Updates in the HADES-RICH simulations.

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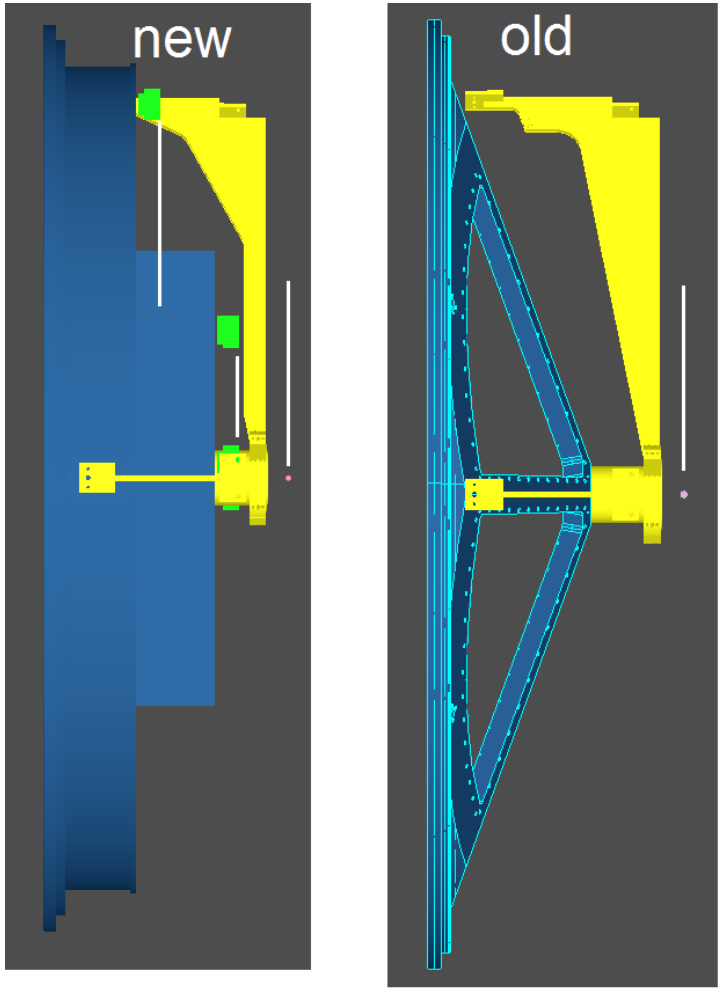
Intro

- Geometry testing, comparison with CAD model
- Implementation of cross-talk hits
- Implementation of noise hits
- Improvement in ring reconstruction, implementation of ring-candidate selection algorithm and ghost-rings rejection
- Clean up code, ready to commit to SVN.

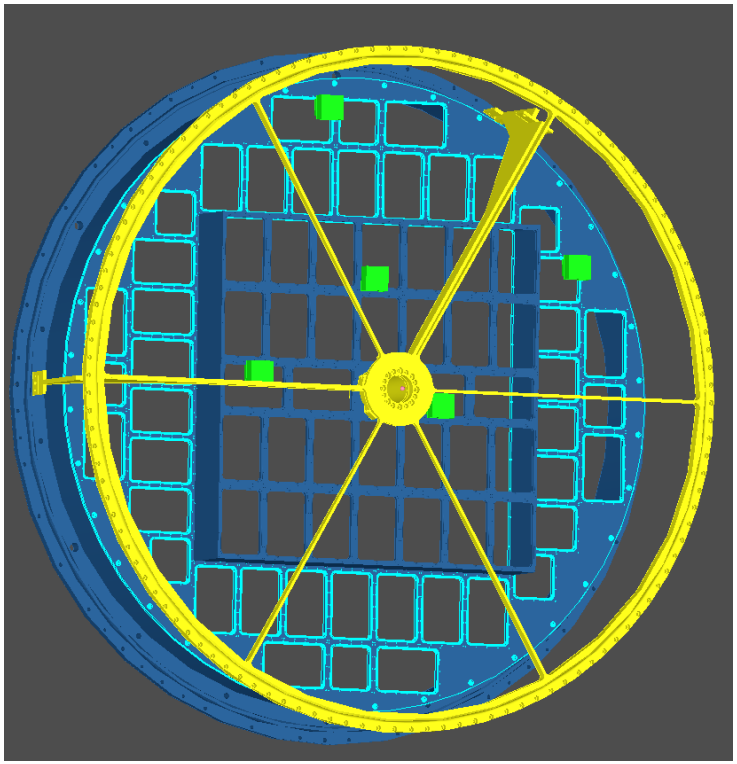
Simulation

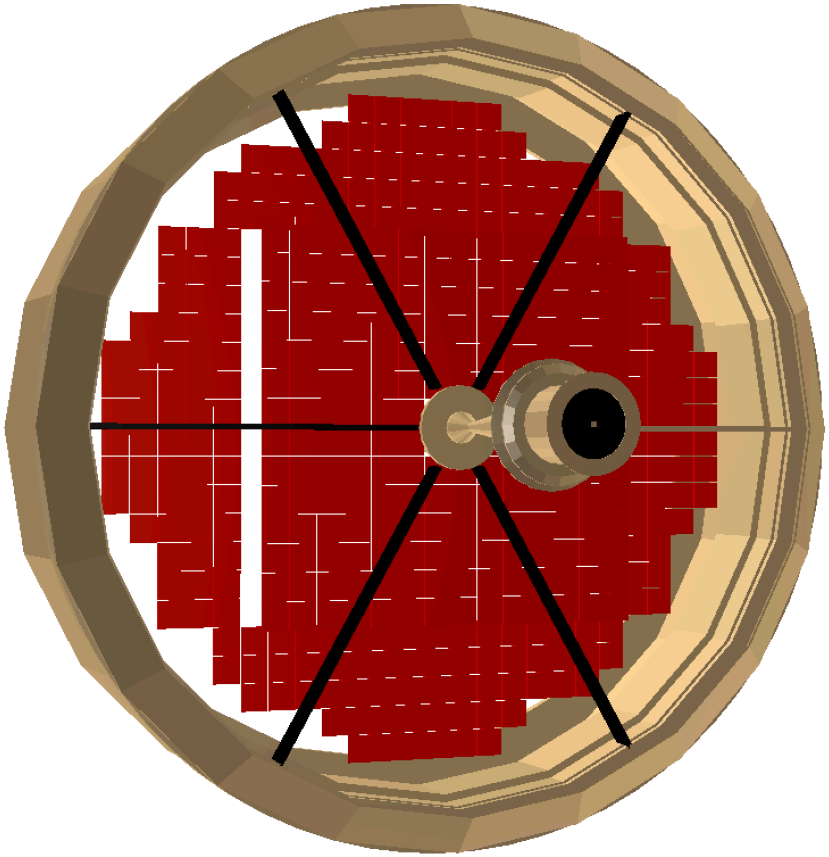
- Electrons were generated with Kine θ [15-80]°, ϕ [0,360]°, P [100, 1500] MeV/c
- 100% collection efficiency.

