A fast muon tagger method for IACTs

Roberta Pillera, Leonardo Di Venere,
Rubèn Lopez-Coto

INFN and University of Bari

Image credits: CTA

Dipartimento Interateneo di Fisica
Michelangelo Merlin

cherenkov telescope array

www.cta-observatory.org

Outline

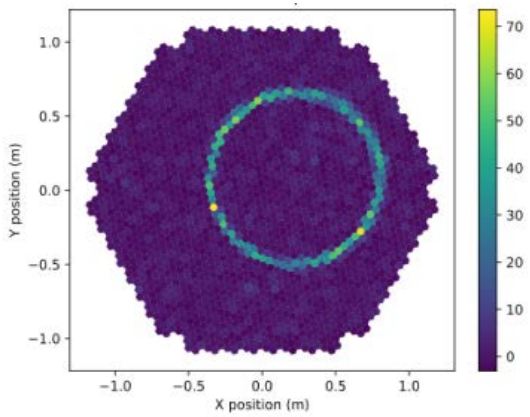
- Muon identification parameters
- Size preselection on MC
- Size preselection on data

Parameters for muon identification (1)

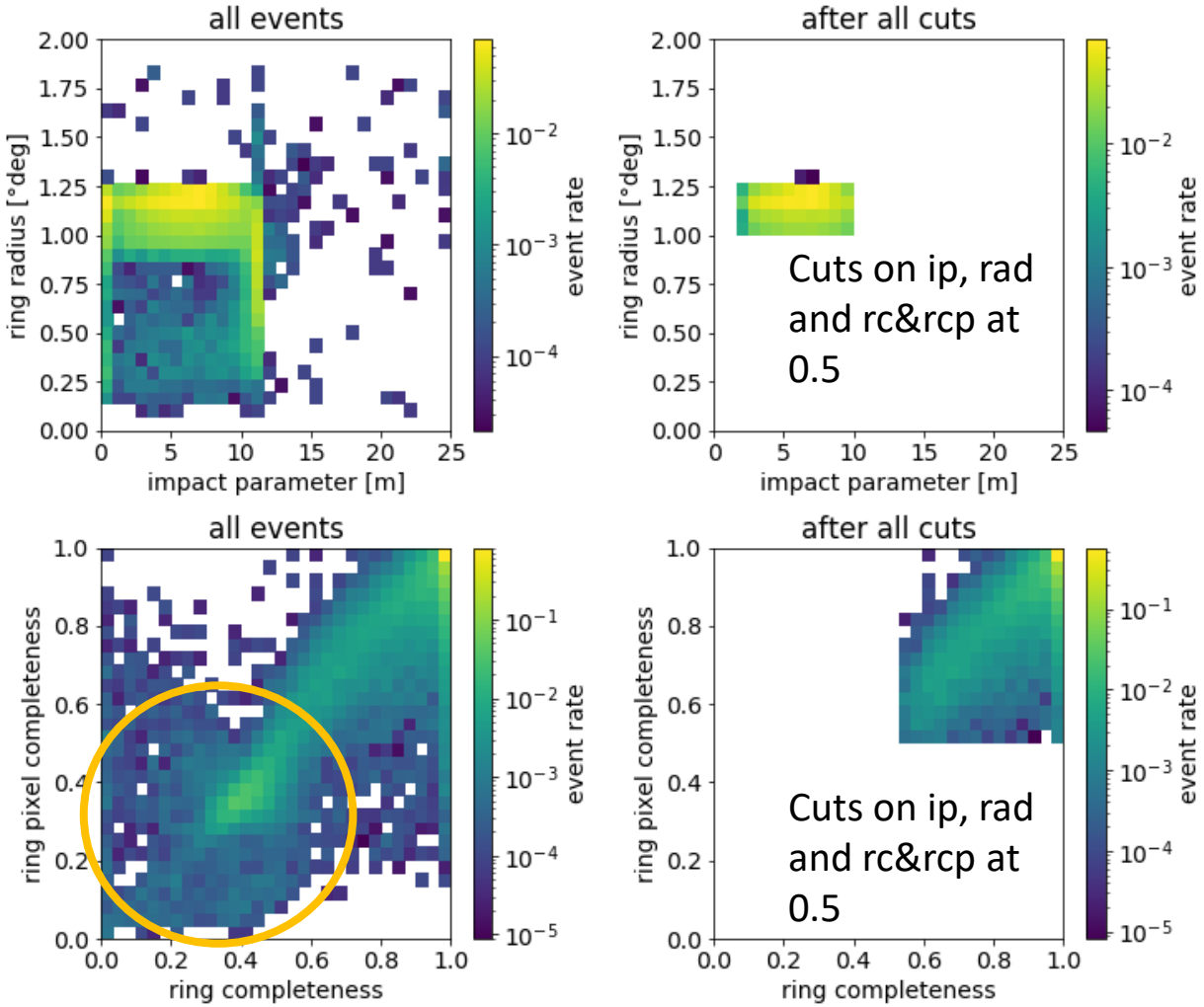
- **Impact parameter** in 20 % and 90 % of mirror radius
- **Ring radius** btw 1° and 1.5°

