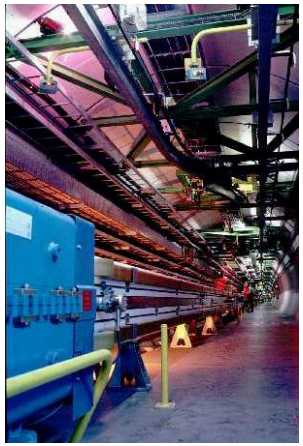
Detector Development in Helsinki

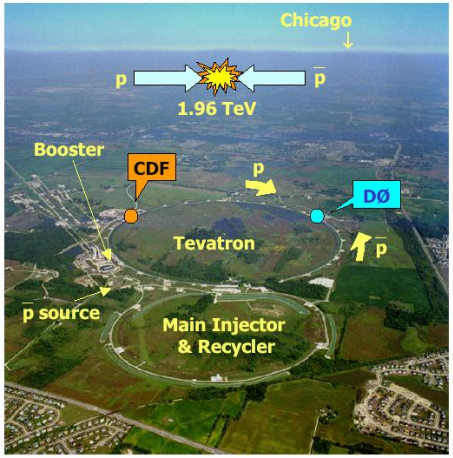
SiLC Meeting 2. February

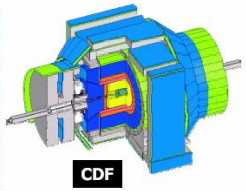
Risto Orava

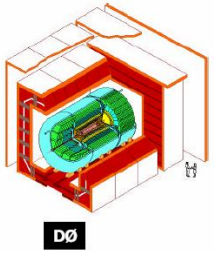
From LEP experiments to LHC

University of Helsinki & Helsinki Institute of Physics







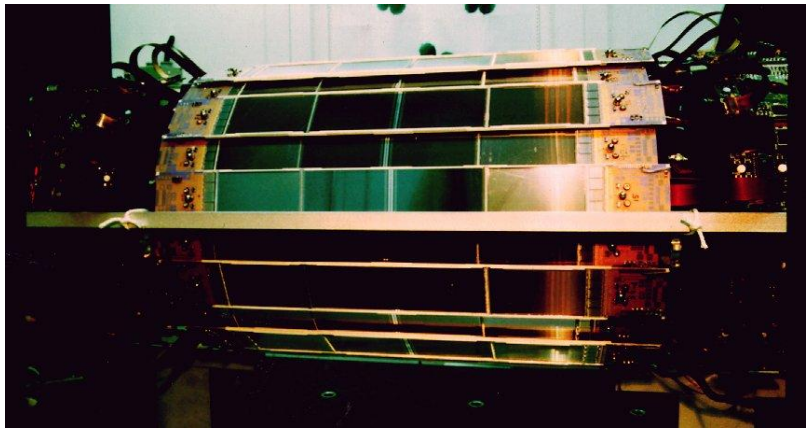


LEP/CERN → Tevatron/Fermilab → LHC/CERN

Detector Laboratory - basis of experimental hep in Finland.

Where it all started: DELPHI MicroVertexDetector

Two layers of single-sided Si-strip sensors - mechanical support structure & sensor read-out – 1990



