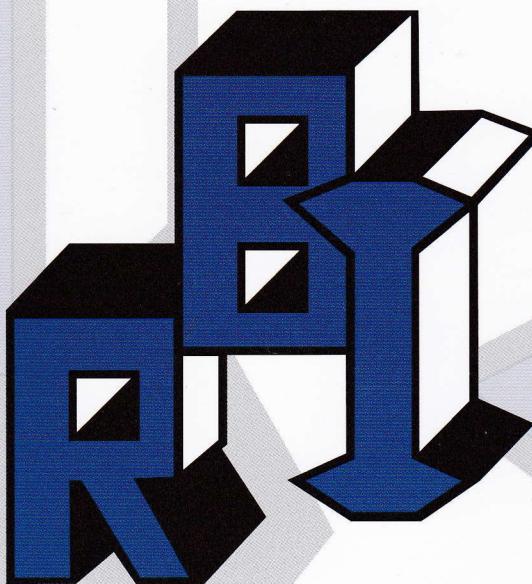


# → Equipment for two-phase flow local measurements

**RBI** designs and produces measuring equipment and signal processing systems for two-phase flow investigation. The performance of such equipment opens a large field of applications in the oil, chemistry, cryogenics and Nuclear power plant industries.

**D**esigned for local measurements, typical equipment is composed of:

- ☞ an optical probe (several sensitive parts are available),
- ☞ electronics which emits the light into the probe and converts the reflected optical signal to electrical information,
- ☞ a specific acquisition board,
- ☞ a user interface software to configure acquisition and treat the data.



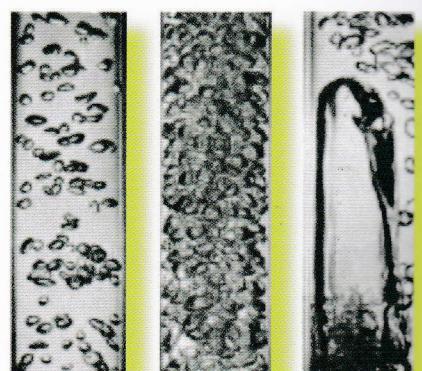
## → GENERAL

In providing accurate information on interface arrival frequencies, interfacial areas, residence times and sizes of bubbles and droplets measurements in gas-liquid enable closer control of the following:

- ☞ two-phase flow in nuclear or chemical plant and the oil industry
- ☞ heat-exchangers efficiency in two-phase flow operation
- ☞ food or pharmaceutical products production processes
- ☞ level measurements in cryogenic research
- ☞ film behaviour in condensation chamber
- ☞ fuel-oil burner atomization...

In other words, plant can be automated and run at optimum conditions.

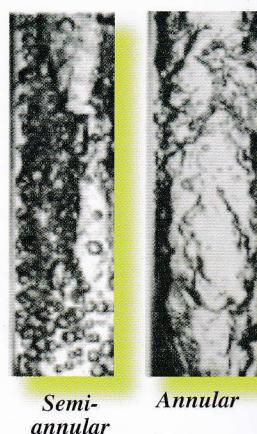
The nuclear engineering and chemical engineering processes studied and oil transportation systems run more efficiency.



Separate bubbles

Clustered bubbles

Slug



Semi-annular

Annular

## → RBI PRODUCES

- ☞ a very complete optical probes and associated optoelectronic amplifiers range,
- ☞ dedicated data acquisition and data processing systems,
- ☞ mechanical supporting devices (displacement and positioning systems...)

### → Operating principle:

Optical probes are sensitive to the change in the refractive index of the surrounding medium. Emitted light hitting the sensitive tip surface is refracted when liquid surrounds tip, and reflected when gas is present. Consequently, bubbles and droplets can be detected at a given point in the flow. Among other information, the optical probe permits measurements of local void fraction and arrival frequency of bubbles and droplets. Using two sensors and a cross-correlation method makes it possible to obtain information on transit velocity. A specific optoelectronic module emits light and converts optical information (reflected light level) to electronic signal.

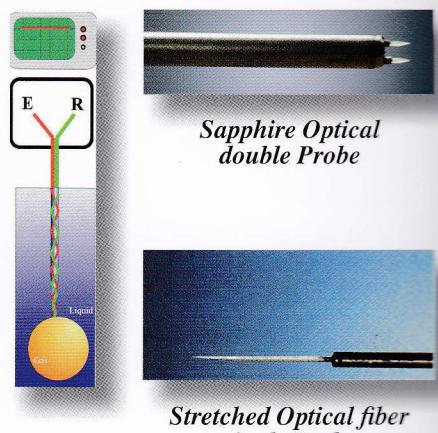
An optical probe is made of two parts:

- a light guide,
- a sensitive cone-shaped tip,

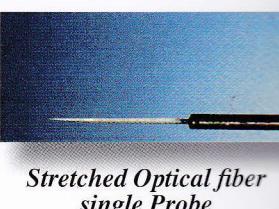
The choice of sensitive part depends on the flowing conditions and geometrical resolution required.

When very thin resolution (detection of submillimetric bubbles) is needed one has to choose stretched optical fiber tip. Pressure (<0.5Mpa) or temperature (<80°C) stresses involve the use of sapphire tips.

