Prevention of Sympathetic Detonation between Reactive Armor Sandwiches

A. Holzwarth

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EMI
Fraunhofer Institut
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ontents

Introduction and objectives

Experiments

- Test set-ups
- Materials
- Tests with foams
- Tests with layers
- Flash x-ray photographs
- Experimental results

Summary and conclusions

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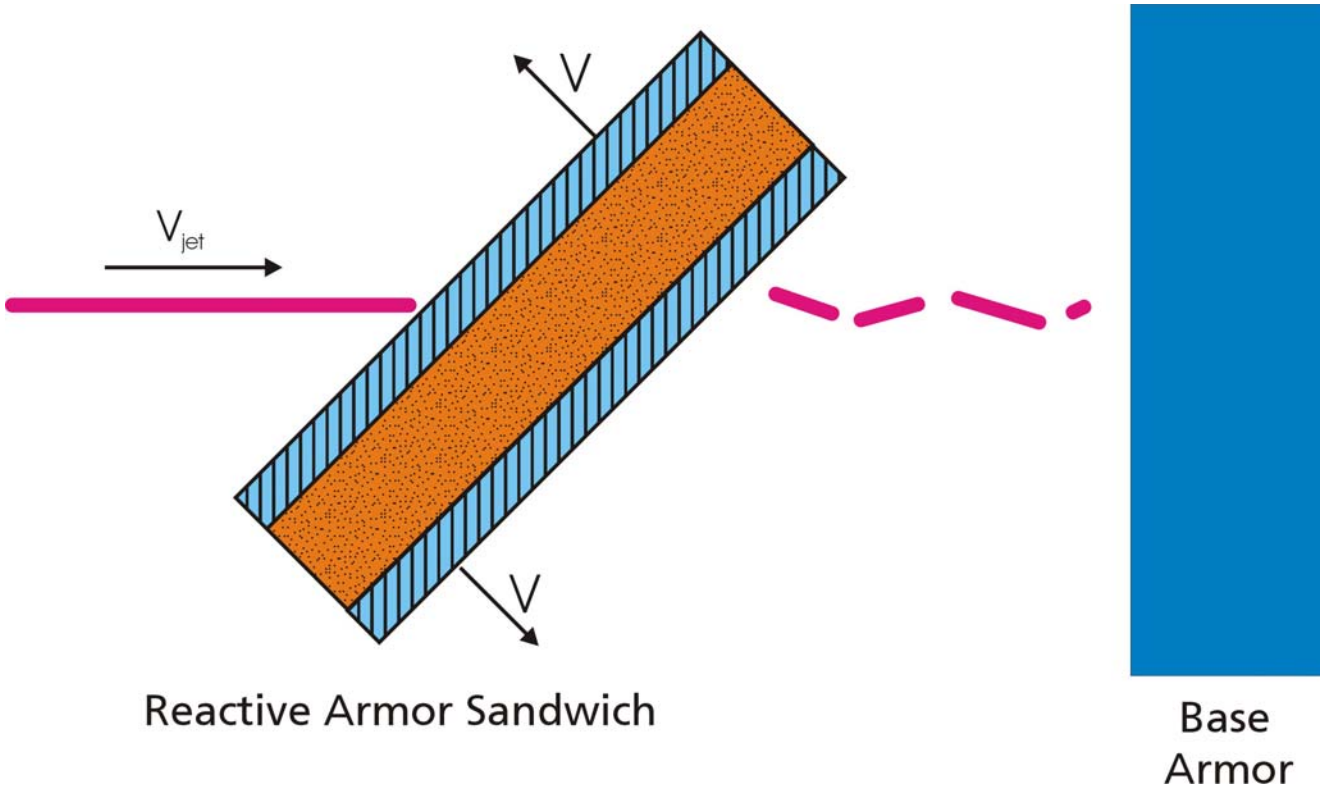
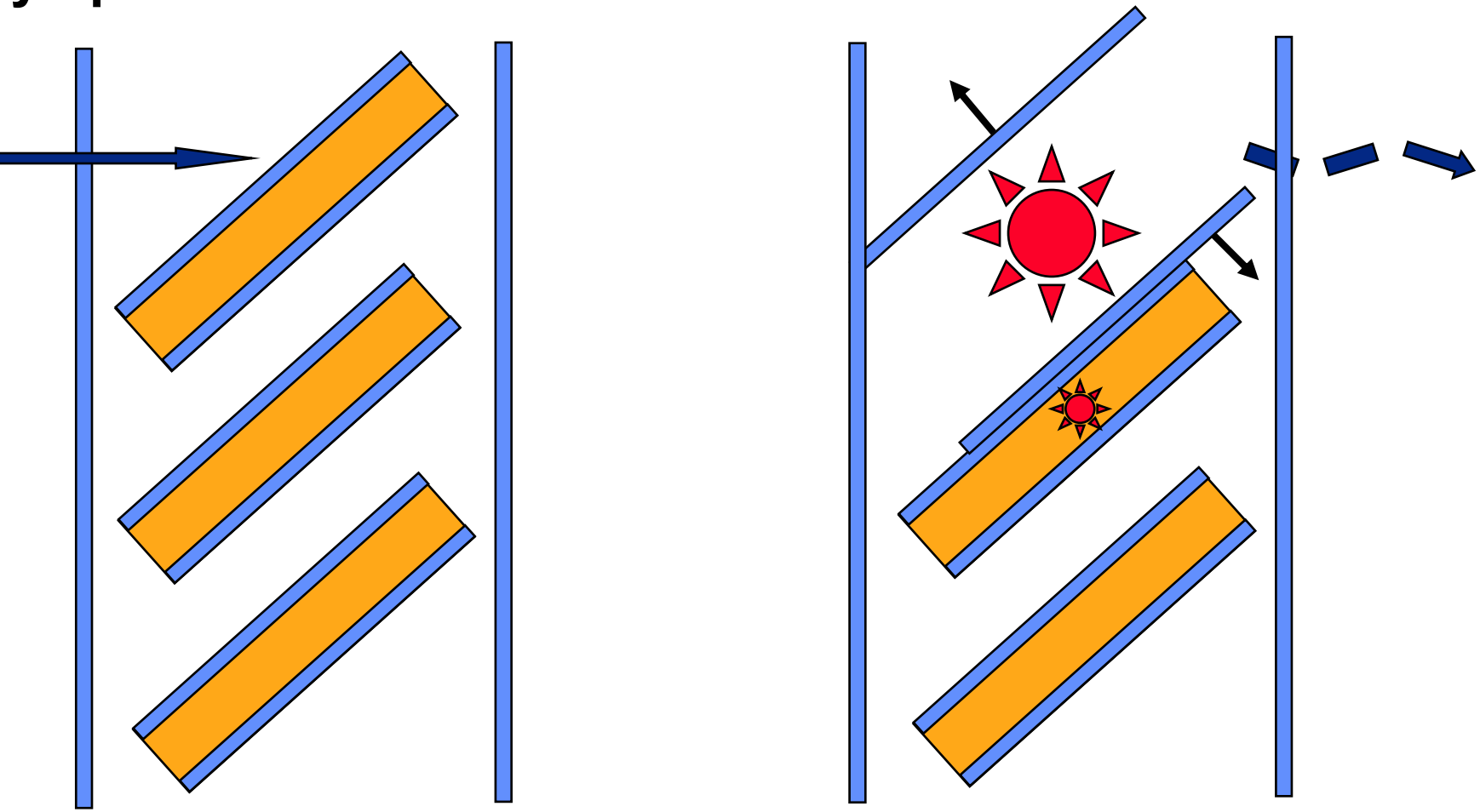
unctioning of Reactive Armor Sandwiches