➢ not enough to identify good muon events

- **Ring completeness** (rc) and **ring pixel completeness** (rpc)
- Orange highlighted region contains non-muon events -> cut on RC necessary.
- This is important when considering a more realistic mc sample: muons in proton showers

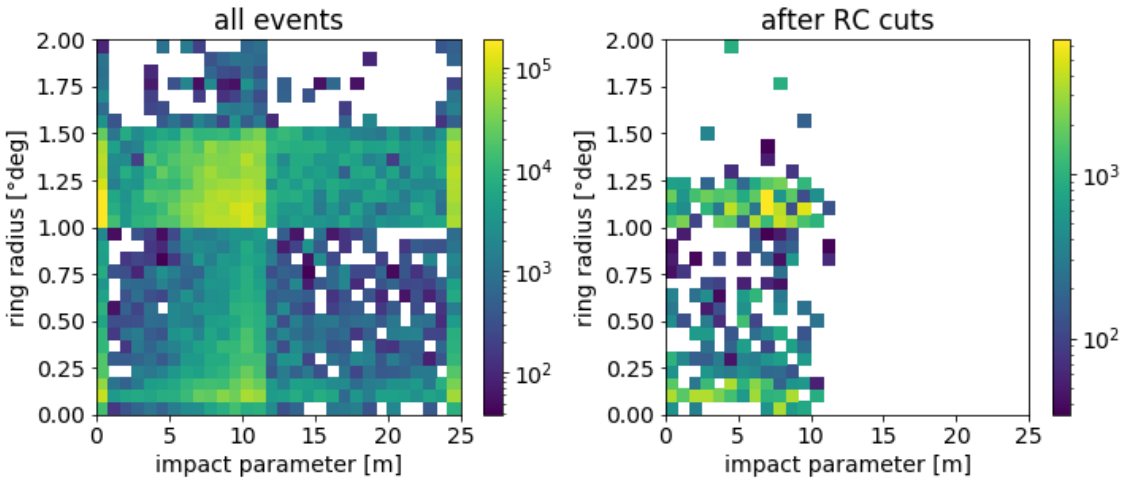


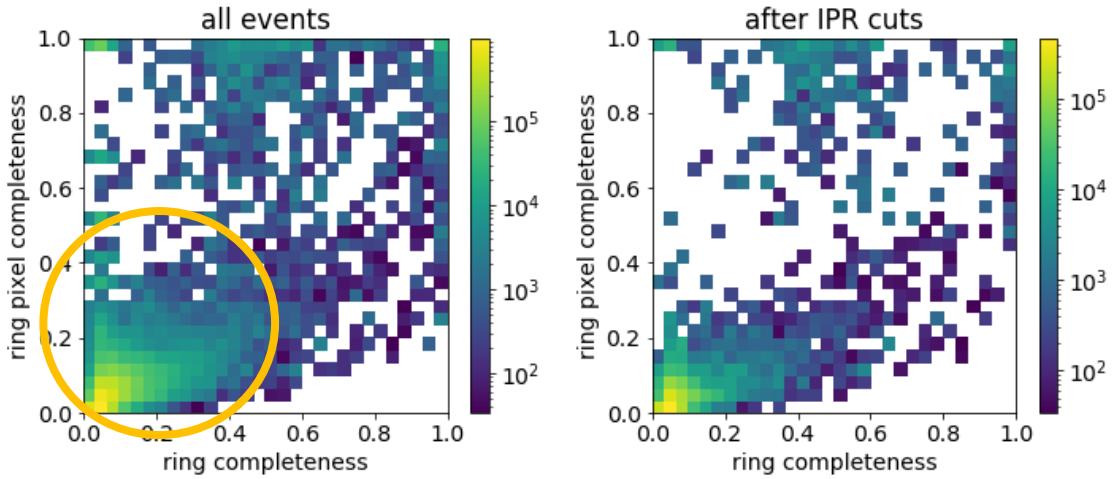
muon mc distributions



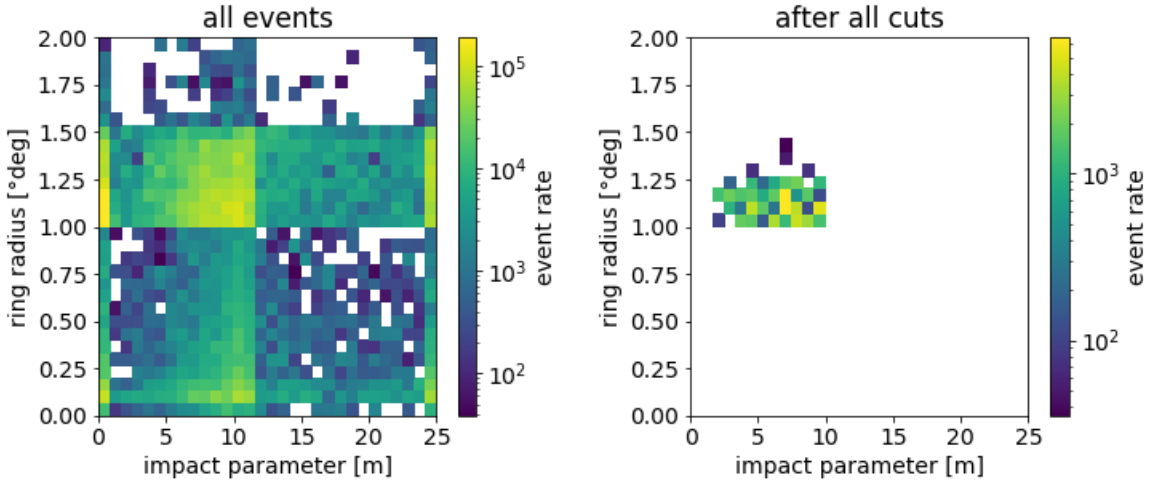
Parameters for muon identification (2)

