CLICdp Collaboration Meeting

Vertex detector mechanics and cooling update

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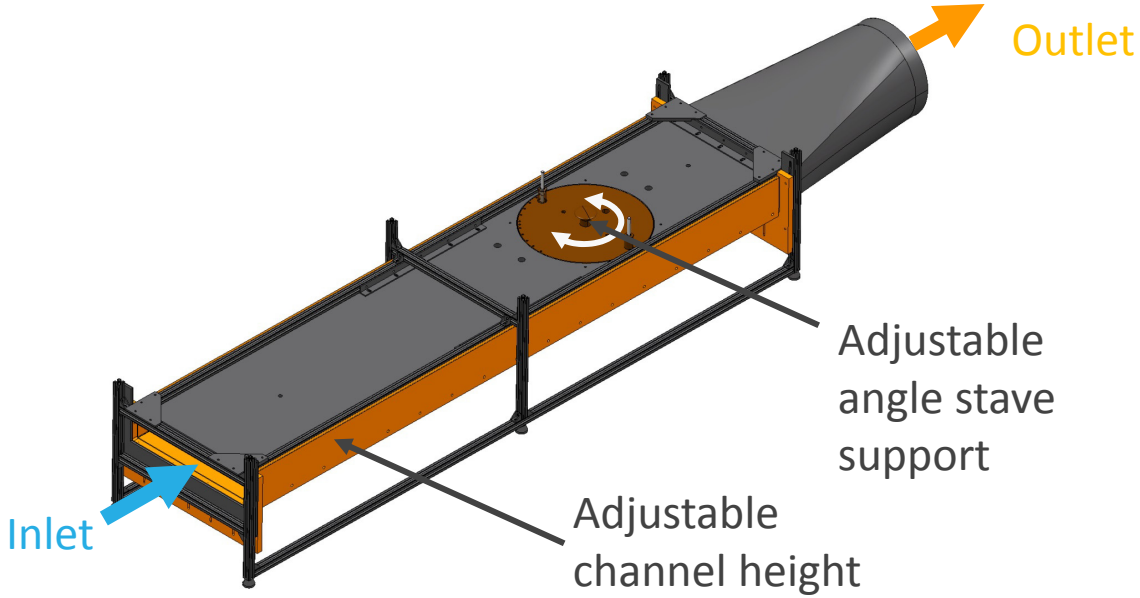
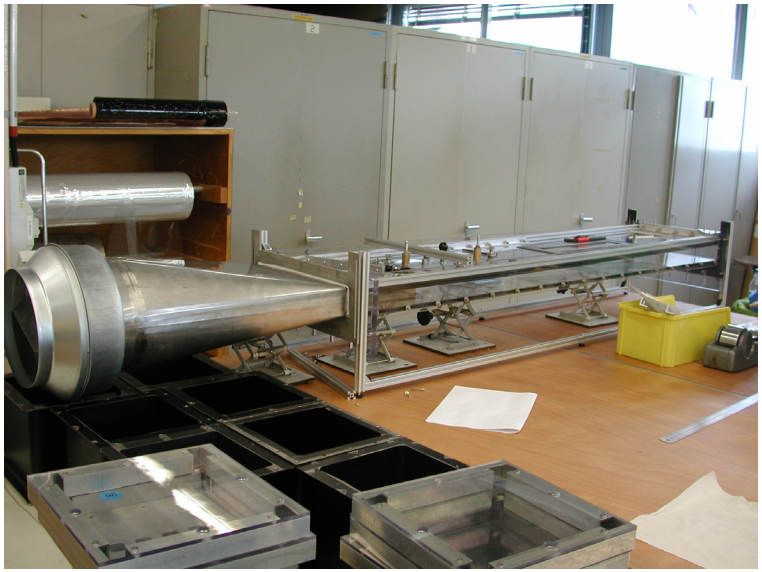
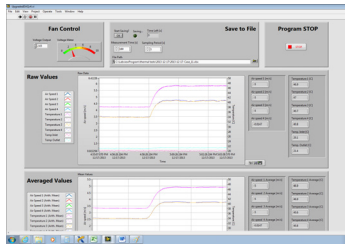
June 11, 2014

