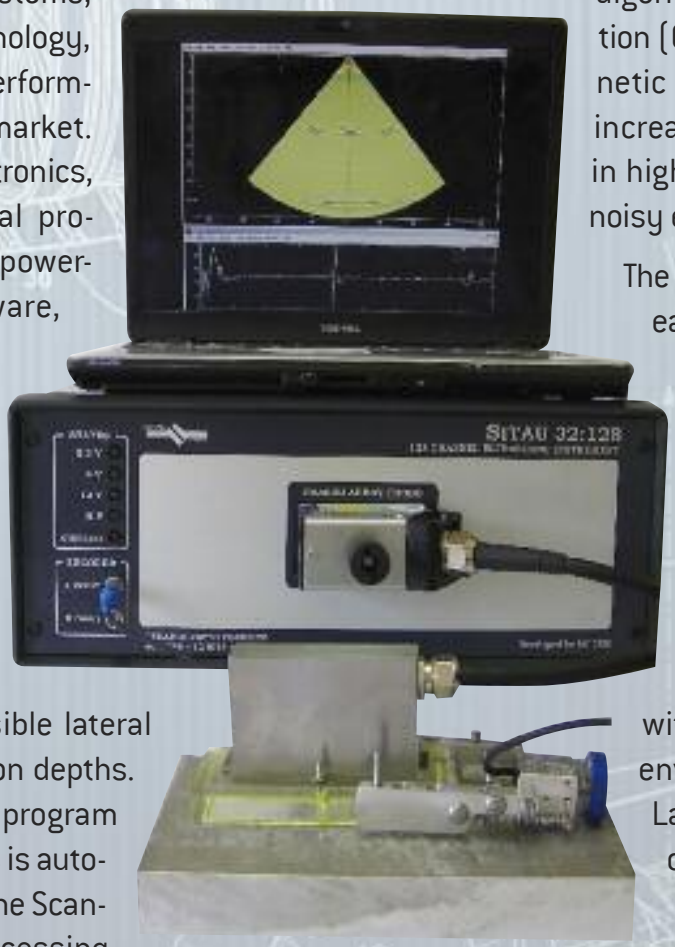
PHASED ARRAY SYSTEMS

Phased Array systems, by using several transducer elements, are capable of obtaining real-time images.

Our phased array systems, based on the **SITAU** technology, are among the highest performance equipments in the market. Their high resolution electronics, along with unique signal processing algorithms and powerful evaluation software, allows obtaining high quality images in any inspection condition.

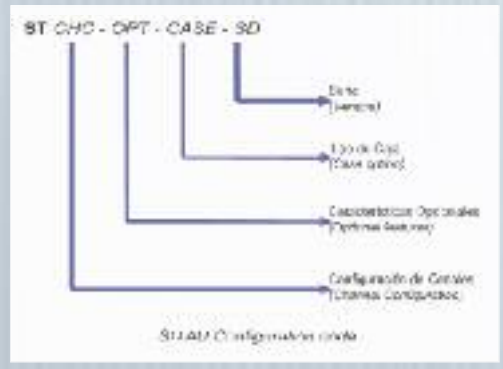


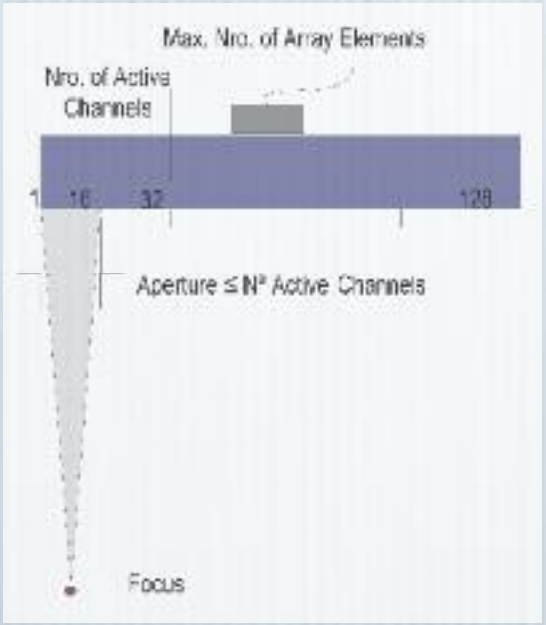
SITAU equipments are the only ones that integrate the **Progressive Focal Correction Technique (ProFoc)**, achieving the best possible lateral resolution at all inspection depths. It also avoids the user to program the focus position, as this is automatically carried out by the ScanView software. Other processing algorithms such as Coded Excitation (**CoDex**), and the Electromagnetic Interference Filter (**EMI**) increase the signal-to-noise ratio in highly attenuating materials or noisy environments.

