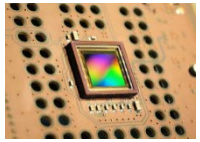
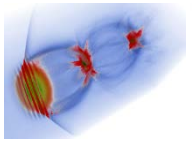
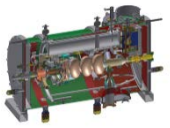
Matter and Technologies

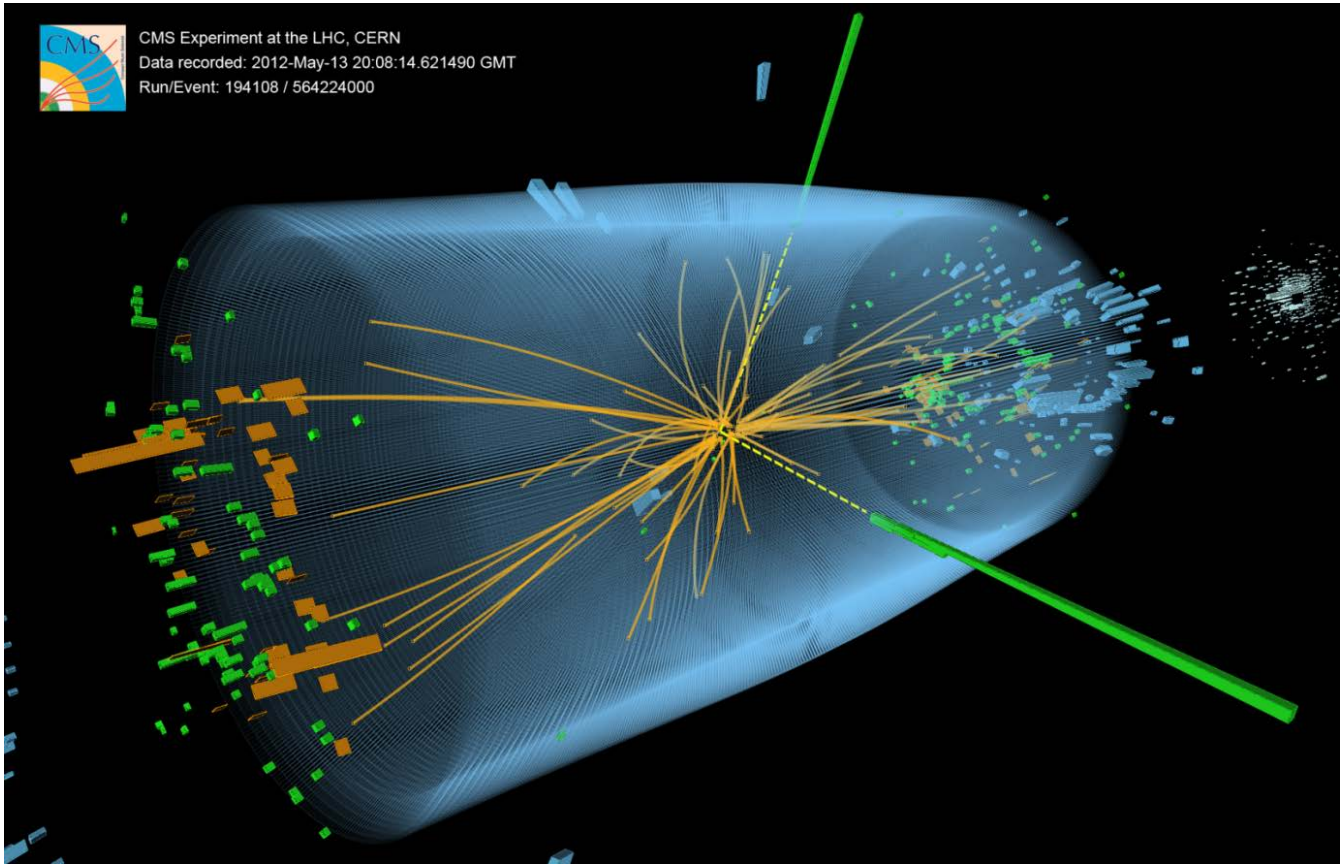
Introduction “particle physics”

