Research on EFI's in relation to Insensitive Munitions

TNO | Knowledge for business

Wim Prinse Research Scientist

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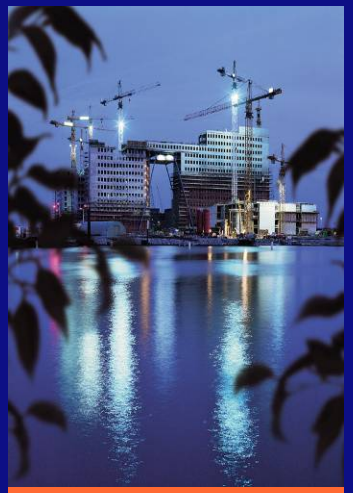
TNO has organised its business in five core areas

TNO Quality of Life

TNO Defence, Security and Safety

TNO Science and Industry



TNO Environment and Geosciences

TNO Information and Communication Technology

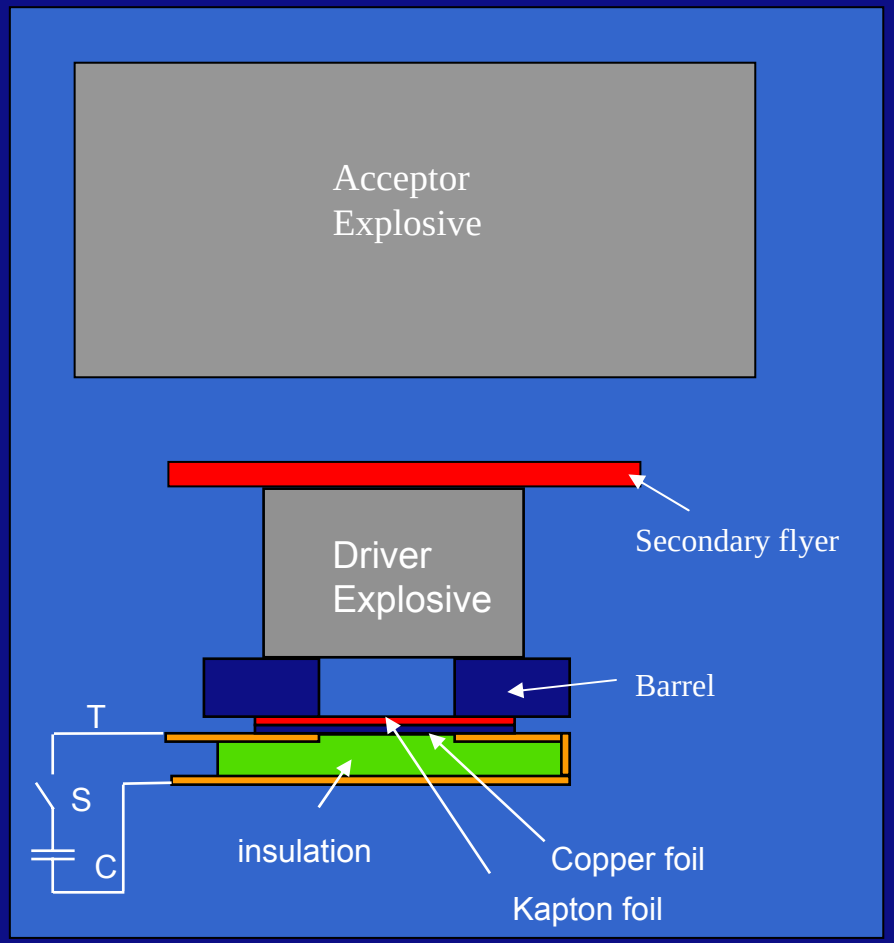
TNO Defence, Security and Safety focuses on:

- **Defence**
  - Military operations
  - Military equipment
  - Command and operational decision making
  - Threat and protection
  - Education and training
- **Security and Safety**
  - Combating crime, calamities and terrorism
- **Aerospace**
  - Improving safety
- **Maritime**
  - Shipbuilding

