Air duct with engine fan
Case n°5

Gildas Kubické[1], Yannick Béniguel[2], Philippe Pouliguen[1]

1 DGA, Bruz (DGA MI) et Paris (DGA AID)
2 IEEA, Courbevoie

Target description

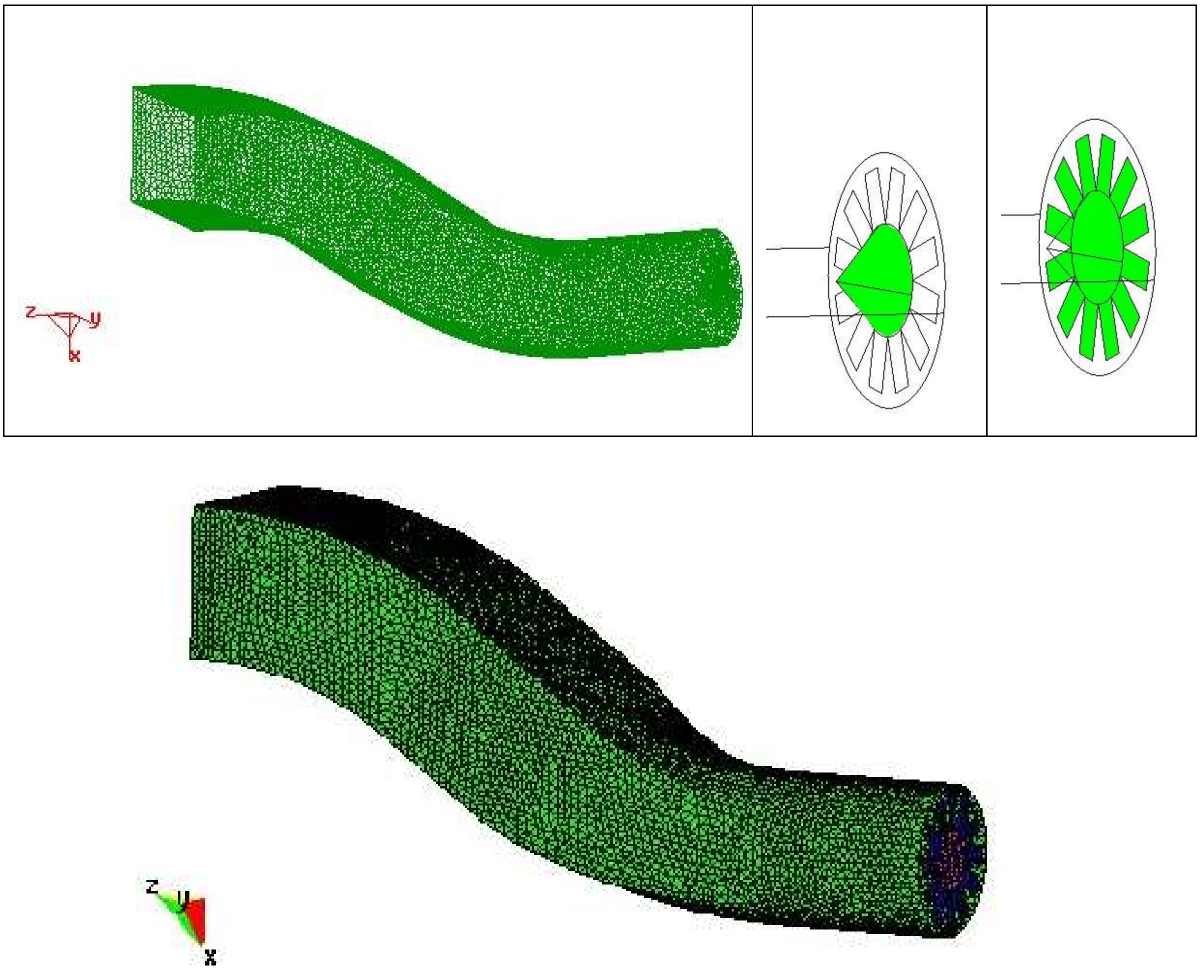

Figure 1: air duct ended with an engine fan

The target is an air duct ended with an engine fan as shown on Figure 1. This fan, with a cone at its center, is not directly seen from the rectangular cross section aperture of the air duct. The entrance cross section is in the xy plane.

The end of the duct, where is located the fan, has a circular cross section.
The IGES geometrical CAD definition is provided.

