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化工材料研究所

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Initiation Characteristics of TATB-based Explosive Shocked by RDX-based Booster





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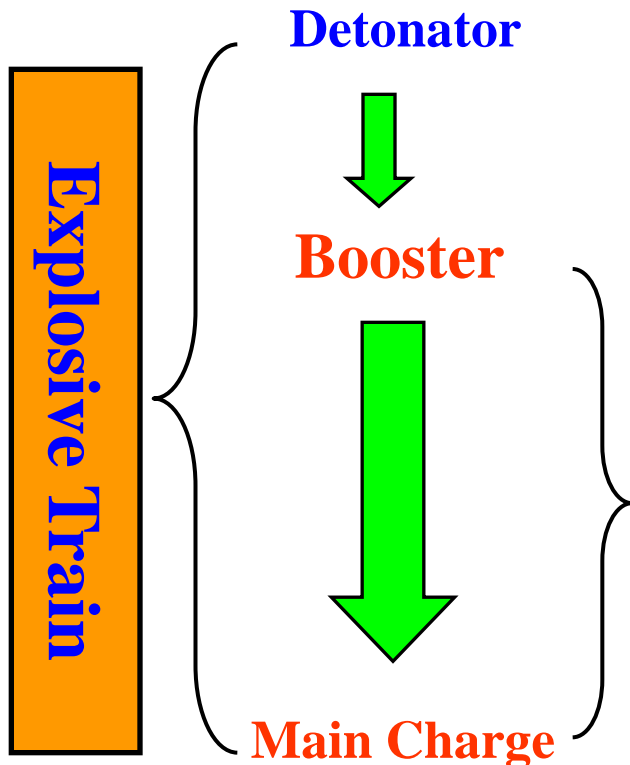
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1 Introduction

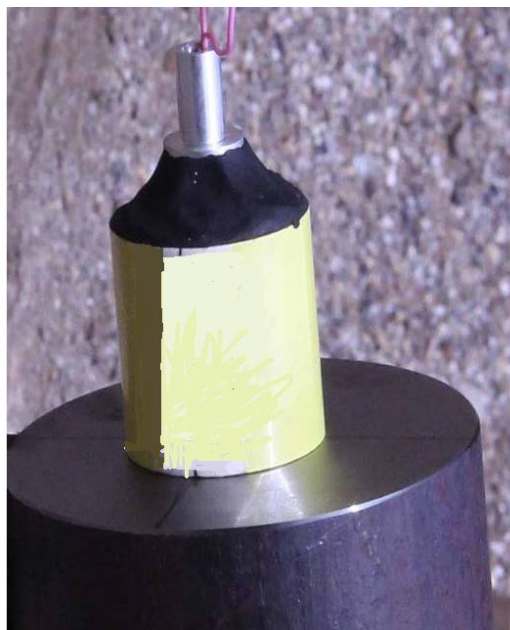
- ◆ Explosive trains are generally composed of series components ,for example, detonator - booster - main charge, which the sensitivity is from high to low, the power output from weak to strong,the size from small to large.
- ◆ As an important component to decide whether the function can be realized, the reliability and security need to be taken into account.



- Matching design for booster - main charge
 - ✓ characteristics of the booster (energy\security\...)
 - ✓ characteristics of main charge (initiation\chemical reaction...)
 - ✓ energy match and size match...
- How to evaluate whether the main explosive can be reliably initiated by booster

1 Introduction

➤ According to the damage of witness-steel-plate, the detonation state can be simply judged, but lacking of the interpretation of the detonation process