Thermo-mechanical test bench



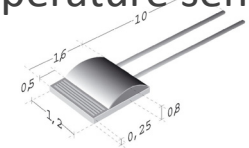


LabVIEW interface



Schmidt anemometer

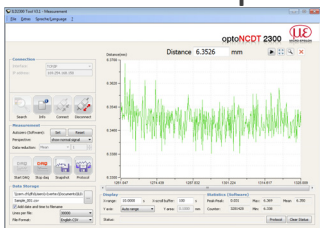
Temperature sensors

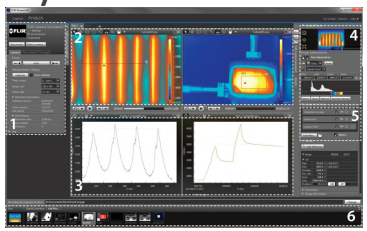


Micro-Epsilon vibration sensor

FLIR thermal camera

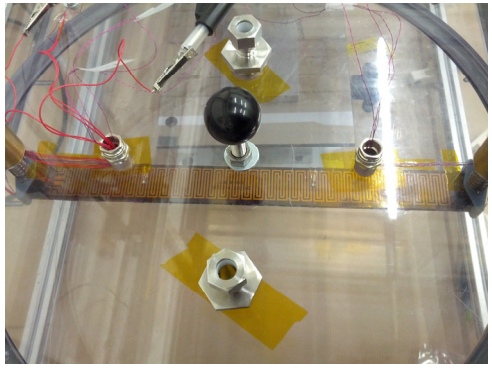
Proprietary software



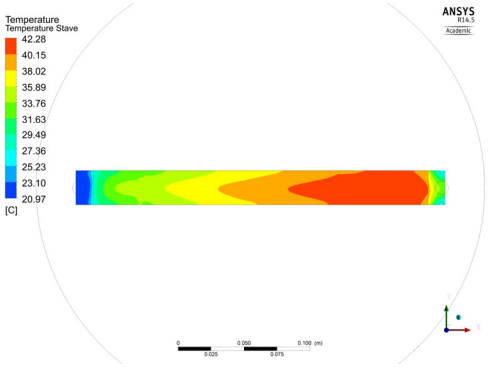


Thermal studies on dummy staves

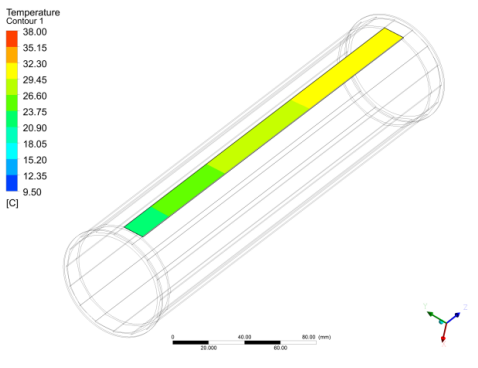
Stave temperature measurements

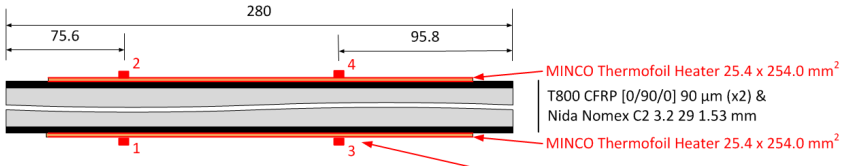


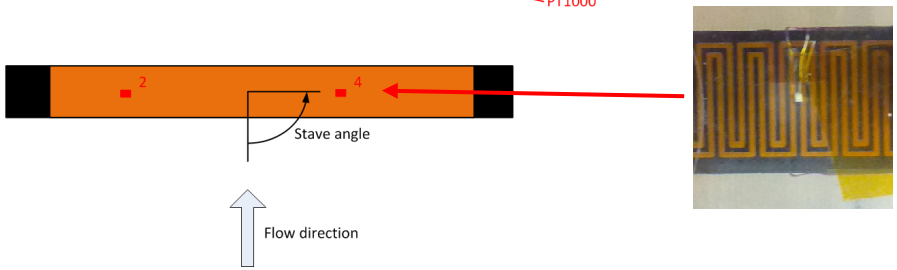
Dedicated simulations

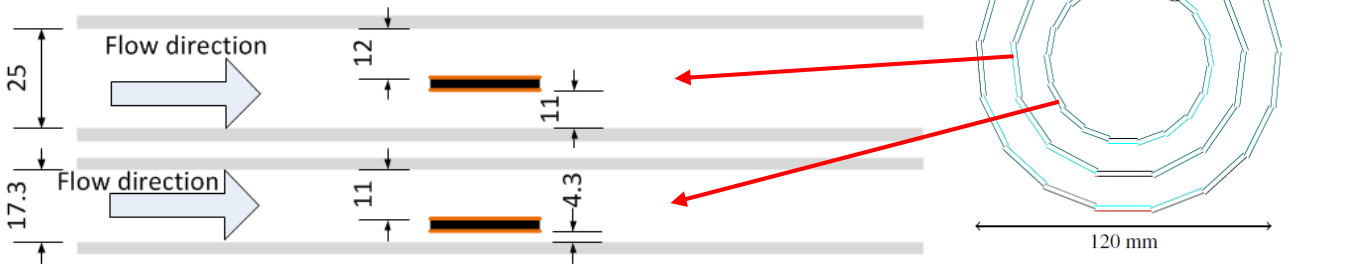


Preliminary validation



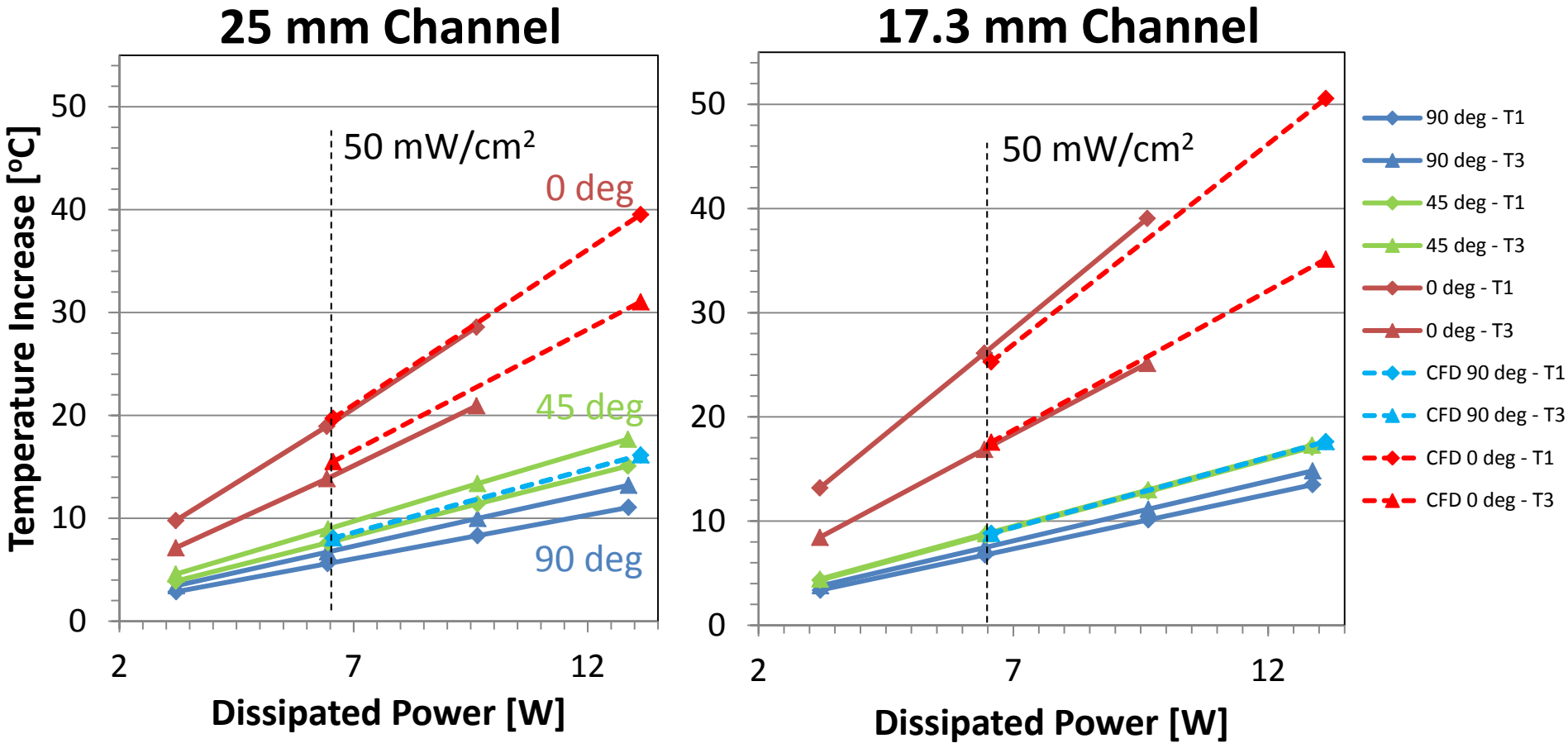






Stave thermal tests

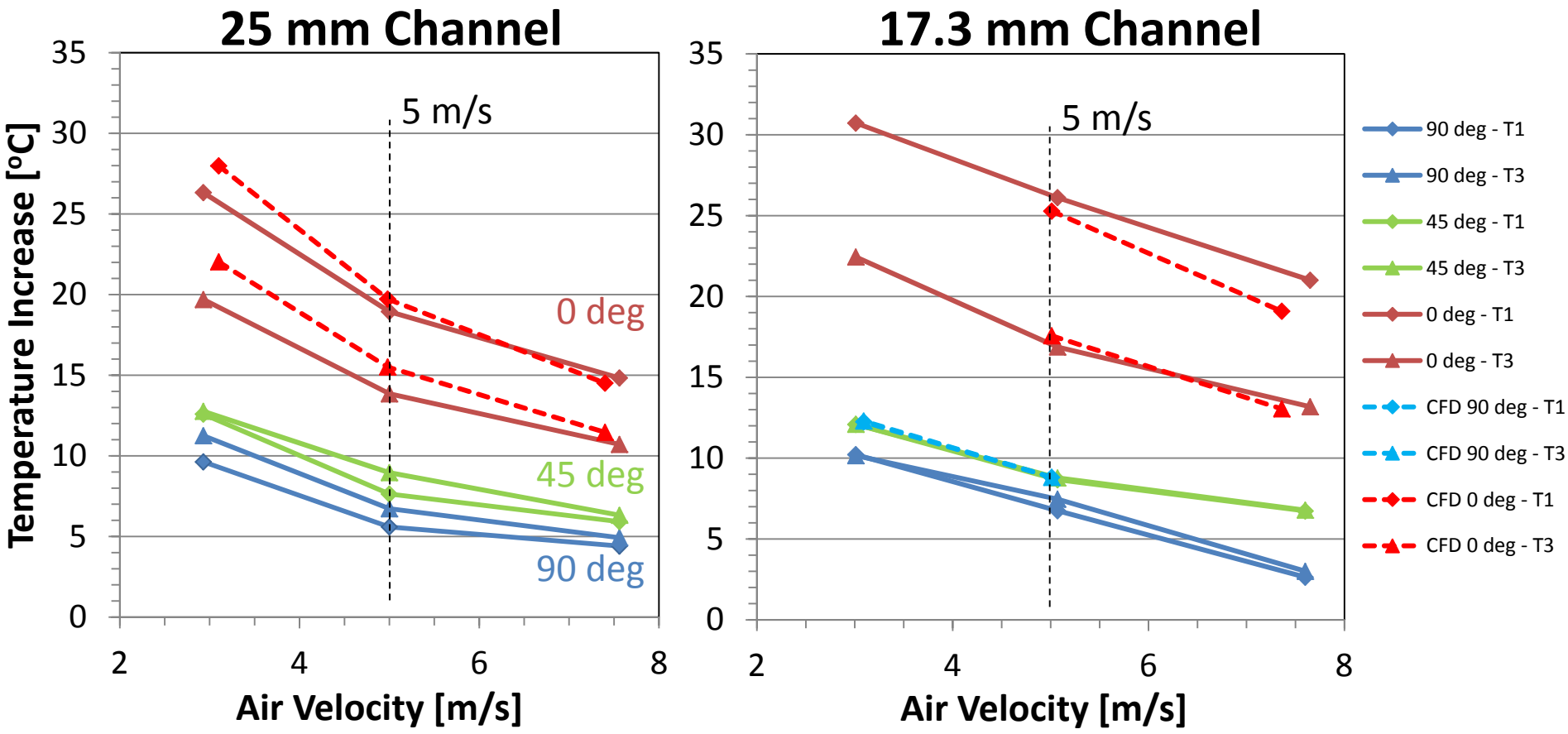
Constant air velocity (5 m/s)



