LINEAR AND NON-LINEAR STAGES OF THE RICHTMYER-MESHKOV INSTABILITY DEVELOPMENT IN A LARGE CROSS SECTION SHOCK-TUBE

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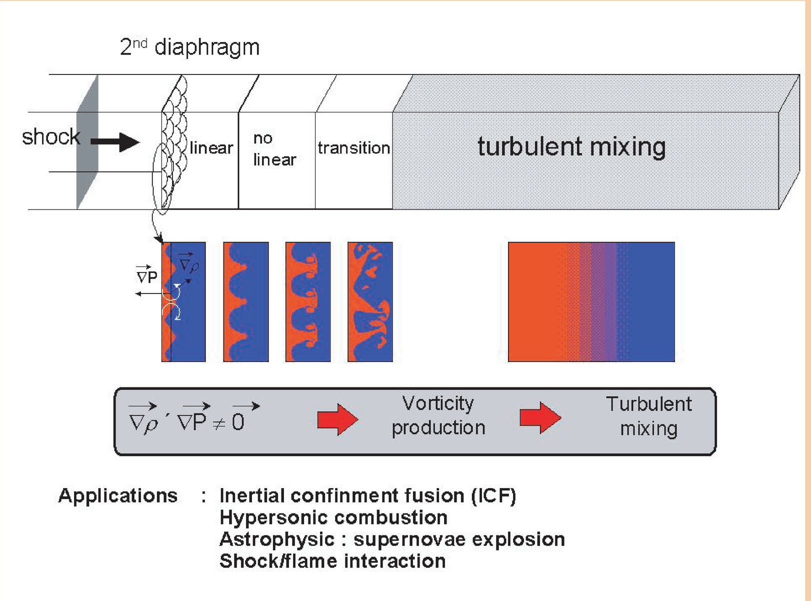
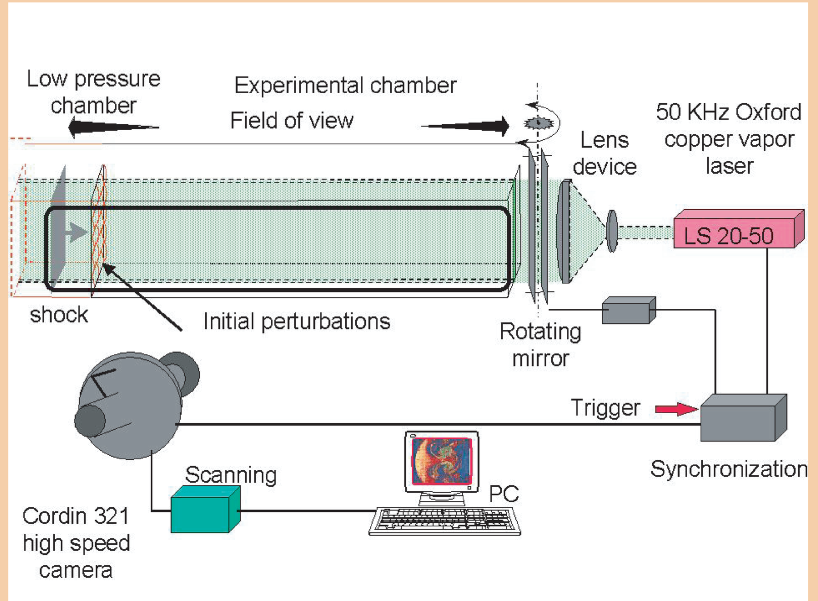
I- INTRODUCTION

Present research topic: Fundamental research

- Characterization of the transition phases to turbulence from the development of hydrodynamic instabilities within a shock accelerated interface

