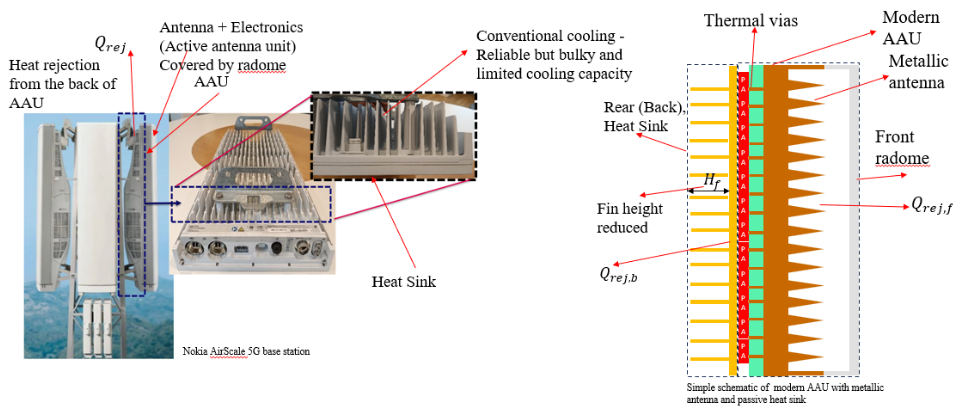
Portfolio Mohammad Shahid

Rapid Thermal Screening of Front- and Rear-Side Natural Heat Dissipation in Active Antenna Units

Modern 5G active antenna units generate high thermal loads. While conventional passive cooling relies mainly on the rear heat sink, newer architectures also route part of the heat toward the front surface through the metallic antenna structure. The thermal value of this front-side path is still not well quantified for full-scale AAUs, and detailed 3D CFD is too expensive for early design exploration.



Nokia AirScale 5G base station and simple schematic of modern AAU with metallic antenna and passive heat sink

During my research work at TU/e in collaboration with Ericsson, I developed a simplified analytical thermal framework to address this challenge. Based on a thermal resistance network, the model represented the AAU enclosure, radome, and metallic antenna structure, and combined conduction, radiation, and natural-convection correlations to estimate front temperature and total heat dissipation using an energy-balance formulation and control-volume analysis.
I validated the model against full 3D CFD results in CST Studio Suite across multiple geometries and emissivity conditions. The comparison showed that the method captured the dominant thermal trends with acceptable error for rapid screening, while also showing where the approximation became less accurate.

Engineering value: Enabled early-stage thermal screening in seconds, before committing to full 3D CFD simulations that require hours.

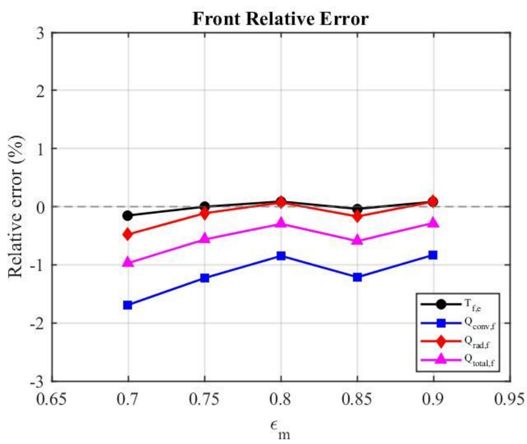


Figure1. Relative error of the energy-balance model against full 3D CFD for front-side thermal quantities across different metal emissivity values for a fixed radome emissivity of 0.85.

Portfolio Mohammad Shahid

Analytical Design Study for Forced-Convection Cooling of Active Antenna Units

As a follow-up to earlier TU/e-Ericsson work on front-side heat dissipation in AAUs, I investigated a forced-convection concept for removing heat more effectively from the front face. The motivation came from a key finding in the natural-cooling study: in radome-covered AAUs, front-side natural cooling was limited.

I developed an analytical design framework for an air-to-air heat-exchanger concept using parameters such as fin count, channel dimensions, airflow rate, outlet temperature, and heat rejection. I compared the analytical predictions with numerical results across different fin lengths and configurations. For shorter fins, the simplified model captured the main thermal trends reasonably well and supported early design exploration. As fin length increased, flow and thermal interactions became stronger and the error rose, showing where full 3D CFD became necessary.

