

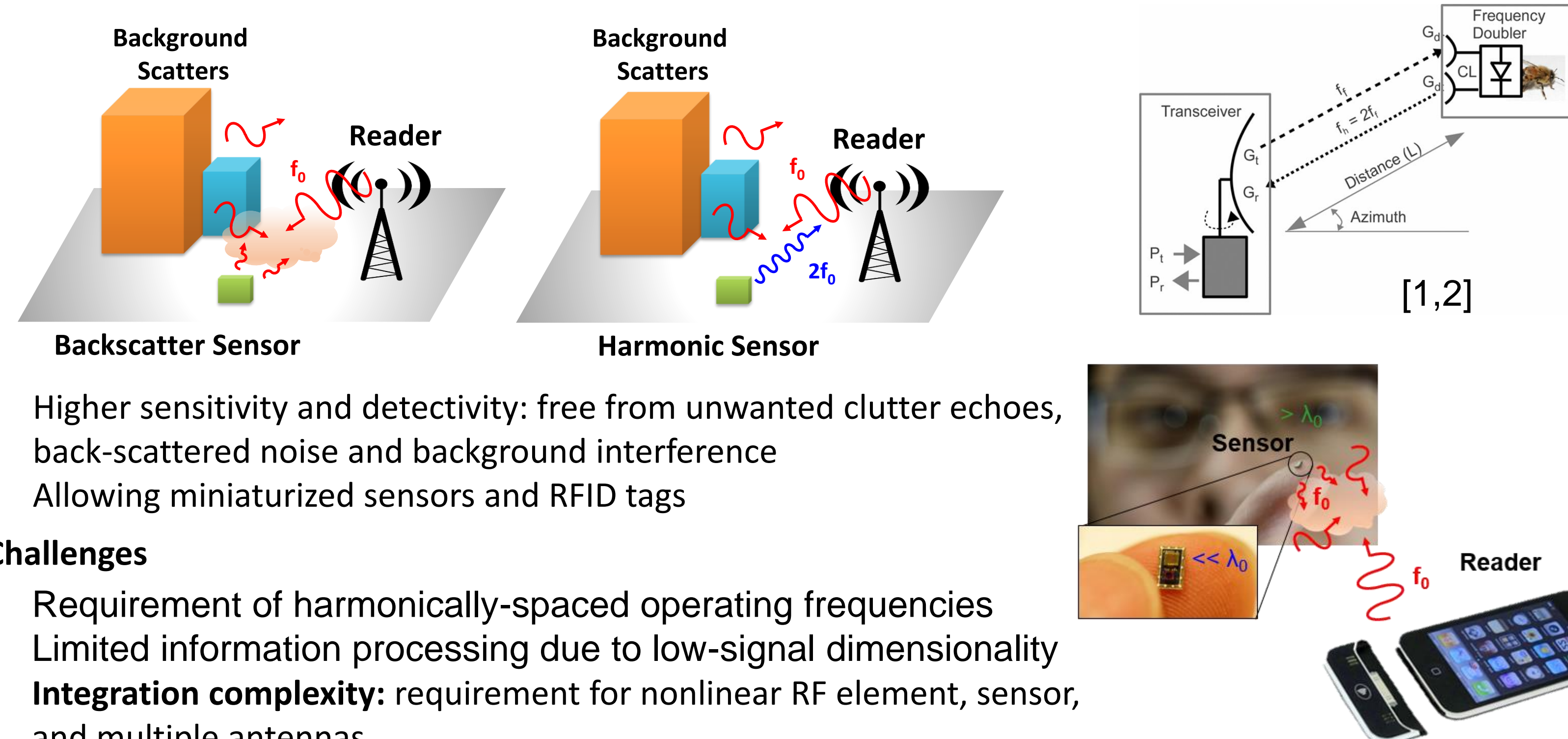


Transparent and Self-Activated Harmonic Microsensors for IoT Healthcare Applications