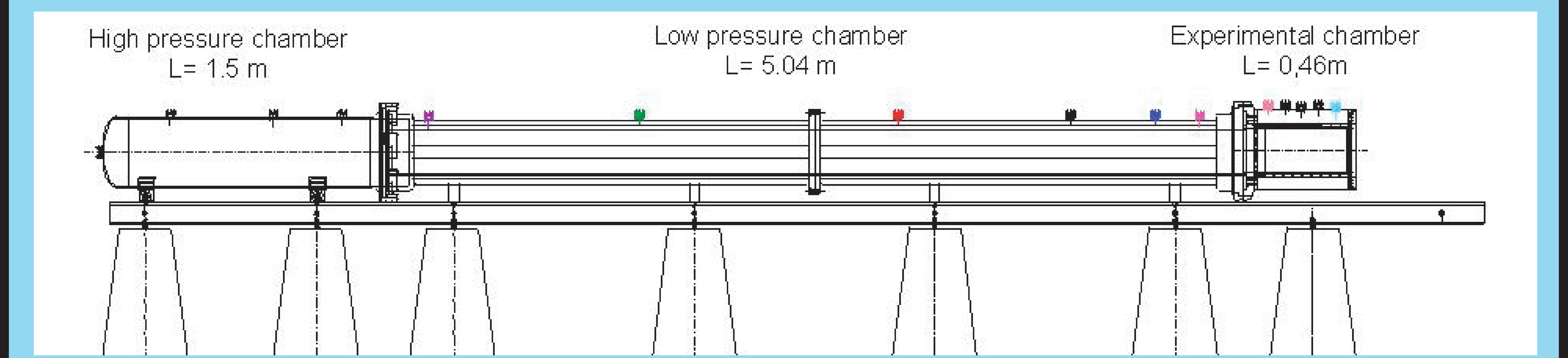


The Richtmyer Meshkov instability



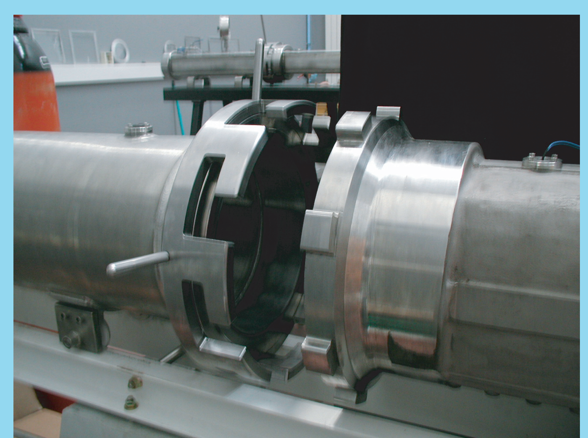
Principle of the measurements

II- THE NEW LARGE CROSS SECTION SHOCK TUBE OF IUSTI



Characteristics and usual performances

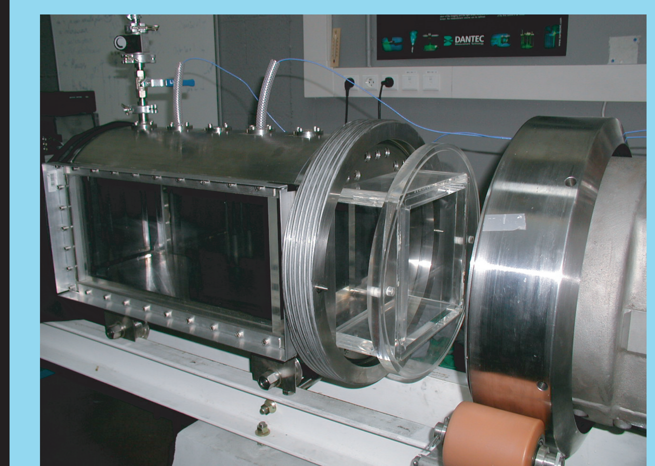
- Square cross section: 20x20 cm2
- Length: 7.04 meters
- Mach number: from 1.1 to 3
- Initial pressure: from 0.5 atm to 1 atm



View of the high pressure-low pressure chamber connection

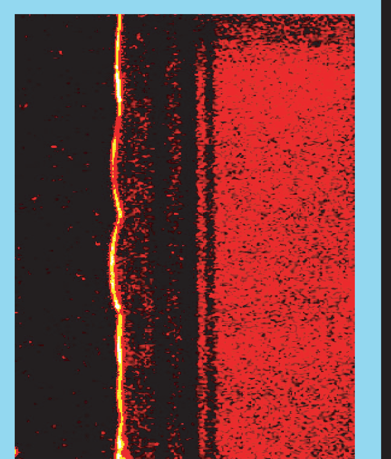
First diaphragm before and after run (Aluminium, thickness=1 mm, ϕ=360 mm)