Organisation TNO Defence, Security and Safety

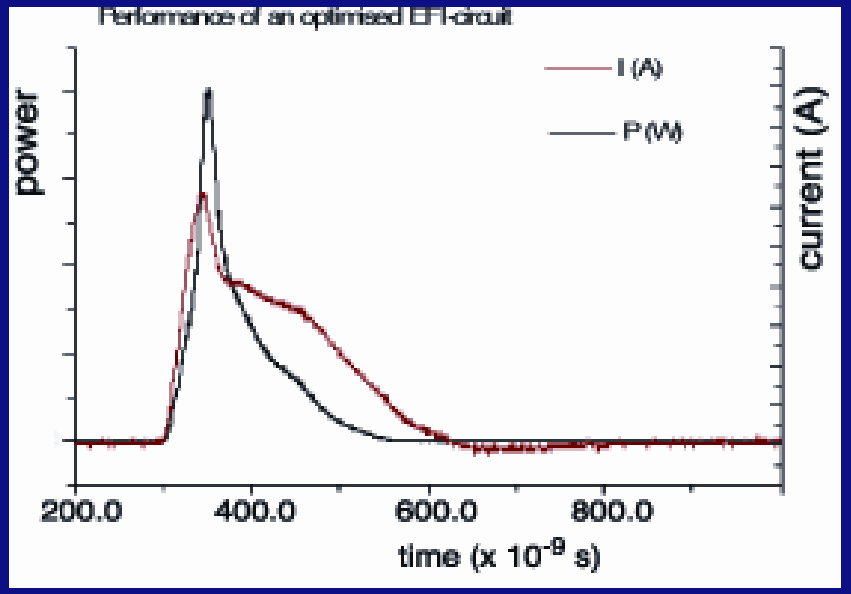
Exploding Foil Initiator Research

- Electrical circuit
- Exploding foil
- Velocity of the flyer
- Driver Explosive
- Secondary flyer
- Acceptor explosive



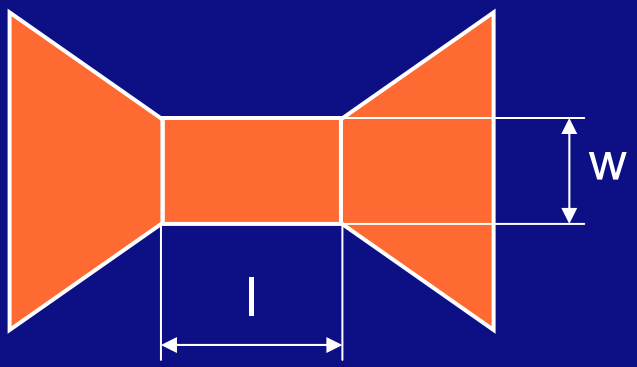
Electrical circuit

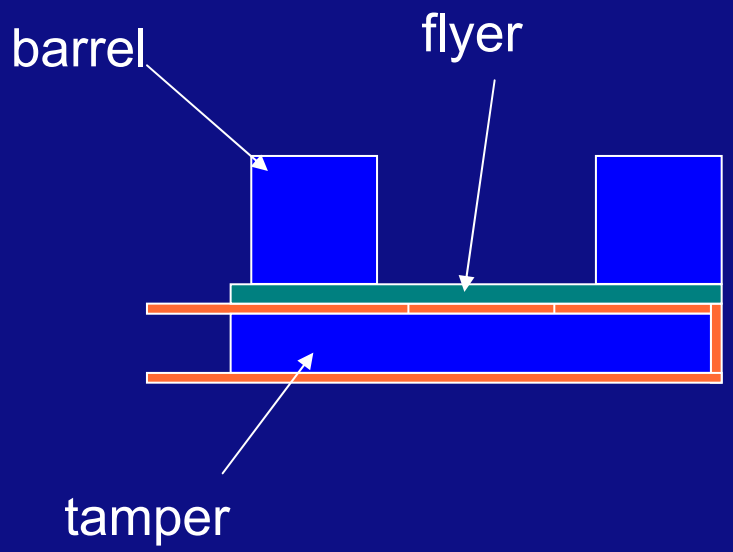
- Optimisation of the circuit
  -low loss capacitor,
  -switch,
  -transmission line
- Development of measuring techniques
- 90% efficiency of energy deposited in the exploding foil (50 % other circuits)