TATB based PBX shocked by RDX based booster with different diameters



$\Phi 20 \times 10\text{mm}$



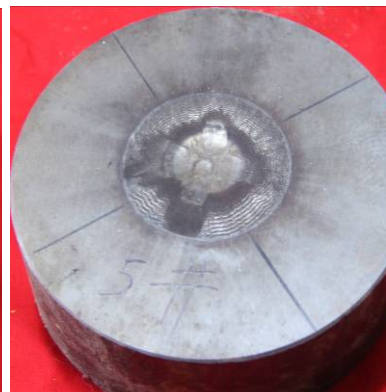
$\Phi 15 \times 10\text{mm}$



$\Phi 11 \times 10\text{mm}$



$\Phi 9 \times 10\text{mm}$ 4



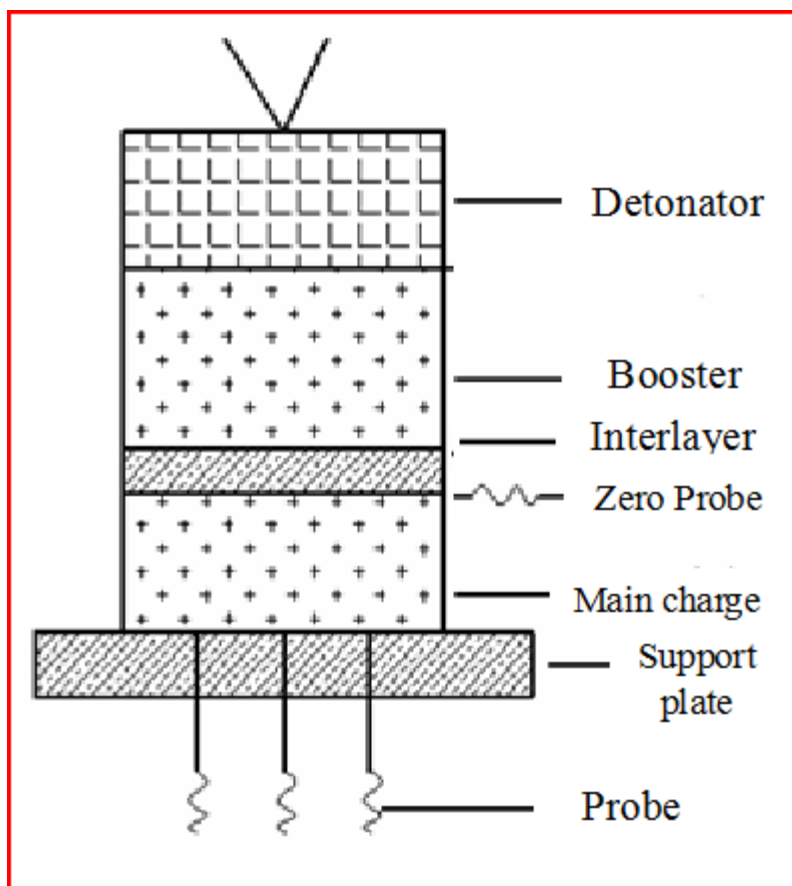
$\Phi 7 \times 10\text{mm}$



$\Phi 20 \times 10\text{mm}$
with 1mm air gap

1 Introduction

- Over propagation time which is the time difference(Δt) between the actual propagation time and the time under CJ detonation velocity

