UCIMU-SISTEMI PER PRODURRE

Lamiera
Bologna, 12-15/5/2010

mecc

MUSP
Macchine Utensili e Sistemi di Produzione

RETE ALTA TECNOLOGIA
EMILIA-ROMAGNA
HIGH TECHNOLOGY NETWORK

POLITECNICO DI MILANO





Margini di miglioramento tecnologico: innovazioni dalla ricerca

13 Maggio 2010

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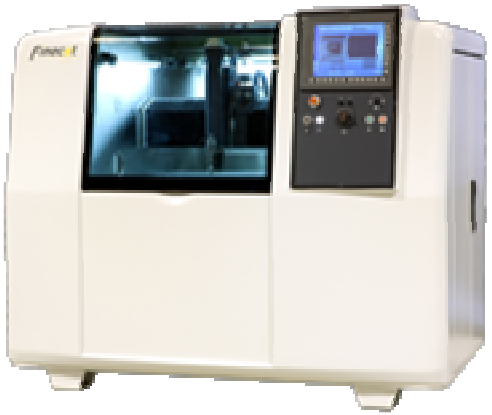
New trends: high precision WJ cutting

AWJs: diameter > 300 micron

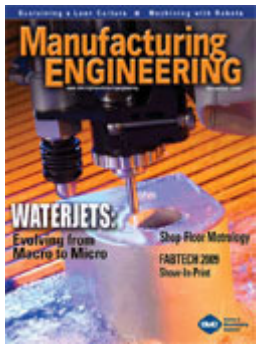
FAWs: 50 < diameter < 300 micron

MAWs: diameter < 50 microns

Miller, D. S. (2006)



Miniature components cut on “Finecut” waterjet fine abrasive (FAW) machining centre (www.waterjetsweden.com)



“Waterjets: evolving from Macro to Micro, cutting smaller, faster and deeper”, Manufacfturing Engineering, SME, November 2009 Vol. 143 No. 5

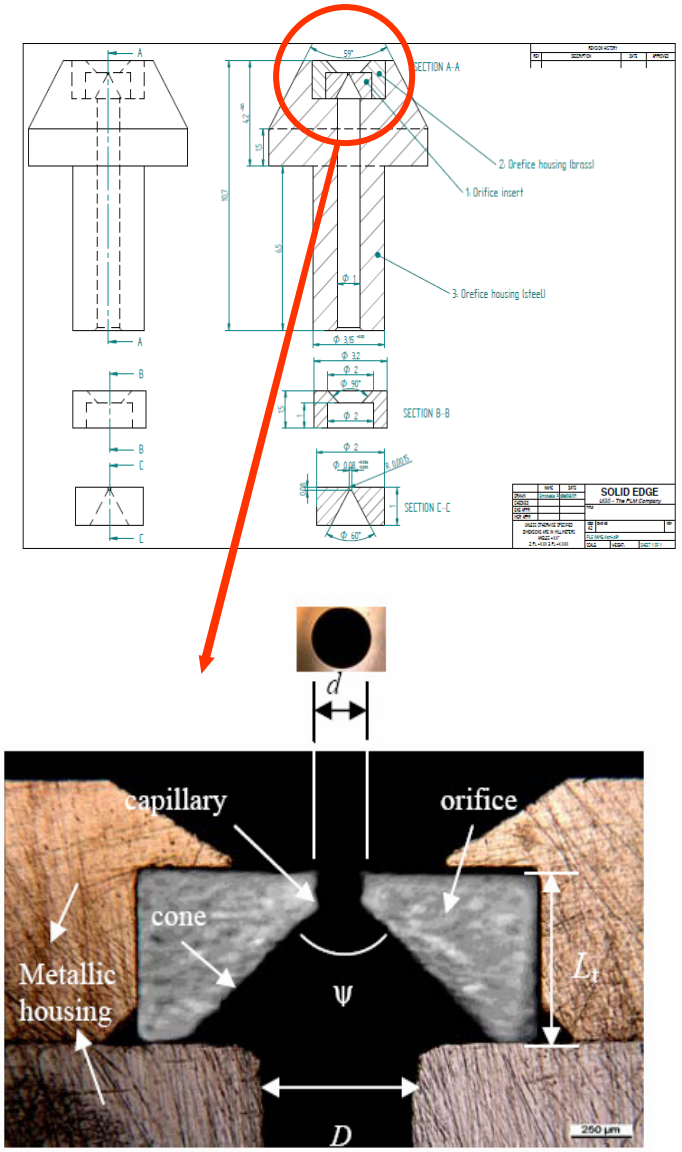
High precision WJ cutting (tollerance = 0.01 mm on the workpiece)

Improvement of the current components:

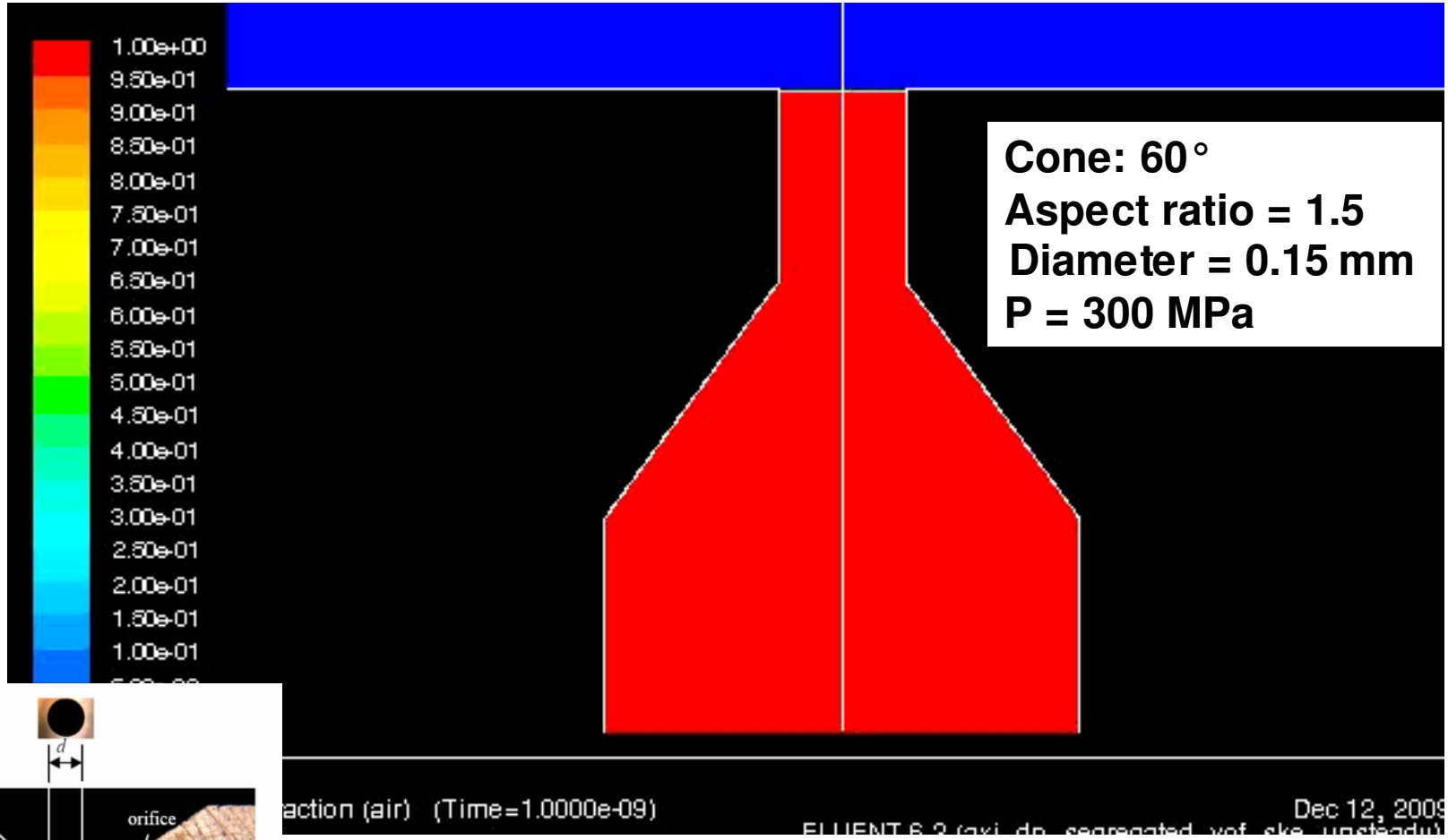
- Orifice
- Mixing chamber
- Focuser

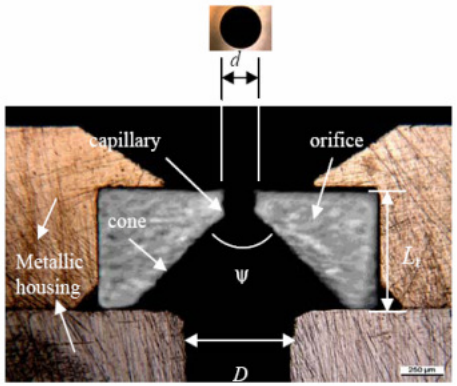
By means of:

- CFD simulations
- Experimentations
  - Fluid-dynamic validation of simulations
  - Cutting performance



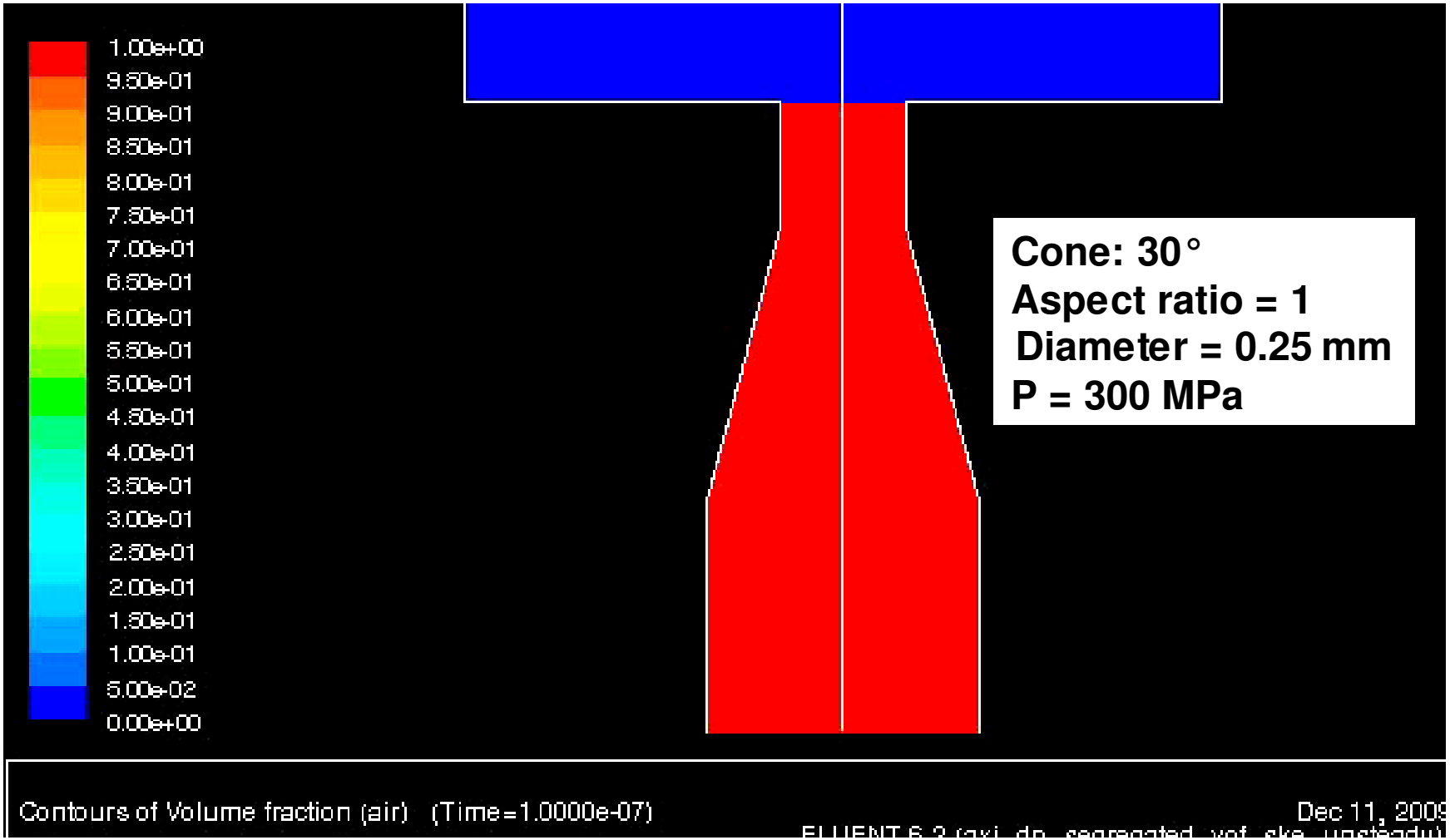
CFD simulations
Constricted water jets (transient state)