Exploding foil

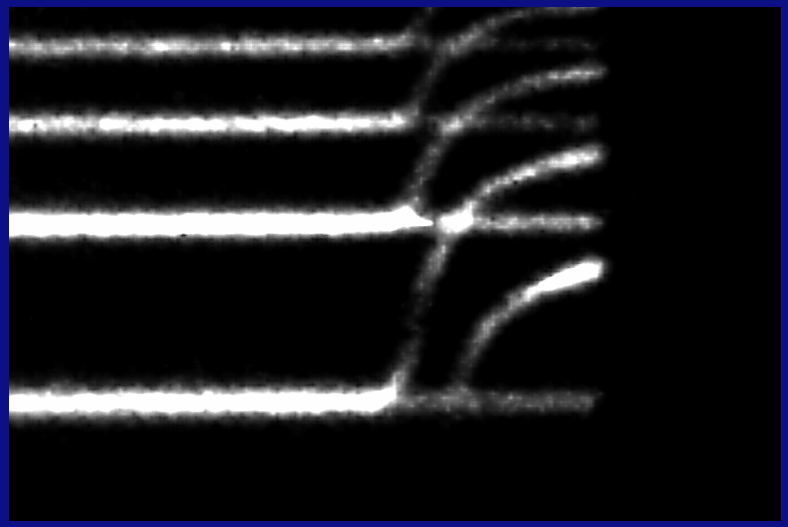
- Dimension of the foil (length, width, thickness, material)
- Shockwave impedance of the tamper
- Thickness and material of the flyer
- Length and width of the barrel

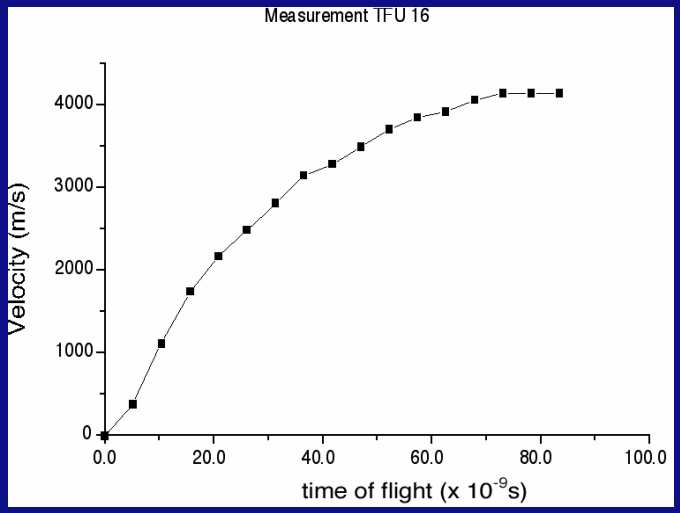




Flyer velocity measurement by F-P Interferometer

- Acceleration of the flyer influenced by:
  -thickness and material
  -exploding foil dimensions and material
  -shockwave impedance of the tamper
- Integrity of the flyer during acceleration
  -Determination of optimum barrel length



