EXPERIMENTAL STUDIES ON WIND INFLUENCE ON HYDROGEN RELEASE FROM LOW PRESSURE PIPELINES

Nicola Mattei, Martino Schiavetti and Marco Carcassi

Department of mechanical, nuclear and production engineering

University of Pisa – Italy

UNIVERSITÀ DI PISA

PURPOSE

The HPBT experimental apparatus has been designed in order to investigate the behavior of a release of hydrogen from a low pressure pipe.

Afterwards the jet has been ignited to study the behavior of the jet-fire originated from the release described in the previous tests.

S

B
C
D
E

ANEMOMETER

Can measure wind velocity and direction. Was at about 3 m from ground and far from obstacles to avoid turbulence
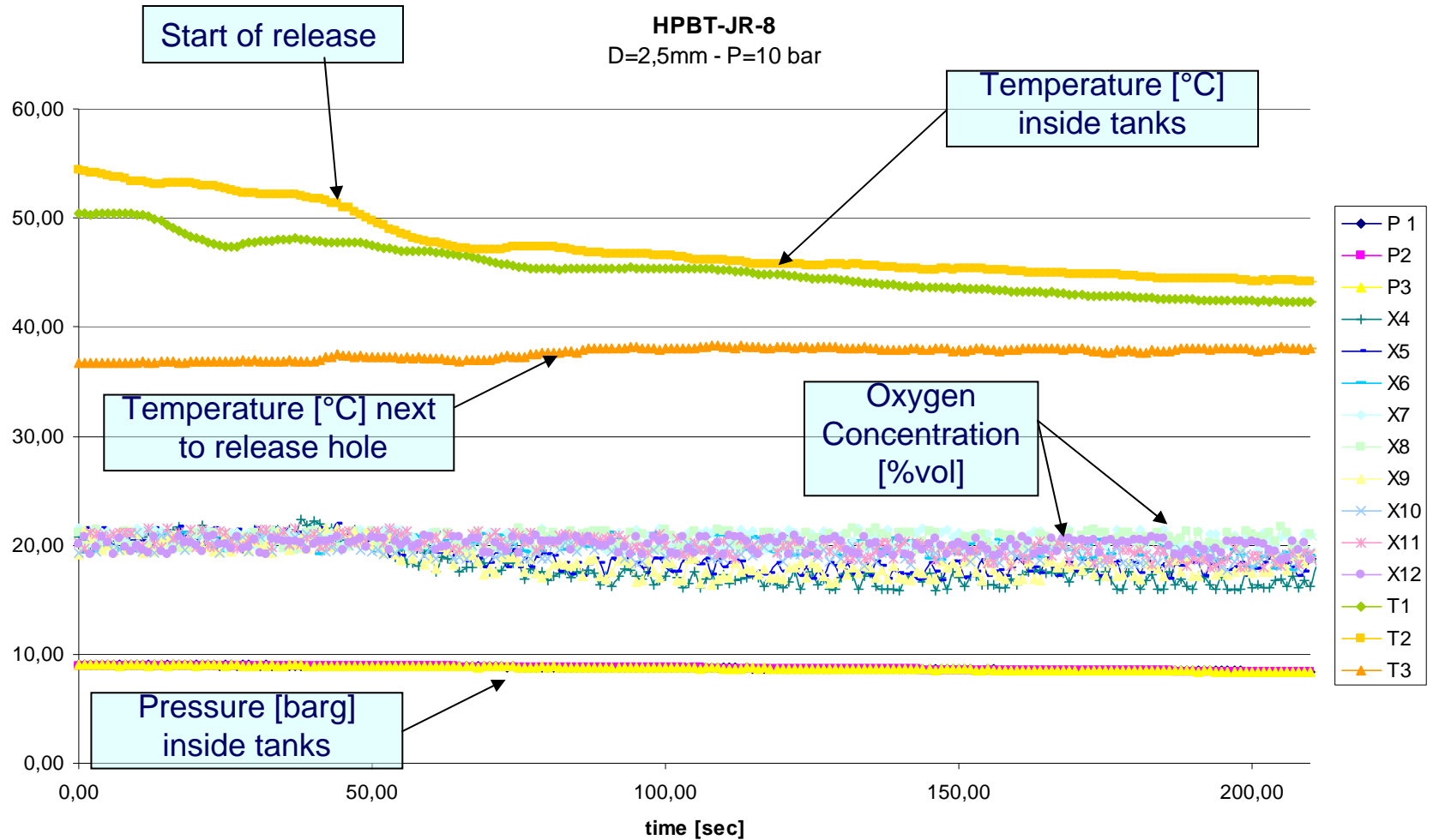
EXPERIMETAL PARAMETERS

During tests the following parameters could be modified:

• internal pressure: up to 10 bar

• diameter of release hole: Ø 2.5 - 5 - 11 [mm]

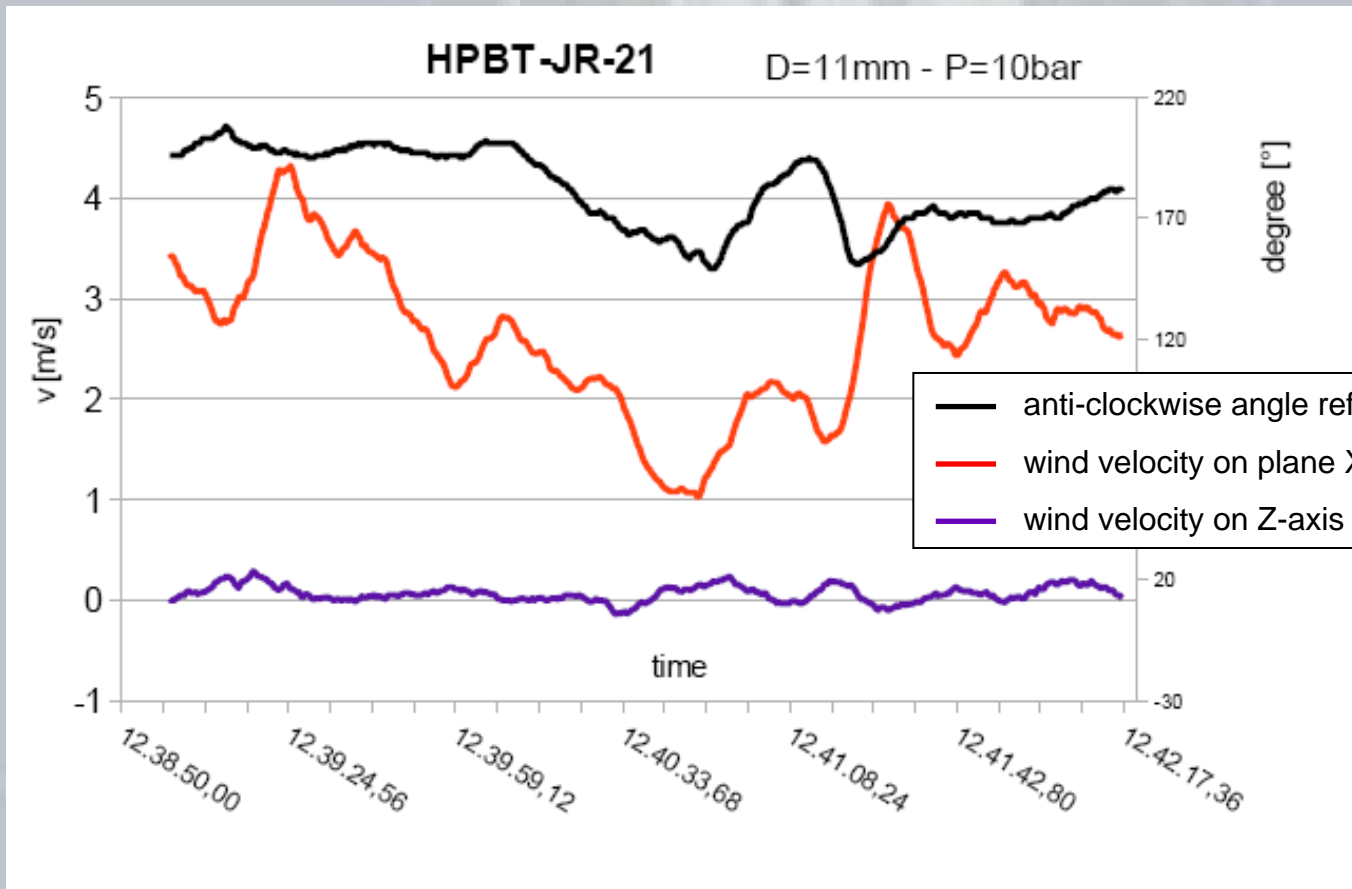• release time: from 90 to 240 s depending on internal pressure and on release hole diameter.

