







NSTU, Laboratory of Superconducting Nanoelectronics

Multifrequency Receiving Systems based on Resonant Antennas with Cold-Electron Bolometers for COrE and LSPE

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Outline

- Multi-frequency focal plane arrays with Cold-Electron Bolometers (CEB) for COrE, ESA.
- Dual-frequency arrays of CEBs for 210/240 GHz of LSPE.
- Perspectives

CORE Cosmic ORigins Explorer

A satellite mission for probing cosmic origins, neutrinos masses and the origin of stars and magnetic fields

through a high sensitivy survey of the microwave polarisation of the entire sky

A proposal in response to the European Space Agency Cosmic Vision 2015-2025 Call ESA/ ESTEC - ITT AO/1-7393/12

Multifrequency Systems for COrE. Next Generation Sub-millimetre Wave Focal Plane Array.

APC Paris Laboratoire de Astroparticule et Cosmology Chalmers Technical University, Göteborg La Sapienza, Rome Cardiff University, UK Manchester University, UK NUI Maynooth, Ireland

université

ERO

PARIS







Sinuous Antenna

R. O'Brian et al., IEEE Appl. Sc. (2011)



Length of Microstrip lines is 7 mm!



Cold-Electron Bolometer (CEB) with capacitive coupling to the antenna



2 main features of CEB:

- 1. Effective electron cooling from 300 to 100 mK! Photon-noise-limited mode can be achieved without dilution refrigerator.
- 2. Due to small size of CEB the Multi-frequency system can easy realized by ⁷ ibsersion of CEBs in any antenna system

Concentric "Seashell" Slot Antenna with RCEBs

For OLIMPO

Leonid Kuzmin , Rome, 21 Sept 2013 Stimulative discussions with Paolo de Bernardis ar<u>e acknowledged</u>



Resonance Cold-Electron Bolometer (RCEB) with Nanofilter by a Kinetic Inductance of the NbN strip and a Capacitance of the SIN Tunnel Junctions

L. Kuzmin, ISSTT, 2013; IEEE TST, 2014



21:32:21

Seashell Antenna with $\lambda/2$ H-slots and MSLs with CEB



ReZ = 13 Ohm Bandwidth: 20% Crosspol: 12-20 %

Seashell Antenna with CPW and RCEB for 75/105 GHz

L. Kuzmin, A. Chiginev, E. Matrozova, and A. Sobolev. IEEE Trans. on Applied Superconductivity, (2016); L. Kuzmin, A. Chiginev, Proc. SPIE (2016)



<u>CPW: 1 RF layer (4 layer technology):</u>

- 1. DC wires (30 nm Au)
- 2. SiO2 insulation, 50 nm
- 3. Ground plane (Au or Nb, 150 nm)
- 4. CEB (FeAl/oxid./Al)

Ellipticity: 2% – 4% ! ReZ = 13 OhmBandwidth: > 20% **Crosspol: 15-20 %**

18.8 8.66

4.33 2.16 8 -2.84 -5.67 -8.51 -11.3 -14.2 -17 -19.8

One polarization Seashell antenna with 2 RCEBs







Multifrequency Seashell Antenna based on Resonant Cold-Electron Bolometers with Kinetic Inductance Nanofilters for CMB measurements (AIP Advances 2018)





One polarization Seashell antenna with resonant slot antenna and CEBs







One polarization Seashell antenna with resonant slot antenna and CEBs





Measurements

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Featured article

Multichroic seashell antenna with internal filters by resonant slots and cold-electron bolometers

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LSPE –Balloon Telescope Rome University, ...

The Large Scale Polarization Explorer



SWIPE optics and focal planes



Cold-Electron Bolometer connected to a Slot Antenna by the Coplanar Waveguide



Dual-band Slot Antennas with Cold-Electron Bolometers connected by Coplanar Waveguides for the 220/240 GHz



Measurements



Dual-frequency arrays of slot antennas with CEBs in Voltage-Bias mode



Perspectives:

1. Concentric "Seashell" Antenna with resonant slots and CEBs





Absorption in 4-Frequency Seashell Slot Antenna with RCEBs designed for 75, 105, 135, and 165 GHz

Perspectives:

2. Arrays of resonant dipole (or slot) sntennas with CEBs



4-Frequency Resonant Dipole Antennas with CEBs

Conclusions

- 1. Multi-frequency system can be easy realized by ibsersion of CEBs in any antenna system due to small size of CEB.
- 2. Concentric Seashell antenna with CEBs is recommended for a single cell with a lens for small power load.
- 3. Arrays of resonant antennas with CEBs are recommended for any power load.
- 4. High sensitivity due to effective electron self-cooling: NEP_{CEB}<NEP_{phot} at 300 mK without dilution refrigerator!

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