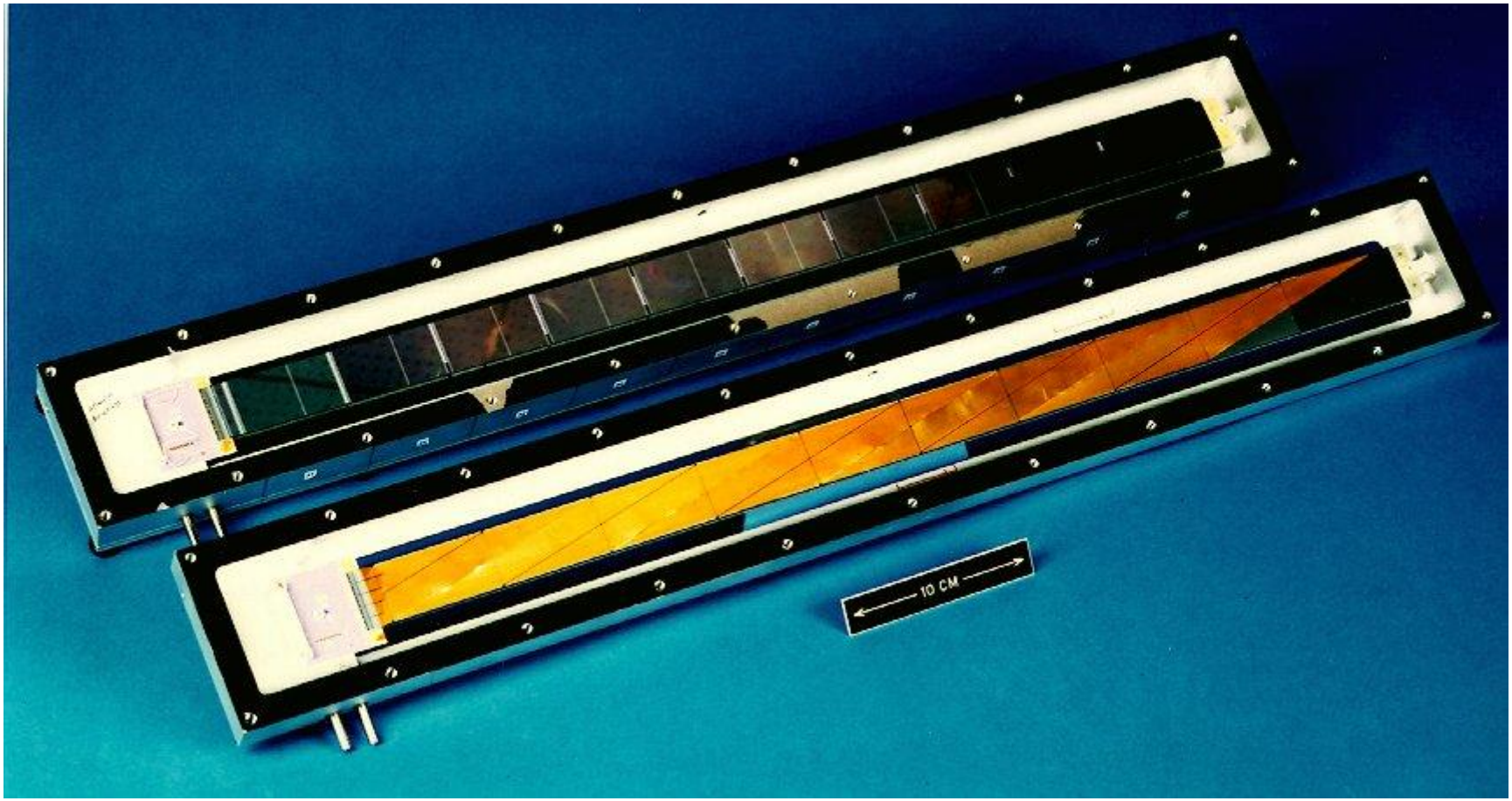
A 3rd single-sided layer added & beam pipe reduced in diameter - Finnish Si-sensors (VTT), mechanical support structure & mounting –1991

