Impact of beam far-sidelobes: a calibration related approach


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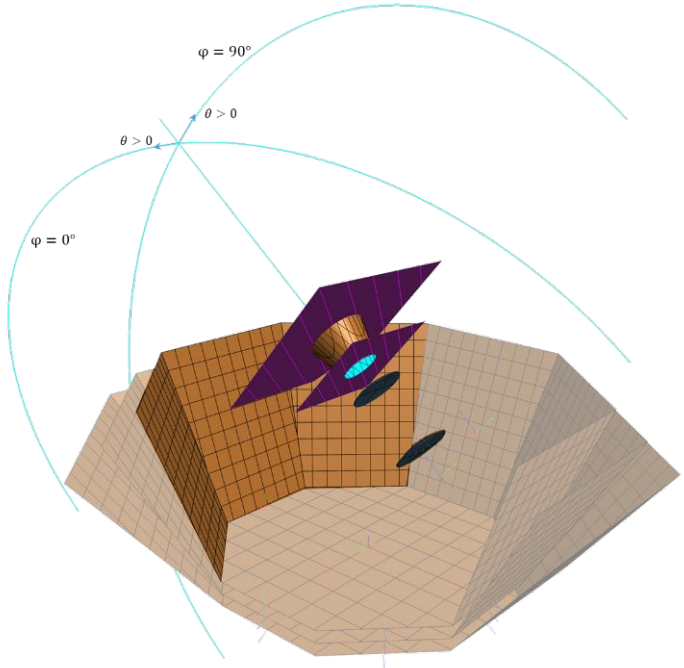
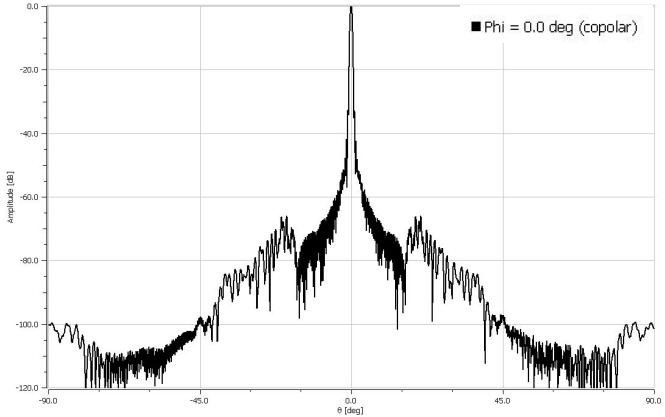
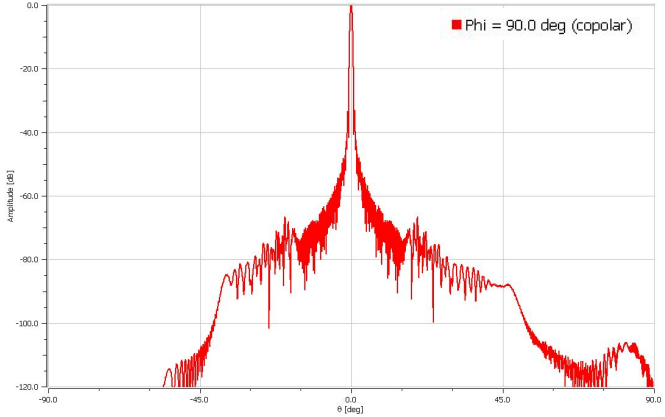
Side-lobes with Physical Optics (PO)

- **GRASP® PO simulations for on-axis pixel with V-grooves**
  - 3 front panels of 1st V-groove
  - Phi = 0 and phi = 90 planes at LOS direction
  - Beam former → aperture stop → baffle aperture → VG1

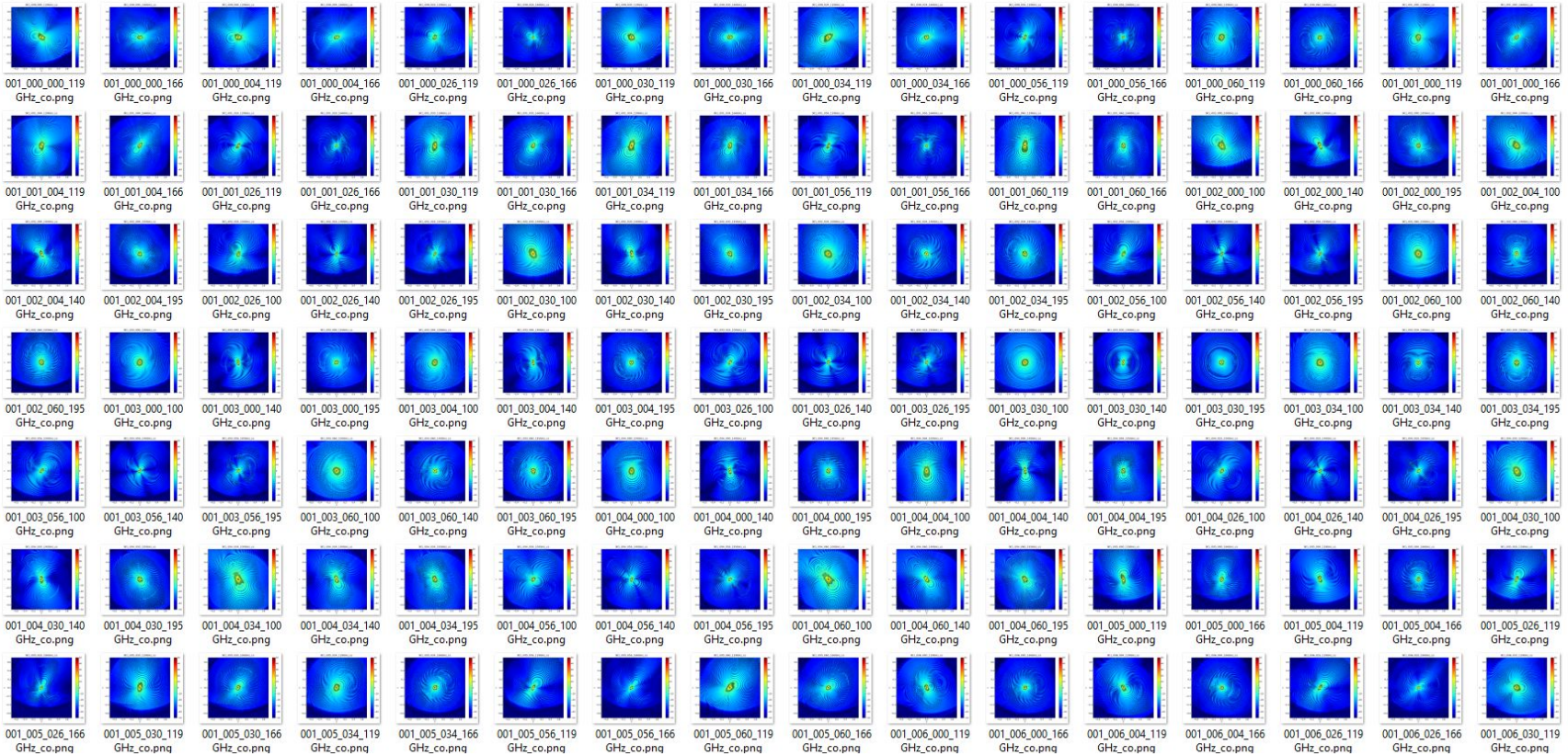






Typical Side-lobes with Physical Optics (PO)

- **Co-polar and cross-polar for a set of beams at 100, 119, 140, 166 and 195 GHz**



