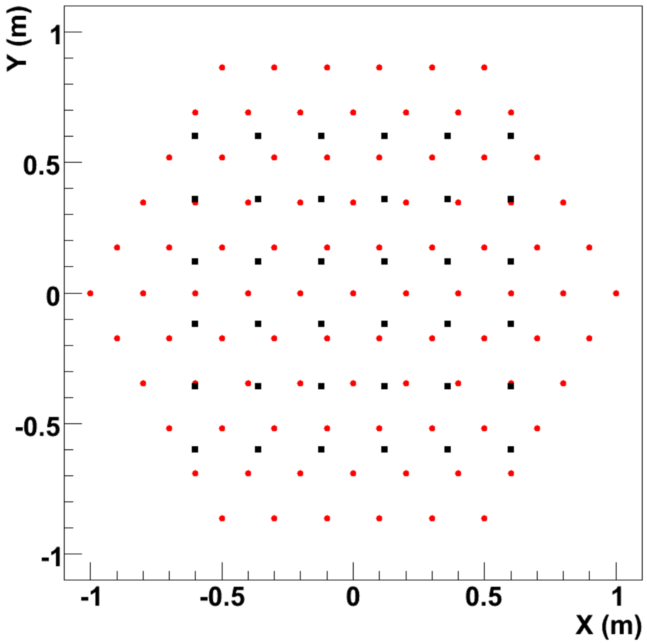
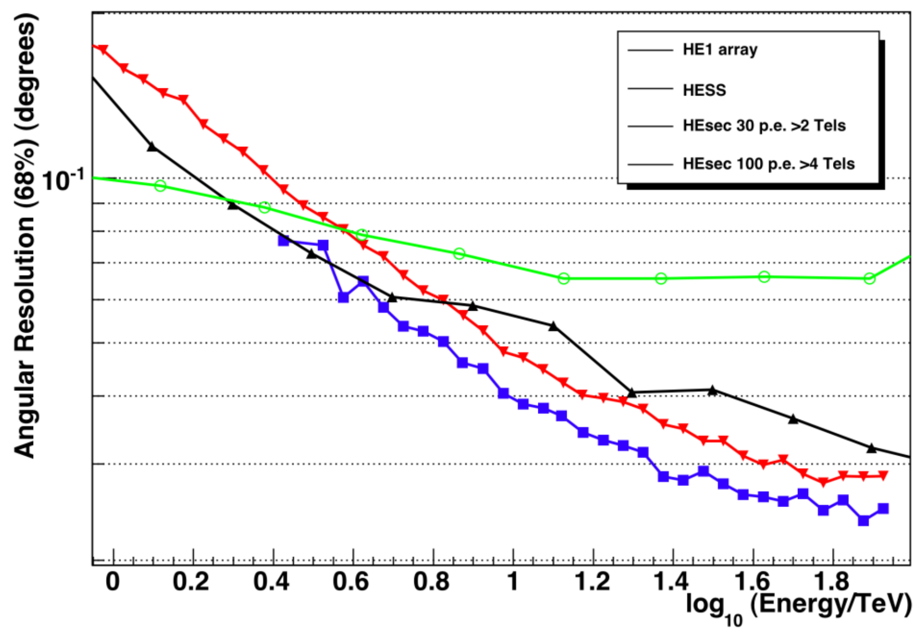
Secondary Optics in sim_telarray

