



SLAG DETECTION SYSTEM

Continuous Thermal Monitoring to Minimize Slag Carry-Over in Steel Production



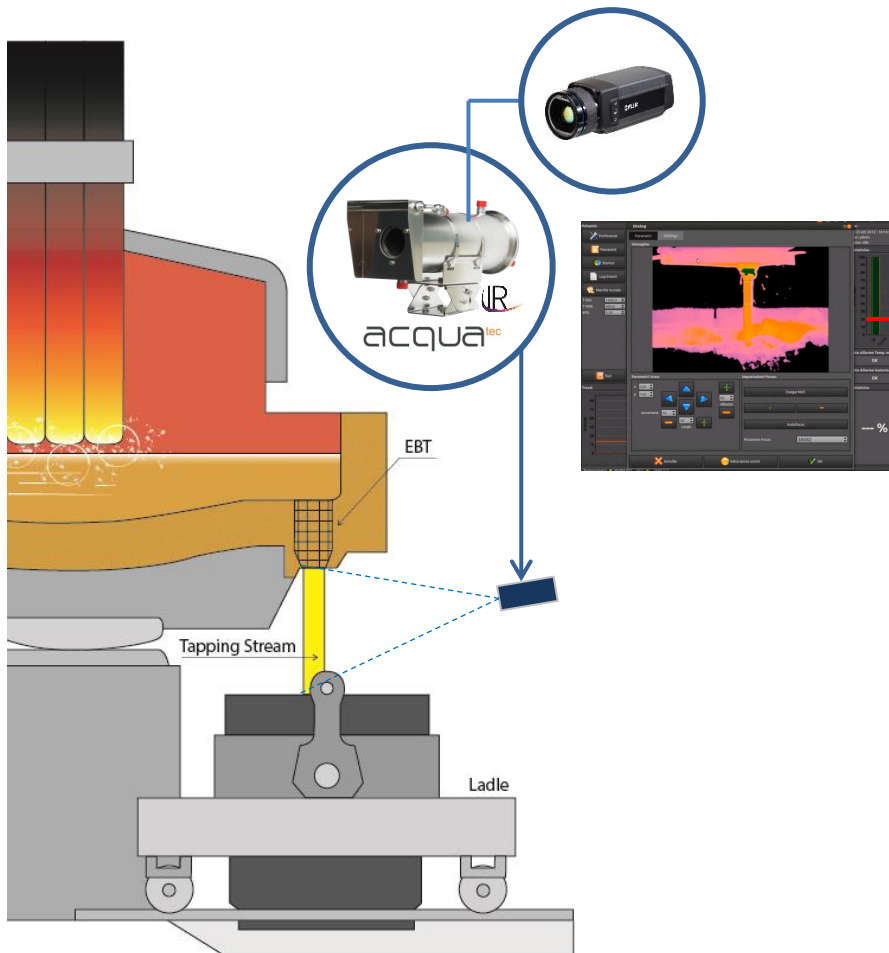
SLAG DETECTION SYSTEM

When liquid steel is tapped from a basic oxygen furnace (BOF) or electric arc furnace (EAF), **it is essential to minimize the quantity of slag carried over into the ladle.**

The innovative slag detection system allows the **highest detection reliability** using thermal imaging cameras protected inside industrial cooled housings and a dedicated software.



SLAG DETECTION SYSTEM'S COMPONENTS



Our basic system includes the following components:

- **IR camera** and lens inside **industrial cooled housing**;
- Industrial image processing unit (PC);
- **Fiber optic signal transmission** for noise free images;
- **Basic display software**;
- **I/O interface module**;

KEY FEATURES

- **Automatic stream identification and tracking** - accurately identifies the stream and reduces background interference
- **Alarms** generated by the system can be used **for directly stop the tap** before the slag is carried over or give alarm to operator
 - **Fully automatic operation**
 - **Reliable alarm** independent of the operator
 - **Improved connectivity** through the use of Ethernet





KEY BENEFITS

- **Improved production yield**
- Lower slag content improving **steel quality**
- Lower maintenance on BOF/ EAF vessel
- **Reduced energy costs**

