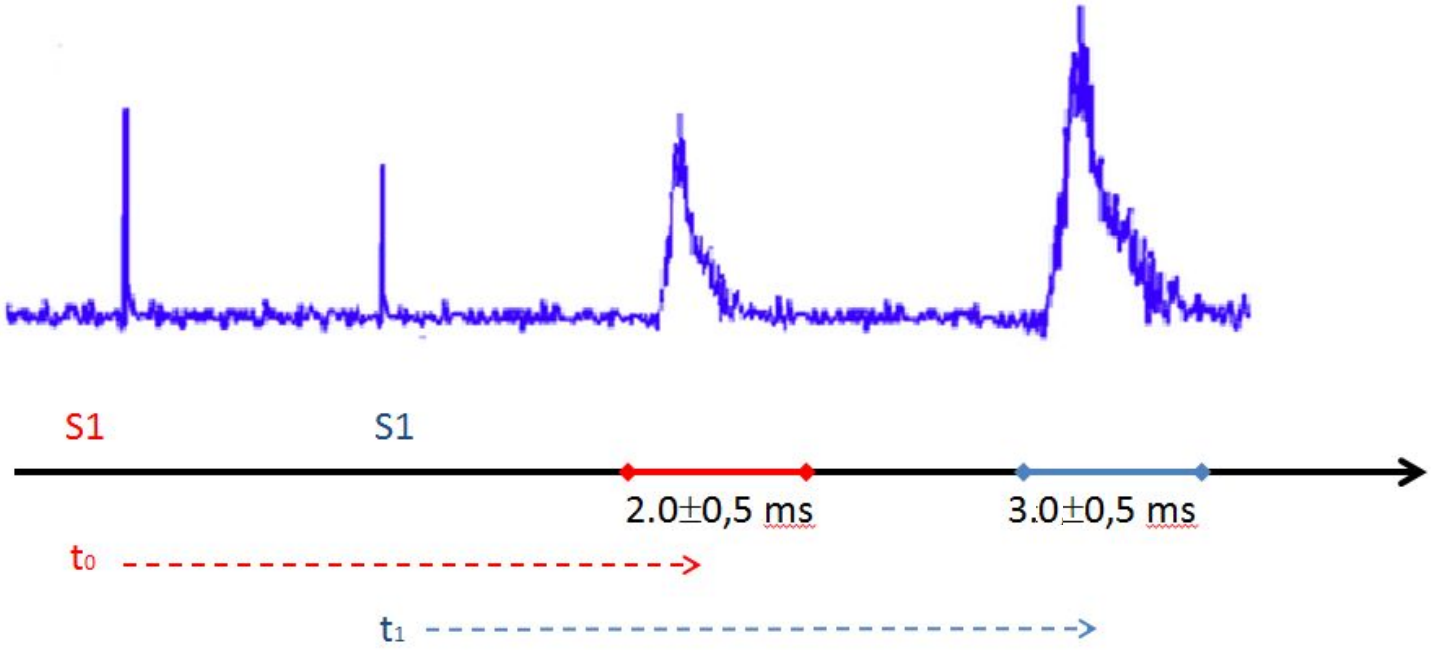
- We don't want another S1 during the drift in order to get rid of this ambiguity
- TPCs are “slow” detectors with large drift distances (up to some ms drifts)
- This widely limits the maximum allowed interaction rate in the TPC
- … setting very stringent limits on the material contamination (gamma)

Possible fix?

- Reducing the drift time (larger fields, less S1…)
- Position reconstruction from S1

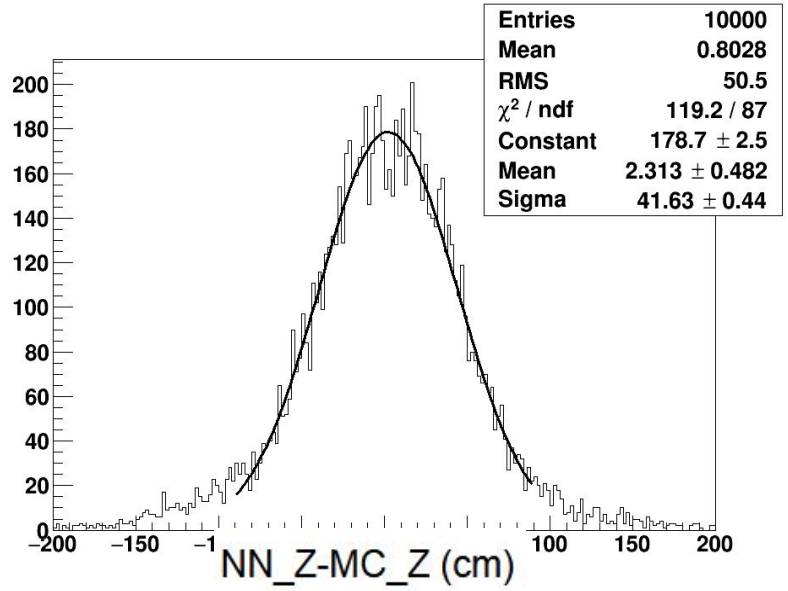
Possible fix?

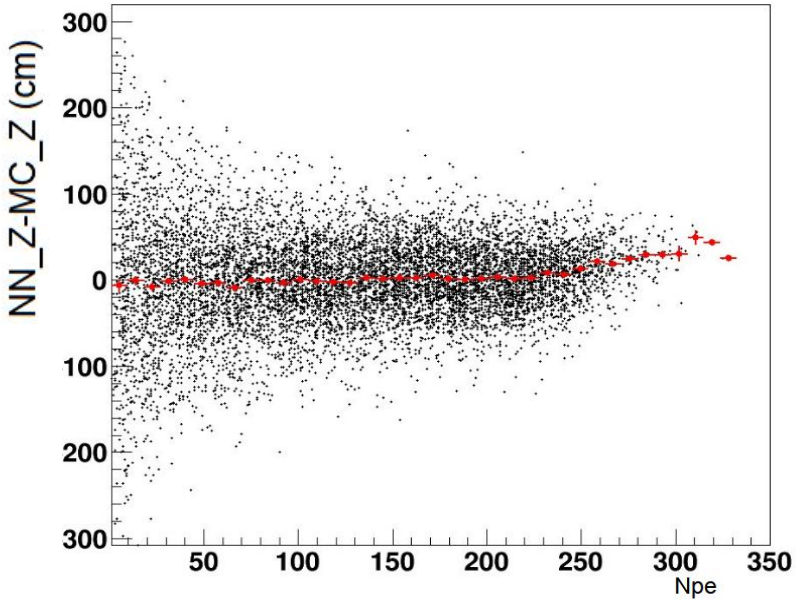
- In case we are able to reconstruct the z (possibly x,y) coordinate from the S1 light pattern, we can unambiguously associate S1 and S2 if the events are spatially separated
- In this case, we have a certain time window in which the S2 corresponding to a specific S1 is expected