R.D. Parsons

Secondary Approximation

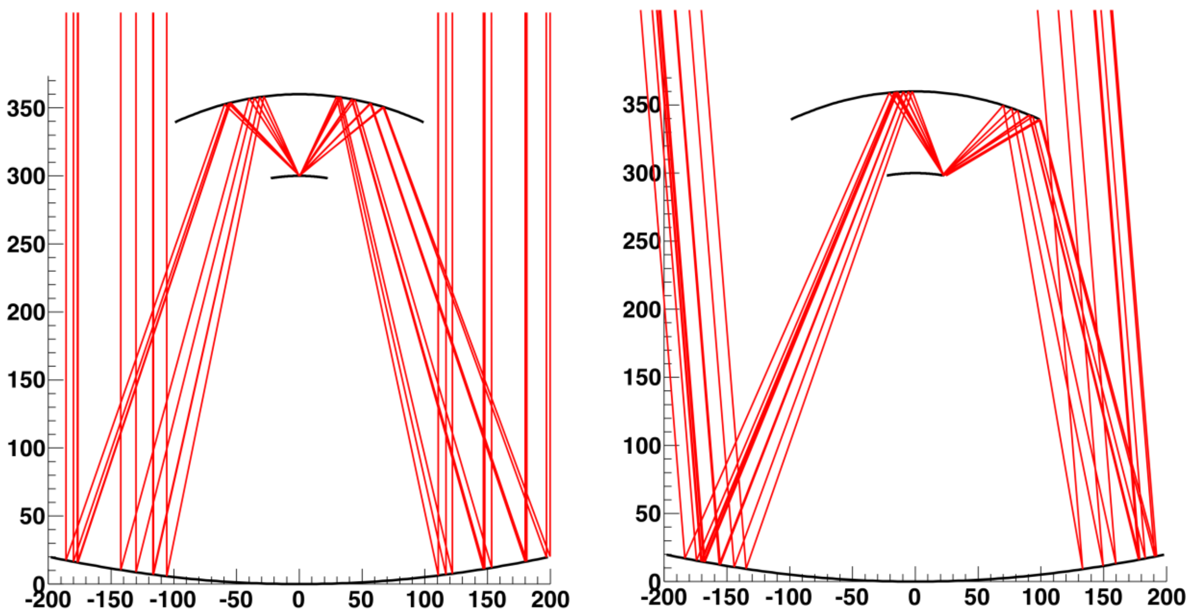


- Approximation of a secondary optics array presented in Zurich
- 91 tels simulated with expected mirror area, camera layout, angular pixel size etc.



- Can produce an increased angular resolution + effective area for the same array cost

Ray Tracing in sim_telarray

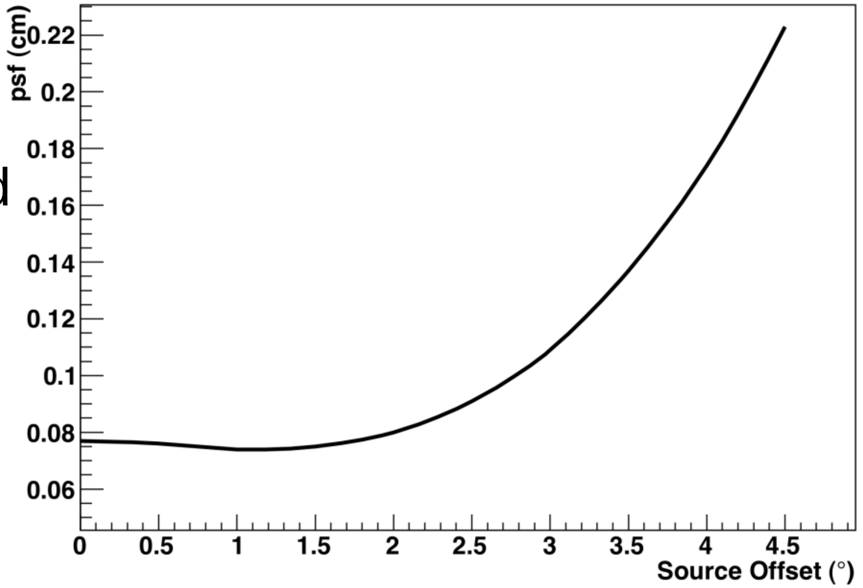


- Simulation of secondary optics is now possible in sim_telarray
- Curved focal planes are also allowed, by ‘stepping back’ the pixels

- Pixels normal to the focal surface are coming in the next version
- Mirror and focal surfaces must be defined in terms of a polynomial

Telescope psf

- Version 17 telescope (JS) found to have best performance
- Telescope has 4m primary and 2m secondary
- Psf does not degrade too significantly across the field of view
- Plate scale is however too large for our pixel size
- Telescope size must be scaled down