Simulated Measured

Stave thermal tests

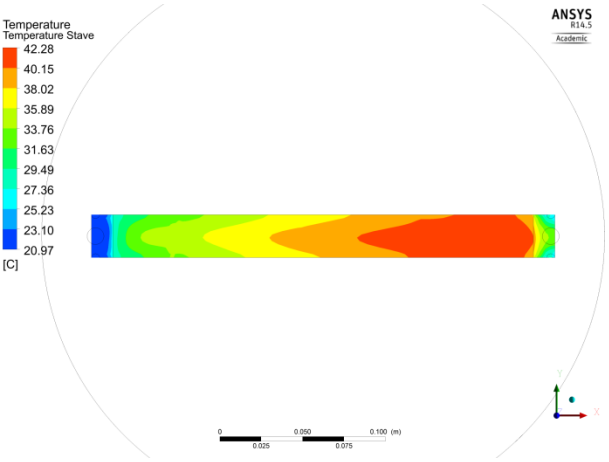
Constant heat dissipation (50 mW/cm^2)

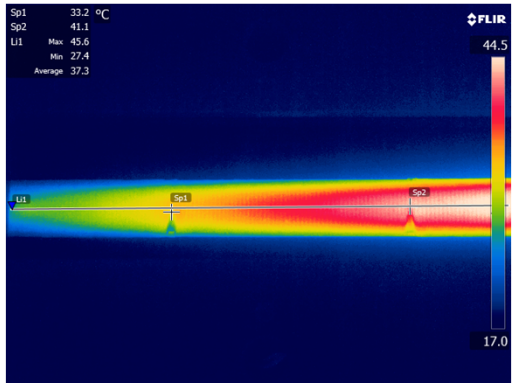


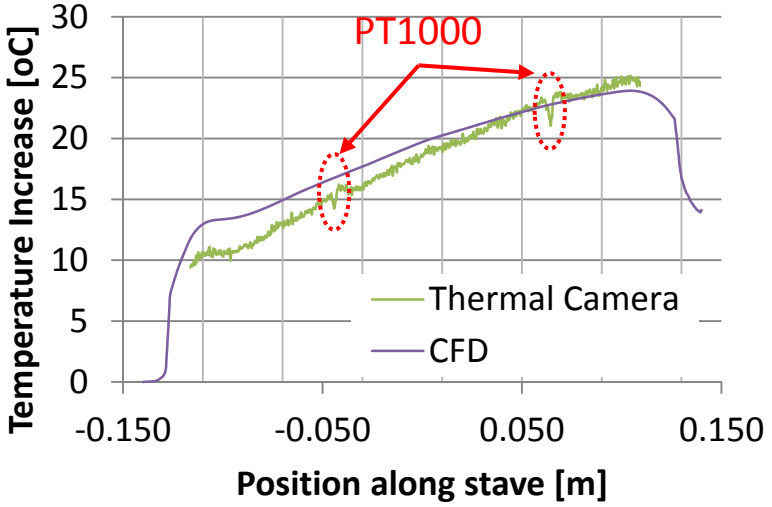
Simulated Measured

Measurements vs. simulations

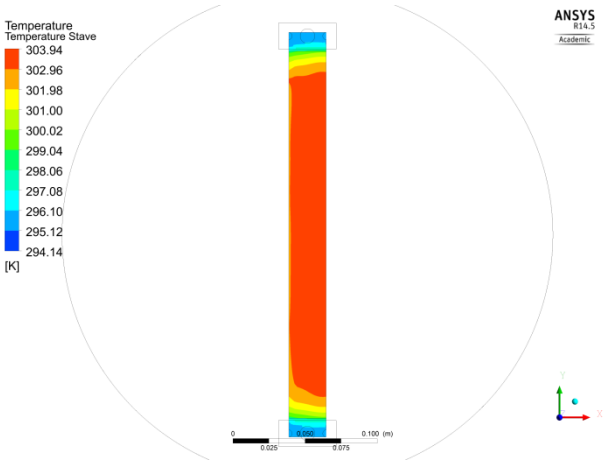
0 deg

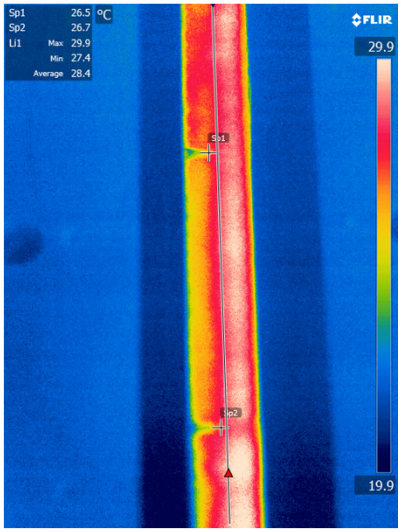


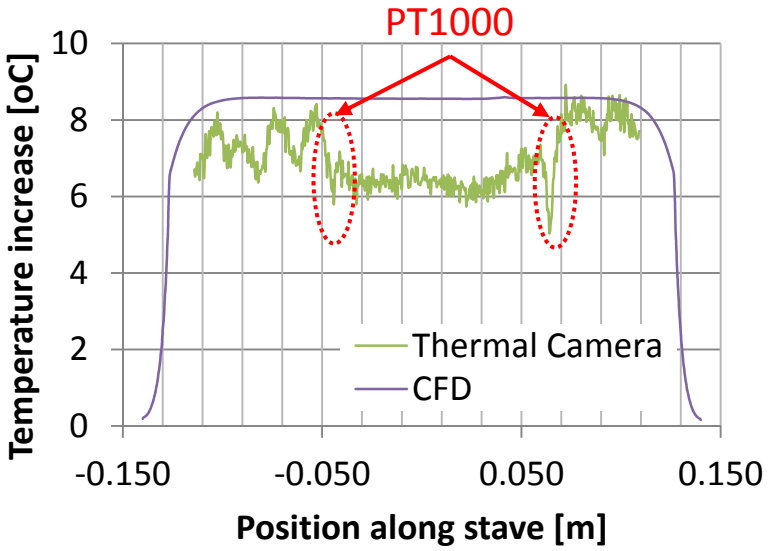




90 deg

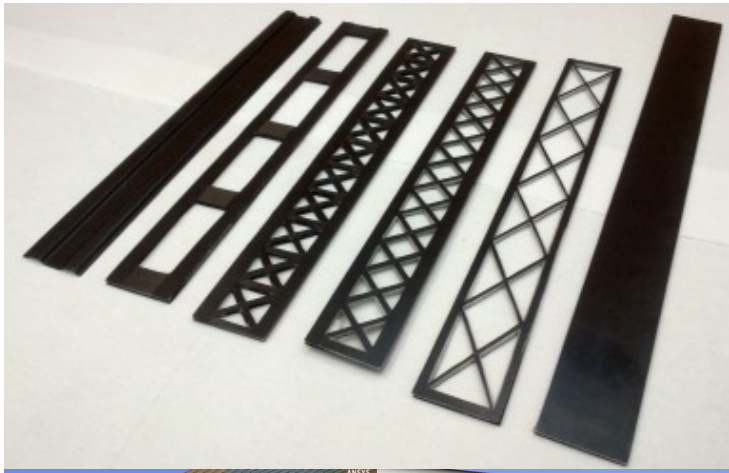


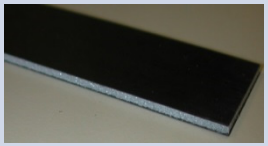
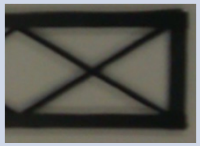
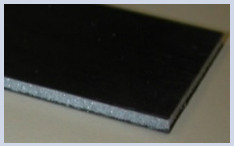
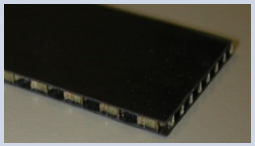




Stave support structures

- Development of support structures that fulfil the 0.05% X0 of radiation length (1.8x26x280mm^3);
- 2 designs currently being pursued (full sandwich & cross bracing);
- Other ideas being investigated (Omega shape, filament winding,...).

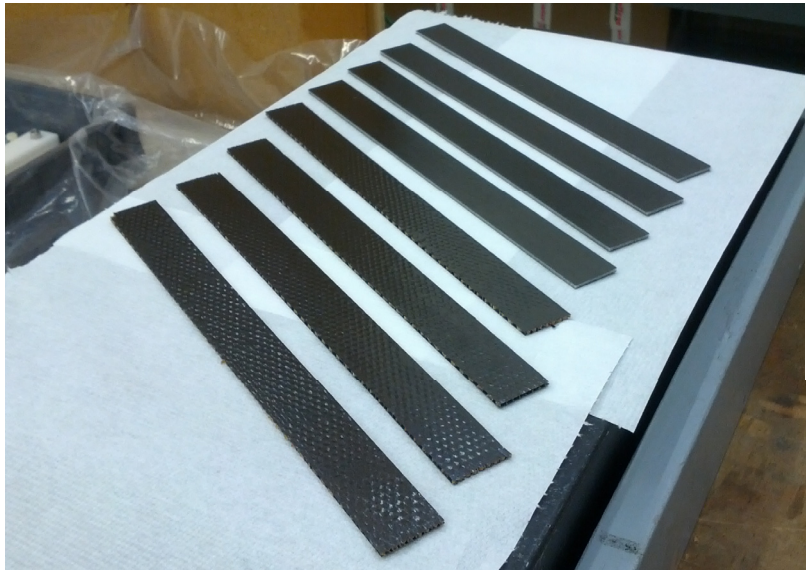


Stave label #	#1	#5	#7	#8
