The Forward Silicon Tracker at STAR

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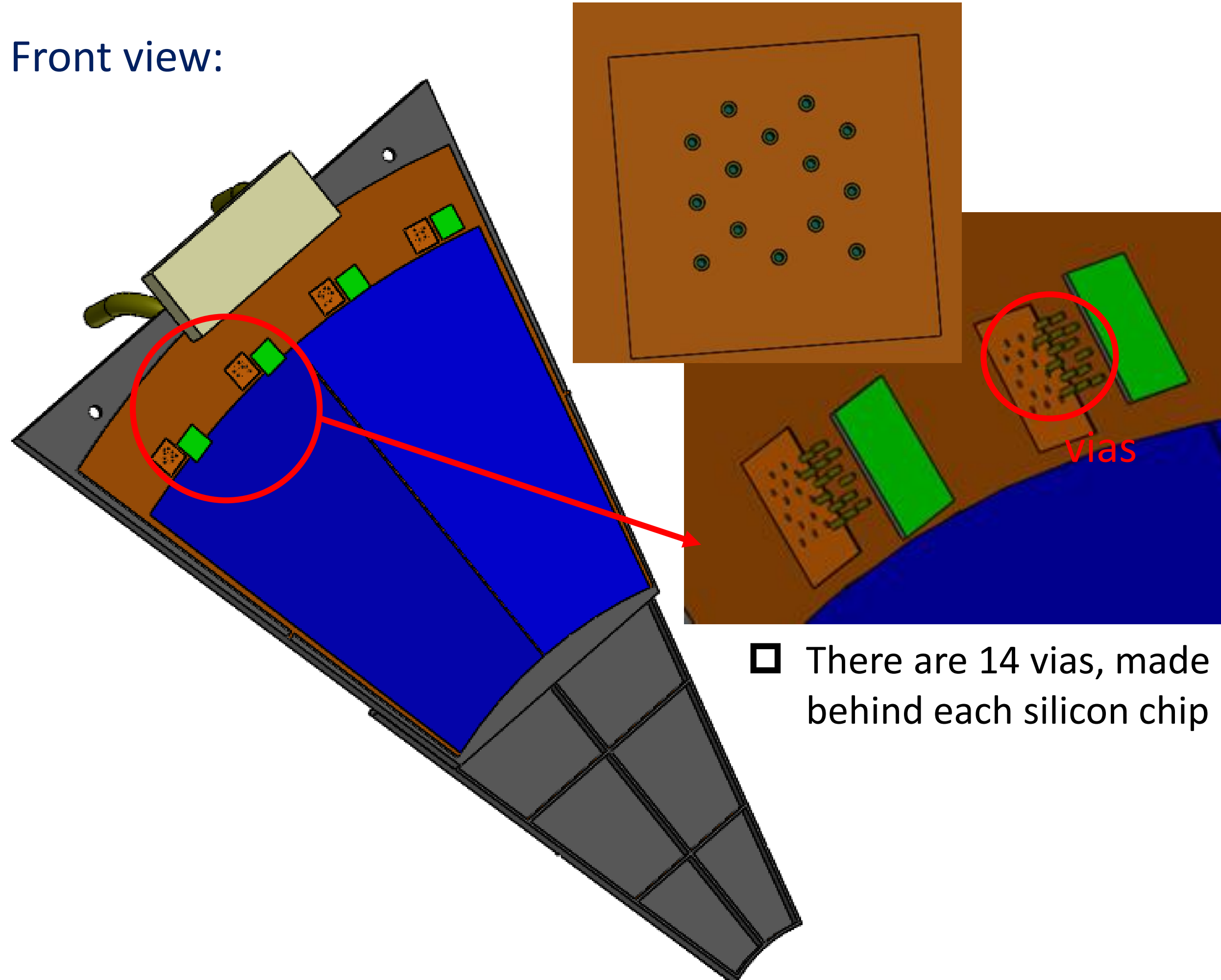
Basic Setup