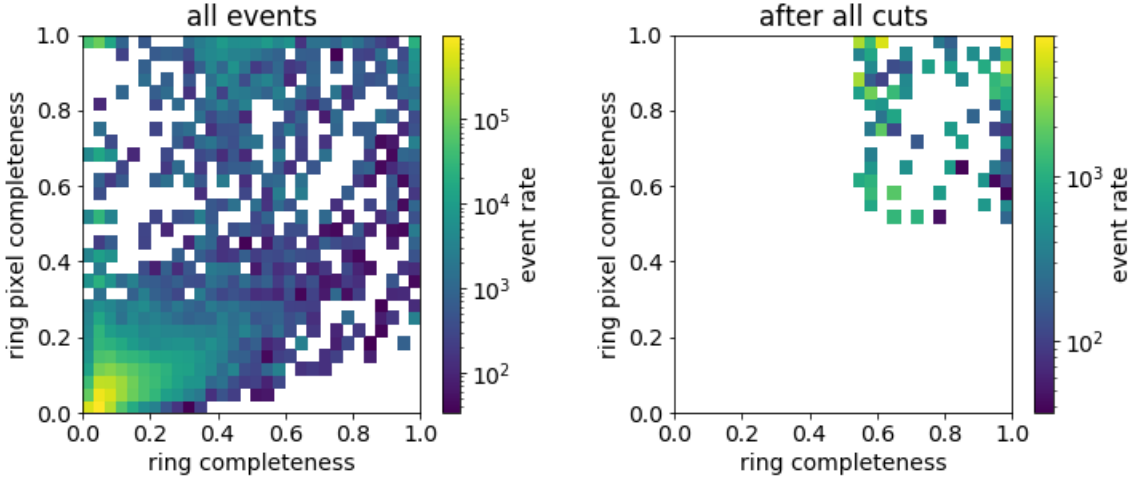
Proton shower mc distributions





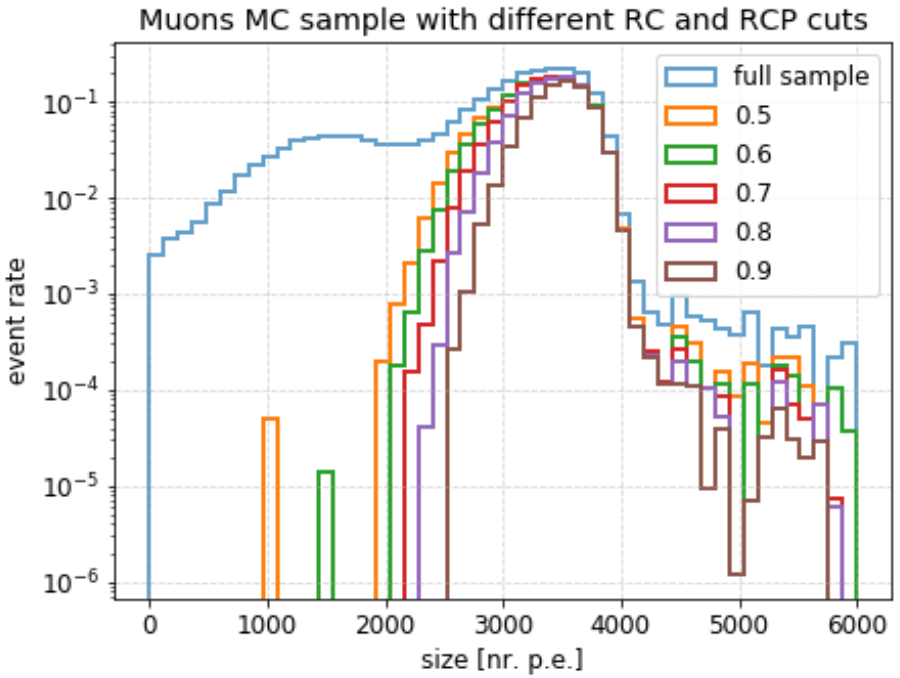
combined cuts

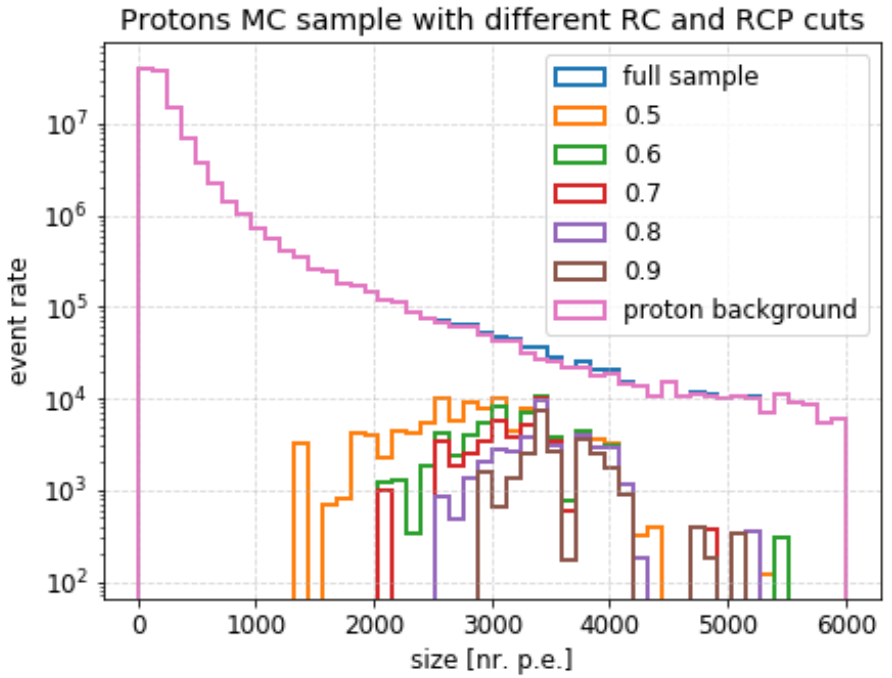




- Cutting only on IP and Radius does not significantly reduce the events in that region.
- Cut on rc and rpc is necessary.

Parameters for muon identification (3): MC size distributions