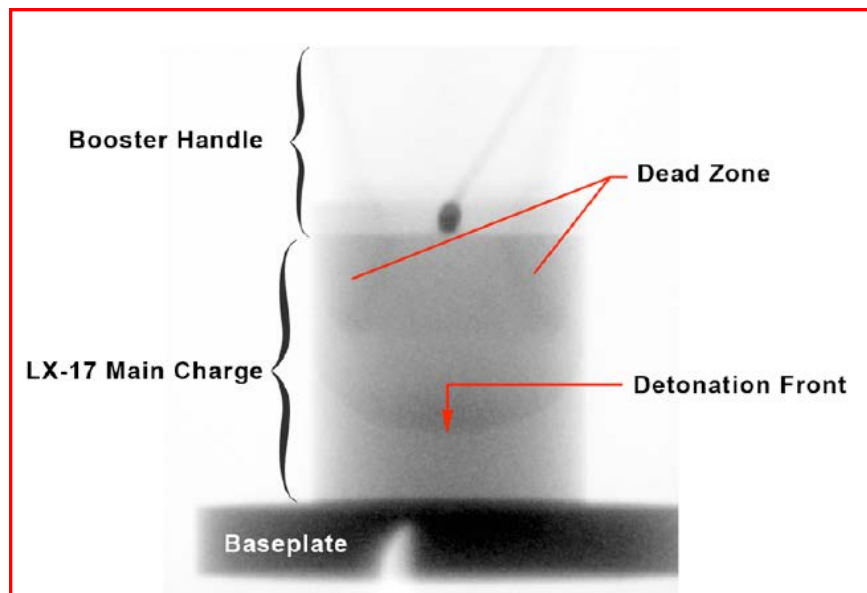


- The longer the time difference is, the longer the process of main charge run to stable detonation is, the worse the transfer reliability is.
- This method somewhat reflect the detonation process, but lacks the understanding the detonation dead zone and corner turning of detonation wave

WEN Shang-gang. Detonation transfer reliability test method for interlayer initiation train[J]. Chinese Journal of Explosives and Propellants, 2008, 31(6): 8~11.

1 Introduction

- X-ray diagnostic allowed us to examine the onset and evolution of dead-zone formation.

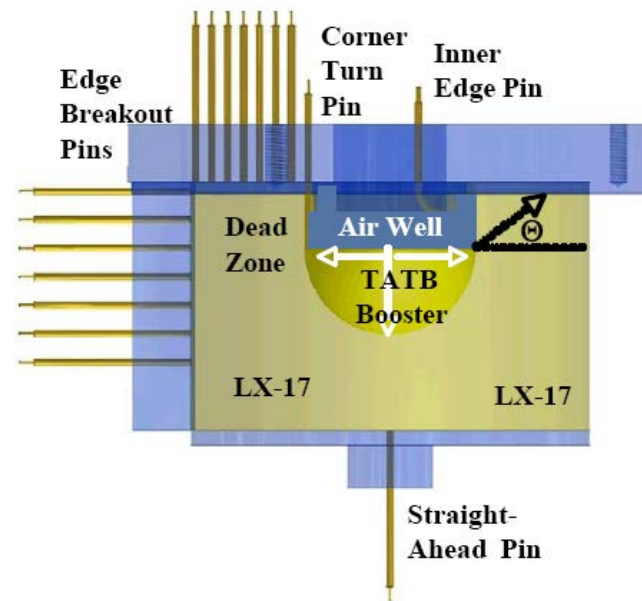
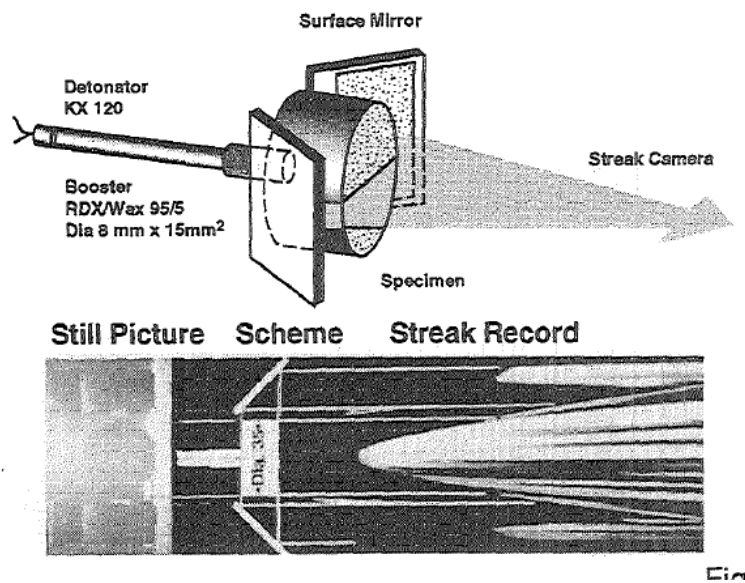


- **Booster: LX-14, $\Phi 12.7 \times 12.7$ mm**
- **Main charge : LX-17, $\Phi 50.8 \times 50.8$ mm**
- **In LX-17 the detonations ability to corner-turn increases as the desity is reduces.**
- **Higher accuracy is the characteristic of this method, but the technical requirements are higher.**

J.D. Molitoris, H.G. Andreski, R.G. Garza, et al. An experimental investigation of detonation corner-turning using high resolution radiography[A]//13th International Detonation Symposium,2006.