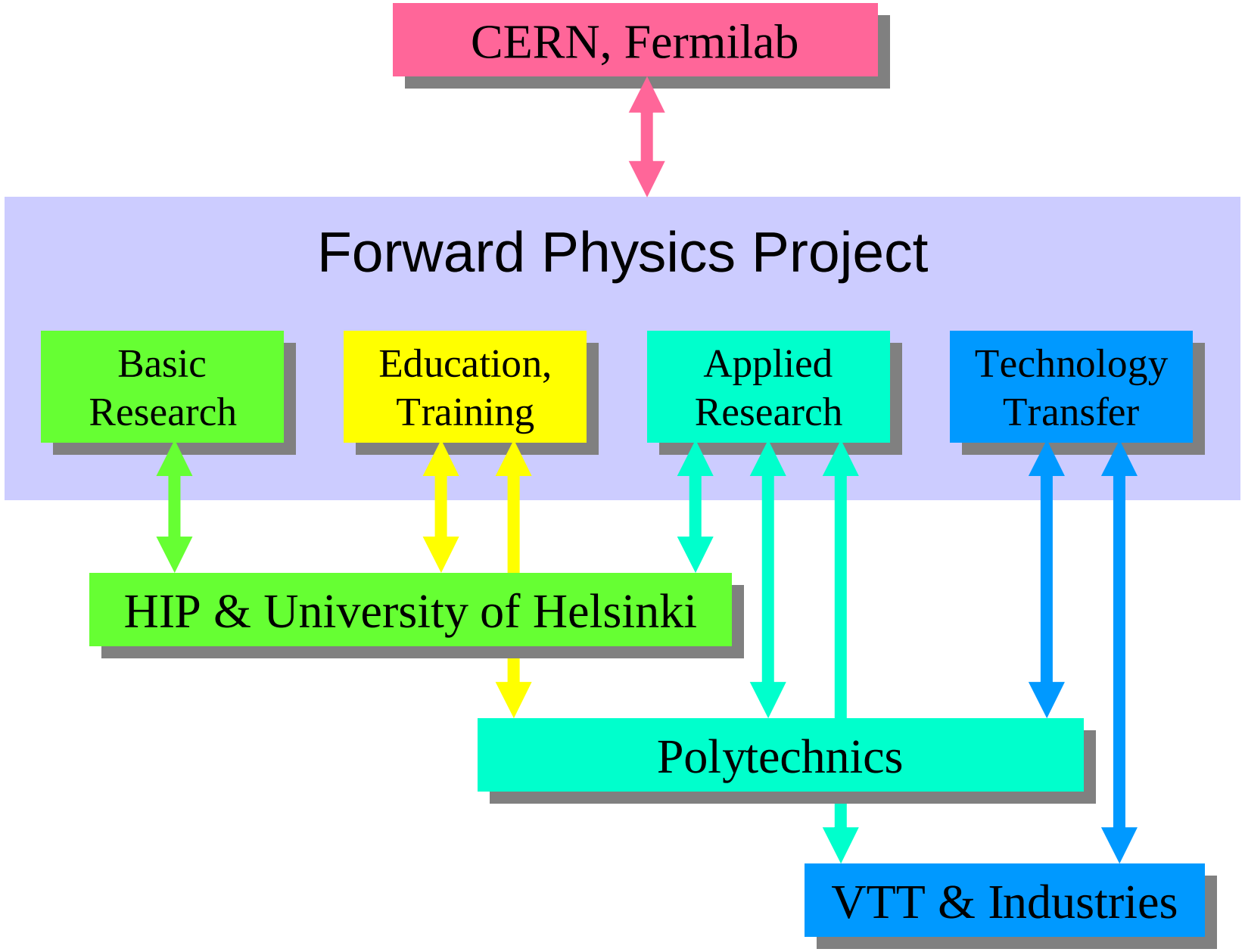
Two single-sided layers exchanged to double-sided double-metal sensors
-double-sided sensor development, mounting & cooling - 1994

An extended three-layer barrel tracker with fwd crowns of pixel & mini-strip sensors (DELPHI Silicon Tracker)
-assembly of outer layer modules & mounting - 1996

Design & feasibility studies, pattern recognition and hit reconstruction software development, coordination of the project