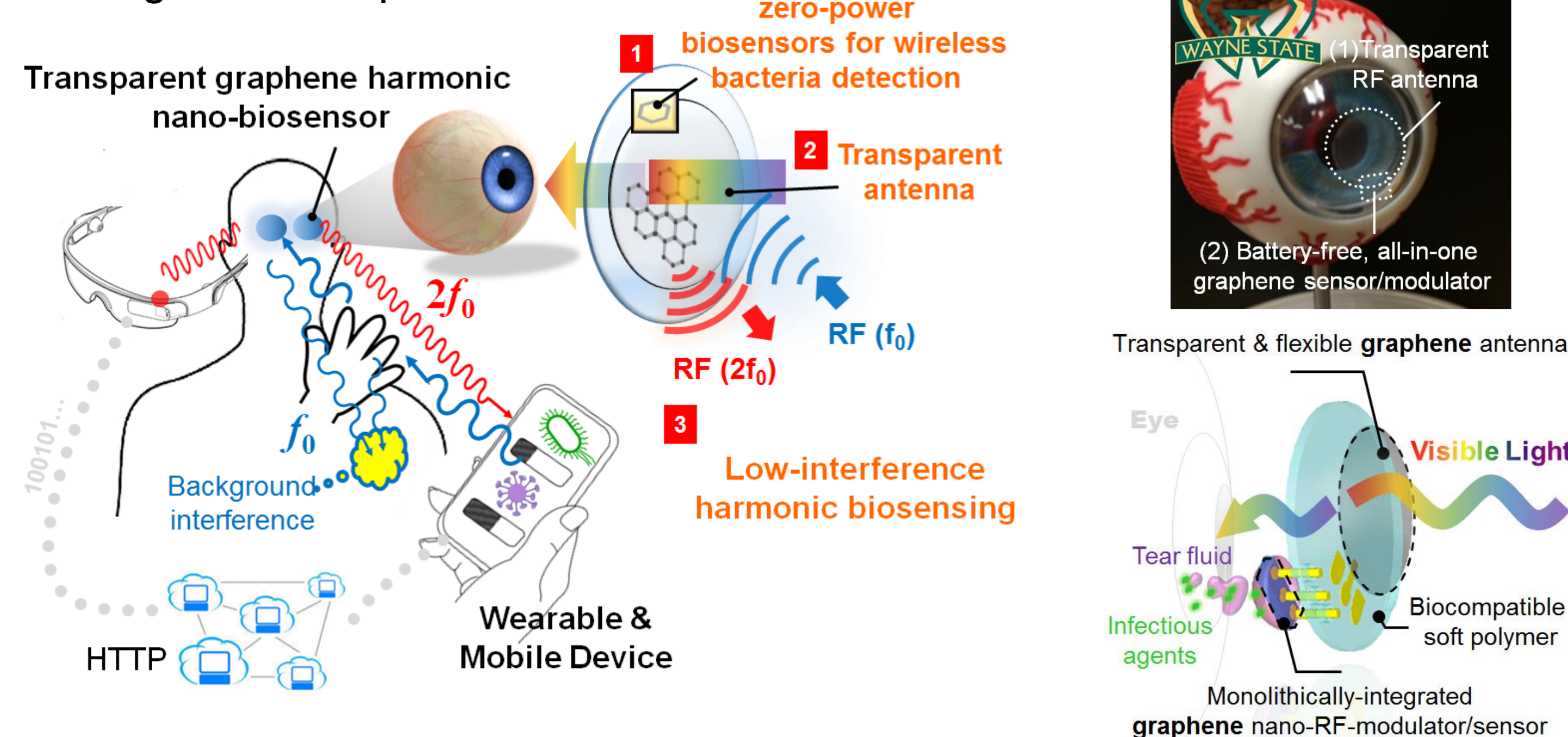
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Introduction: Harmonic IoT Sensors