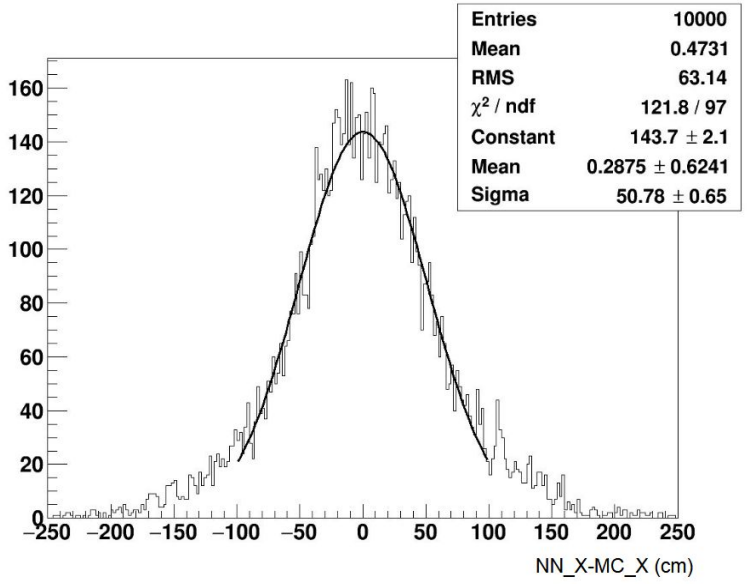


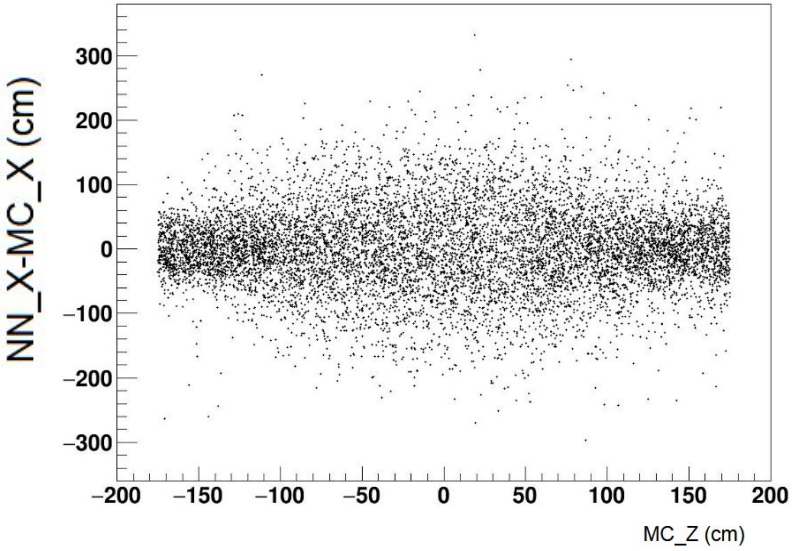
This could considerably relax the maximum event rate we can handle and the requirements on the event rate/material contamination

S1 position reconstruction with ANN: algorithm trained (MC) with the light pattern signal









First conclusions:

- We still do not have an estimation of the event rate in the TPC: it could be ~100 of Hz
- WE DO NEED TO GET POSITION INFORMATION FROM S1
- It is possible to reconstruct the x,y,z position from the S1 light pattern: this is fundamental to link an S2 to the right S1
- The resolution strongly depends on total charge and position
- Additional work required on the MC and the algorithm

Questions:

- What is the current pileup probability? What level is acceptable?

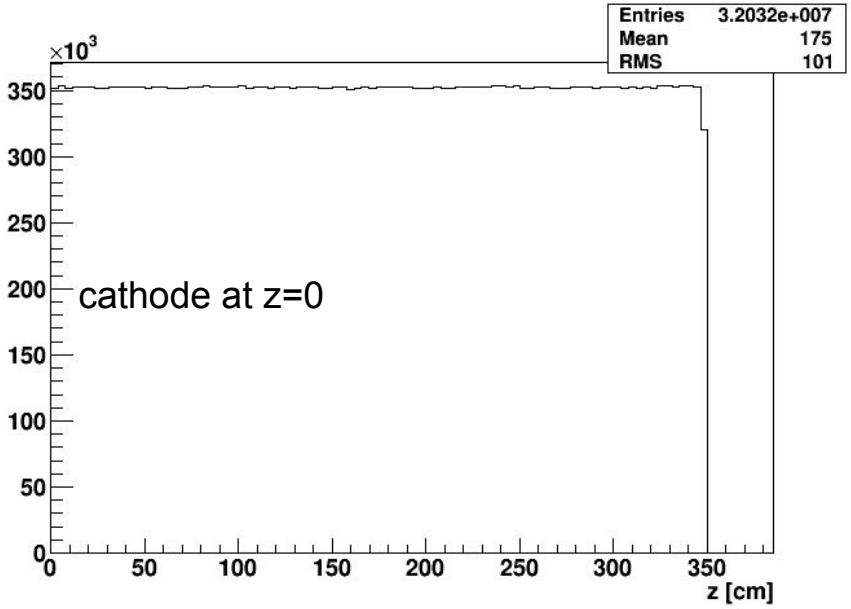
- How much does the pileup probability change with the $S1_{xyz}$ resolution?

