Mercury targets

A. Fabich

ENG Target and Collector Section

26. March 2003

TOC

- target configurations
- Tests on liquid targets with free surface
- Laser induced cavitation

- Radiation aspects of high power targets

Matteo Magistris

Primary Target Configuration

Contained

SNS, ESS, MegaPie, …

Hot issues:

- cavitation
- corrosion
- beam window

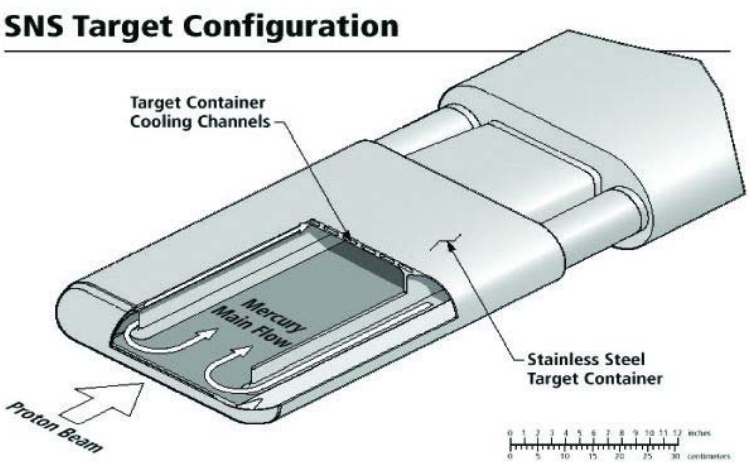
R&D at Oakridge (US), Juelich (D), Villigen (CH), …

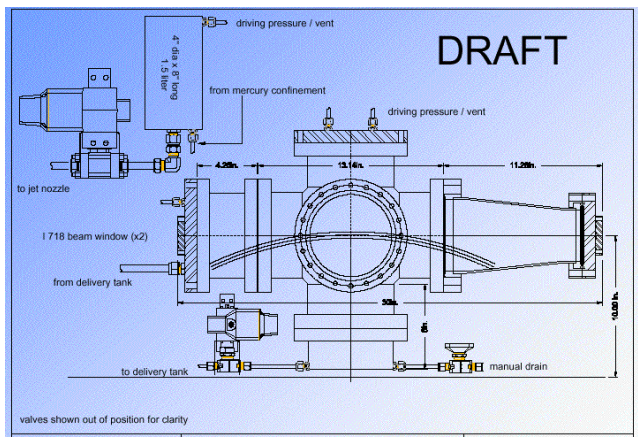
Free Surface

ν-factory, …

Hot issues:

- violent explosion
- mechanical challenge
- Less experience





Liquid Targets with free surface

• jet	To avoid beam window
• Mercury	increased meson yield for high-Z materials
• v~20 m/s	Replace target at 50 Hz
• D= 1-2 cm	Optimized for re-absorption of mesons

??? What is the impact on the jet by

- 4 MW proton beam
- 20 T solenoid field

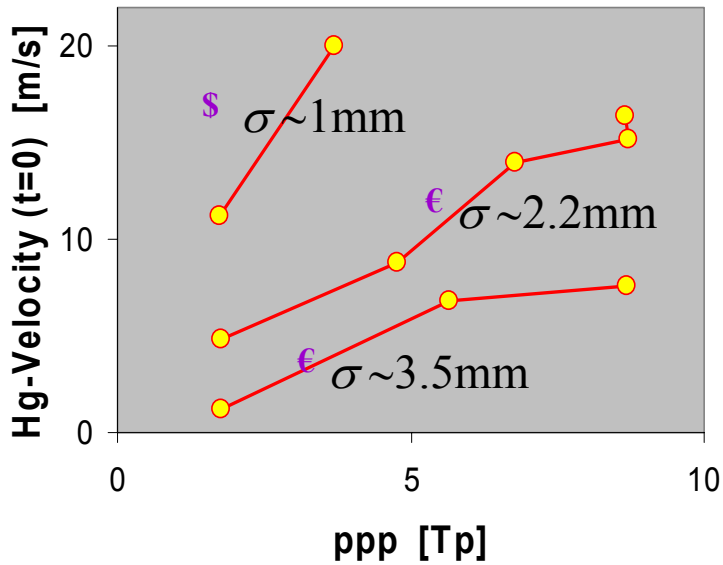
Liquid Metal Target Studies

(ν-Factory, μ-Collider,

EURISOL or n-spallation source)