From beam profiles to instrument requirements

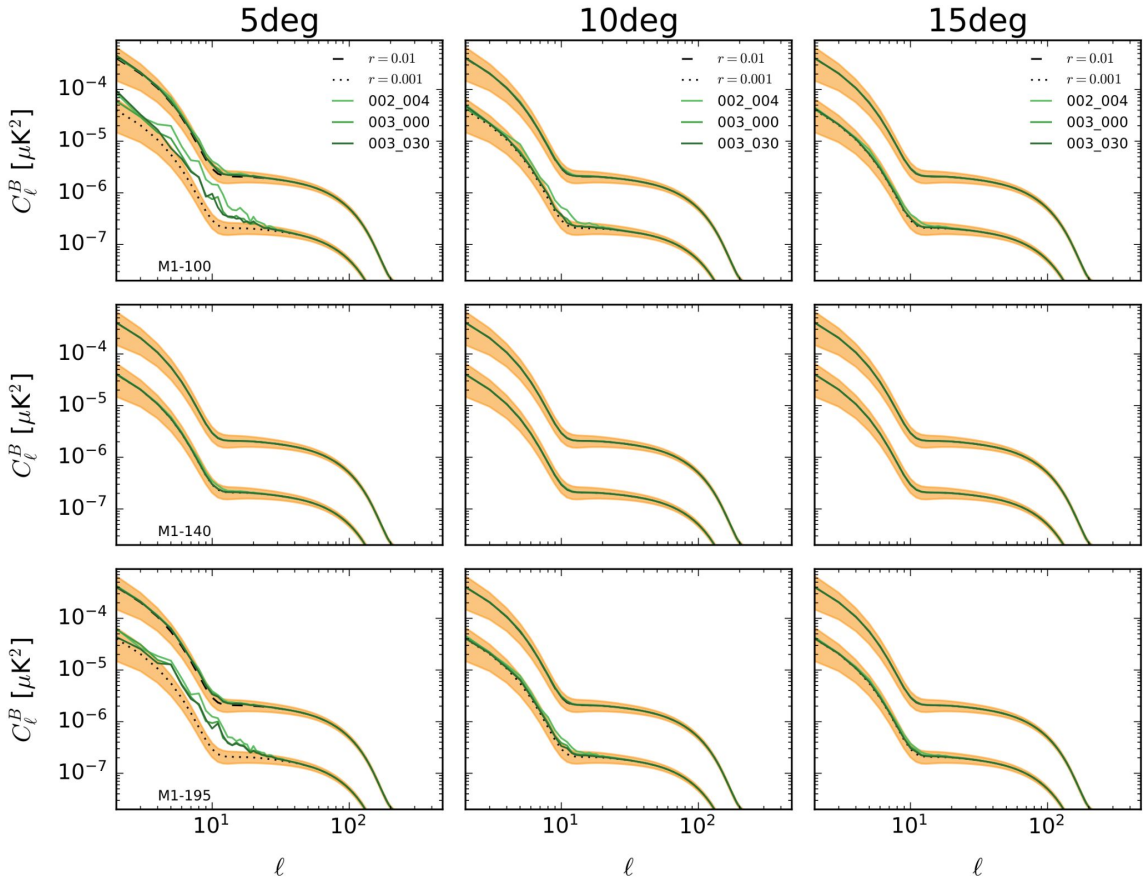
Motivation

- find a simple and direct way to derive beam requirements:
  - closer to actual beam measurement procedure
  - directly related to actual beam properties specified by, e.g., power dB level
  - avoid complications due to full data processing: clearly isolate the actual impact of beam shape only

Proposed approach

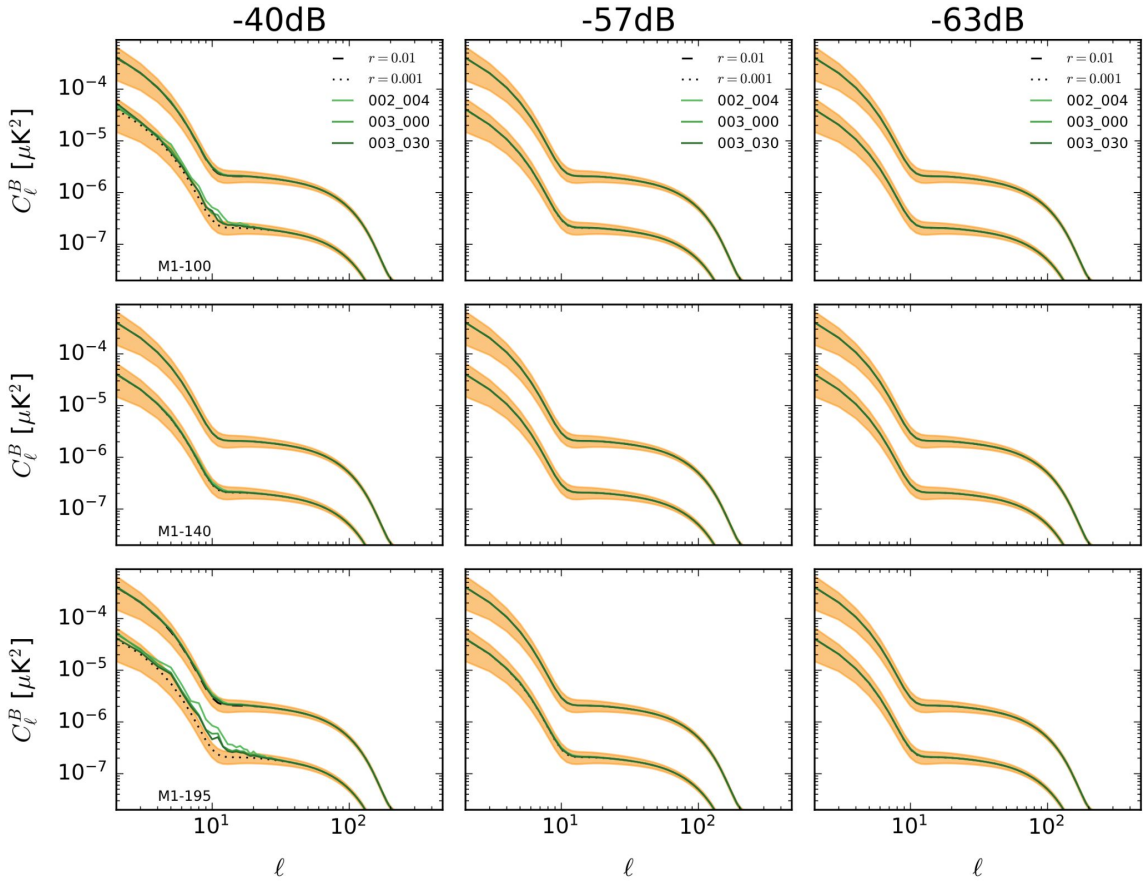
- Assume that we recover the input CMB B spectrum but for cosmic variance (CV)
- No component separations, no instrumental noise
- Use sidelobe convolved galactic signal as residual contamination
- Compare CMB B spectrum + galactic signal w.r.t. CV (we cannot beat cosmic variance!)
  - visual inspection of contaminating signal
  - construct likelihood for *r* to evaluate its impact in terms of Δr
- Useful to evaluate the goodness of polarised beam approximation in convolution without HWP
  - ***NO-HWP:*** use Planck *totalconvolver* with beam as produced by GRASP (this is the actual beam shape)
- Cut sidelobes according to:
  - angular distance from main beam direction (the usual 5,10 and 15 degs)
  - power level in the sidelobes (-40, -57 and -63 dB, LFT has -57dB requirement)

