

First results from the first low-cost SDR-based Ionosonde in African equatorial region

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Outline

- Introduction
- Ionosonde
- ISDR
- Conclusions

Ionosonde

- invented about one hundred years ago,
- remains one of the most versatile and efficient tools for studying the ionosphere
- The ionosonde is a HF range radar
- It engages sweeping frequency (1-20 MHz) to reconstruct the electron density profile at heights from about a hundred kilometers to the absolute maximum of the plasma frequency, named the critical frequency of the ionosphere.



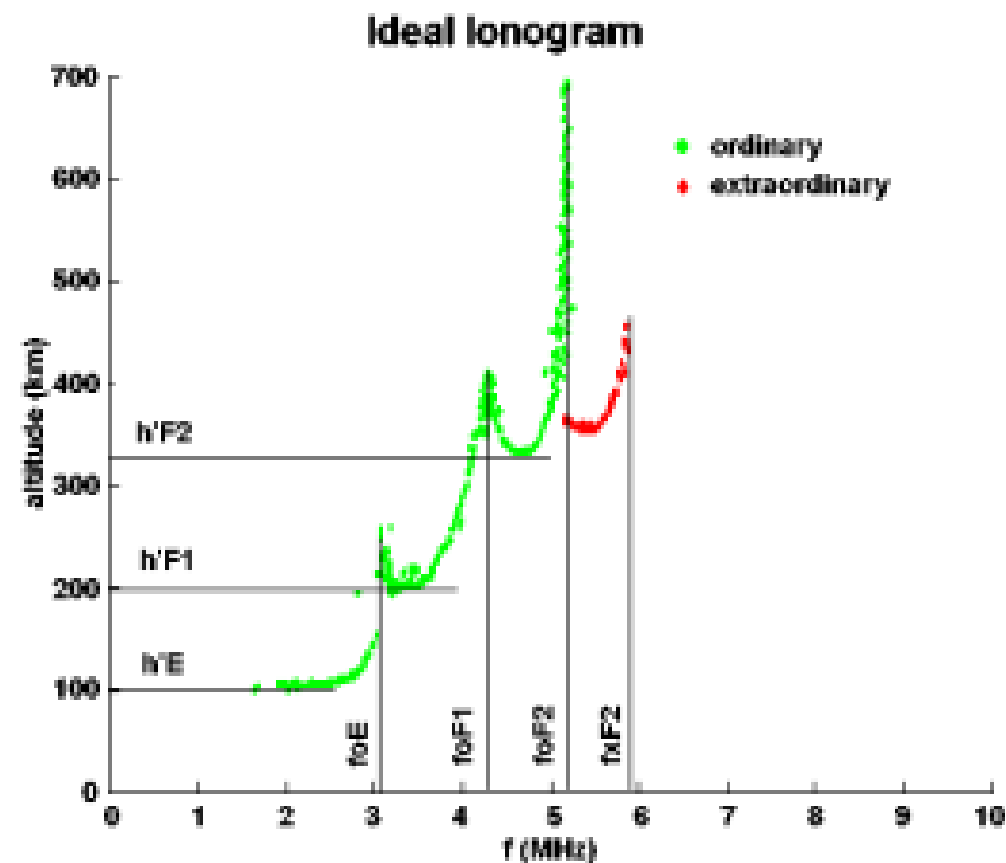
Digisonde

- Modern ionosonde (Digisonde) routinely performs a variety of complementary operations in real time, including:
- automatic ionogram scaling, calculation of electron density profiles,
- plasma drift velocity, polarisation,
- precision group height
- etc

