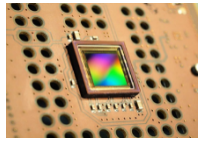
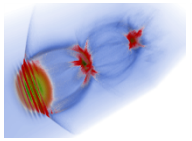
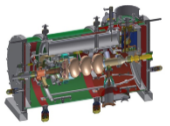
Matter and Technologies

Future Detectors - The Engineering Challenges

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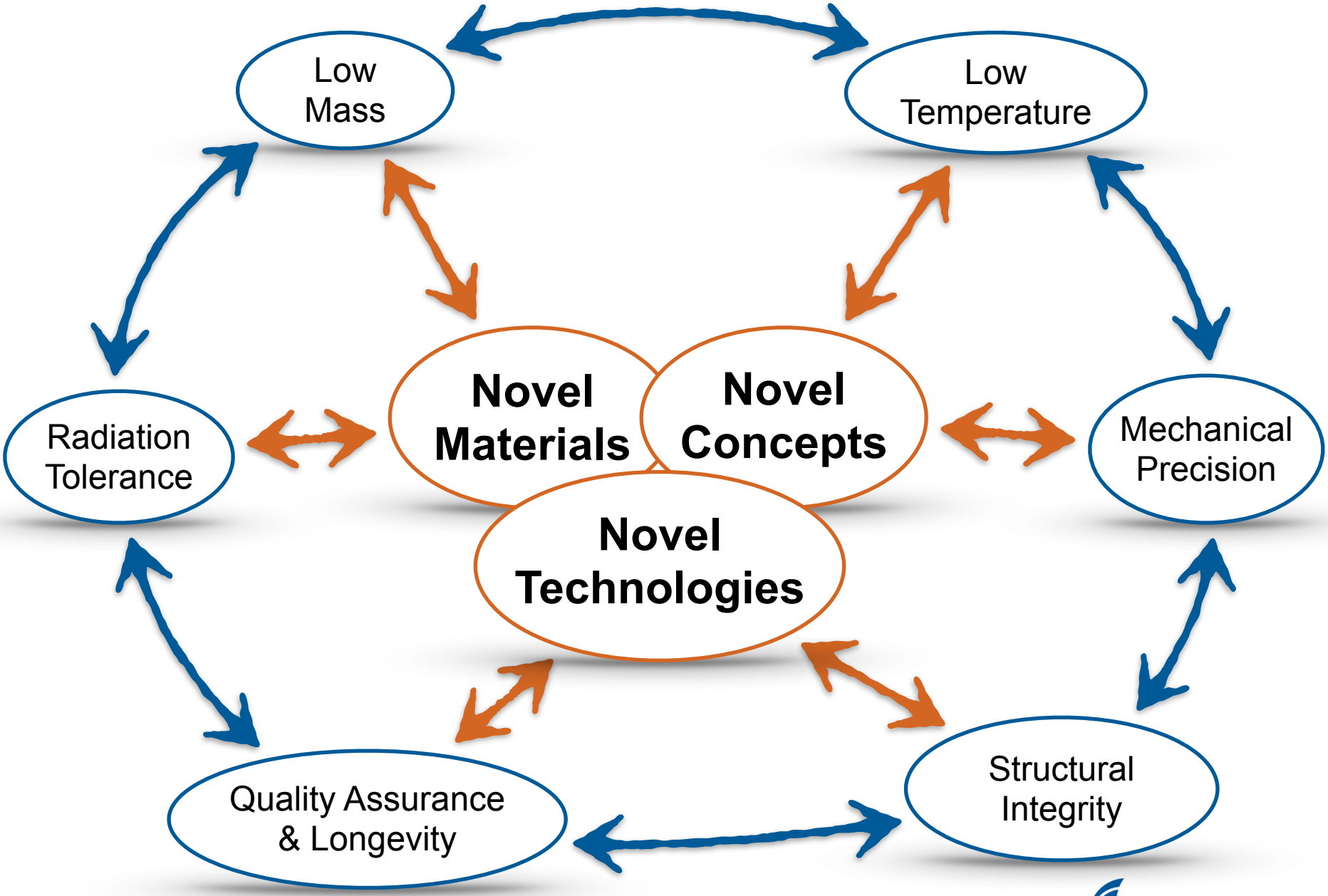