Material	M55J + Rohacell 51 	M55J + Rohacell 51 	T800 [0°; 90°; 0°] + Rohacell 51 	T800 [0°; 90°; 0°] + Nomex HC 
Flexural stiffness (N/mm) Measurements	6.95 N/mm	2.23 N/mm	2.12 N/mm	2.17 N/mm
Flexural stiffness (N/mm) FEM Model	6.95 N/mm	2.30 N/mm	2.15 N/mm	2.26 N/mm
Mass (g) 280mm long	3.74 g	1.76g	3.17 g	3.45 g
X/X0 %	0.121 %	0.051%	0.104 %	0.112 %

Stave support structures

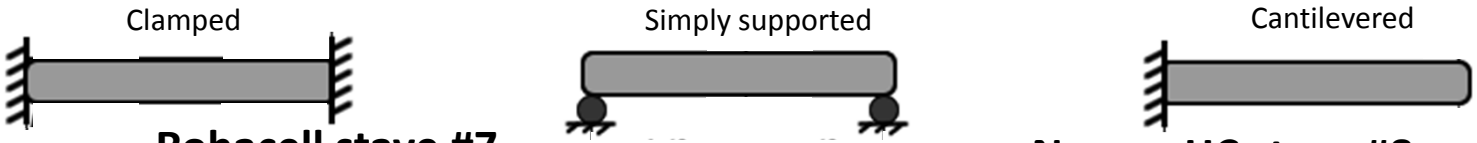
Estimated properties (to be measured)

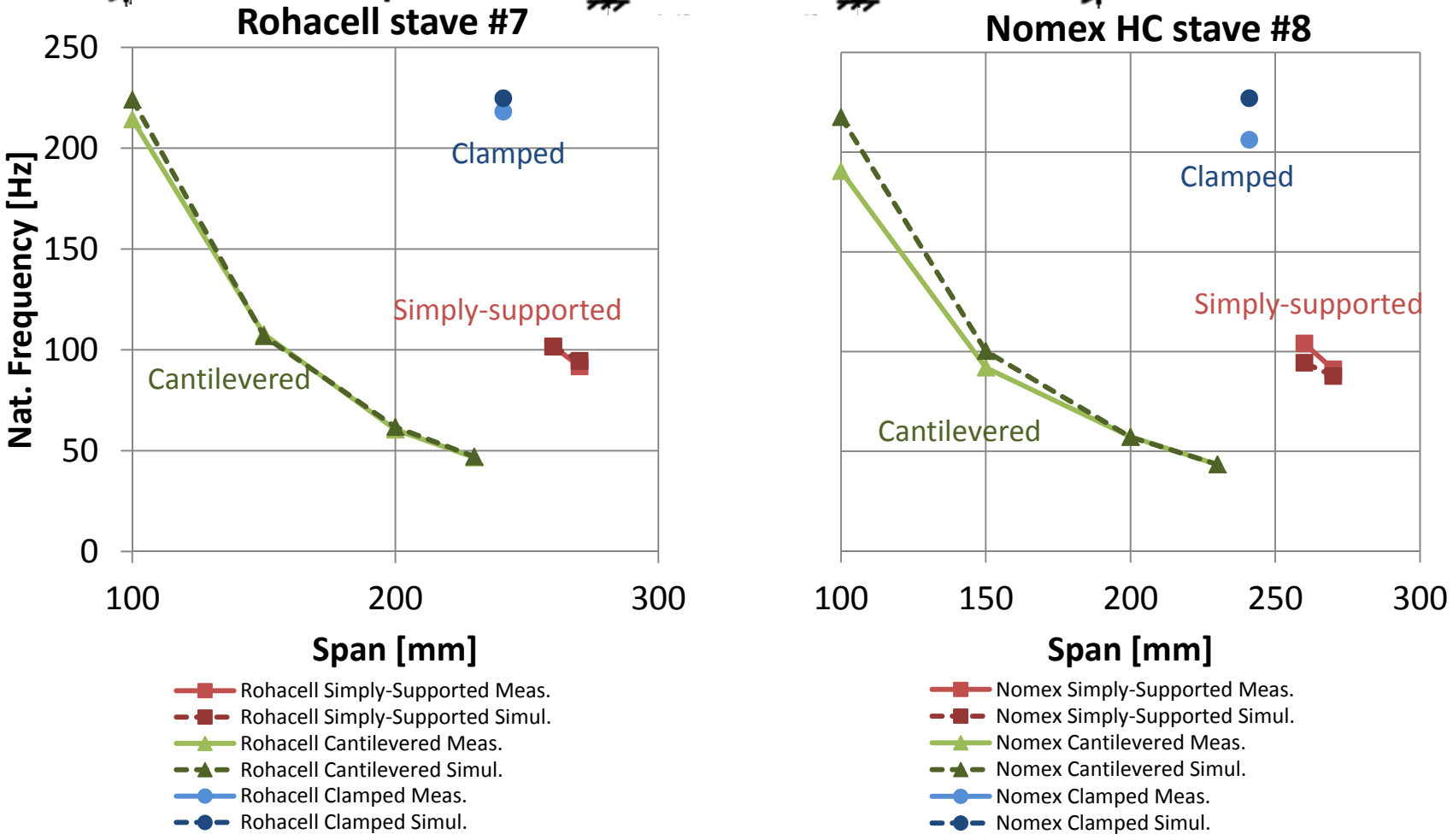
		SANDWICH SHAPE (2mm core thickness)	
Design	Skin	1 lay. M55J per skin (0°)	
	Core	Nida nomex 2mm thick	Rohacell (E~30MPa) 2mm thick
Mass with glue	g	1.5g	1.5g
Radiation length	Skin	0.022%	0.022%
	Core	0.014%	0.025%
	Glue	*(40 µm* 200%)* 0.019%	*(20 µm* 200%)* 0.010%
	Total	**0.055%**	**0.057%**
Flexural stiffness	N/mm	3.45N/mm	3.26N/mm
Bending stiffness	$N.mm^2$	$5.21*10^5$ $N.mm^2$	$5.21*10^5$ $N.mm^2$
Approx. natural frequency	Clamped Hz	~203Hz With modules	~203Hz With modules