# EXAMPLE OF DATA ACQUIRED
(Ø 2,5mm and P = 10bar)

HPBT-JR-8
D=2,5mm - P=10 bar

Start of release

Temperature [°C] inside tanks

Temperature [°C] next to release hole

Oxygen Concentration [%vol]

Pressure [barg] inside tanks

time [sec]

EXAMPLE OF DATA ACQUIRED
wind data

HPBT-JR-21   D=11mm - P=10bar

Legend:
- anti-clockwise angle referring to jet axis
- wind velocity on plane XY
- wind velocity on Z-axis

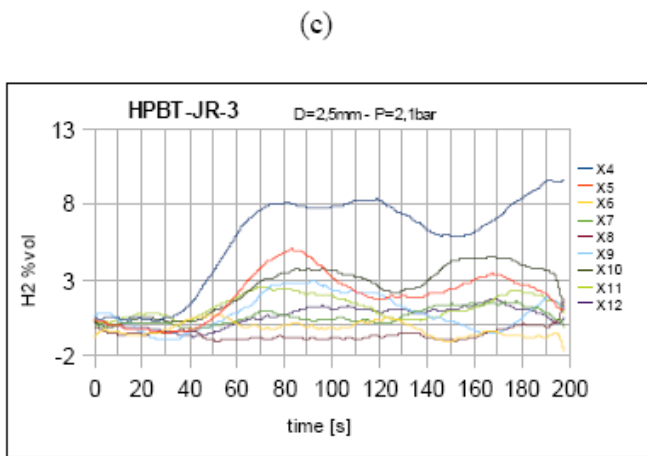# HYDROGEN CONCENTRATION vs. TIME

WIND VELICITY & HYDROGEN CONCENTRATION vs. TIME

WIND VELICITY & HYDROGEN CONCENTRATION vs. TIME

HPBT-JR-3   D=2,5mm P=2,1bar
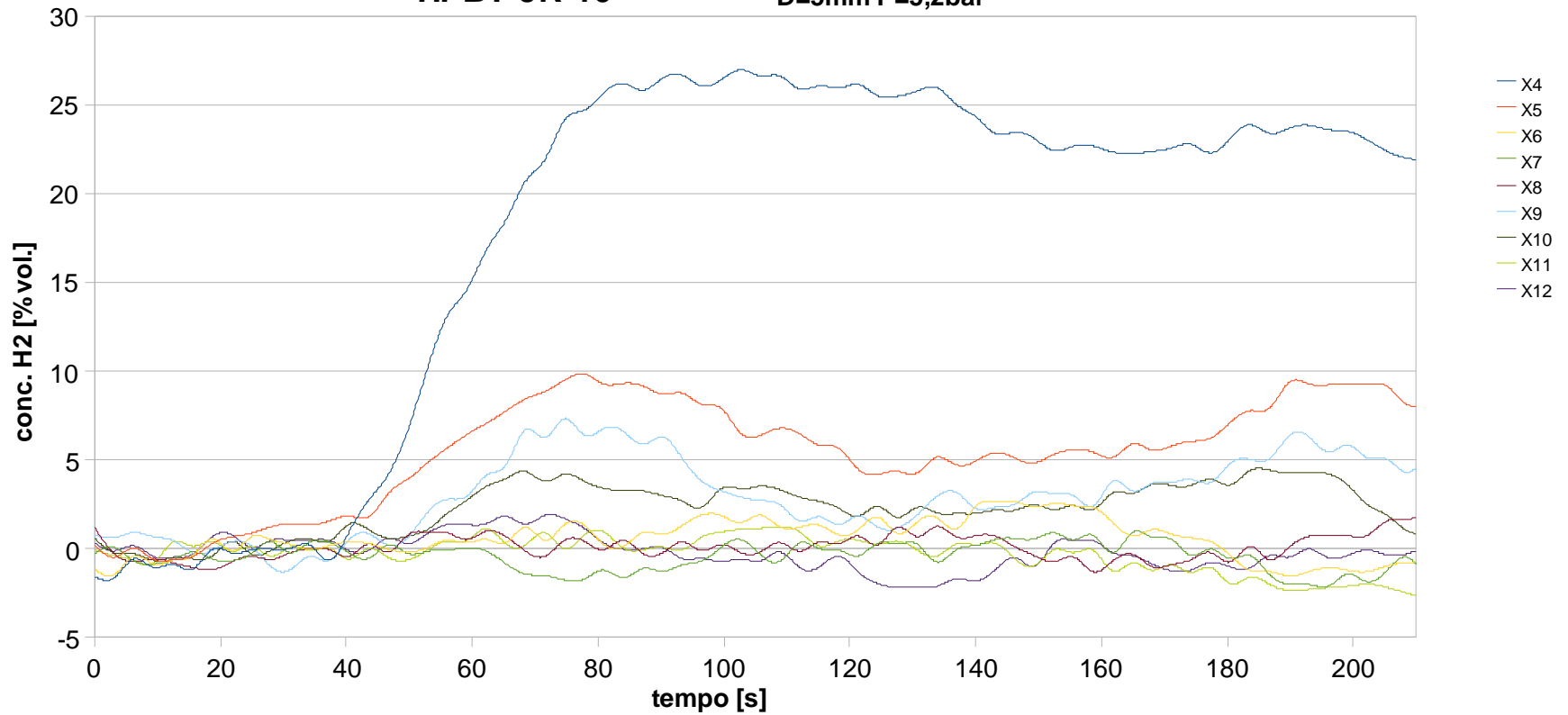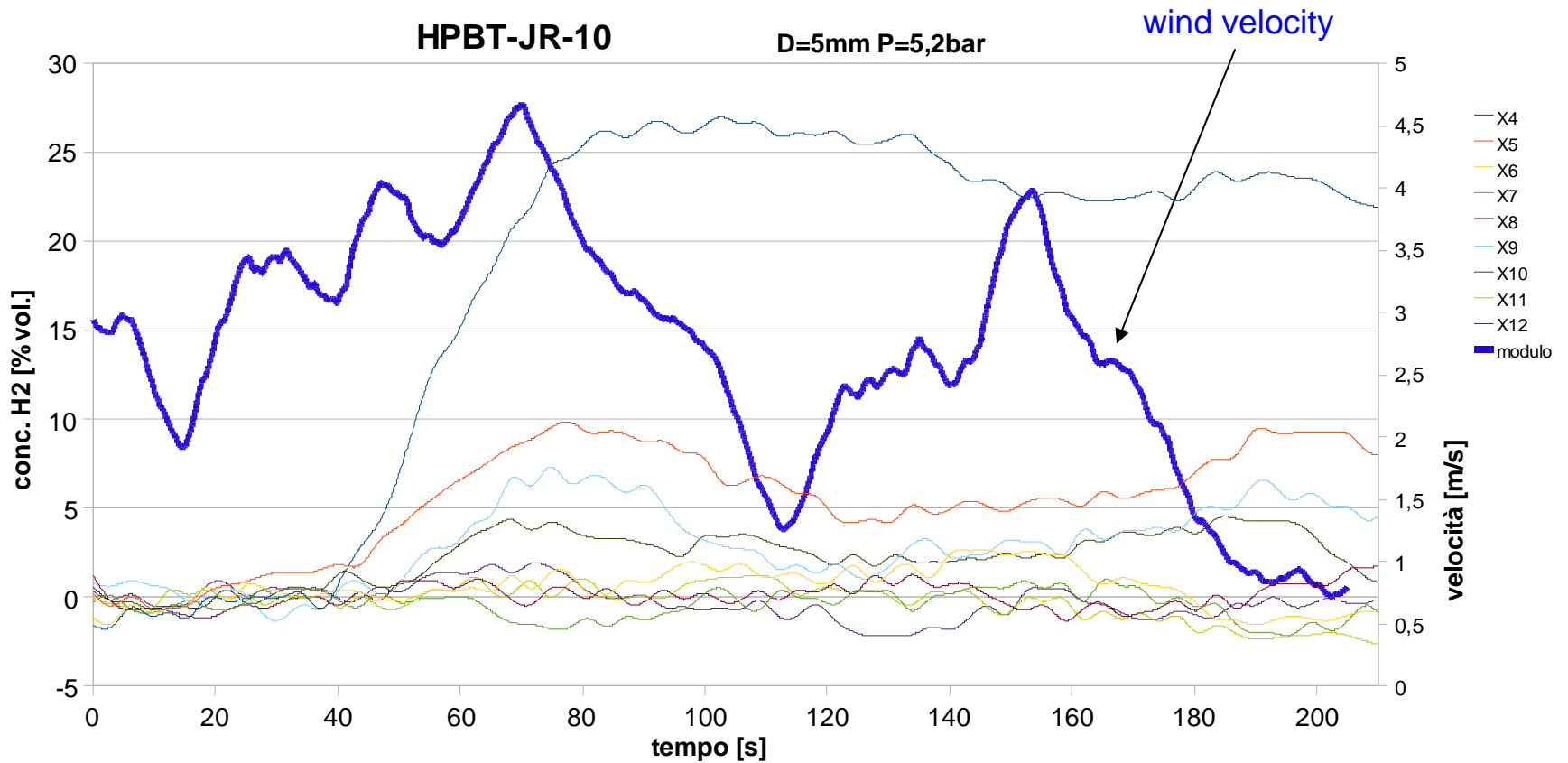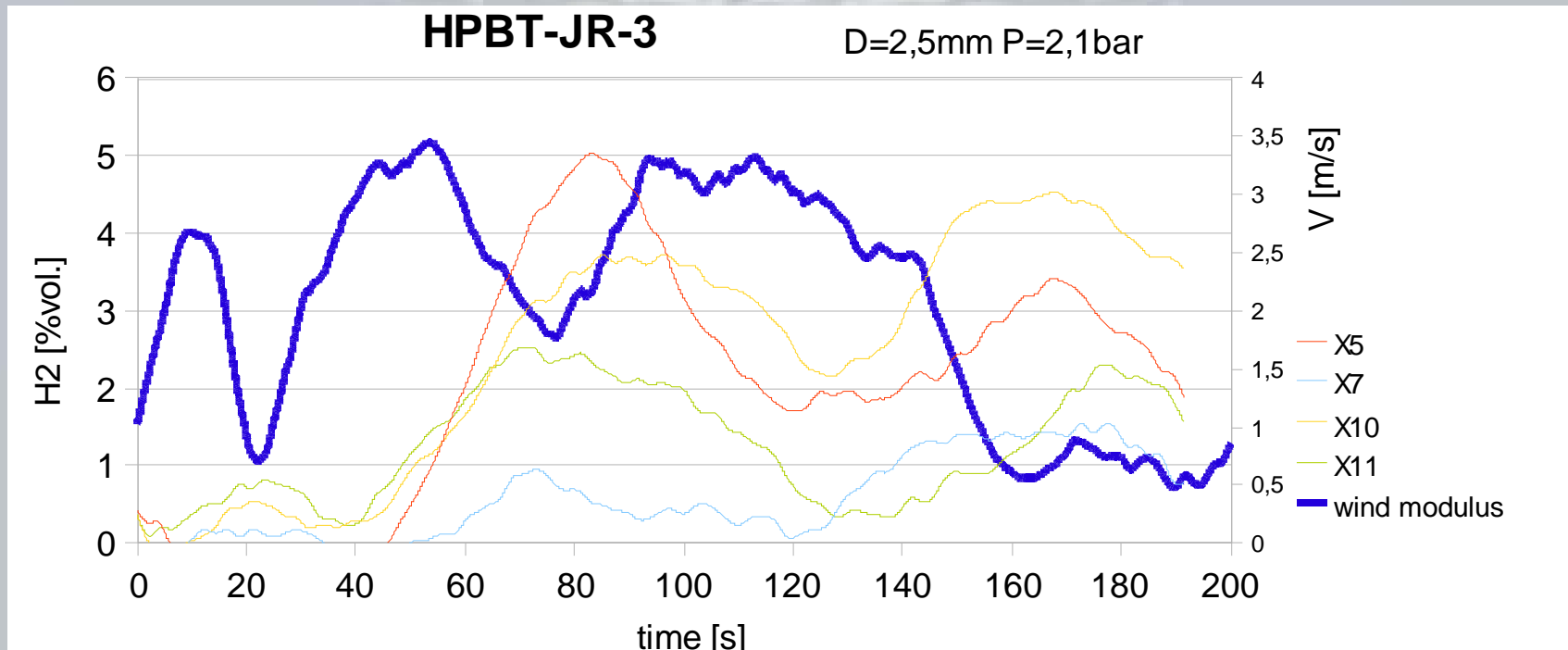
SUMMARY OF DATA AVAILABLE FOR EACH TEST