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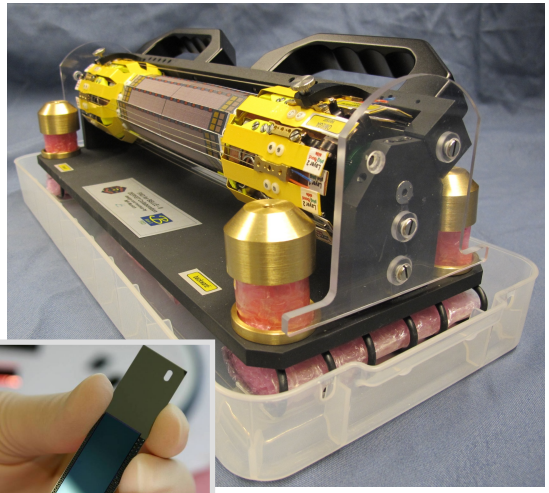
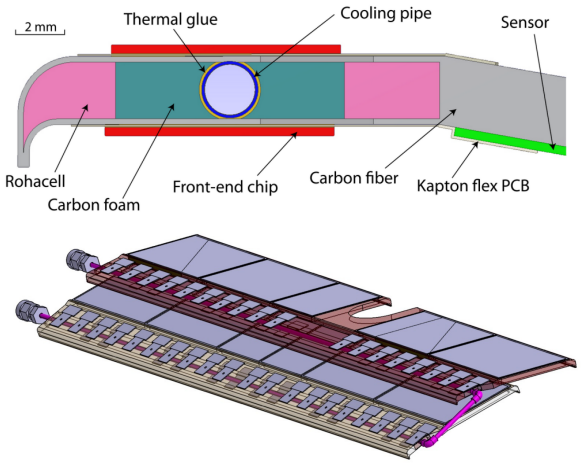
Low Mass System Designs

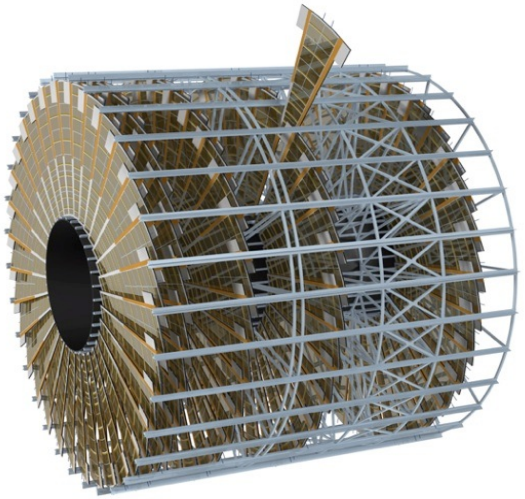
- essential for reconstruction performance
- future detectors demand lightweight or even ultra lightweight support structures
  - including cooling and cabling



Belle II Vertex Detector
- 2 layers
- 10 cm length
- 2.8/4.4 cm diameter
- 0.21% X_0 for inner layer



Panda MVD Barrel
- 4 layers
- 31 cm length
- 27 cm diameter
- < 10% X_0 for most parts of the acceptance



ATLAS Strip Tracker Endcap
- 35 m^2 of silicon
- 1.7 m length
- 2 m diameter
- 180 kg mass

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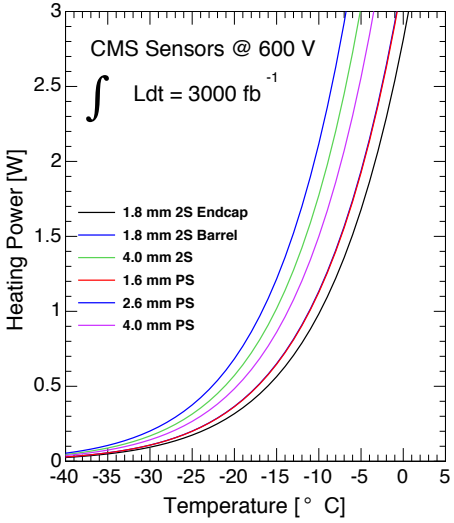
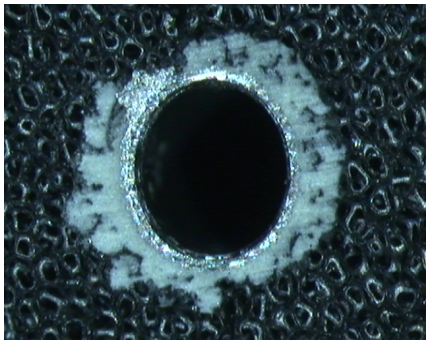
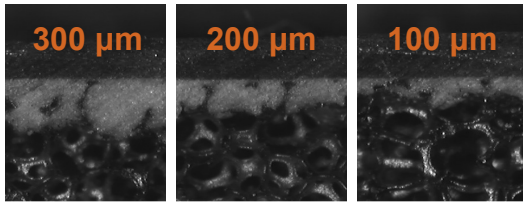
Low Temperature Operation