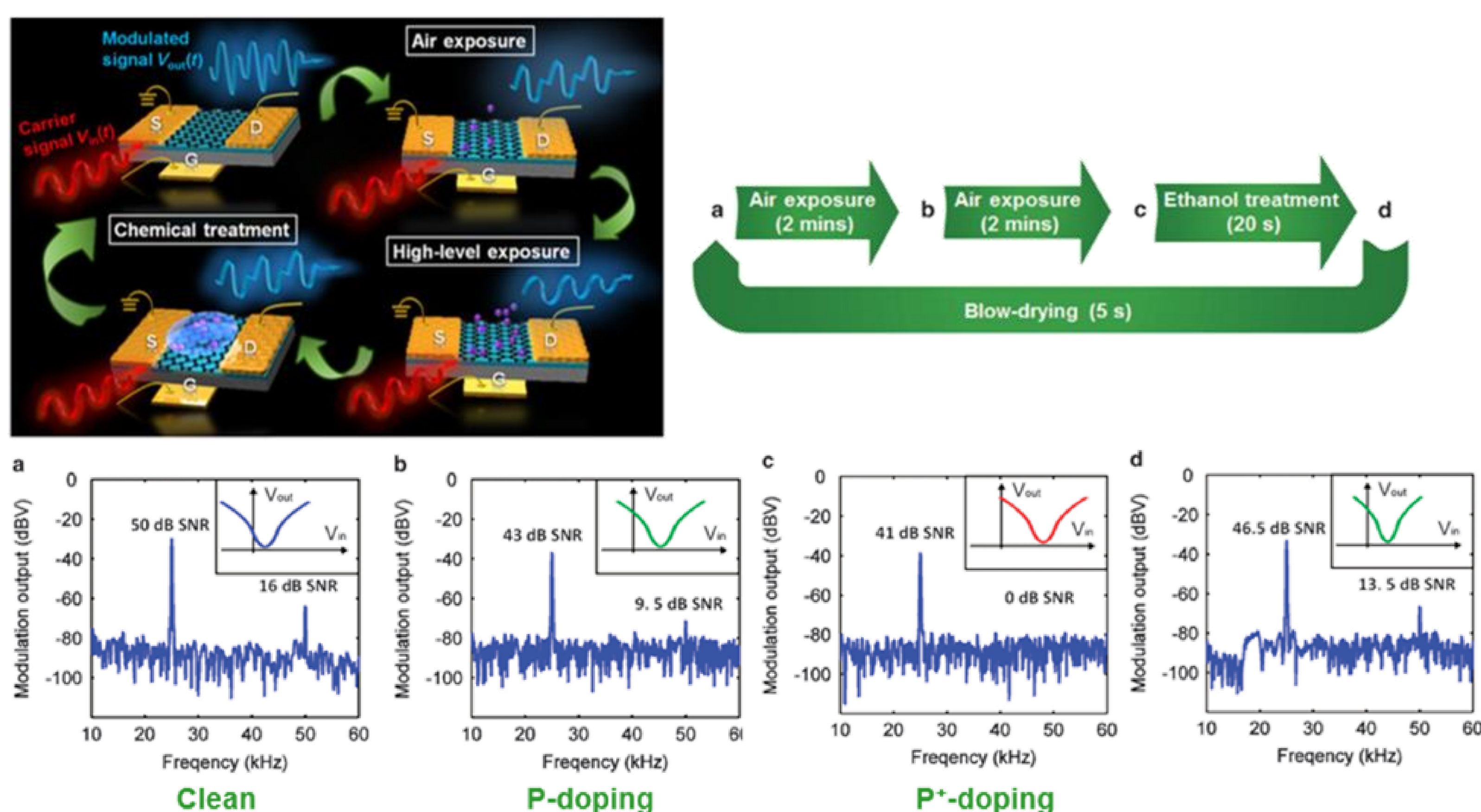
❖ Harmonic Radar/Sensor



❖ All-graphene harmonic sensor: exceptional sensing & RF mixing functions in a single RF component