angle between wind direction and jet axis
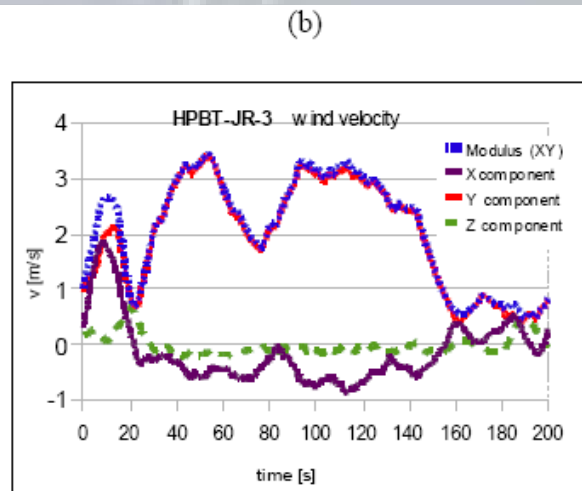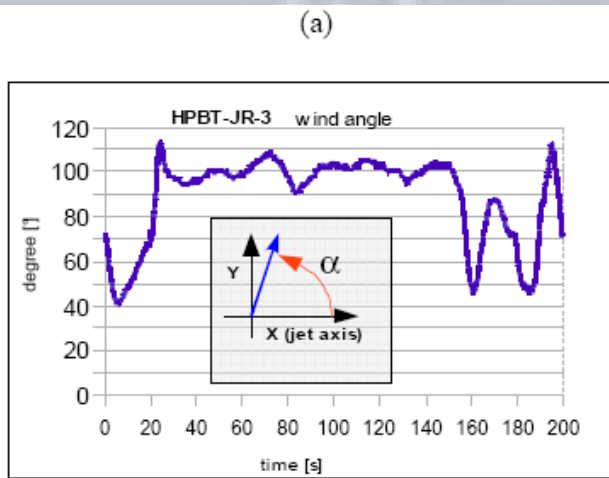
wind velocity

H2 concentration vs. time
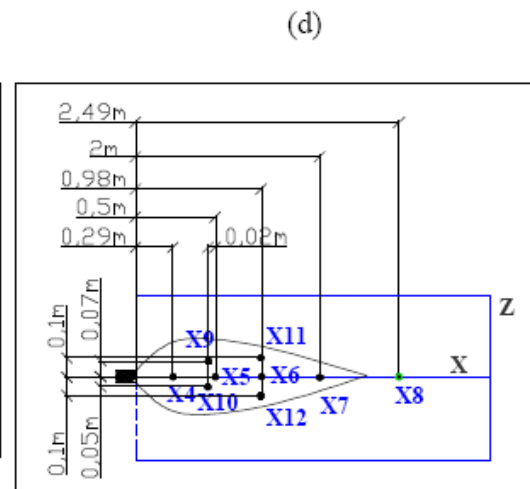
spatial coordinates of sample points

TESTS PARAMETERS

During the experimental series a total of 22 tests were performed. Only three of the tests performed are reported and analyzed:

	HPBT-JR-3	HPBT-JR-7	HPBT-JR-8
Ø [mm]	2.5	2.5	2.5
P_{int} [bar]	2.1	5.9	10
Wind modulus [m/s]	1.68	1.24	2.10
Wind angle (anticlockwise from release direction)	79.4°	87.5°	55.4°
Time before G drops under 90% of $G_{initial}$ [s]	>155	>180	>250
Time before G drops under 95% of $G_{initial}$ [s]	>155	>180	175