Geometry
old RICH vs. new RICH

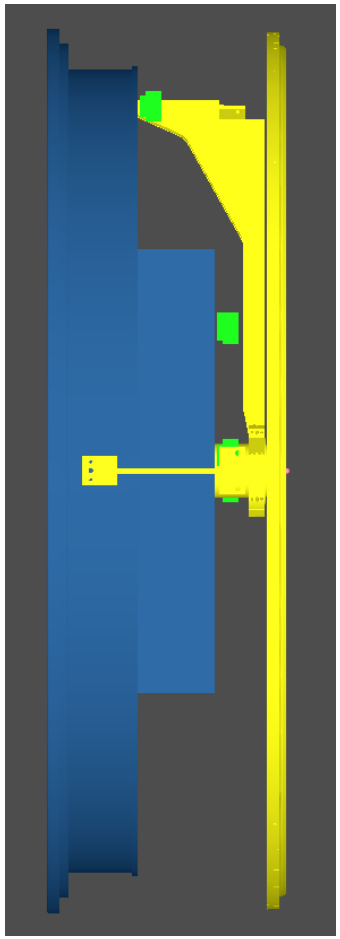


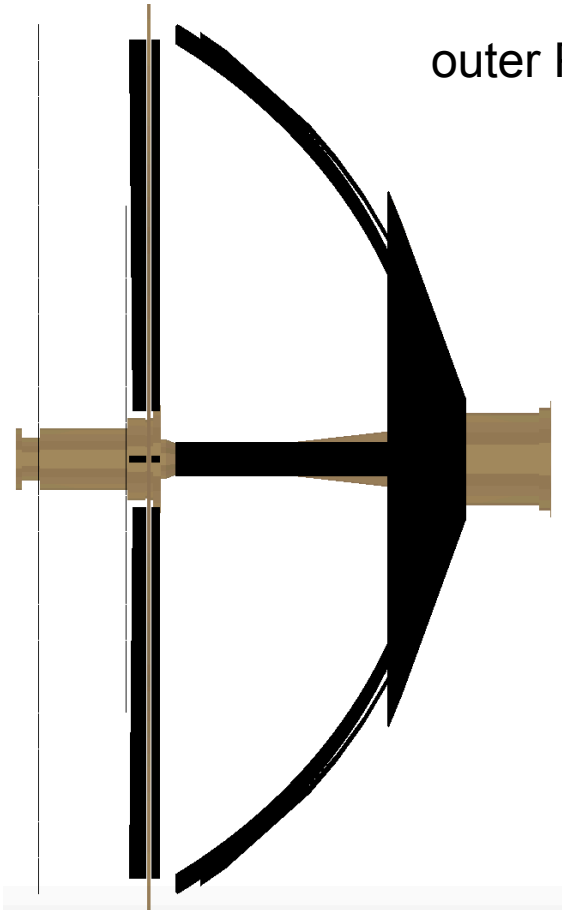
CAD vs. sim geometry

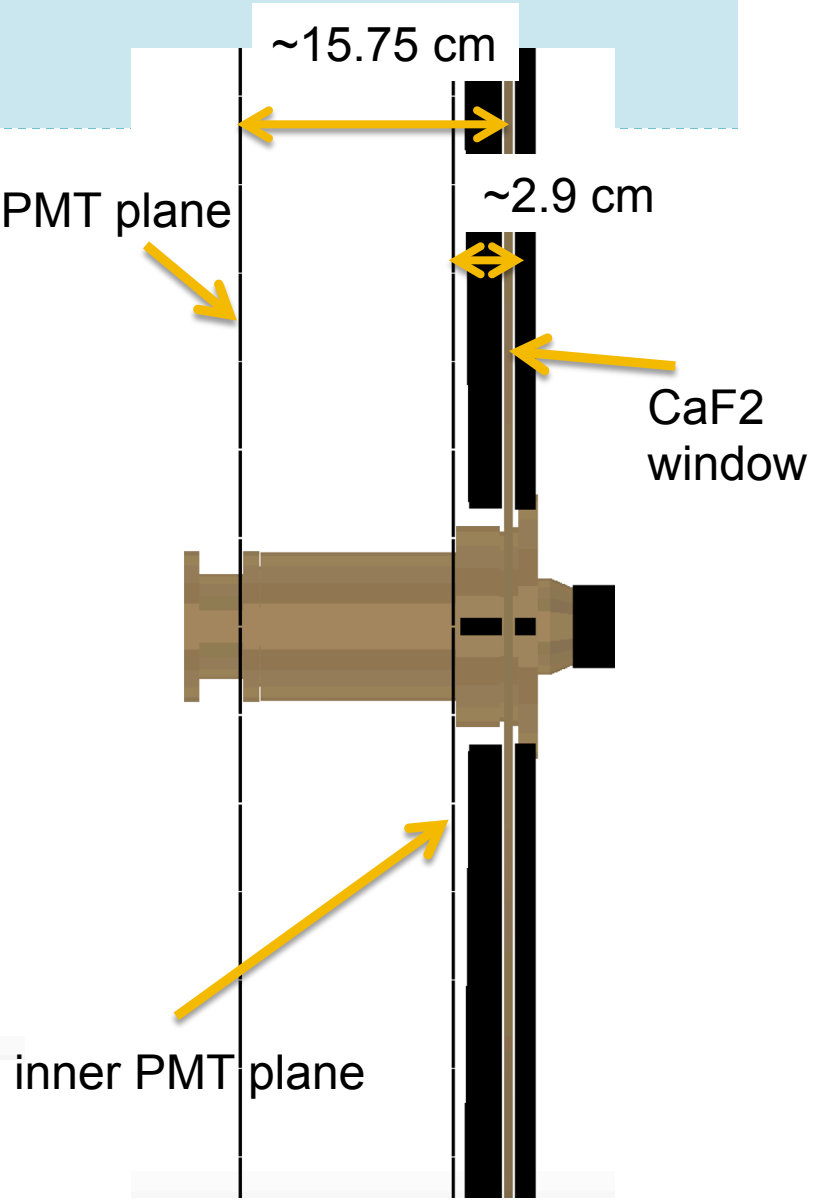




CAD vs. sim

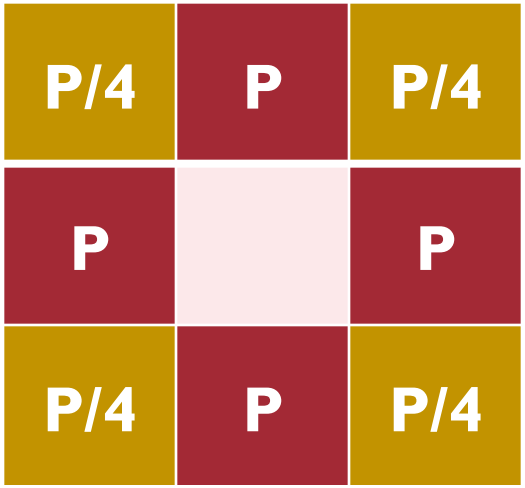






Cross-talk hits