Control of the initial conditions



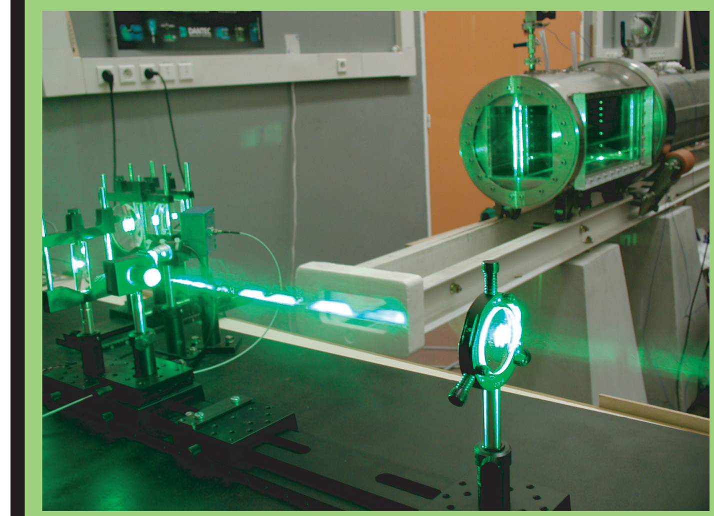
View of the experimental chamber

Initial interface materialized by a 0.8 μm thick nitrocellulose membrane resting over metallic horizontal lines



Initial 2D perturbations

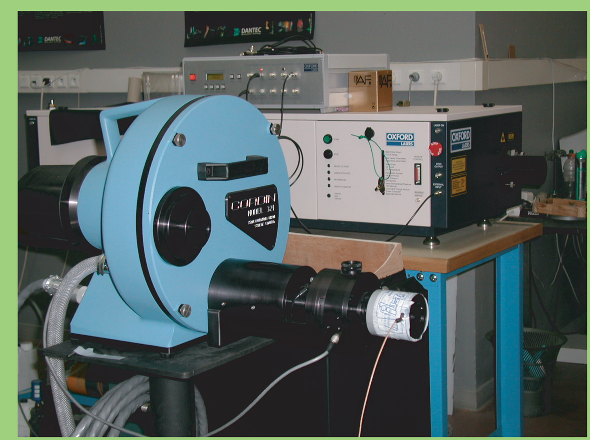
III- DIAGNOSTIC SYSTEM - Laser sheet high speed visualization



Laser sheet optical system

View of the general experimental device

- Source: from 2 to 50 kHz pulsed copper vapour Oxford laser
- Camera: 321 Cordin streak camera
- External shutter: Electro-optical shutter
  - *Response time: ~ 1 μs*
- Acquisition device: 720 Tektronix scope
  - *4 channels*
- Trigger: signal from PCB pressure gauge



321 Cordin camera coupled with the LS 20-50 copper vapour Oxford laser

IV- INITIAL CONDITIONS

P_{Exp} ~ 1 atm P_{LP} ~ 1 atm P_{HP} ~ 3 bars

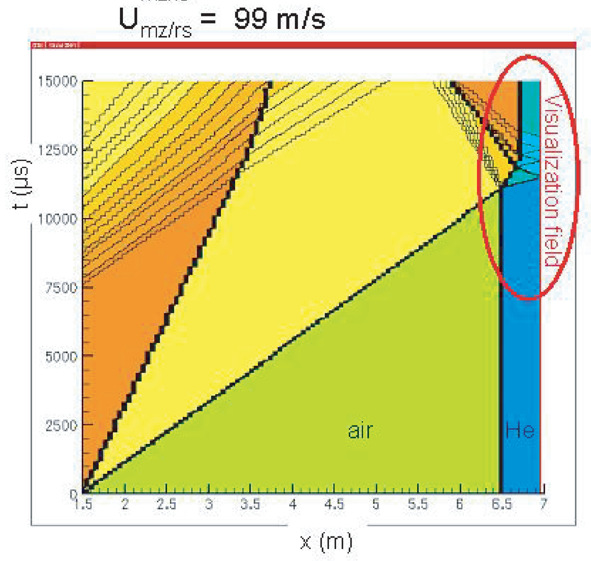
Gas test He or Kr	Driven= air + smoke	Driver= air

M_{is} ~ 1.32 in air W_{is} ~ 460 m/s

Heavy/light case (air/He)

$$A_{air\backslash He} = \frac{\rho_{He} - \rho_{air}}{\rho_{He} + \rho_{air}} = -0.7$$

