ADENEAS Newsletter #7

Shielded Aircraft Windows to Protect Radio Altimeters in the Presence of Wireless Avionics Intra-Communication

Hi There! My name is Yuri Konter and I am a research and development engineer within the Electromagnetic Technology and Antennas group of the Royal Netherlands Aerospace Centre (NLR). Within the ADENEAS consortium I am involved in Work Package 2 (WP2) “Wireless Technologies”. My work involves simulation and verification of wireless propagation in and around the aircraft. In this newsletter I will discuss our paper on “Shielded Aircraft Windows to Protect Radio Altimeters in the Presence of Wireless Avionics Intra-Communications” which has recently been accepted by EMC Europe 2023, taking place from September 4 – 8 in Krakau, Poland!

ADENEAS develops technology enablers to pave the way for a safe, light, self-configuring, autonomous and modular power and data distribution network that is scalable to all aircraft sizes. For the data distribution network this implies that ADENEAS is researching a hybrid network combining wired, wireless and power line communication. A strong collaboration between Technical University of Eindhoven (TU/e), GKN Fokker Elmo and NLR within WP2 focusses on the development of technologies for Wireless Aircraft Intra Communication (WAIC). One of the challenges of WAIC is that the wireless technologies should not disturb any other on-board equipment. Since a specific allocated frequency band for WAIC coincides with the operational band of the (safety critical) radio altimeter, this system is especially of concern. With this concern in mind, EUROCAE WG-96 on WAIC is considering to limit the Effective Isotropic Radiated Power (EIRP) of the aircraft where WAIC is in operation. This concerns a combination of the transmitted power and attenuation caused by the fuselage.

Early simulations on the T100 aircraft model (a representative aircraft model based on the Fokker 100 and provided to us by Evektor) showed that the cabin windows are a dominant source of radiated power. As part of WP2, simulations were done to study the effectiveness of shielded aircraft windows in reducing the EIRP of on-board WAIC systems. The shielding properties of Indium Tin Oxide (ITO) coating on passenger windows were studied using Layer, an in-house research tool developed at the NLR, which determines the transmission and reflection properties of multilayered structures. ITO coated cabin windows were found to have a transmission of WAIC signals between -16 dB and -24 dB, depending on the placement of the ITO layer in the window structure. The results of the Layer simulations were used to create a simplified representative material, which could be used together with the T100 model to simulate how the EIRP of WAIC transmitters in the fuselage is affected by ITO shielding. These simulations were done in WinProp, a ray-tracing simulation package from Altair Feko.

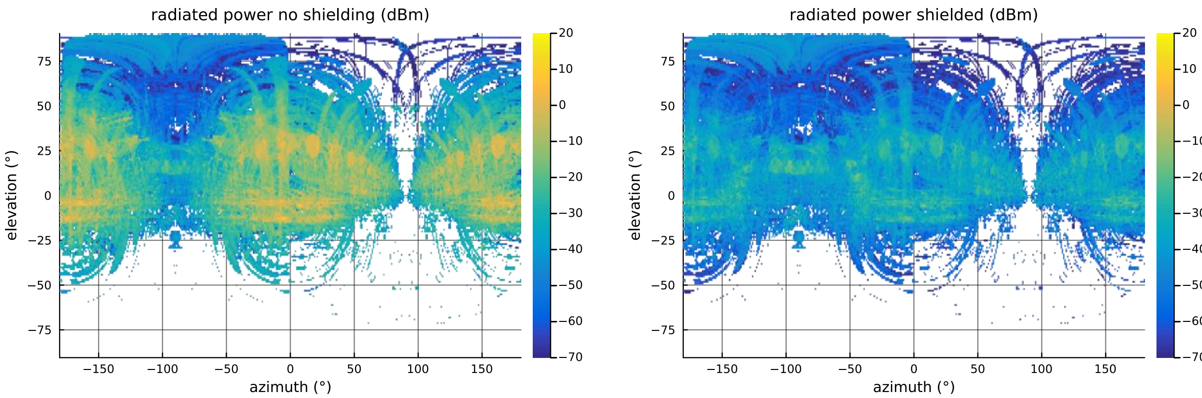

Figure 1 Radiated power of transmitter in aircraft with no ITO shielding on cabin windows (left) and with ITO shielding on the cabin windows (right). Cockpit is directed at -90 azimuth and 0 elevation. The tail of the aircraft is directed at 90 degrees azimuth and 0 degrees elevation. WAIC transmitter is set at 0 dBm EIRP

The simulation results in Figure 1, show that:

- ITO shielding on the passenger windows leads to a reduction of the radiated power of, on average, about 20 dB. This is slightly less than the reduction in transmission simulated in Layer.
- The average reduction in transmitted power does not translate to a similar reduction in EIRP.
  - Instead, the simulated reduction in EIRP is roughly 10 dB.
  - While the shielded cabin windows reduce the power transmitted through the cabin windows, the power reflected back into the cabin is increased. This reflected power can, in some cases, increase the radiated power.

These results help to get a better understanding of the effect of wireless transmitters inside the aircraft fuselage. Additionally, the simulation methods and models developed in this work can be used to:

- Study the properties of on-board radio channels
- Analyze the effect of (moving) passengers on the reliability of on-board radio channels
- Optimize placement of antennas in the fuselage