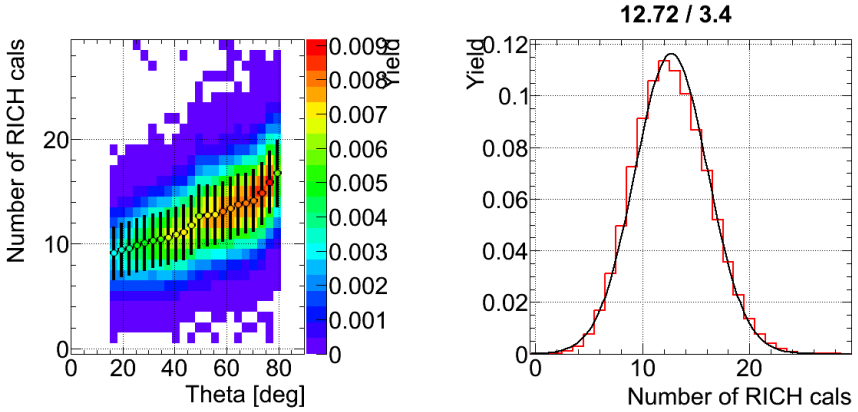
Probability to get cross-talk hit.



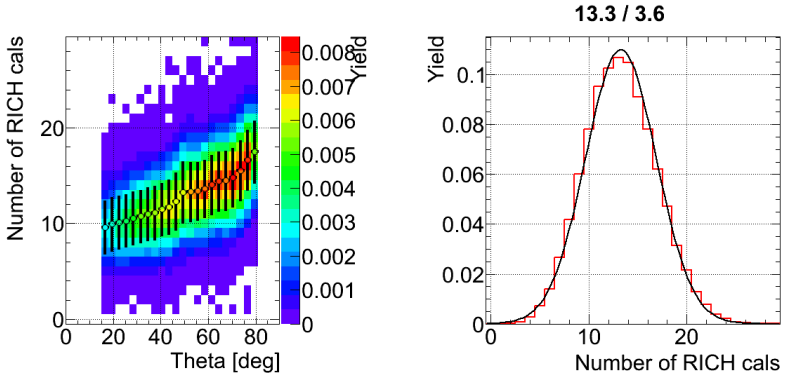
- Each hit can produce only one cross-talk hit.
- Cross-talk hit probability is set to 2% by default (P=2%).
- MCTrackId is taken from main hit.