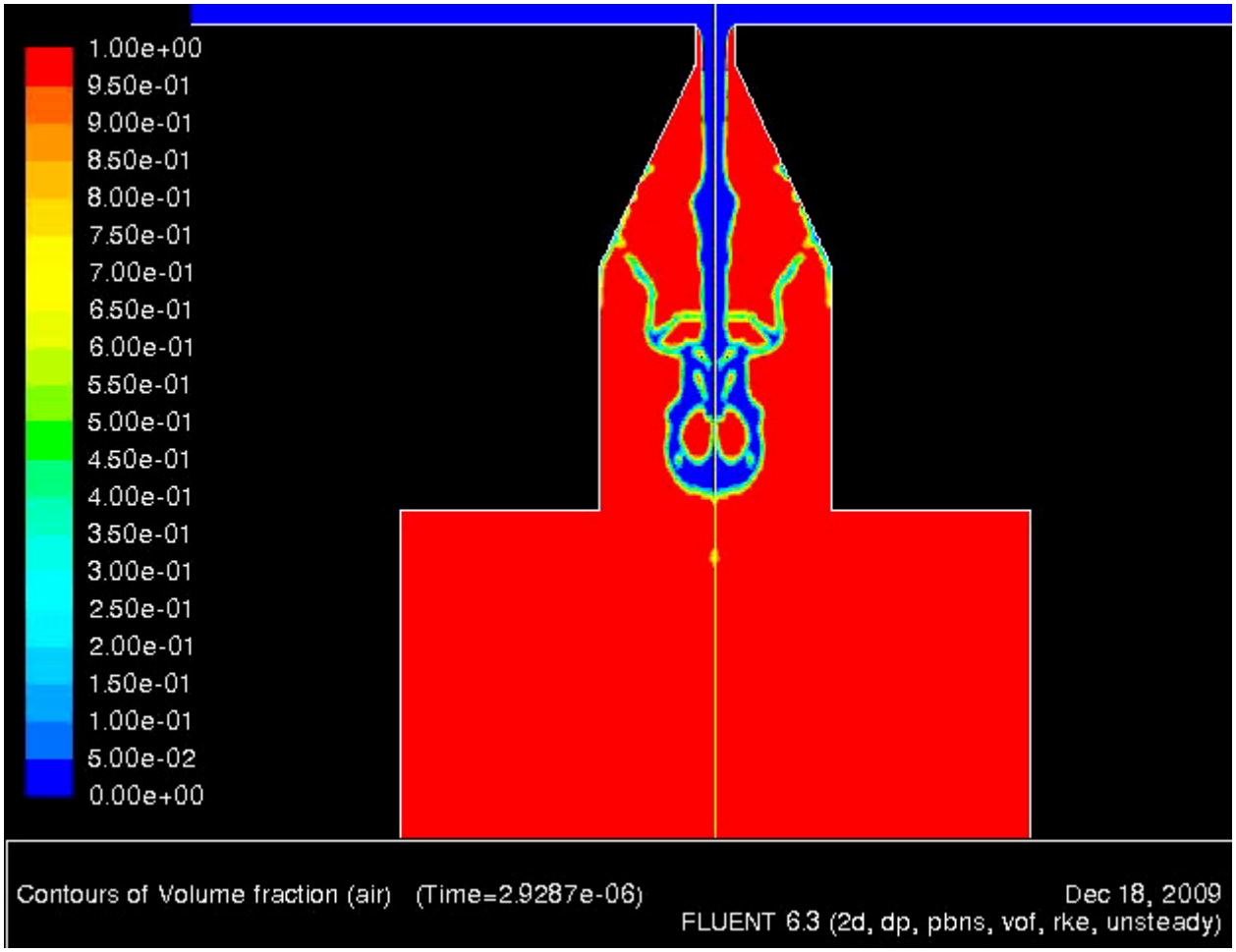
M. Annoni, M. Monno, Effect of water jet orifice geometry on jet behaviour and cutting capability, Key Engineering Materials, Vol. 344 (2007), pp. 177-184, ISSN 1013-9826.

CFD simulations
Reattachment of water jets (transient state)



A.T. Basha, M Annoni, M. Monno, "Numerical Simulation Of The Formation And Reatachment Length Of WaterJets For Different Orifice Geometries" WJTA confrence. Aug. 2009,USA

CFD simulations
Jet and droplets formation



In collaboration with:

fatronik tecnalia

Camera and Settings

SensiCam by PCO (www.pco.de)

- 1280x1024 pixels maximum
- Frame rate 1 Hz
- Delay flash-exposure 6 microseconds
- Exposure time 0.3-1 microsecond depending on nozzle diameter and configuration

Zoom:

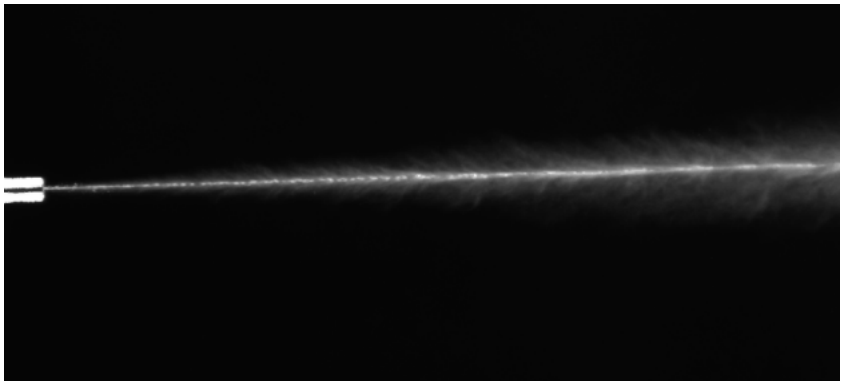
- Focal 80, f/a 4 (completely open)
- Distance water jet - camera body 136 cm
- Resolution 11.4 pixel/mm (11.5 the preliminaris)
- Image size 1280x576 pixels (x544 on the scale)

Flash position:

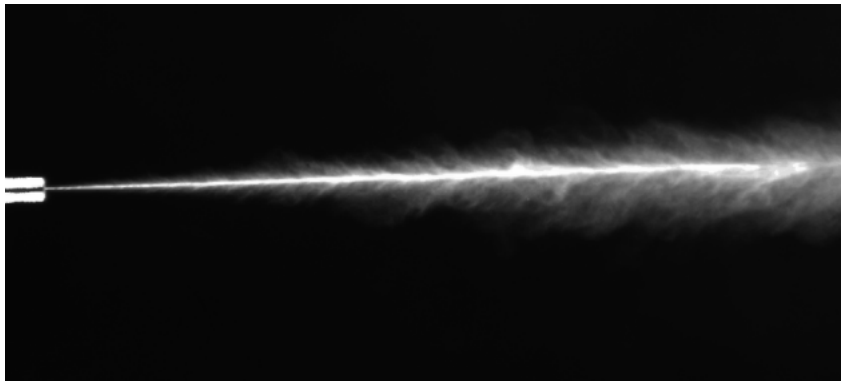
- Preliminari 2x Flash high, side +90 -90, distance 11 cm:
- And 2x Flash high, side +100 -100, distance 11 cm:

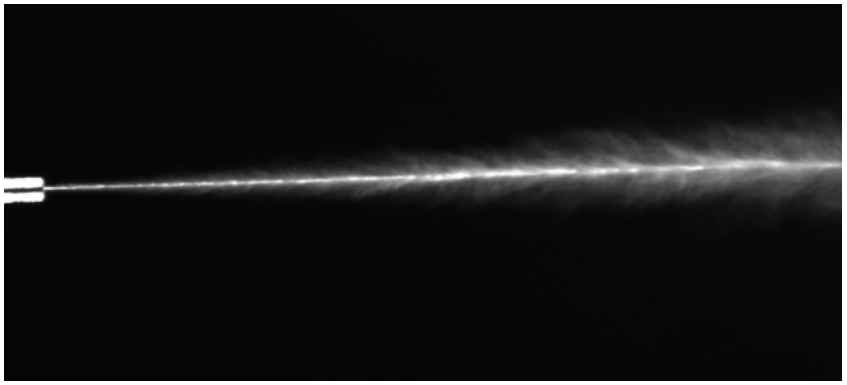
Experimentation
High speed camera observations