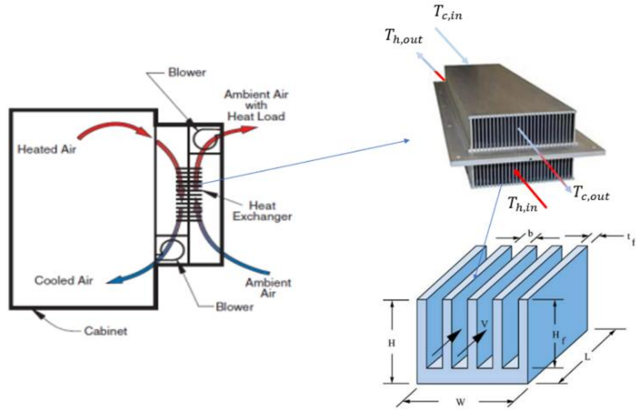


Figure2. Proposed front-side cooling concept: air-to-air heat exchanger integrated into the AAU with fin-channel representation used in the analytical model

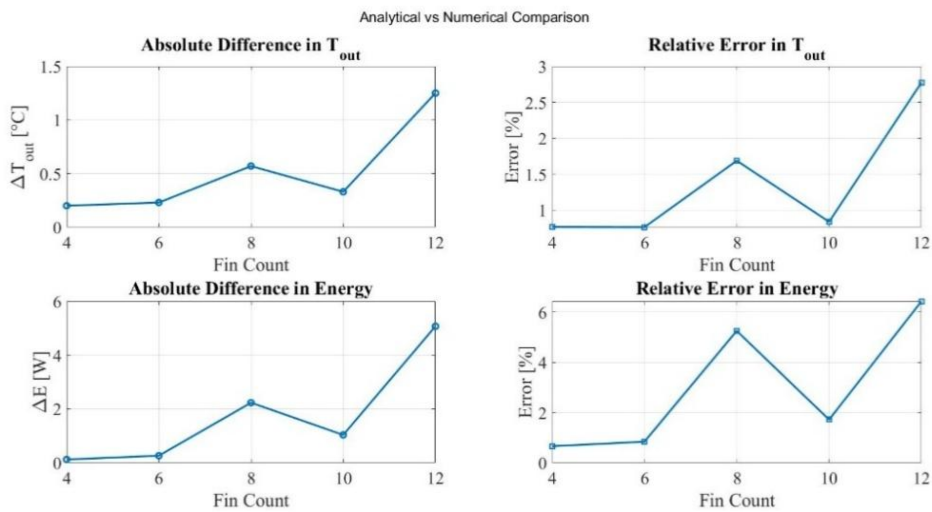


Figure 3. Analytical-to-numerical comparison of outlet temperature and heat rejection across fin-count configurations, showing stronger agreement for shorter fin lengths

Engineering value: Enabled rapid early-stage comparison of front-side forced-cooling concepts and identified when full 3D CFD was required for reliable prediction

Portfolio Mohammad Shahid

Sequential Electro-Thermal-Mechanical Workflow Development in CST for thermally loaded RF hardware

During research work linked to TU/e, Ericsson, and the MyWave project, I built a sequential multiphysics workflow in CST to evaluate how thermal loading can influence the structural and electromagnetic behavior of RF hardware. To establish the method reliably and reduce uncertainty in the prediction, I first recreated a CST reference example based on a combline filter and used it to verify the full simulation chain: electromagnetic loss calculation, steady-state thermal analysis, structural deformation, and RF sensitivity to the deformed geometry.

A key part of the work was making sure that the results transferred correctly and meaningfully from one solver to the next. This included preparing the geometry and materials correctly, defining the heat-load transfer from the EM solver to the thermal solver, carrying the temperature field into the structural model, and checking how deformation affected RF response.

Rather than treating the workflow as a black box, I used the reference model to confirm that each stage behaved as expected before extending the approach to more complex antenna applications.

Engineering value: Reduced uncertainty in coupled EM-thermal-structural analysis by verifying how thermal loads propagate through the simulation chain and affect RF response.