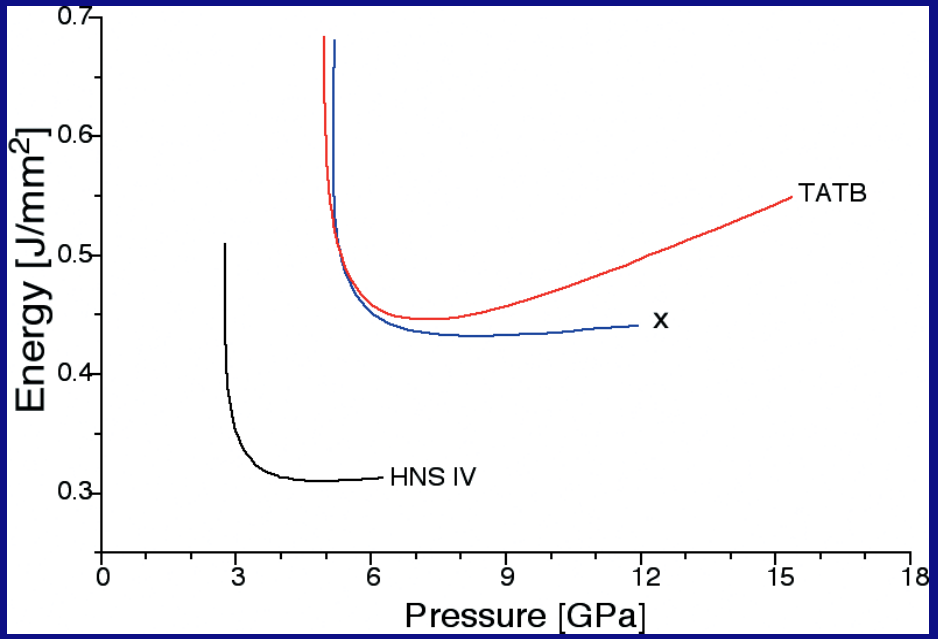


Research on Explosives I

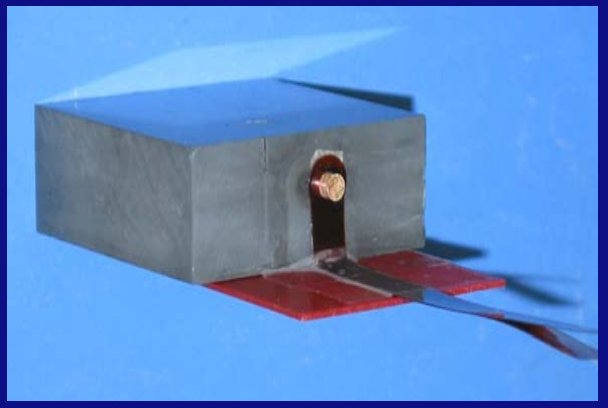
- Recrystallisation of HNS II to HNS IV
- The crystals are more uniform (smaller distribution)
- The length to width to thickness is 10:3:2
  a further increase in specific surface area is possible