Crosstalk results
Number of hits per ring

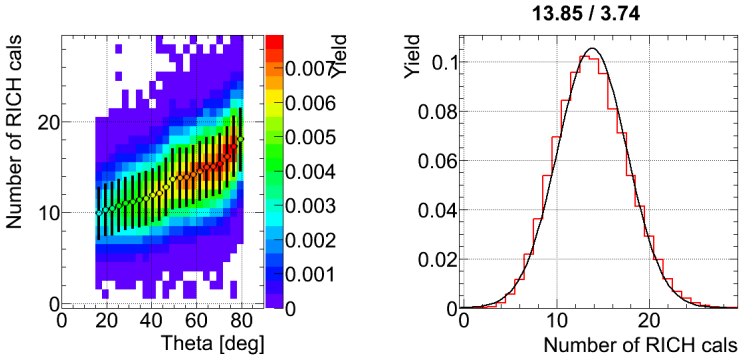
P=0%



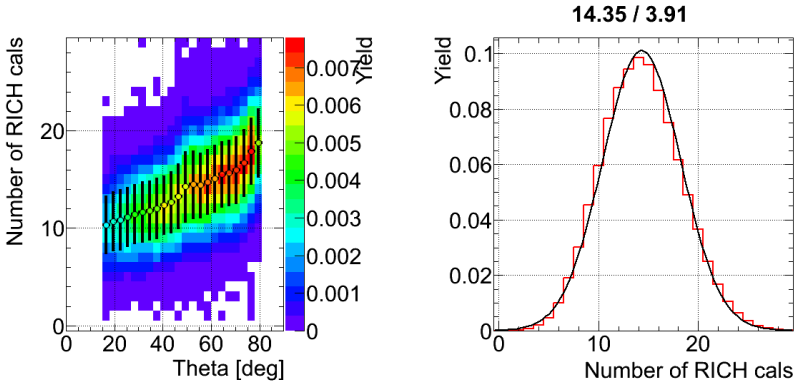
P=1%



P=2%

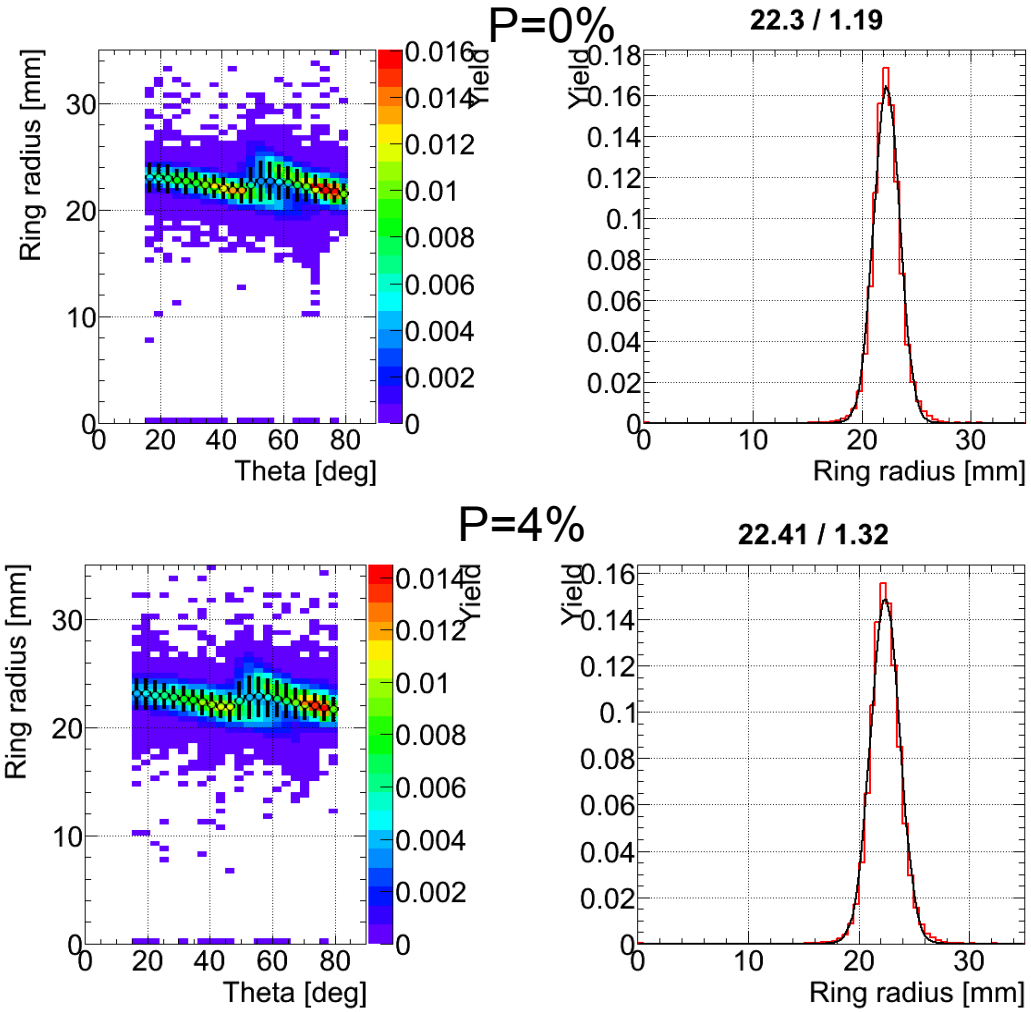


P=3%



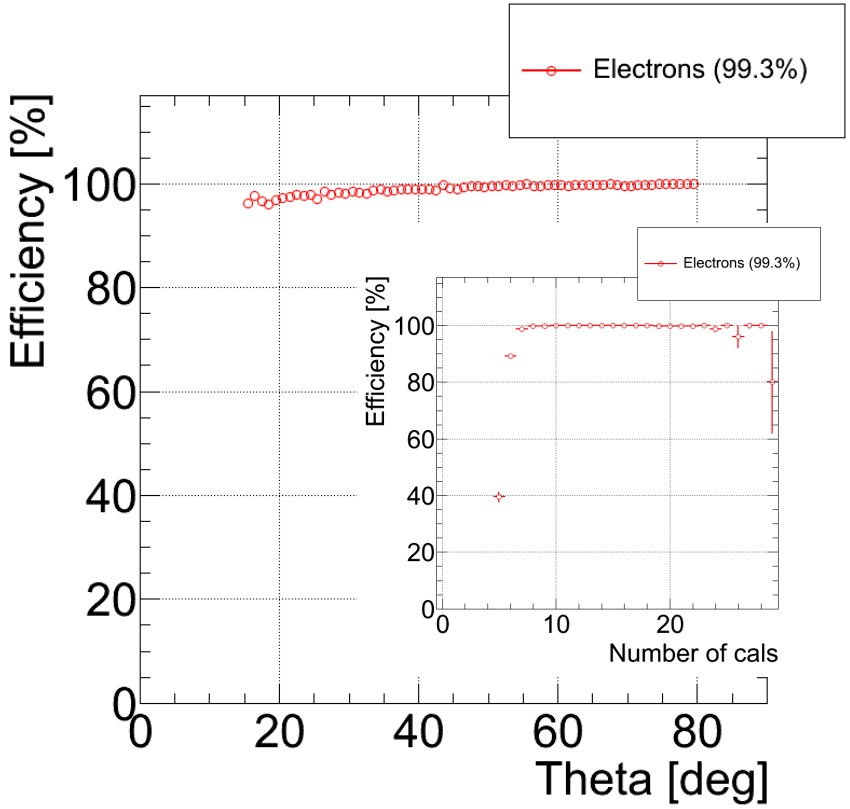
- From the measurements one estimates crosstalk P = 2%