Proton induced shock wave

ISOLDE€ and BNL$

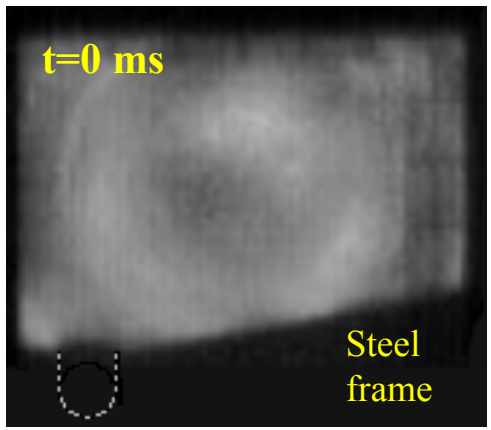


PS-Booster:

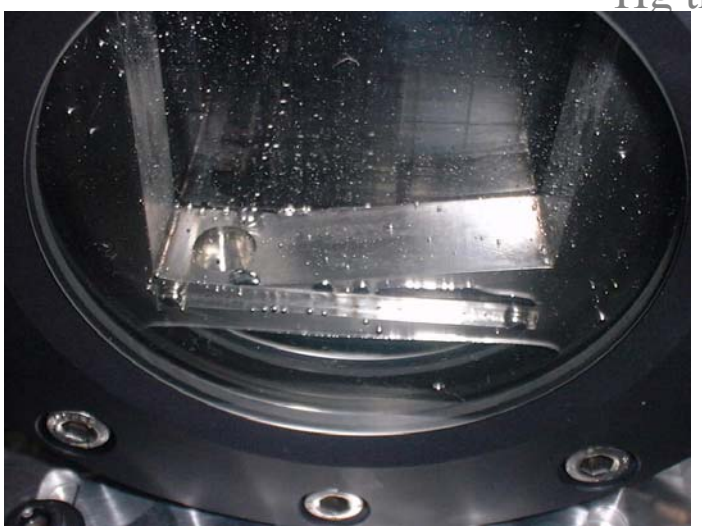
1.4 GeV protons

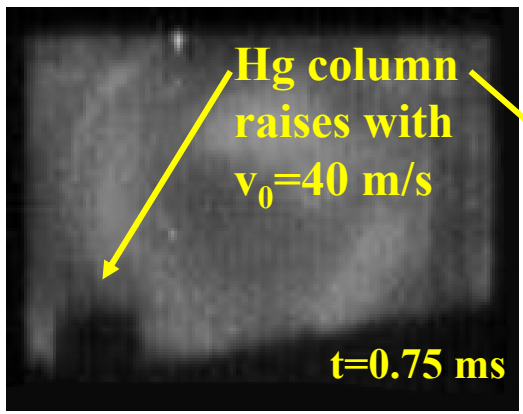
3×10^{13} ***ppp***

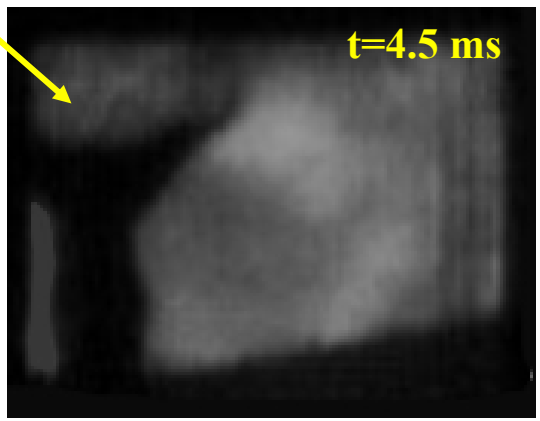
$\tau = 2.2\mu s$