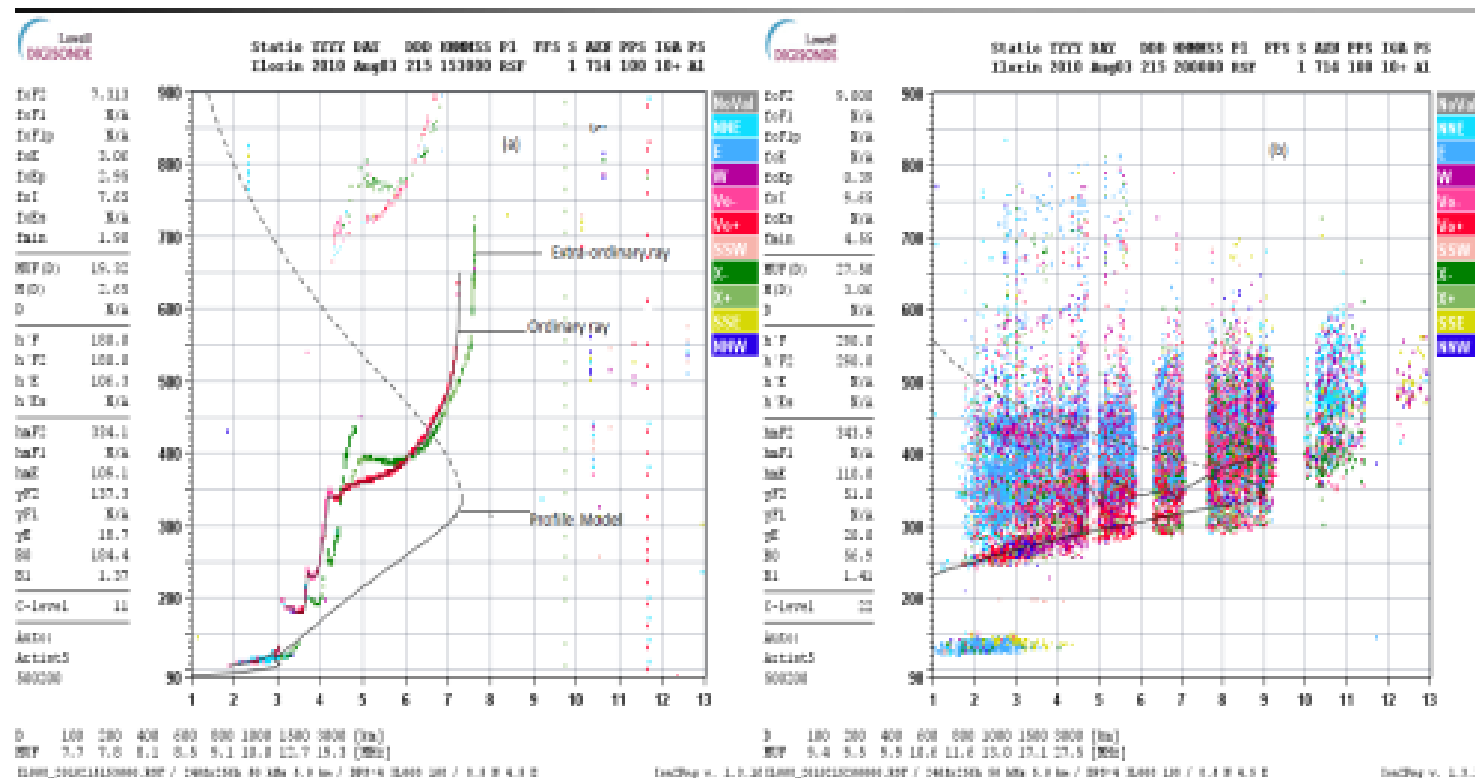
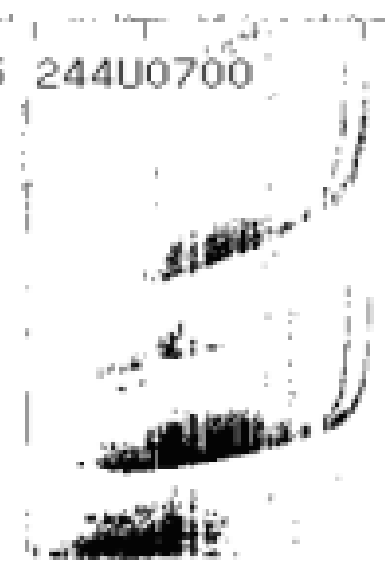


Reinisch, 1986

Typical ionograms



1281 95 244U0700



Why SDR?

- Conventional Ionosonde are relatively expensive and of high radiated power
- Limitation to have it widely distributed in developing nations
- The developed prototypes of SDR-based ionosondes combine the smart capabilities of digisondes with:
 - ✓ the low-cost,
 - ✓ low-power, and
 - ✓ compact size of SDR-based devices.



Software-defined radio ionosonde (ISDR)

- This work presents a software-defined radio ionosonde (ISDR) first developed at:
 - ✓ the Abdus Salam International Centre for Theoretical Physics (Italy) and
 - ✓ the Institute of Radio Astronomy (Ukraine)
- installed at the Space Environment Research Laboratory, Abuja, Nigeria, in February 2024.