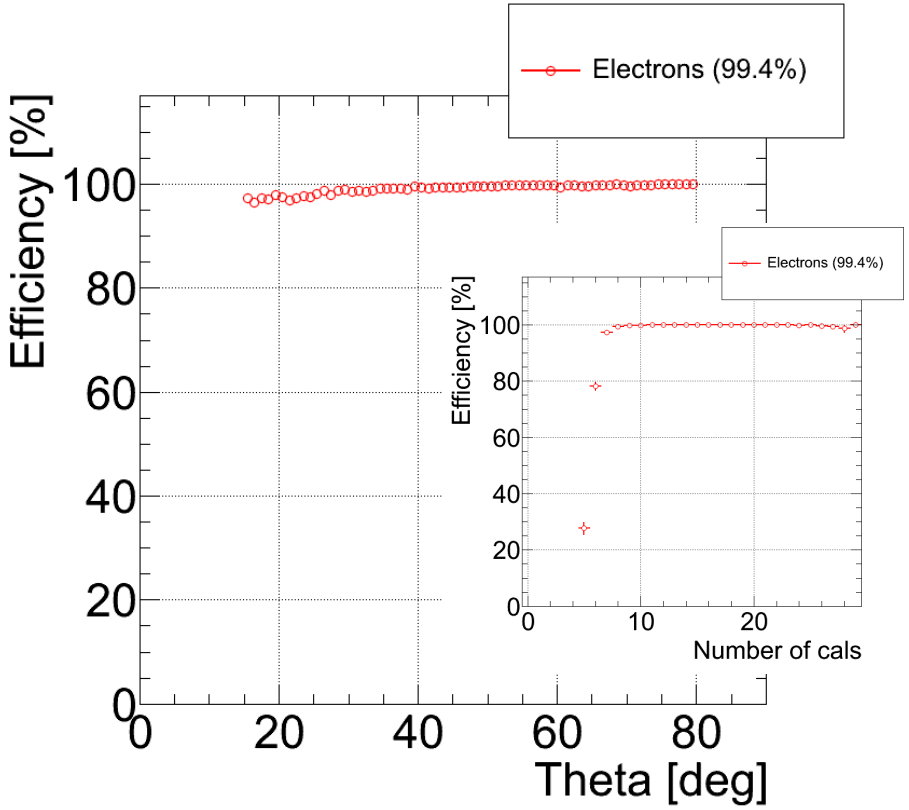
Crosstalk results
Ring radius



- Ring radius resolution increased ~10%
- Not crucial for HADES

Crosstalk results
Single electron reconstruction





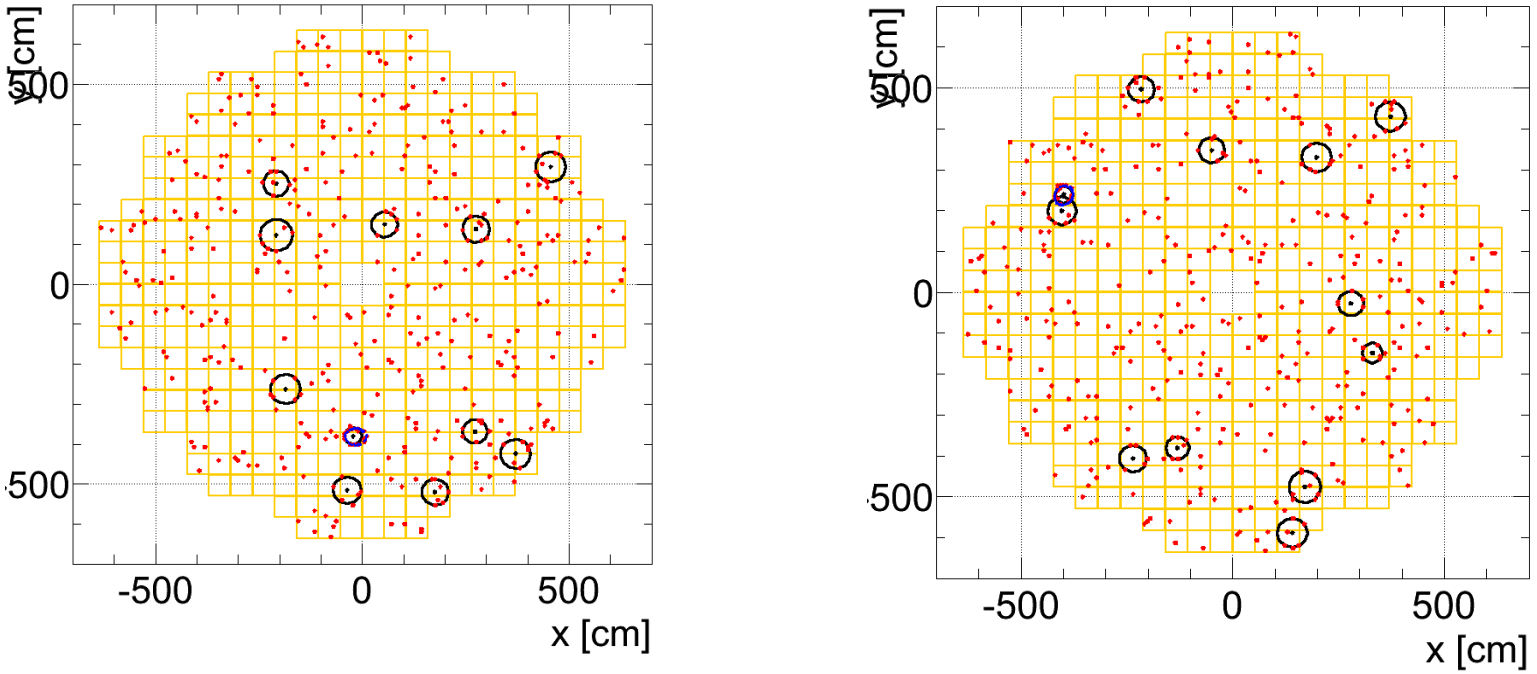
Crosstalk results
Summary table

Prob of CT [%]	0	1	2	3	4
Single electron					
Nof hits/ring	**12.72**	**13.3**	**13.85**	**14.35**	**14.84**
Ring radius, mean/sigma	**22.3/1.19**	**22.33/1.23**	**22.36/1.27**	**22.39/1.30**	**22.41/1.32**
Rec. Eff. [%]	**99.3**	**99.3**	**99.3**	**99.4**	**99.4**
Electron/positron pair ($\Delta\phi$=3°)					
Pair rec. eff. [%]	**77.8**	**79.0**	**79.8**	**81.0**	**81.5**

- Integrated efficiency for the rings with >=5 hits.
- If cross-talk hit is assigned to reconstructed ring it is counted as correct hit.