DISPLACEMENT OF SAMPLE POINTS

HPBT-JR-3

HPBT-JR-7

HPBT-JR-8

	x [mm]	y [mm]	z [mm]
X4	290	0	-10
X5	500	0	20
X6	980	0	-10
X7	2000	0	0
X8	2490	0	0
X9	480	0	70
X10	480	0	-50
X11	980	0	100
X12	980	0	-100
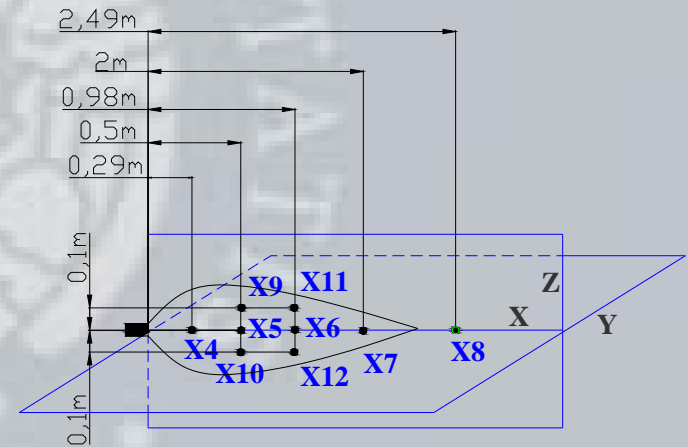
Wind Angle vs. Time
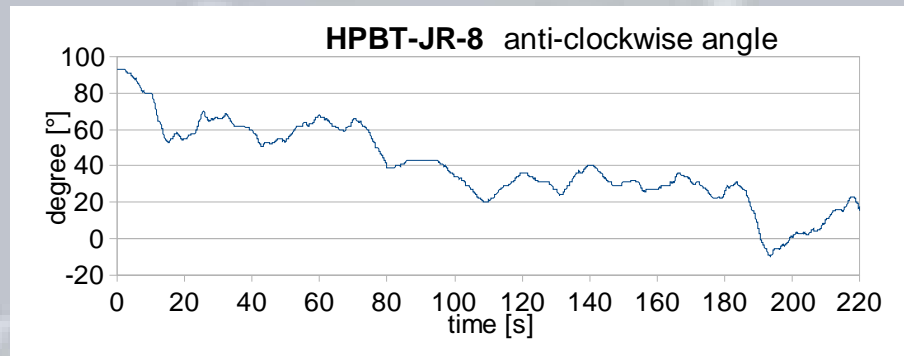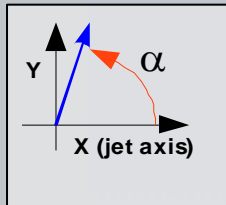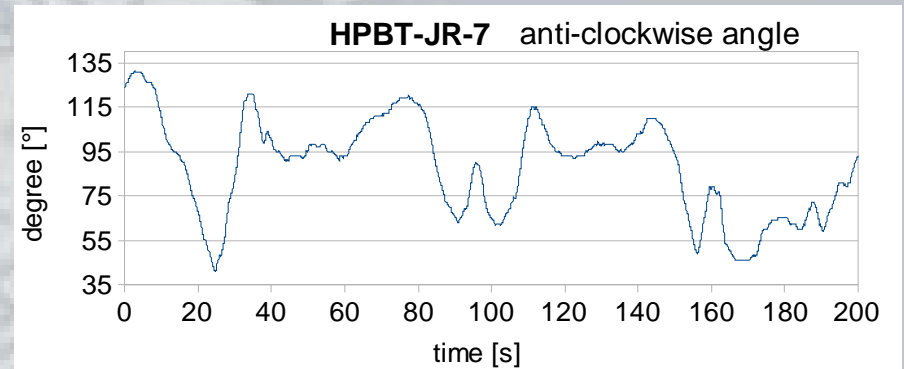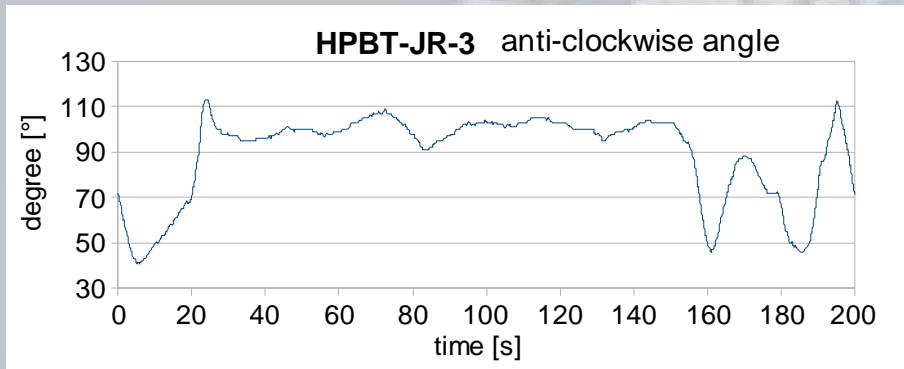
Wind Velocity vs. Time
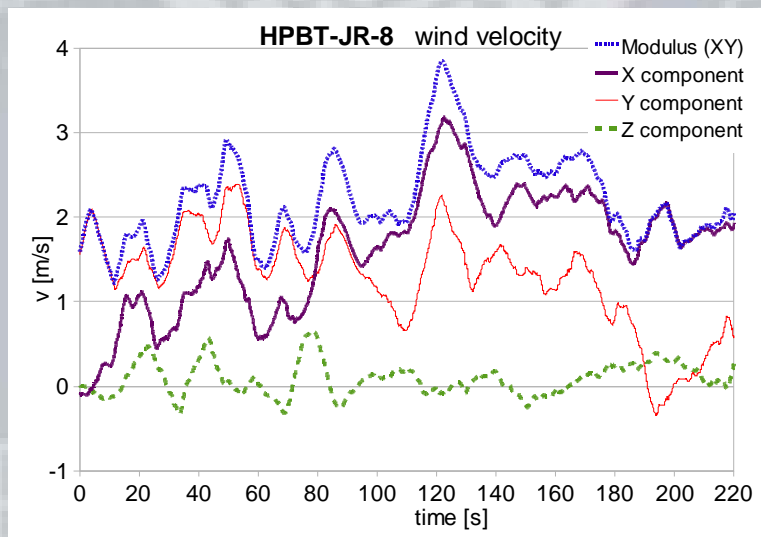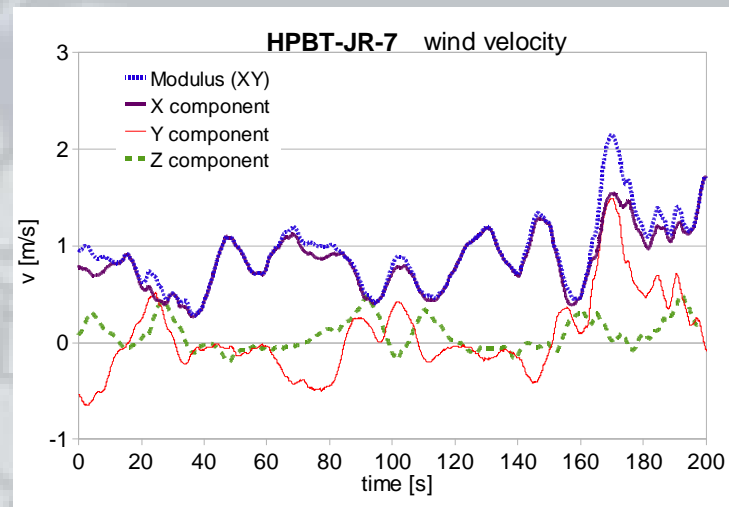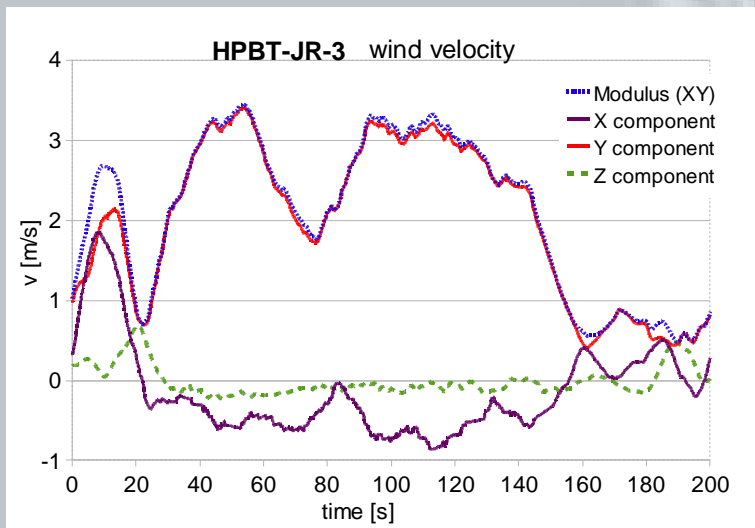
TIME GAPS
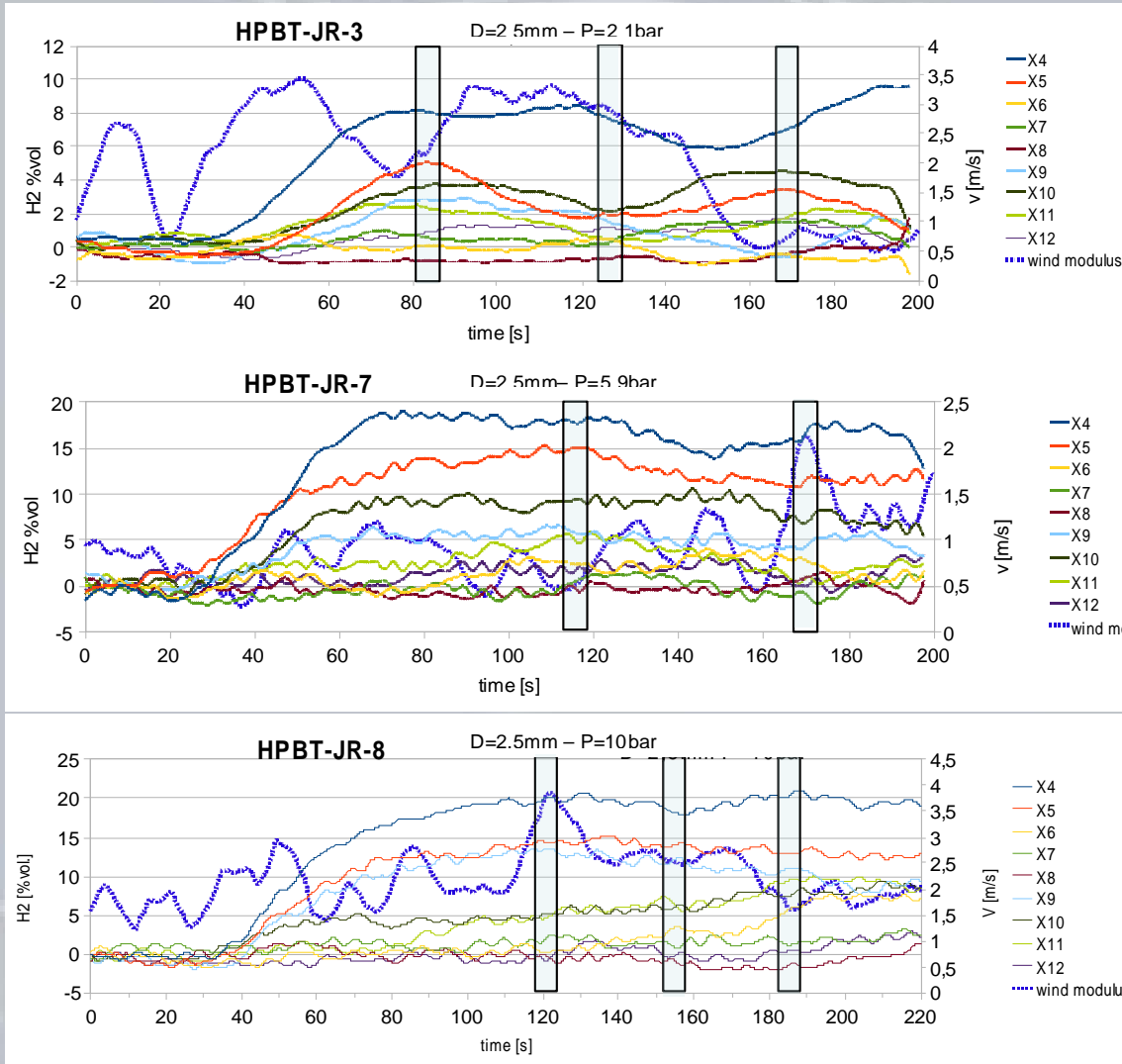
COMPUTER CODES