Marc Weber

DTS

607. WE-Heraeus-Seminar
14-17 February 2016

Proton-proton collision at the LHC

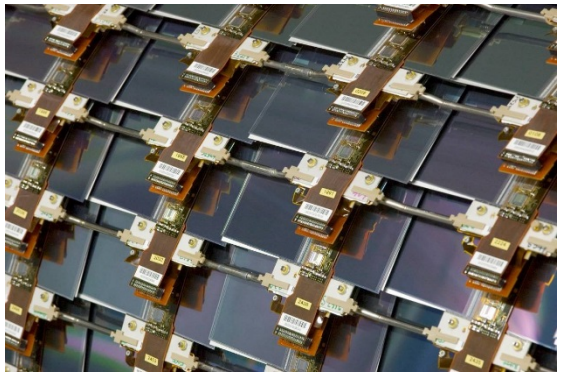


- Event „images“ are 3D
- Event reconstruction combines all subdetector systems
- Event rate („frames per second“): 40 MHz

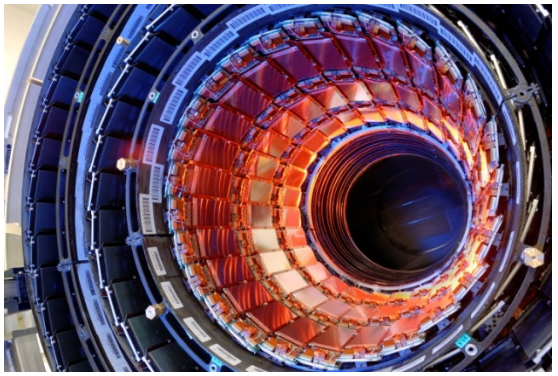
HELMHOLTZ ASSOCIATION

Silicon detectors on the rise

Belle 2

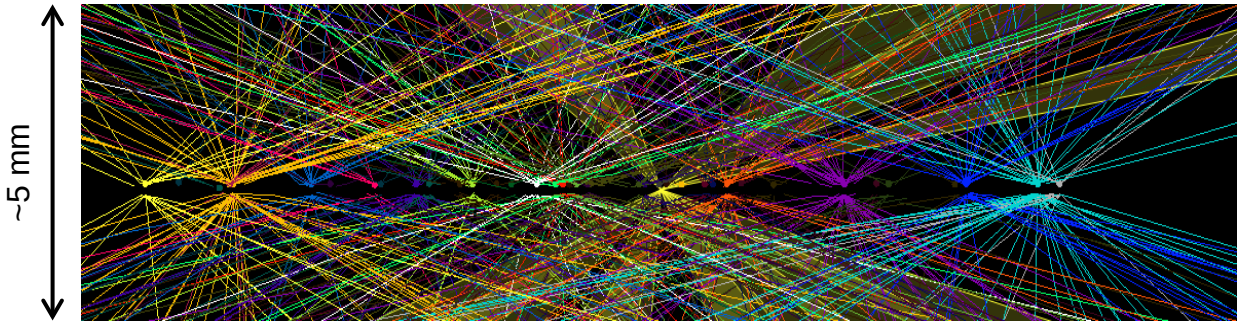


ATLAS SCT



CMS

- Silicon detectors come in many flavours.
- Vertex detection of relativistic charged particles (e, μ, pions, kaons, …)