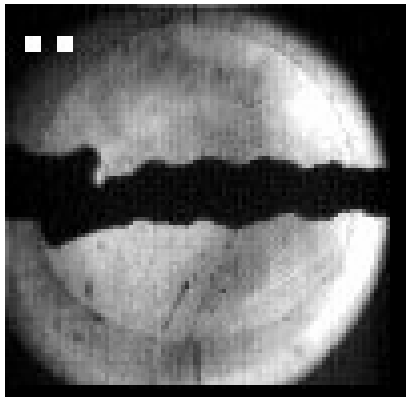
Hg thimble (ϕ 12mm)



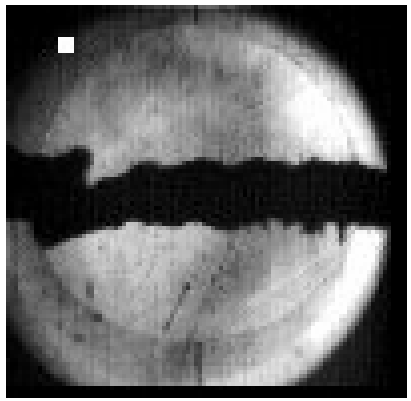


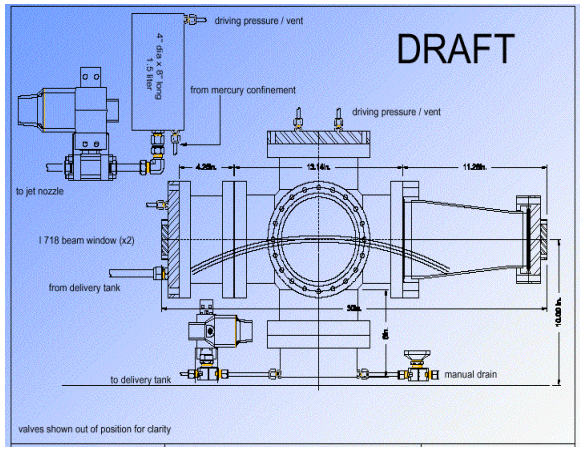


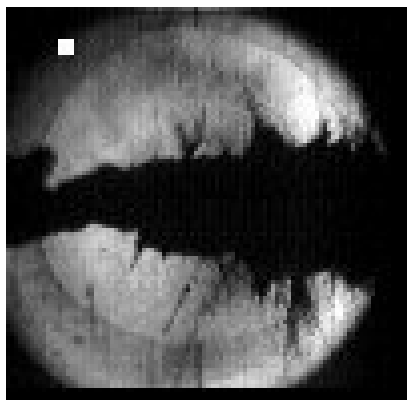
Jet test at BNL E-951



Event #11 25th April 2001







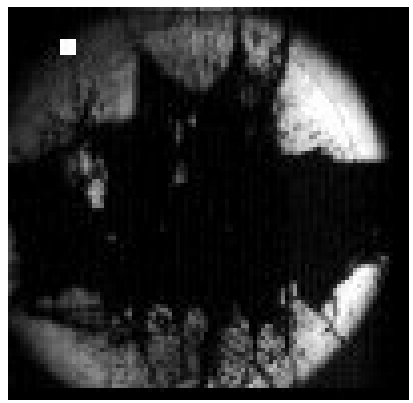
Picture timing [ms]