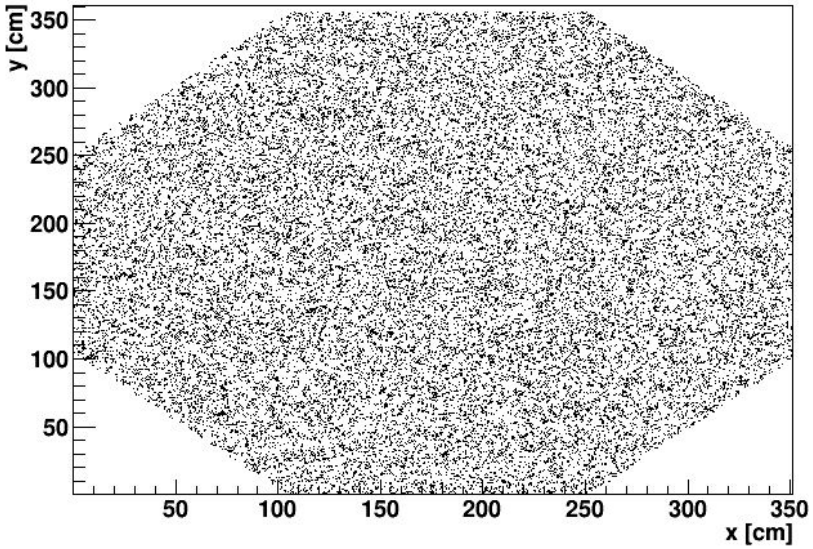
- What $S1_{xyz}$ resolution is necessary in order to have a certain pileup probability at most?

Simple MC event generator:

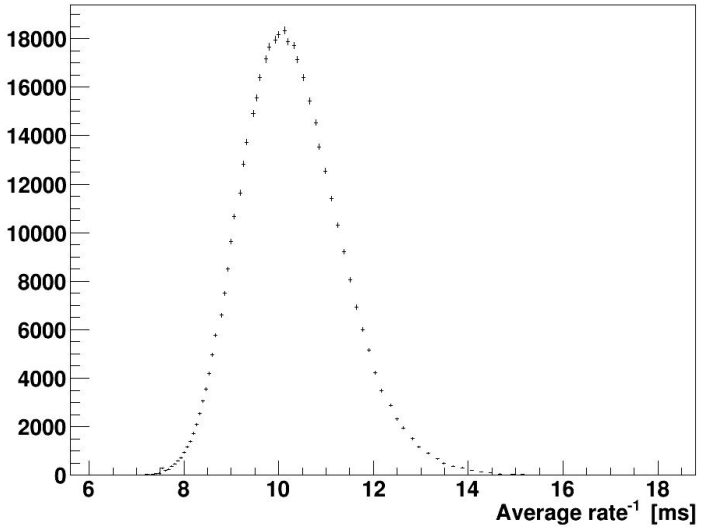
Maximum drift [ms] | Rate [Hz] | Rate [ms] | Eventime | Position x,y,z_{123} [cm] | #S2 | Drift time [ms]

Row	dtmax	rt	tm	s1ms	x	y	z1	z2	z3	Ns2	s2ms1	s2ms2	s2ms3
0	0.5	50	20.408163	0	229.66995	355.16290	349.90960	0	0	1	0.4998708	0	0
1	0.5	50	20.833334	11.535420	139.71221	113.94720	57.018455	98.916229	0	2	11.616875	11.676729	0
2	0.5	50	20.833334	31.742656	334.26171	98.484970	331.52038	81.079788	0	2	32.216259	31.858484	0
3	0.5	50	23.809524	54.244476	194.07826	330.74429	169.74076	0	0	1	54.486961	0	0
4	0.5	50	17.241378	62.271736	34.746334	189.73996	335.11694	260.50686	0	2	62.750473	62.643890	0
5	0.5	50	14.925373	63.317779	103.75193	254.65863	189.01527	0	0	1	63.587802	0	0
6	0.5	50	17.857143	91.488433	20.504861	123.80440	258.98355	0	0	1	91.858413	0	0
7	0.5	50	19.230770	95.681610	207.94230	182.16857	265.98031	0	0	1	96.061584	0	0
8	0.5	50	18.867923	123.58232	316.18920	169.39231	230.52281	0	0	1	123.91163	0	0
9	0.5	50	18.518518	127.65071	244.70748	95.213188	110.47316	0	0	1	127.80854	0	0

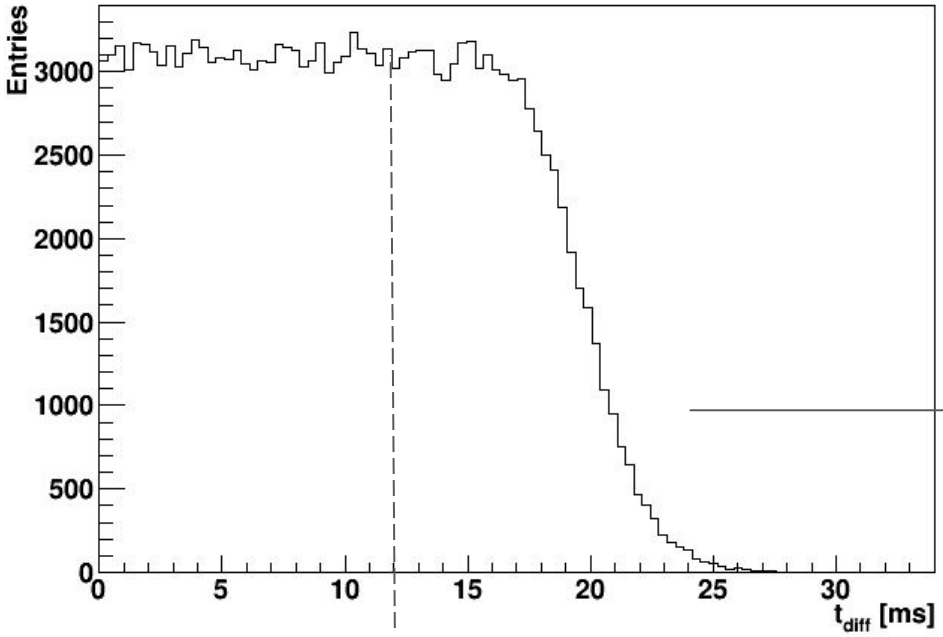




Simple MC event generator:



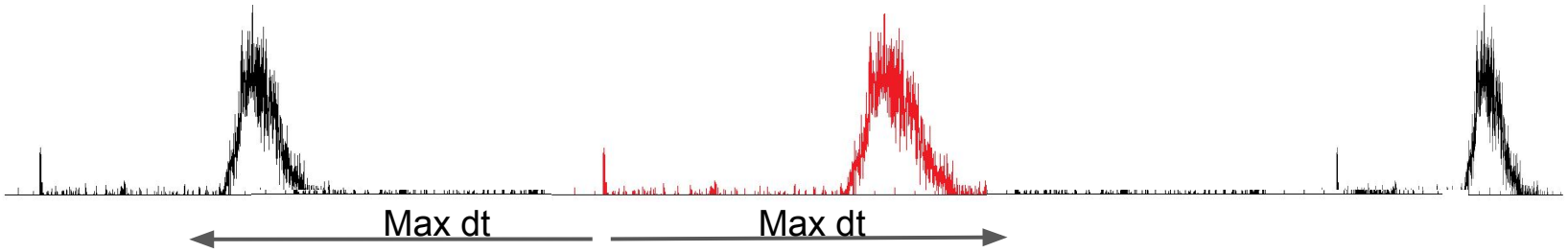
- Event extracted uniformly between [0, 2×1/rate] (flat)



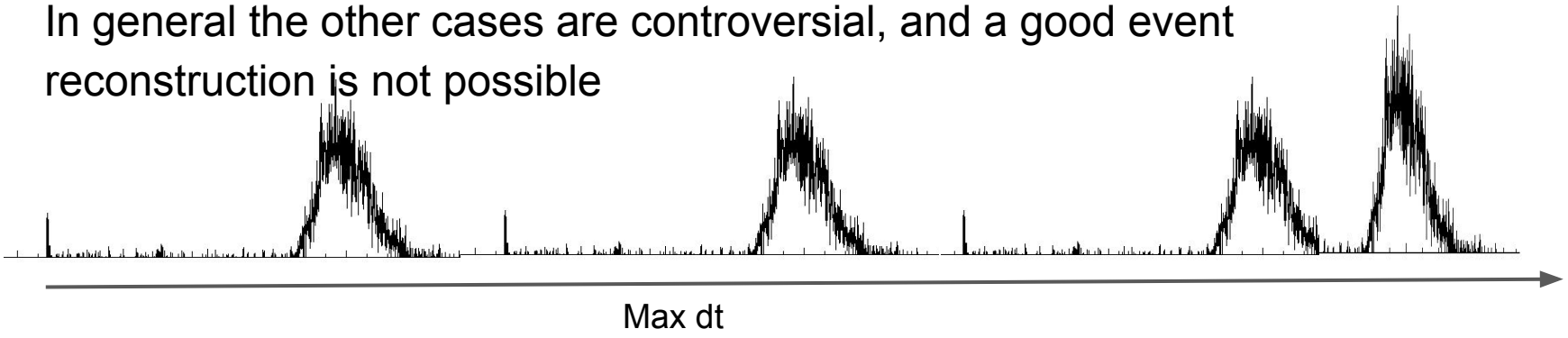
Additional Poisson smearing of the average rate

Cases:

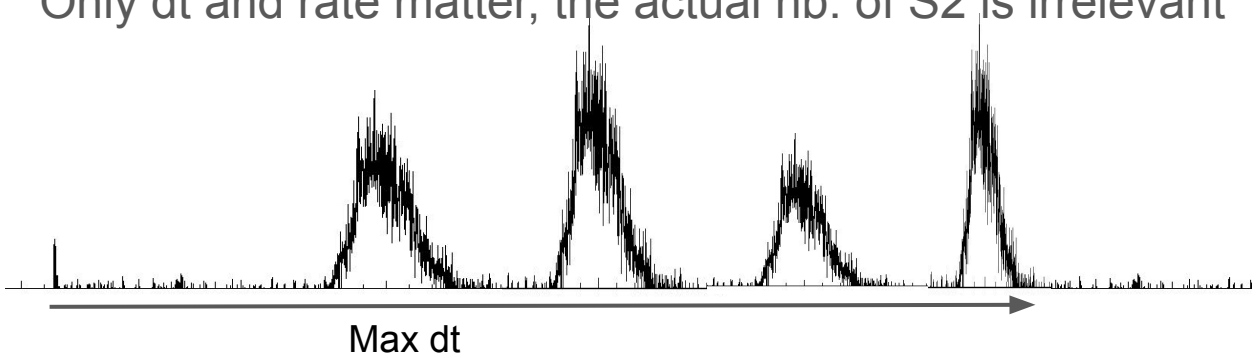
- 2×(Max dt) “clean” time windows (empty of other S1) → Good Event