Stave natural frequencies

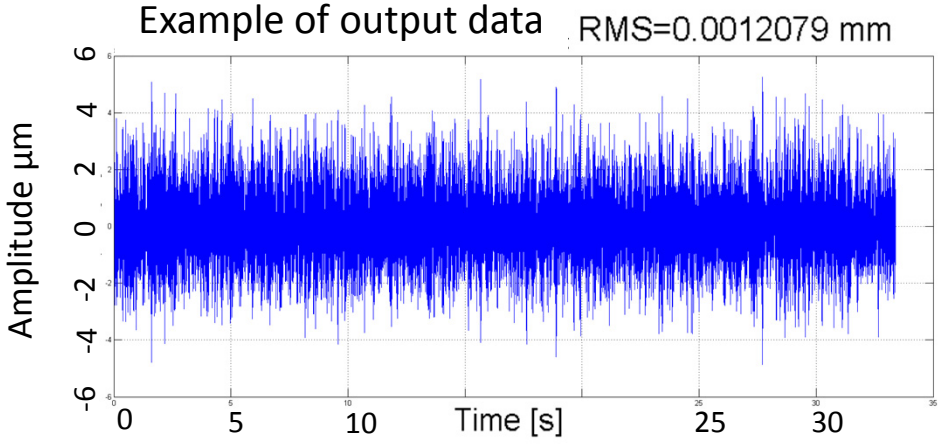
Simulations vs Measurements

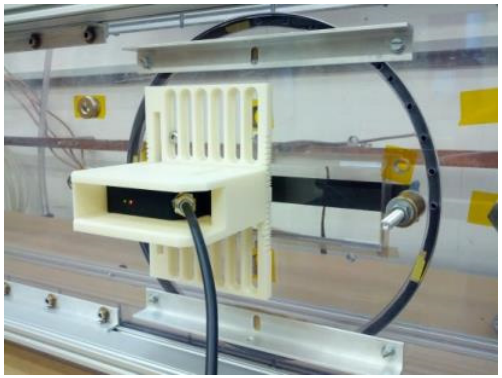


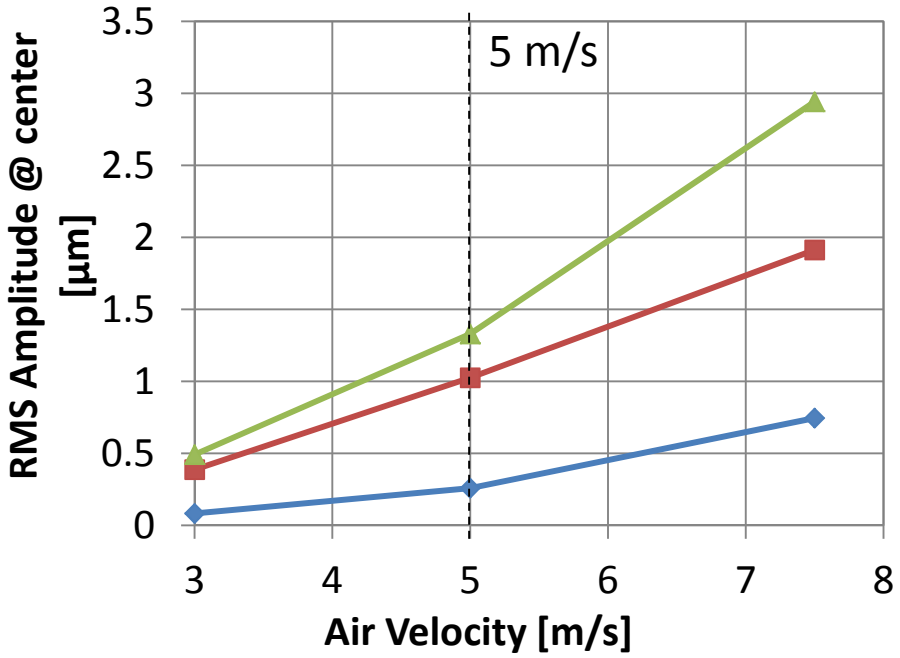


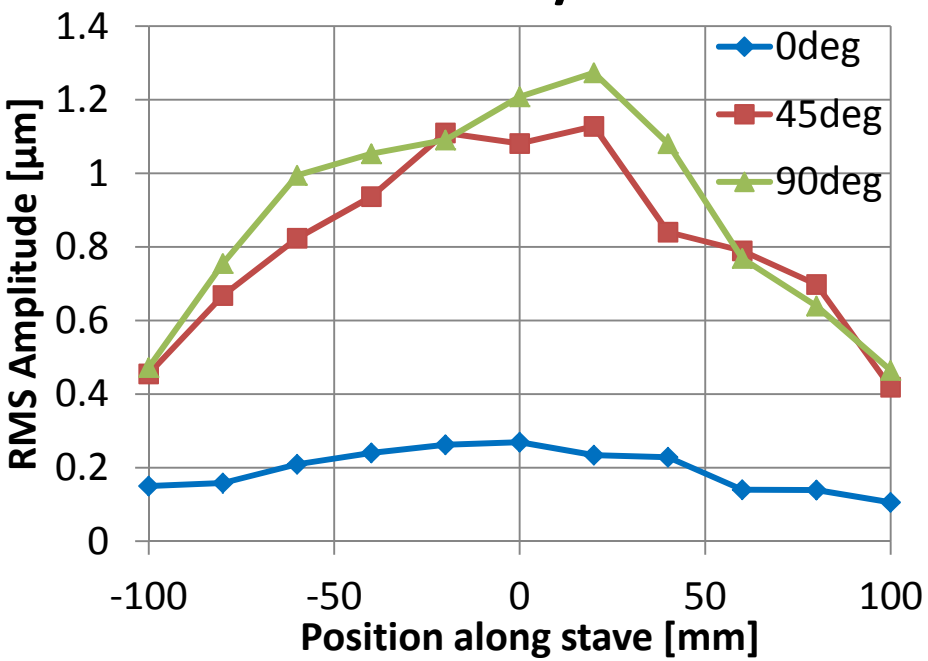
Vibration measurements

Out-of-plane amplitudes – 17.3 mm channel – Rohacell stave #7



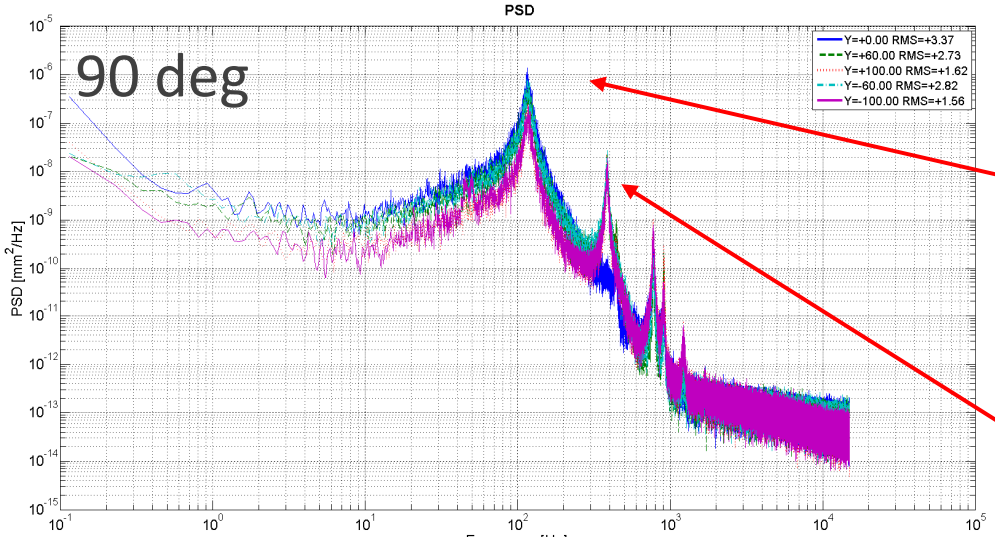


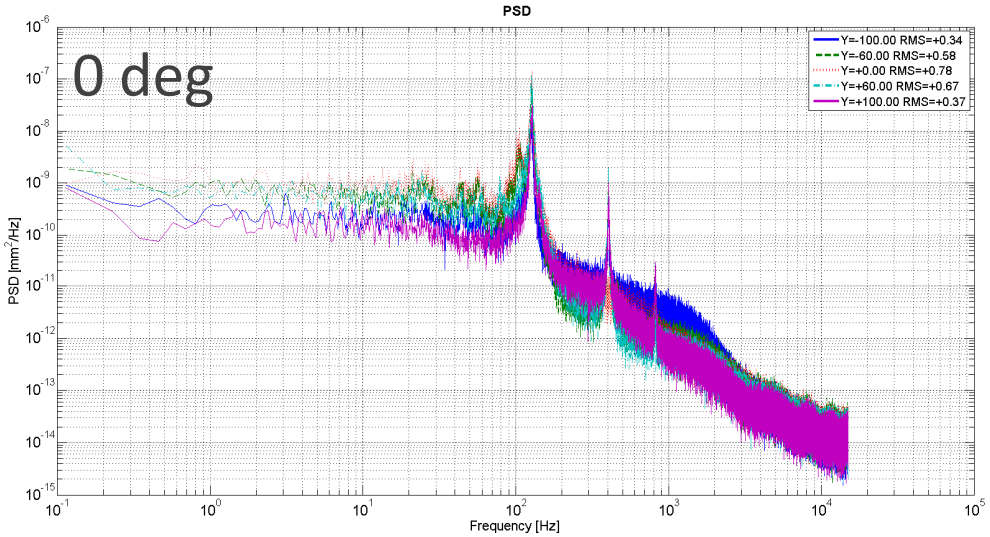




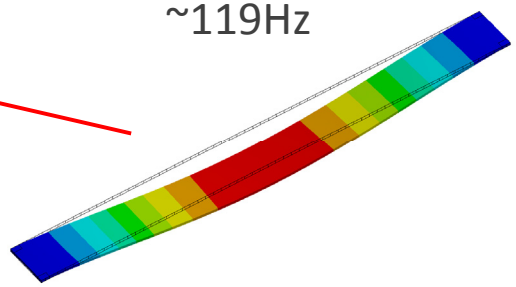
Vibration measurements

Sweep along length – 25 mm channel – 7.5 m/s – Nomex HC stave #8

