RD_FCC preventivi TK

Perugia

> Mechanical Studies on the Vertex
> Innovative LGAD designs

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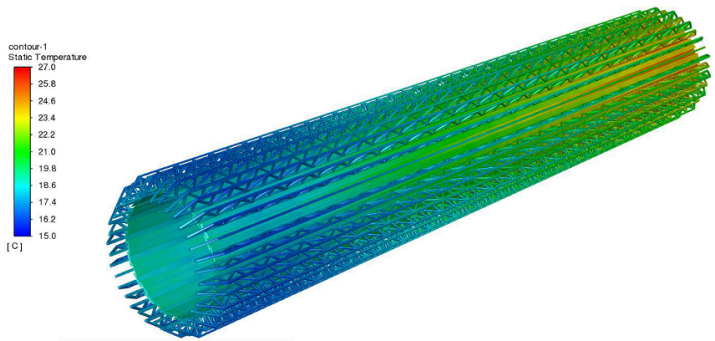
Mechanical Studies on The Vertex

Simulations so far

Thermal Analysis

Aeroelastic Analysis

THERMAL ANALYSIS

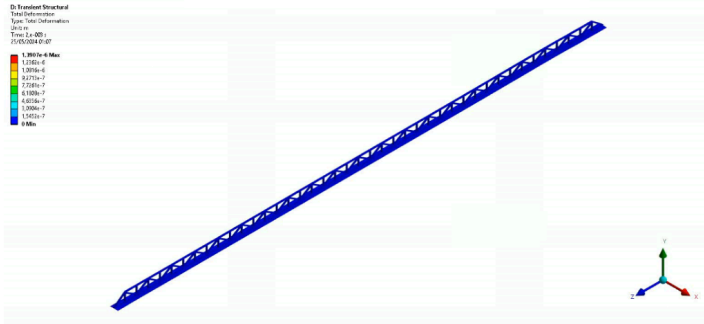


Software: Ansys Fluent (Finite-Volume-Method)

Scope: Evaluate cooling performance

The application of two different types of simulation has been studied

AEROELASTIC ANALYSIS



Software: Ansys Fluent (Finite-Volume-Method)

+Ansys Mechanical (Finite-Element-Method)

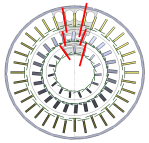
Scope: Evaluate fluid- induced vibrations under aerodynamic loads

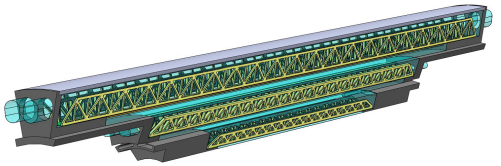
Simulations so far

Thermal Analysis

Aeroelastic Analysis

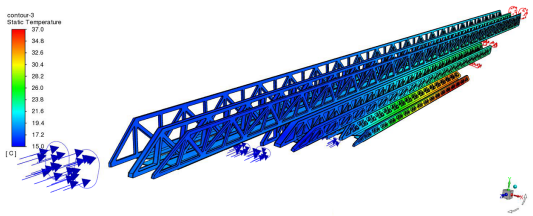
We managed to simulate a full sector of the vertex which includes all the three layers.



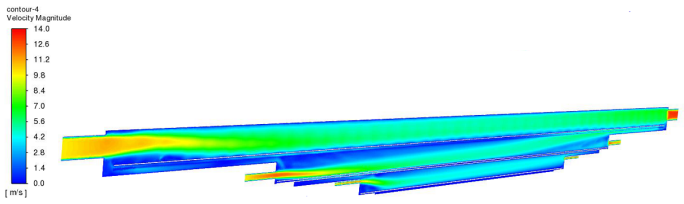


- Maximum temperature of about 35°C in layer 1, when having inlet air at 15°C with a constant velocity of 10 m/s and 10% turbulence instensity.
- Some cross-talk found between air flow of different layers (this opens for further optimizations for layer 1 and 2).