Sympathetic Detonation between Reactive Armor Sandwiches



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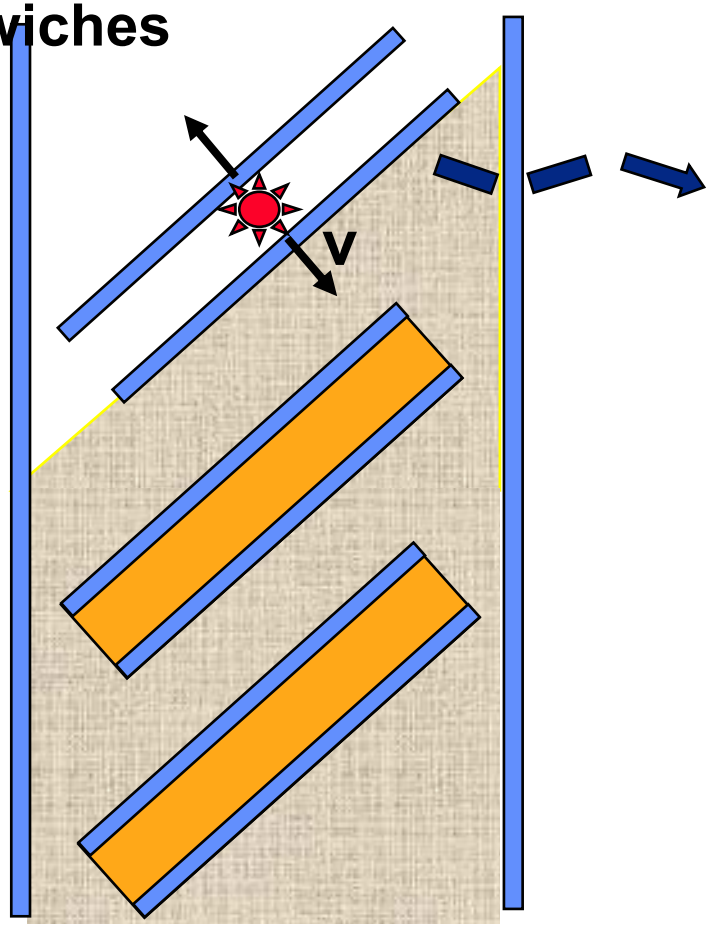
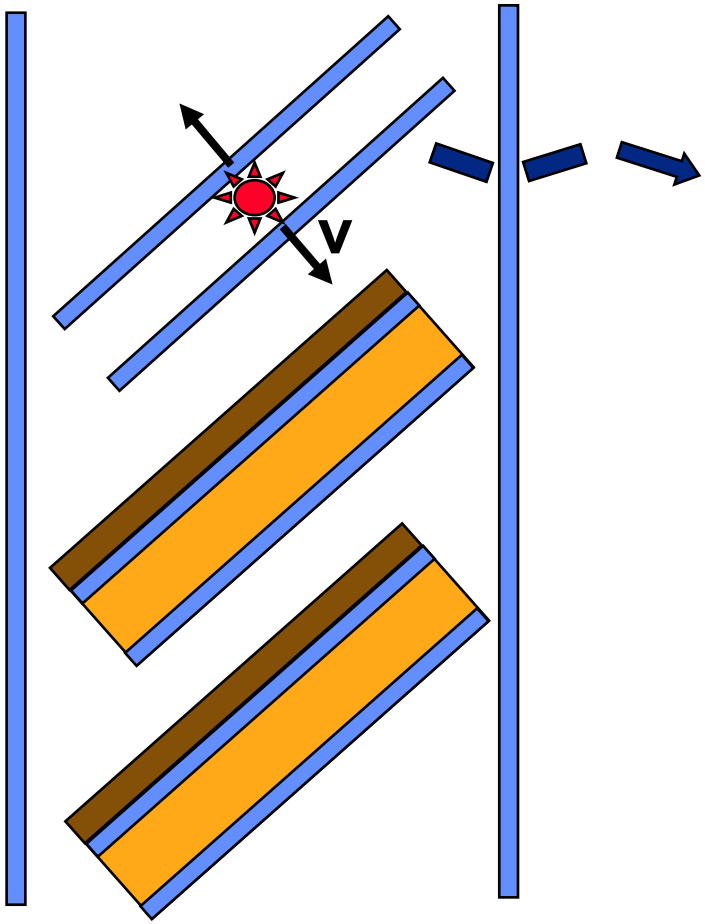


2.



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ubjects of Investigations

Appropriate materials

- Absorption of kinetic energy
- Damping of shock waves

Useful and necessary densities

Arrangement of materials

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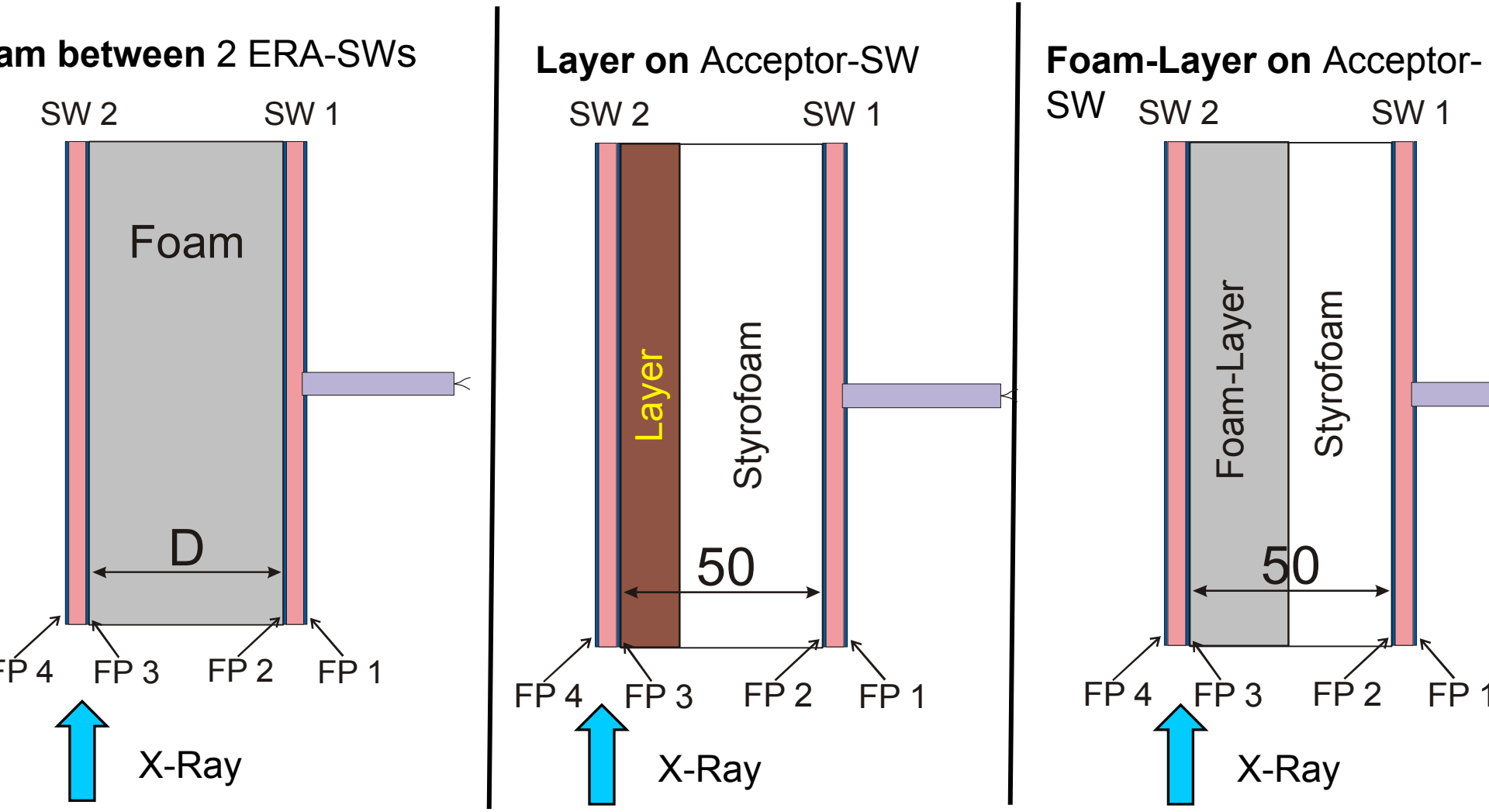
est Set – ups: Tests of Foams and Layers