Results @ 100/140/195 - deg cuts



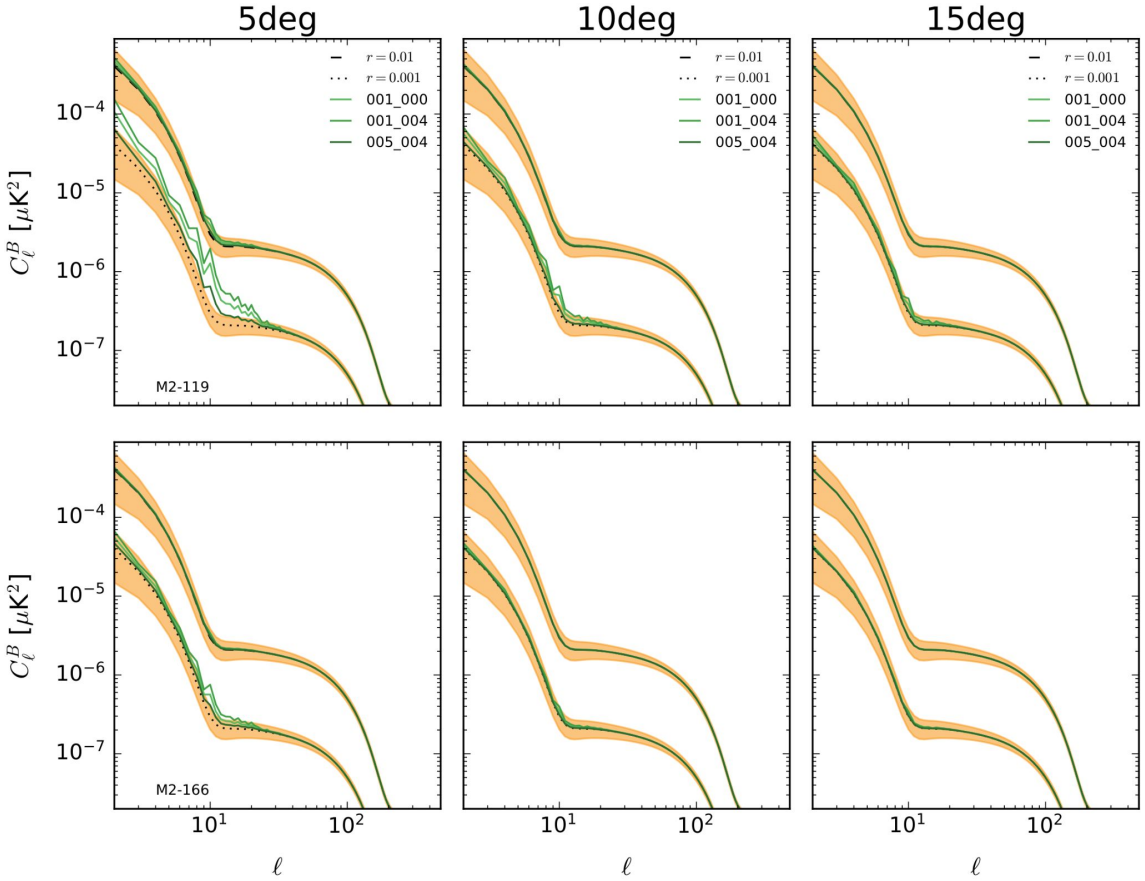
3 pixels: different location on FP

Results @ 100/140/195 - pwr cuts



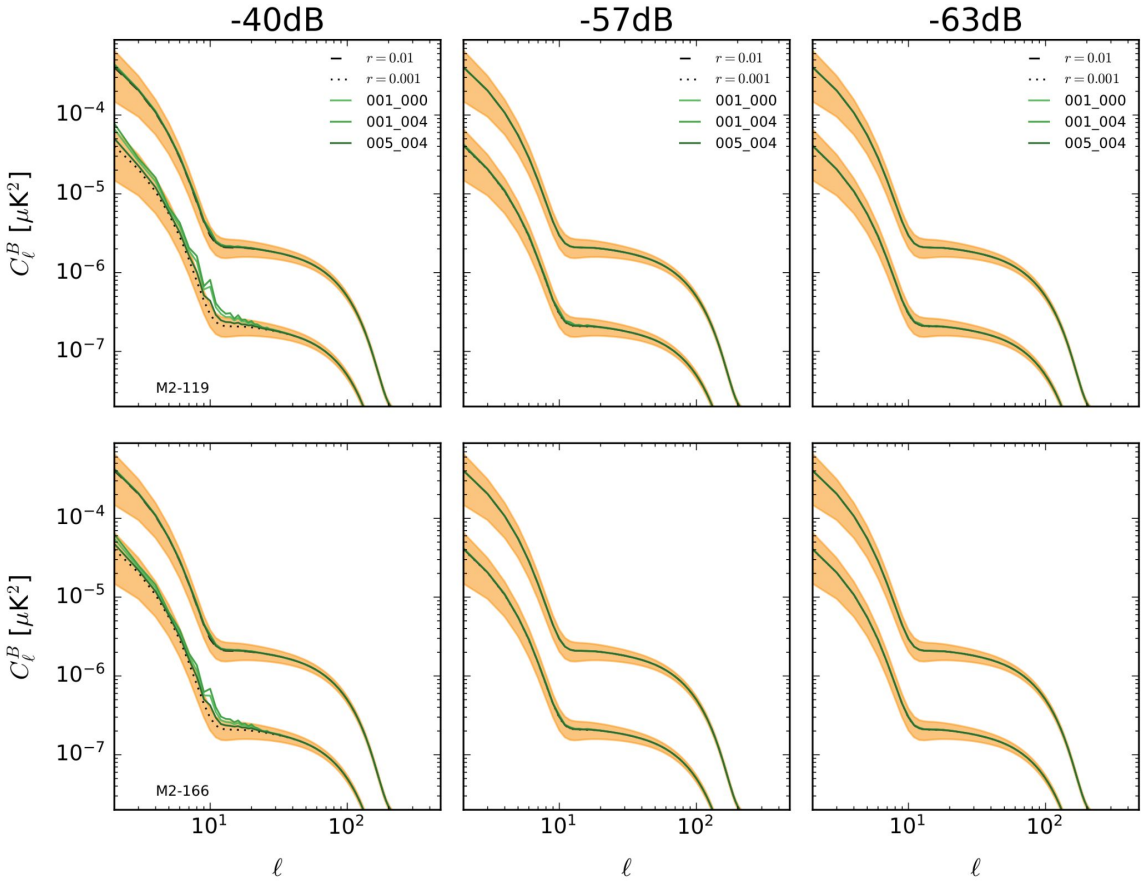
3 pixels: different location on FP

Results @ 119/166 - deg cuts



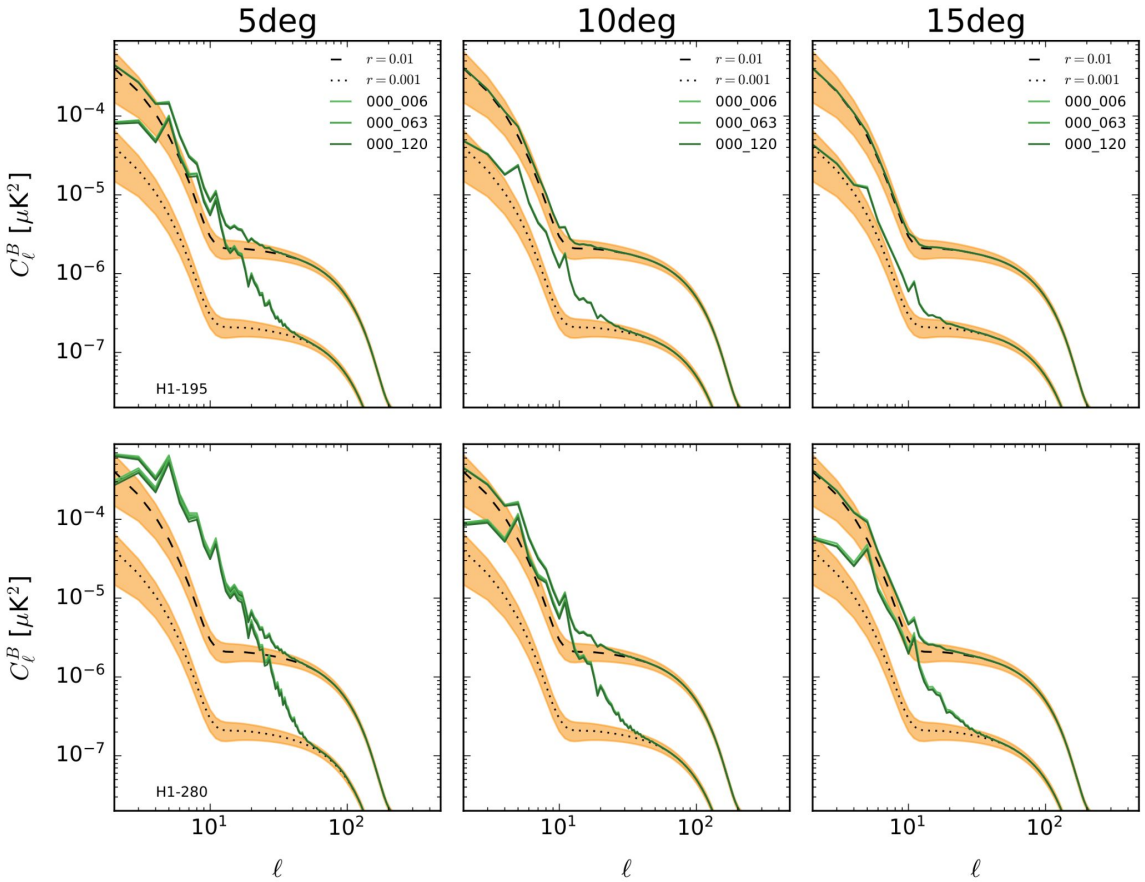
3 pixels: different location on FP