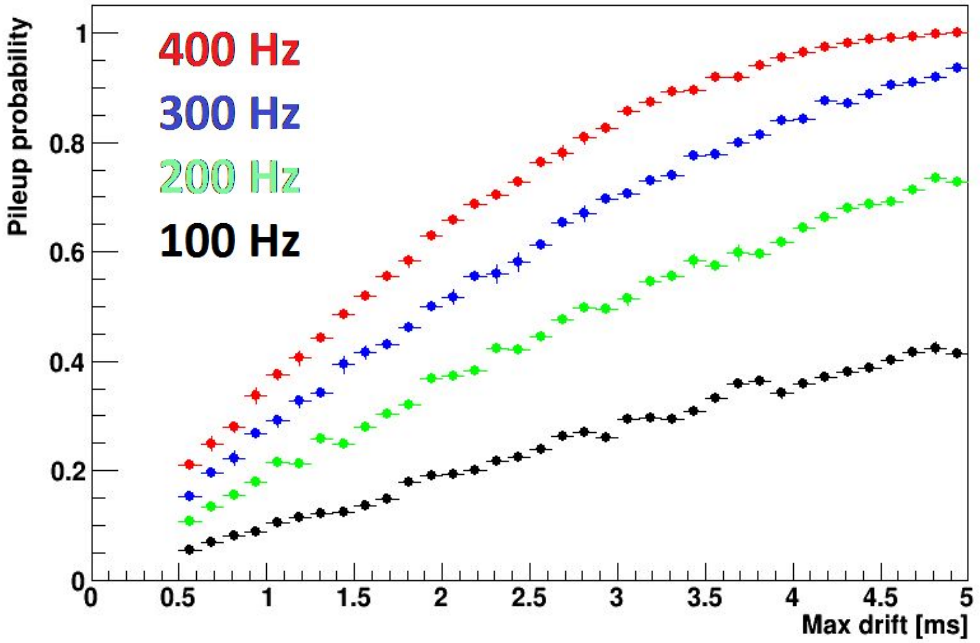


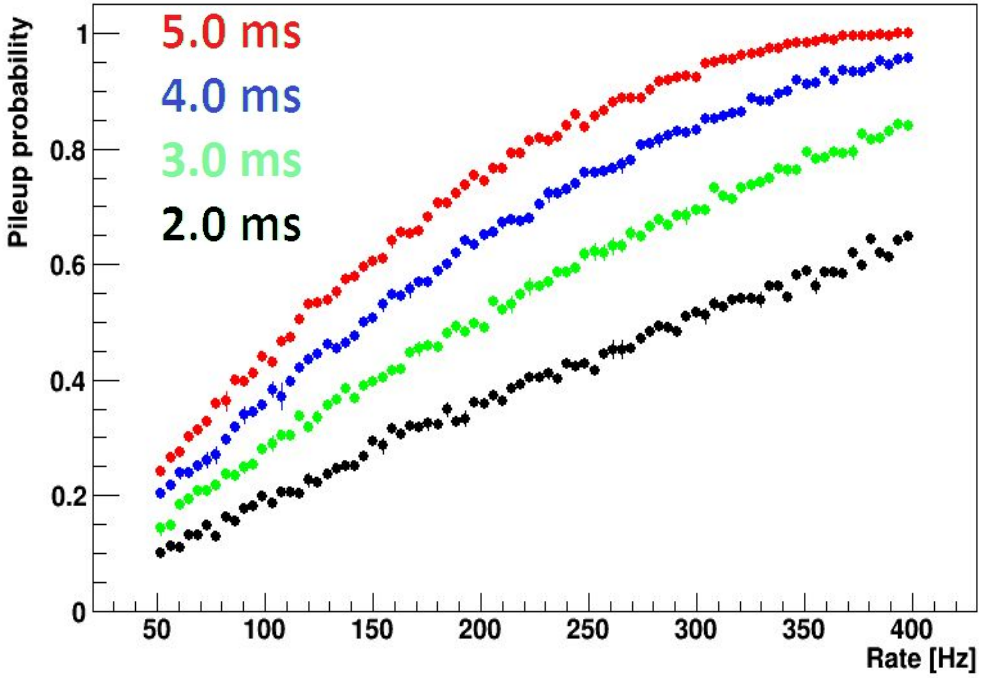
- In general the other cases are controversial, and a good event reconstruction is not possible