1 Introduction

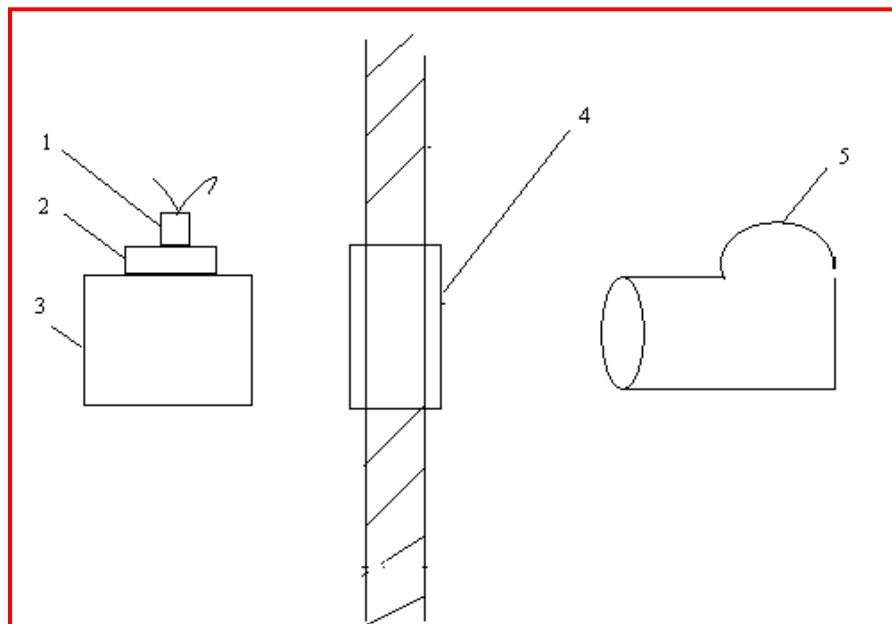
- The high speed scanning camera can be used to obtain the propagation of detonation wave .



M.Held, Optical test method to measure the corner turning and the retonation distance[A]//23rd International Congress on High-Speed Photography and Photonics.

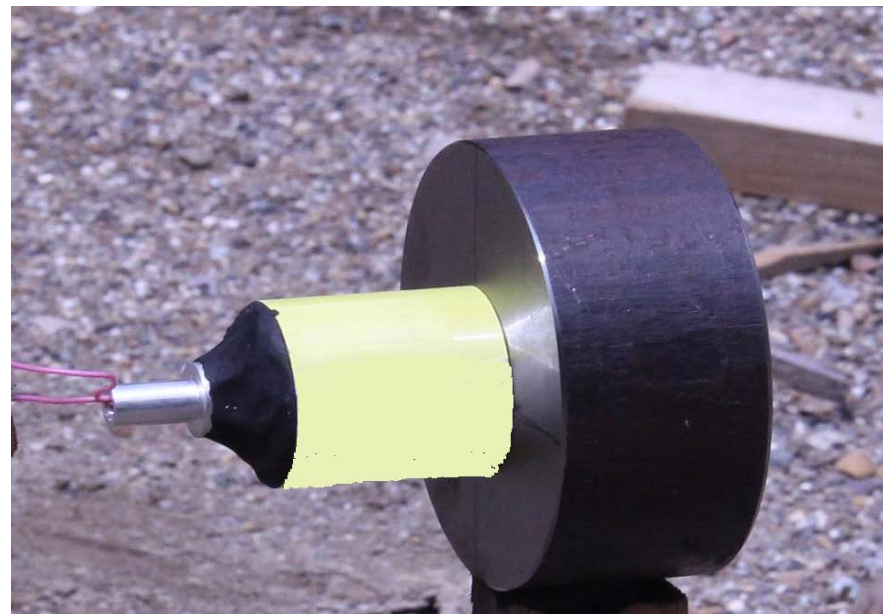
P.C. Souers, A. Hernandez, C. Cabacungen, et al. Air gaps, size effect and corner turning in ambient LX-17[J]. Propellants, Explosives, Pyrotechnics,2007.