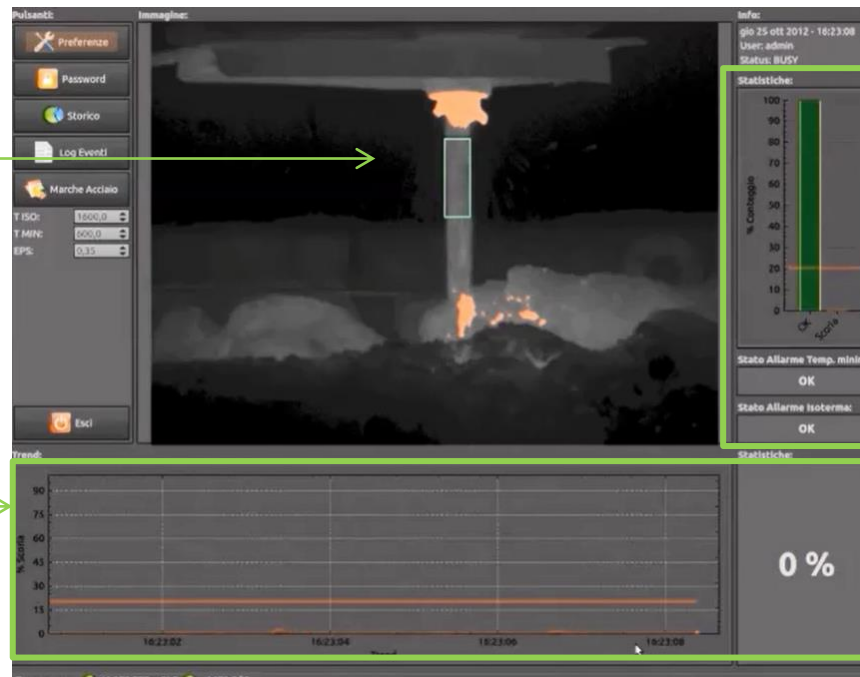


SLAG DETECTION SOFTWARE

Dedicated Software for furnace/ladle casting management

The graphic user interface allows complete control of the process being displayed in real time

- Thermal image in real time



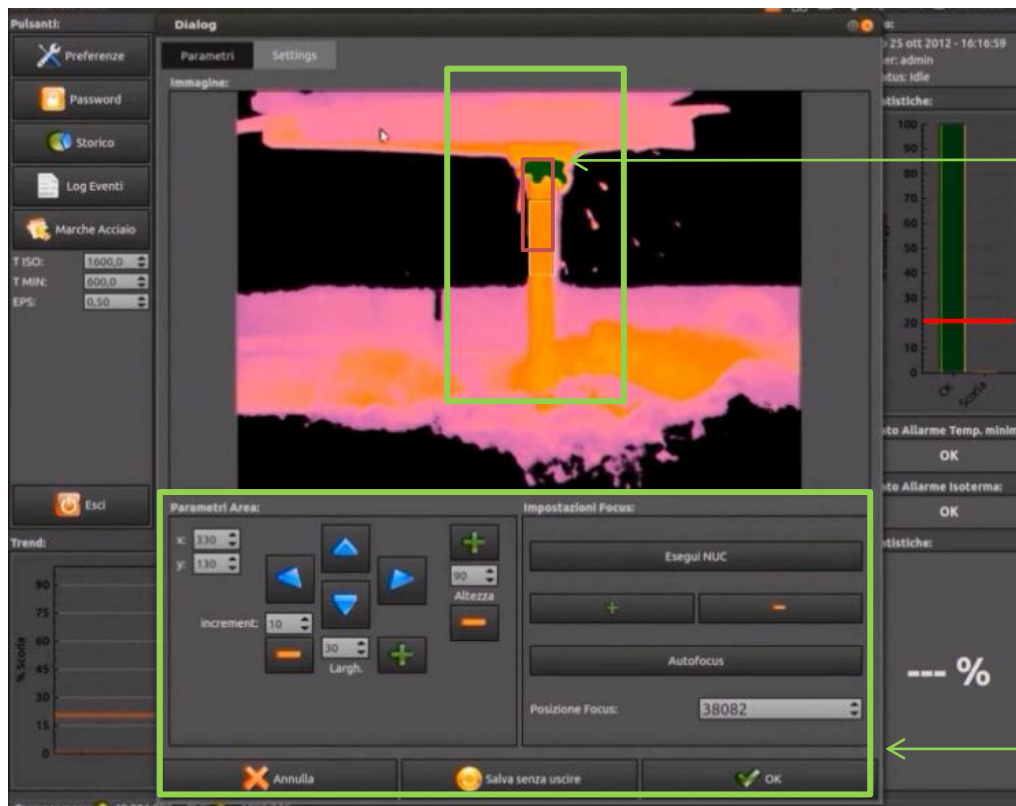
- Alarm level window:

- Steel and slag percentages
- Alarm level
- Alarm status

- Display Graphs:

A bar or line graph displays the steel and slag percentage versus time.

SLAG DETECTION SOFTWARE: INTERFACE

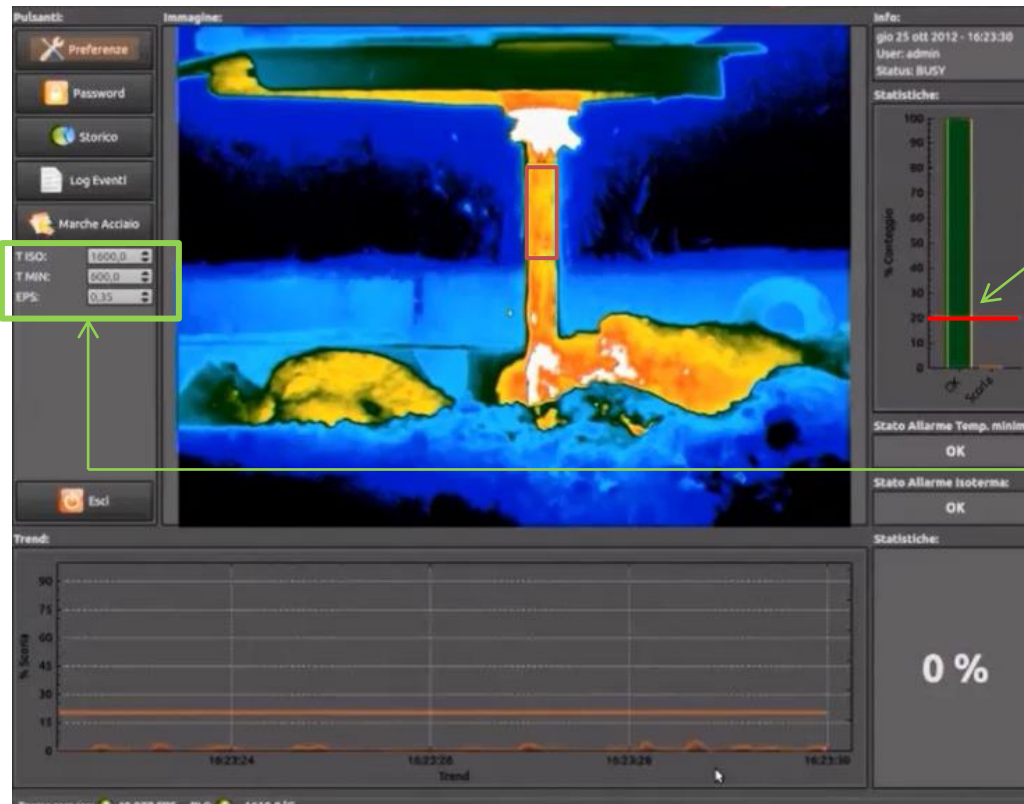


- Automatic Stream Tracking:

Automatically identifies and tracks the stream position within the thermal scene to reduce the effect of background interference.

Settings window for control of camera focus, size and location area for calculating the percentage of steel/slag.