## → SENSORS

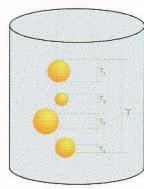


Sapphire Optical double Probe



Optoelectronic Amplifier  
2 channels

## → TWO-PHASE FLOW SPECIFIC QUANTITIES



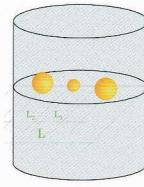
Local void fraction  $\alpha$ :

$$\alpha = \frac{\sum_{i=1}^{i=n} T_i}{T}$$



Instantaneous volumetric fraction:

$$R_G^3 = \frac{\sum_{i=1}^{i=n} V_i}{V}$$



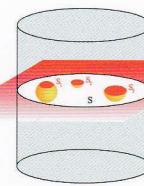
Instantaneous space fraction on a segment:

$$R_G^l = \frac{\sum_{i=1}^{i=n} L_i}{L}$$



Specific area:

Total interfacial area of bubbles in a control volume



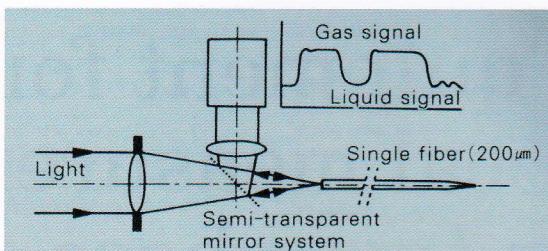
Instantaneous fraction on a section:

$$R_G^s = \frac{\sum_{i=1}^{i=n} S_i}{S}$$

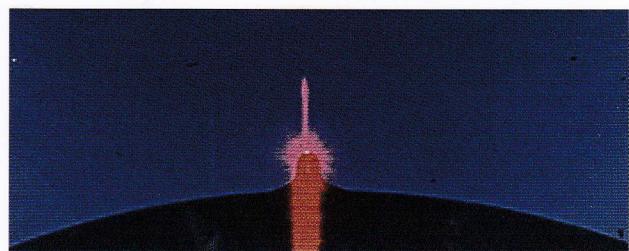


Interface velocity

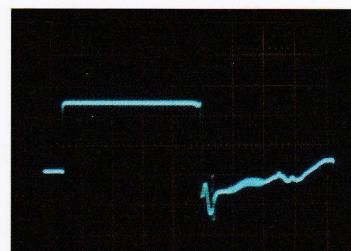
## → PRINCIPLE



Principle



Bubble penetration

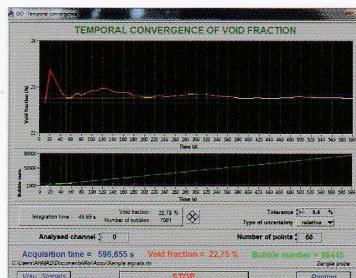


Corresponding Signal

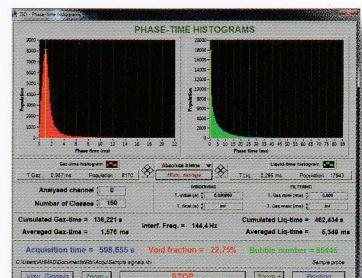
## → DATA ACQUISITION AND PROCESSING



Interface Board - 16 channels



ISO User Interface



# → PROBES SPECIFICATION

Optical Probes					
Optical fiber stretched tips			Sapphire tips		
F1 Optical fiber 200-400			S1 Standard sapphire probe		
	d : 30 µm	P<9 MPa		d : 30 µm	P<9 MPa
SPECIAL SAPPHIRE PROBE			S2 High Temp/high Pressure Probe		
	d : 30 µm	P<9 MPa		d : 30 µm	P≤15,5 MPa
T<200°C			T≤360°C		

Optoelectronic Amplifiers		Acquisition boards
Designation	Associated probe designation	
OPA 1	F 1 S 1	ISO : • 2 Channels • 16 Channels  Specifications : PC + Windows® XP or 7 200 000 events samples, graphic user interface, standard data processing
OPA 2	S 2	
OPA 3	F 2	

Our probes design depends on customers specifications:

□ number of sensitive parts (from 1 to 4) □ tubes diameters □ materials □ optical cable length etc.

*Following photos*

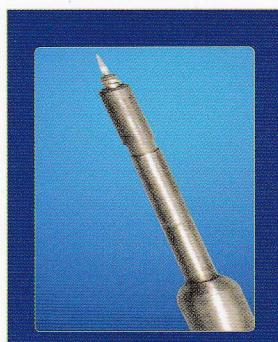
*show some specific*

*supporting devices*

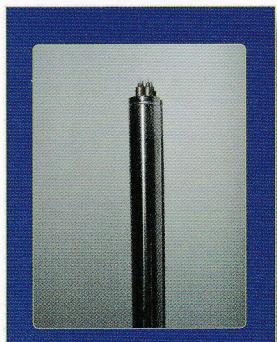
*and special designed*

*probes studied and*

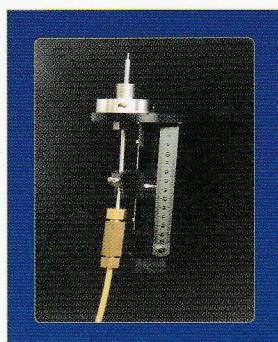
*realized by RBI:*



HT/HP probe



HT/HP double probe



Supporting device:  
moving system



Special design probe