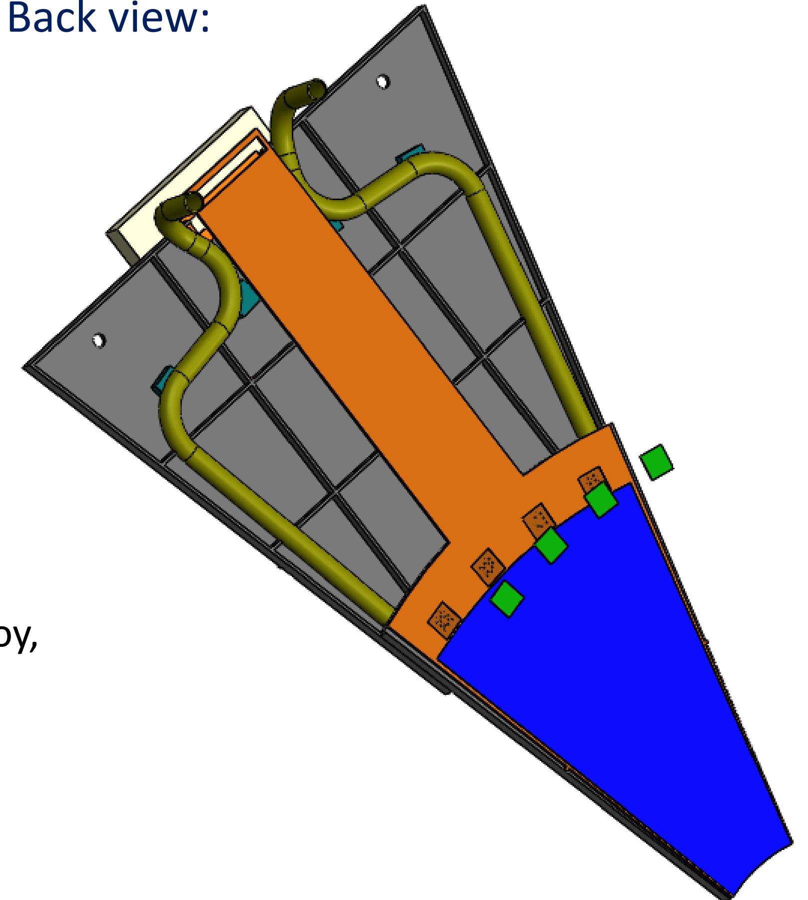
- Materials:
  - Tube: **Titanium** (8.3 W/m/K)
  - Heat sink: **Aluminum** (150 W/m/K)
  - Sensor: **Silicon** (130 W/m/K)
  - Hybrid: **Kapton** (0.12 W/m/K)
    - Via: **Copper** (400 W/m/K)
  - Main structure: **PEEK** (0.24 W/m/K)
- Ambience temperature: 22℃
- Heat generation
  - The power consumption (per chip): $300\,\frac{\text{mw}}{\text{per chip}} = 0.01524\ \frac{w}{mm^3}$
- Convection
  - The nature convection coefficient to stagnant air: $5 \times 10^{-6}\,\frac{w}{mm^2 \cdot ℃}$
- The temperature of cooling tube
  - The temperature of inside wall: 20℃

Hybrid design

- Current hybrid design for thermal simulation



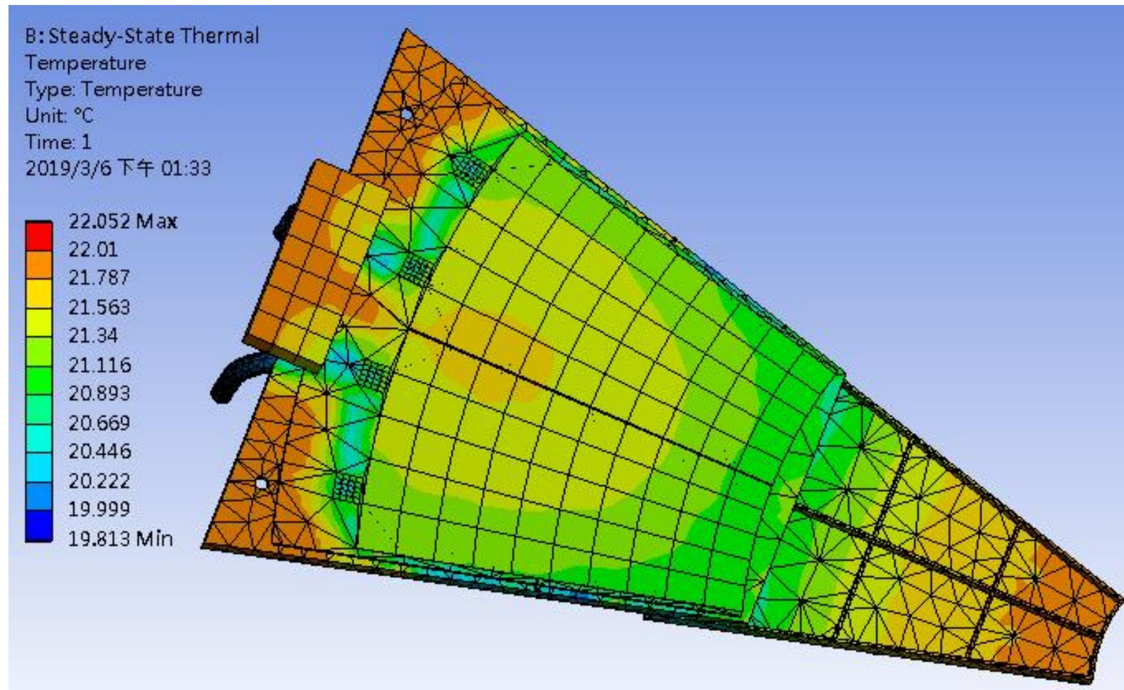
- There are 14 vias, made by copper alloy, behind each silicon chip