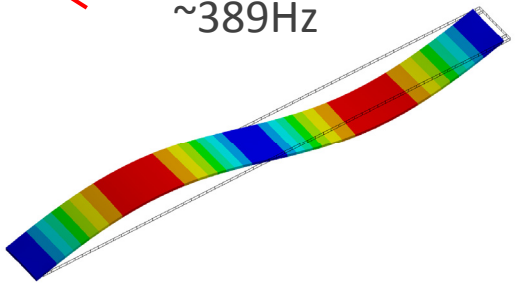




1st Eigenmode
~119Hz

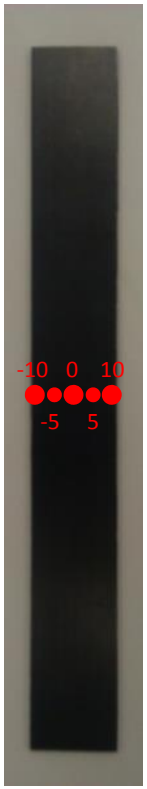


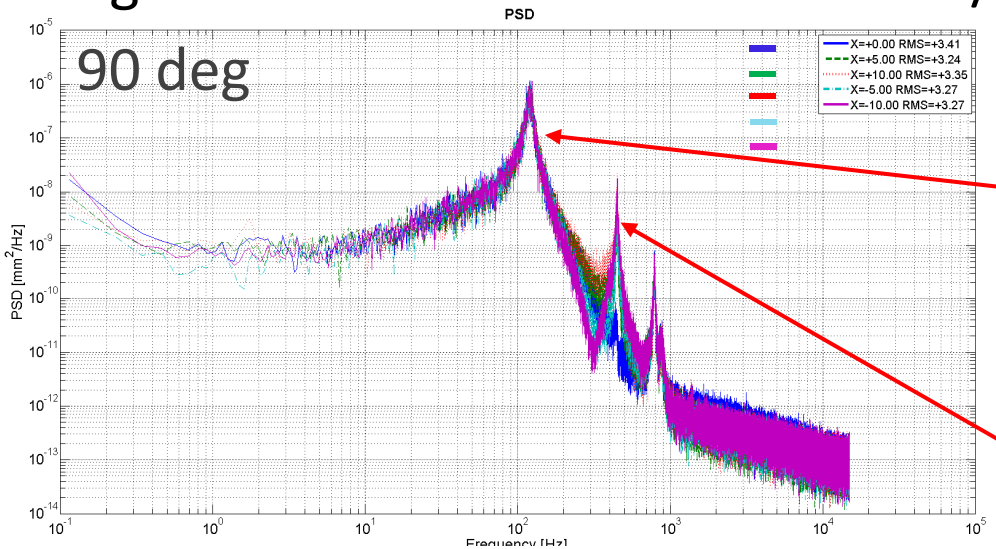
2nd Eigenmode
~389Hz

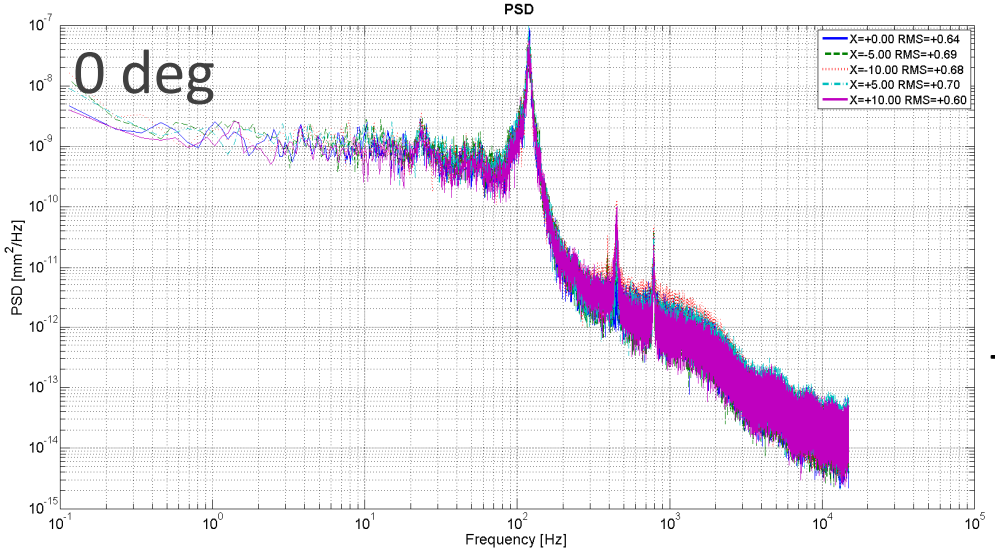


Vibration measurements

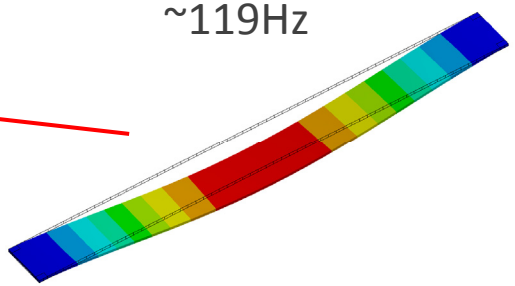
Sweep along width – 25 mm channel – 7.5 m/s – Nomex HC stave #8



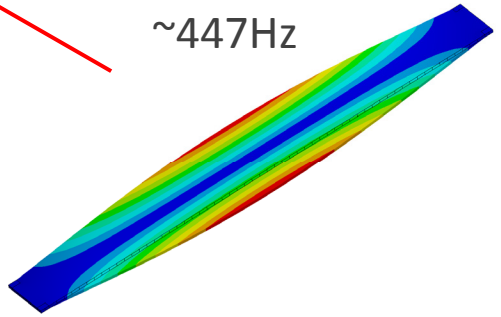




1st Eigenmode
~119Hz



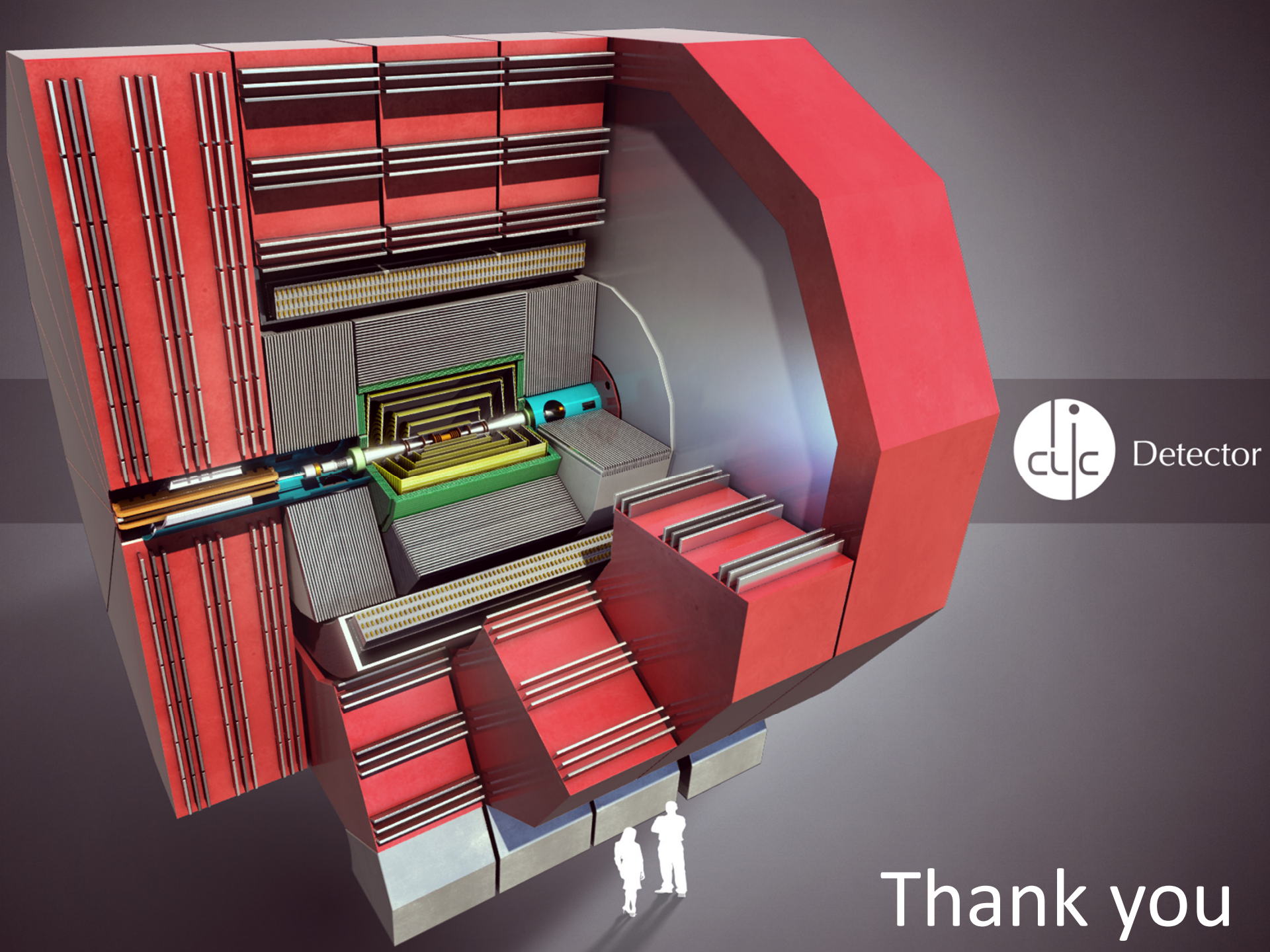
3rd Eigenmode
~447Hz



The first three eigenmodes seem to be the most excited ones

Summary