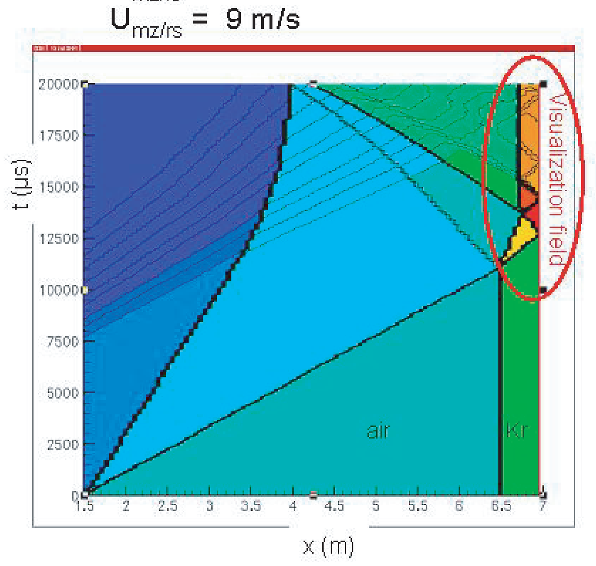
W_{ts}=1111 m/s
$U_{mz/is}$ = 226 m/s
$U_{mz/rs}$ = 99 m/s

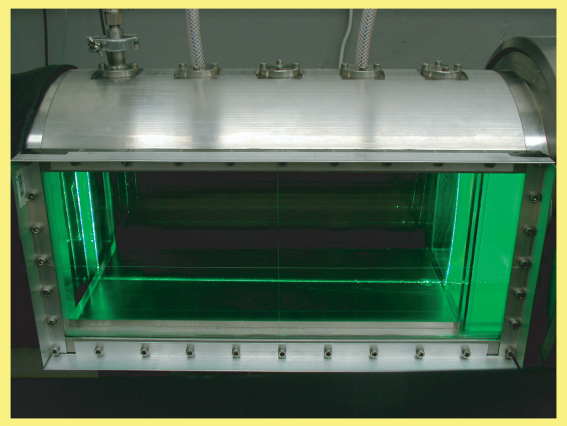


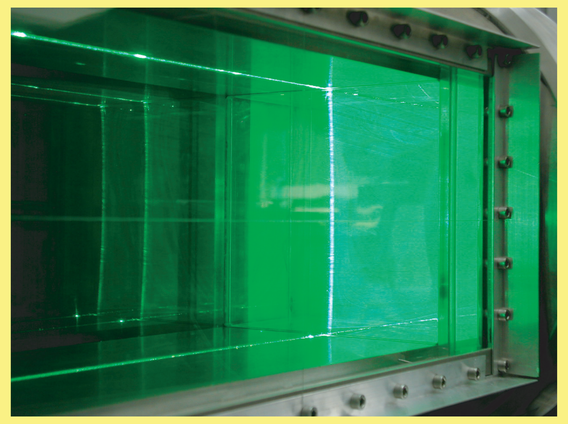
Light/heavy case (air/Kr)

$$A_{air\backslash Kr} = \frac{\rho_{Kr} - \rho_{air}}{\rho_{Kr} + \rho_{air}} = +0.5$$