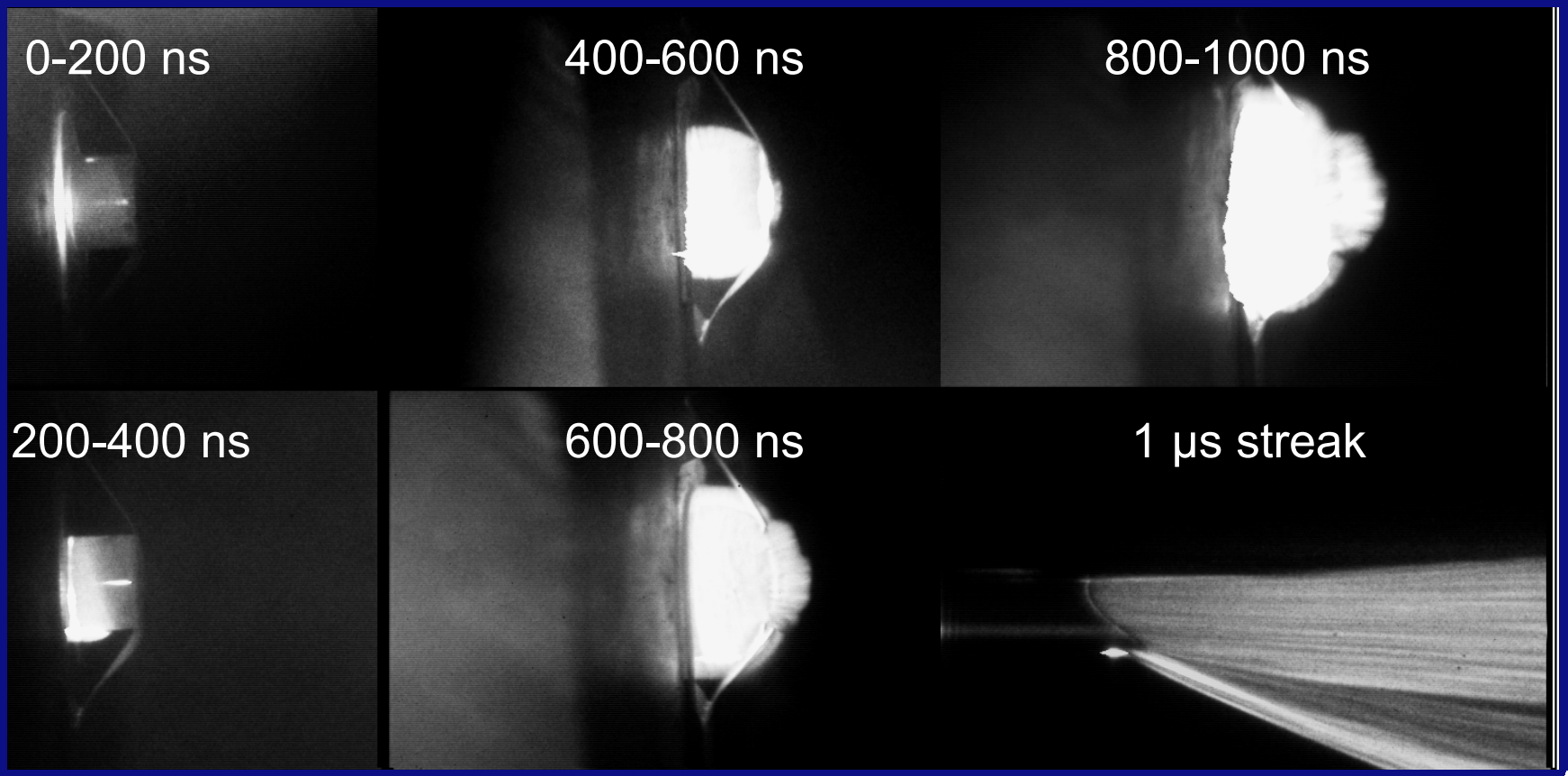
Initiation behaviour of different explosives

- Different types of explosives
  - HNS IV several brands
  - TATB several grades
  - New explosives
- Initiation energy depends on flyer thickness and velocity