50 MPa

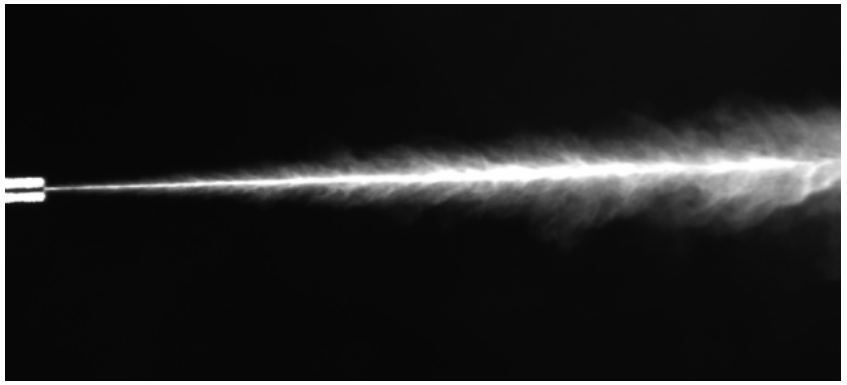


160 MPa





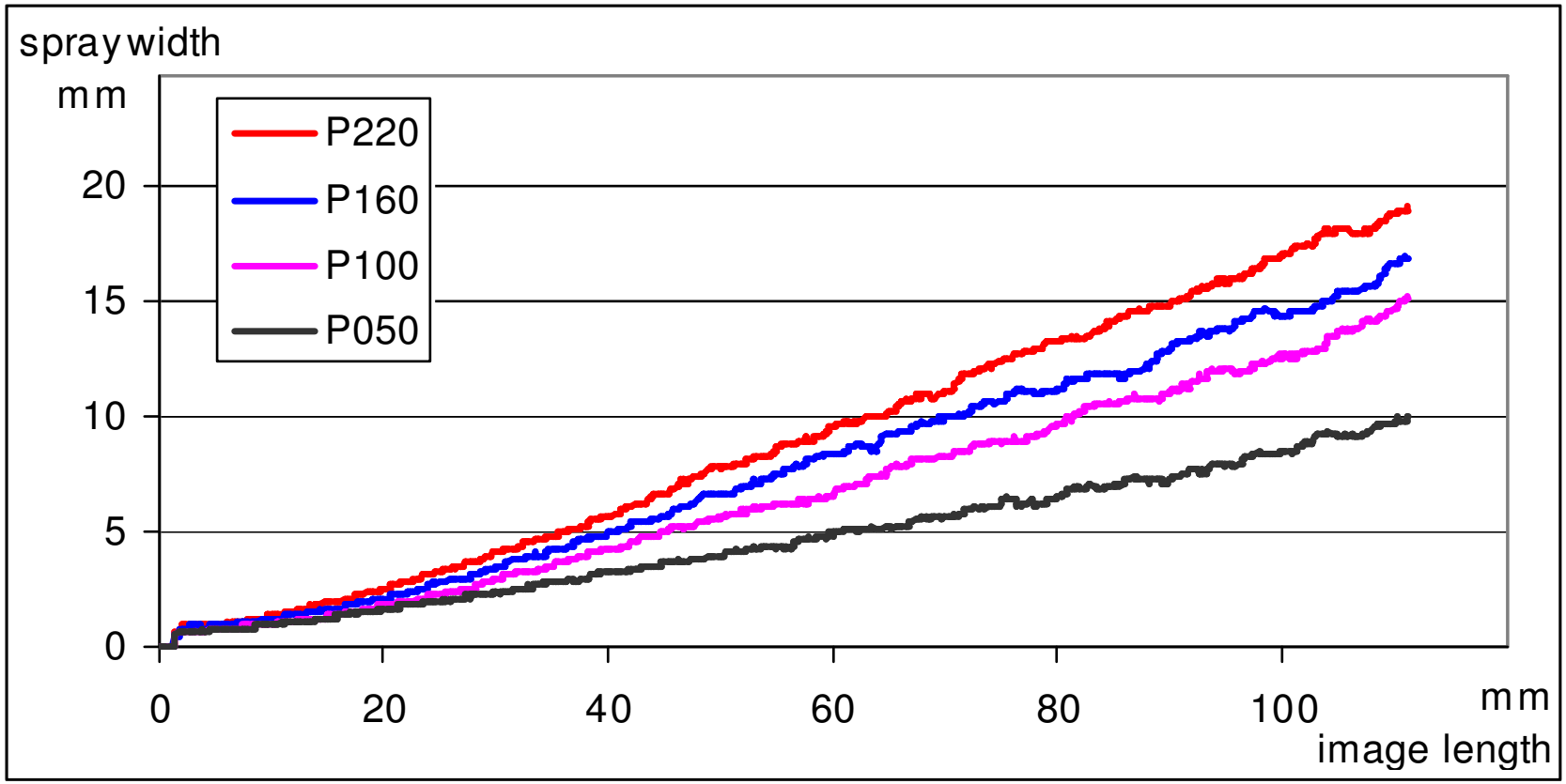
100 MPa



220 MPa

d = 0,080 mm

Experimentation
High speed camera observations



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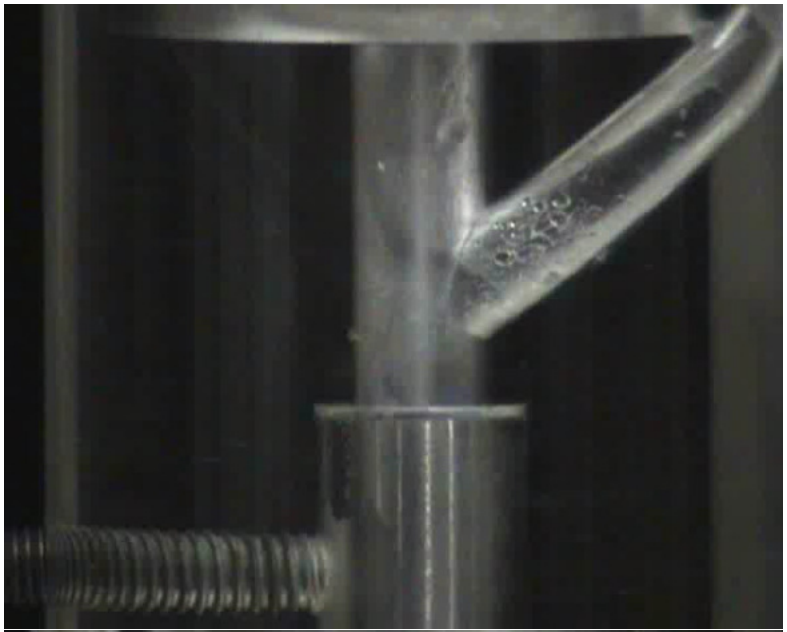
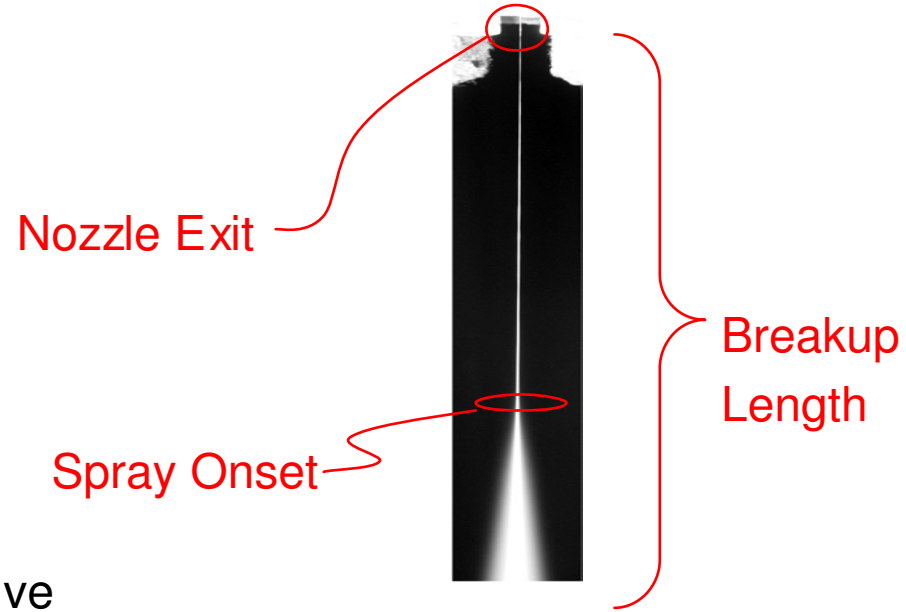
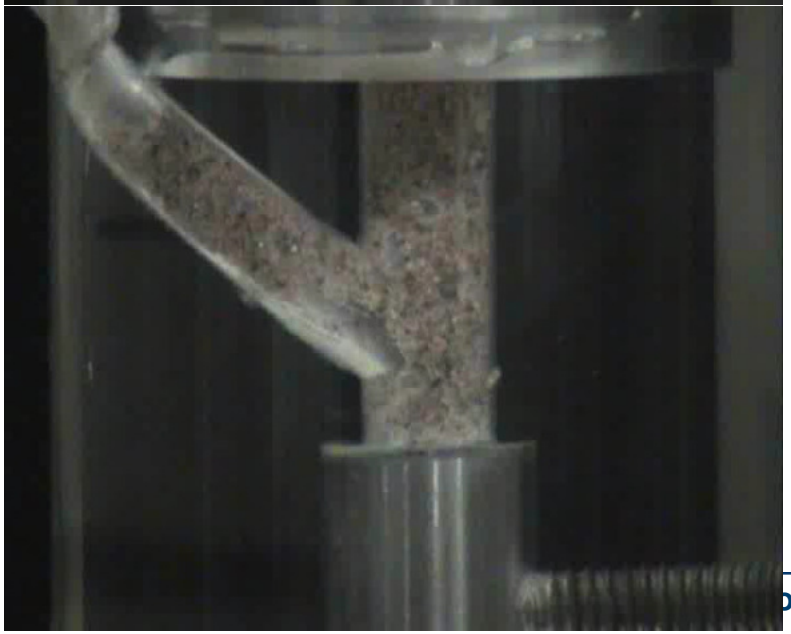
Experimentation
Water jet observations



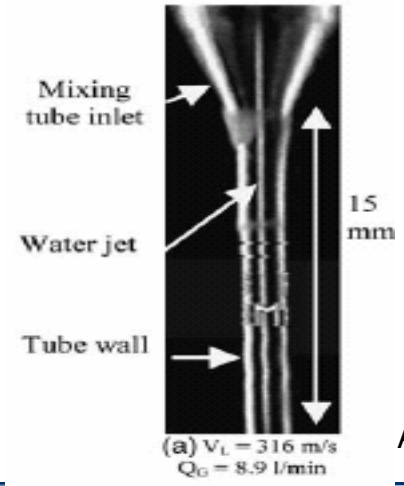
Air effect

Vahedi Tafreshi et al. (2004))