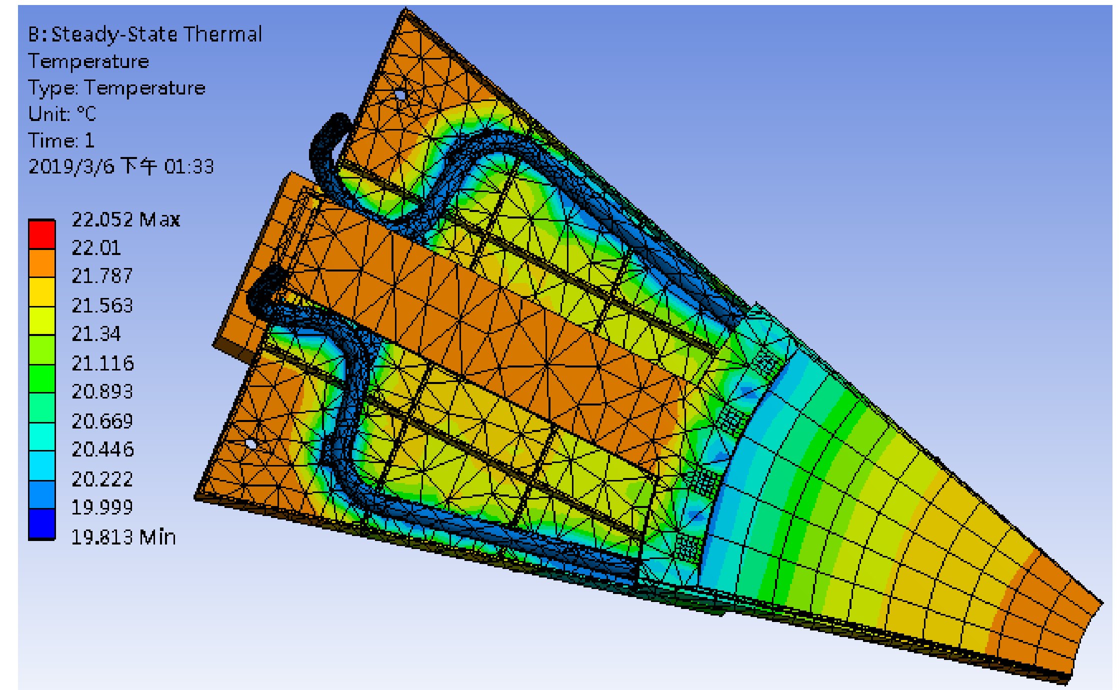
Analysis-Thermal-Stress analysis

- Temperature profile at the steady state

Front view:



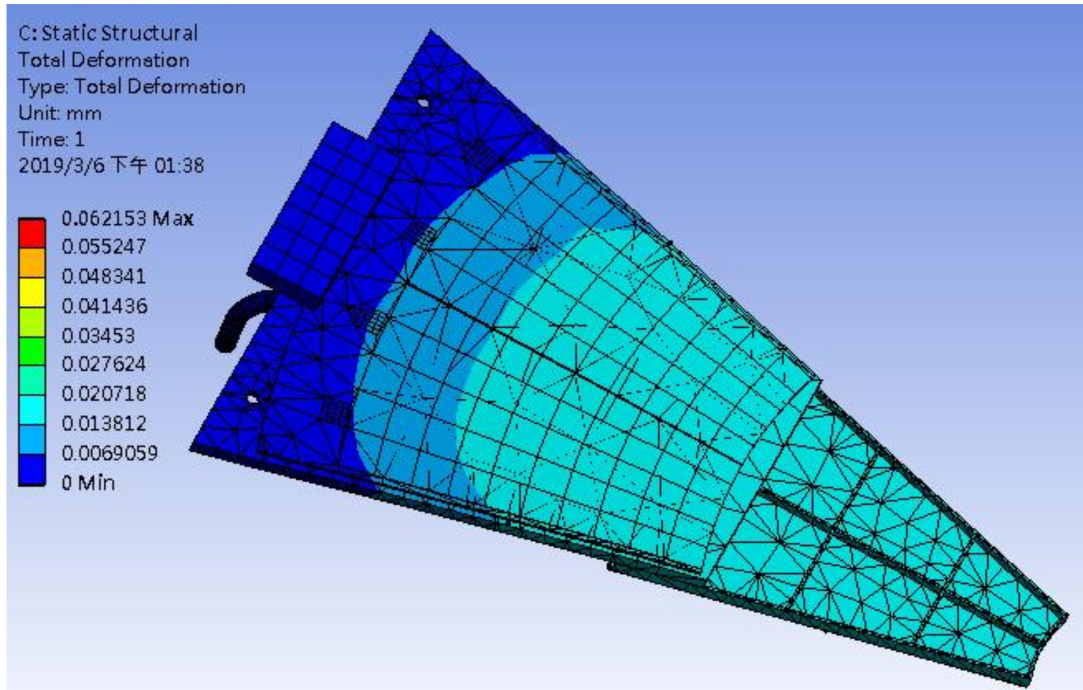
Back view:

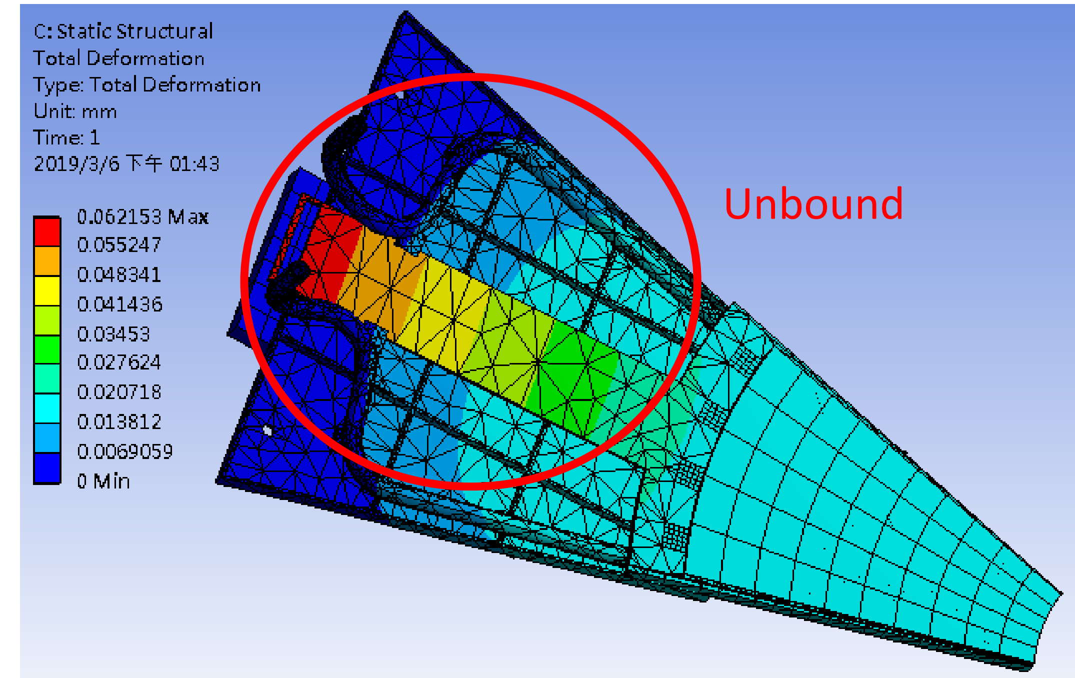


APV chips will be about 20°C within the working temperature of chips

Analysis-Thermal-Stress analysis

- Total deformation ($\epsilon_{tot} = \sqrt{\epsilon_x^2 + \epsilon_y^2 + \epsilon_z^2}$)





The maximum deformation is about $60\mu m$ on the hybrid, since the inner hybrid is flexible. And the deformation for the main structure is around $20\mu m$

Conclusion

- We have updated the vias in the hybrid for thermal analysis
- When reaching thermal equilibrium, APV chips will be about 20℃
- The total deformation for the main structure is about $20\mu m$