2 Experimental



1 detonator 2 booster 3 main charge
4 observation window 5 scanning camera

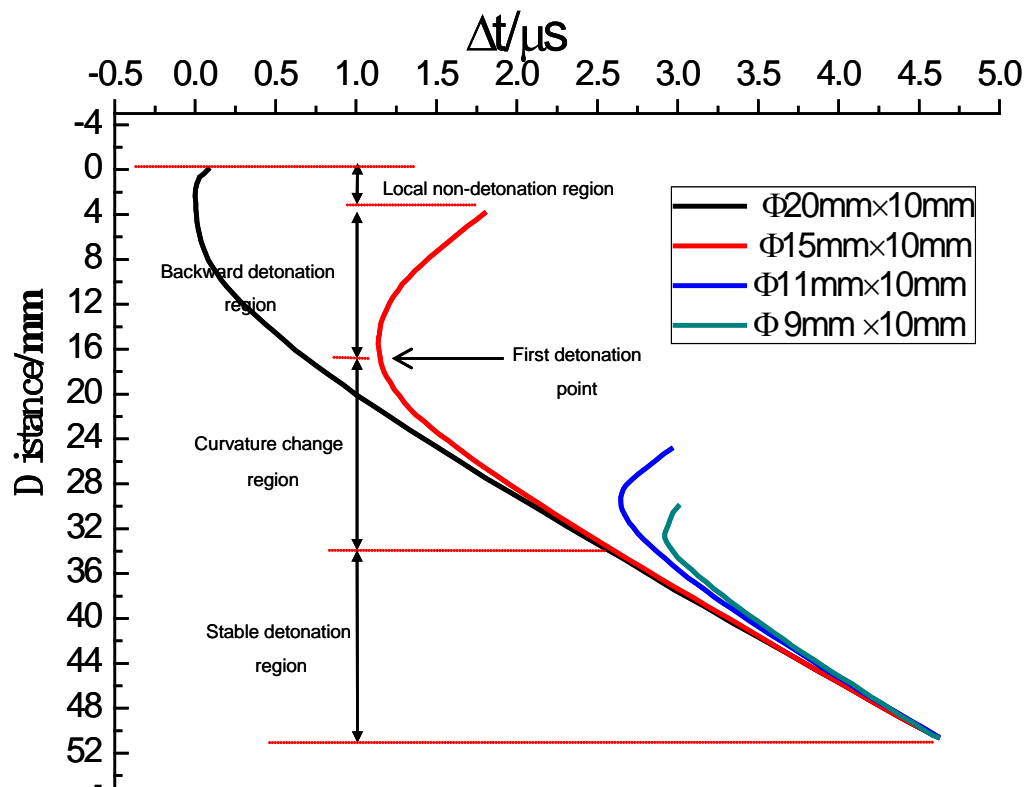
The experimental set-up



- **Diameter of the Booster**
 - ✓ $\Phi 10$ 、 $\Phi 15$ 、 $\Phi 20$...
- **Initiation mode**
 - ✓ contact detonation、 with air gap

3 Results and Discussion

- **Booster:** RDX based-1, Density 1.58g/cm³, Detonation Velocity 7.8km/s, Detonation Pressure 20GPa;
- **Main Charge:** TATB based PBX-1, $\Phi 50 \times 50$ mm.