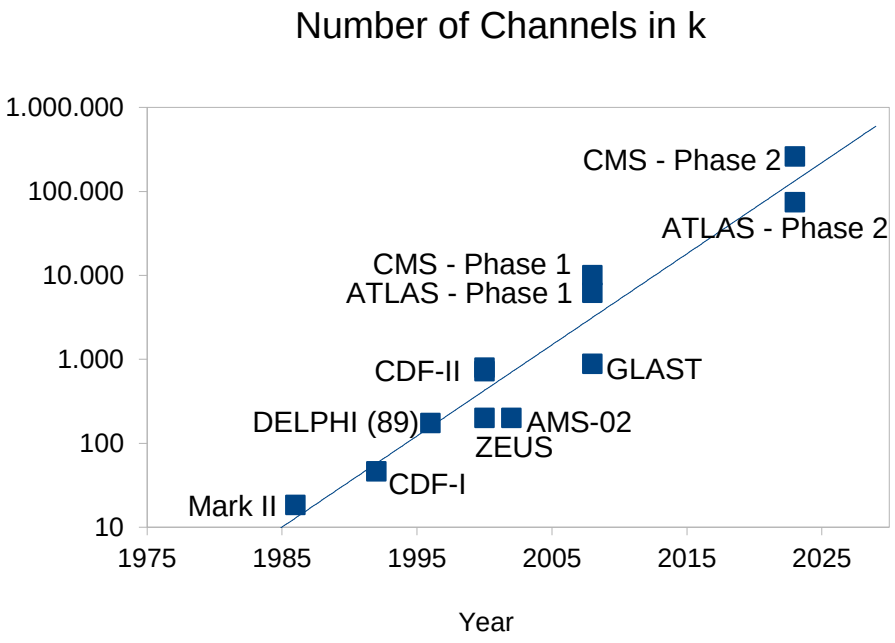


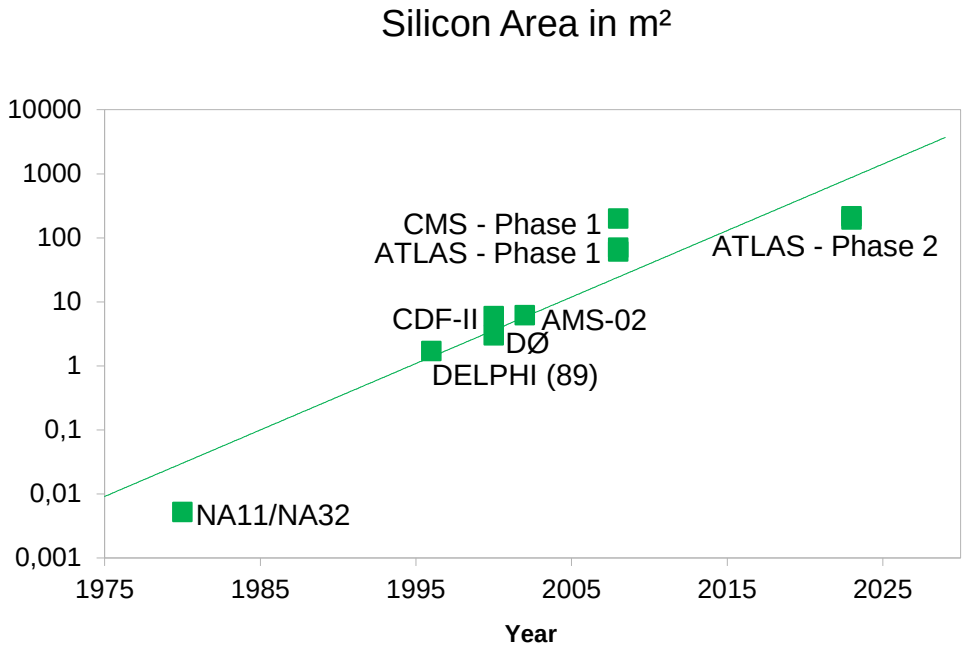
- Tracking of charged particles

HELMHOLTZ ASSOCIATION

Moore's law for Silicon detectors

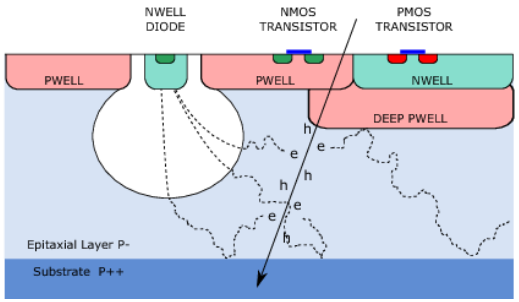
- Ever larger systems (> 100 m^2) and more channels (> 300 million)
- Exponential rise