Results @ 119/166 - pwr cuts



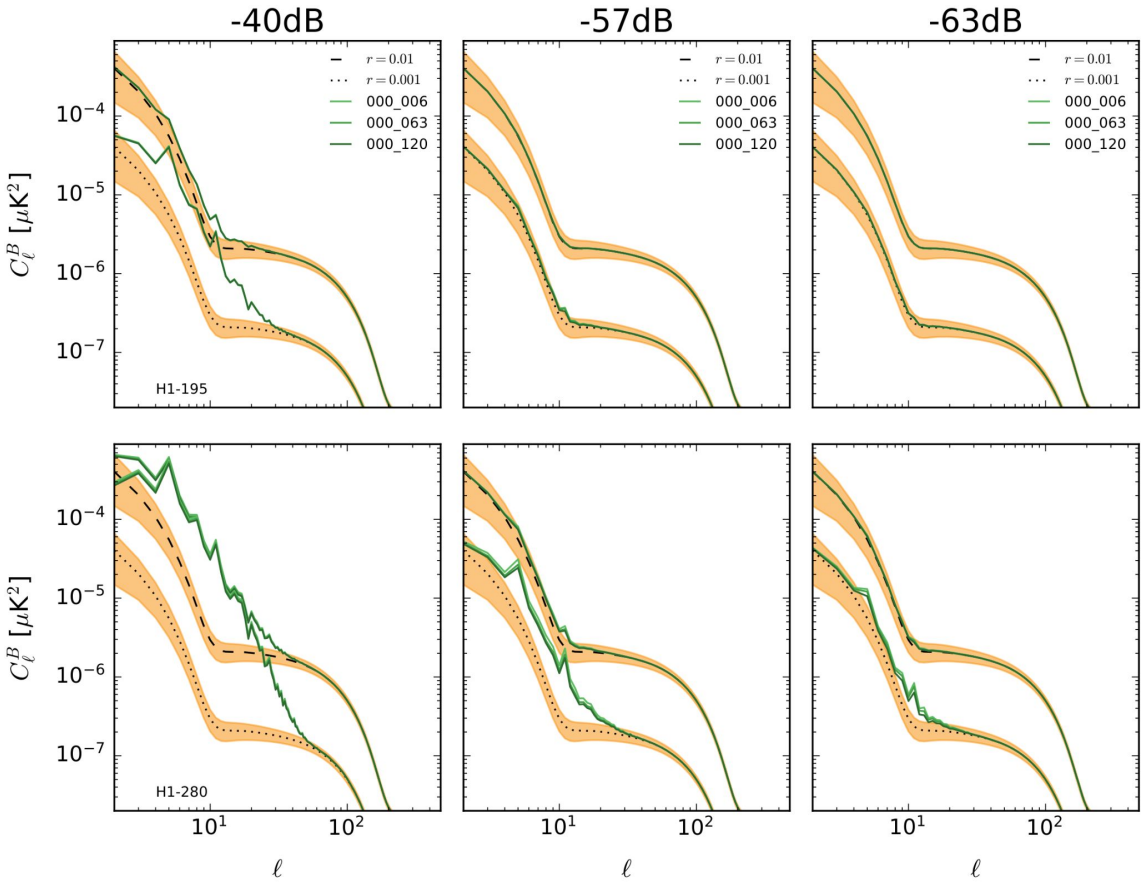
3 pixels: different location on FP

Results @ 195/280 - deg cuts



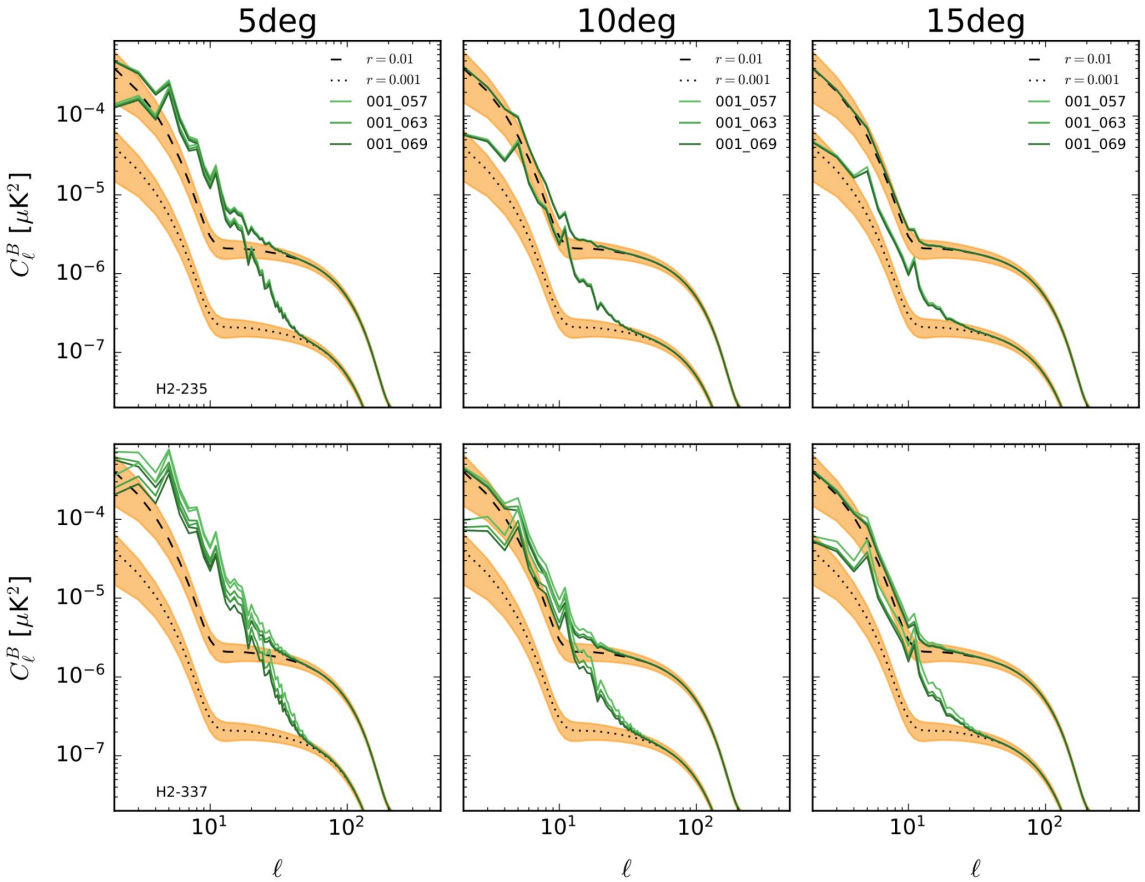
3 pixels: different location on FP

Results @ 195/280 - pwr cuts



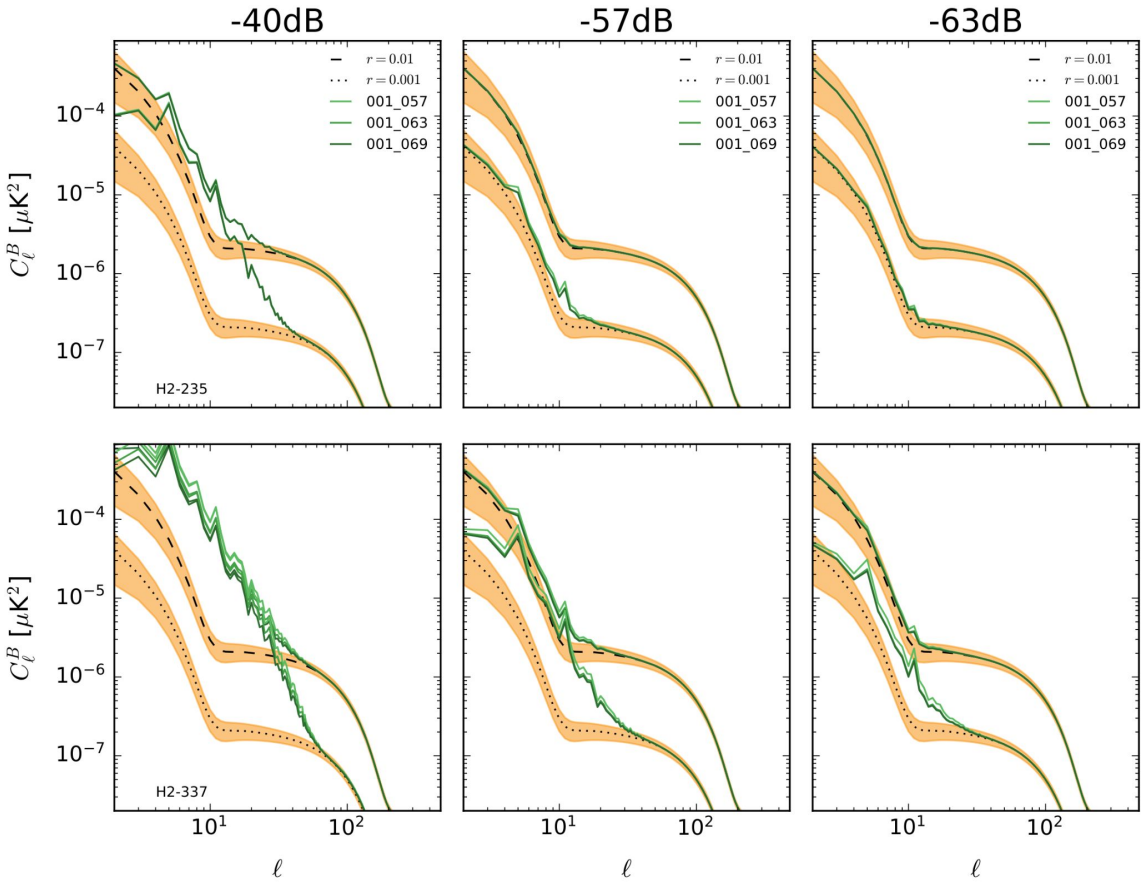