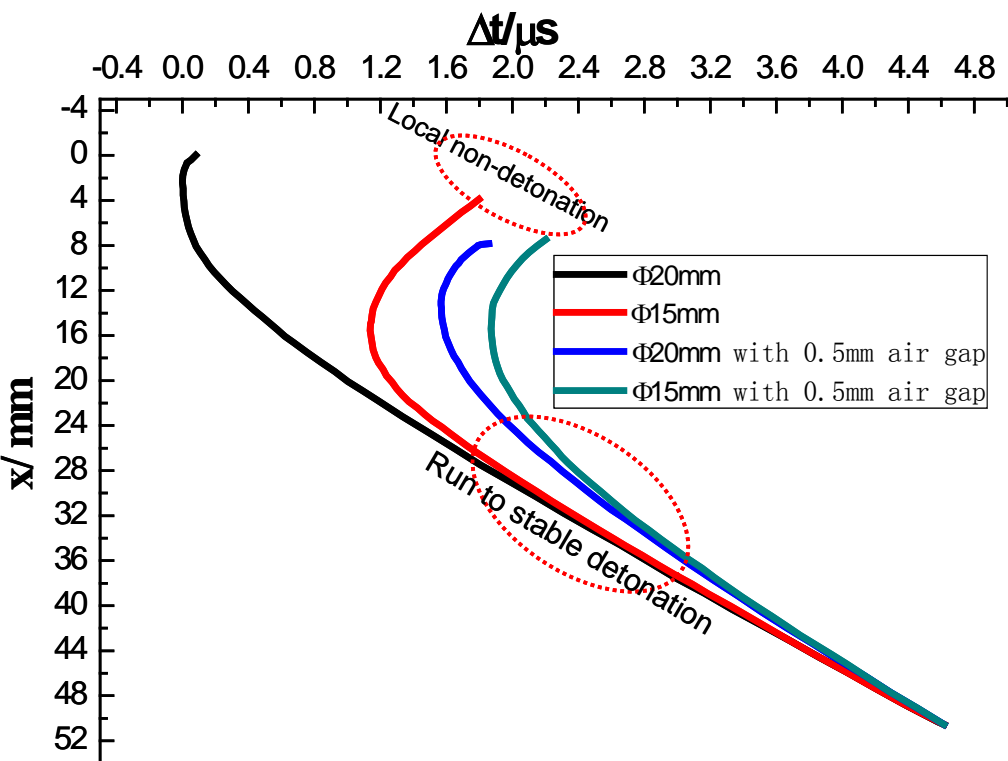
- According to the damage of witness-steel-plate, the detonation states were considered to be consistent;
- But by this method, we can find that the processes of the detonation are different;
- There are lots of dead zones in the shoulders of the main charge when the diameter of the booster is less than 11mm.



- Specially when the diameter is 7mm, all the outer surfaces are dead zones.

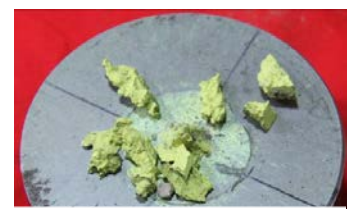
3 Results and Discussion

- **Booster:** RDX based-1, Density 1.58g/cm³, Detonation Velocity 7.8km/s, Detonation Pressure 20GPa;
- **Main Charge:** TATB based PBX-1, $\Phi 50 \times 50$ mm.



● Though the gasket, the air gap was made between the booster and main charge

- Air gap has a great influence on the detonation transfer reliability;
- the run distance to stable detonation is longer because that the air gap causes the loading pressure decreasing .