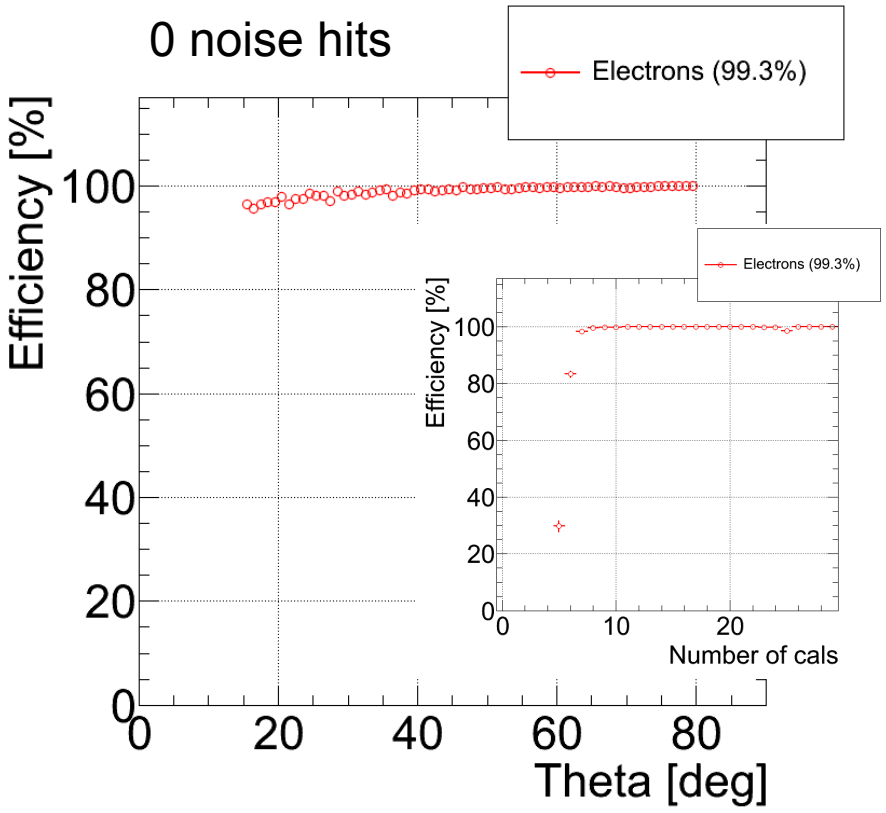
Noise hits

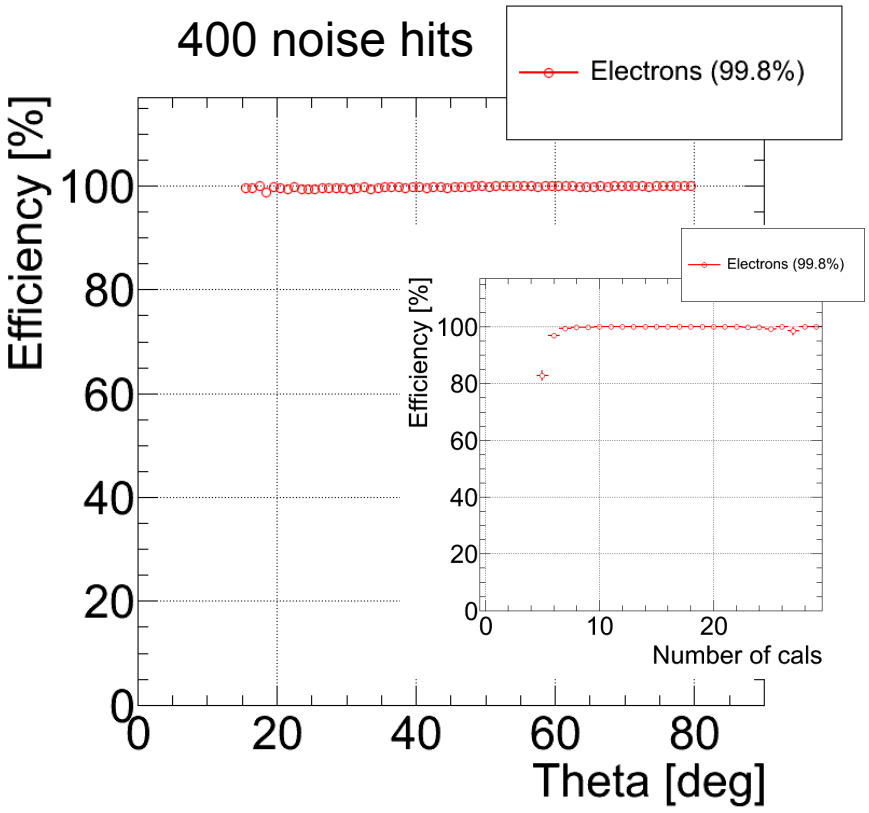
Examples with 400 noise hits per event (~1,5% of pixels).



- User can specify the number of noise hits.
- Hits are distributed uniformly.
- MCTrackId is set to -1.
- Problem with fake rings?

Noise hits results, single electron





- Efficiency increased for the ring with 5-7 hits. Because sometimes a noise hit is attached to the found ring. Since we are using "70% true hits" criteria, most of such rings are marked as correctly reconstructed.