• The purpose of this work is to have experimental data that are useful for codes simulations.

• Three tests have been simulated with EFFECTS, FLACS code and with SPRAY code.

• EFFECTS 7.6.1 is a commercial program by TNO based on numerical methods for solving fluidodynamic equations.

• FLACS v9.0 is a commercial program by GexCon As and is based on CFD codes.

• SPRAY is a program under development in Italy by CNR-ISAC (in Turin) and ARIANET (in Milan - Polytechnic): it is a Lagrangian particle dispersion model that considers the buoyancy effects and is based on evaluating the behaviour of a large number of small particles.

SPRAY v9.0

Pictures of SPRAY simulation of test HPBT-JR-19 showing the effects of wind
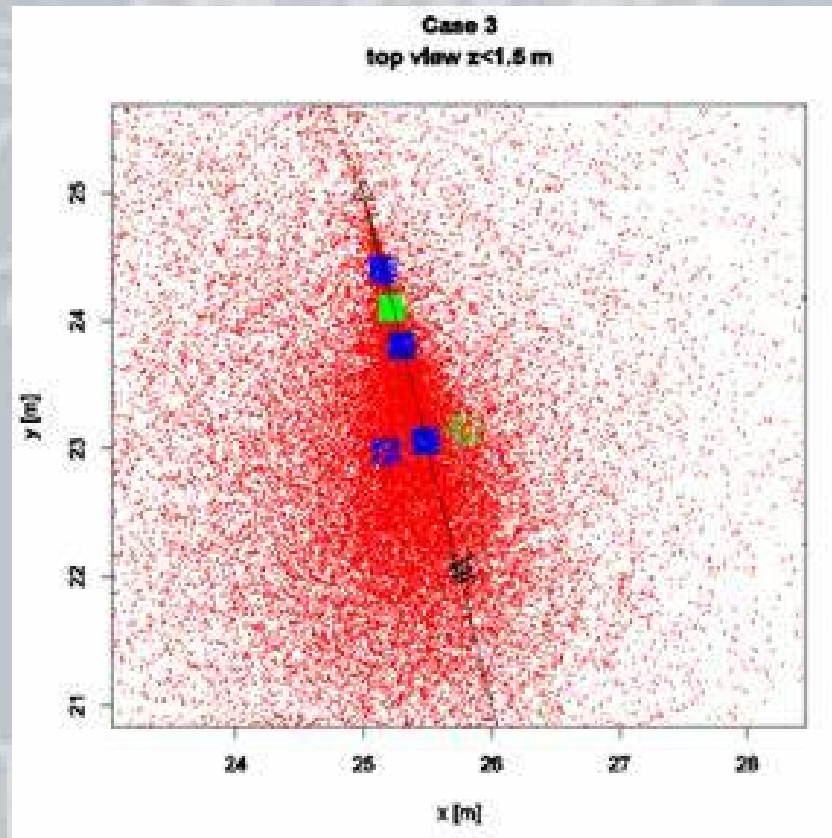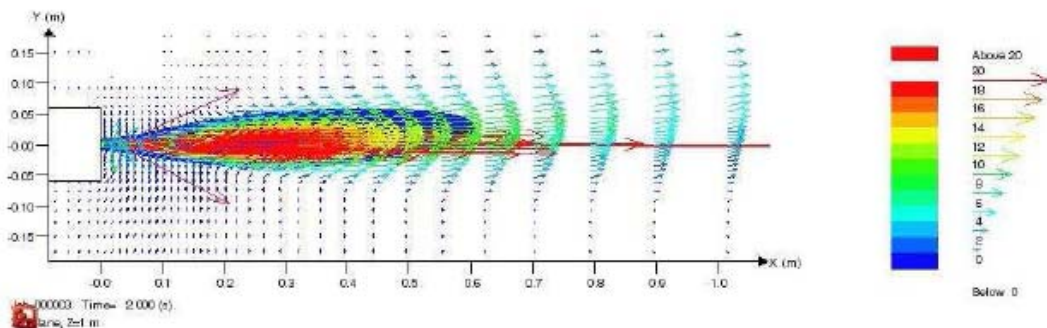
FLACS v9.0