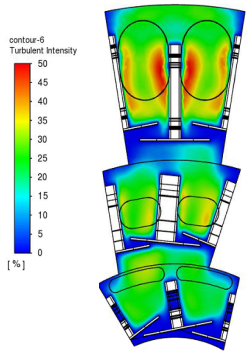
Temperature along the staves



Velocity field



Turbulent intensity

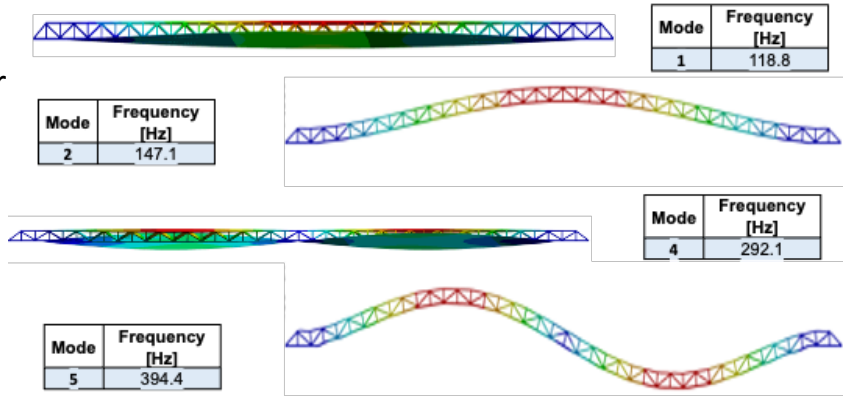


Simulations so far

Thermal Analysis

Performed on a single stave of layer 3 (the longer one, so it is plausibly a worst case for vibrations)

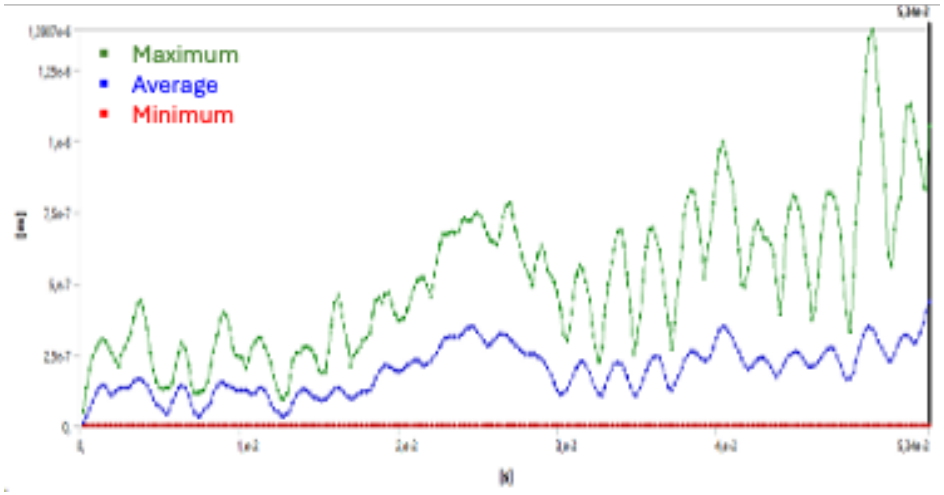
Natural frequencies of the structure have been estimated



Natural frequencies and vibrations modes

Aeroelastic Analysis

Global deformation:



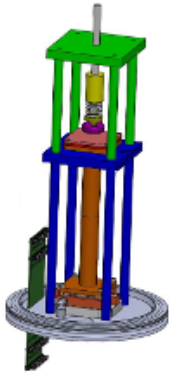
- 1st mode @ about 120 Hz.
- Vibrations found in the micron scale.

Huge dependency of the results on mechanical constraints and material properties → Experimental measurements are crucial

2026 activity

Measurement campaign of thermal and mechanical properties of solid materials in use.

- Now they are estimated based on libraries and experience.
- For example, Carbon Fiber (CF) behaves very differently depending on plies base-materials, orientation, number of layers, pressure during the curing…
- Synergy **with DRD8 Project 2.2** “Characterisation of Material Properties and Database Development”. (Perugia is involved).