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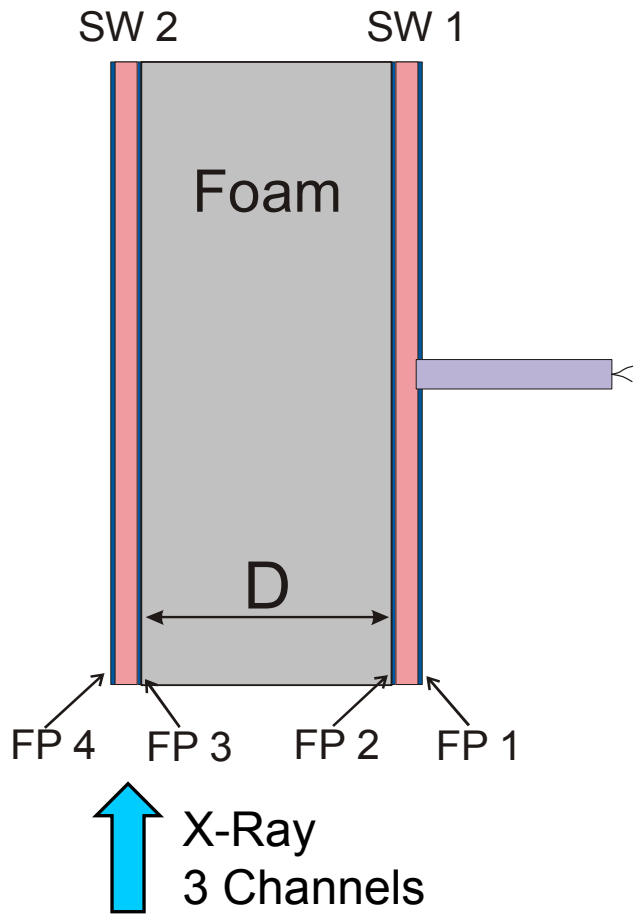
xperiments 1: Foams between 2 ERA-Sandwiches



Test set-up data

Sandwiches:	<2 / 4 / 2>, 160 x 40 mm^2
Flyer plates:	Mild steel, 2 mm dick
Explosive:	Seismoplast (PETN + binder) 4 mm thick; 42,5 g
Distance D:	D = 50 mm – 80 mm Standard value: D = 50 mm

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ested Foams

ρ < 400 kg/m^3

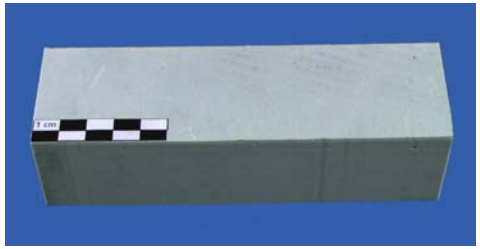
PS 28, ρ=28 kg/m^3
PS 50, ρ=50 kg/m^3

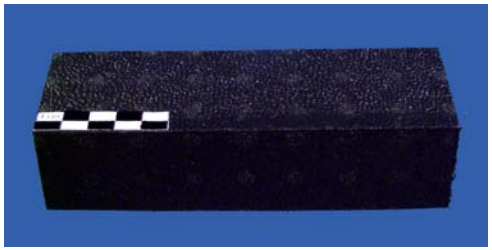
PP 50, ρ=50 kg/m^3
PP 300, ρ=255 kg/m^3

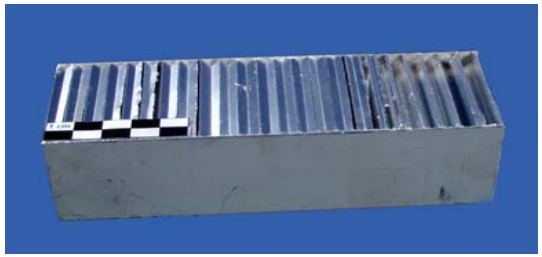
J - Foam, ρ=330 kg/m^3

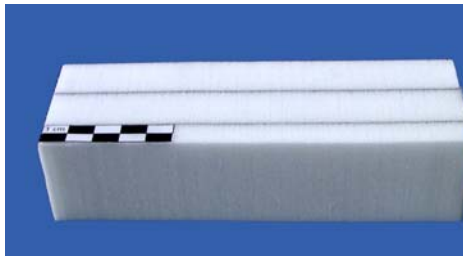
uminum-Honeycomb, ρ=152 kg/m^3

hite Foam, ρ=137 kg/m^3









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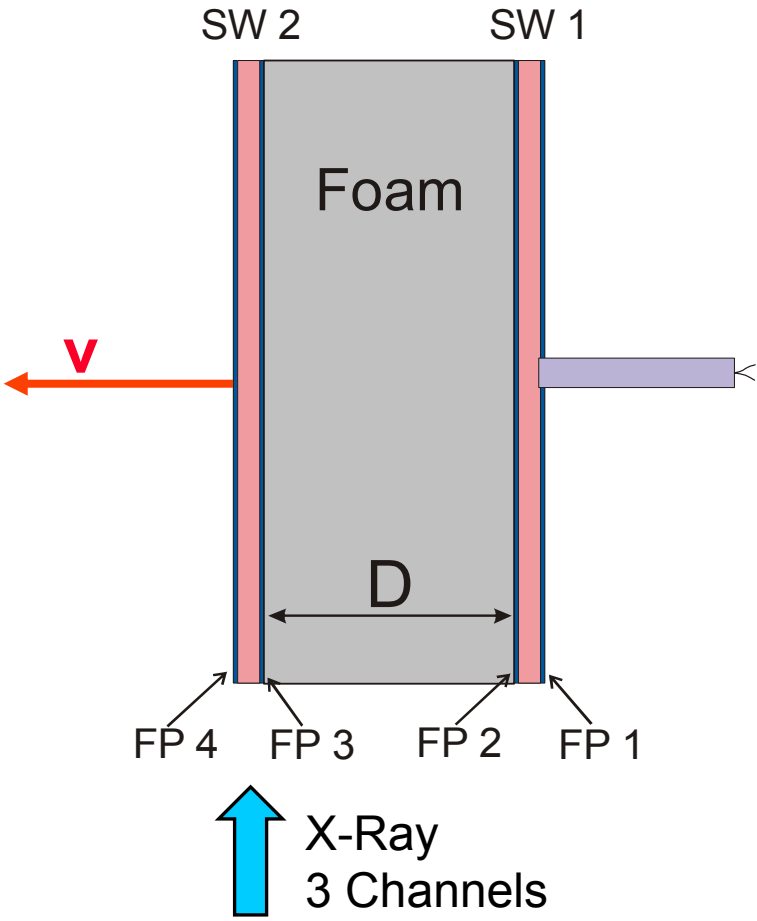
bservations with flash x-ray

elocity of flyer plate FP 4:

- o Strength of reaction in SW 2
  - Detonation / Partial Detonation
    Deflagration / No Reaction



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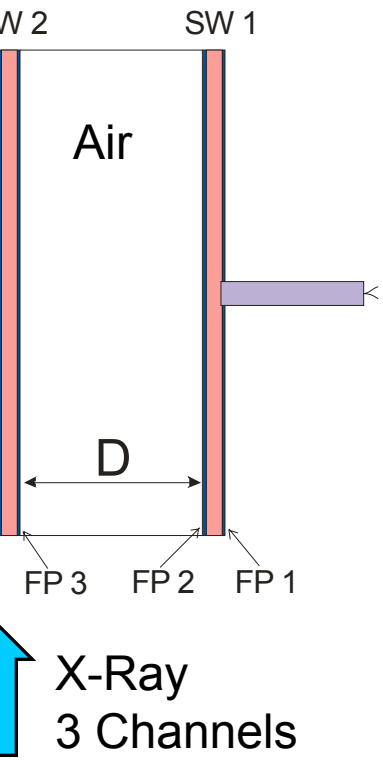
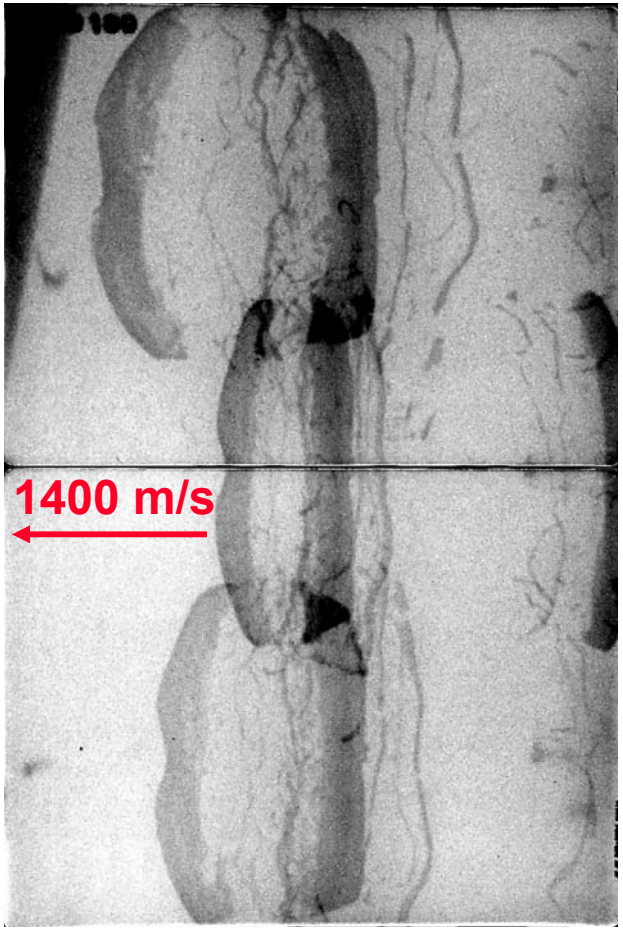
reliminary Tests: No Material between Reactive Sandwiches