HPBT-JR-3
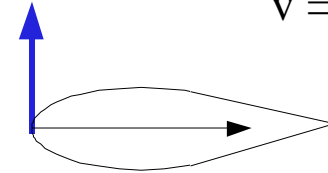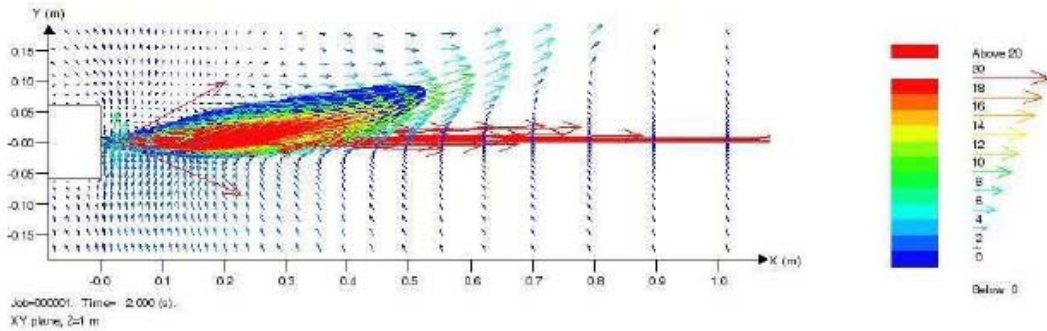
a = 91°
v = 2.15 m/s
plane XY
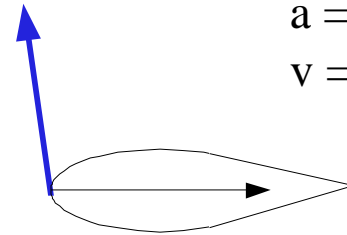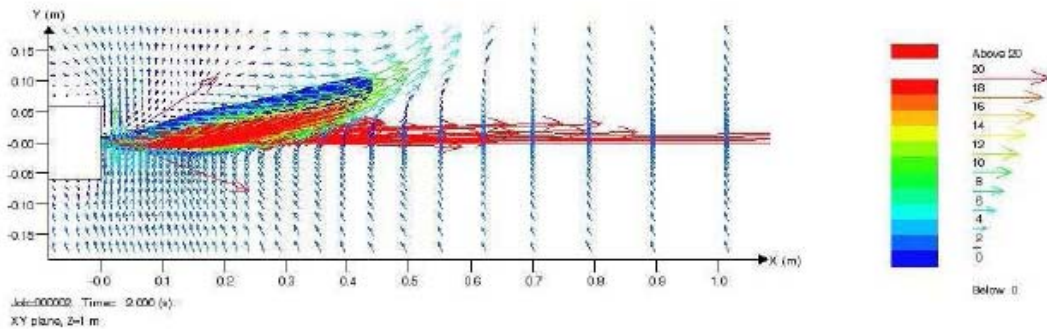
a = 100°
v = 3 m/s
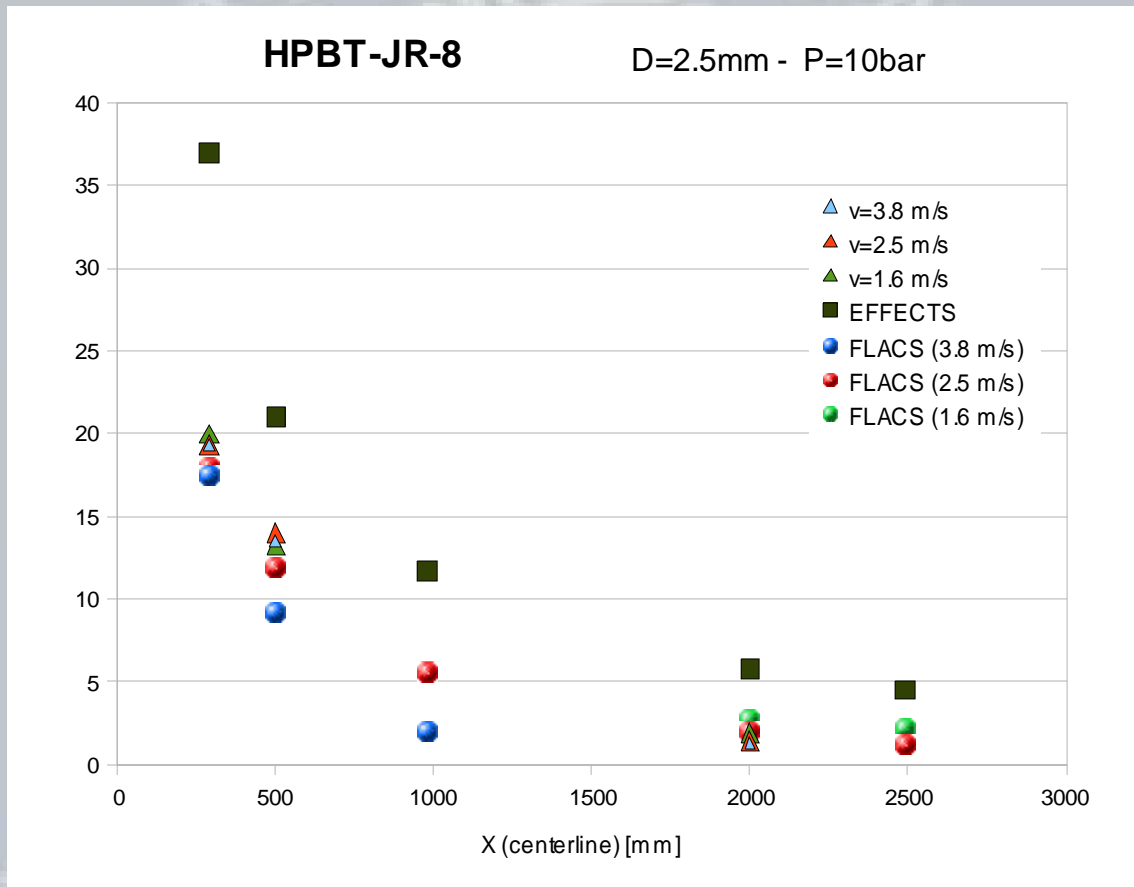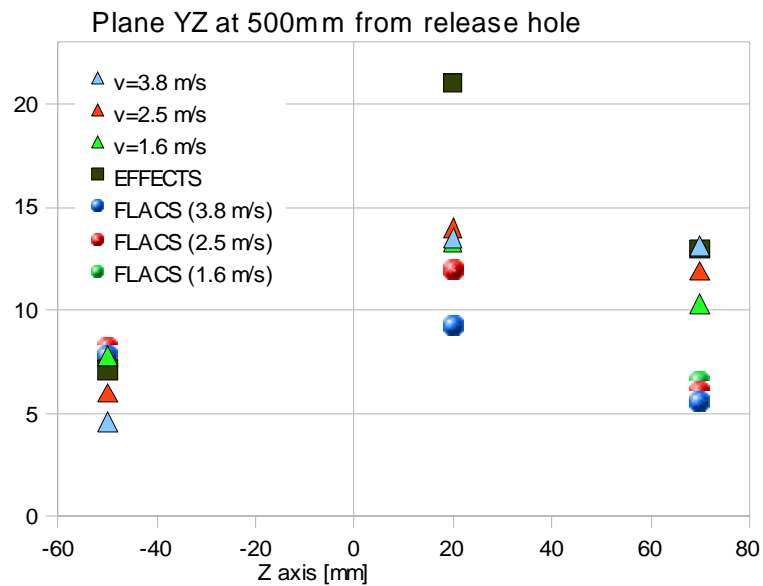plane XY
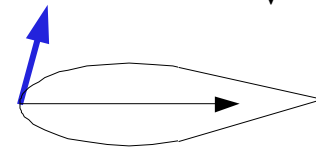
a = 82°
v = 0.76 m/s
plane XY