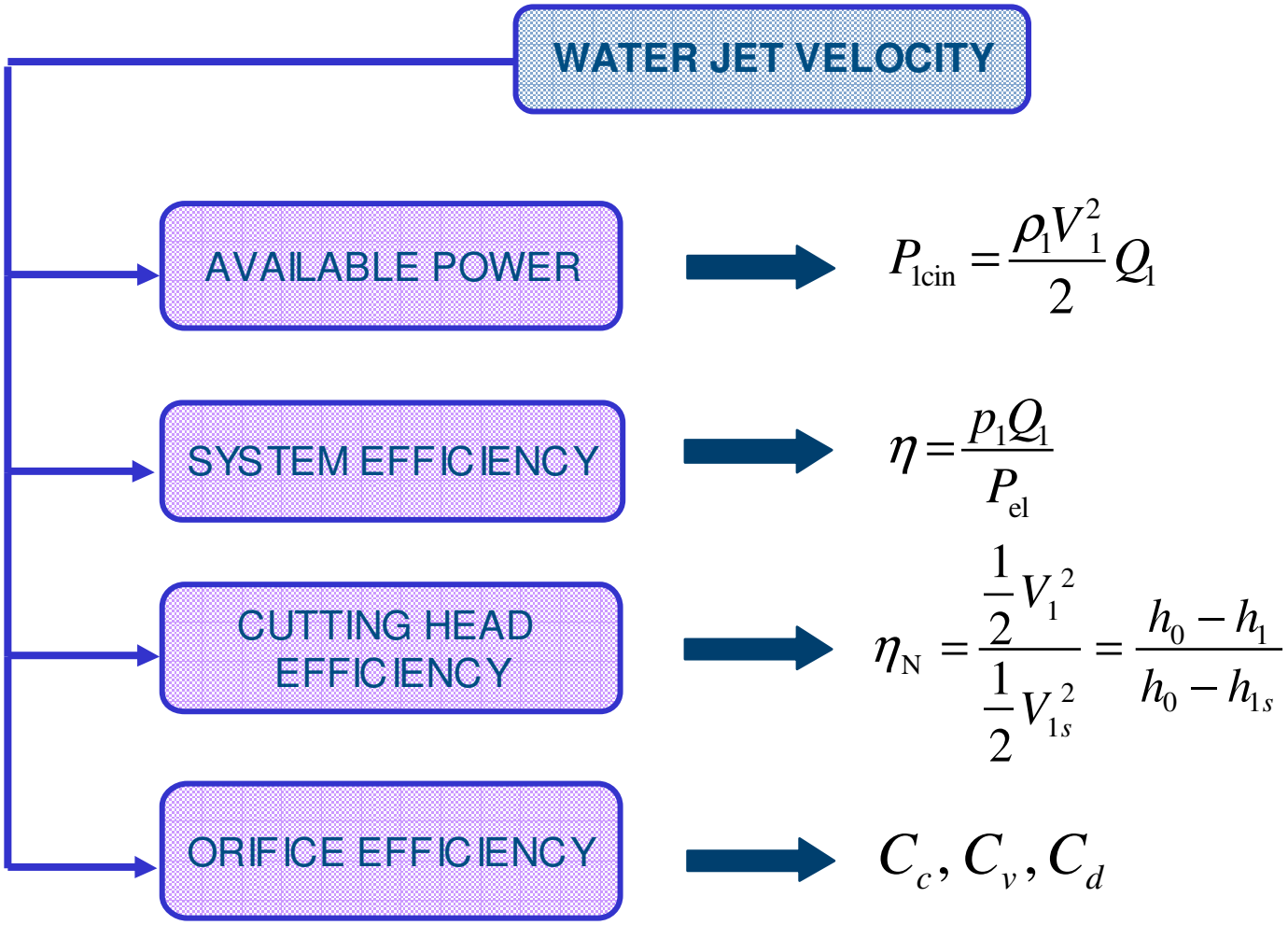


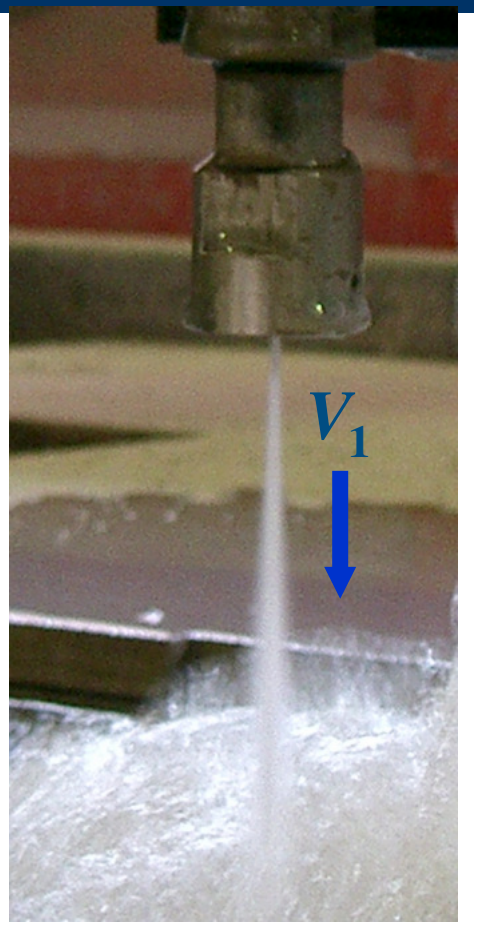
Abrasive



A.H. Osman et al. (2003)