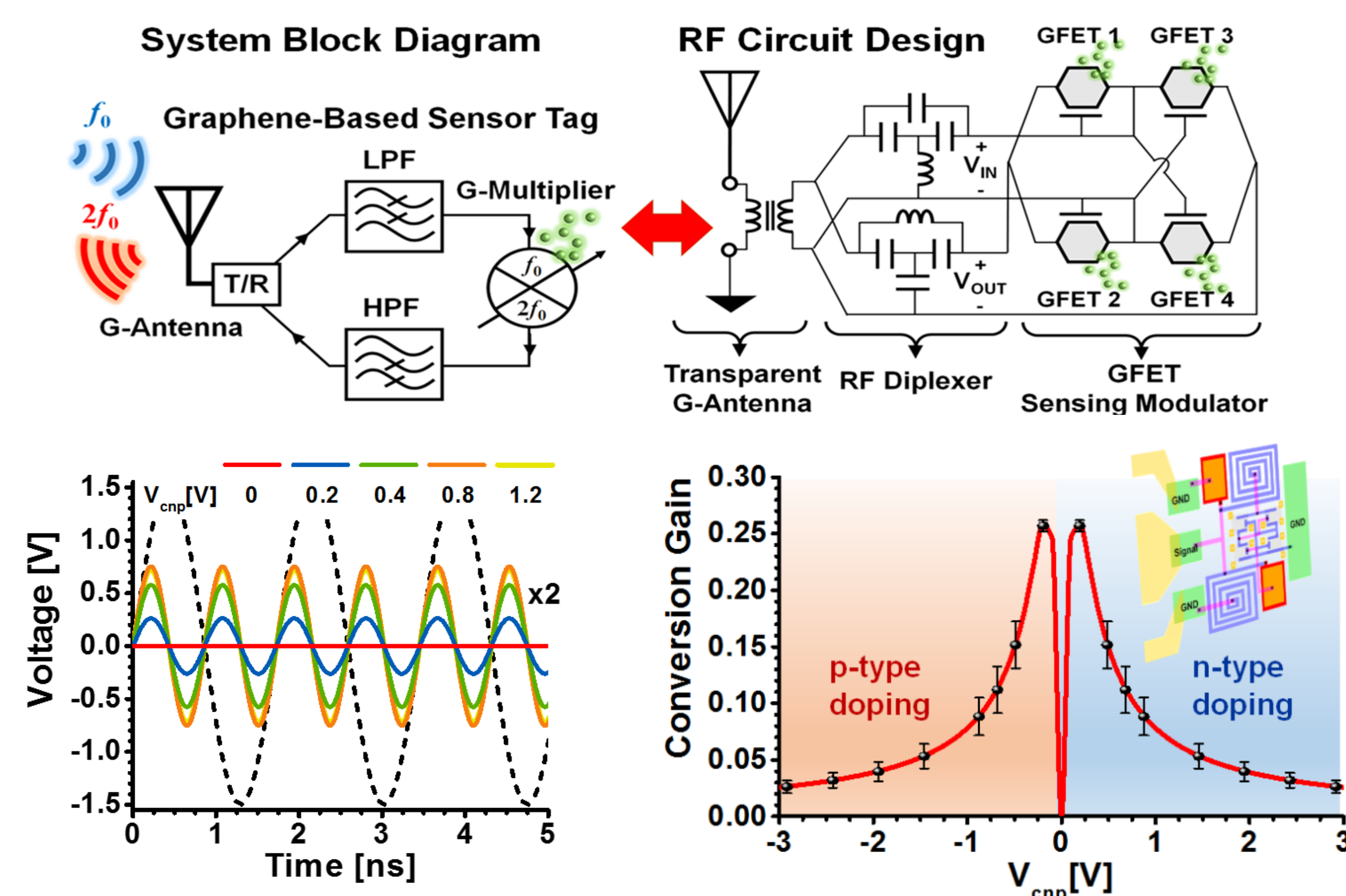


Graphene-Based Harmonic Sensor

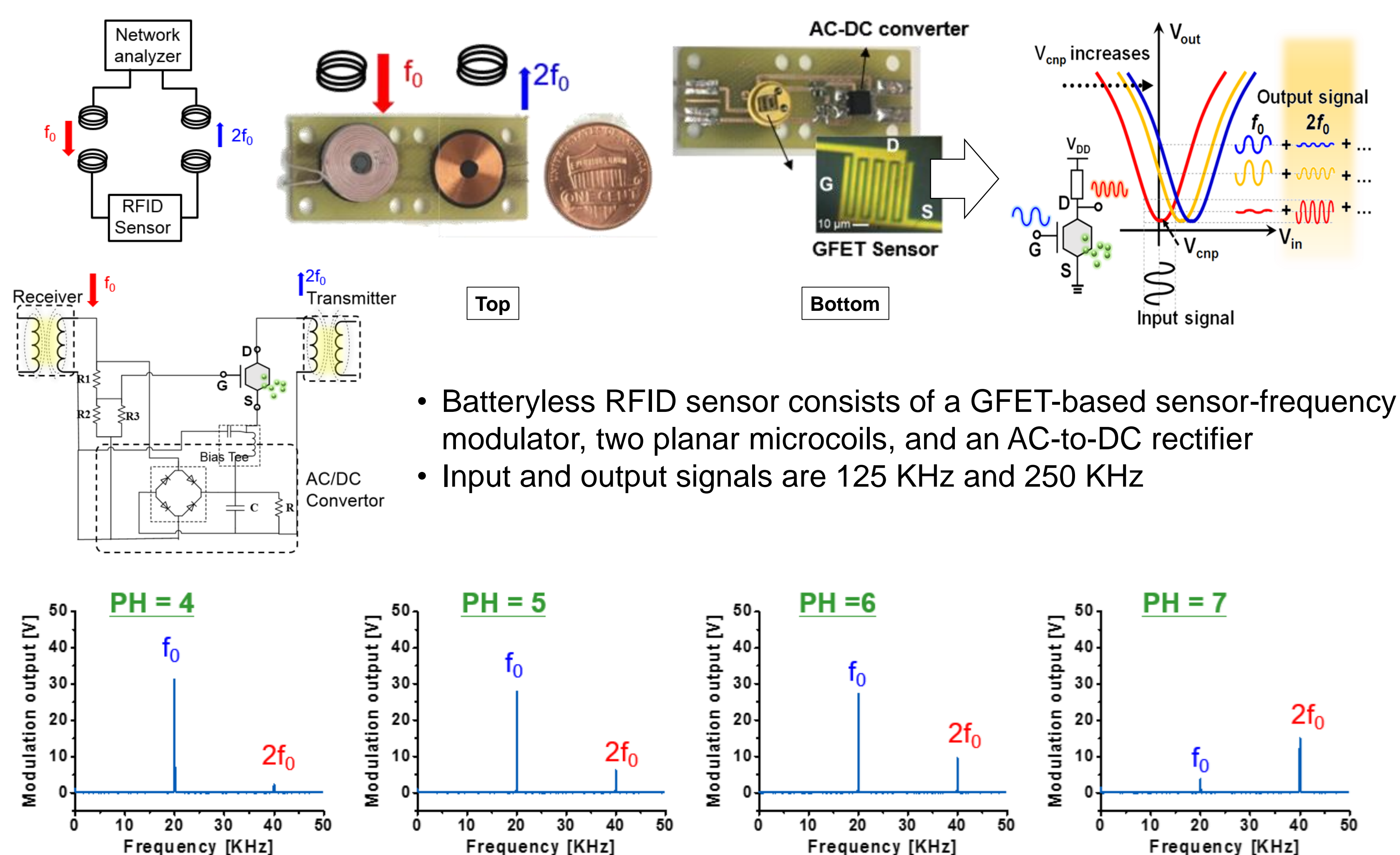


- Unique “V-shape” drain current-gate voltage characteristic (only possible with GFET) [3]
- Cut-off frequency up to 155 GHz [4]
- Molecular-level sensitivity to certain gases, chemical, and bimolecular agents [5-7]