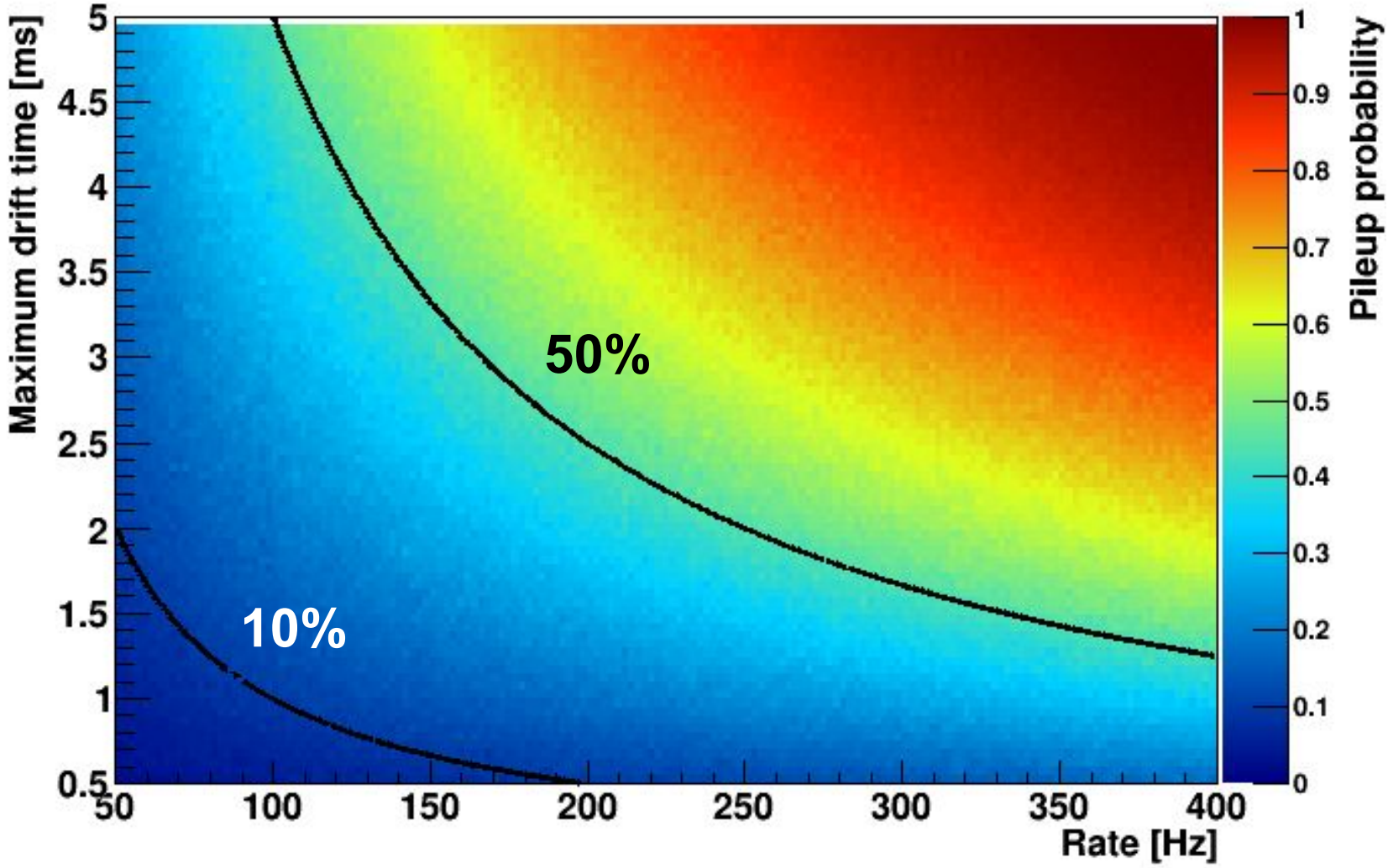


- Only dt and rate matter, the actual nb. of S2 is irrelevant



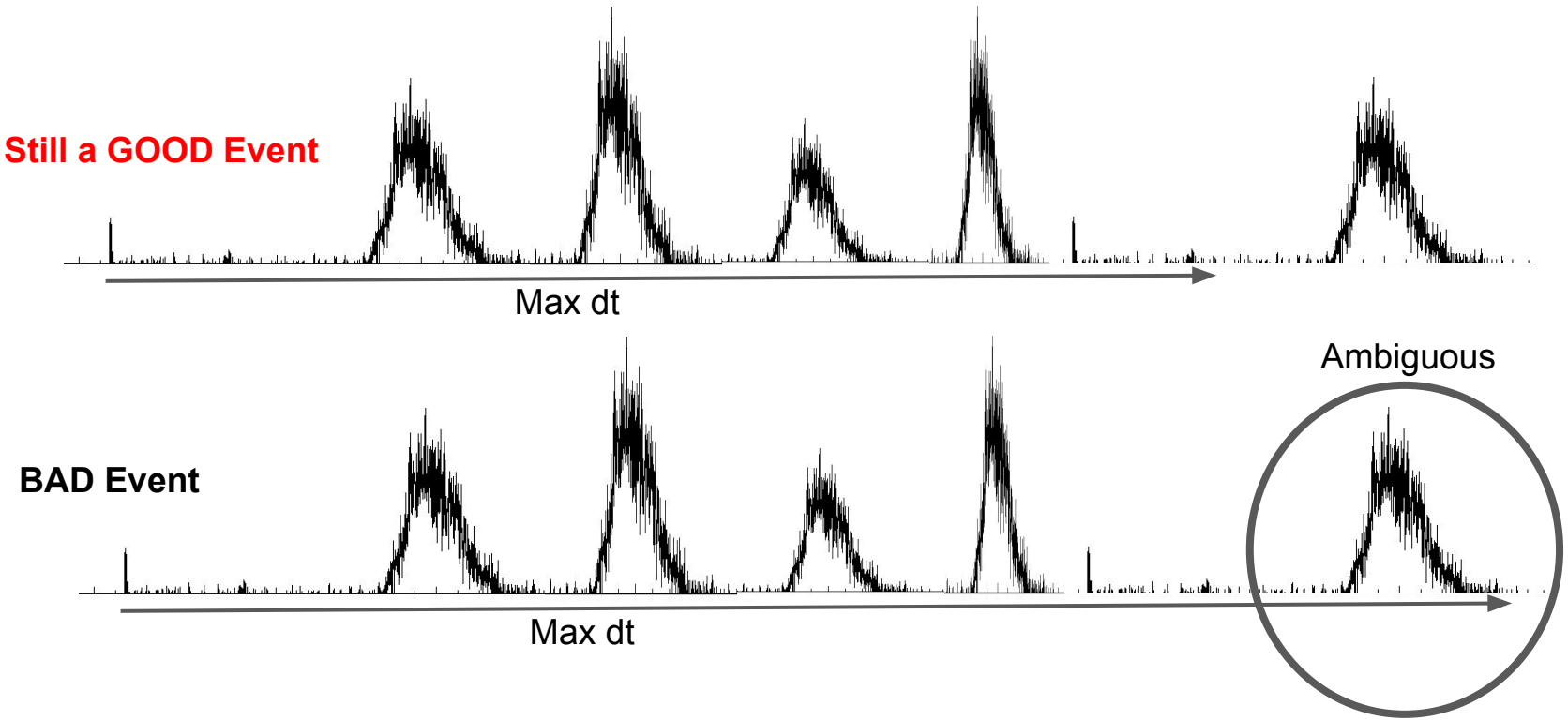

400 Hz
300 Hz
200 Hz
100 Hz
Pileup probability
Max drift [ms]
0
0.2
0.4
0.6
0.8
1
0.5
1.5
2
2.5
3
3.5
4
4.5
5


5.0 ms
4.0 ms
3.0 ms
2.0 ms
Pileup probability
Rate [Hz]
0
0.2
0.4
0.6
0.8
1
50
100
150
200
250
300
350
400


Maximum drift time [ms]
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
50
100
150
200
250
300
350
400
Rate [Hz]
50%
10%
Pileup probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