3 pixels: different location on FP

Results @ 235/337 - deg cuts



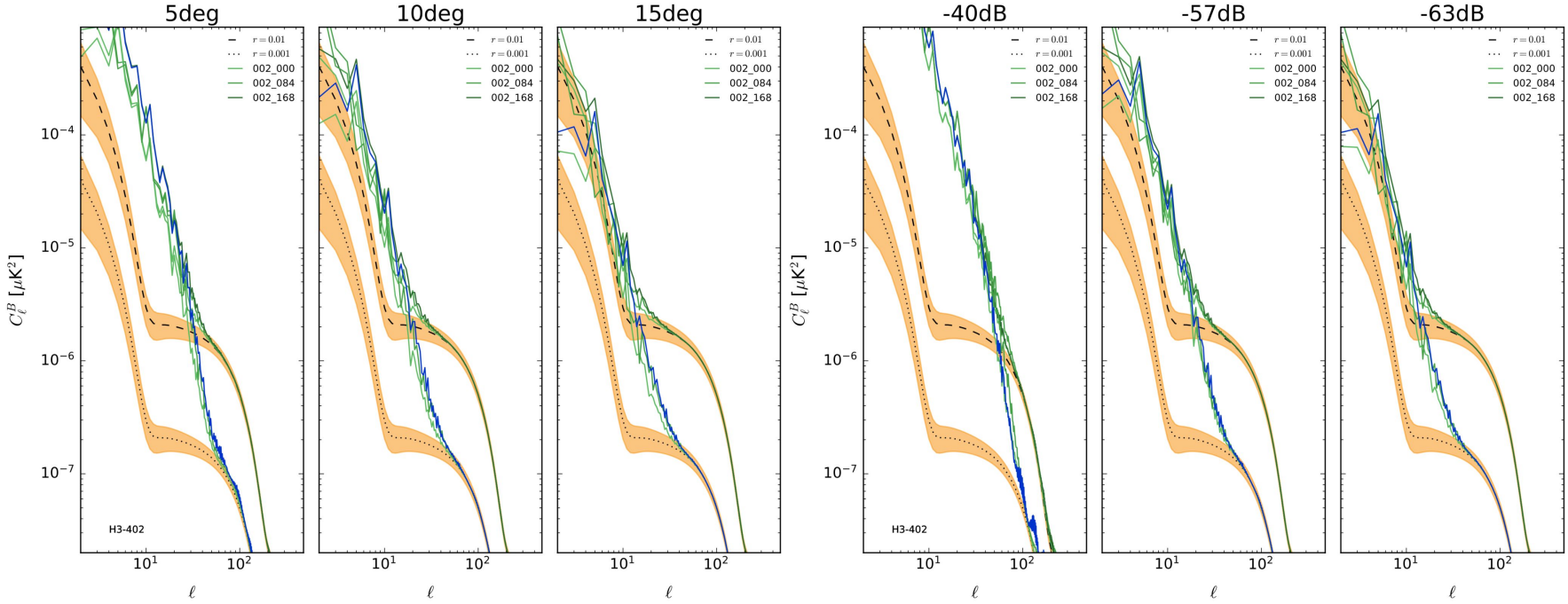
3 pixels: different location on FP

Results @ 235/337 - pwr cuts

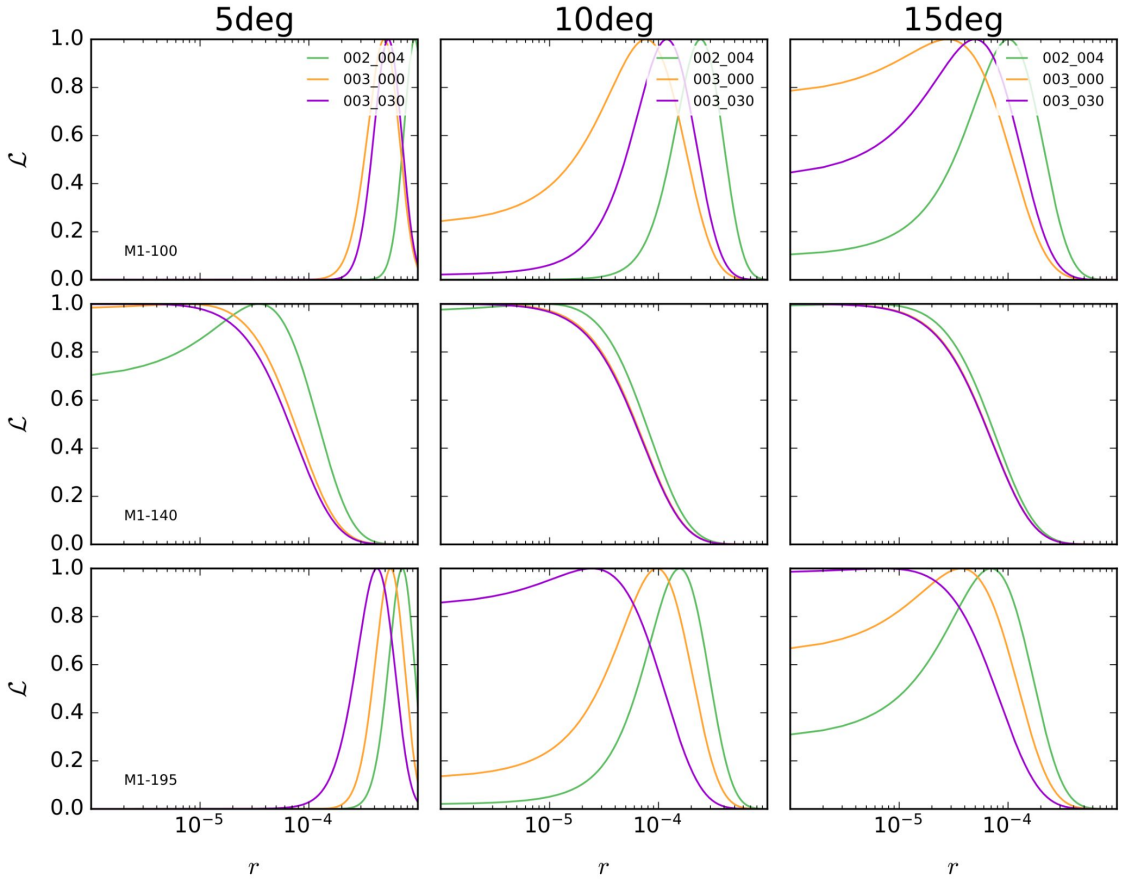


3 pixels: different location on FP

Results @ 402- deg & pwr cuts

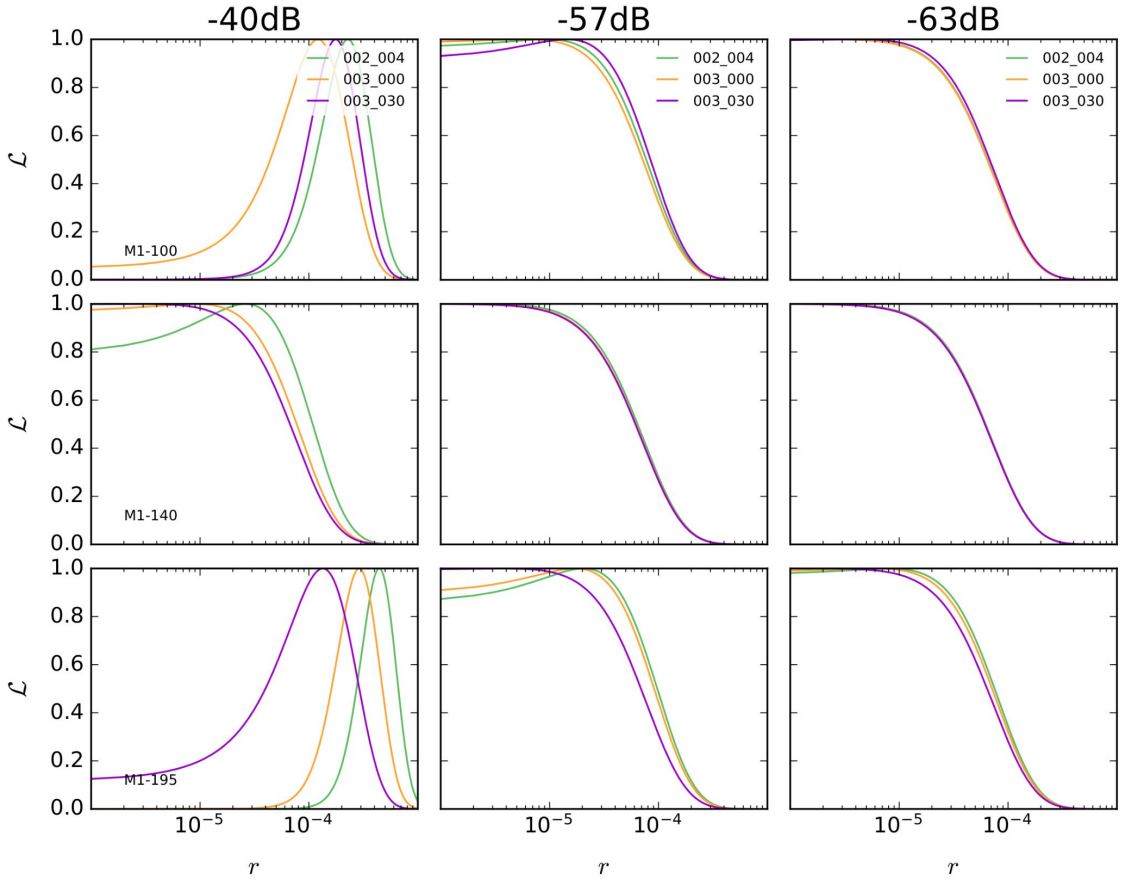


