

# PROCEEDINGS OF SPIE

[SPIDigitalLibrary.org/conference-proceedings-of-spie](https://spiedigitallibrary.org/conference-proceedings-of-spie)

## BoloCalc: a sensitivity calculator for the design of Simons Observatory (Erratum)

Charles Hill, Sarah Marie Bruno, Sara Simon, Aamir Ali, Kam Arnold, et al.

Charles A. Hill, Sarah Marie Bruno, Sara M. Simon, Aamir Ali, Kam S. Arnold, Peter C. Ashton, Darcy Barron, Sean Bryan, Yuji Chinone, Gabriele Coppi, Kevin T. Crowley, Ari Cukierman, Simon Dicker, Jo Dunkley, Giulio Fabbian, Nicholas Galitzki, Patricio A. Gallardo, Jon E. Gudmundsson, Johannes Hubmayr, Brian Keating, Akito Kusaka, Adrian T. Lee, Frederick Matsuda, Philip D. Mauskopf, Jeffrey McMahon, Michael D. Niemack, Giuseppe Puglisi, Mayuri Sathyanarayana Rao, Maria Salatino, Carlos E. Sierra, Suzanne Staggs, Aritoki Suzuki, Grant Teply, Joel N. Ullom, Benjamin Westbrook, Zhilei Xu, Ningfeng Zhu, "BoloCalc: a sensitivity calculator for the design of Simons Observatory (Erratum)," Proc. SPIE 10708, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX, 107084C (12 September 2023); doi: 10.1117/12.3010424

**SPIE.**

Event: SPIE Astronomical Telescopes + Instrumentation, 2018, Austin, Texas, United States

# BoloCalc: a sensitivity calculator for the design of Simons Observatory (Erratum)

Charles A. Hill<sup>a,b</sup>, Sarah Marie M. Bruno<sup>c</sup>, Sara M. Simon<sup>d</sup>, Aamir Ali<sup>a</sup>, Kam S. Arnold<sup>e</sup>, Peter C. Ashton<sup>a,b</sup>, Darcy Barron<sup>f</sup>, Sean Bryan<sup>g</sup>, Yuji Chinone<sup>a</sup>, Gabriele Coppin<sup>h</sup>, Kevin T. Crowley<sup>c</sup>, Ari Cukierman<sup>a</sup>, Simon Dicker<sup>h</sup>, Jo Dunkley<sup>c</sup>, Giulio Fabbian<sup>i</sup>, Nicholas Galitzki<sup>e</sup>, Patricio A. Callardo<sup>j</sup>, Jon E. Gudmundsson<sup>k</sup>, Johannes Hubmayr<sup>l</sup>, Brian Keating<sup>e</sup>, Akito Kusaka<sup>b,m</sup>, Adrian T. Lee<sup>a,b,n</sup>, Frederick Matsuda<sup>o</sup>, Philip D. Mauskopf<sup>p</sup>, Jeffrey McMahon<sup>d</sup>, Michael D. Niemack<sup>l</sup>, Giuseppe Puglisi<sup>q</sup>, Mayuri Sathyanarayana Rao<sup>b,r</sup>, Maria Salatino<sup>e</sup>, Carlos Sierra<sup>d</sup>, Suzanne Staggs<sup>c</sup>, Aritoki Suzuki<sup>b</sup>, Grant Teply<sup>e</sup>, Joel N. Ullom<sup>l</sup>, Benjamin Westbrook<sup>a</sup>, Zhilei Xu<sup>h</sup>, Ningfeng Zhu<sup>h</sup>

<sup>a</sup>Univ. of California, Berkeley (United States), <sup>b</sup>Lawrence Berkeley National Lab. (United States), <sup>c</sup>Princeton Univ. (United States), <sup>d</sup>Univ. of Michigan, (United States), <sup>e</sup>Univ. of California San Diego, (United States), <sup>f</sup>Space Sciences Lab., Univ. of California Berkeley (United States), <sup>g</sup>Arizona State Univ. (United States), <sup>h</sup>Univ. of Pennsylvania (United States), <sup>i</sup>Institut d'Astrophysique Spatiale, CNRS, Univ. Paris-Sud, Univ. Paris-Saclay (France), <sup>j</sup>Cornell Univ. (United States), <sup>k</sup>Stockholm Univ. (Sweden), <sup>l</sup>NIST (United States), <sup>m</sup>Univ. of Tokyo (Japan), <sup>n</sup>Radio Astronomy Lab., Univ. of California Berkeley (United States), <sup>o</sup>Kavli IPMU (WPI), The Univ. of Tokyo (Japan), <sup>p</sup>Arizona State Univ. (United States), <sup>q</sup>Stanford Univ. (United States), <sup>r</sup>Raman Research Institute, <sup>s</sup>AstroParticle and Cosmology (APC) Lab., Univ. Paris Diderot (France)

Proceedings Volume 10708, Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX; 1070842 (2018) <https://doi.org/10.1117/12.2313916>

**Event:** SPIE Astronomical Telescopes + Instrumentation 2018 10-15 June

**Online Publication Date:** 9 July 2018

**Erratum Published:** 12 September 2023

A revised version of this manuscript was published on 12 September 2023. Details of the revision are provided in the text that accompanies this Erratum. The original paper has been updated.

**Publisher's Note:** This article [SPIE Conference Series. 10708, 1070842 (2018) doi: 10.1117/12.2313916] was originally published online on 9 July 2018 which had a typo in equation 4, which is in subsection 2.2 Photon noise, and labeled as equation 4 in the original publication. Below is the original equation identified as 4a and the corrected equation identified as 4b.

## 2.2 Photon noise

Photon noise in bolometric detection is the result of fluctuations in the arrival times of photons at the absorbing element<sup>26, 31, 32</sup>

$$\text{NEP}_{\text{ph}} = \sqrt{2 \int_0^{\infty} \left[ h\nu \sum_{i=1}^{N_{\text{elem}}} p_i(\nu) + \left( \sum_{i=1}^{N_{\text{elem}}} p_i(\nu) \right)^2 \right] B(\nu) d\nu} \quad (4a)$$

$$\text{NEP}_{\text{ph}} = \sqrt{2 \int_0^{\infty} \left[ h\nu B(\nu) \sum_{i=1}^{N_{\text{elem}}} p_i(\nu) + \left( B(\nu) \sum_{i=1}^{N_{\text{elem}}} p_i(\nu) \right)^2 \right] d\nu} \quad (4b)$$

Equation 4b is a corrected version of Eq. 4a that was added via a 2023 erratum to the original 2018 publication.

There are two contributions to  $\text{NEP}_{\text{ph}}$ . The first term represents shot noise  $\text{NEP}_{\text{shot}}$ , which dominates when the photon occupation number  $\ll 1$  (e.g. optical wavelengths) and is  $\propto \sqrt{P_{\text{opt}}}$ . The second term represents wave noise  $\text{NEP}_{\text{wave}}$ , which dominates when the photon occupation number is  $\gg 1$  (e.g. radio wavelengths) and is  $\propto P_{\text{opt}}$ . For ground-based experiments, the photon occupation number at  $\sim 100$  GHz is  $\sim 1$ , and therefore a careful handling of both terms is necessary for an accurate NET estimate.

Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX,  
edited by Jonas Zmuidzinas, Jian-Rong Gao, Proc. of SPIE Vol. 10708, 107084C  
© 2018 SPIE · CCC code: 0277-786X/18/\$18 · doi: 10.1117/12.3010424