The **ScanView** software allows to easily program all the inspection parameters while being a powerful acquisition and defect evaluation tool. To easily integrate SITAU systems in automated inspection machines, **DASEL** provides a full set of software libraries compatible with most used development environments, such as C++, LabView, Python, Visual Basic or Matlab.

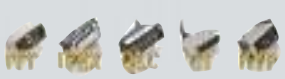
SITAU SERIES SELECTION GUIDE

SITAU, the phased-array solution that better fits your needs.





SITAU phased array technology offers you the flexibility of a custom-made system at a very competitive price. The number of active channels and encoder inputs, and the type of connector and case are some of the configurable parameters to better adapt the equipment to your inspection requirements. Some special featured models are: **MC** (with conventional channels), **LF** (for low frequency), **PC** (with embedded computer) and **TR** (with pitch-catch connector).

CHC	Channel Configuration		
Code	Number of Active Channels	Maximum Number of Array Elements	Number of Array Connectors
331	32	32	1
332	32	32	2
334	32	32	4
311	32	128	1
312	32	128	2
661	64	64	1
991	96	96	1
111	128	128	1
OPT	**Optional Features**		
LF	Adapted to operate with low frequency arrays		
TR	With array connector for Trough-Transmission or Pitch-Catch mode		
PC	With on-board Computer		
MCXX	Multi-channel (XX: Multiplexed channels number)		
CASE	**Case Option**		
63D	Desktop Rack 3U - 63HP		
84D	Desktop Rack 3U - 84HP		
84R	Industrial Rack for Cabinet mount 3U – 84HP		
PRT	Rugged and Portable Case (with batteries and touch-screen tablet PC)		
STP	**Customization Code**		
00	Standard Equipment		
others	Customized Equipment		
Connector Type			

SITAU TECHNICAL SPECIFICATIONS

DASEL offers four standard types of cases for the SITAU systems in all versions (MC, LF and PF) to fulfil your application requirements. Moreover, their modular architecture allows us to design custom-made cases under customer request.

TECHNICAL FEATURES OF SITAU SYSTEMS		
Excitation type	Negative square wave pulse	
Excitation voltage	[OPT ≠ MC]	100 V
	[OPT = MC]	Phased Array : 100 V
		Multi-channel : Programmable from 20 V to 190 V
Pulse width	[OPT ≠ LF]	Programmable from 50 ns to 1.6 us, with a resolution of 6.25 ns
	[OPT = LF]	Programmable from 50 ns to 25.5 us, with a resolution of 25 ns
Pulse repetition frequency (PRF)	≤ 20 kHz	
Burst mode	≤ 256 consecutive pulses	
Coded excitation	Programmable codes of 16 bits length	
RECEIVER AMPLIFIER		
Amplifier type	Wide-band and low-noise amplifier	
Gain	Programmable: 0 to 100 dB	
CAT (TGC)	Arbitrary Time-Gain-Compensation curve (2048 points)	
Bandwidth (-3 dB)	[OPT ≠ LF]	0.8 MHz to 16 MHz
	[OPT = LF]	30 KHz to 2 MHz
Anti-aliasing filter	[OPT ≠ LF]	Low-pass, fC = 16 MHz
	[OPT = LF]	Low-pass, fC = 2 MHz
Equivalent input noise	[OPT ≠ LF]	3.5 μV rms
	[OPT = LF]	1.1 μV rms
Input protection circuit	Low resistance MOSFET active circuit	
A/D Converter		
Resolution	12 bits	
Sampling frequency	40 MHz	
Hardware interpolation	160 MHz (Lagrange filter bank).	
Acquisition depth	Phased-Array	Programmable up to 20.000 samples per scan line.
	Parallel Acquisition	Programmable up to 4.096 samples per array element.
Beamformer		
Focusing delays	Programmable for each channel (up to 409μs, resolution of 6.25 ns). Independent for emission & reception.	
Real Time Dynamic Focusing	Focus at every image sample (hardware implemented).	
Focusing technique	Progressive Focal Law Correction (PFLC) with Lagrange interpolation.	
Delay resolution	± 3.125 ns -> timing resolution equivalent to 160 MHz.	
Dynamic aperture	Programmable per channel and scan line.	
Trigger modes		
Trigger modes by model	[CASE = 63D, 84D, 84R, PRT]	Software Trigger.
	[CASE = 63D, 84D, 84R, PRT]	Encoder Trigger.
	[CASE = 63D y 84D]	Ext. Input Signal Trigger.
Signal processing		
Signal processing features	Real-time signal processing of acquired scan lines (Hardware Implemented)	
Digital Filter	Band-Pass filter with programmable cutoff frequencies 63 coefficients FIR implementation).	
Envelope detection	Digital, implemented by Hilbert Transform	
Scan compression	Non-Peak-Loss compression algorithm, up to 128:1 compression rate	
Acquisition modes (GMR and Autofocus)	A-scan, B-scan, peak position and amplitude (gates), encoders count	
Other specifications		
Power consumption	[CHC = 311, 312, 331, 332, 334]	58 W
	[CHC = 661]	95 W
	[CHC = 991]	132 W
	[CHC = 111]	166 W
Power supply	100- 220 Volt 47- 63 Hz , Fusible 3 A.	
Batteries	[CASE = PRT] 2 lithium batteries of 6.6Ah each one.	
Dimensions	[CASE = 63D]	360 x 150 x 390 mm
	[CASE = 84D]	470 x 150 x 450 mm
	[CASE = 84R]	480 x 130 x 420 mm
	[CASE = PRT]	490 x 230 x 400 mm
Approximately Weight	[CASE = 63D]	7.5 Kg
	[CASE = 84D]	8.5 Kg
	[CASE = 84R]	9.2 Kg
	[CASE = PRT]	4.5 Kg