H₂ CONCENTRATION ALONG JET AXIS
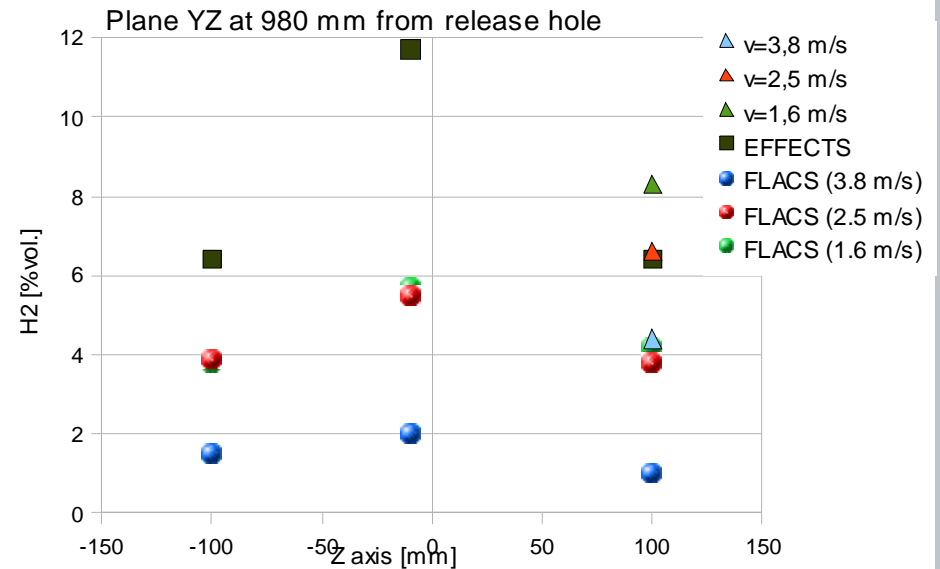
H₂ CONCENTRATION ON VERTICAL PLANES

H₂ CONCENTRATION ALONG JET AXIS
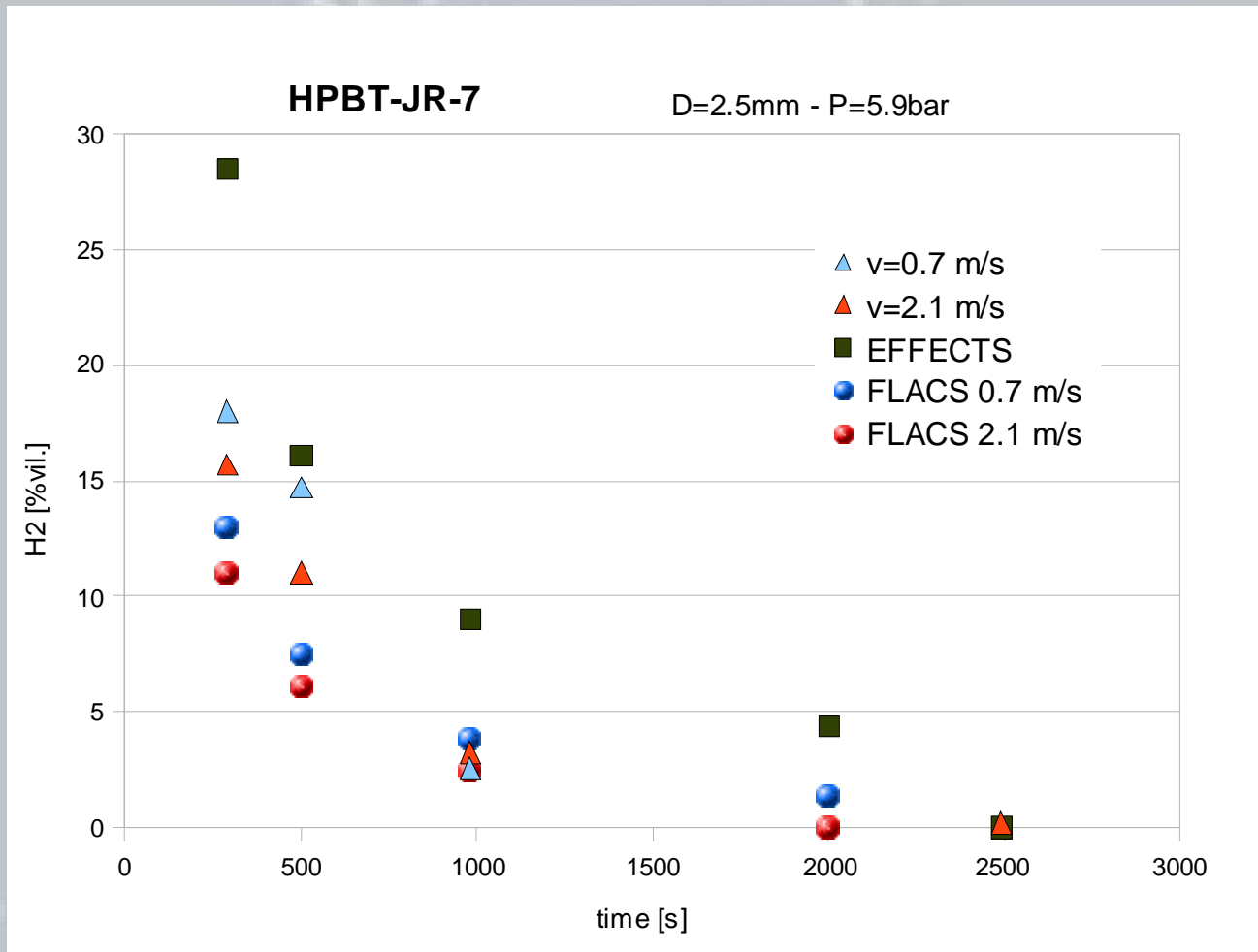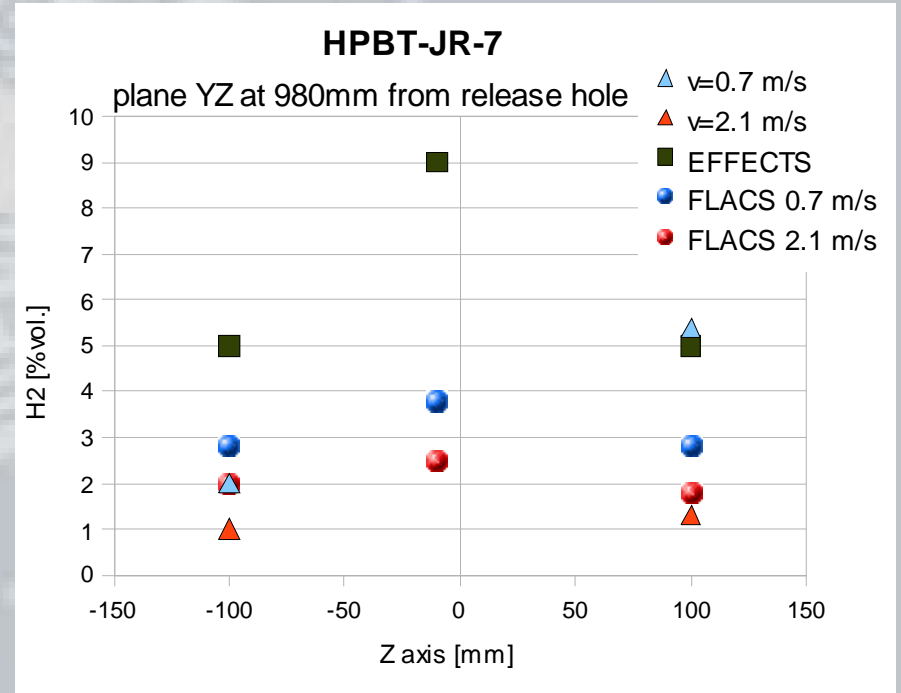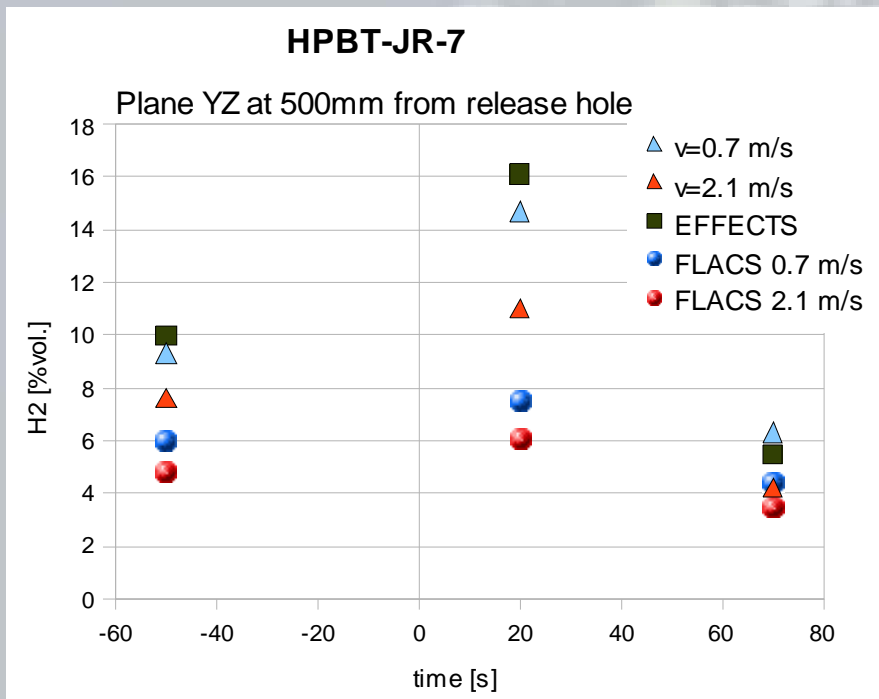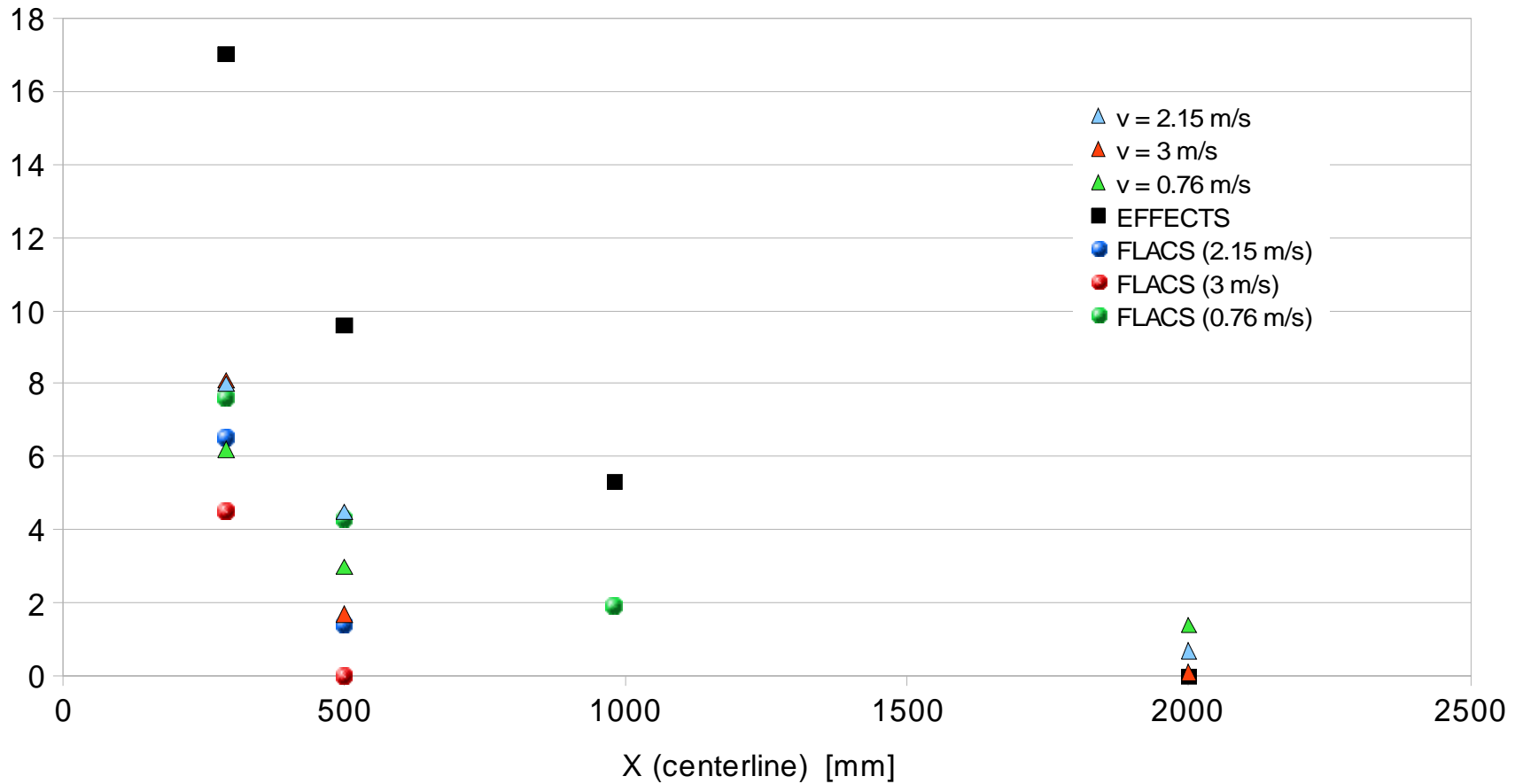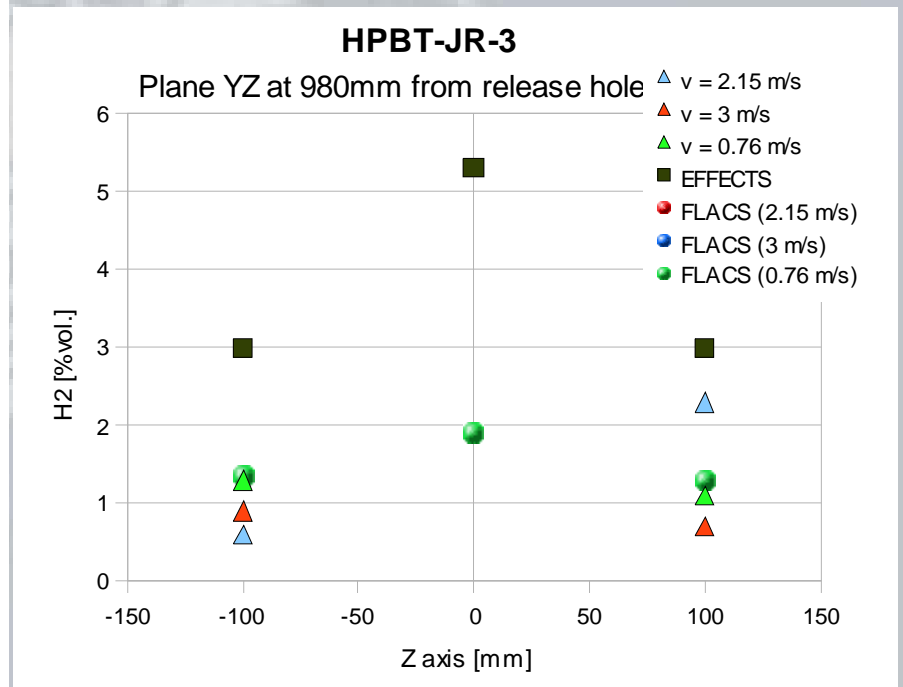
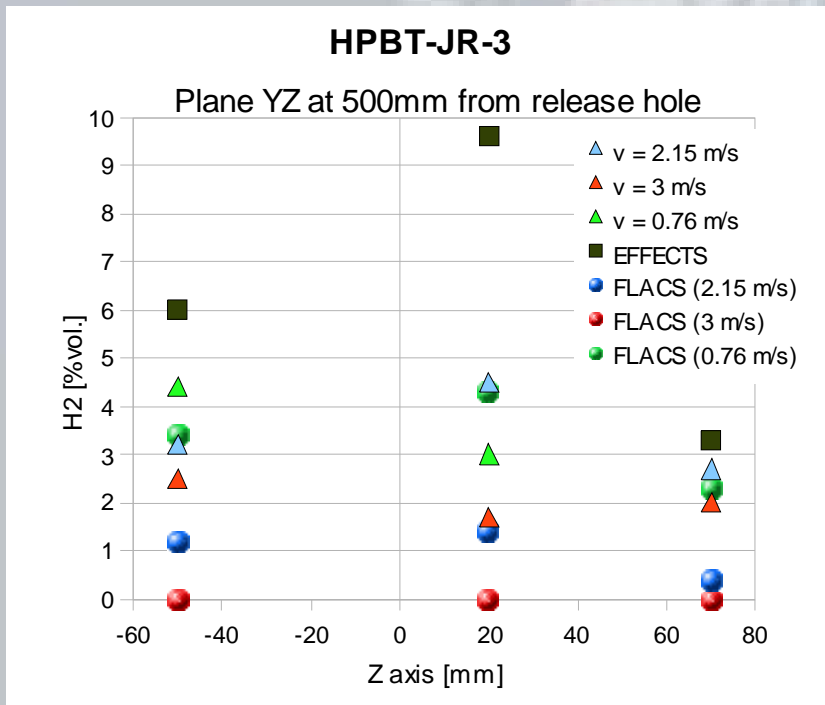# H₂ CONCENTRATION ON VERTICAL PLANES