60cm Long Si-Strip Detector Ladder

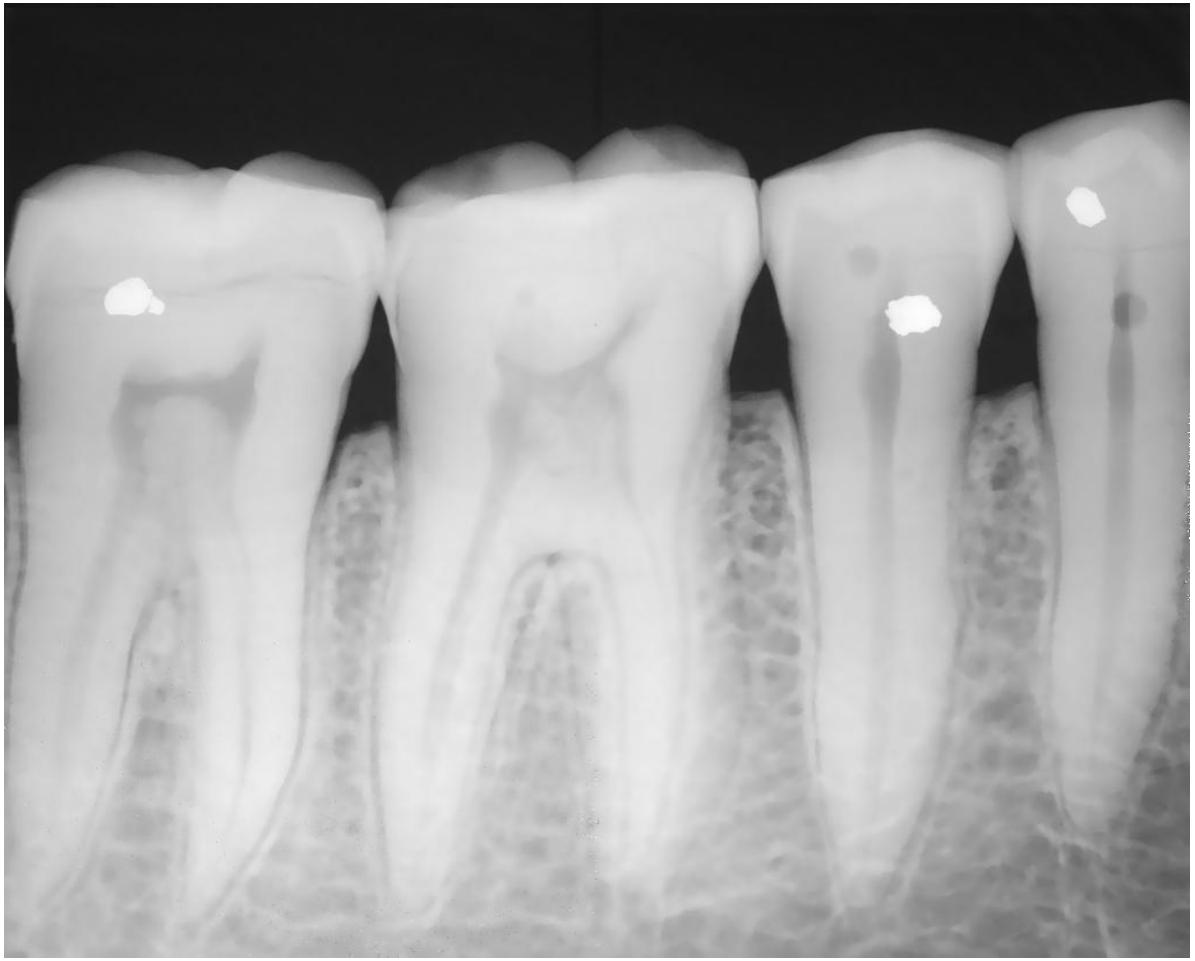


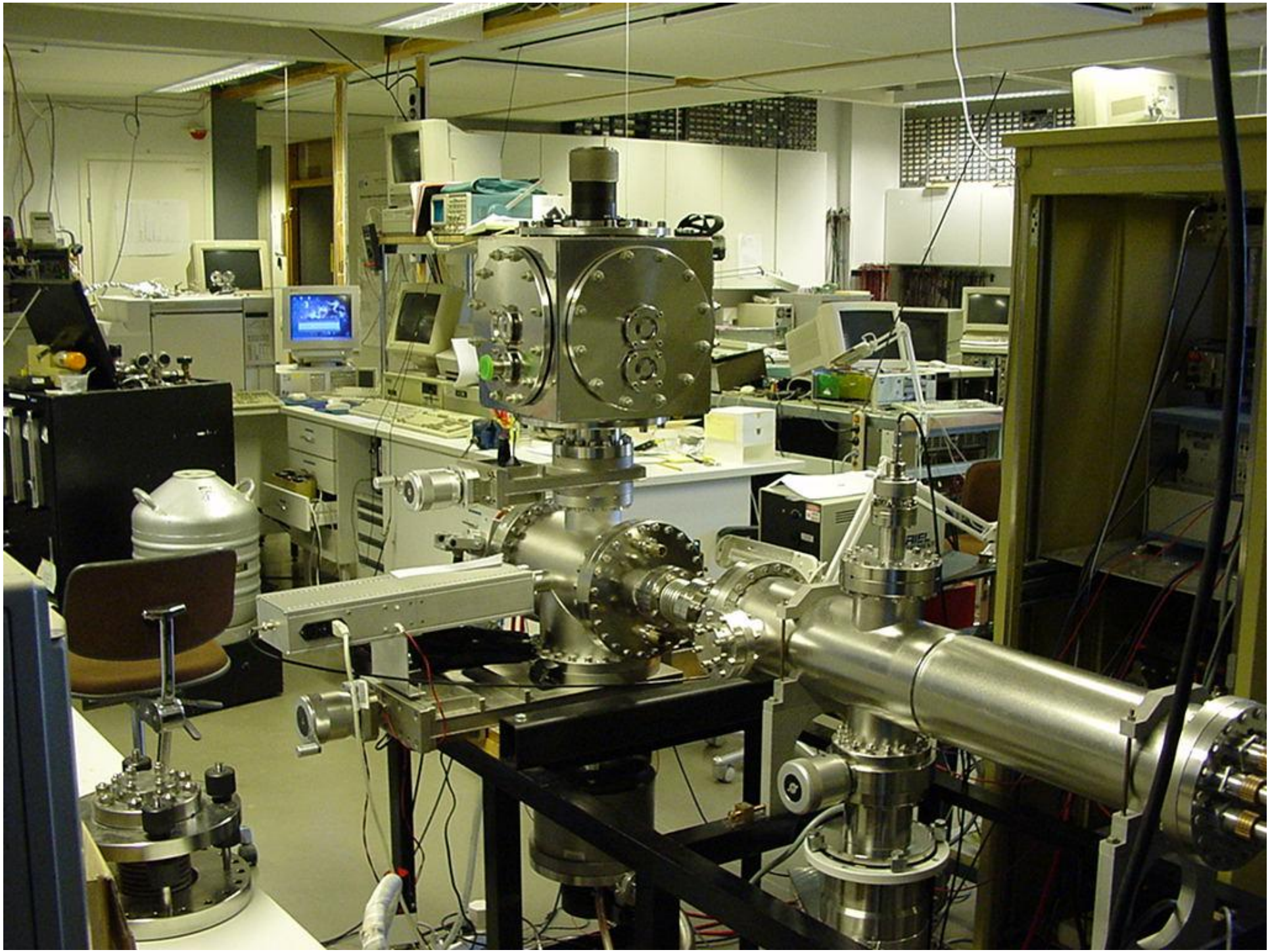

CERN, Fermilab
Forward Physics Project
Basic Research
Education, Training
Applied Research
Technology Transfer
HIP & University of Helsinki
Polytechnics
VTT & Industries

Applications of precision sensors in industries:

Non-destructive testing: paper industry mechanical wood processing pcb-producers,... safety	Agilent, Honeywell, Valmet,...
Environment: public sector (air pollution) energy sector (dosimetry) medical sector (dosimetry)	Säteilyturvakeskus - Kumpula Westinghouse, Siemens, IVO...
Medical: medical imaging...	General Electric, Philips, Siemens, Toshiba
Services: flip chip bonding custom designs consulting	CERN, Fermilab,... Metorex, Detech,... ESA, NASA,...R&D programs