SW 2 reactive - detonation

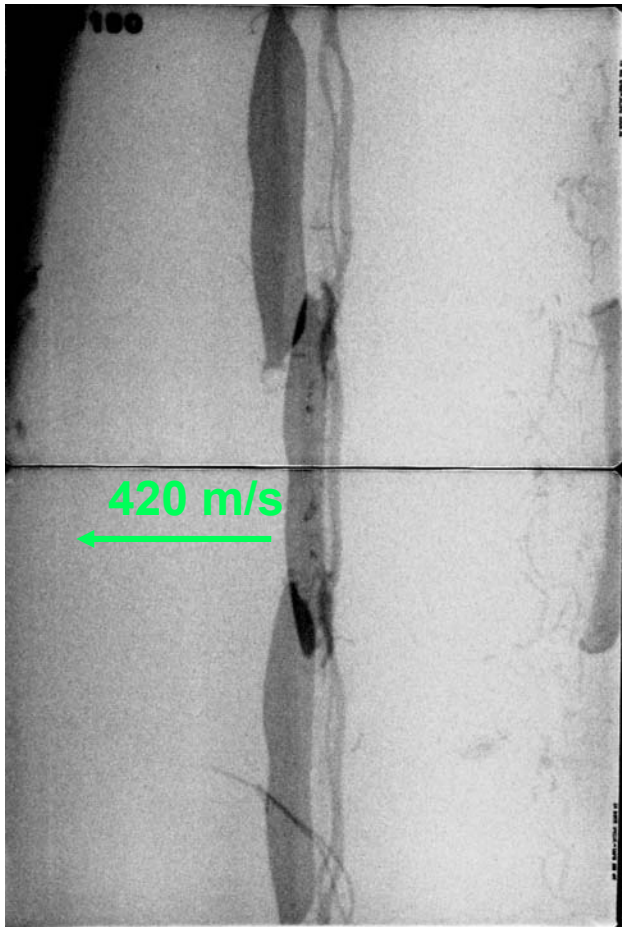


120 µs

80 µs

100 µs

SW 2 inert – no reaction



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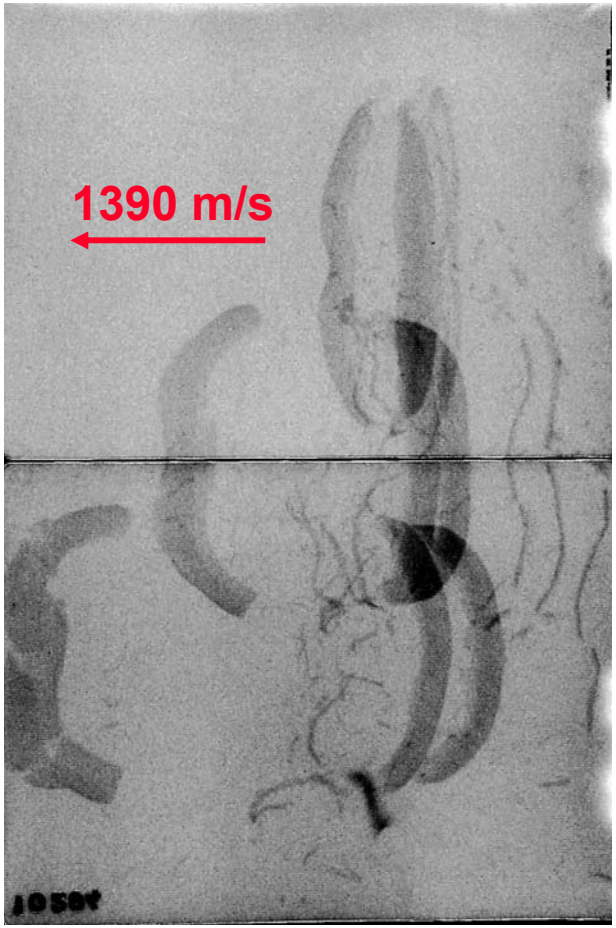
Flash X-Ray Photographs: Foams

EPS 28 – D=50 mm

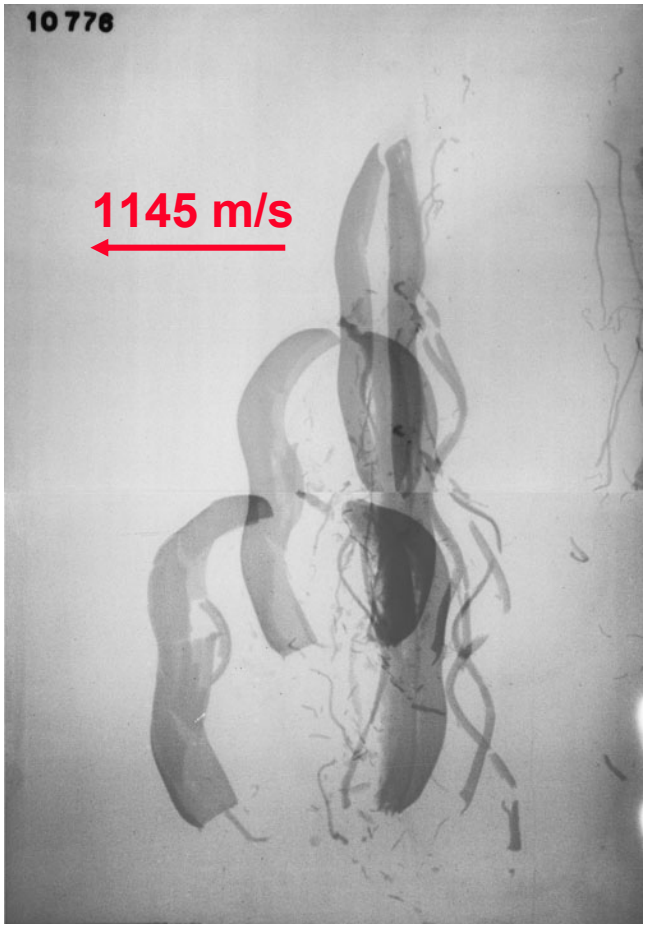


80 µs

140 µs

200 µs

EPS 50 – D=50 mm



80 µs

120 µs

160 µs

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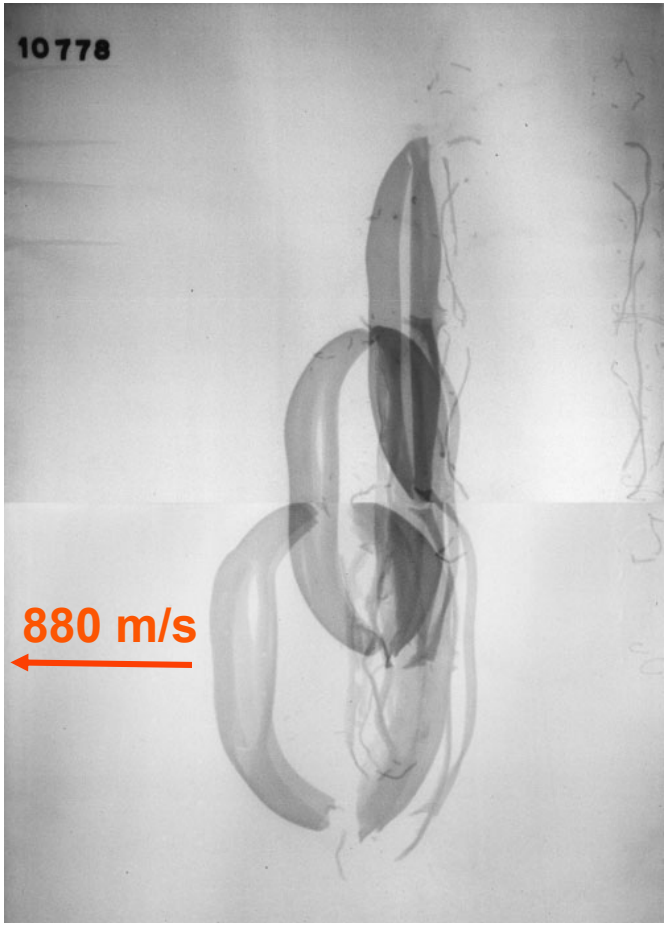
Flash X-Ray Photographs: Foams