- higher granularity detectors and more functionality in front-end
  - ➡ higher front-end power to be cooled away
- radiation levels at e.g. HL-LHC require operation at -20 °C
  - ➡ minimise leakage currents and noise
  - ➡ avoid thermal runaway
- novel materials and technologies can combine demands of a low mass system design with thermal management needs

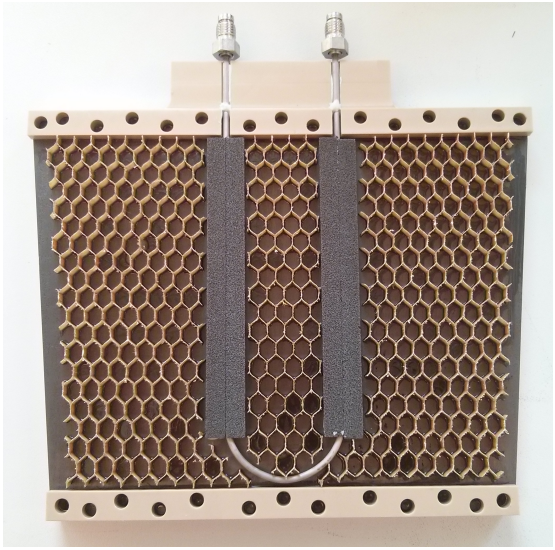




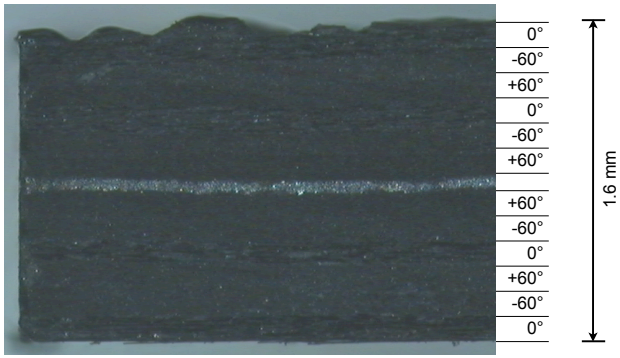
Ti-Pipe embedded in C-Foam



C-Foam glueing test
to optimize amount of glue



ATLAS Endcap Petal Prototype



Graphite foil laminated into CFRP
combines structural with thermal management material

