Numerical simulation is one of the most commonly used tools for the study of gun firing phenomenology, in terms of knowledge and performance evaluation.

Modelling codes have to describe accurately the internal ballistics cycle, from the ignition of the propellant charge to the dynamics of the gun powder and projectile motion.

The ignition behaviour of the solid propellant bed influences significantly the ignition delay and propagation of the combustion wave. Ignition models for gun propellants currently used are generally based on a threshold in terms of temperature or heat generation in the solid or gas phase. This kind of ignition model is challenged by the thermal behaviour of the new generation insensitive gun propellants.

Modelling the ignition of such propellant requires improvement of the ignition model. In particular, this model should provide a better description of the response of the material to the energetic stimuli from the igniter.

An internal ballistics code has been developed within the framework of a cooperation between NEXTER Munitions and the PRISME Laboratory. It focuses on the description of the heat and mass transfers between gas and porous media.

This code takes into account solid phase decomposition kinetics and gas phase reaction mechanisms. It aims at describing the propellant behaviour in the early stages of the internal ballistics cycle. Depending on the hypotheses made...
on the heat and mass transfer correlations and the description of the thermal behaviour of both the solid and gas phases, an ignition model or criterion can be determined.

The Figure 1 illustrates some of the current abilities of the code: modelling the propagation of the hot gases released by the igniter through the solid propellant bed. The grains are heated by convective and radiative fluxes, and start reacting when the ignition threshold of 400 K is reached at their surface.

![Igniter burnt gas mass fraction, t = 400μs](image)

![Propellant burnt gas mass fraction](image)

![Propellant grains surface temperature](image)

**Figure 1**: 2D case: 105mm gun chamber at 400μs after the beginning of the emission of hot gases by the igniter (black rectangle in the lowest graph): top: igniter burnt gases mass fraction; middle: propellant burnt gases mass fraction; bottom: surface temperature of the propellant grains [K].

In the present work, the code and its hypotheses are first described. The model of compressible porous flow through a bed of inert powder is compared to compressible 1D and 2D test cases, and a submodel of temperature conduction in the solid phase at the vicinity of the propellant grain surface is added and validated by reproducing semi infinite wall transient conduction theoretical behaviour. The addition of solid phase decomposition kinetics and gas phase reaction mechanisms to the code allows describing the ignition of the solid propellant bed.

In conclusion, different ignition models are compared in terms of ignition delay through the computed evolution of the breech pressure.