EPP 50 – D=50 mm



80 µs

120 µs

160 µs

White Foam – D=50 mm

80 µs

140 µs

200 µs

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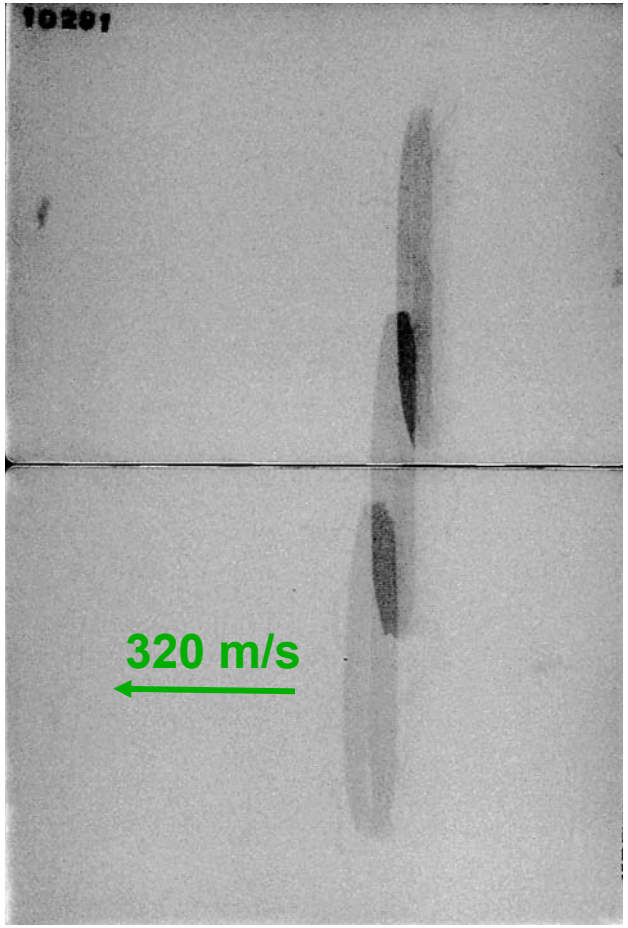
Flash X-Ray Photographs: Foams

EPP 300 – D=50 mm

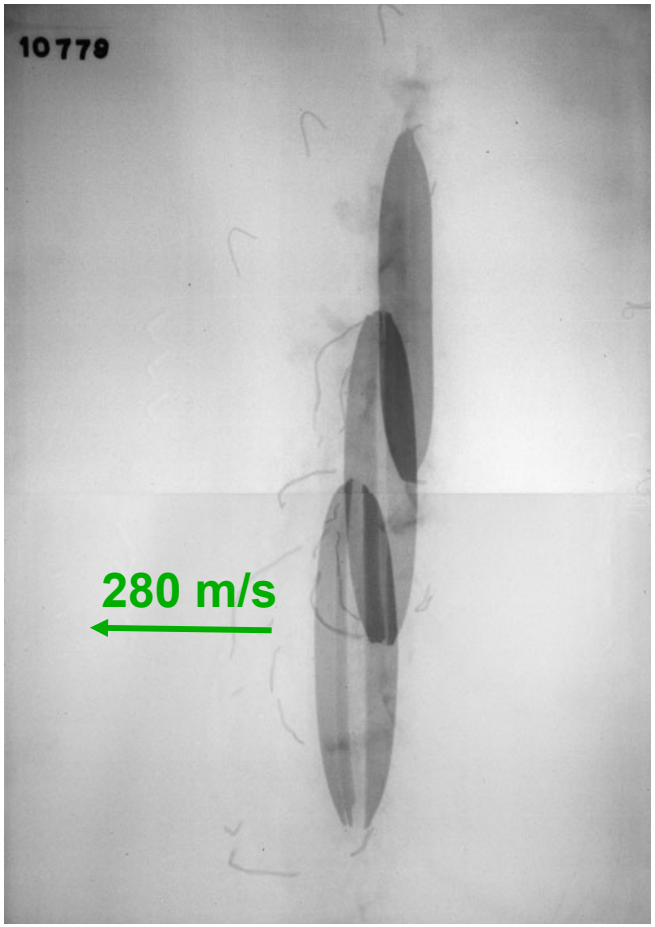


80 µs

120 µs

160 µs

PU-Foam – D=50 mm



100 µs

160 µs

220 µs

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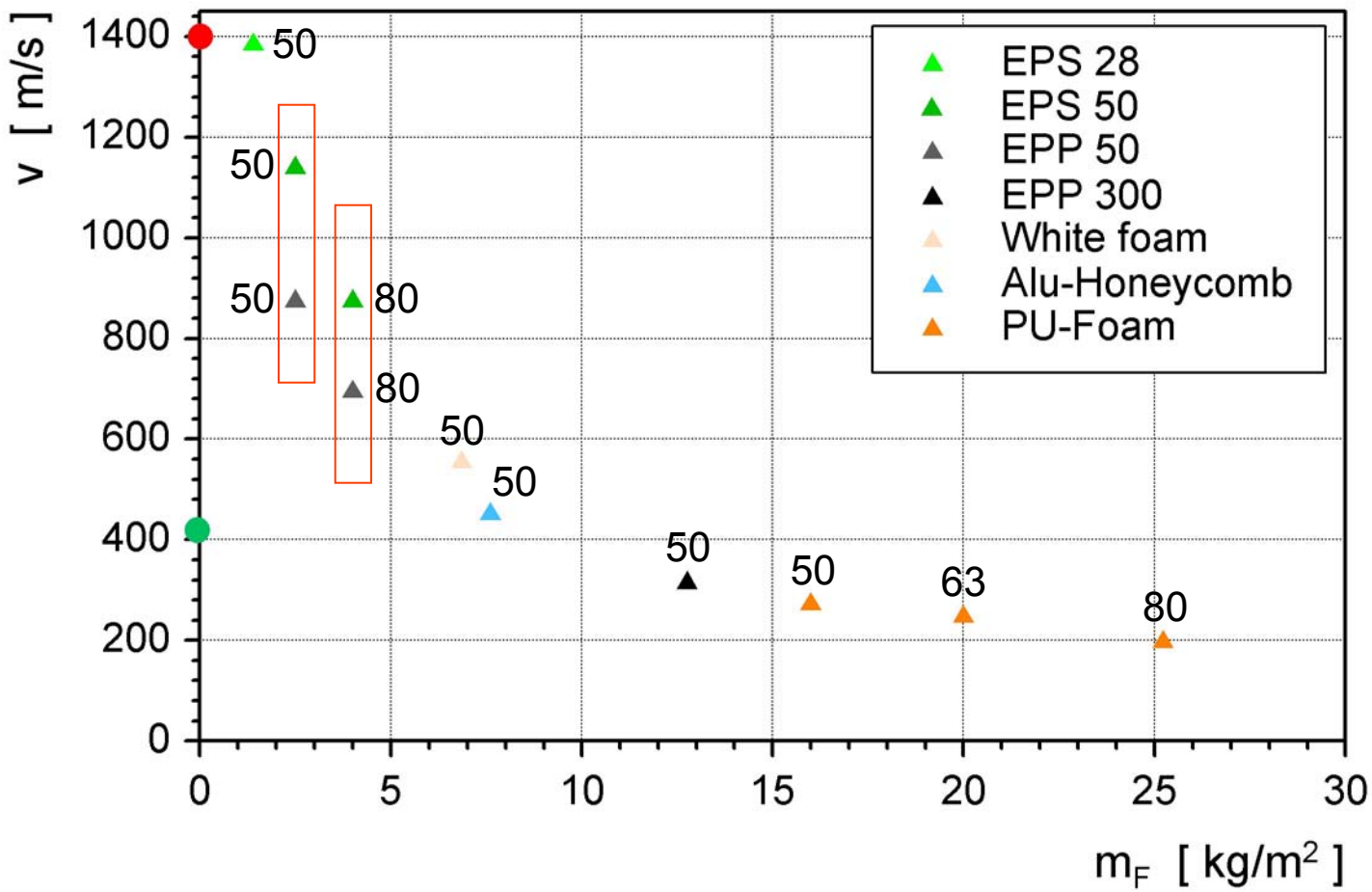
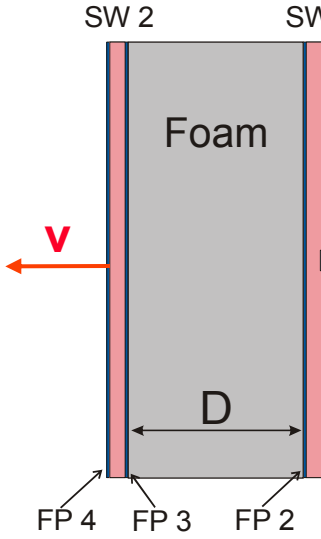
(FP 4) versus Areal Density m_F of Foam Fillings