H₂ CONCENTRATION ALONG JET AXIS

HPBT-JR-3   D=2.5mm - P=2.1bar

H₂ CONCENTRATION
ON VERTICAL PLANES
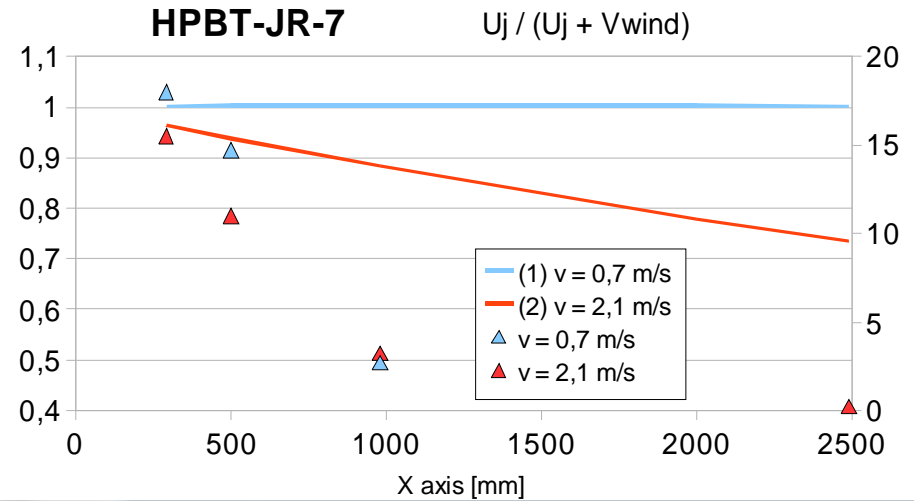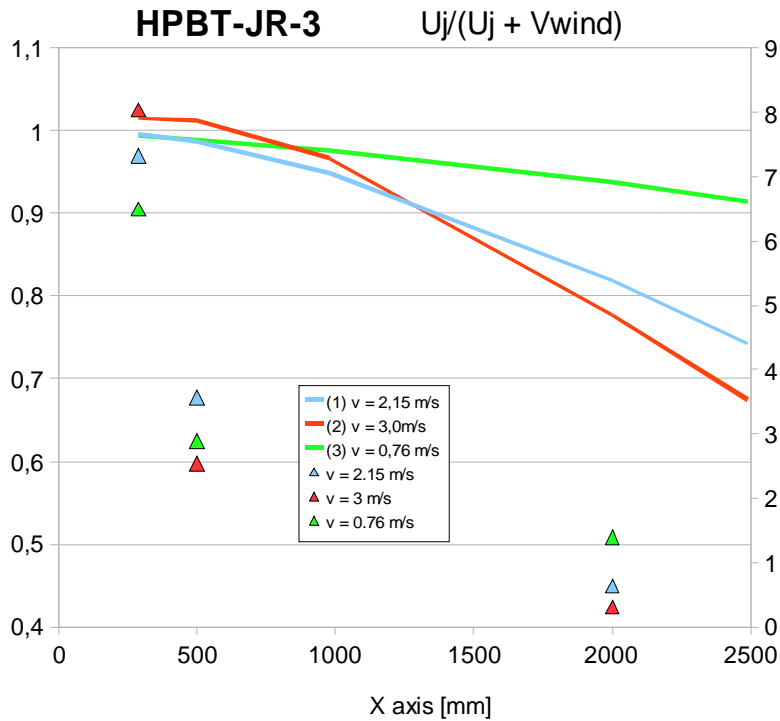
EXPERIMENTAL DATA
WIND - CONCENTRATION

THANK YOU