Configuration of the software-defined radio ionosonde (ISDR)

1. A USRP N200 Kit (Universal Software Radio Peripheral)

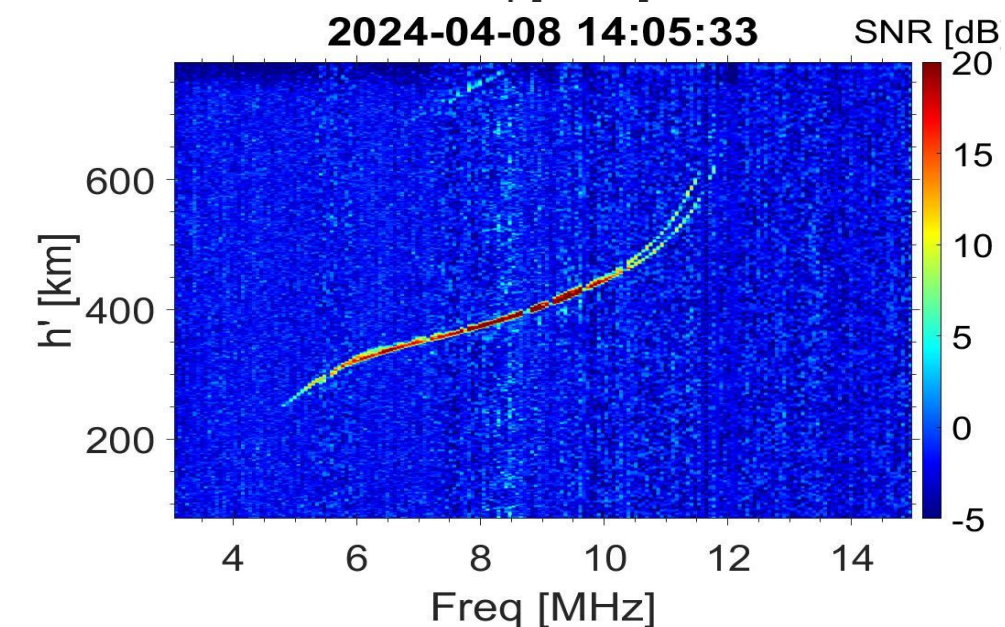
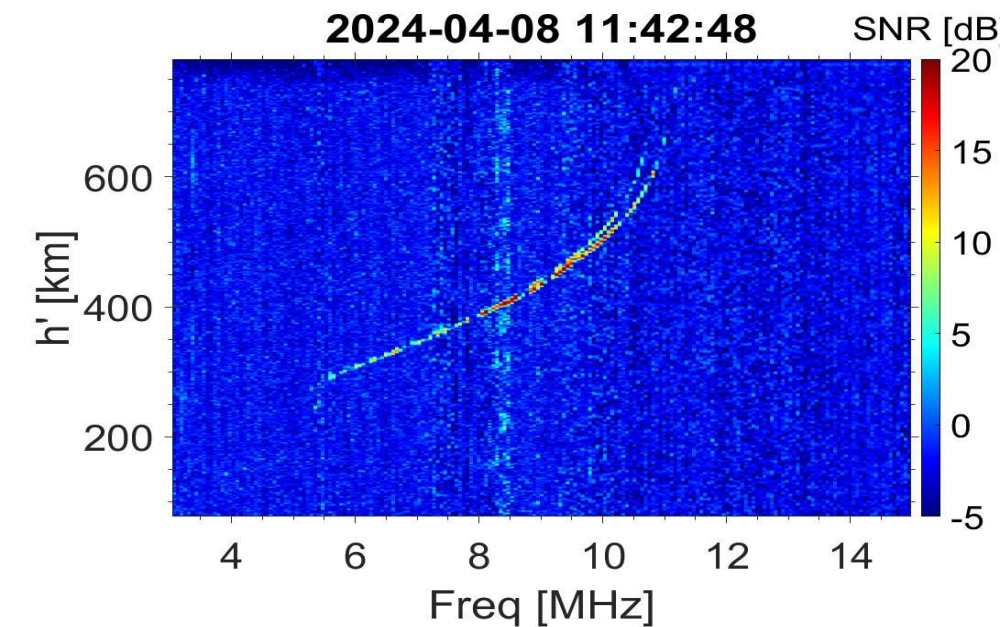