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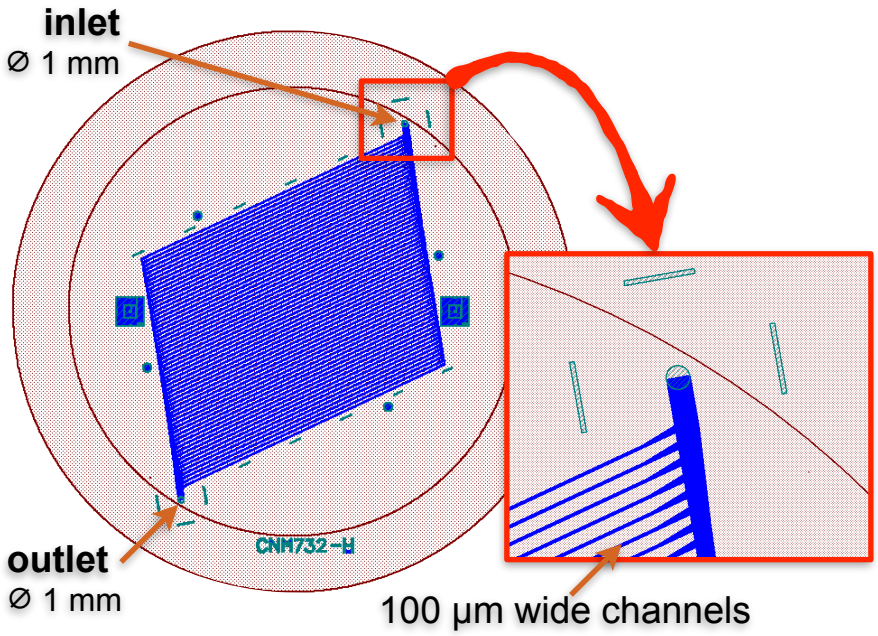
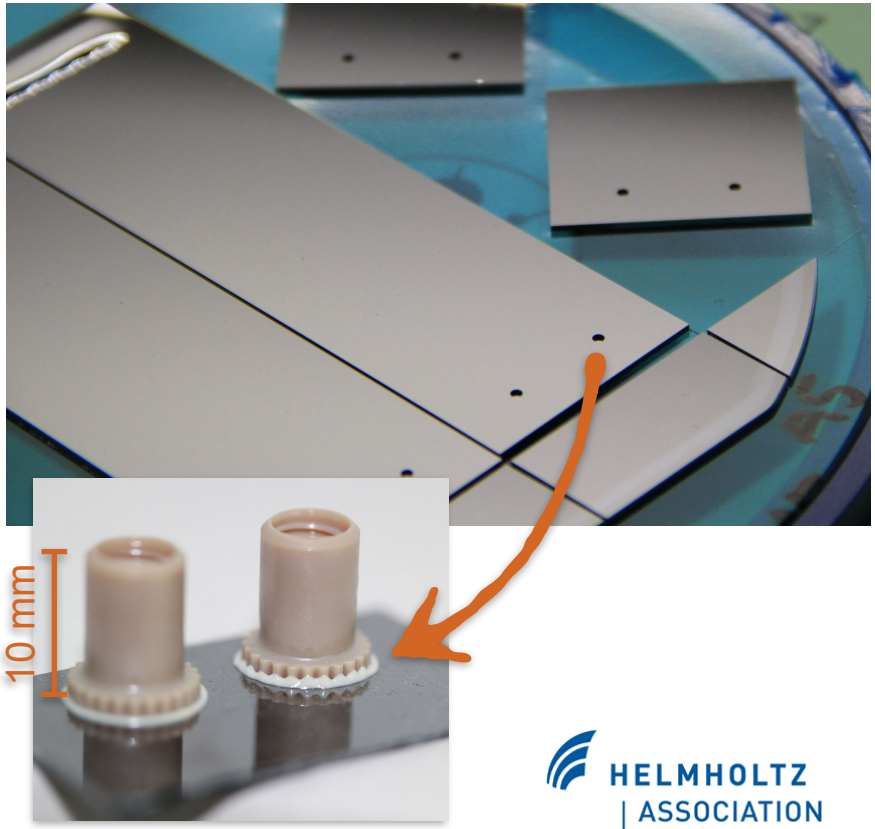
Novel Cooling Concepts

- state-of-the-art cooling systems for detectors rely on heat conduction
- micro-fabricated cooling channels embedded in thin silicon substrates
  - bring coolant to where the heat is actually generated
  - no CTE mis-match between sensitive element and cooling
    - ➟ no stress on sensor and no deformation
    - ➟ ideal for both X-Ray imagers and HEP
    - ➟ Helmholtz-Cube could be test bench





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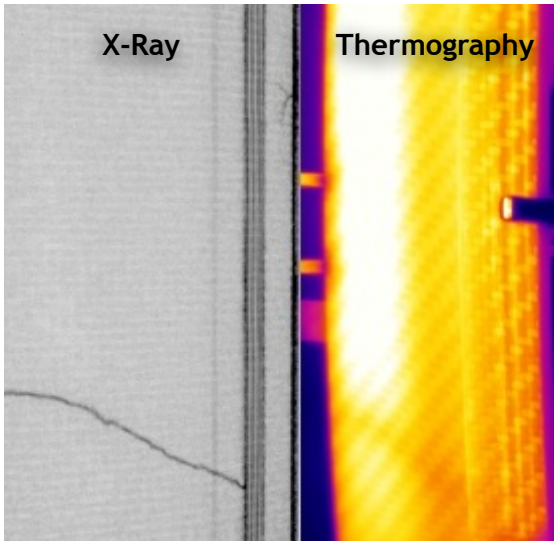
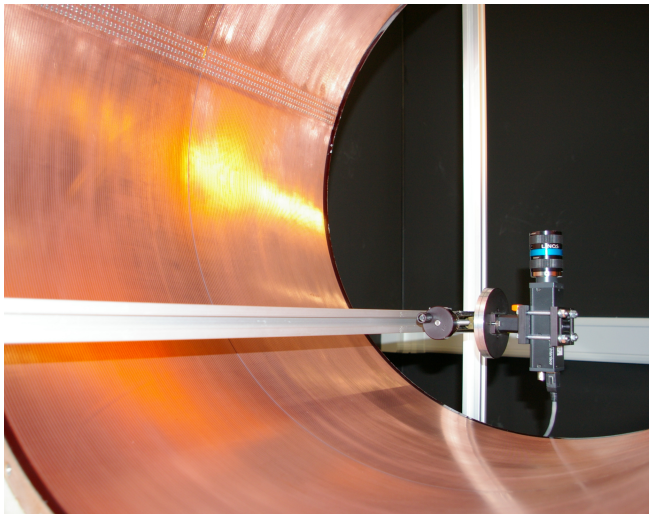
Longevity Engineering