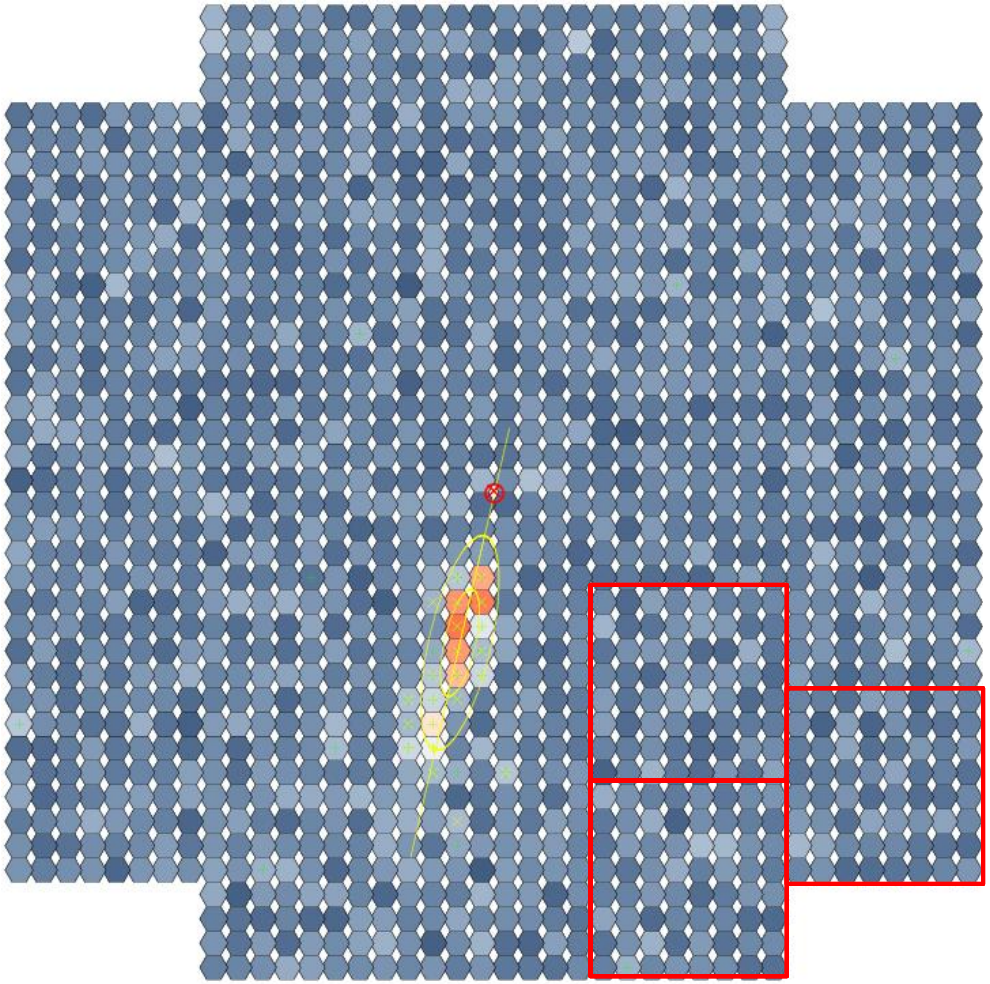


How many tels can we afford??

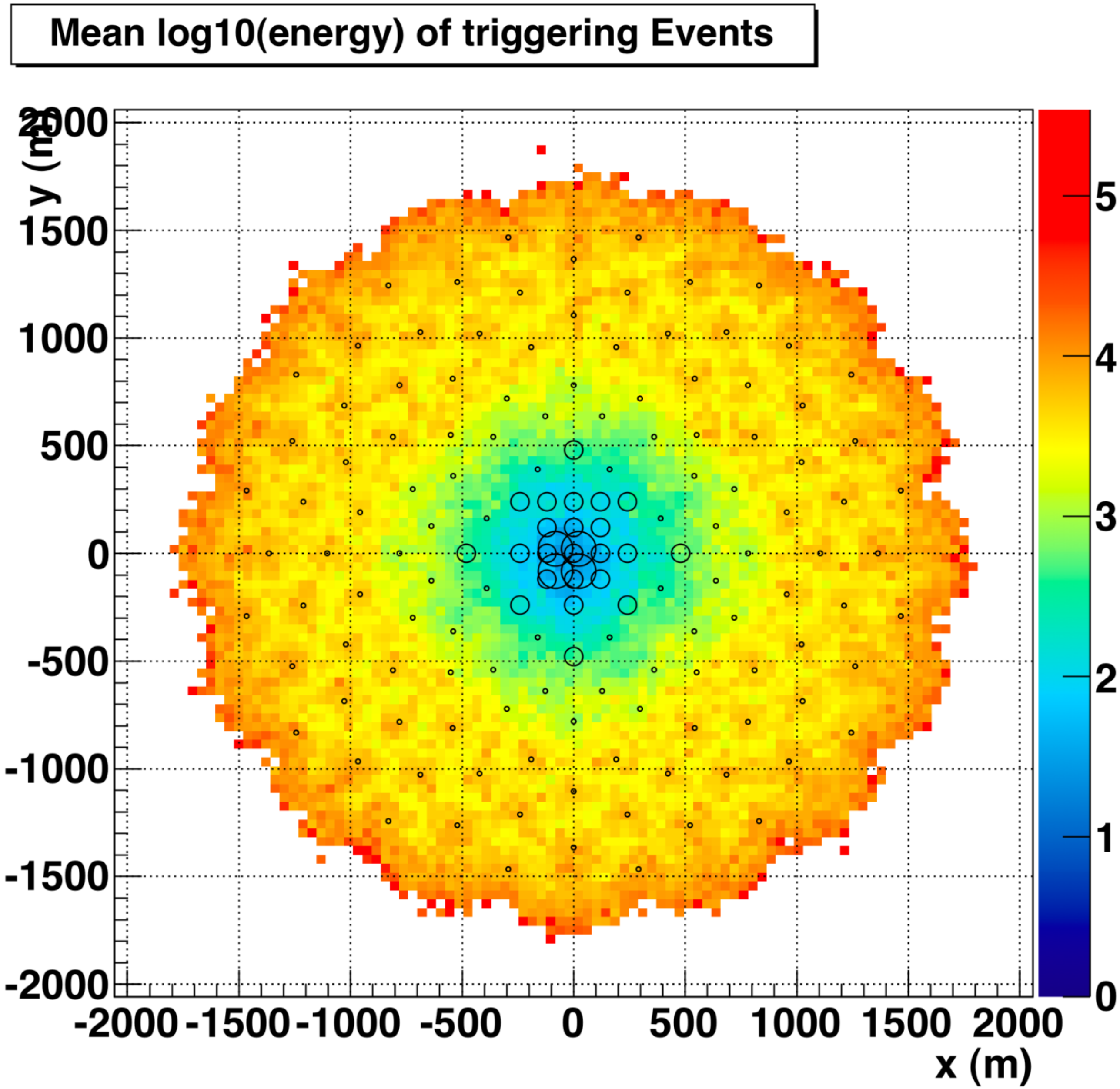
- Tests made with version 17 design scaled down to 3.4 metres
- Test camera has 1472 pixels
- Cost assumptions
  - 70 Euros per pixel (camera + electronics)
  - 3 kEuros per sq. metre of mirror
  - Structure cost scales to power 2.7