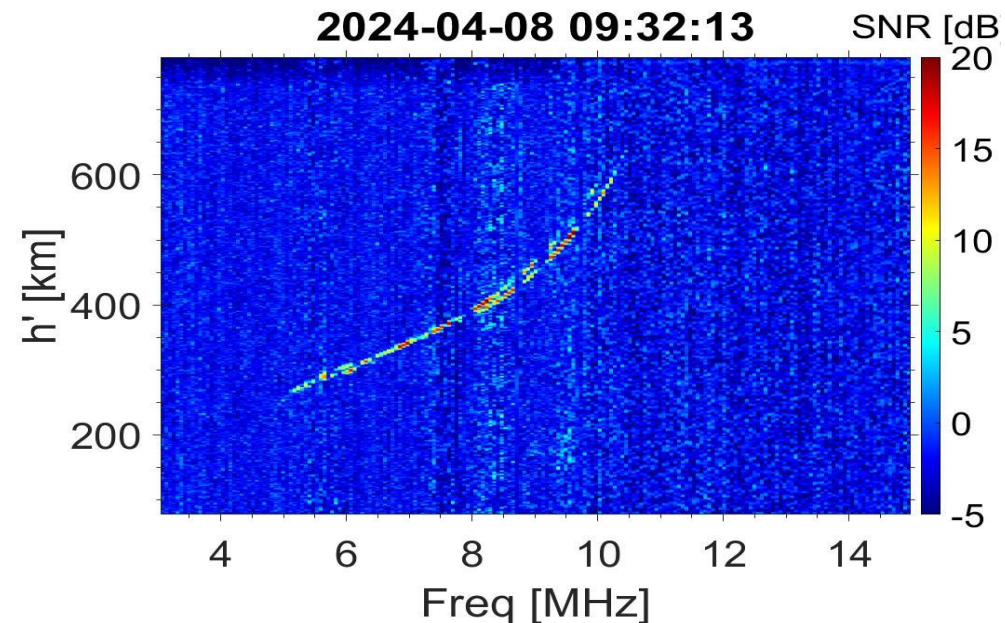
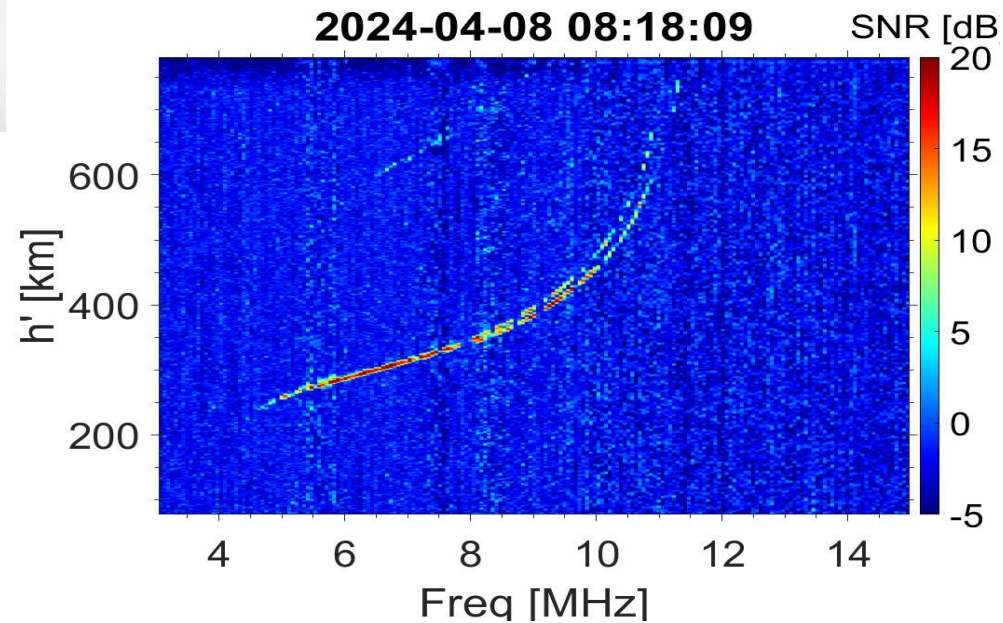
The SDR allows converting the digital representation of the TX signal waveform in the baseband to its analog counterpart on the selected carrier frequency