Energy scaling:

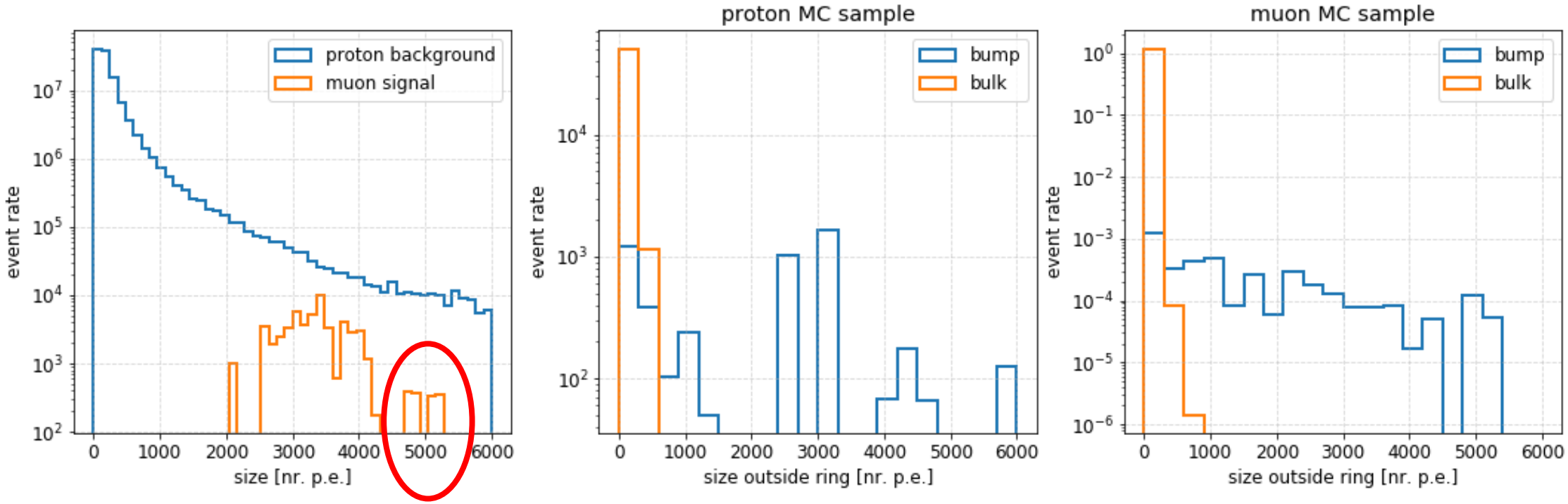
- proton sample: powerlaw with spectral index -2.7
- muon sample: Greisen flux formula (PDG) with a cutoff at low energies (Lipari 1992)

- The best cut reproducing the muon MC sample size distribution is with at least **0.7** rc&rcp
- Use this as signal for preselection performance evaluation.