- With a 20 MEuro budget we can afford 129 telescopes
  - 65% spent on camera
  - 20 % spent on mirror
  - 15% spent on structure

Camera Layout

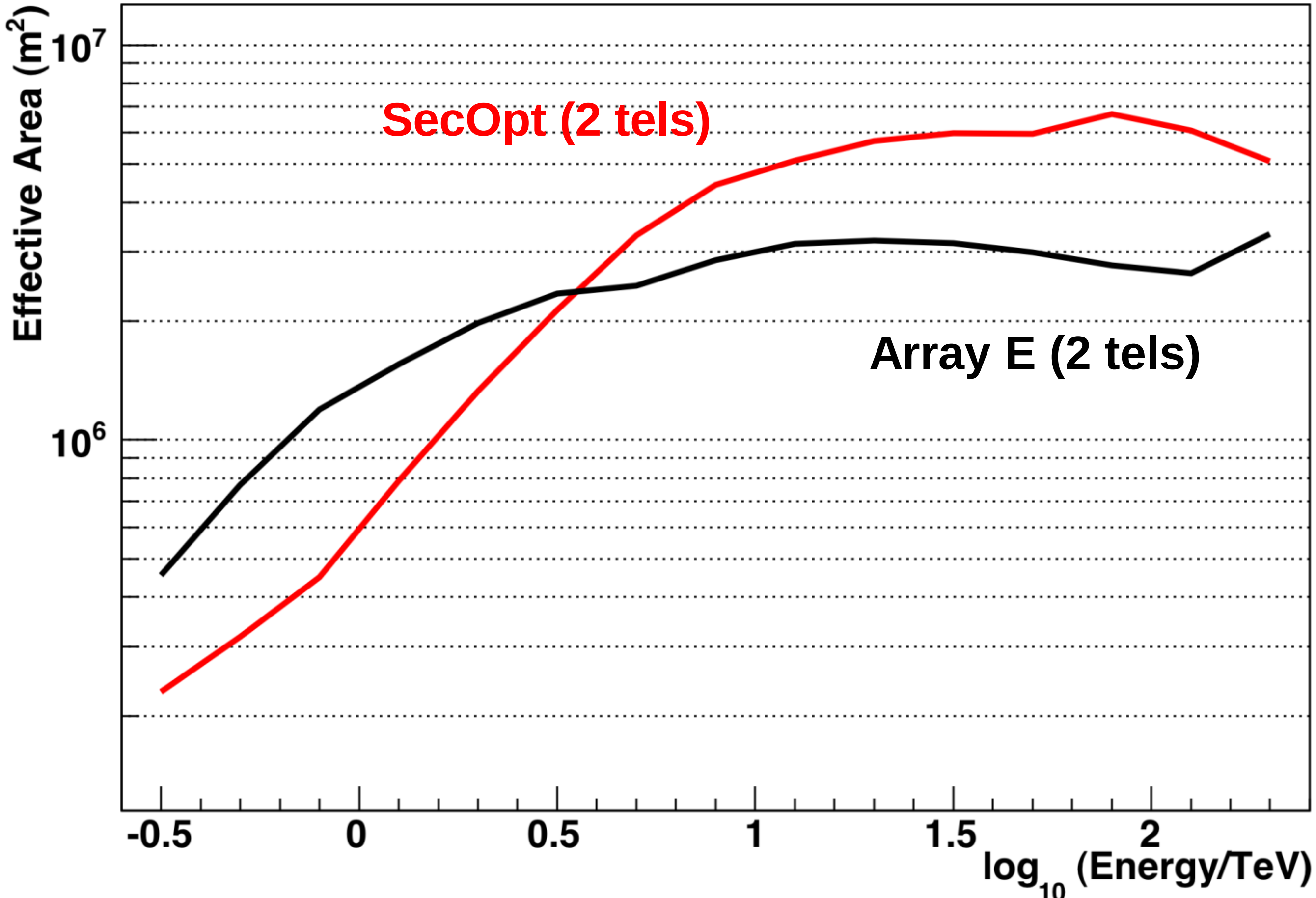


- 1472 pixel camera
- Consists of 23, 64 channel MaPMTs