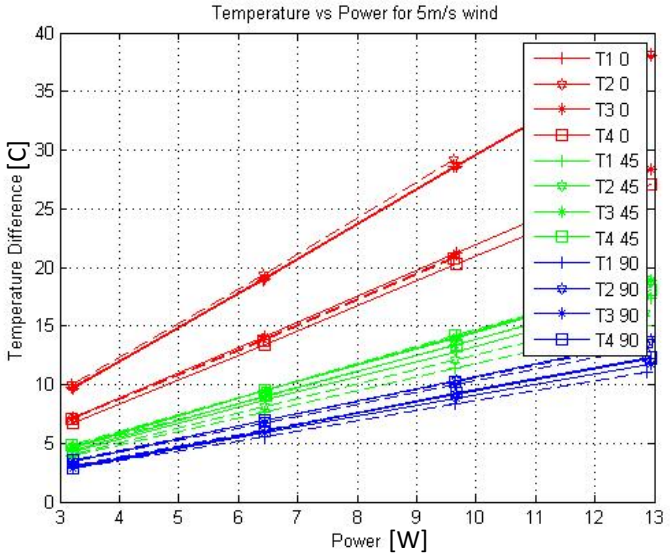
- Simulations indicate that it will be possible to maintain sensor temperatures <40 ^{o}C for a nominal heat load of 50 mW/cm^2;
- A thermo-mechanical test set-up has so far confirmed the simulations' results;
- A next generation (more detailed) set-up is foreseen;
- Air flow induced vibration tests on support structure prototypes have shown that amplitudes are within the acceptable range;
- The development of support structures shows promising results in terms of obtaining radiation length goals.