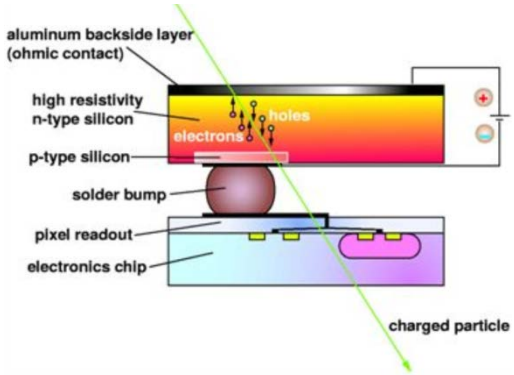




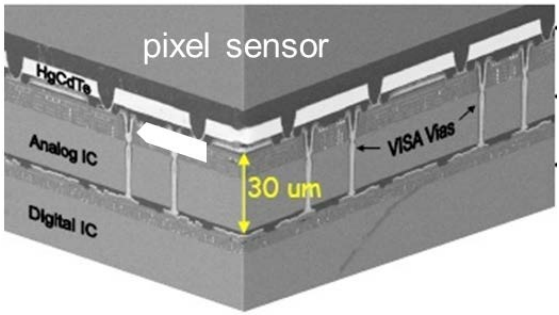
More than Moore

- Monolithic rather than hybrid sensors

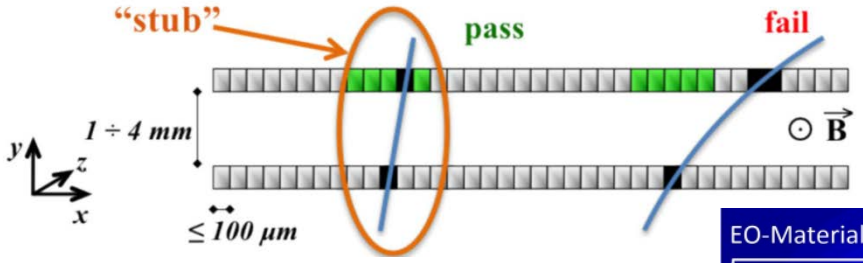




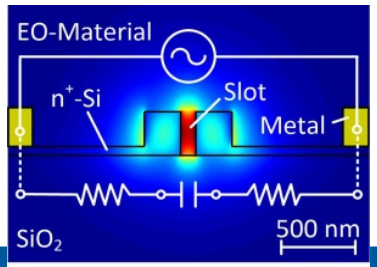
- CMOS sensors, HV-CMOS, DepFETs and more
- 3D technologies in ASICs and sensors