GNR FILTER: SEE BEYOND STRUCTURAL NOISE

NO MATTER GRAIN NOISE PRESENT ON THE MATERIAL

GNR filter*: included in all SITAU models, reduces grain noise and improves flaw detection by increasing the signal to noise ratio.

GNR filter is an advanced image processing technique that reduces **grain noise** while preserving flaw indications:

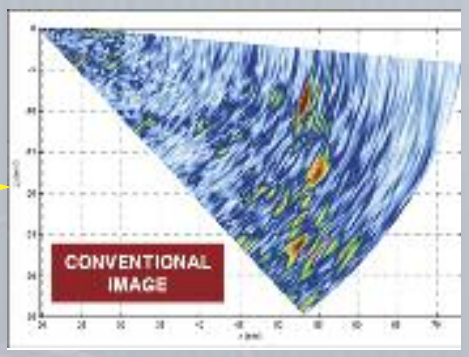
- Real time: no PRF reduction.
- Simple operation: no user defined parameters.
- Reliable: no missed defects.
- Specially designed for Fiberglass or Carbonfiber reinforced parts inspections and austenitic steel welds and parts.

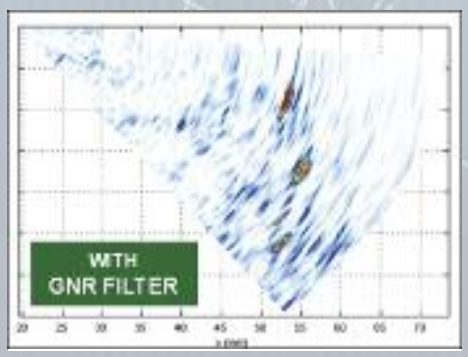
A valuable tool for most applications.

- Stainless steel welding inspections.
- Wind-blades **GFRP** inspections.
- Aerospace **CFRF** testing.

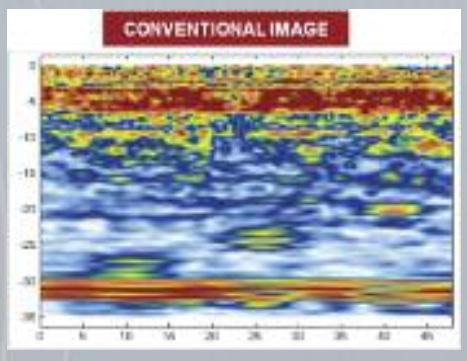
GNR filter feature:

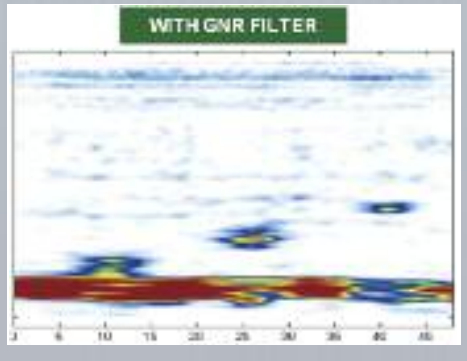
- Reduces grain noise.
- Improves contrast.
- Improves spatial resolution.
- Suppress grating lobes indications