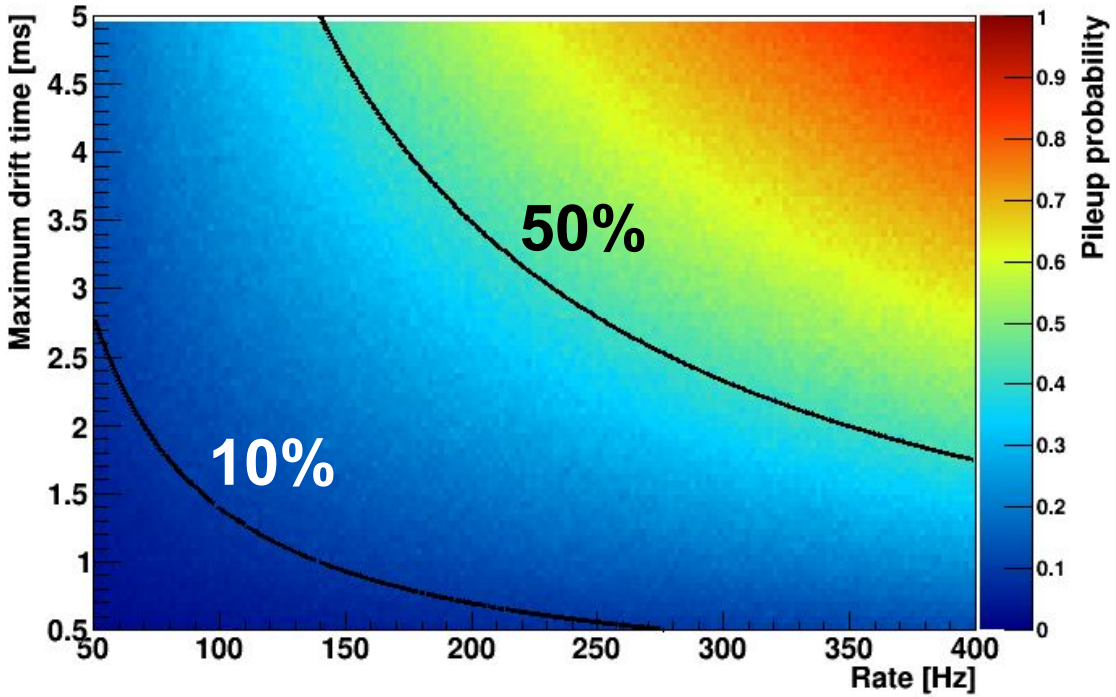
There is one exception for the multiple S1 case:

- One (or more) S1 within the Maximum Drift Time window **NOT** followed by any S2 within the same window

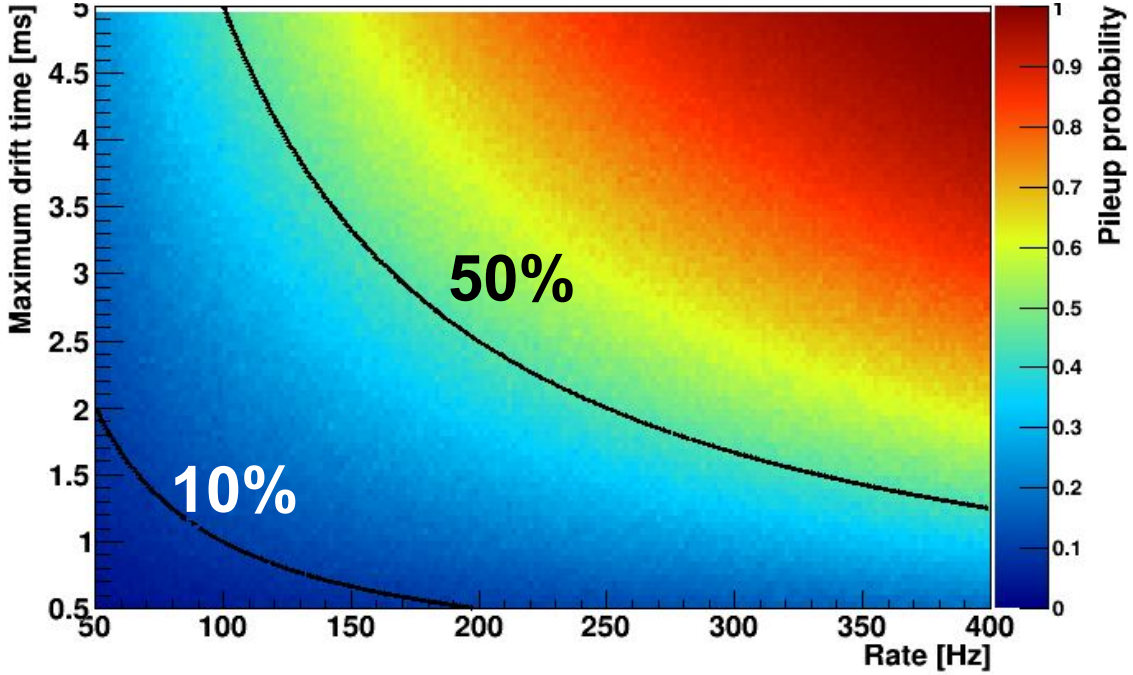


Good event definition:

Given an S2 we require only one S1 in the previous Max_DT window (Nb. of S2 irrelevant)