The purpose of this case is to study the radar cross section (RCS) varying the frequency and the fan rotation.

Three cases are submitted to analysis:

Two for a static fan, considering the inlet walls either perfectly conducting or covered with an absorbing material and one for a rotating fan.

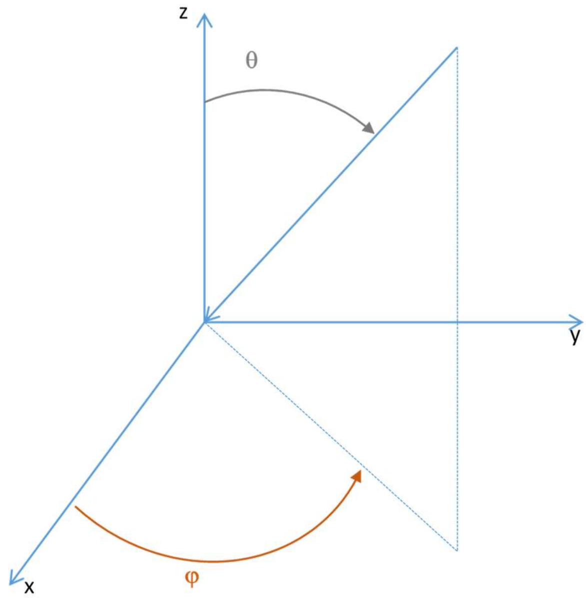

Figure 2: angular convention

The y direction is normal to the inlet entrance and towards the inlet interior

Problem N°1 – PEC duct and static fan

The whole structure is constituted by a perfectly conducting material.

The incident wave (fixed and only one) is a plane wave, defined in the xz plane, with **φ_i =0° and** θ_i = 30°. The fan is consequently not directly seen from the source.

Requests:
The bistatic scattering coefficient ρ (defined here as $\sigma=|\rho|^2$ in which σ is the radar cross section) for **both co-polarizations (VV and HH)** in a vertical plane (in the xz plane, azimuth **φ=0°**) for **θ from - 45° up to 45° with an angular step of 0.5°**.

This calculation will be repeated varying the **frequency from 6 to 18 GHz with a 500 MHz frequency step** (i.e. 25 frequency points).

Results shall be given in two ASCII files (one for VV polarisation and one for HH polarisation) organised as follows:

- ✓ The first line will contain the values of the frequency (skip the first column)

- ✓ The 91 following lines will contain the theta value in the first column followed by the values of the scattering coefficient for each frequency: Real then imaginary. There will be consequently 2 columns per frequency point and a total of 1 + 50 columns.

Problem N°2 – Duct with absorbing materials and static fan

Identical to problem N°1 except that the cone is made of a dielectric with relative permittivity ε_r**=2.1+j0** (and relative permeability μ_r=1+j0) and the PEC duct walls are covered with an absorbing material with relative permittivity ε_r**=20+j2** and relative permeability μ_r**=1.3+j1.3** with **1mm thickness**.

The cone basis is perfectly conducting (metal with zero thickness).
The absorbing material is placed on the internal wall of the duct.

Same requests than in problem n°1.

Problem N°3 – PEC duct and rotating fan

The whole structure is constituted by a perfectly conducting material.

The incident wave (fixed and only one) is a plane wave, defined in the xz plane, with φ_i **=0° and** θ_i = 30°. The fan is consequently not directly seen from the source.

<u>Requests</u>:

The bistatic scattering coefficient ρ (defined here as $\sigma=|\rho|^2$ in which σ is the radar cross section) for **both co-polarizations (VV and HH),** at one spot frequency **10GHz,** in a vertical plane (in the xz plane, azimuth **φ=0°**) for θ **varying from-10° to +30° with an angular step of 0.5°.**

Two levels of results as a user option

- ➢ For six values of the fan rotation angle (every 5°, from 0° up to 25°, clockwise)
- ➢ For 300 values of the fan rotation angle (every 0.1° from 0° up to 29.9°, clockwise).

Results shall be given in two ASCII files (one for VV polarisation and one for HH polarisation). Each file in ASCII format, will contain 3 lines, one per observation angle. These lines will contain the theta value (observation angle) in the first column followed by the values of the scattering coefficient for each rotation angle: Real then imaginary. There will be consequently 2 columns per rotation angle and a total of 1 + 12 columns or 1 + 602 columns, depending on the option selected.