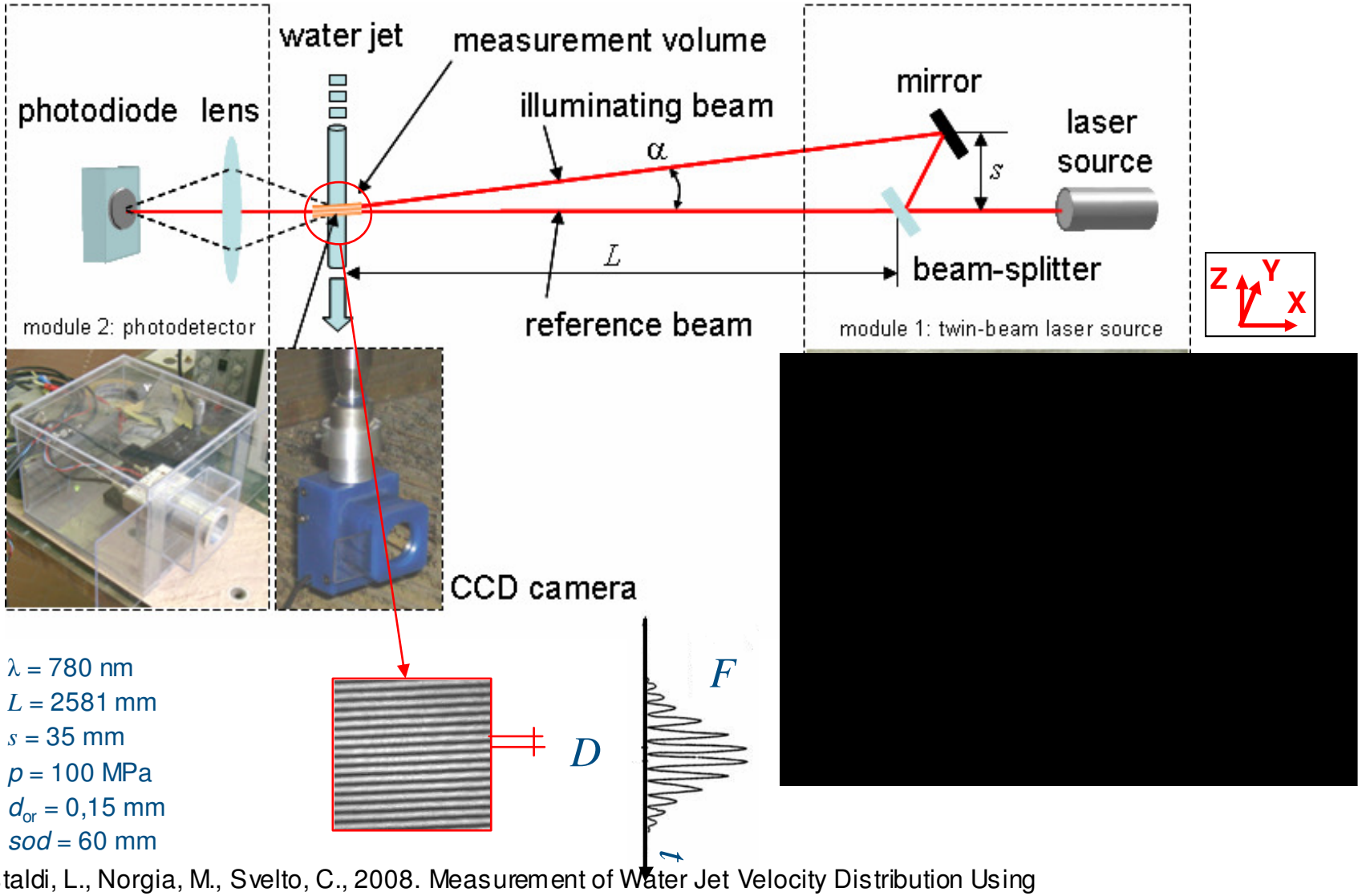
Experimentation
Laser Doppler Velocimetry





M. Annoni, L. Cristaldi, M. Norgia, C. Svelto, Efficiency Measurement of Water Jet Orifices by a Novel Electrooptical Technique, IEEE Transactions on Instrumentation and Measurement, Vol. 57, No. 1, January 2008, pp. 48-54.

Experimentation
Laser Doppler Velocimetry

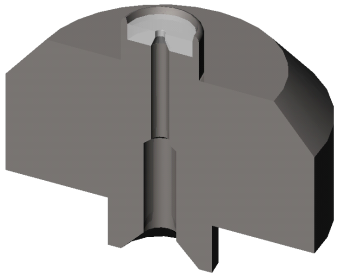


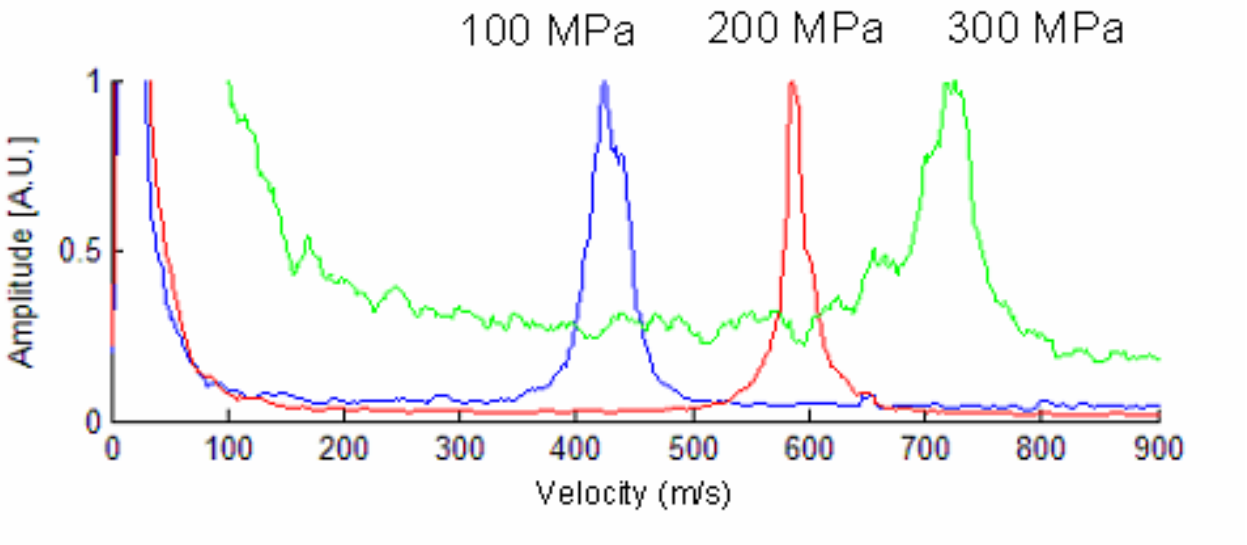
- λ = 780 nm
- L = 2581 mm
- s = 35 mm
- p = 100 MPa
- d_{or} = 0,15 mm
- *sod* = 60 mm

Annoni, M., Cristaldi, L., Norgia, M., Svelto, C., 2008. Measurement of Water Jet Velocity Distribution Using Laser Velocimetry, *IEEE Trans. on Instrumentation and Measurement*, Vol. 57, No. 8, August 2008, pp. 1524-1528