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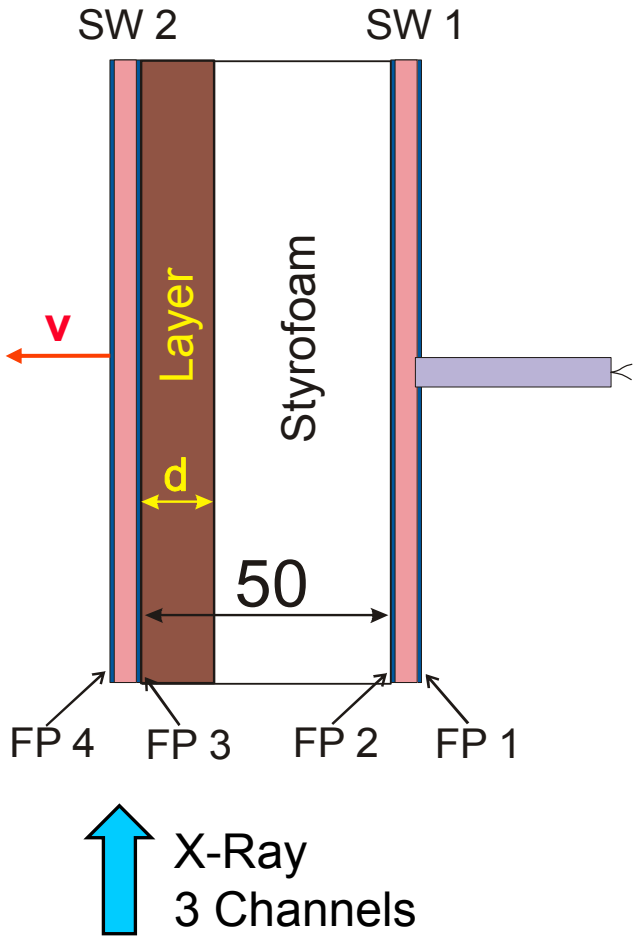
xperiments 2: Layers on Acceptor-Sandwich



Distance between SWs: **D = 50 mm**

Thickness of layer: **d = variable**

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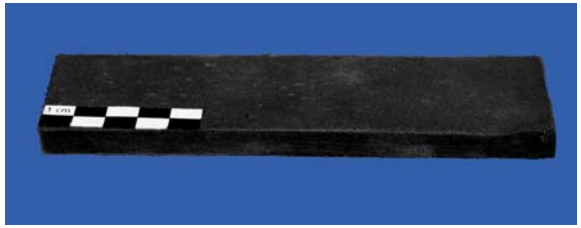
ested Layers

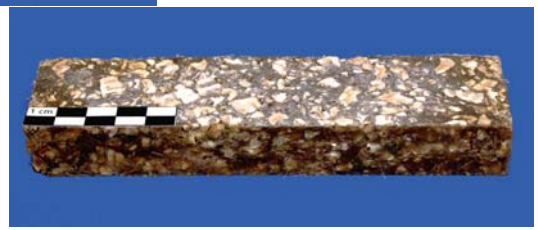
$\rho \geq 1100\ kg/m^3$

ıbber (Perbunan), ρ=1450 kg/m^3

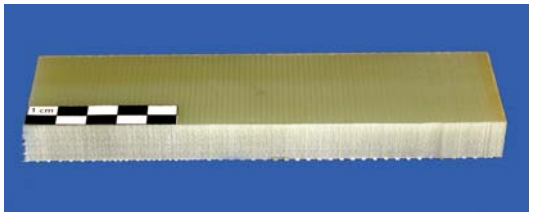


lyurethane **(PU),** ρ=1260 kg/m^3

ganic–plastic material **(OGK),** ρ=1100 kg/m^3



RP, ρ= 1950 kg/m^3



vlar, ρ= 1200 kg/m^3

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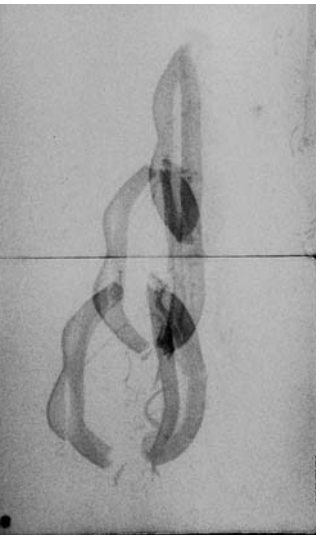
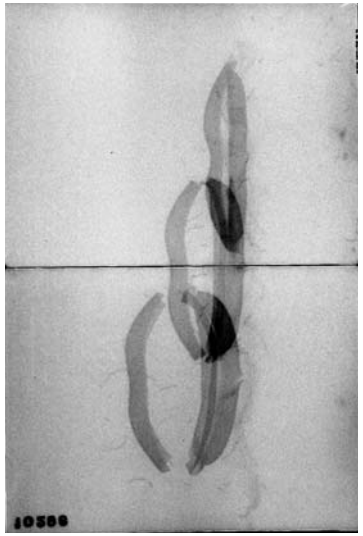
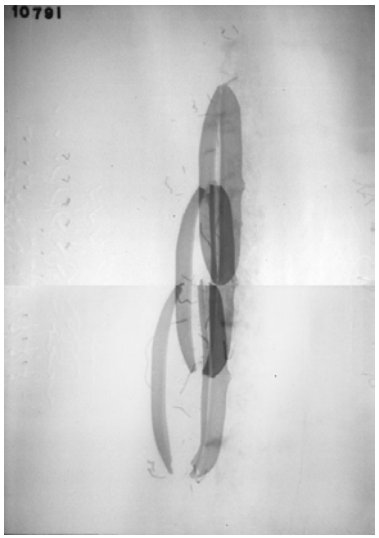
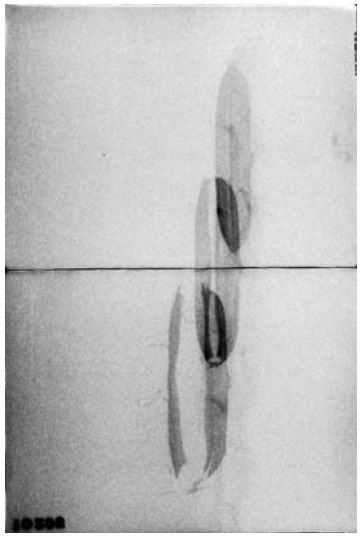
Flash X-Ray Photographs: Layers

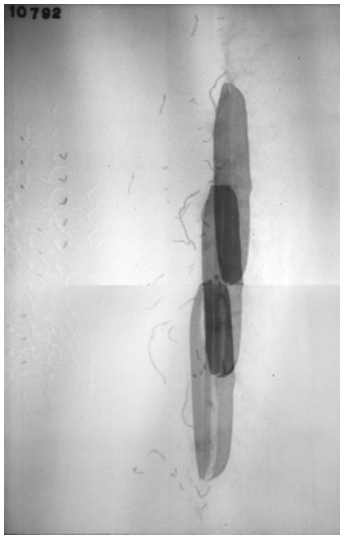
Rubber	PU	OGK	PU	OGK
d=5,6 mm	d=10 mm	d=14 mm	d=20 mm	d=22 mm











V_{FP4}: **800 m/s**	V_{FP4}: **585 m/s**	V_{FP4}: **490 m/s**	V_{FP4}: **350 m/s**	V_{FP4}: **265 m/s**
Flash times:	Flash times:	Flash times:	Flash times:	Flash times:
80, 140, 190 µs	80, 140, 200 µs	120, 160, 200 µs	80, 140, 200 µs	140, 180, 220 µs