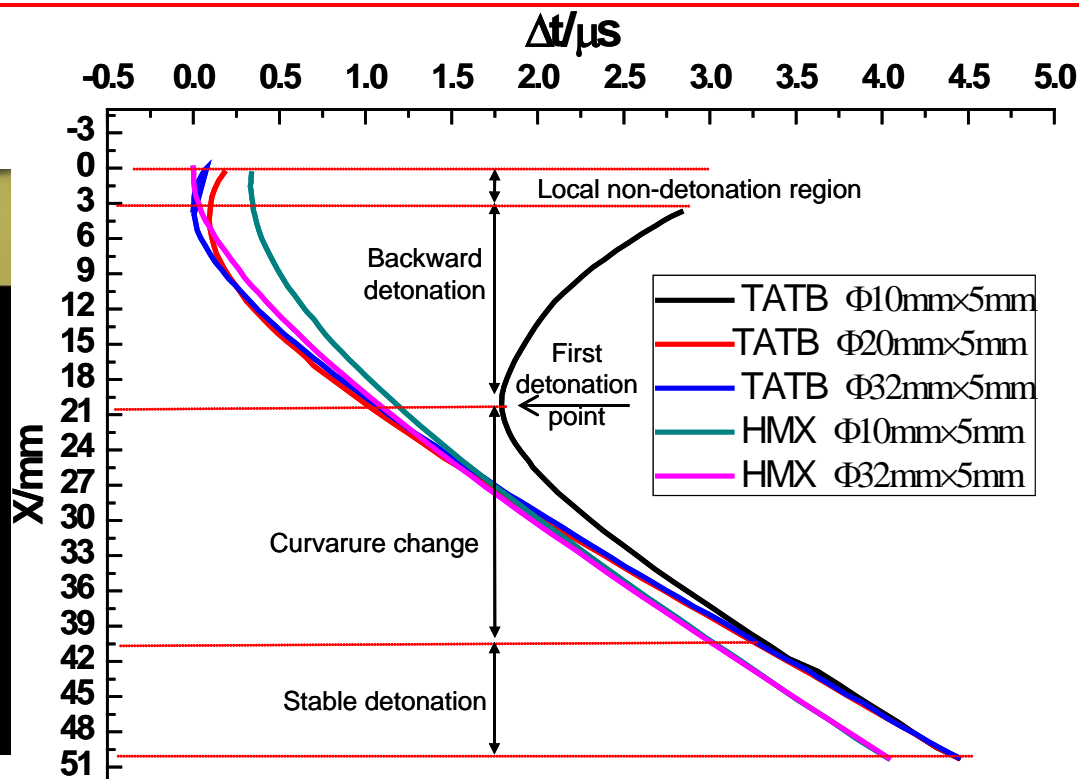


$\Phi 20 \times 10$ mm with 1mm air gap

● When the thickness is above 1mm, the TATB based main explosive can not be detonated..