❖ Self-Powered, All-Graphene Harmonic Sensor



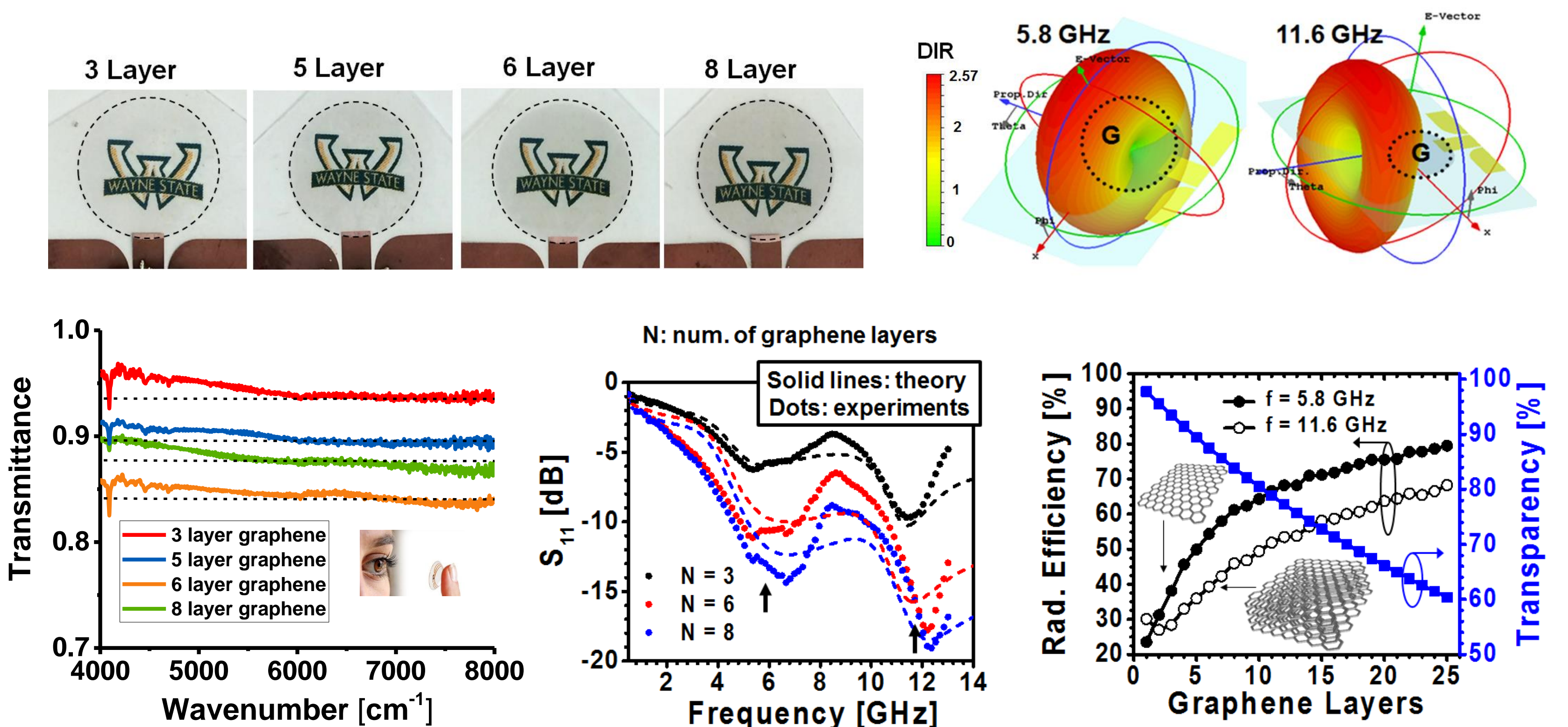
RFID Sensors for IoT Healthcare



- Batteryless RFID sensor consists of a GFET-based sensor-frequency modulator, two planar microcoils, and an AC-to-DC rectifier
- Input and output signals are 125 KHz and 250 KHz