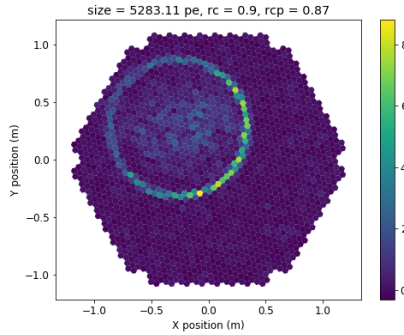
muon signal:

- IP&rad cuts
- rc&rcp > 0.7

Preselection efficiency and purity (1)



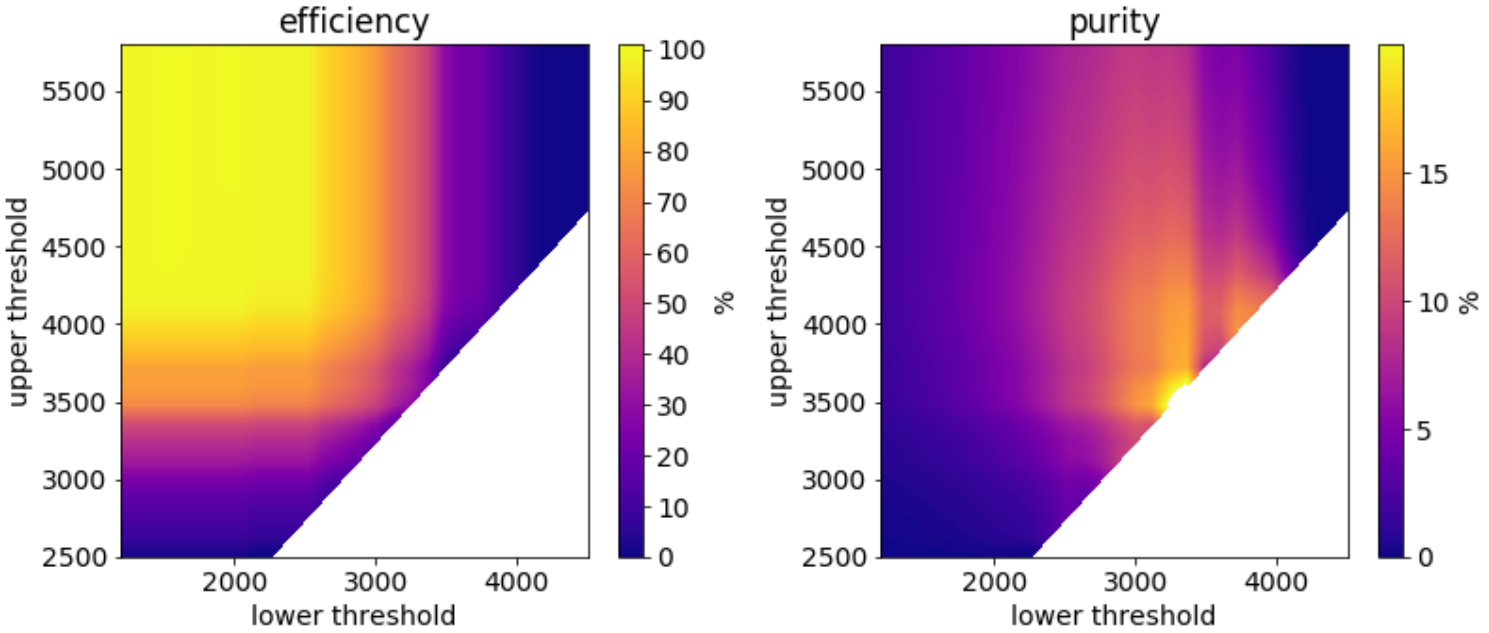
- Bump at 5000 is present both in muon and muons-in-protons MC distributions
  - probably showering muons:
- Taking the size outside the ring, in the bulk it is low, exactly as for the muon mc sample.
- To have clean rings the preselection has to exclude them
  - events eliminated from signal for efficiency evaluation

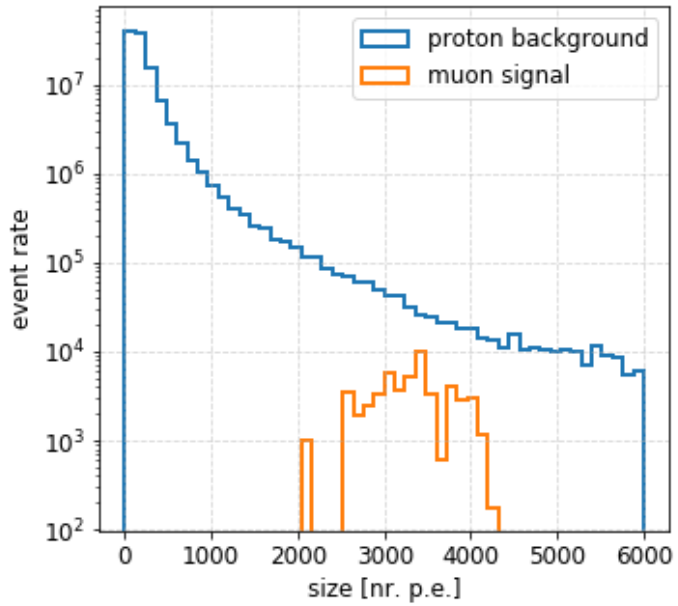


example from muon MC

Preselection efficiency and purity (2)