- Realization of a custom apparatus for the measurement of the thermal conductivity.
- Design already in hand.
- Request of **4K€** for the purchase of the components.

- Simulation so far were done through two medium-performance desktop workstation
- Dynamic simulations require larger computation resources, present resources are currently saturated.

- New resources in a different computational model, exploiting the local clusters

Request **4K€ to co-fund** a new server with large disk space

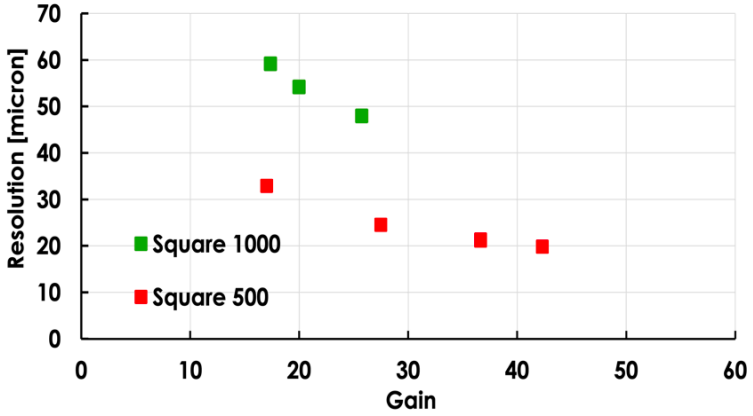
Innovative LGADs

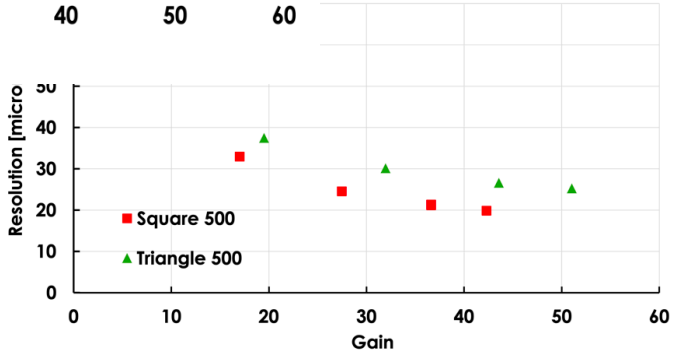
Innovative LGADs

The first prototype run of **DC-RSD** was released by FBK in November 2024

Compensated LGAD show good gain behaviour after fluences of the order of 5×10^{15} n/cm^2

New NLGAD batch is in progress to study donor removal – expected delivery by mid August





All sensors achieve a space resolution **below 5% of the pitch**

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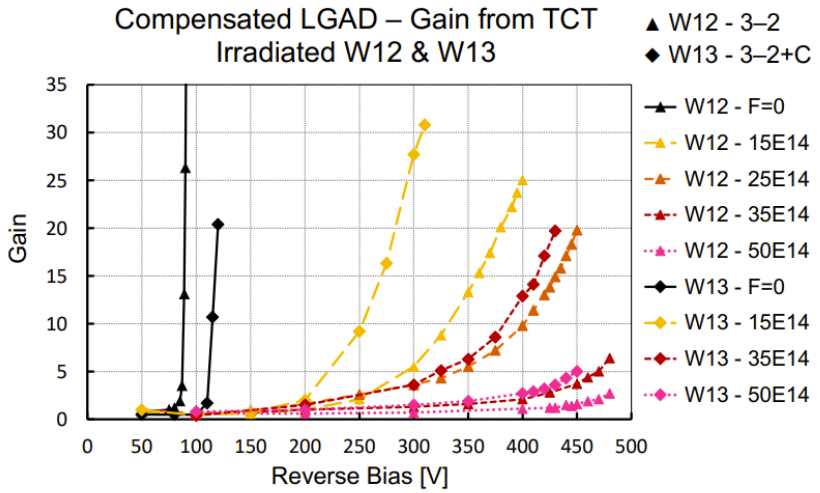