0.00

0.75

4.50

13.00



P-bunch: 2.7×10^{12} ppb

100 ns

$t_o = \sim 0.45$ ms

Hg- jet : diameter 1.2 cm

jet-velocity 2.5 m/s

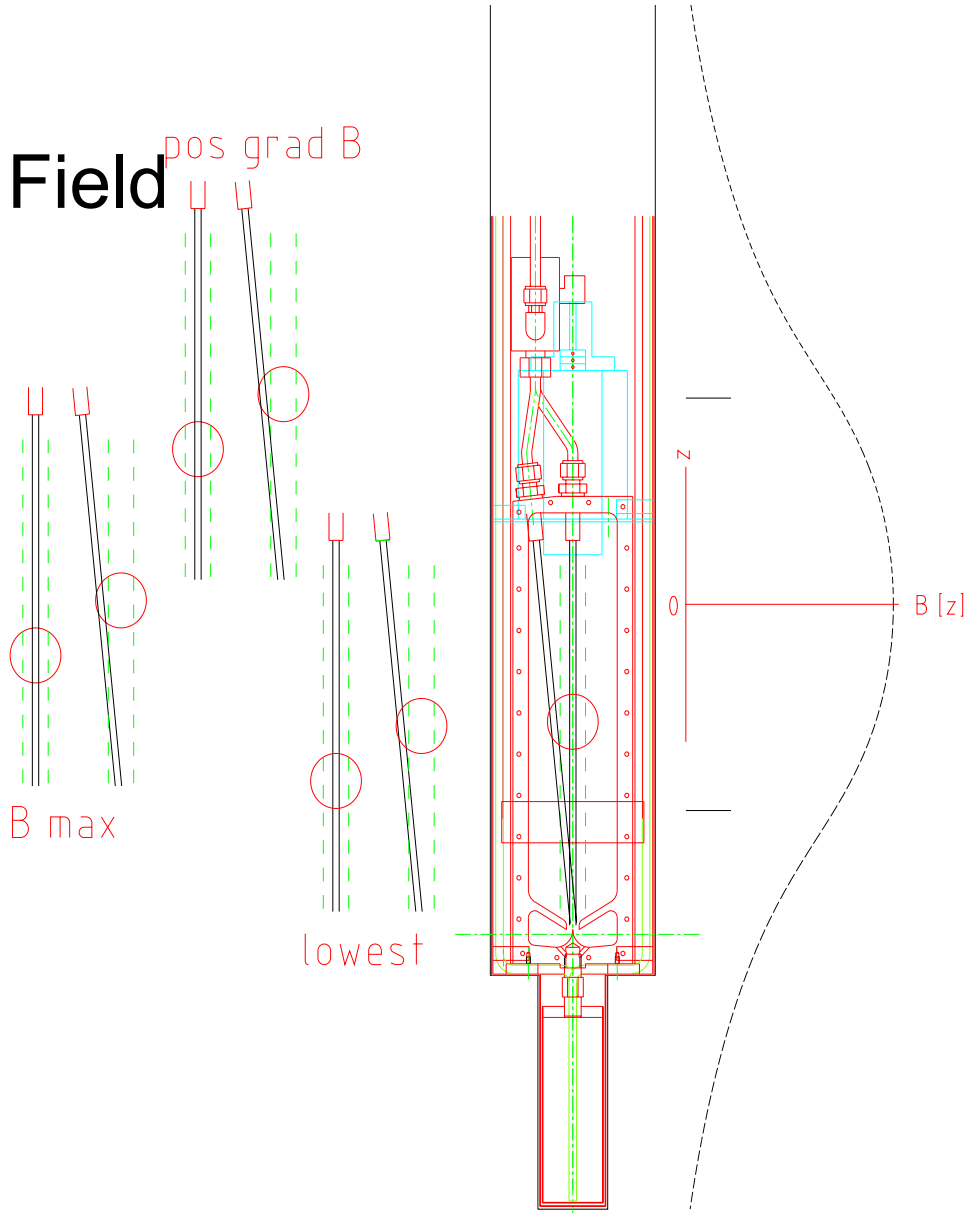
perp. velocity ~ 5 m/s

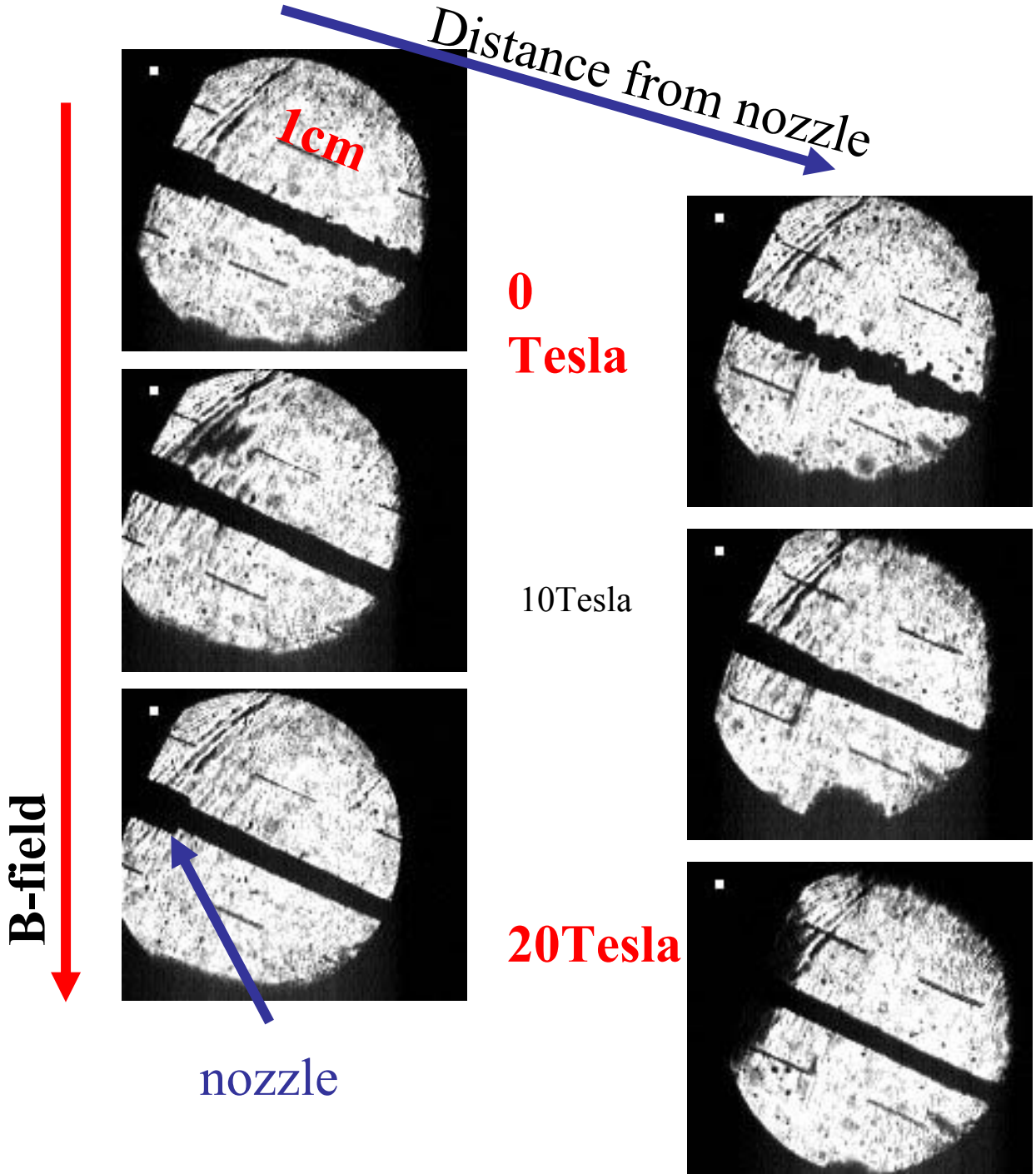
K. Mc Donald, H. Kirk, J.Lettry, A. Fabich

MHD

Grenoble High Magnetic Field laboratory
(setup)

- mercury jet
- d_{nozzle}=4 mm
- colinear/inclined injection
- $v_{jet} \leq 12$ m/s
- B-field up to 20 Tesla