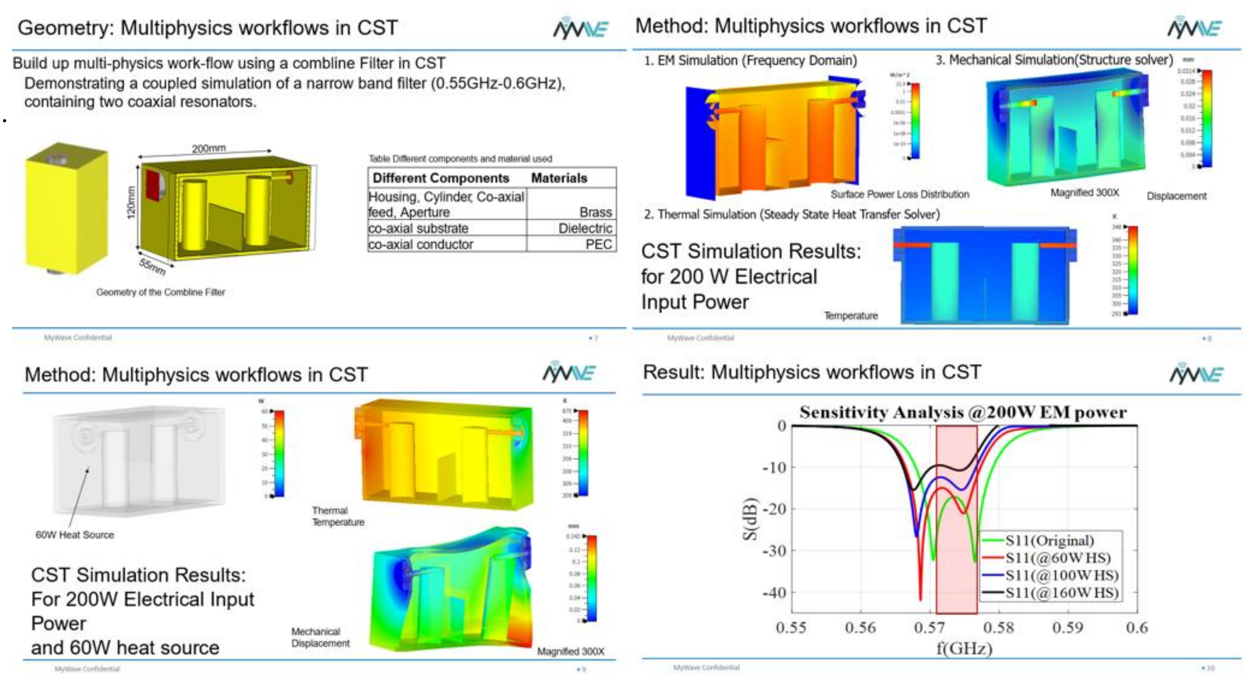


Figure 4. Development and verification of a sequential CST multi-physics workflow, linking EM loss calculation to thermal, structural, and RF sensitivity analysis

Portfolio Mohammad Shahid

Reduced-Order Thermal Modeling and Validation for ET-PIM Via Structures

Localized self-heating in RF interconnect vias can create temperature-dependent resistance changes and contribute to electro-thermal nonlinearity. During research work with TU/e and Ericsson, I developed a reduced-order thermal model to study that behavior more efficiently than with a full 3D model alone.

Starting from a simplified parallel-plate waveguide representation, I translated the problem into an analytical 1D radial heat-conduction model that captured the dominant temperature-rise mechanism. I then solved transient thermal cases in MATLAB under different boundary conditions and validated the results against high-fidelity finite-element simulations in COMSOL. The analytical and numerical results showed very good agreement, confirming that the simplified framework captured the governing thermal behavior reliably.

Engineering value: Provided a faster and physically grounded way to assess localized electro-thermal heating in RF via structures.