Wind Mill Blade Sample





*GNR Filter is based on the patent "Phase Coherence Imaging Technique" (PCT/ES09/070303)

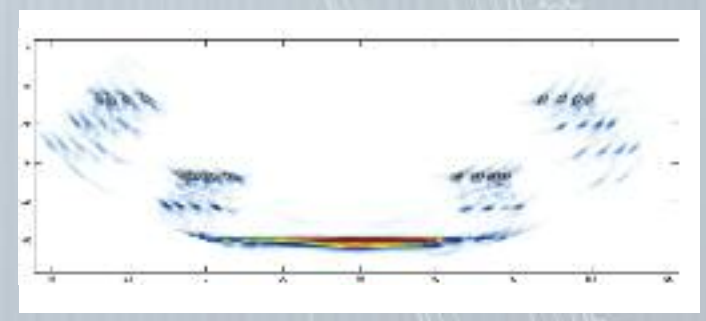
AUTOFOCUS: GET THE BEST IMAGE QUALITY WITH A SINGLE CLICK...

NO MATTER HOW COMPLEX THE GEOMETRY IS

A fully automated process detects the surface profile of the part, calculates the focal laws and programs the equipment to get the best possible image. No matter how complex the geometry is, **Auto-Focusing** will set-up all parameters for you.

It not only saves you time, but also allows you to face challenging inspections where the part geometry is not accurately known or changes during the scan.

Auto-focusing algorithm, included in all SITAU models, simplifies the process of setting-up a phased-array inspection.



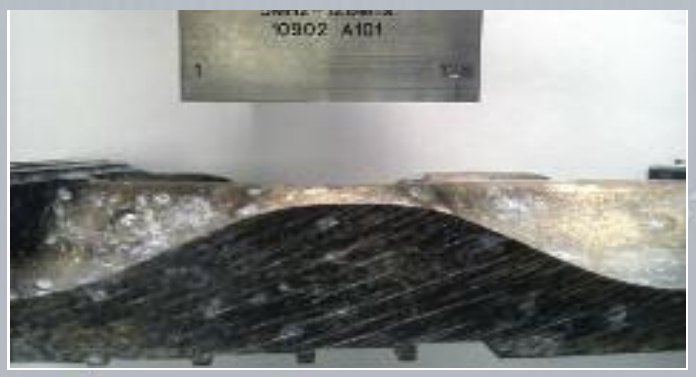
Auto-focusing is a fully automated 2-step process, carried out in less than 1 second:

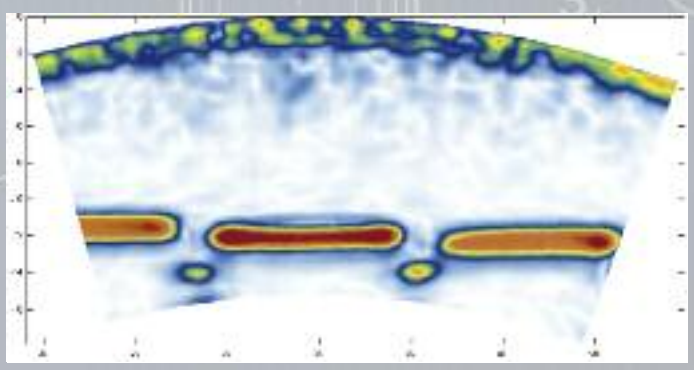
1 - Part geometry detection: Using a few emission events, the geometry of the part is detected and estimated.

2 - Focal-Law calculation: With our patented Virtual-Array method, dynamic focal laws are calculated for the whole image, giving the best resolution at all depths.

Typical applications:

- Water-tank immersion inspections.
- Irregular surface parts.
- Custom-developed wedges.
- Automated inspection of shape varying components.