- inner tracking detectors in HEP experiments are typically inaccessible for repair
- a lifetime of ten or more years has to be taken into account
  - already in the design phase and
  - ensured during large scale productions
- engineering design has to guarantee
  - quality of detector components ➟ yield and longevity
  - tolerance to expected radiation levels (e.g. glues)
  - structural integrity (e.g. for up to 100 thermal cycles)



Panda MVD Strip Barrel Stave



Optical Inspection of a TPC Field Cage

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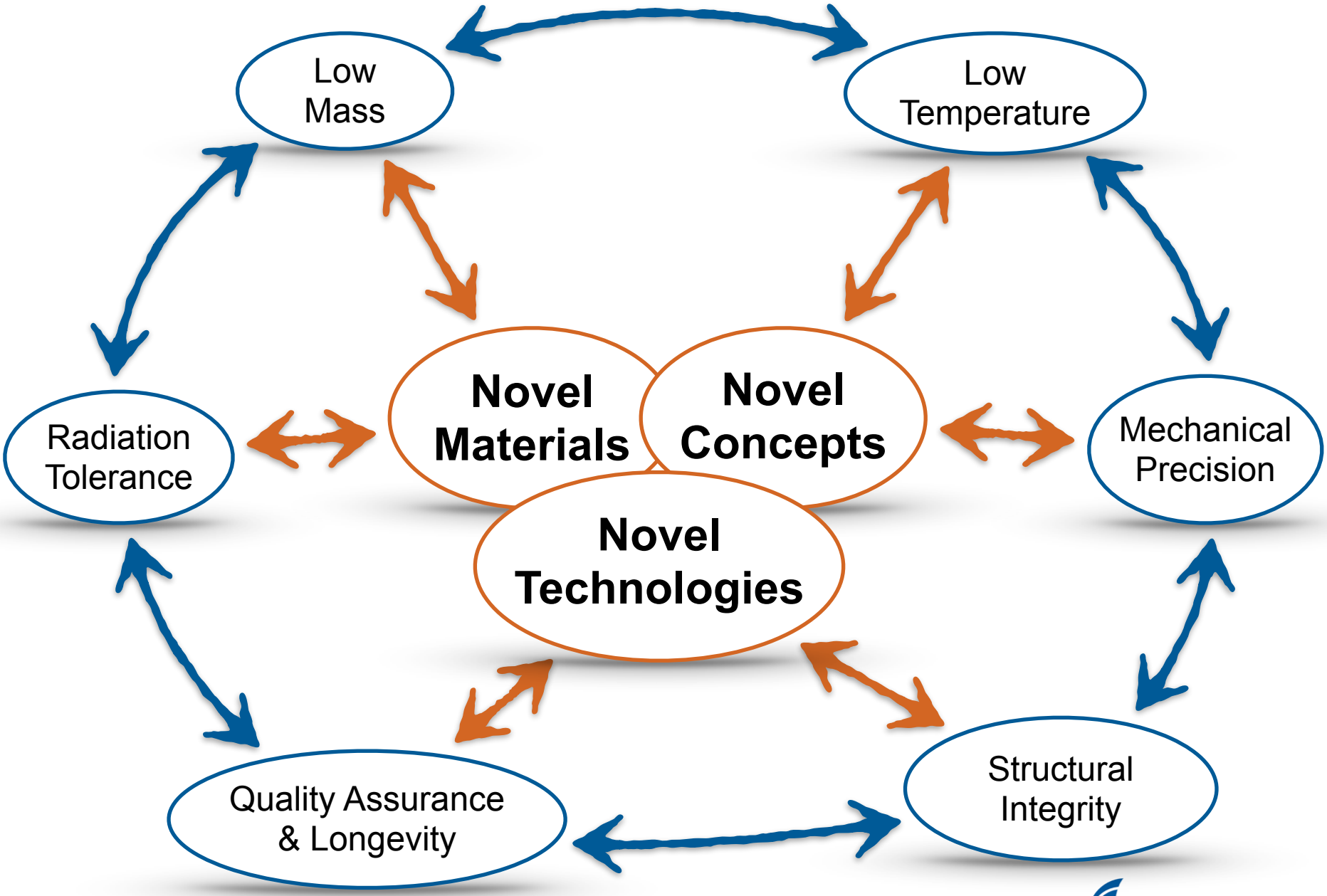

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