NS- Digital Image

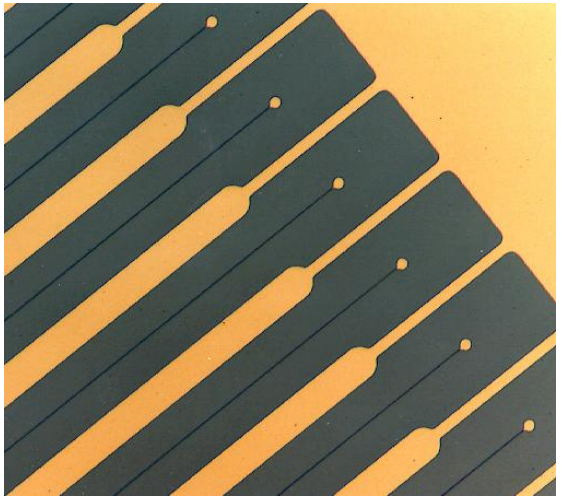




DETECTOR LABORATORY - FACILITIES

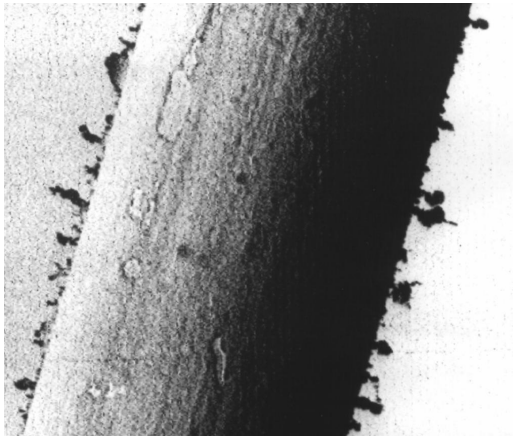
- Clean room, class 100 and class 1000
- Ultrasonic automatic wedge bonder (Kulicke-Soffa) with video monitoring
- Manual probe station
- LCR-meter (HP 4284A)
- Computer controlled measurement system for static detector analysis
- Precision detector alignment system for mechanical assembly of strip detectors, accuracy 5 μm
- Printed circuit and electronics design tools
- Electronics design programs
- Visual scanning microscope
- Gas chromatograph with TCD, FID detectors, integrator and cryotrap sampling unit
- Gas chromatograph with mass spectrometer (HP G1800B)
- Vacuum gauge system (several gauges)
- X-ray devices
- Several NIM and VME crates with many data acquisition modules
- Automatic four-point resistivity meter station with Picoammeter and Electrometer
- PC-controllable gas mixer unit
- MALDI-TOF mass spectrometer
- Several high voltage units, counters, pulse generators, multichannel analyzers
- Vacuum metal evaporator (Edwards Auto 306)
- Excimer and nitrogen lasers

Gas amplified detectors



- proportional counters
- streamer tubes
- multistep multiwire chamber for beta particle imaging
- microstrip gas chambers
- study of ageing of gas filled radiation detectors

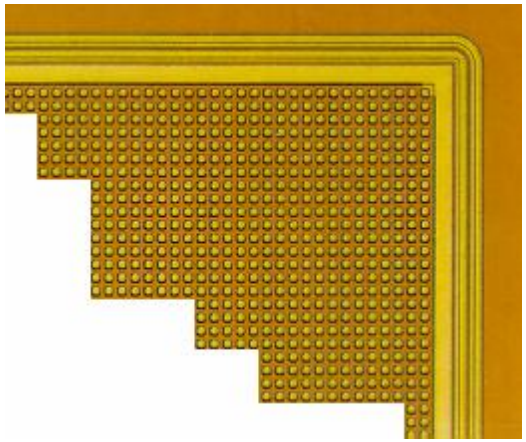
Ageing of gaseous detectors



- polymer deposits on anode and cathode surfaces
  created by large radiation doses; mechanism not well known
- depends on the purity of the gas mixture, on the materials used and on the electric field strength on electrodes
  gas analysis system based on sample concentration by cryotrap unit
  - purity level measurements of fill gases
  - analysis of outgassing products of construction materials
  - analysis of stable compounds created by electron avalanches
  - effect of additives to the chemistry of gaseous detectors