TCT Setup from Particulars
Pico-second IR laser at 1064 nm
Laser spot diameter ~ 10 µm
Cividec Broadband Amplifier (40dB)
Oscilloscope LeCroy 640Zi
Laser intensity ~ 4 MIPs
T = -20°C

Good gain behaviour of the compensated LGAD sensors after irradiation

Even in compensated LGADs, carbon mitigates the acceptor removal

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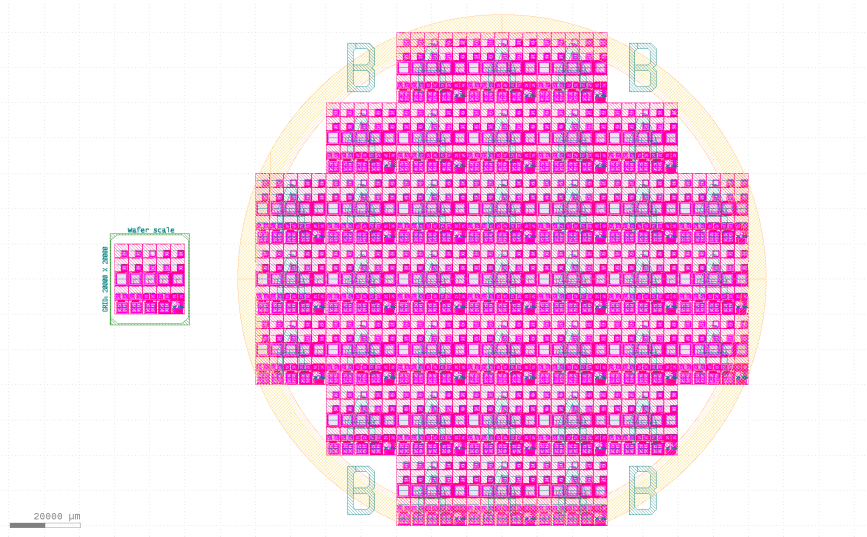

The NLGAD batch will be used to study the donor removal coefficient, c_D

14 epitaxial substrates with active thickness of 55 µm

+ 3 substrates with active thickness of 450 µm

2026 activity

- Study of the radiation hardness of the first **DC-RSD** production
- Simulation and design of the second **DC-RSD** production replacing the isolating trenches with surface resistors to improve both the fill factor and the resolution uniformity
- For **compensated LGAD** characterization of **NLGAD** production, with extraction of donor removal coefficient
- Simulation and design of the second Compensated production

All the activities are financed by external projects.

LGAD activity: there are no financial requests for 2026 in RD_FCC

2026 summary

Mechanical simulation needs experimental constraints: 4 keu for a custom apparatus

Simulation are hungry: 4 keu for additional, specialized, computational resource

LGAD activity is funded by its own for now, no request for 2026

Anagrafica 2025

RD_FCC Perugia

Nome	% FTE	Qualifica (2023)		sigla principale
Alessandro Rossi	10	PA		CMS
Attilio Santocchia	20	PA		CMS
Claudia Cecchi	10	PA		BELLE2
Cristiano Turrioni	10	PostDoc		Fase2
Daniele Passeri	10	PA		Fase2
Elisa Manoni	10	Ric. INFN		BELLE2
Francesco Moscatelli	10	Ric. CNR		Fase2
Gabriele Martelli	30	PostDoc		LHCb
Gian Mario Bilei	10	DR INFN		CMS
Giorgio Baldinelli	20	PA		Fase2
Livio Fanò	10	PA		Fase2
Maria Elena Ascioti (*)	20	PhD (II anno)		CMS
Arianna Morozzi	10	Tecnologa		GR5
Orlando Panella	10	I ric. INFN		GR4
Stefano Moneta	10	PostDoc		BELLE2
Valentina Mariani	20	RTD		CMS
Giulia Pascoletti	50	Assegnista ING		CMS
Totale FTE	**2,7**