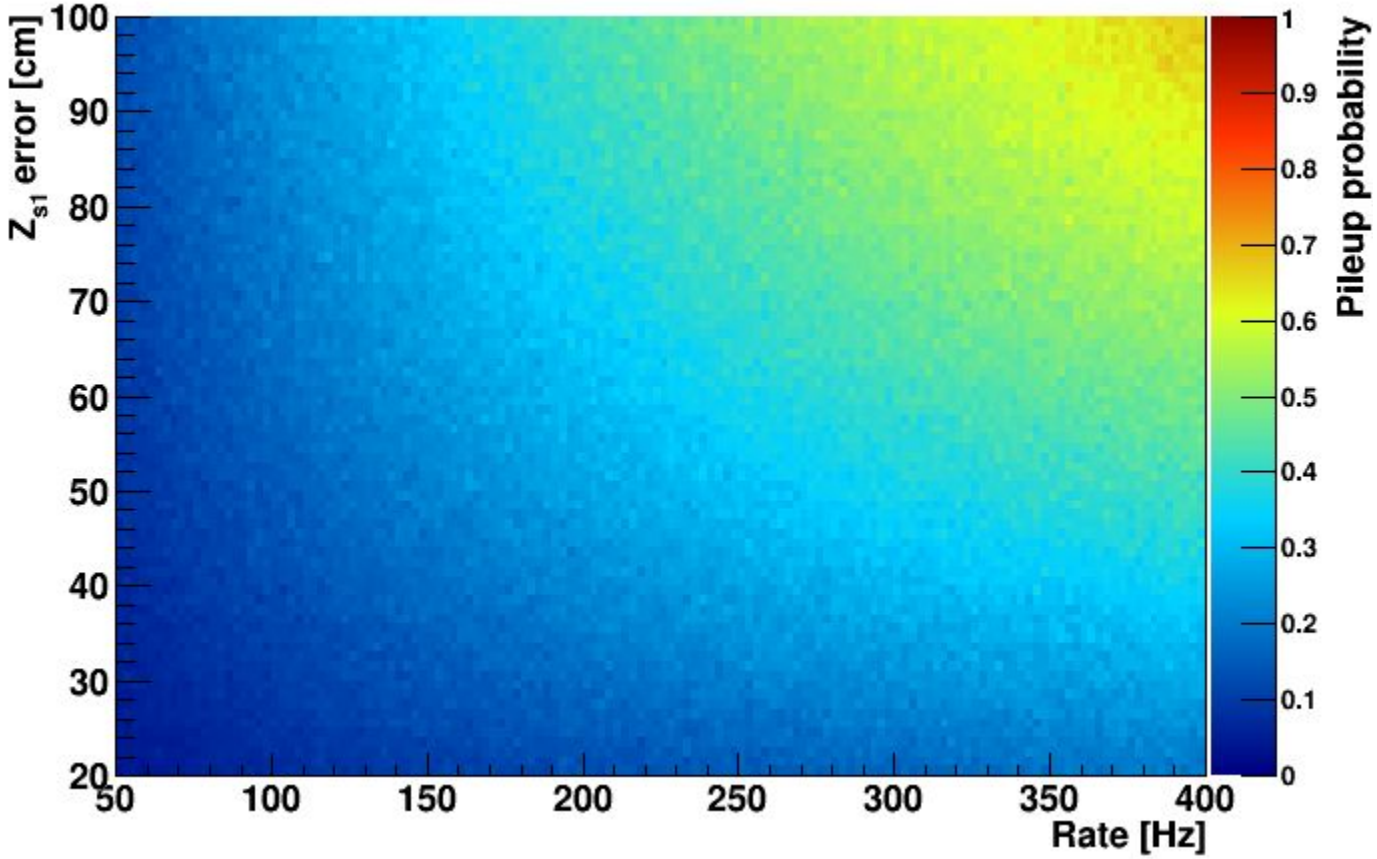


Quick test considering S1 within the maximum drift and no S2



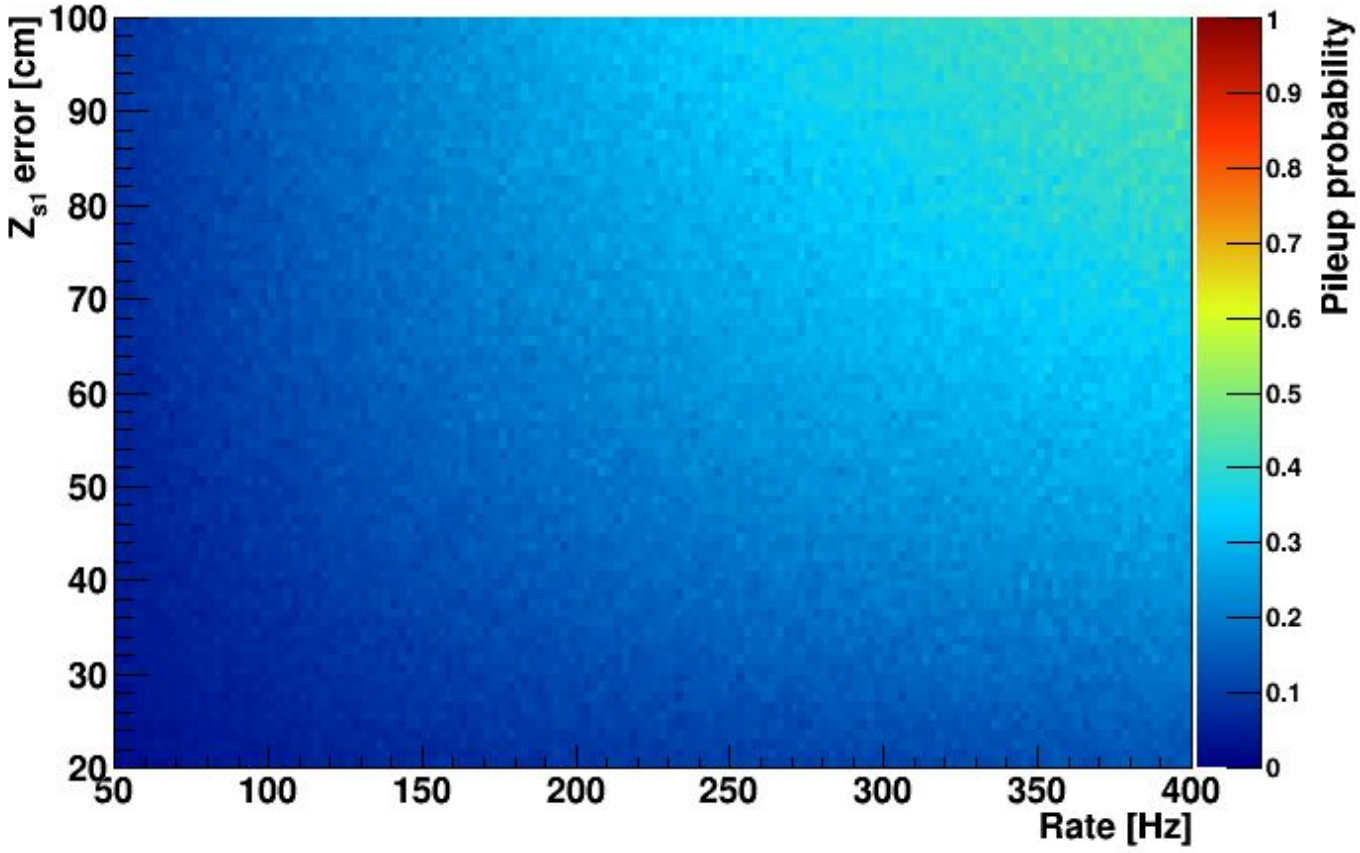
Only rate and dt (reference)

dt=3.5 ms



Preliminary

dt=3.5 ms && $S1_{xy}$ reconstruction 150 cm



Preliminary

Conclusions and open questions:

- Very important issue!
- S1 seems to be fundamental in order to mitigate this effect
- A detailed S2 model is needed (true MC)
- Probability that an S1 is in an S2 (S1 missing, and S2 linked to the wrong S1)
- Calibration issues?