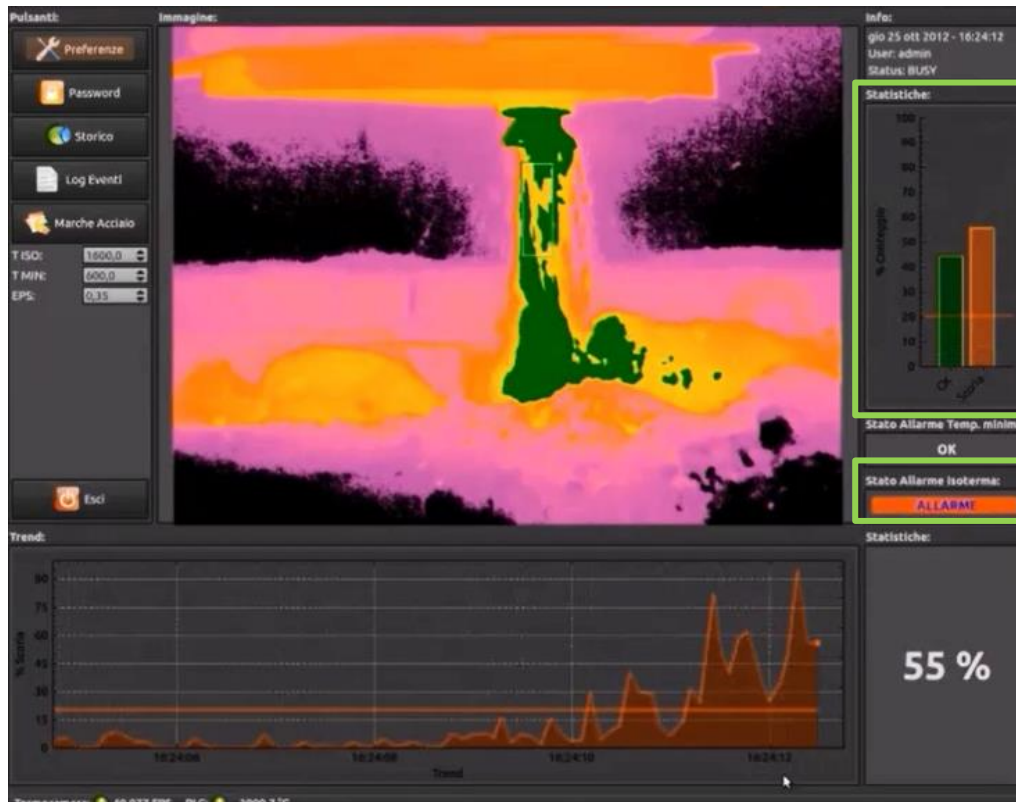
SLAG DETECTION SOFTWARE: INTERFACE



The red line set the alarm threshold in percentage

“T ISO” indicates alarm threshold in temperature, which is set manually or automatically loaded by selecting “Type of Steel”

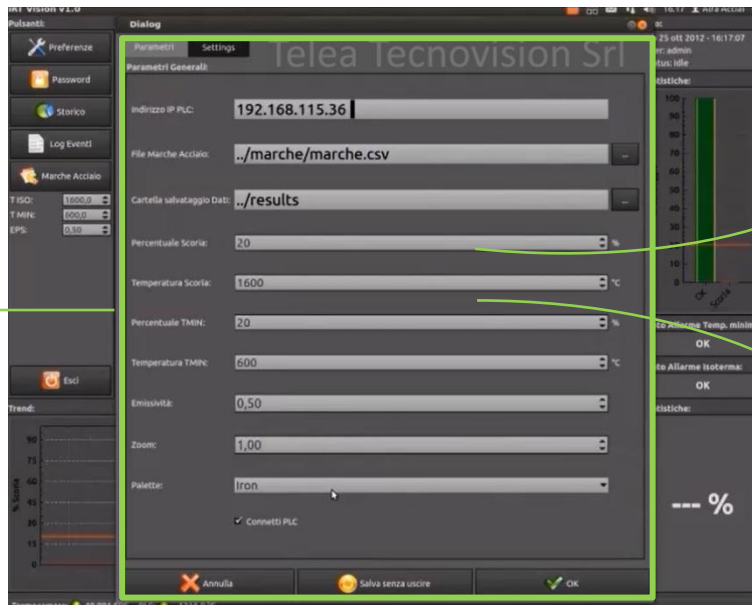
SLAG DETECTION SOFTWARE: INTERFACE



Two bars show constantly the level of steel (green) and slag (orange)

Alarm signal activated if the preset threshold is exceeded

SLAG DETECTION SOFTWARE: INTERFACE



Overlay virtual keyboard

- Setting pages:

You can load the “Type of Steel”, set the temperature alarm, the percentage slag, the saving folder, emissivity, zoom and type palette colours, variables that can be provided directly by the PLC.