  aim: experimental data for ageing model

Semiconductor detectors

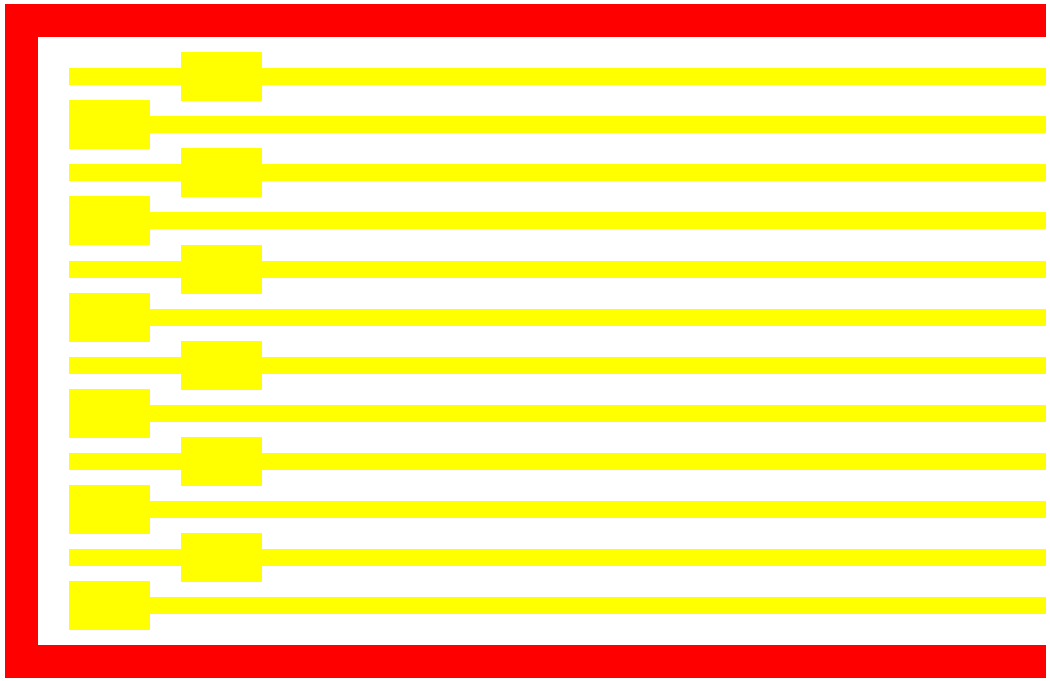


- diodes
- single sided silicon strip detectors (AC & DC)
- double sided silicon strip detectors (AC)
- single sided stereo angle strip detectors
- silicon drift chambers
- silicon drift chambers with integrated FET
- radiation hardness studies
- pixel detectors (Si & CdZnTe)
- 3D silicon detectors

TOWARDS EDGELESS DETECTORS

1. EDGELESS DETECTORS

- Normal strip or pad detector (with or without gr) scribed into or near active region