- Double threshold selection

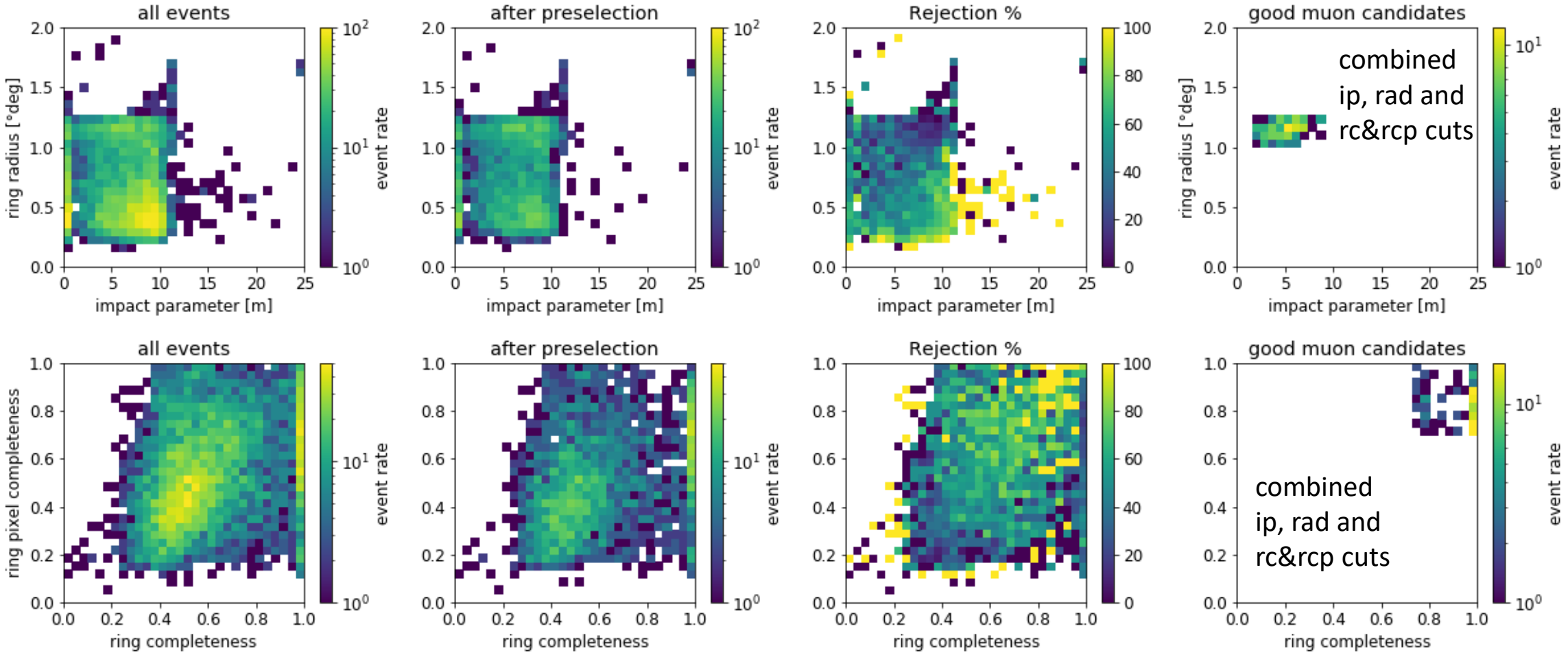




- @ 90% efficiency -> highest 8% purity
- size lower thr = 2500 pe
- size upper thr = 4000 pe

Preselection MC performance summary (1)

2500 and 4000 p.e.



Rejection = (all events – events after cuts)/(all events)

Size preselection rejection is higher in the non-interesting parameter regions.

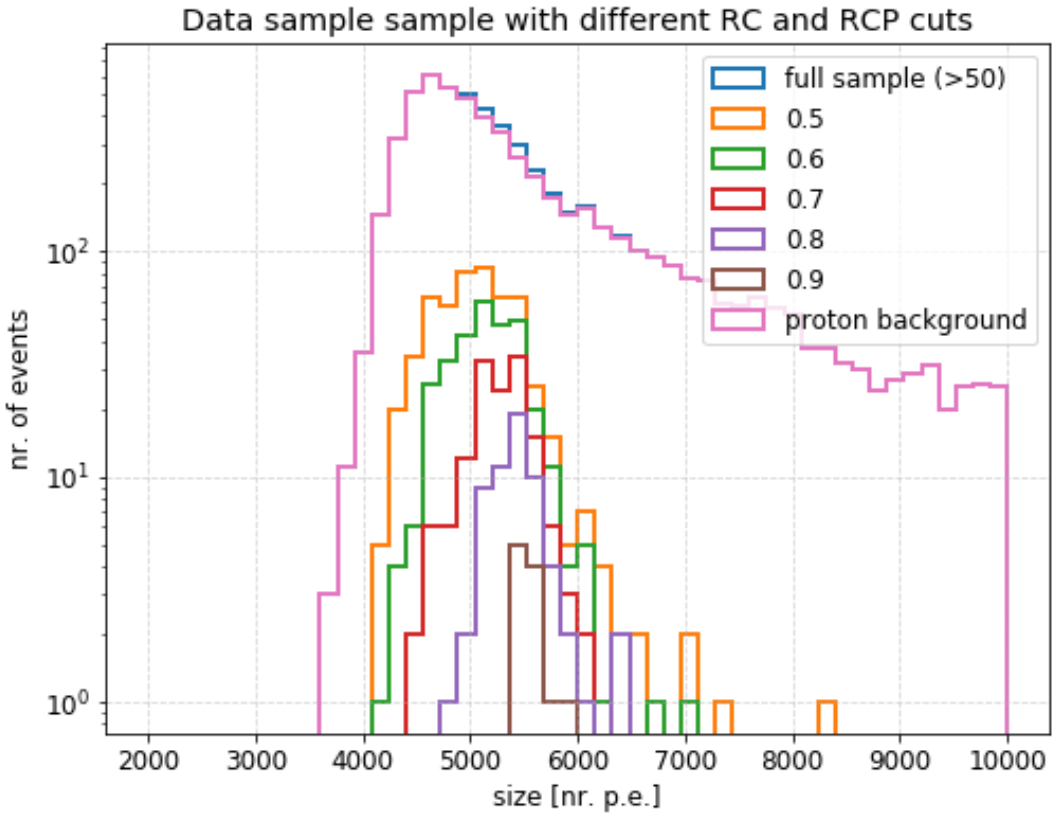
Preselection MC performance summary (2): speed tests