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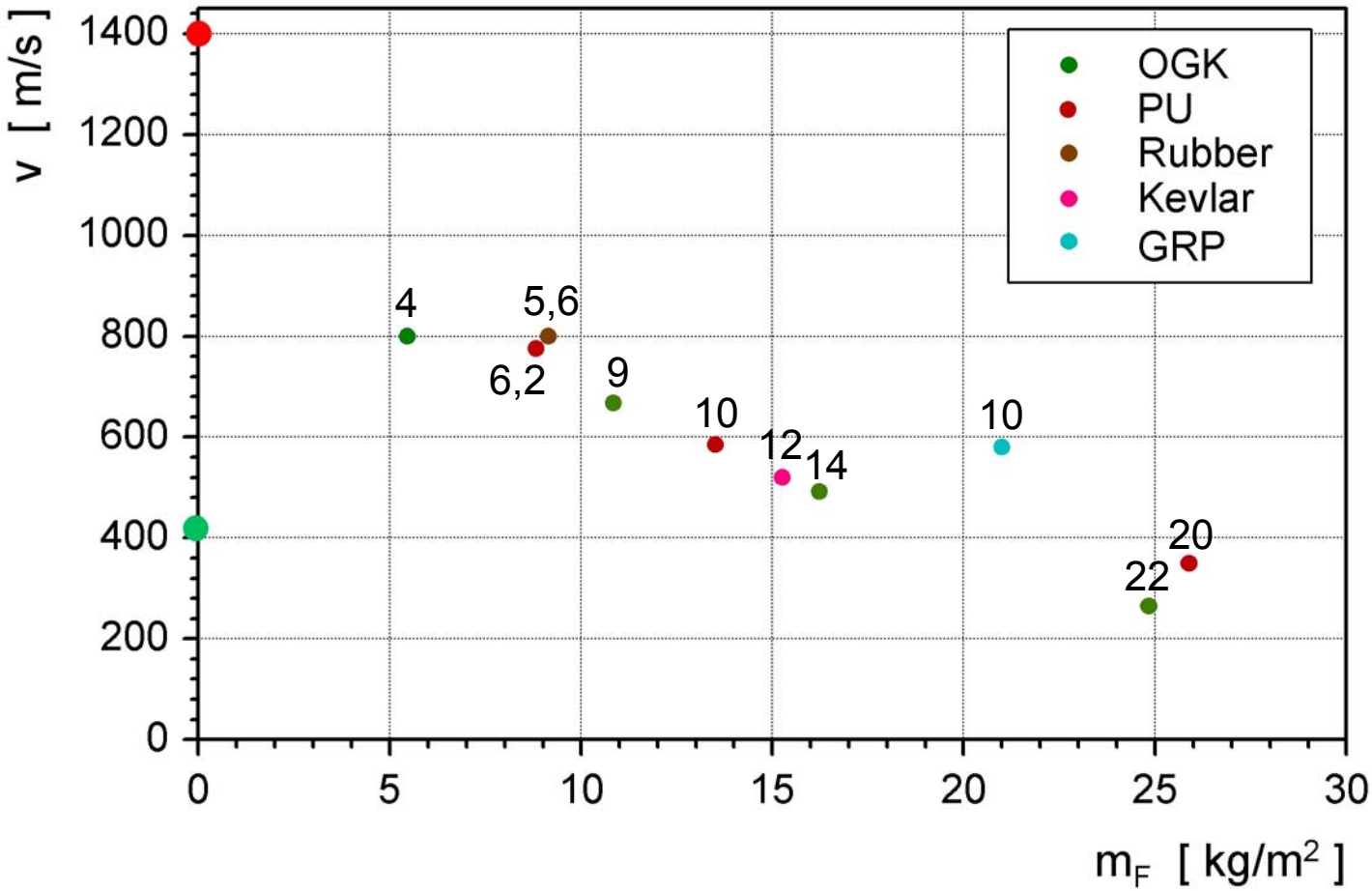
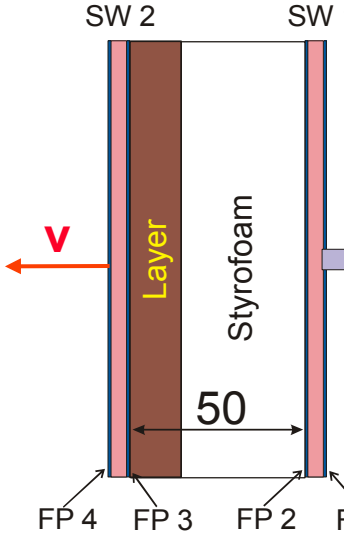
(FP 4) versus Areal Density m_F of Layers





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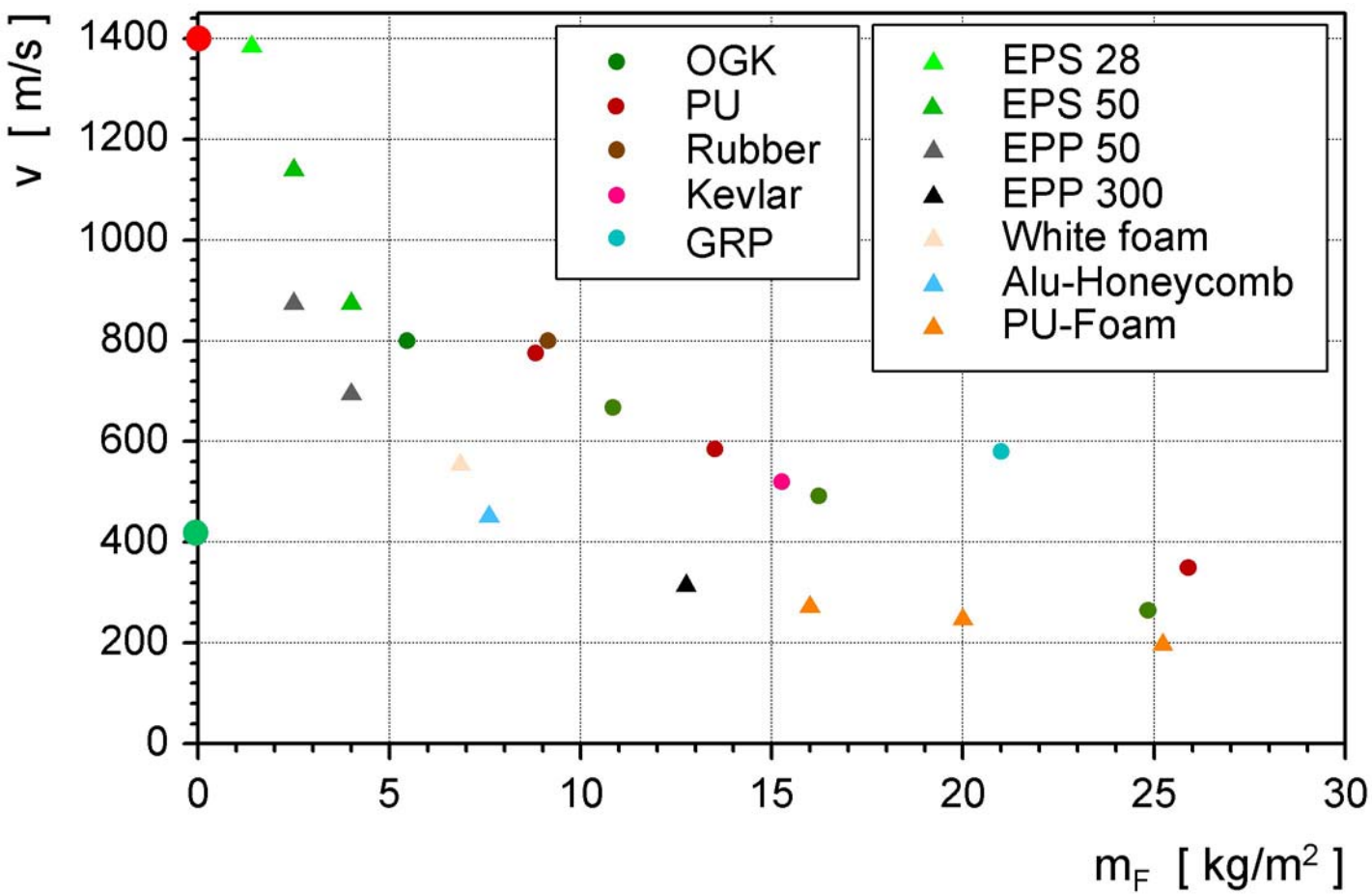
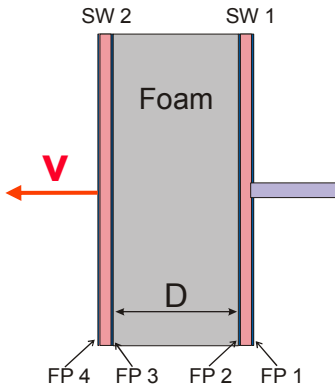
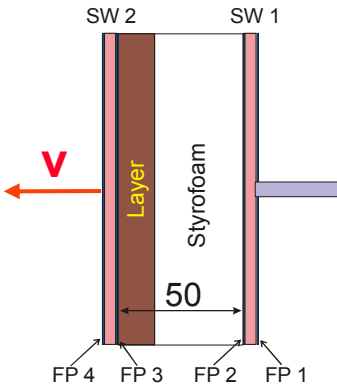
omparison: v (FP 4) versus Areal Density m_F of Layers and oams