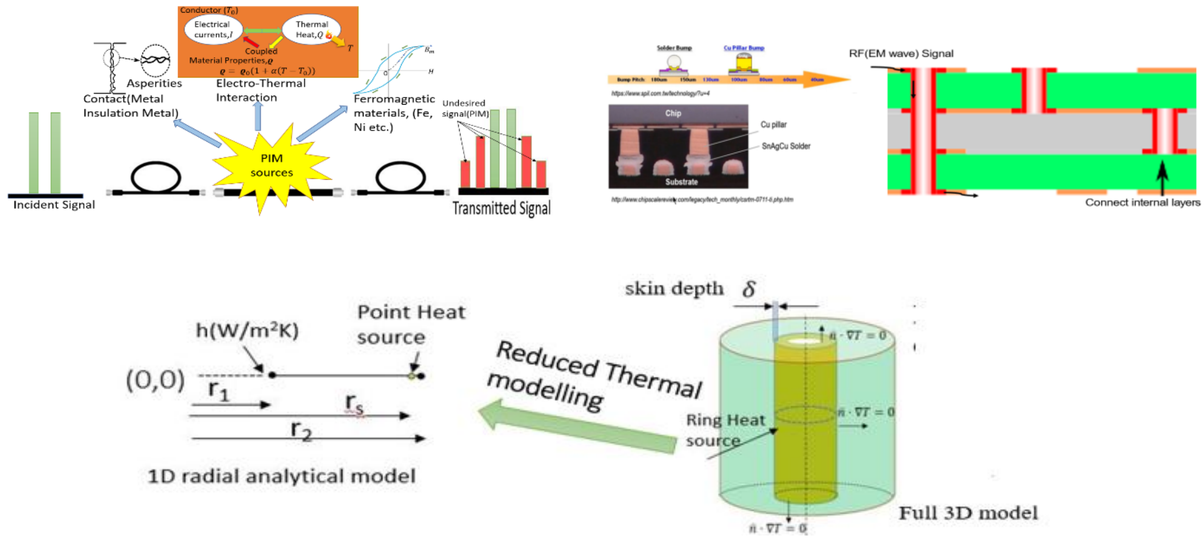


Figure 5. From electromagnetic dissipation in a via to reduced-order thermal modeling: analytical framework used to study heat generation and radial heat diffusion in ET-PIM structures

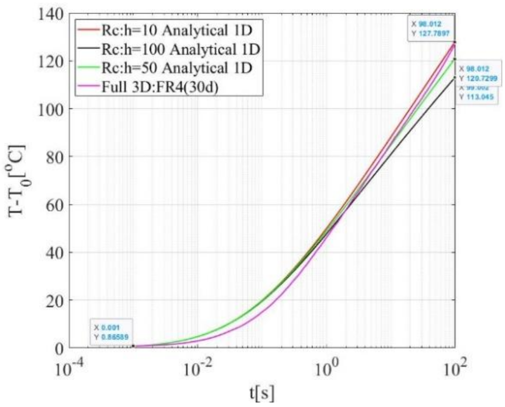


Figure 6. Analytical MATLAB and COMSOL comparison for transient and steady radial heat conduction, showing very good agreement for the reduced-order thermal model

Portfolio Mohammad Shahid

Verification and Validation of an In-House Plasma-Flow Solver for Thermal Plasma Applications

During my MSc internship at AKRYVIA, I worked with YAPS, an in-house plasma-flow solver based on the finite-volume method for thermal plasma torch applications. My contribution focused on verification, validation, and refinement of the modeling setup, including boundary-condition treatment, geometry adjustments, and numerical settings needed to obtain stable and physically consistent results across representative benchmark cases.

I carried out sensitivity studies on mesh density, under-relaxation, and progression-factor effects, and assessed how these choices influenced convergence, stability, and solution behavior. I then validated the solver against analytical solutions, published numerical references, and experimental benchmark data for cases such as Poiseuille flow, de Laval nozzle flow, laminar round jet, and free-burning argon arc behavior.

Engineering value: Increased solver reliability through structured verification, validation, and numerical robustness assessment.

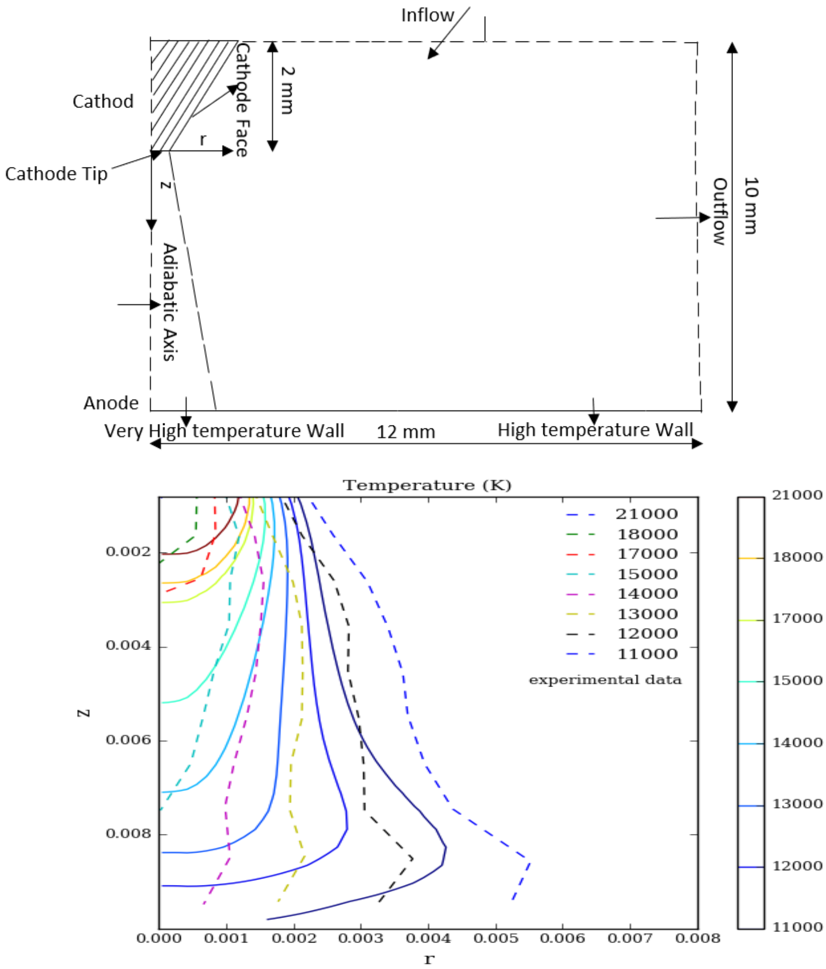


Figure 7. Free-burning argon arc benchmark: computational domain (top) and comparison of predicted temperature isotherms with experimental reference data for plasma-model validation (bottom)