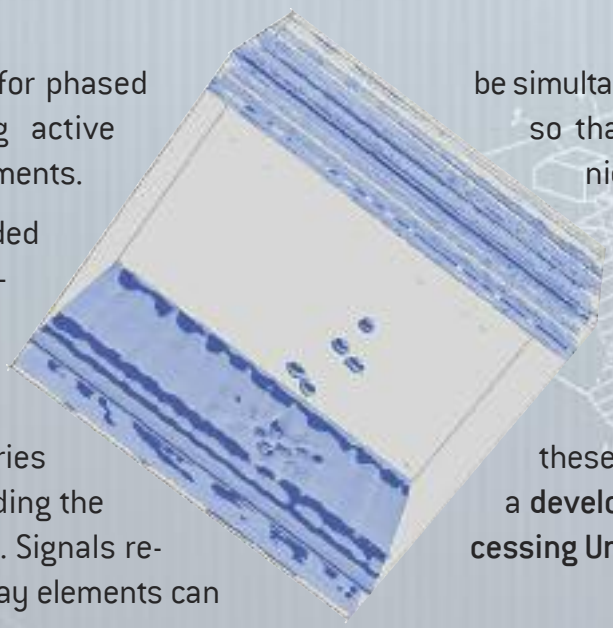
FULL PARALLEL PHASED ARRAY

SITAU FP (Full Parallel)

Undoubtedly the most advanced technology of the SITAU series, allowing simultaneous control of up to 1024 ultrasound channels

This is the ideal solution for phased array inspections requiring active apertures larger than 128 elements.

SITAU FP, along with provided Matlab, LabVIEW, C++, etc. libraries which can be interfaced with **GPU platforms; SITAU FP** becomes a powerful tool for Ultrasound Laboratories and **Research Centres**, providing the maximum possible flexibility. Signals received by each one of the array elements can be simultaneously acquired and stored, so that Synthetic Aperture Techniques (**SAFT**), Full matrix capture (**FMC**), total focusing method (**TFM**), Sampled Phased array, can be implemented.

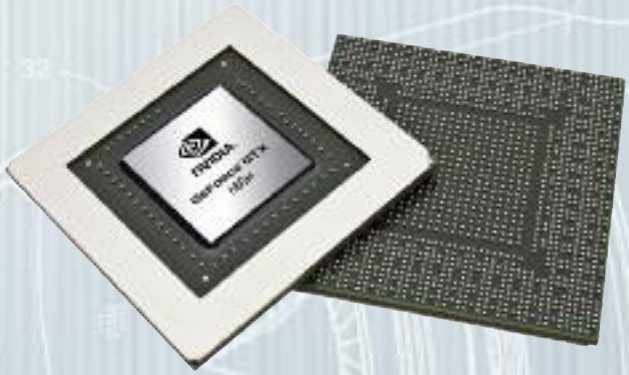


For the implementation of these techniques, DASEL provides a **development kit for Graphics Processing Units (GPU) programming**.

Full Parallel Systems (SITAU FP)				
Model	Active Channels	Array Elements	Array Connectors	Others
STP1-84	128	128	1 pulse-echo	8 Encoders input Sinc Out Trigger In
STP2-84	256	256	2 pulse-echo	
STP3-84	384	384	3 pulse-echo	
STP4-84	512	512	4 pulse-echo	
STP5-84	1.024	1.024	8 pulse-echo	
STPX-84	Customizable	Customizable	X pulse-echo	

All SITAU FP models are also available for Low Frequency Arrays, see LF model features.

GPU DEVELOPMENT KIT



Complete your SITAU Phased-Array system with the power of GPU's.

SITAU GPUs package was developed for interfacing DASEL's technology with this powerful processing hardware using **PyOpenCL**, the most extended multi-platform programming language. Acquired data can be easily handled and plotted using Python packages, such as, Scipy, Numpy, etc.

SITAU Python's package also includes innovative procedures for **3D reconstruction** at high frame rates. This novel 3D imaging modality combines two techniques: Phased Array (PA) and Synthetic Aperture Focusing (SAFT), to get an accurate representation and quantification of flaws. The method uses conventional linear PA probes and a mechanical scanning to inspect the whole volume of the component with high resolution in all axes.

On SITAU Python's package you will find a complete set of example functions for ultrasonic imaging. These functions were used to obtain the 3D image of a "spring" showed on the right:

- Ultrasonic data was captured on SITAU-111-84D Full Parallel Phased Array system with 128 active channels using a Python script.

- Image reconstruction was performed on a GPU platform using PyOpenCL.

- Visualization was carried out on Mavayi embedded on Python.

You can use any Python IDE for Eclipse if you are familiarized with these tools and keep your project organized. These tools also provide many other features for authoring, modifying, compiling, deploying and debugging your software.

3D algorithms technical features

- Easy integration on your Python code
- Flexible hardware platform selection (CPU or GPU).
- 3D algorithm tested at 6 frames of 97x1860 pixels per second.