2. The ICOM IC-708 HF transceiver
3. 13.5 V/14.9 A power supply unit
4. A personal computer (PC)
5. RX and TX antennas.

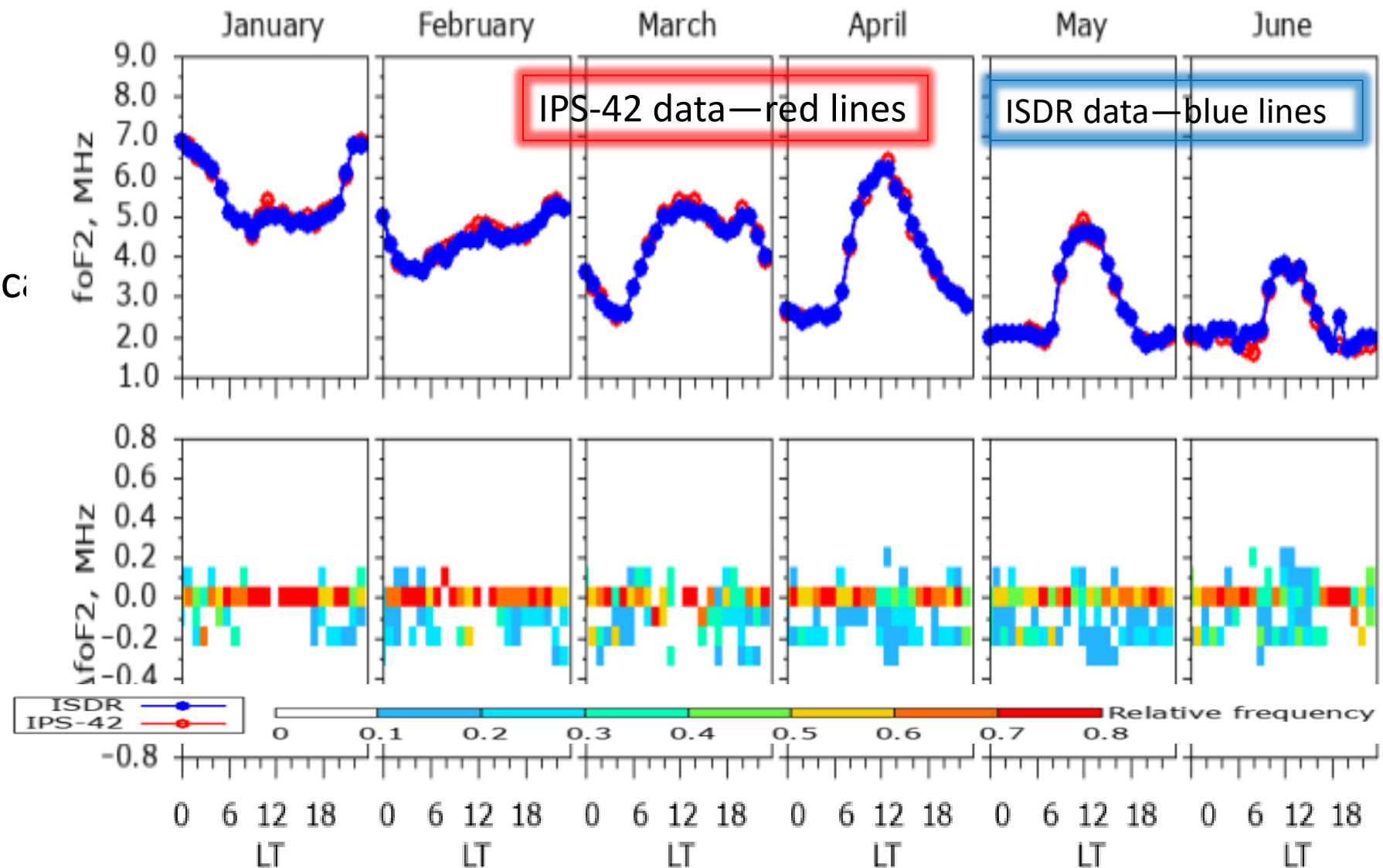


The basic principles described in Koloskov, et al. (2023)



First shots of ionogram recorded from Abuja station (geographic: 7.39°E, 8.99°N; dip latitude -1.37°) obtained on 08 April 2024 at 08:18 LT, 09:32 LT, 11:42 LT & 14:05 LT respectively.