TECHNOLOGIES & PRODUCTS

Choice of the most suitable solution:

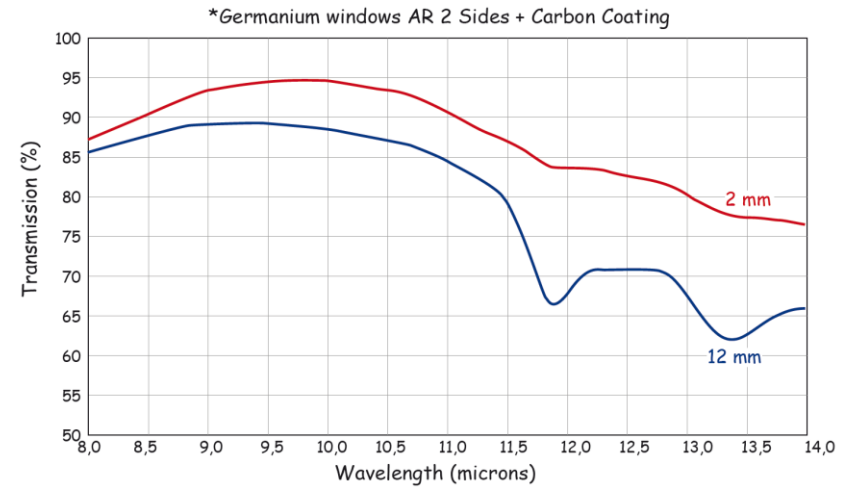
- Different type of IR cameras available;
- Different type of housings available;
- Different type of lens available;



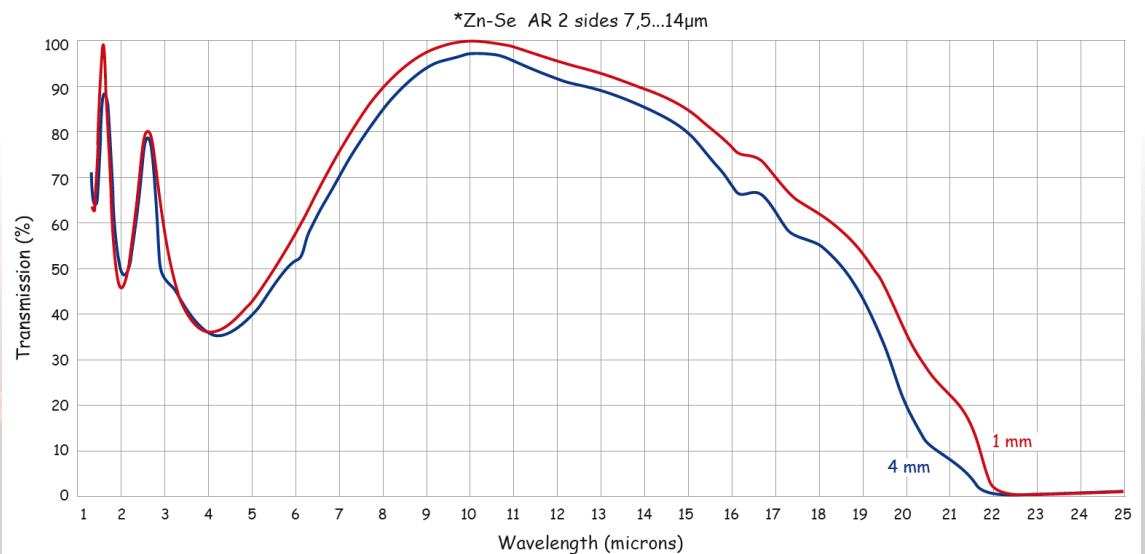
I	R	X	A	B	C	D
			Type of housing	Type of camera	Focal length	Versions
			0: THK525 (with Ge window Ø 55mm)	1: FPA 382 x 288 pixels	4: 7.7 mm	PROGRESSIVE VERSION: Is identified with progressive numbering 1, 2, 3, or other symbol... for change the original project classified with 0 T: Extended temperature
			1: THK with transparent glass	2: FPA 640 x 480 pixels	5: 18.7 mm	
			2: THK525 (with Ge window Ø 30mm)	3: CMOS 764 x 480 pixels	6: 41.5 mm	
			3: ACQUATEC with Ge window	4: FPA 320 x 240 pixels	7: 10.5 mm	
			4: ACQUATEC with Zn-Se window	5: FPA -F 640 x 480 pixels	8: 18 mm + 30mm	
			5: ACQUATEC with transparent glass	6: FPA HT 382 x 288 pixels	9: 41.8 mm	
			6: DOV.57 with Ge window Ø 55mm	7: FPA HT 160 x 120 pixels	A: 16 mm	
			7: DOV.57 with Ge window Ø 30mm		B: 25 mm	
			8: DOV.57		C: 50 mm	
			9: CF.E.05.IR50		D: 75 mm	
			A: AIRTEC		E: 3.3 mm	
			B: ATEX CF.EX.129IRL		F: 5.7 mm	
			C: ATEX CF.EX.129.IRSWL		G: 10 mm	
			D: IRScanDOV54		H: 35.5 mm	
			E: AIRTEC (with GE window Ø 55mm)		L: 20 mm	
					M: 12,7 mm	
					N: 88,9 mm	