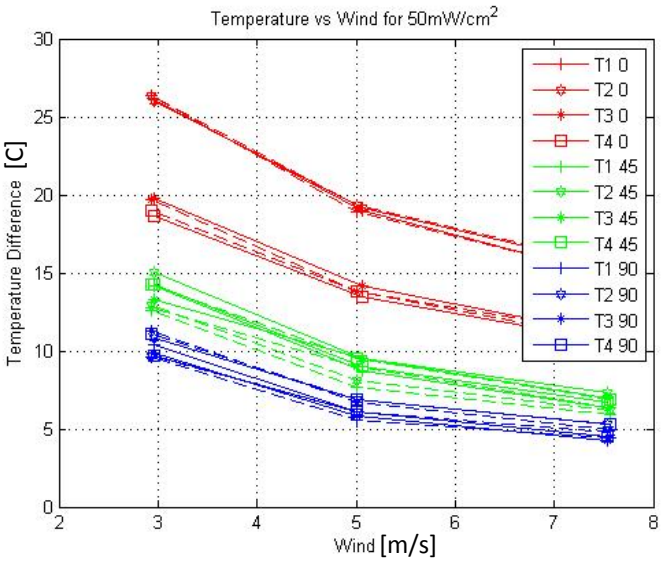

clic
Detector
Thank you

Backup slides

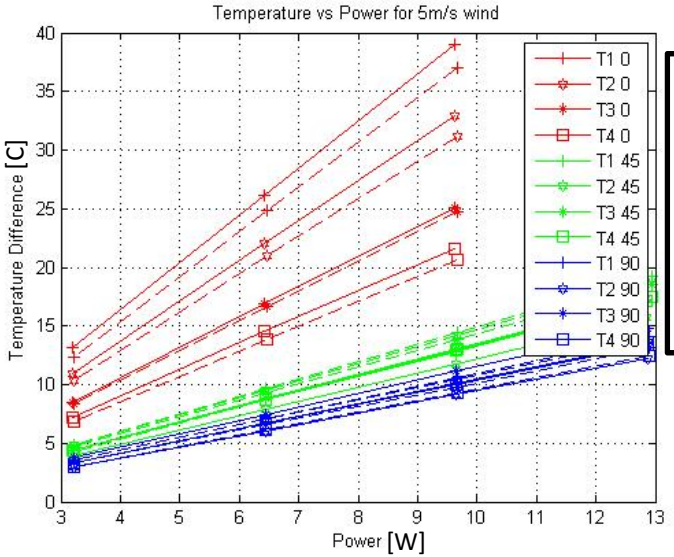
Nomex vs Rohacell core

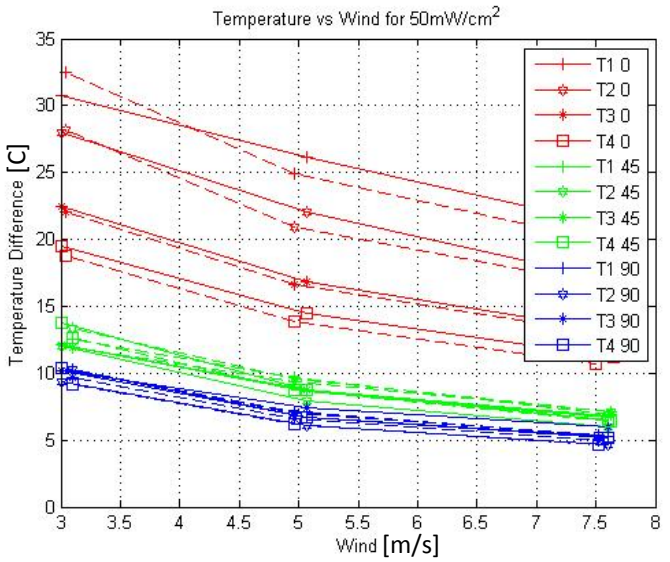
25mm channel

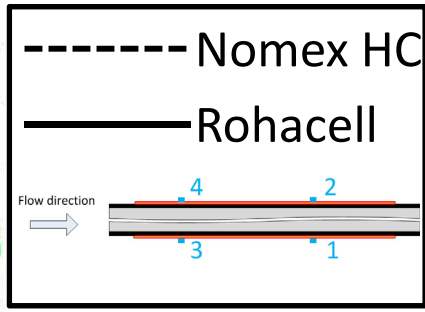




17.3mm channel



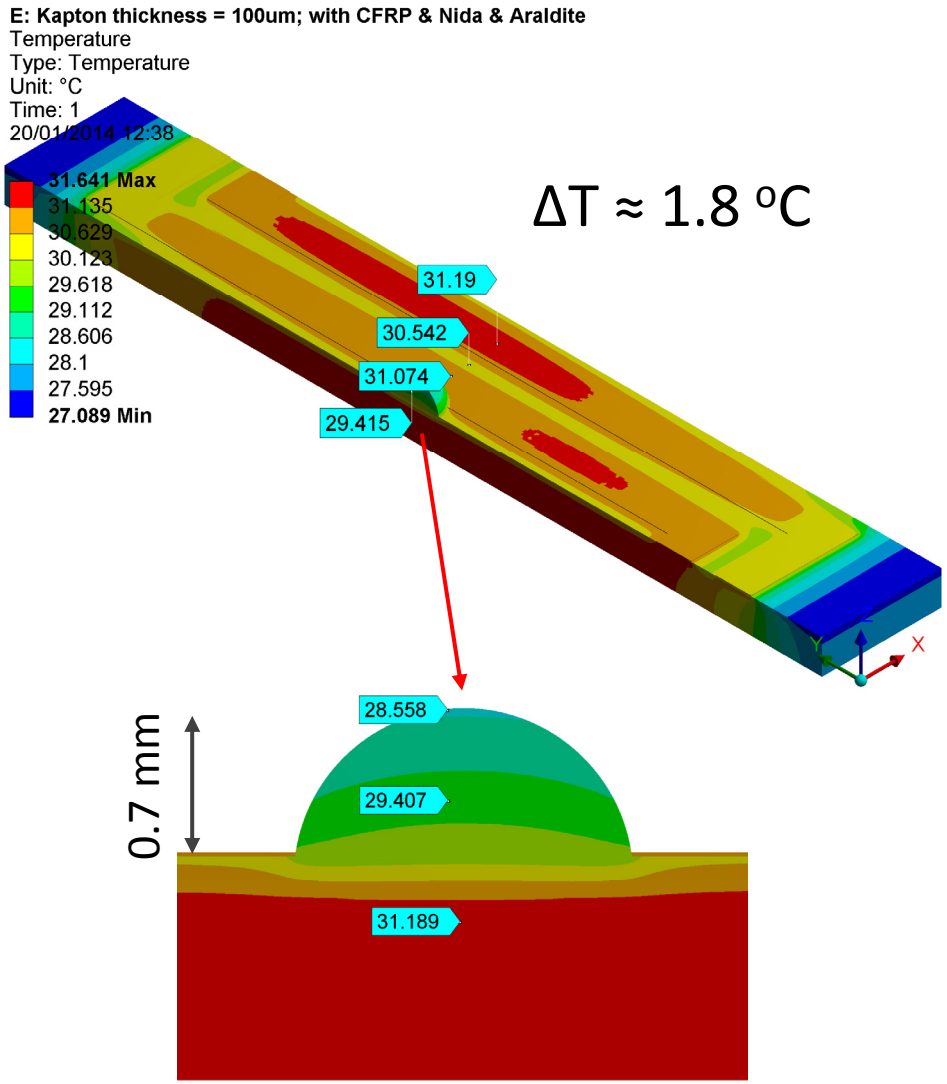




$K_{rohacell}$ = 0.029 W/mK

$K_{nomex\ HC}$ = 0.058 W/mK

Diff. between simulations and measurements



$\Delta T \approx 1.8\ ^{o}C$

Thermal camera **FLIR A655 sc:**

PH-DT
Detector Technologies

-Resolution: 640*480 pixels
-Images frequency: 50Hz
-Sensibility: < 50mK