r likelihood:@100/140/195 (deg cuts)



- Impliment a simple *r* likelihood (no noise, CV and residual galactic sidelobes signal as contaminant)

r likelihood:@100/140/195 (pwr cuts)



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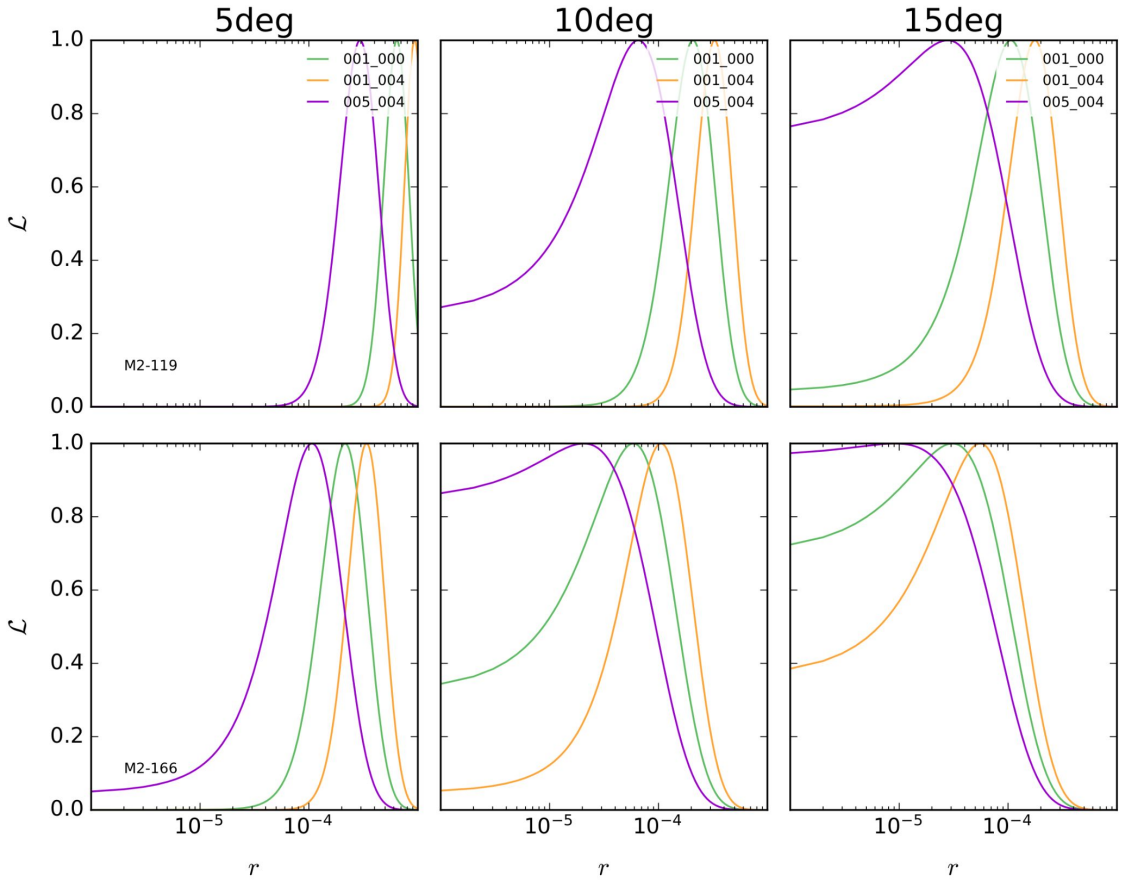
r likelihood:@ 119/166 (deg cuts)