W_{ts}=322 m/s
$U_{mz/is}$ = 115 m/s
$U_{mz/rs}$ = 9 m/s

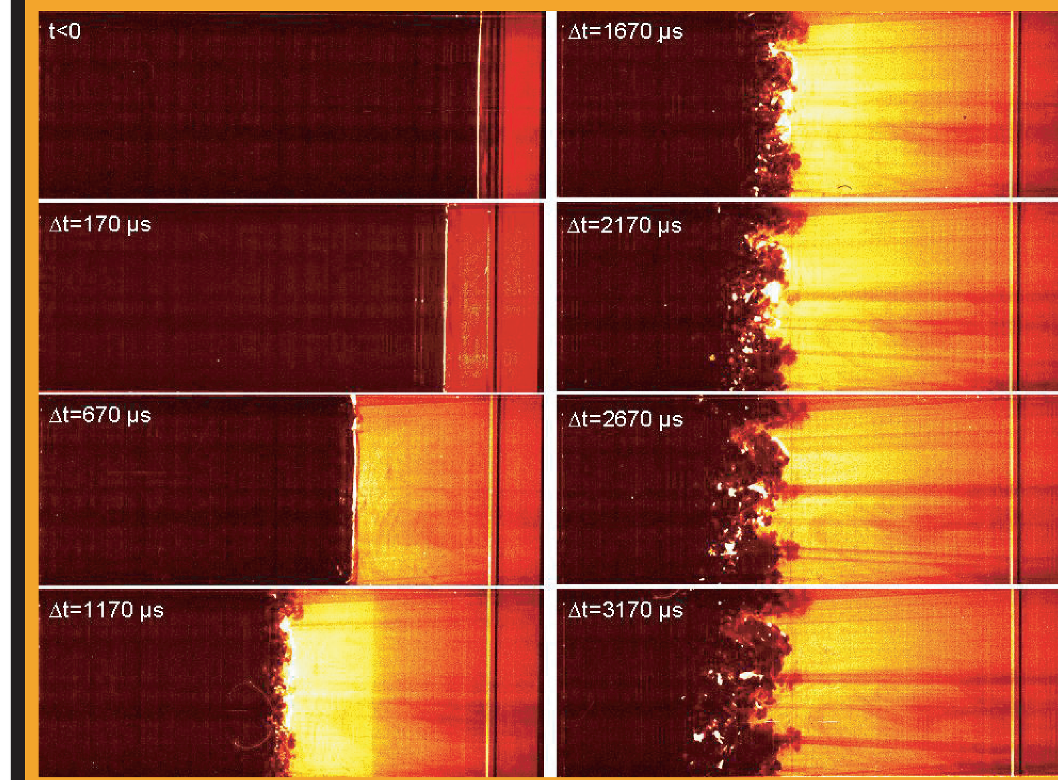


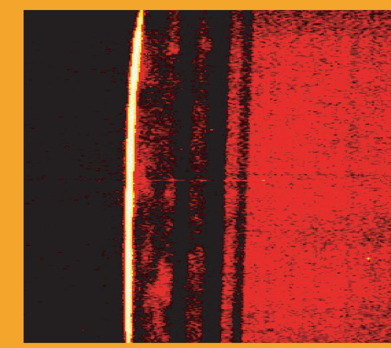




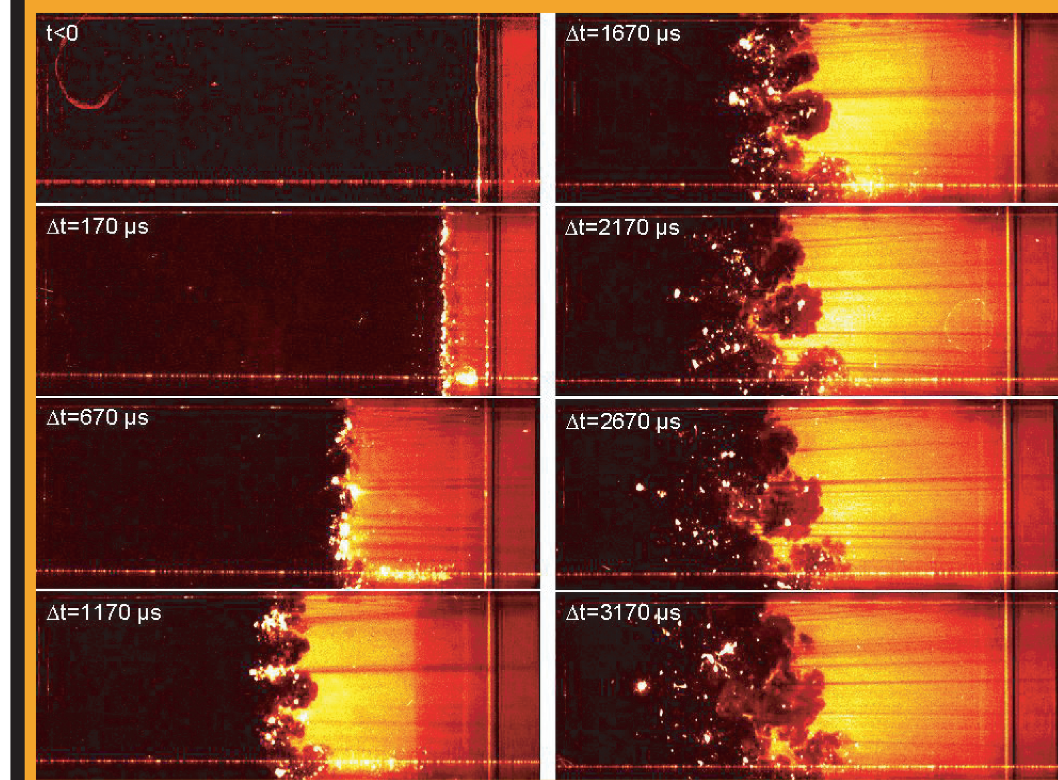
Pictures taken just before the run. Air at right is seeded by smoke cigarette and mosquito incense. Pure helium or krypton are used in the left part in order to study both the heavy/light and light/heavy configurations for the same initial shock wave. The initial interface is materialized by two layers of a thin membrane of nitrocellulose (0.4 μm thick) resting over fine metallic horizontal lines which create 2D perturbations of different wavelengths (2 cm and 4 cm).