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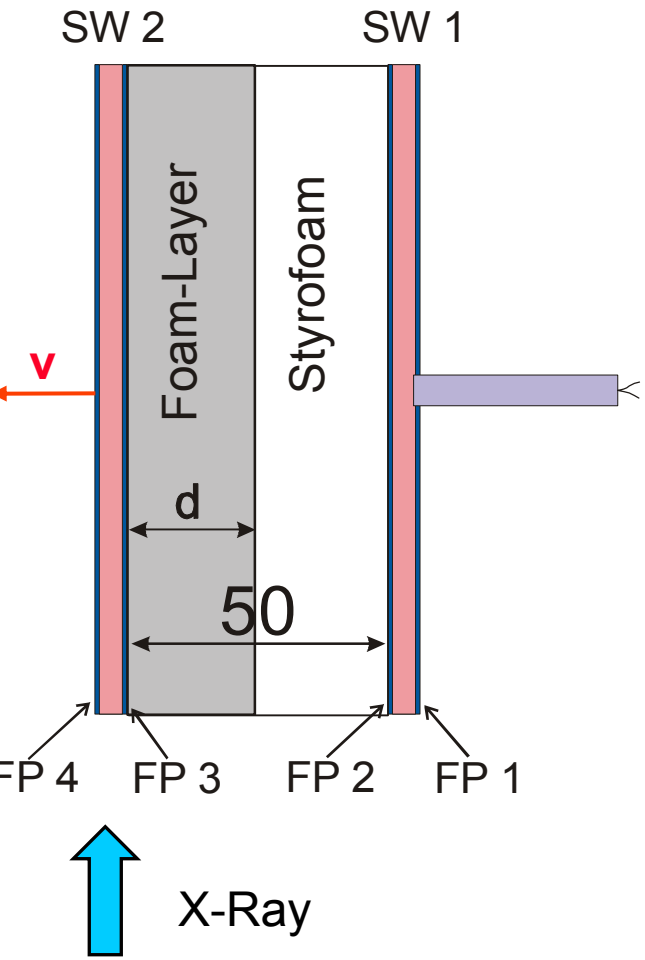
xperiments 3: Foams as Layers on the Acceptor Sandwiche

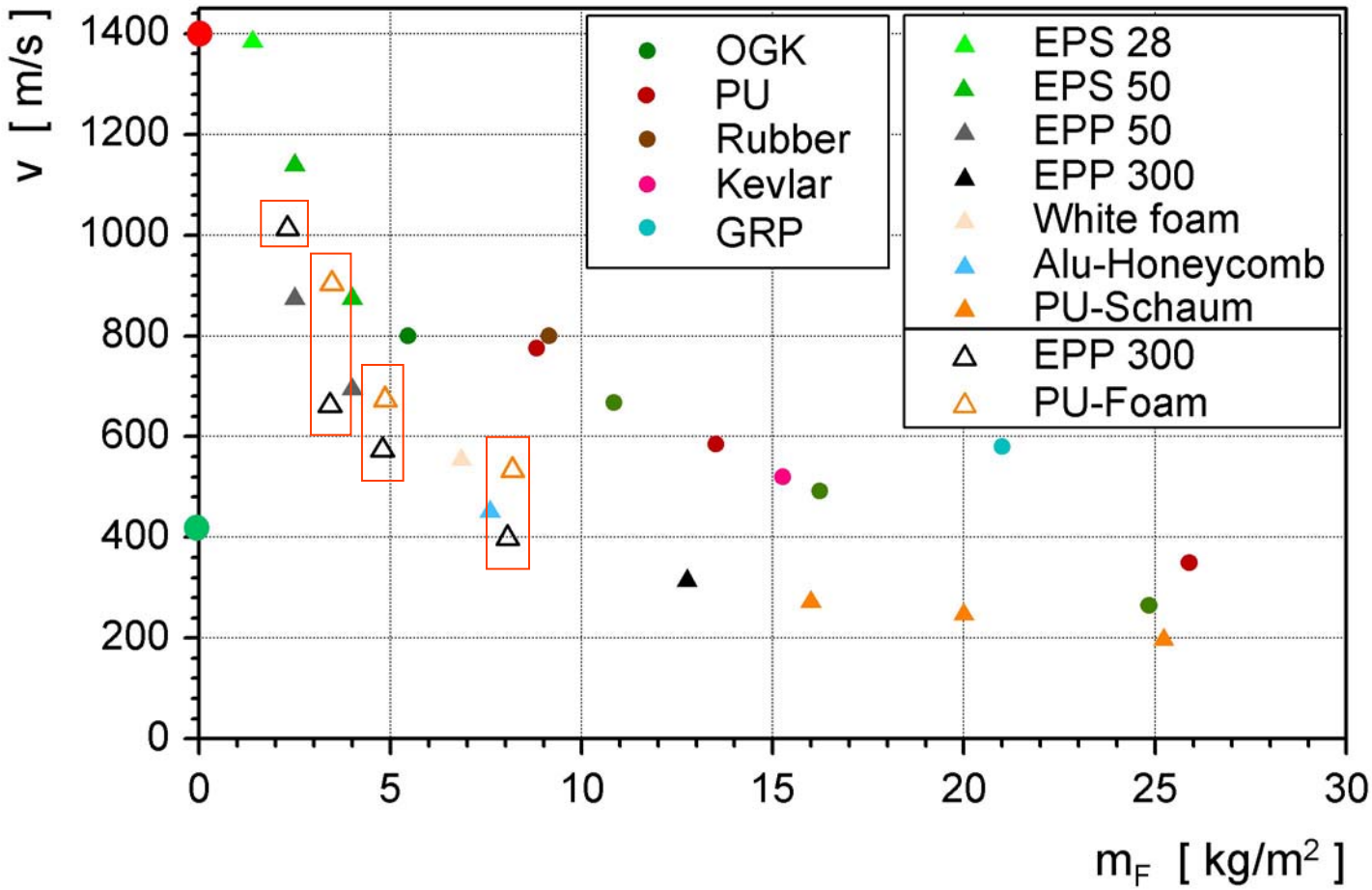


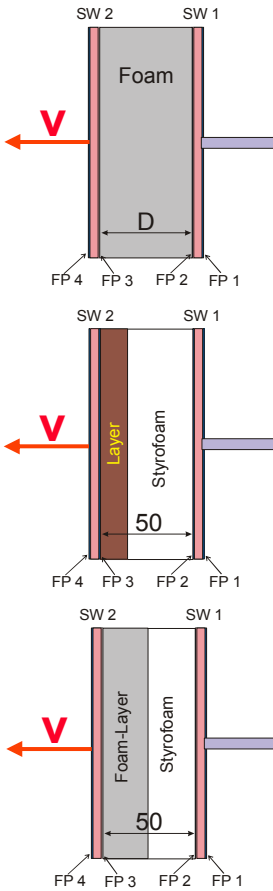
Tested foams: PU-foam, EPP 03

Distance between SWs: **D = 50 mm**

Thickness of layer: **d = 5 mm – 30 mm**

Overview: Foams, Layers, Foam-Layers





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ummary

The experiments didn't exhibit a clear distinction between detonation and no reaction.

Porous foams (ρ < 400 kg/m^2) are more effective than layers (ρ > 1100 kg/m^2) without porosity, regardless of the way they are placed between reactive sandwiches.

The areal densities necessary for a certain prevention of sympathetic detonation were :

- In case of foams: Areal density $\geq$ 8 – 10 kg/m^2
- In case of layers: Areal density $\geq$ 20 – 25 kg/m^2

For the prevention of sympathetic detonation not only the density of a material is important l also other material properties, e.g. porosity.

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End of Presentation

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uture Work

More accurate investigation of the material properties important for the avoidance of sympathetic detonation

Decrease of protection power of reactive armor caused by damping materials

nvestigations with larger reactive armor systems

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ontact Information

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