Noise hits results
Summary table

Noise hits per event	0	100	200	300	400
Single electron					
Eff. [%]	**99.3**	**99.5**	**99.6**	**99.8**	**99.8**
Nof fake rings/ event	**0**	**0.012**	**0.39**	**2.45**	**7.7**
Electron/positron pair ($\Delta\phi$=3°)					
Pair eff. [%]	**79.8**	**81.7**	**83.2**	**84.0**	**85.3**
Nof fake rings/ event	**0**	**0.012**	**0.39**	**2.45**	**7.8**

- Integrated efficiency for the rings with >=5 hits.
- Number of fake rings increased dramatically with noise hits.

Ring finder optimization.

- Noise hits can form "good" rings with 5-7 hits. Stronger cuts in the ring finder can help.
- The implemented ring reconstruction algorithm is very flexible, there is always a possibility to optimize cuts and get reasonable ghost ring level, almost without efficiency loss.

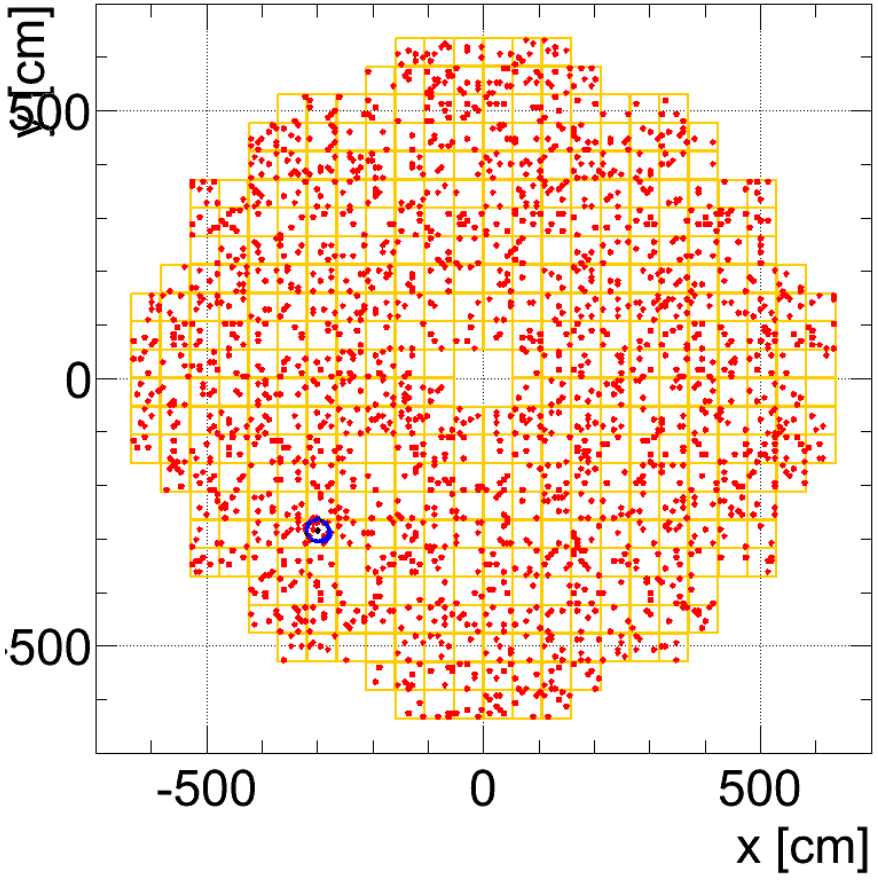
Noise hits results, **after RF optimization** Summary table

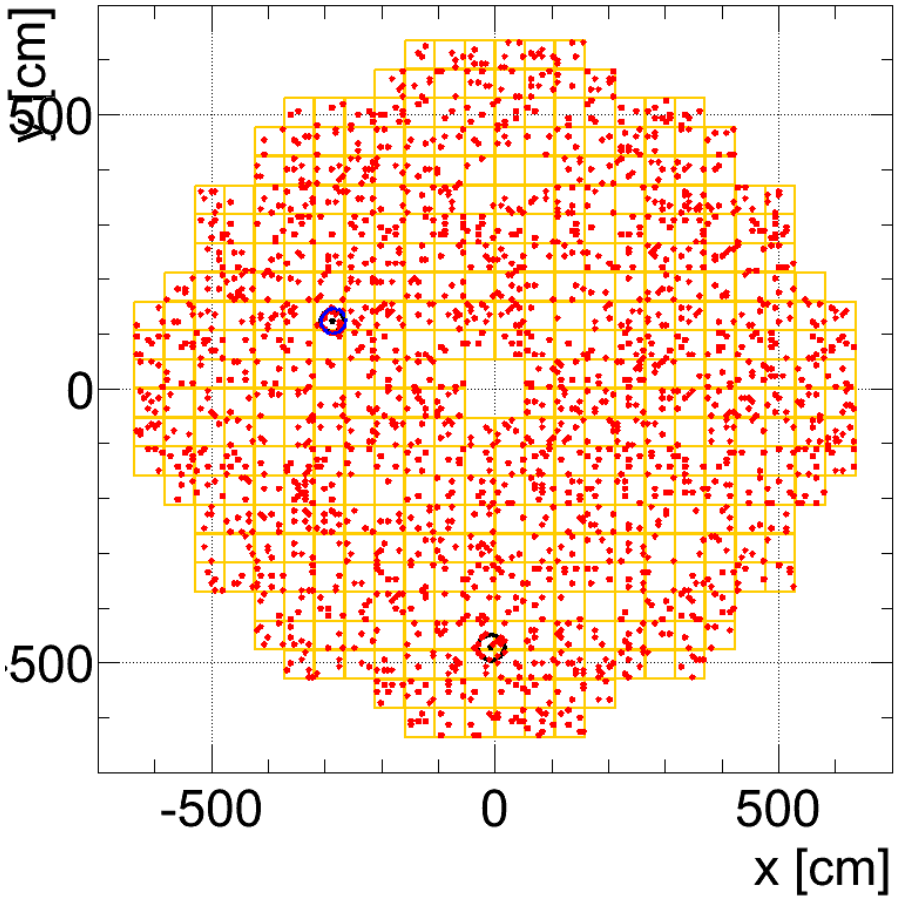
Noise hits per event	0	100	200	300	400
Single electron					
Eff. [%]	**98.4**	**98.6**	**98.7**	**99.0**	**99.1**
Nof fake rings/ event	**0**	**0**	**0.009**	**0.055**	**0.24**
Electron/positron pair ($\Delta\phi$=3°)					
Pair eff. [%]	**76.6**	**78.3**	**79.7**	**80.5**	**82.3**
Nof fake rings/ event	**0**	**0**	**0.009**	**0.057**	**0.24**

- Integrated efficiency for the rings with >=5 hits.
- Significant fake rejection after RF optimization (for 400 noise hits/event).