TECHNOLOGIES & PRODUCTS

Characteristic curve of Germanium window:



Characteristic curve of Zinco-Selenium window:



TECHNOLOGIES & PRODUCTS

- Different type of thermal imaging cameras available:

FPA detector

Temperature range: -20...+350°C;



IRX-4--

Resolution: 320x240 pixel
Frame rate: 60Hz

FPA detector

Temperature range: -20...+2000°C;



IRX-5--

Resolution: 640x480 pixel
Frame rate: 50Hz

*additional temperature range and other optics can be available;

TECHNOLOGIES & PRODUCTS

- Field of view with IRX-48- camera:

H pixel	V pixel	HFOV	VFOV	Distance	HFOV	VFOV	IFOV
320	240	15°	11°	4 m	1,05 m	0,77 m	3,2 mm
320	240	15°	11°	6 m	1,58 m	1,16 m	4,9 mm
320	240	15°	11°	8 m	2,11 m	1,54 m	6,5 mm
320	240	15°	11°	10 m	2,63 m	1,93 m	8,2 mm
320	240	15°	11°	15 m	3,95 m	2,89 m	12,3 mm



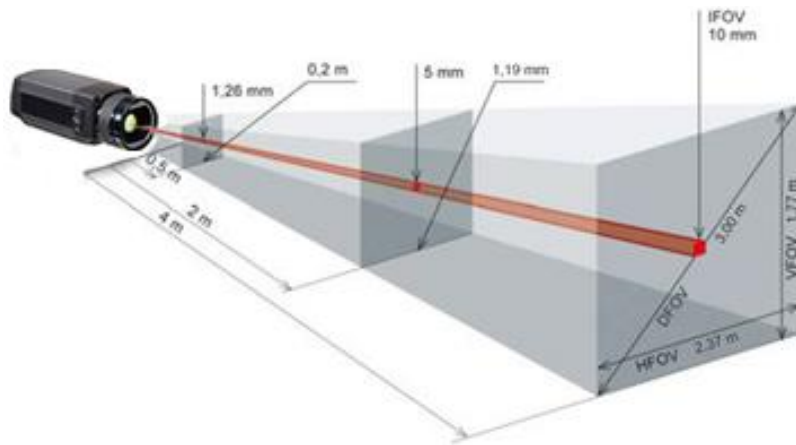
- Field of view with IRX-59- camera:

H pixel	V pixel	HFOV	VFOV	Distance	HFOV	VFOV	IFOV
640	480	15°	11°	4 m	1,05 m	0,77 m	1,64 mm
640	480	15°	11°	6 m	1,58 m	1,16 m	2,45 mm
640	480	15°	11°	8 m	2,11 m	1,54 m	3,27 mm
640	480	15°	11°	10 m	2,63 m	1,93 m	4,09 mm
640	480	15°	11°	15 m	3,95 m	2,89 m	6,14 mm
640	480	15°	11°	20 m	5,26 m	3,86 m	8,18 mm
640	480	15°	11°	25 m	9,21 m	6,75 m	10,23 mm