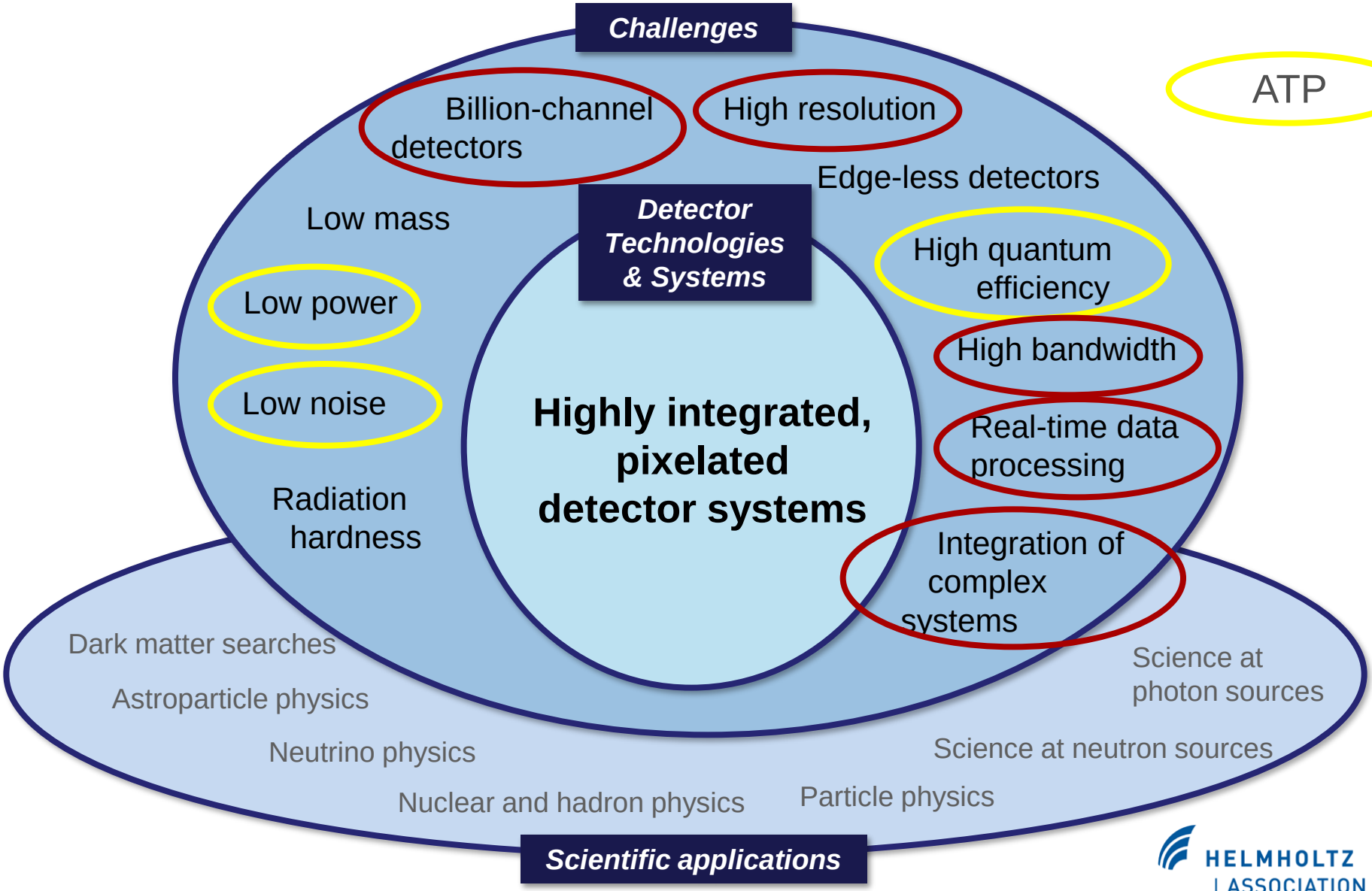
- Intelligent front-end triggers



- Optical data transmission schemes



There is no lack of challenges



HELMHOLTZ ASSOCIATION

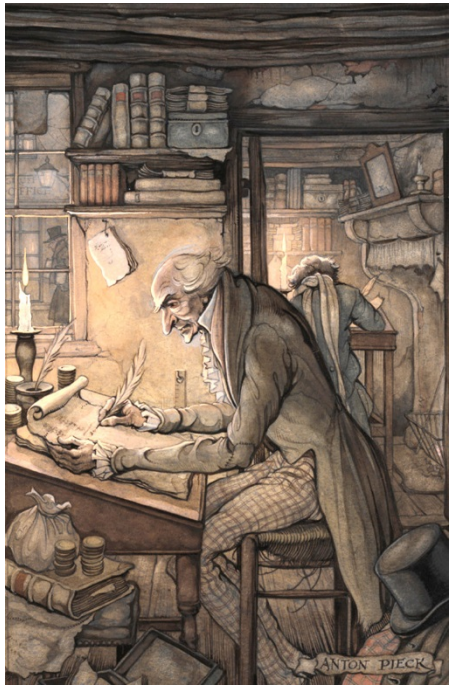
Silicon systems: greed

Want highest position and momentum resolution for physics

- hundreds of millions of pixels
- low detector mass for minimum deflection of particles

while coping with extreme environmental challenges

- irradiation levels
- inaccessible and crowded detectors
- costs

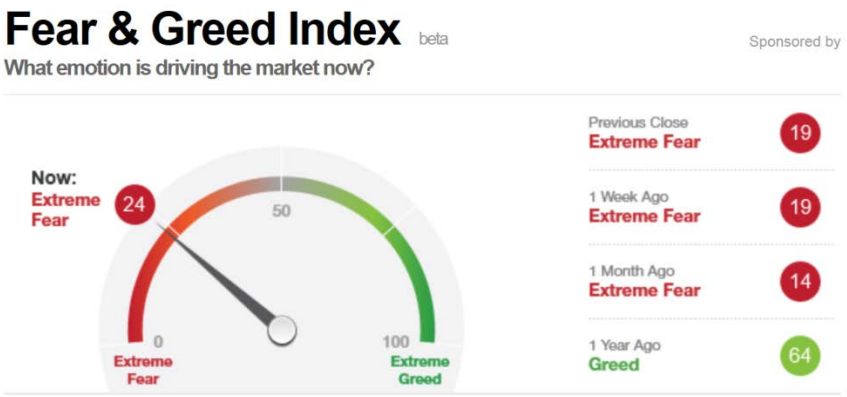


Silicon systems: fear

- Minimum signal-to-noise ratio
- Low-power chip designs with compromises in noise, linearity and resolution
- aggressive power distribution schemes
- high-pressure thin-wall cooling pipes
- grounding and shielding with minimum conductive material