- Test selection speed on proton MC sample of approx. 1 million events
- Average single event processing for preselection at a rate of (27.477 +/- 0.001) kHz

$\Rightarrow$Speed compatible with expected trigger rate

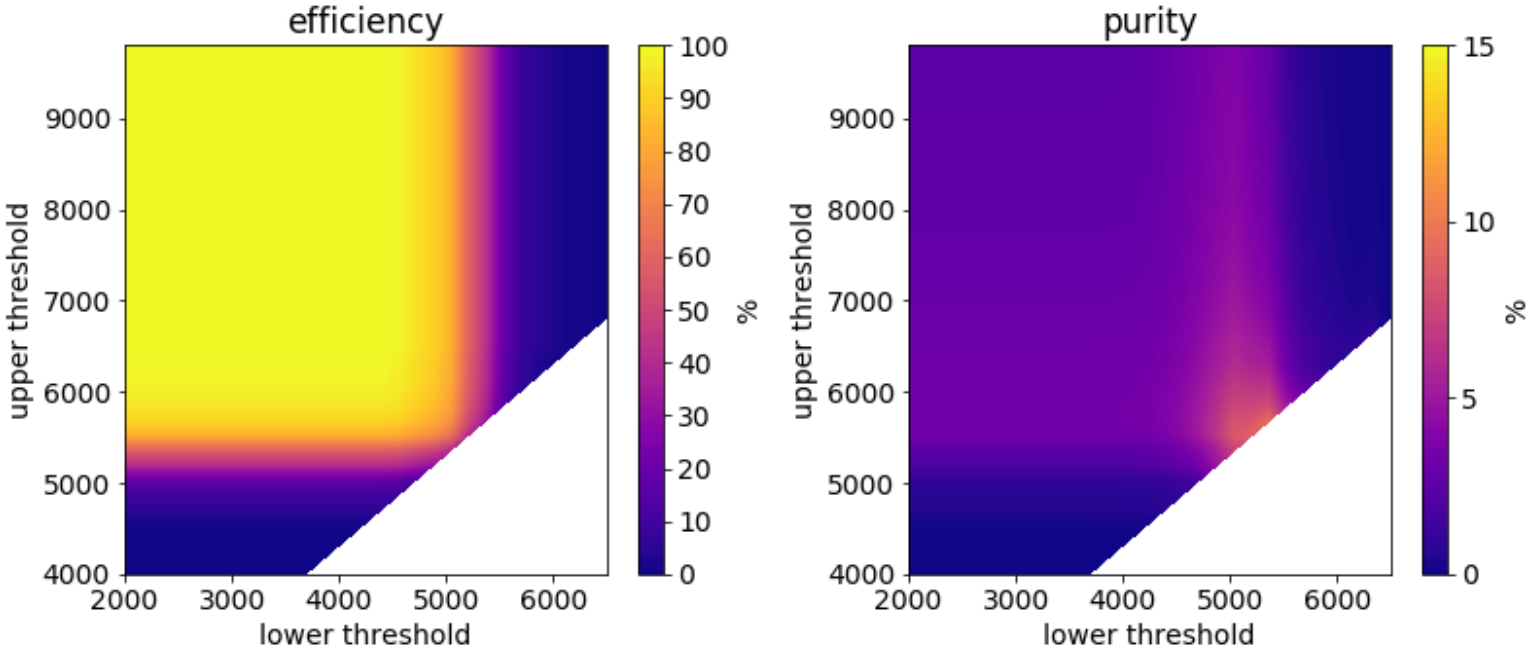
$\Rightarrow$Possible muon flagging directly at camera server level