- What if one has even more noise hits?

High level of noise hits
500-2000 noise hits/event (1.8%-7.5%)





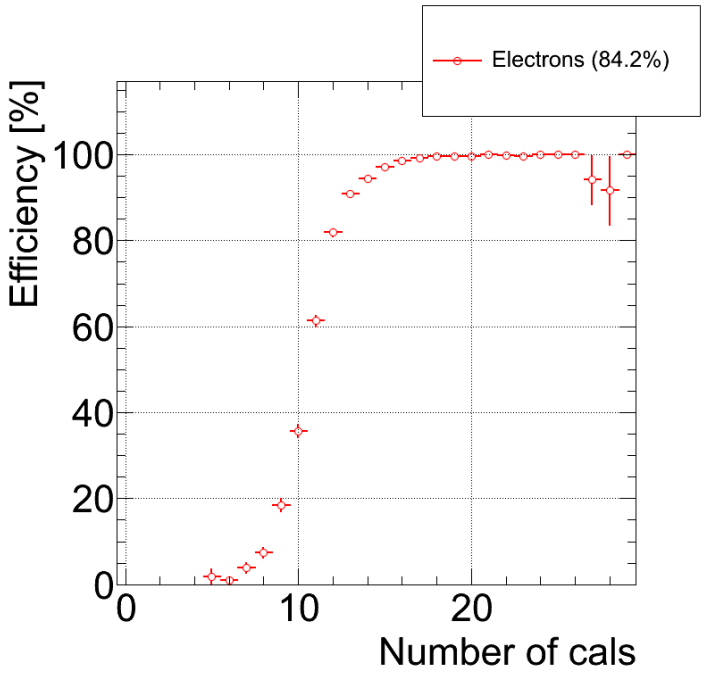
High level of noise hits
500-2000 noise hits/event (1.8%-7.5%)

Noise hits per event	500	750	1000	1500	2000
Single electron					
Eff. [%]	**99.3**	**99.5**	**99.7**	**99.9**	**99.9**
Nof fake rings/ event	**0.71**	**4.7**	**16.0**	**60.0**	**121.0**

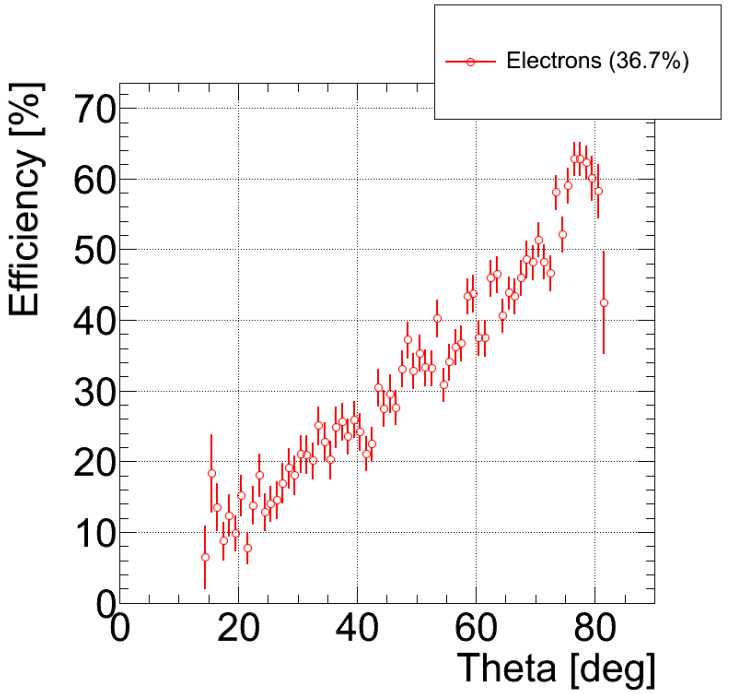
- Results with optimized RF (**for 400 noise hits**)
- Again many fake rings
- RF parameters should be optimized for high level of noise hits (see results on the next slide)

Results
2000 noise hits per event

Single electron efficiency vs nof cals



Pair efficiency vs momentum



- RF was optimized for 2000 noise hits. Keep efficiency high while removing fake rings(**<0.25 per event**).
- Normalized to rings with >= 5 hits!!!

Summary table

Noise hits per event	500	750	1000	1500	2000
Single electron					
Eff. [%]	**98.5**	**96.8**	**94.6**	**90.1**	**84.2**
Nof fake rings/ event	**0.25**	**0.24**	**0.23**	**0.25**	**0.23**
Electron/positron pair ($\Delta\phi$=3°)					
Pair eff. [%]	**78.7**	**70.8**	**63.2**	**49.2**	**36.7**
Nof fake rings/ event	**0.25**	**0.24**	**0.23**	**0.25**	**0.23**

- Integrated efficiency for the rings with >=5 hits.
- For each case RF was optimized **independently** assuming **number of fake rings <0.25 /event**

Summary

- Cross-talk hits and noise hits were implemented.
- Depending on the number of hits per electron ring, noise hit level, event multiplicity one can/should optimize cuts for the best ring reconstruction performance.
- Increase ring finding efficiency allowing more fake rings and later remove fake rings using track information