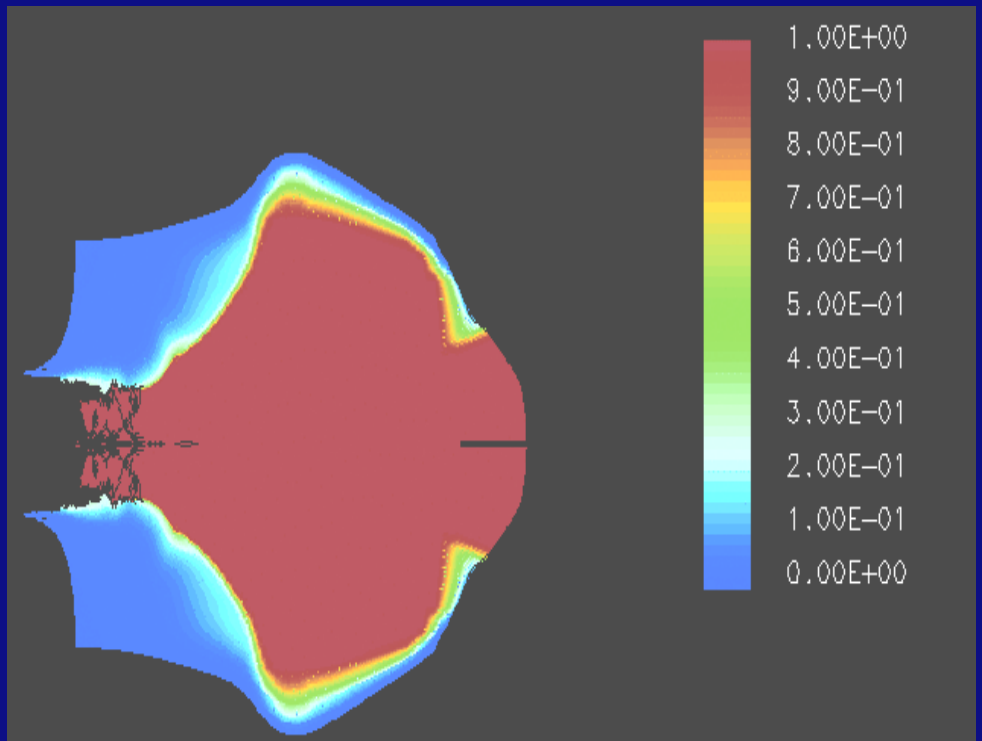
Initiation of HNS IV pellet





Numerical simulations of flyer impact

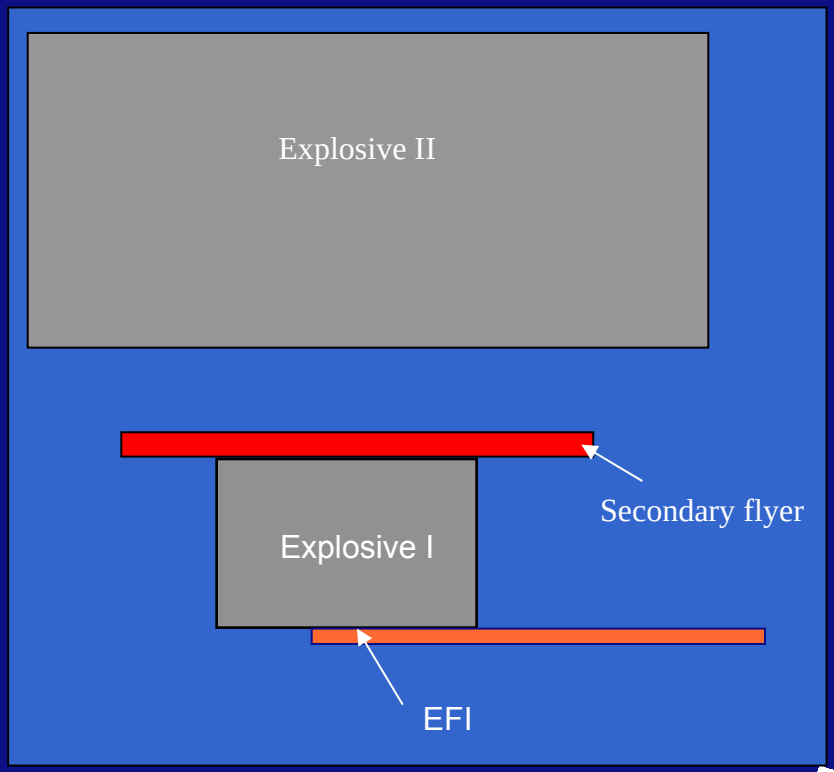
- Lee-Tarver model modified with visco-plastic pore collapse model
- Qualitatively the simulations can explain the experiments