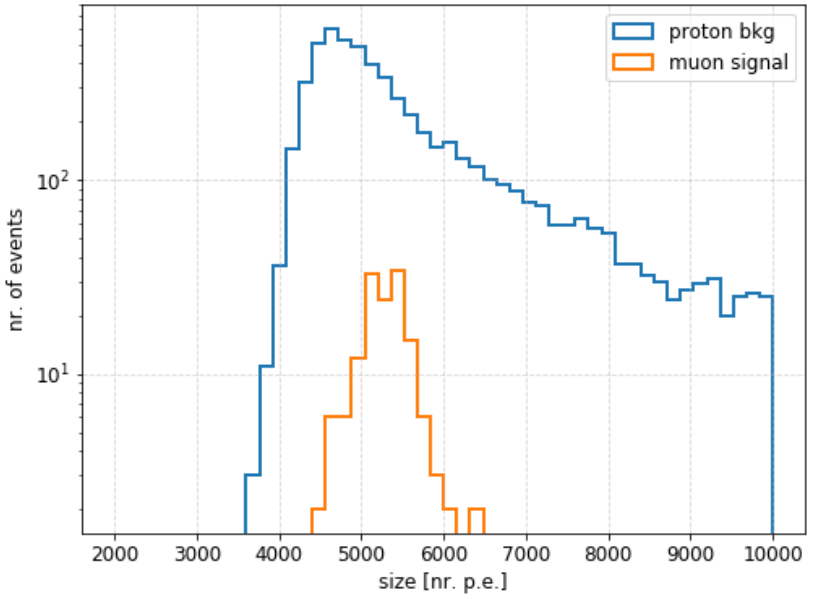
Data: Run 442 size distribution



- No pedestal event flag:
  - take only events with nr of pixels above 10 pe larger then 50 (blue).
  - This cuts also low energy showers in the low size region
  - it has to be corrected

Data: Run 442 preselection efficiency and purity

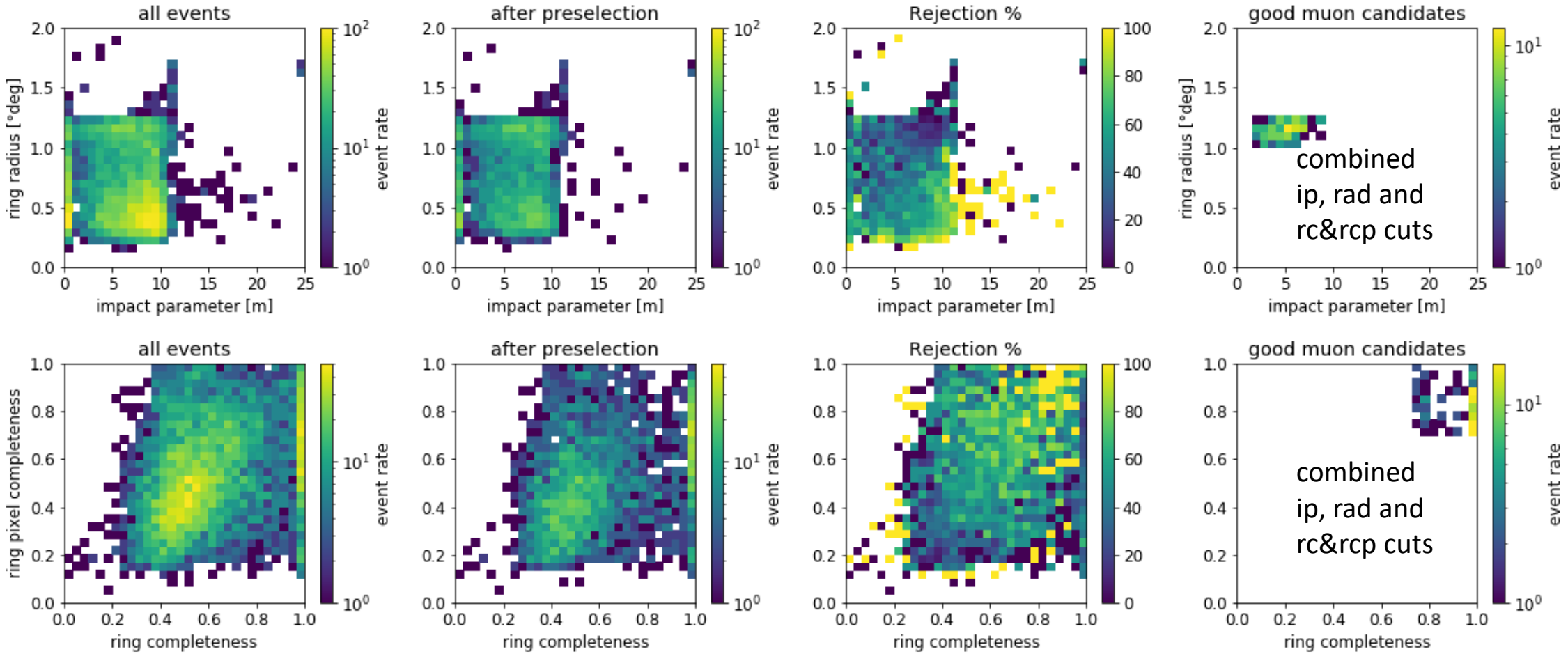




- @ 90% efficiency -> highest 6% purity
- size lower thr = 4500 pe
- size upper thr = 5600 pe

Preselection performance on Run 442 summary

(lower) 4500 (upper) 5600



Size preselection rejection has highest rejection in the non-interesting parameter regions.