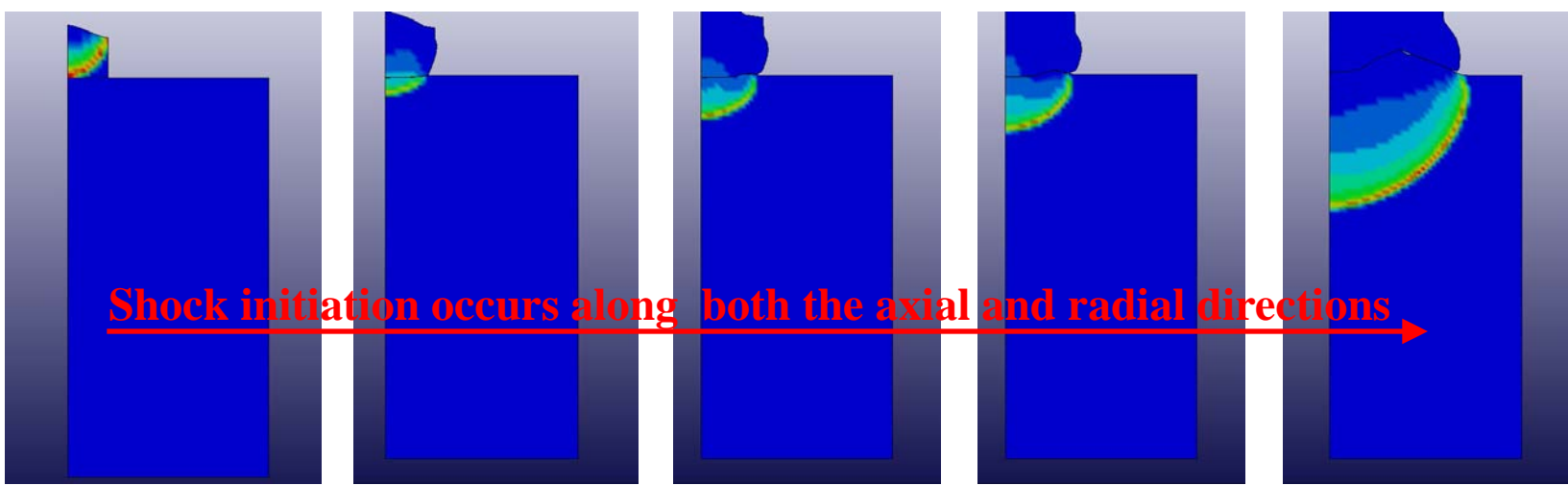
3 Results and Discussion

- **Booster:** RDX based-2, Density 1.65g/cm³, Detonation Velocity 8.2km/s, Detonation Pressure 22GPa;
- **Main Charge:** TATB based PBX-1, HMX based PBX-2 ,Φ50×50mm.

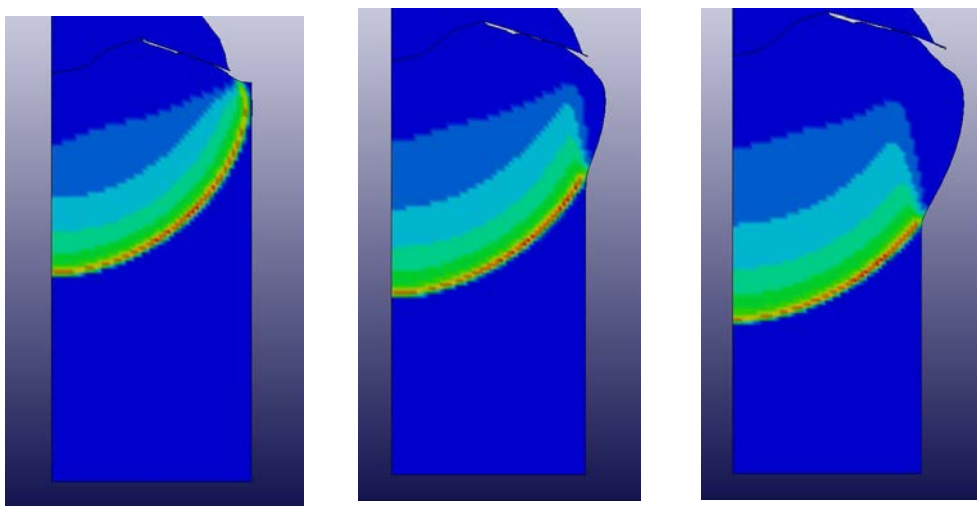


- **Compared with TATB based explosive, the HMX based main explosive is more likely to be reliably initiated by the booster with smaller diameter ,for example the $\Phi 10mm$.**

3 Results and Discussion



Shock initiation occurs along both the axial and radial directions



the curvature decreases gradually

● For a reliable explosive train, the detonation growth process along the radial is quick, so the corner turning area is smaller.

4 Summary

In this work, the initiation characteristics of TATB based explosive shocked by the RDX based booster were studied according to the propagation of detonation wave, and the following conclusions were obtained:

- the method is feasible to evaluate the reliability of detonation transmission;
- the charge of the booster plays an important role on the propagation of the detonation wave;
- Air gap has a great influence on the detonation transfer reliability, when the thickness is above 1mm, the TATB based main explosive can not be detonated by the RDX based booster.

THANKS FOR YOUR LISTENING