MHD

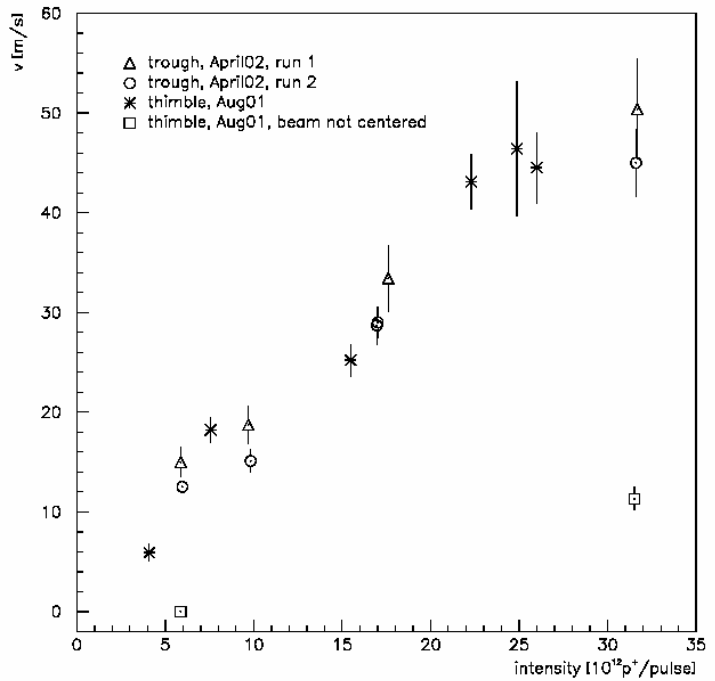
Jet traverses B_{max}

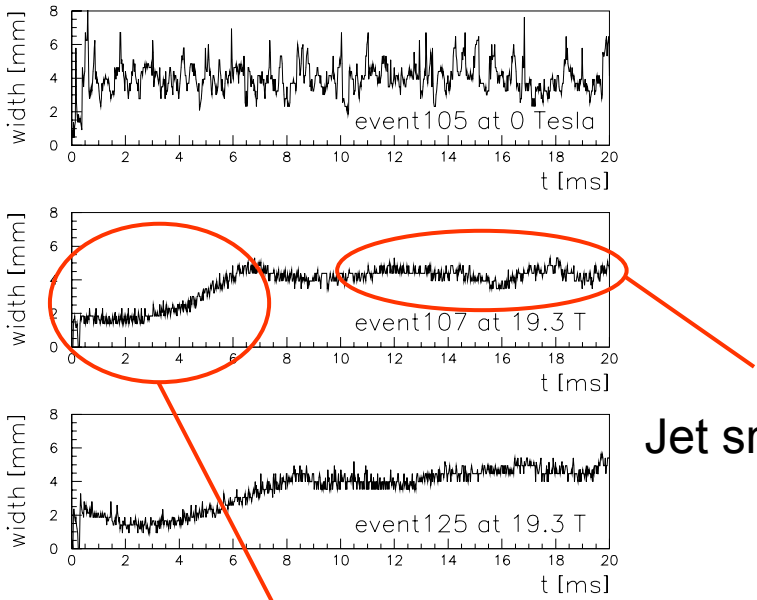
This **qualitative behaviour** can be observed **in all events**.

Experimental results

MHD

Proton induced shocks





Jet smoothing

Tip shaping

Detailed information can be found in

A.Fabich

High Power Proton Beam Shocks and Magnetohydrodynamics in a Mercury Jet Target for a Neutrino Factory

CERN-THESIS-2002-038

Ongoing/needed R&D

- On-going:
  - Estimation of the isotopic inventory and thermal shocks on solids
    R. Wilfinger
  - Corrosion under radiation (Megapie, PSI; FZ Rossendorf)
  - Mitigation of molten metals with micro bubbles to suppress cavitations
  - US MuMu
  - Other target concepts
- Needed:
  - Establish a nominal mercury jet
  - Evaluation of new observation methods for mercury jet experiments
    RADAR?
  - Radiactive mercury Waste disposal, solidification of mercury into amalgams, production of carrier free rare earth isotopes