- Using super bi-alkali photo-cathodes
- Each pixel is 6.5mm
- Angular size of 0.2 deg
- Camera Effective size of 8.2 deg



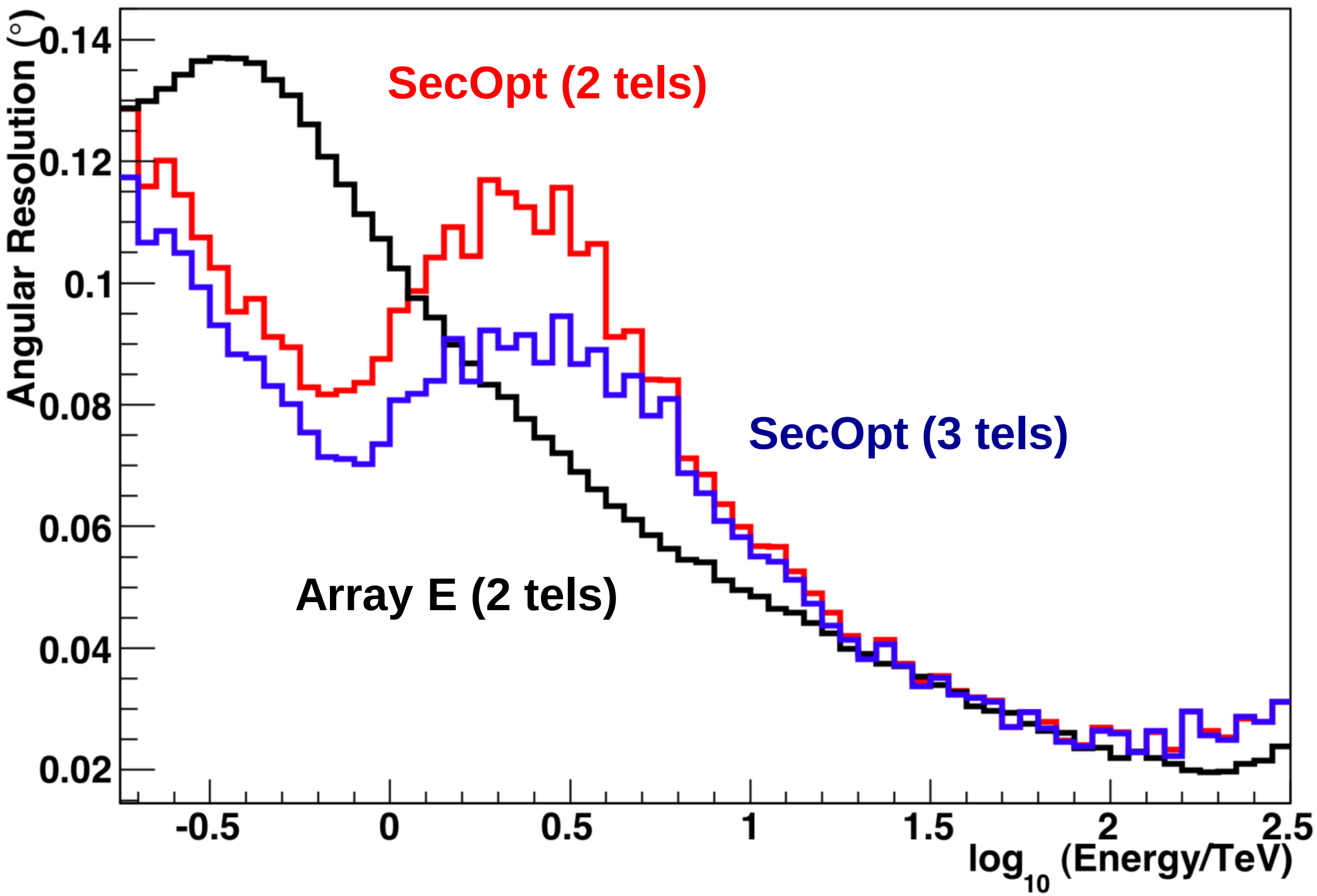
- 4 Large (23m)
- 23 Medium (12m)
- 120 Small (3.4m sec optics)
- Compromise to try and keep event multiplicity high