Portfolio Mohammad Shahid

Numerical(CFD) Modeling of Mixed Convective Flow Around a Torsionally Oscillating Heated Cylinder

In my MTech work, I investigated two-dimensional laminar mixed convection around a torsionally oscillating heated circular cylinder to study how oscillation, buoyancy, and external flow affect wake behavior, force response, and heat transfer.

I worked with an in-house finite-difference Fortran solver and adapted it for this problem through body-fitted mesh generation, boundary-condition adjustments, and targeted setup and code modifications. A key part of the work was numerical verification, including grid-independence checks, time-step sensitivity studies, and validation against published benchmark data before interpreting the physical trends.

I then used the model to study the influence of Reynolds number, Richardson number, and forcing frequency on drag, lift, vortex structure, and Nusselt number behavior.

Engineering value: Provided a validated numerical approach for studying unsteady flow, force response, and heat-transfer behavior in mixed-convection problems

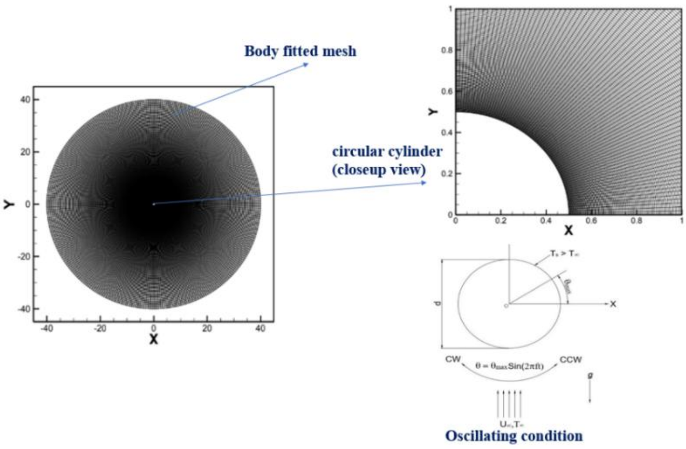


Figure8. Body-fitted mesh, oscillation setup, and validation of the numerical model against published lift-coefficient data

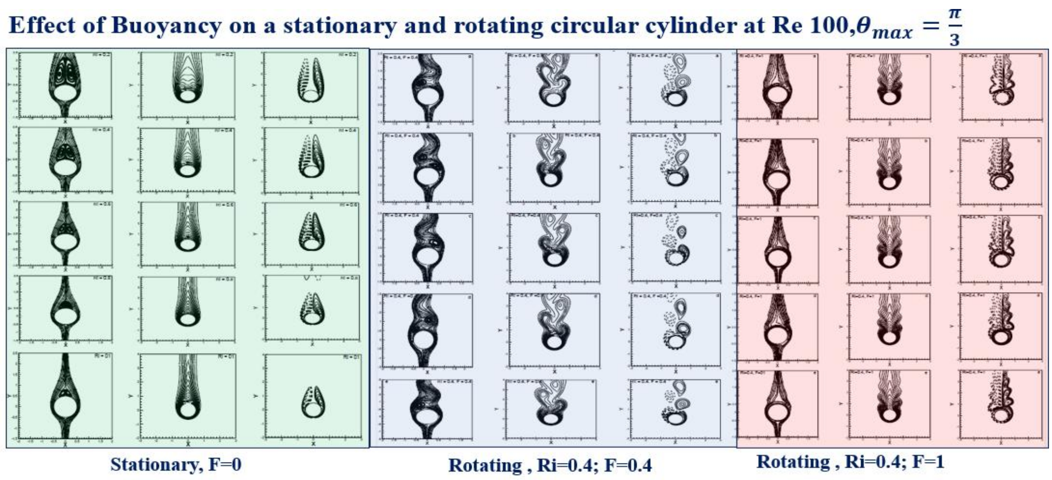


Figure 9. Streamlines, isotherms, and iso-vorticity contours during one oscillation cycle