# optimization of the distribution of sensitivities among CMB-S4 frequency bands

| CMB-S4 “baseline” | | | | | | | |
|---|---|---|---|---|---|---|---|
| frequencies [GHz] | 30 | 40 | 95 | 145 | 155 | 220 | 270 |
| polarization uK-arcmin, fsky=5% | ? | ? | ? | ? | ? | ? | ? |

**approximate focal plane area:** $\sum_{\text{channel \# i}} \frac{d_i}{f_i^2}$

$d_i$: **# of detectors in channel i**

$f_i$: **frequency of channel i**

**Question**: what is the optimal distribution of detectors which minimizes σ(r=0) after CMB+dust+synchrotron separation, while keeping the area of the focal plane constant and keeping the foregrounds residuals bias under control?

# Method

(1) $\mathbf{N_{det}}$, taken such that ***focal plane area is constant***

(2) $\text{map sensitivity } [\mu K - arcmin] = \text{function}(\mathrm{N_{det}}) \propto \frac{1}{\sqrt{\mathrm{N_{det}}}}$

(3) simulated polarized dust and synchrotron
[e.g. PySM maps available at NERSC]

(4) comp sep code
e.g. xForecast (1609.03807)

- component separation ➔ level of residuals and noise in the cleaned CMB map
- computation of the likelihood on tensor-to-scalar ratio given cosmic and noise variances, and the presence of foregrounds residuals ➔ $r^{fit} \pm \sigma(r^{fit})$

(5) penalty on σ if e.g. the significance on the bias = $r^{fit}/\sigma(r^{fit})$ is larger than 1

e.g. σ(r) ➔ σ(r) x [ 1 + bias significance ]

**σ(r)**

| example of a 100k-detector instrument optimized configuration | | | | | | | |
|---|---|---|---|---|---|---|---|
| **frequencies [GHz]** | **20** | **30** | **40** | **95** | **150** | **220** | **270** |
| Ndet | 2000 | 2000 | 5000 | 21000 | 20000 | 15000 | 20000 |
| NET/det [uK.rs] | 371 | 269 | 270 | 296 | 331 | 909 | 1509 |
| **polarization uK-arcmin, fsky=5%** | **6.4** | **4.6** | **2.9** | **1.6** | **1.8** | **5.7** | **8.2** |