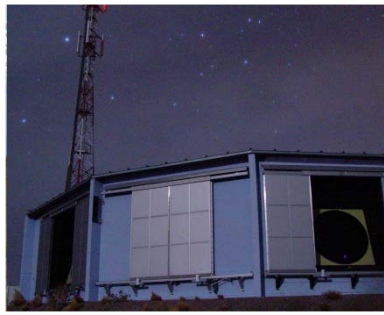
Are novel technologies mature?

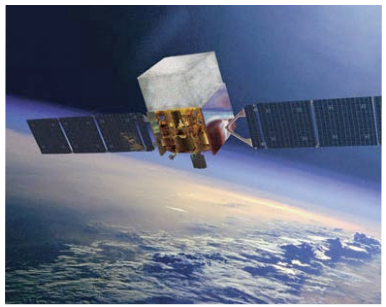
Will system function or fail

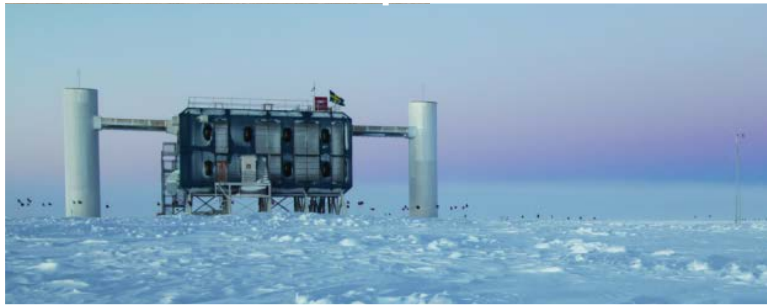
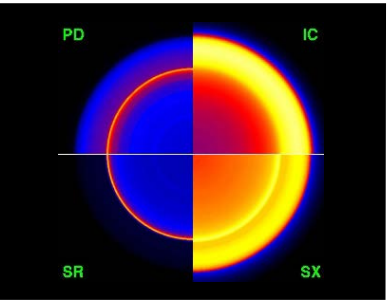


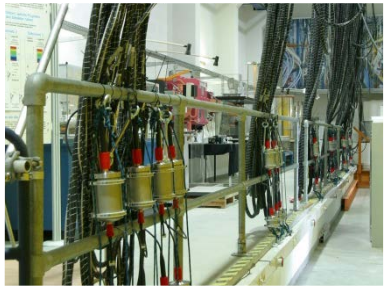
Light sensors in astroparticle physics



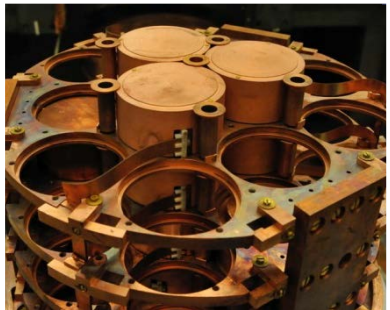
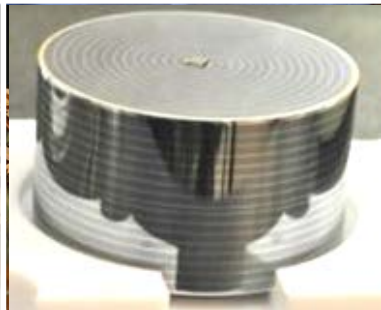







- Marcel Stanitzki — Silicon detectors in particle physics
- Johann Heuser — Ultra-low mass silicon trackers for high-rate, high-multiplicity heavy-ion physics
- Ivan Peric — Sensors for particle physics in commercial technologies
- Jelena Ninkovic — DepFET detectors in astrophysics and particle physics instrumentation
- Christian Dillie — MPPC – A photon counting detector for scientific, medical, and industrial applications

HELMHOLTZ | ASSOCIATION