Array performance (Eff Area)

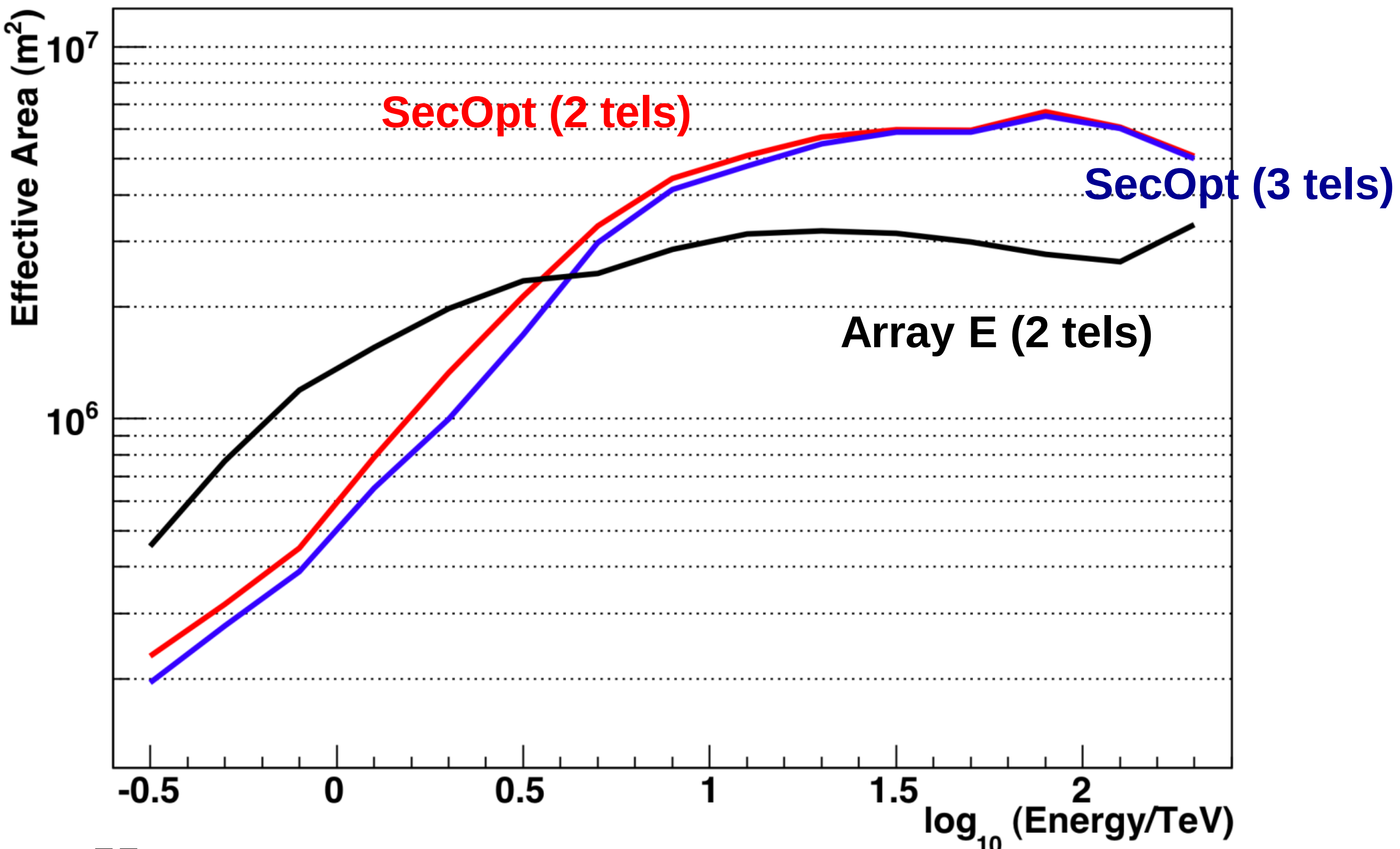


Amp cut 55 p.e.