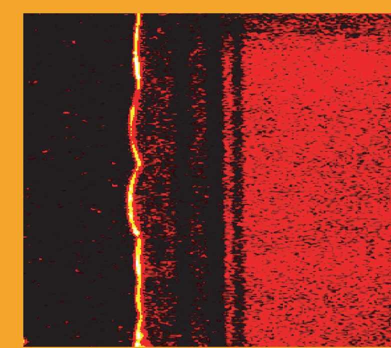
V- FIRST RESULTS





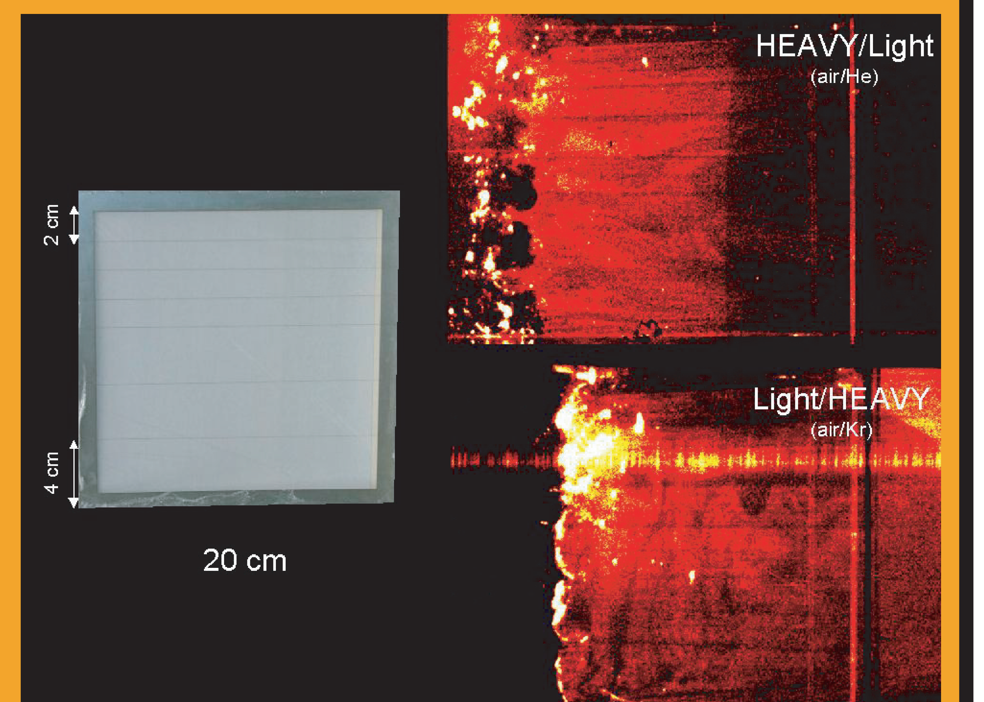
Sequences of a heavy/light (air/He) experiment with an initially non perturbated interface. (burst frequency: 2 kHz camera, velocity: 40 m/s) Air at right is initially seeded and helium is pure. The thin membrane of nitrocellulose is not completely destroyed by the incident shock wave but by the reflected one.





Sequences of a heavy/light (air/He) experiment with an initially perturbated interface. (burst frequency: 2 kHz camera, velocity: 40 m/s) Air at right is initially seeded and helium is pure.

Both heavy/light (air/He) and light/heavy (air/Kr) experiments with an initially perturbated interface. The incident shock wave Mach number in seeded air is 1.3 and the initial pressure of the test gases is 1 atm.



VI- CONCLUSIONS AND PERSPECTIVES

- *First results in a new shock tube coupled with a high frequency laser sheet technique have been obtained for the study of the transition phases to turbulence initiated by the RIchtmyer-Meshkov instability.*
- *The 20 cm large square cross shock tube prevents from wall boundary layer effects and the special device realized for the control of the initial conditions is succesfully available.*
- *The growing up of the initial perturbations at the interface and the RIchtmyer-Meshkov mixing process are cleary visible.*
- *Runs with a higher observation frequency have to be realized (up to 50 kHz).*
- *The quality of the picture and in particular the homogeneity of the seeding have to be improved.*