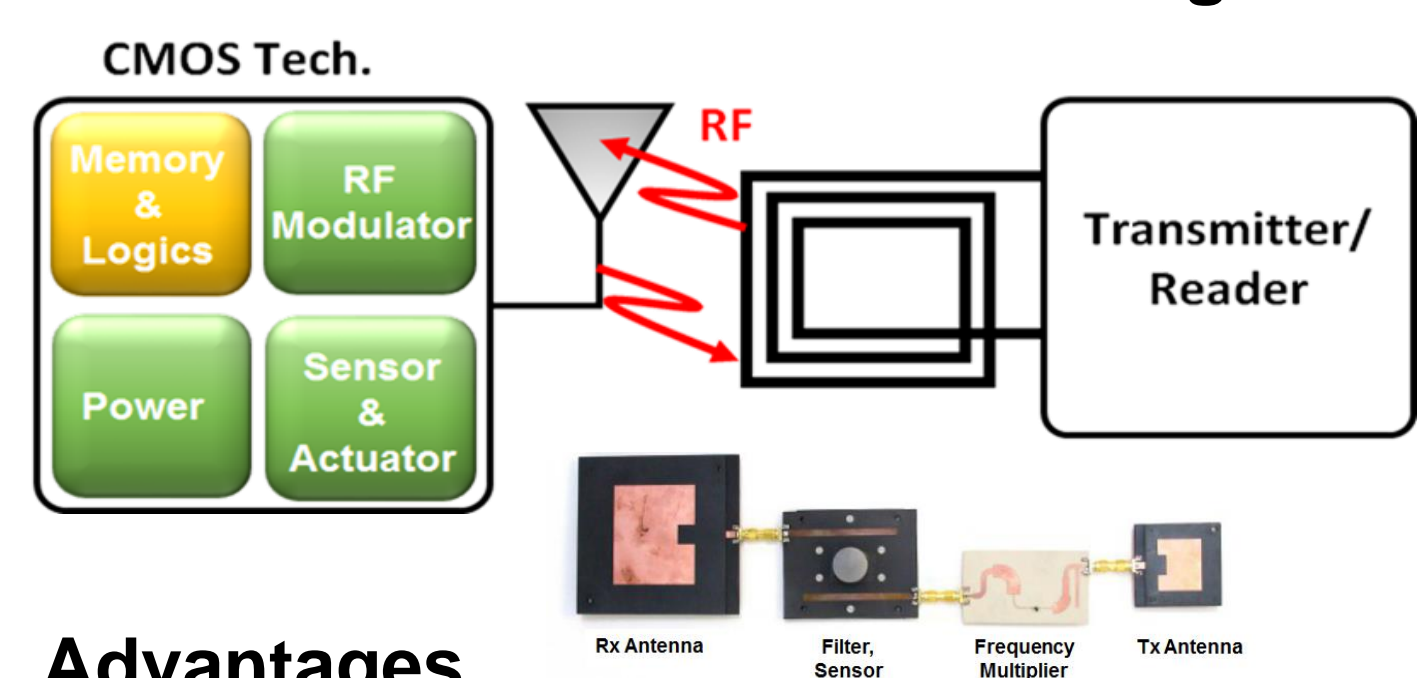
RFID Sensors for IoT Healthcare

❖ Measurement Results



Conclusions

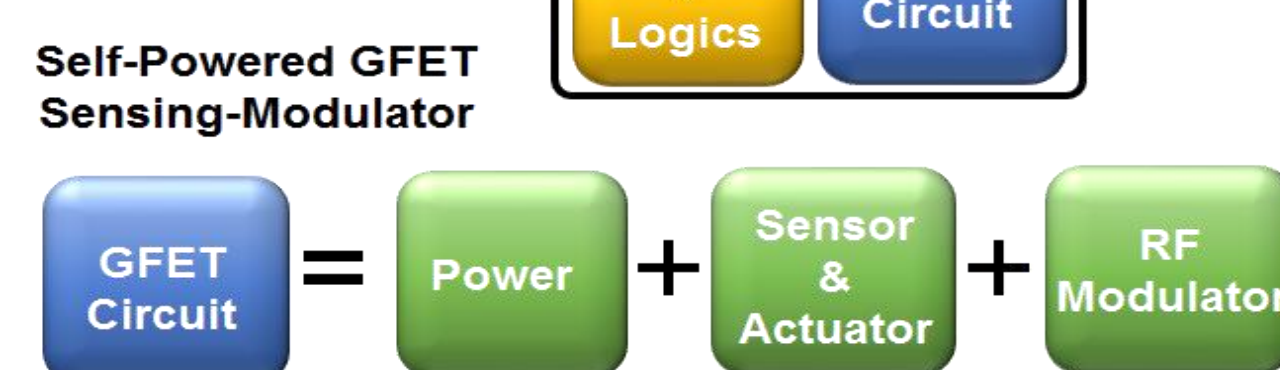
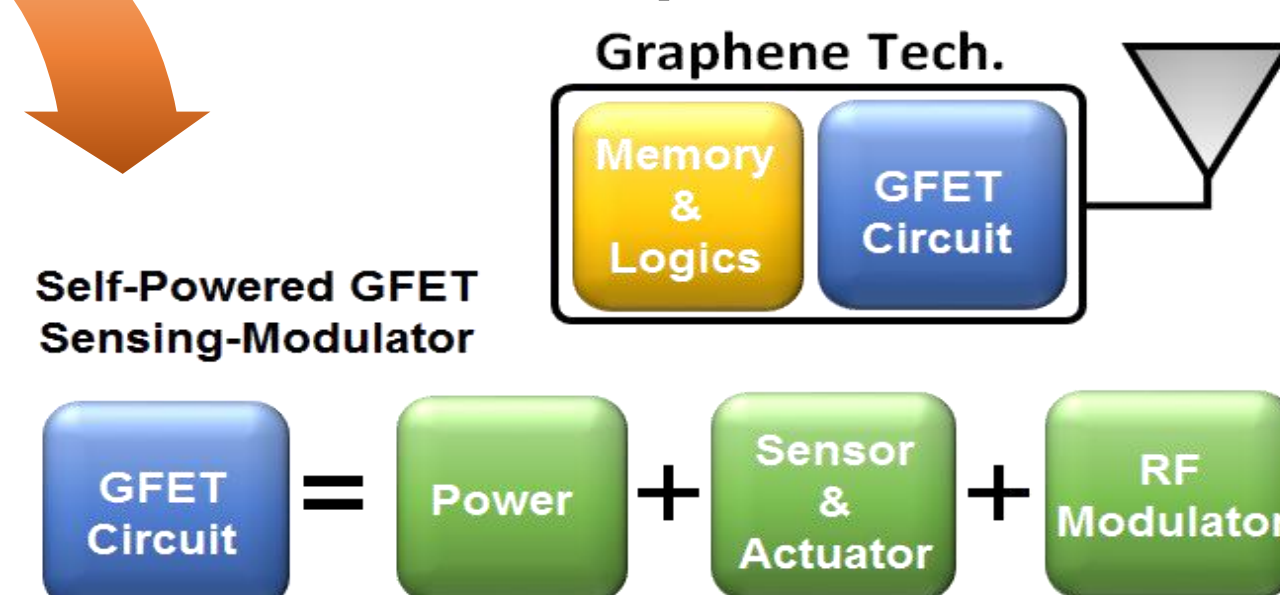
Conventional Wireless Sensor Tag



Advantages

- Battery-free wireless sensing
- Clutter noise free
- Optically transparent
- Flexible
- Light-weight
- High chemical sensitivity
- Integrated on biocompatible PET substrate

Graphene Solution



Transparent, flexible, light-weight and self-powered all-graphene IoT sensor

- Fully-passive, quad-ring frequency multiplier/sensor using graphene field-effect transistors (GFETs)
- Multilayered graphene makes transparent and broadband monopole antenna
- Great potential for wireless sensing and non-invasive diagnosis applications, such as smart contact lenses/glasses and microscope slides that require high optical transparency

❖ References

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- [2] J. R. Riley, et al., *Nature*, (1996).
- [3] Z. Wang, et al., *APL* (2010).
- [4] Y. Wu, et al., *Nature*, (2011).
- [5] A. K. Geim, et al., *Nat. Mater.* (20007)
- [6] H. Huang, P. Y. Chen, et al., *Sci. Rep.* (2016).
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