Array performance (Ang Res)



Array performance (Eff Area)



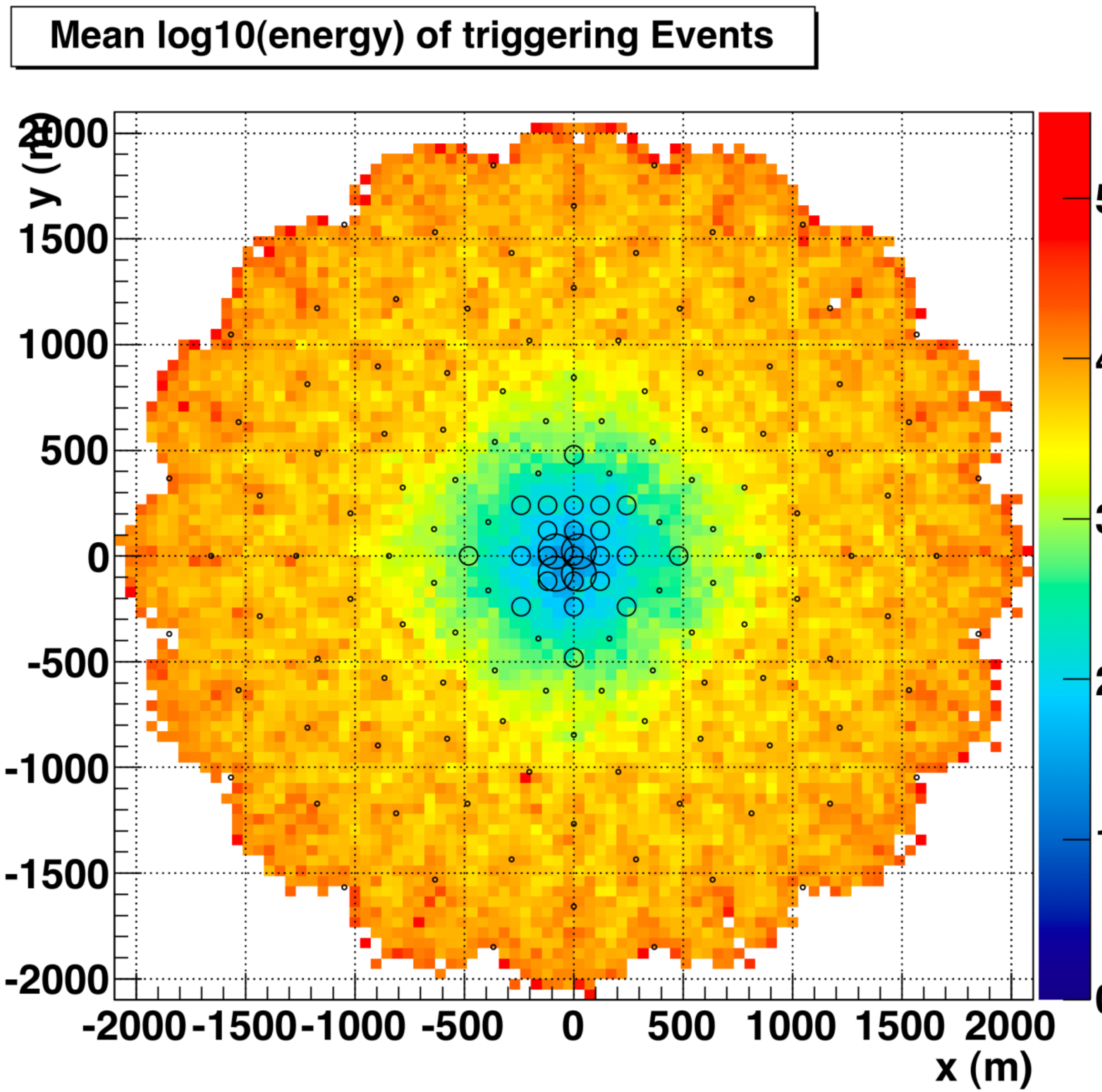
Amp cut 55 p.e.