TECHNOLOGIES & PRODUCTS

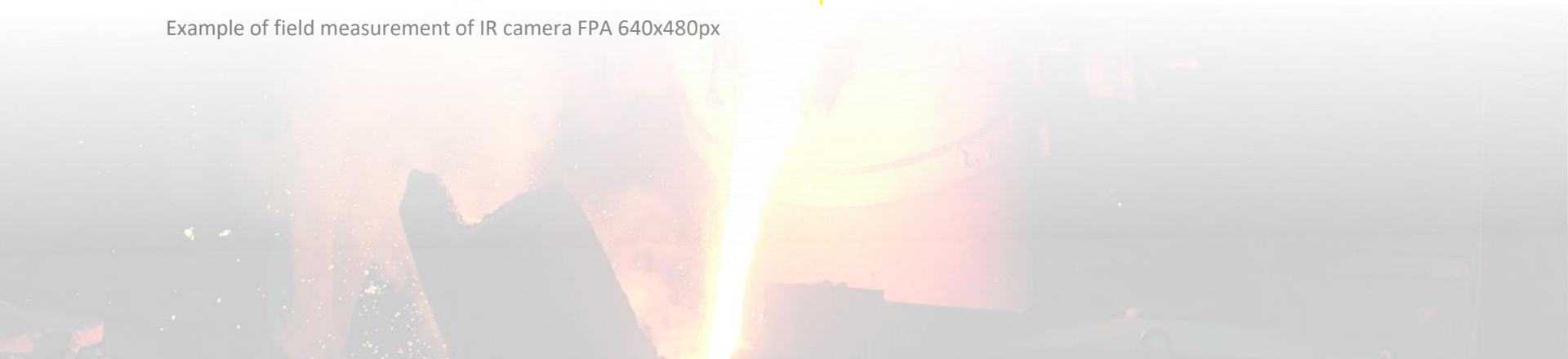
- Different type of thermal imaging cameras available:



Legend:

- HFOV: Horizontal expansion of the total measuring field on the object plane
- VFOV: Vertical expansion of the total measuring field on the object plane
- IFOV: Size of individual pixels on the object plane
- DFOV: Diagonal expansion of the total measuring field on the object plane

Example of field measurement of IR camera FPA 640x480px





TECHNOLOGIES & PRODUCTS

- Example of data exchange table with PLC:

Legend: R= read only; W= write only;

NOME SEGNALE	REGISTRO (%R)	TIPO DATO	NOTE	DIREZIONE
START_CYCLE	400	INT8	Start Ciclo	R
STATUS_BUSY	401	INT8	Stato ciclo a Busy (impegnato)	W
SYSTEM_OK	402	INT8	Sistema regolare	W
SLAG_ALARM	403	INT8	Allarme scoria	W
TMIN_ALARM	404	INT8	Allarme temperatura minima scoria	W
CAM_DISCONNECT	405	INT8	Allarme disconnessione camera	R
				R
CASTING_NUM	409	INT32	Numero di colata	R
SLAG_THRESHOLD	411	INT8	Soglia percentuale allarme scoria	R
SLAG_TIME_MIN	412	INT8	Soglia temporale allarme scoria (ms)	R
SLAG_TMIN_ALARM	413	INT8	Soglia di temperatura minima allarme scoria	R
PESO_RESIDUO	414	INT8	Soglia di temperatura massima allarme scoria	R
TMIN_THRESHOLD	415	INT8	Soglia percentuale allarme temperatura minima	R
TMIN_TIME_MIN	416	INT8	Soglia temporale allarme di temperatura minima (ms)	R
TMIN_TMIN_ALARM	417	INT8	Soglia di temperatura minima allarme temperatura minima	R
EMISSIVITY	418	FLOAT	Emissività	R
CASTING_MANUAL	420	INT8	Marca Acciai in selezione manuale	R
CASTING_SEL_IN	421	INT8	Marca Acciai selezionata nel PLC	R
CASTING_SEL_OUT	422	INT8	Marca Acciai selezionata nel PC	R
TEMPERATURE	423	INT16	Temperatura colata	W