Median values of the critical frequency f_oF2 and the distribution of diurnal differences in the critical frequency Δf_oF2

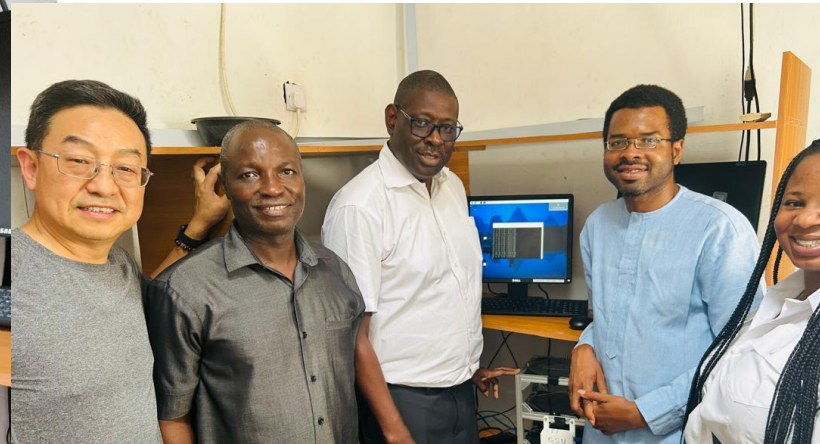


Koloskov, O.; Kashcheyev, A.; Bogomaz, O.; Sopin, A.; Gavrylyuk, B.; Zalizovski, A. Performance Analysis of a Portable Low-Cost SDR-Based Ionosonde. *Atmosphere* **2023**, *14*, 159. <https://doi.org/10.3390/atmos14010159>

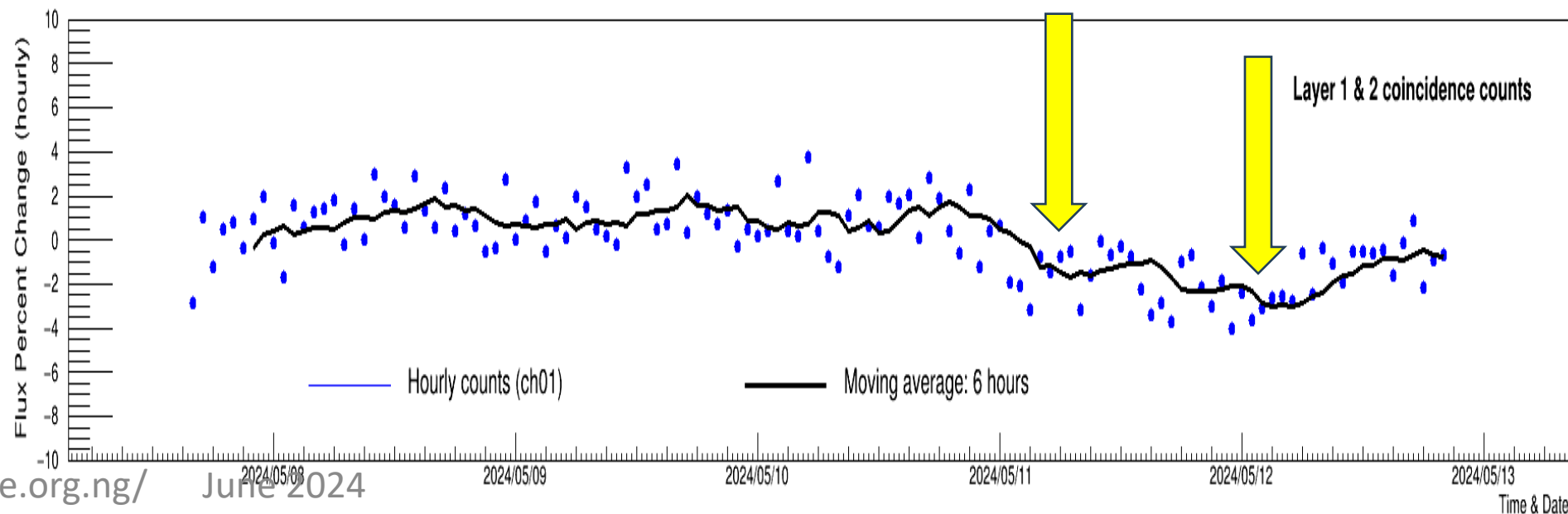


Cosmic ray detector & G5 storm

1-3 May 2024



with Regents Professor Xiaochun He



Last words

- It is hoped that SDR-based ionosonde shall become the main vertical sounding instrument of an ionospheric observatory
- ISDR is low cost (less than 5000)
- There is room for more deployment
- Grants are being solicited

Thank You