Conclusions

- Using SSTs based on secondary optics solution can greatly increase the effective area of an array > 10TeV
- With harder cuts, the angular resolution of the array does not suffer too much
- However as telescopes are smaller, they do not trigger until ~ 1 TeV
- This leads to a lower effective area at 300 GeV, where 6m tels would be triggering
- Trade offs must be made between medium and high energy regions

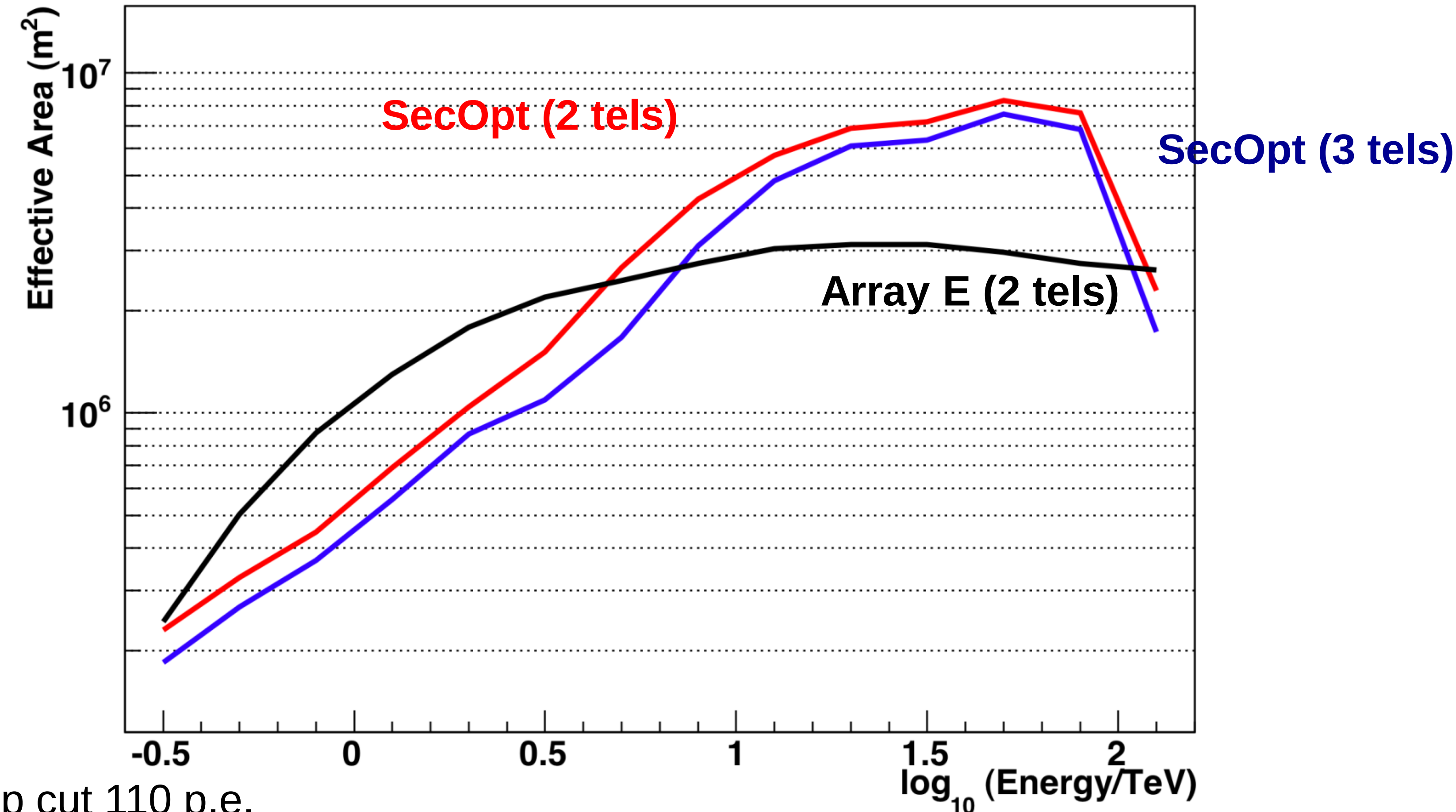
Future Work

- Array design needs work…
  - Must address the issues with effective area at 1 TeV
  - Telescope size could be increased
  - Closer spacing
- More realistic values must be used for camera
  - Efficiency of MaPMT
  - Angular dependence
- Run hadron simulations
  - Check background rejection is OK
  - Produce sensitivity curve



- 4 Large (23m)
- 24 Medium (12m)
- 120 Small (3.4m sec optics)
- Telescope spacing increases with distance from centre
- Effective area increases with energy
- Attempt to maximise effective area at high E

Array performance (Eff Area)



Amp cut 110 p.e.

Array performance (Ang Res)

SecOpt (2 tels)

SecOpt (3 tels)

Array E (2 tels)