Experimentation
Laser Doppler Velocimetry

$$V = D \cdot F$$



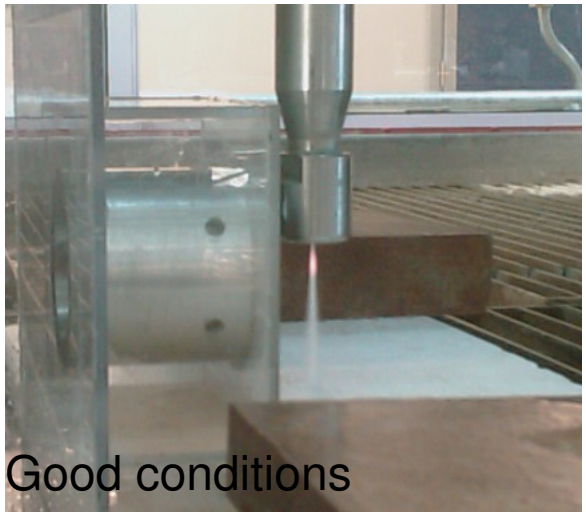


Experimentation
Laser Doppler Velocimetry

Orifice characterization

Experimental conditions (B orifices)	C_d		ψ	C_v		C_c	
	Mean	St. Dev.		Mean	St. Dev.	Mean	St. Dev.
0.30 mm @ 200 MPa	0.67	< 0.01	0.98	0.98	< 0.01	0.70	< 0.01
0.30 mm @ 300 MPa	0.68	< 0.01	0.97	0.97	< 0.01	0.72	< 0.01

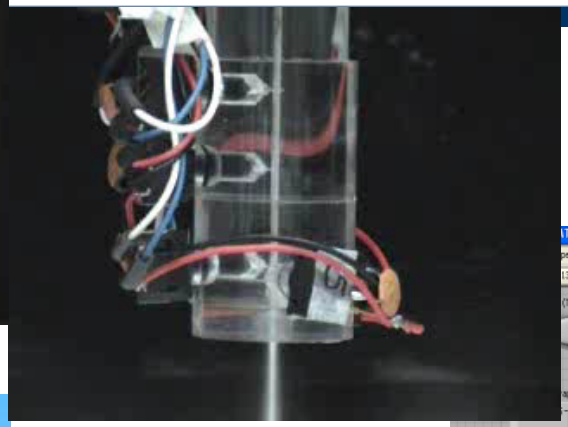
Experimental conditions (B broken orifices)	Mean C_d	ψ	Mean C_v	Mean C_c
0.30 mm @ 200 MPa	0.72	0.98	0.89	0.82
0.30 mm @ 300 MPa	0.70	0.97	0.93	0.78


Good conditions

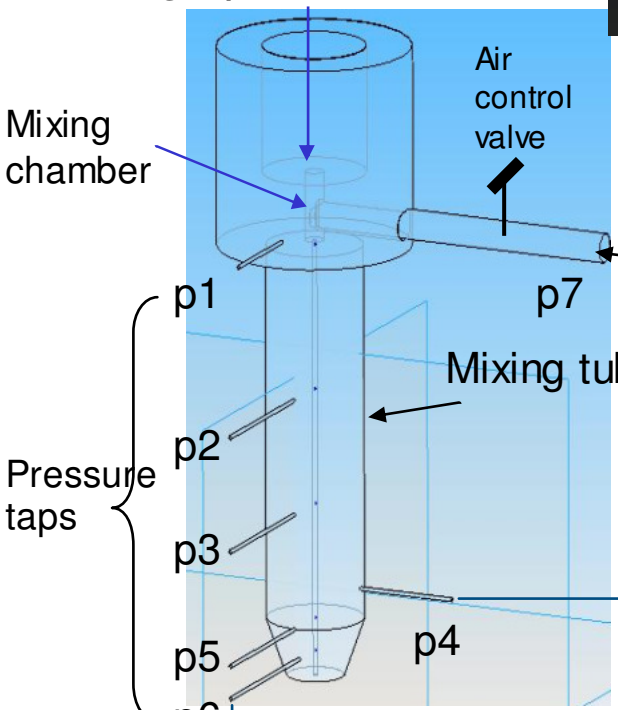

Broken orifice

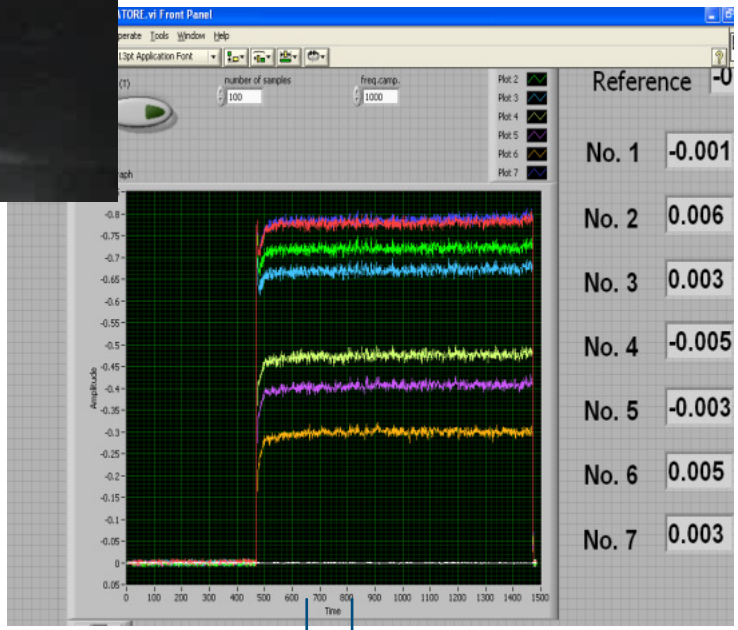
M. Annoni, M. Faifer, M. Norgia, Orifice Coefficients Evaluation for Water Jet Applications, 16th IMEKO TC4 Symposium Exploring New Frontiers of Instrumentation and Methods for Electrical and Electronic Measurements, September 22-24, 2008, Florence, Italy, pp. 761-766.

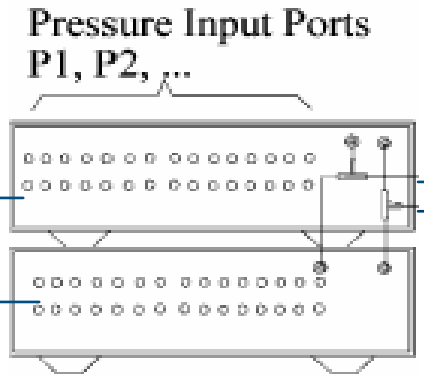
Experimentation
Static pressure measurements



High pressure water







Custom made

LabVIEW program