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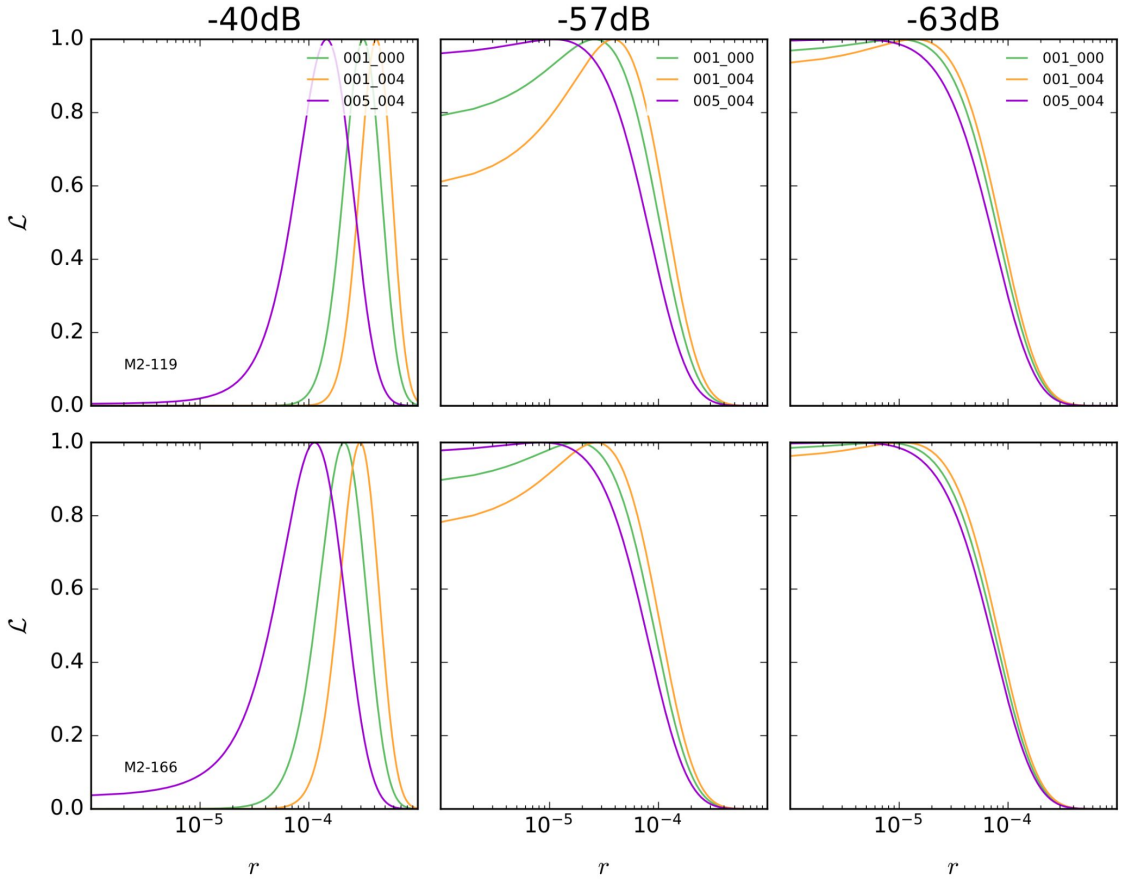
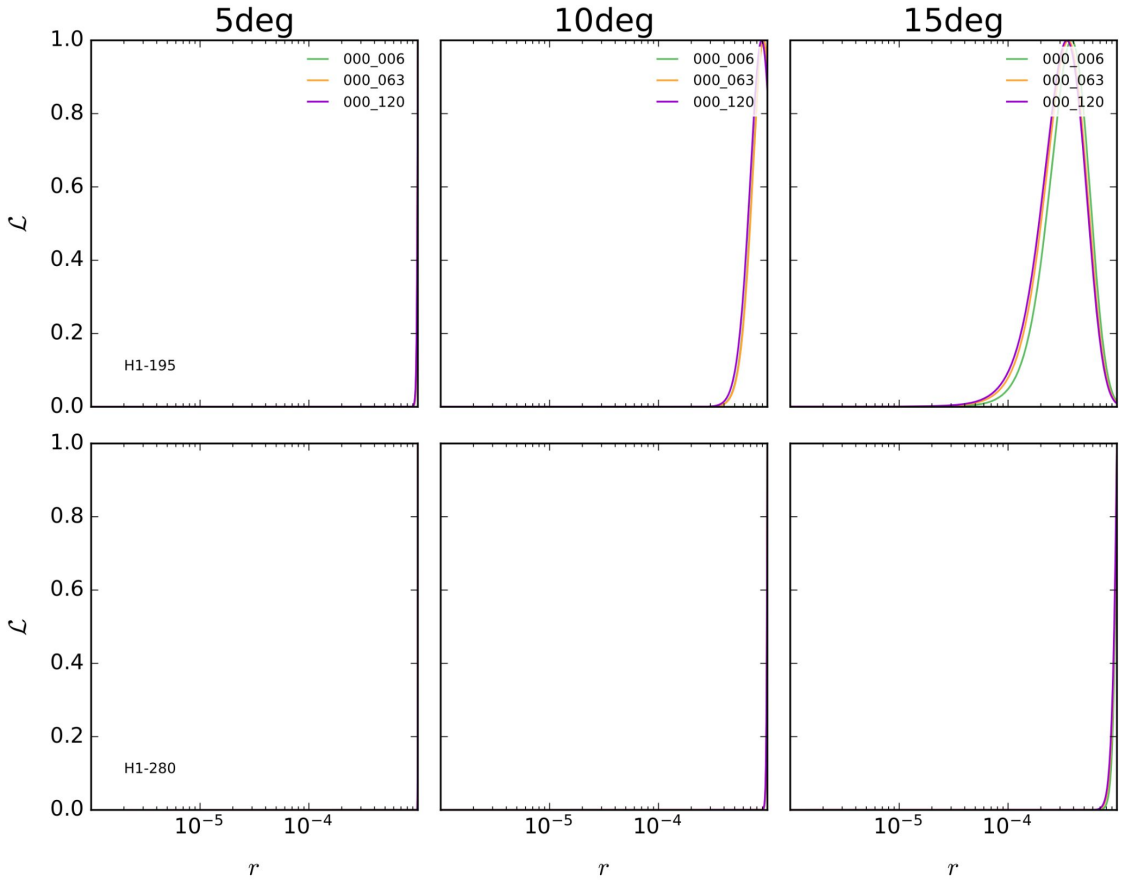


- Impliment a simple *r* likelihood (no noise, CV and residual galactic sidelobes signal as contaminant)

r likelihood:@195/280 (deg cuts)