Reacted fraction of HNS IV after initiation by 5.4 mm/μs flyer

Secondary flyer impact

- Driver explosive (HNS IV, TATB, RDX ……..)
- Confinement of the explosive
- Secondary flyer material:
  - spall strength (attenuator)
  - shockwave impedance
  - size and thickness
- Initiation distance of acceptor explosive

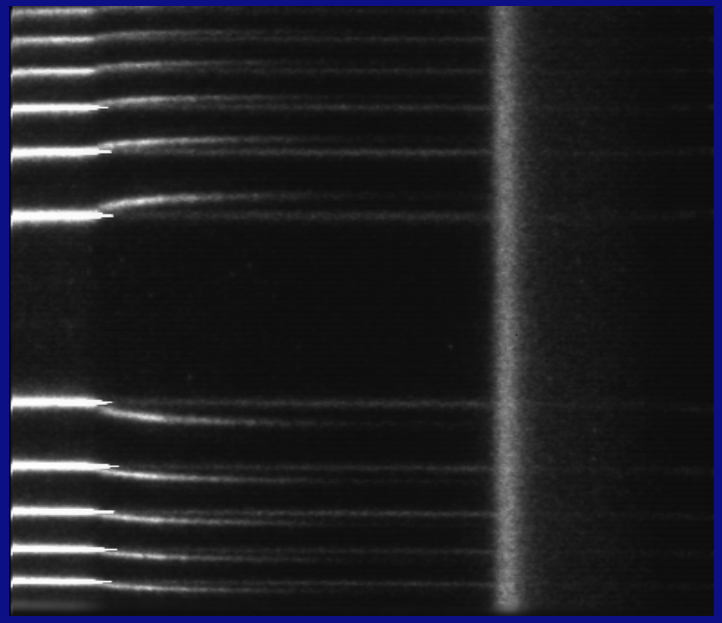


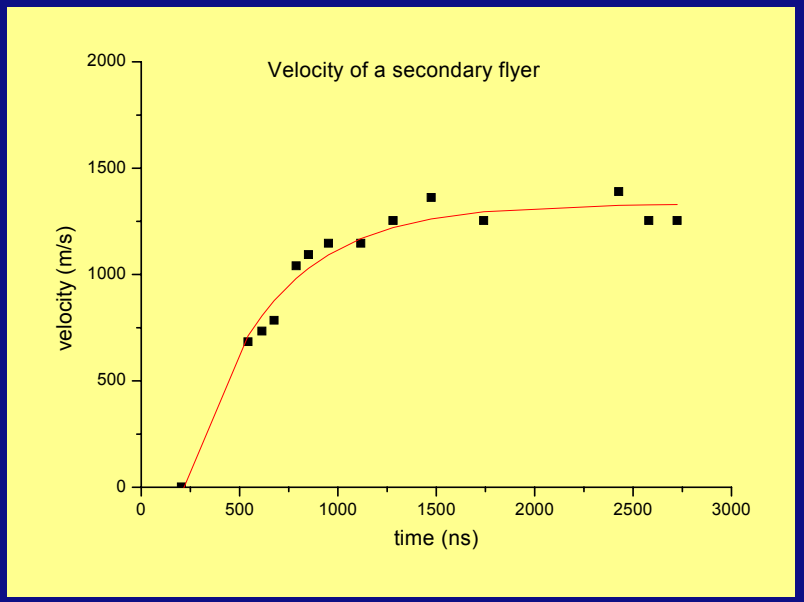
Secondary flyer impact

Acelleration of a 0.25 mm stainless steel flyer by HNS IV

Successful initiation of TATB by

- 0.15 mm SS steel flyer
- 0.35 mm mylar flyer
- 0.3 - 0.5 mm Al flyer





Conclusions

- A very efficient electrical circuit is developed (η = 90%)
- With “of the shelf components” small IM compliant EFI-detonators can be build (8 cm^3 including HV-supply)
- Combining the EFI with the electronic safety and arming unit with MEMS-technology can make a small and cost effective unit
- The use of secondary flyers makes the detonation train more reliable

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