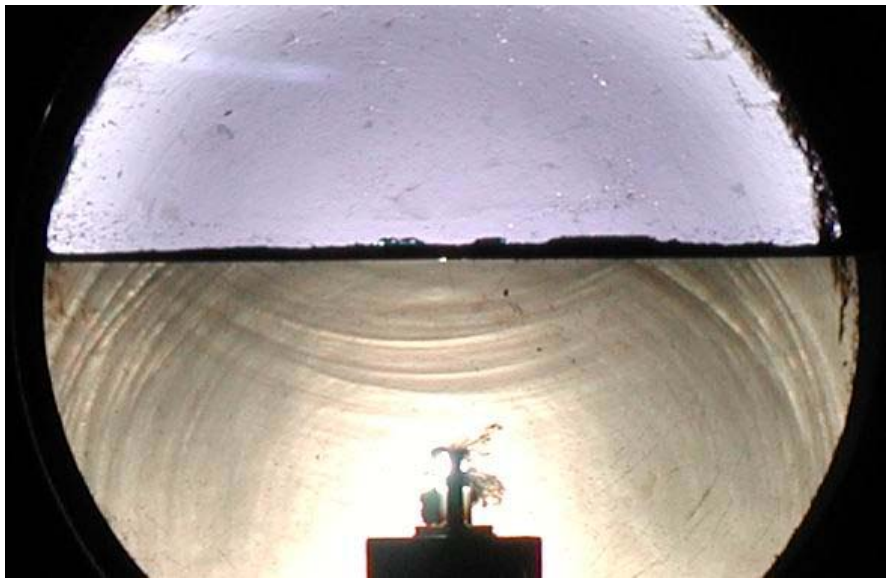
Study of cavitation bubble and shock wave interaction with free surface

Etienne ROBERT

Mohamed FARHAT

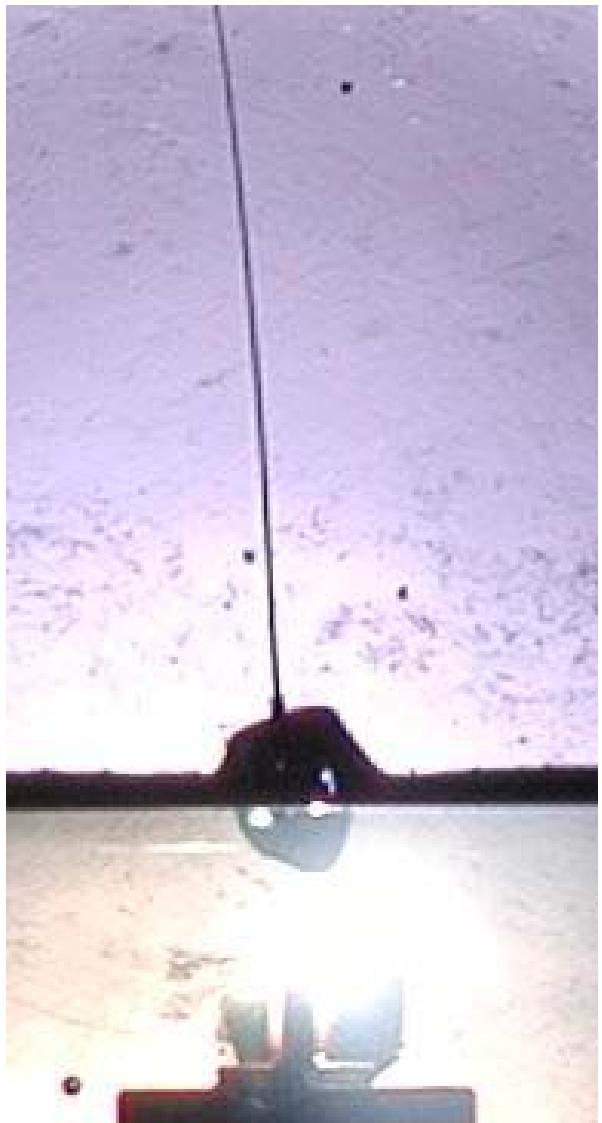
École Polytechnique Fédérale de Lausanne

Shock wave interaction with free surface



- Energy (12.5 J) deposited by a internal combustion engine spark plug.
- Shock wave is reflected on the free surface.
- Minor effect on the interface integrity.

Bubble collapse near free surface



- Vicinity of interface causes formation of a microjet.
- The microjet goes trough the interface with great velocity.
- Surrounding liquid is pulled by the microjet, forming a liquid dome.