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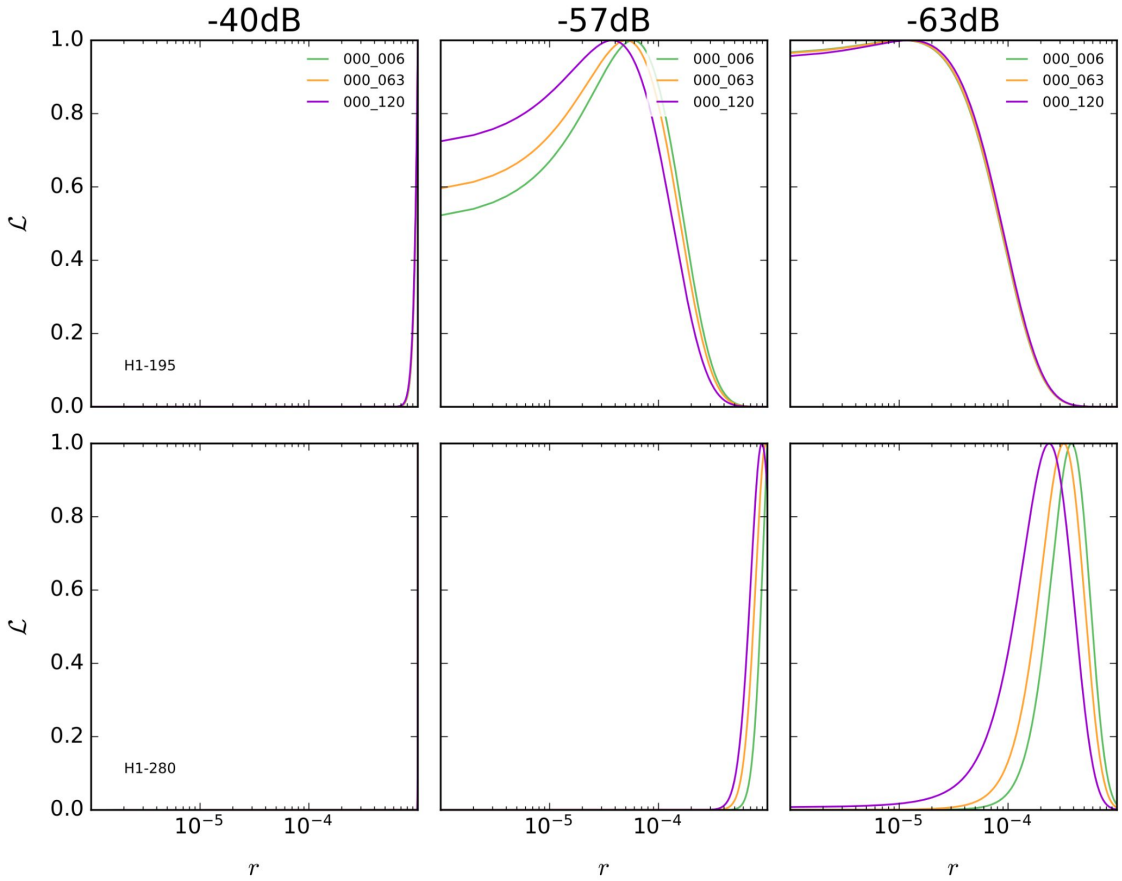
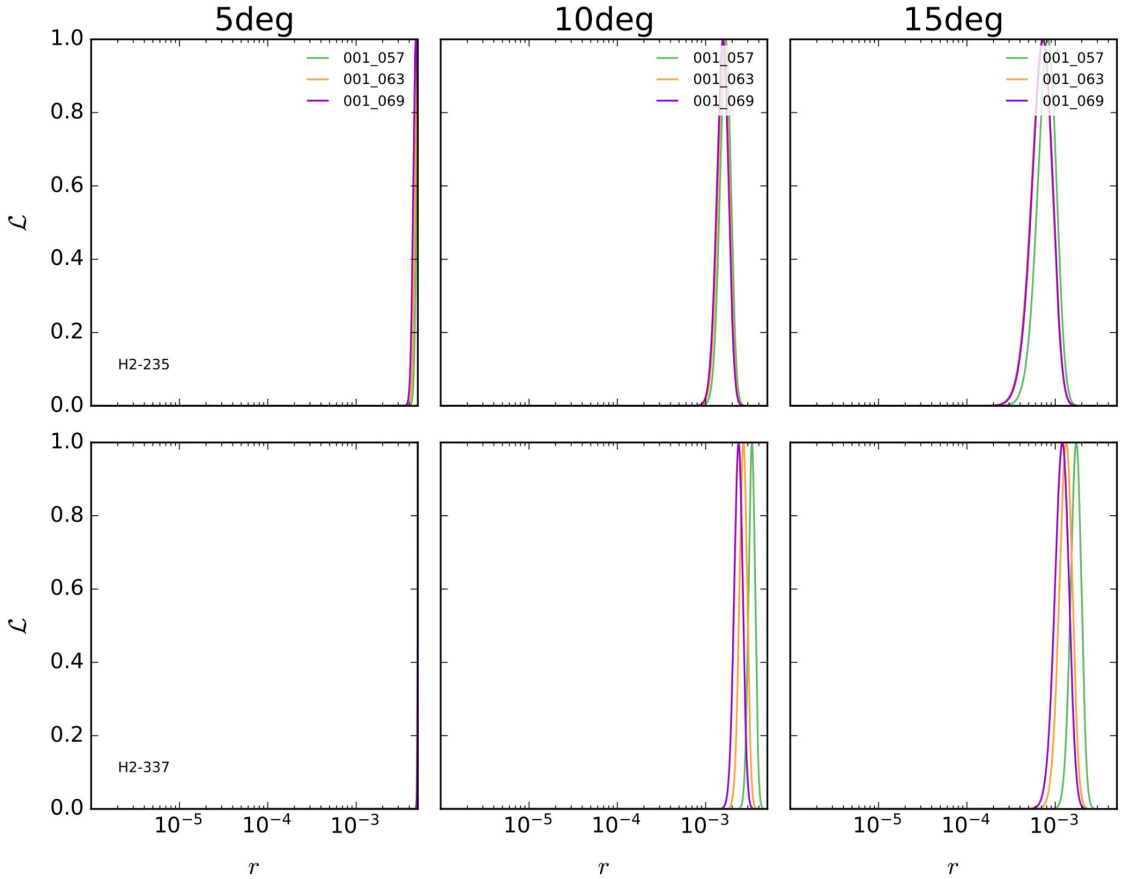
r likelihood:@195/280 (pwr cuts)



- Impliment a simple *r* likelihood (no noise, CV and residual galactic sidelobes signal as contaminant)

r likelihood:@235/337 (deg cuts)



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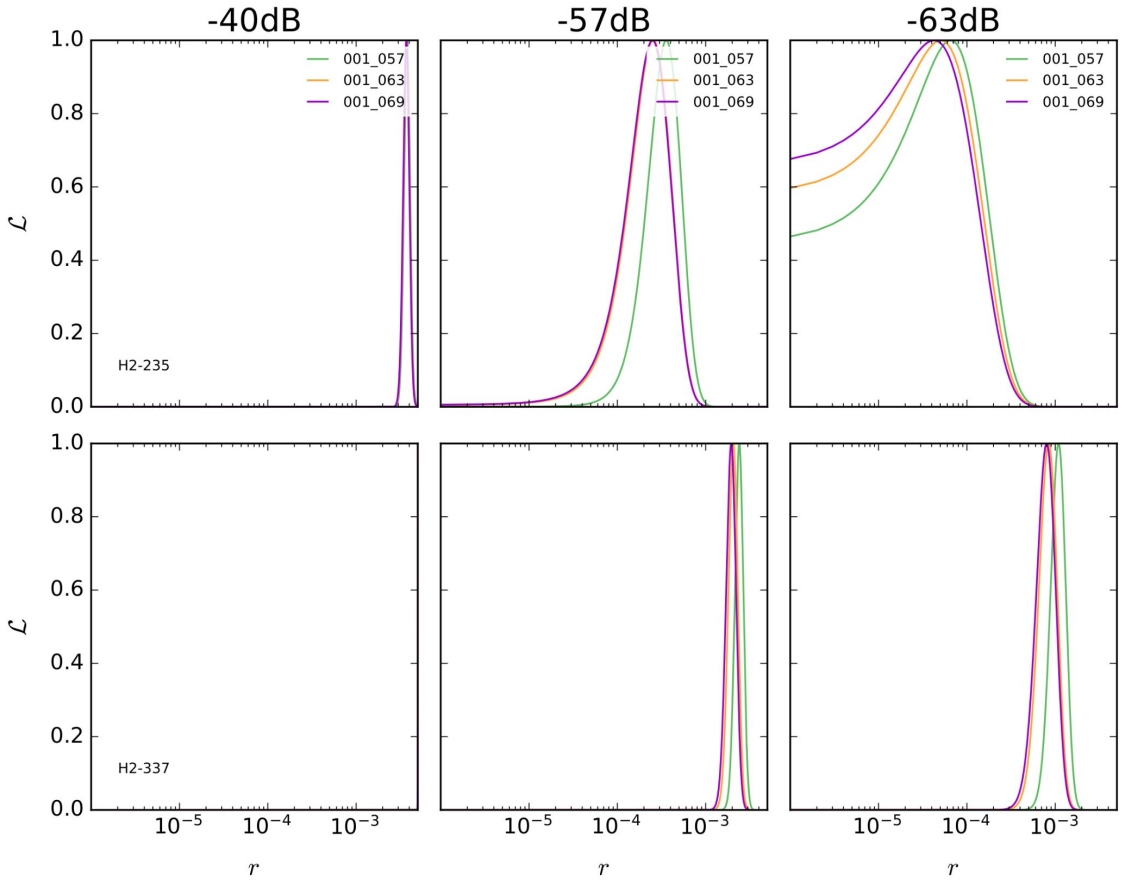
r likelihood:@ 235/337 (pwr cuts)



- Impliment a simple *r* likelihood (no noise, CV and residual galactic sidelobes signal as contaminant)

Conclusions

- @cosmological freqs: within *r* requirement with -57 dB beam knowledge
- Higher frequencies: large contamination due to:
  - large sidelobes
  - higher dust galactic signal
- Issue with component separations: we transpose dust sidelobes contamination into clean cosmological frequencies

Next steps

- **Different convolution approach**
  - run the same analysis but with the TEB convolution approach (Giuseppe) → we expect almost consistent results wrt TotalConvolver (No-HWP)
- **Include component separation**
  - create synthetic sky for with dust and CMB
  - convolve all freqs at the same FWHM
  - run polarized FastICA to get insight of the frequency weights for CMB cleaning
  - “transpose” sidelobe residuals at cosmo-frequencies according to ICA weights
  - compare these wrt cosmic variance and recompute *r* likelihoods