gr = guard ring

Active strips

Scribe line

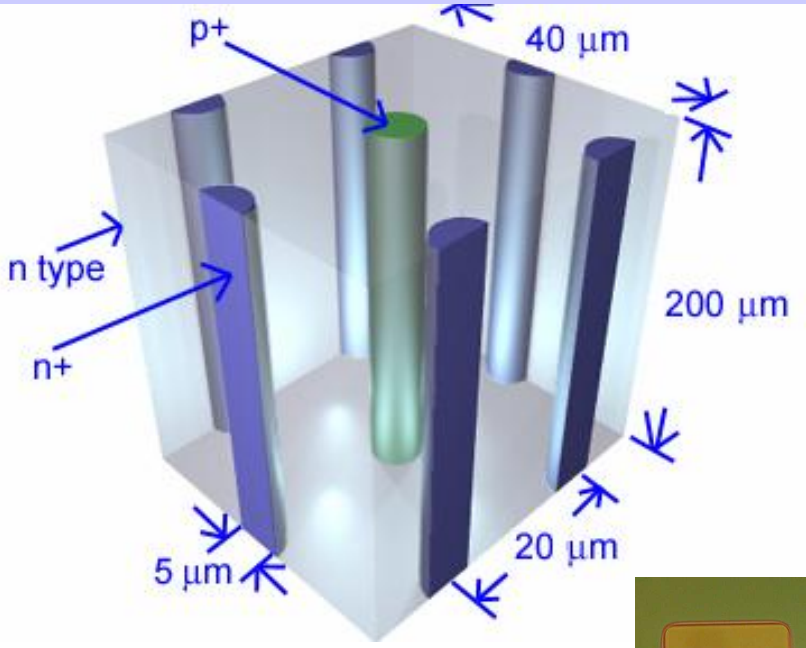
“ACTIVE EDGE DETECTORS”

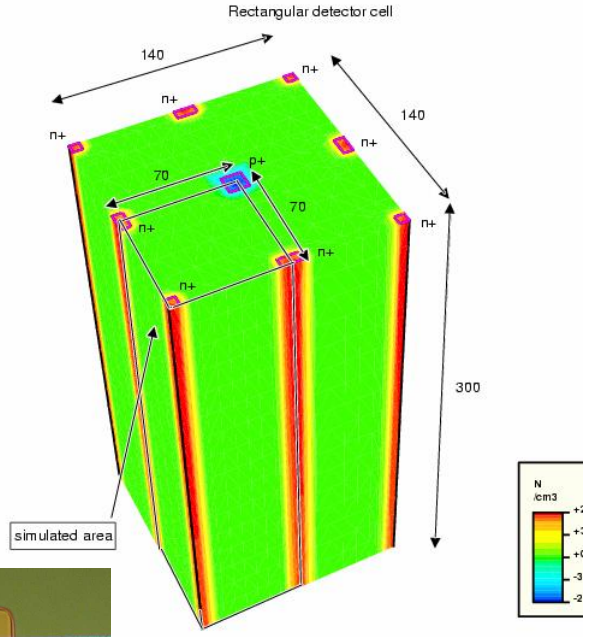
•basic idea: doped edge (n or p) is brought near the active strips/pads
• see principled sketch below

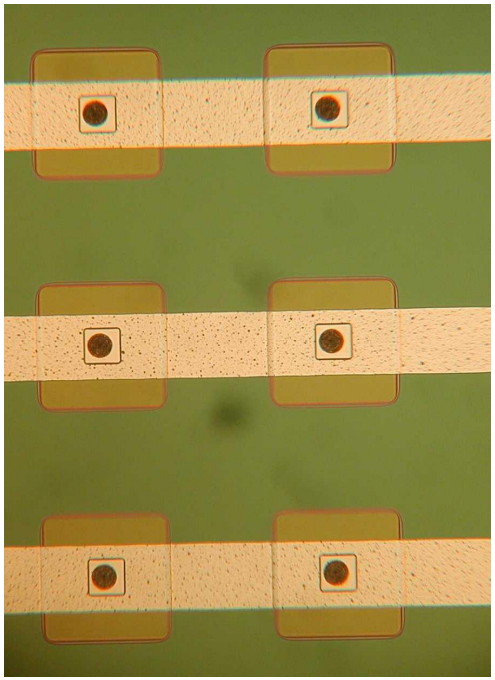
• so far not demonstrated, but could be done at least on SOI

• will probably have breakdown problems, if the distance between the active strips and edge doping is considerably smaller than the termination area in the planar devices

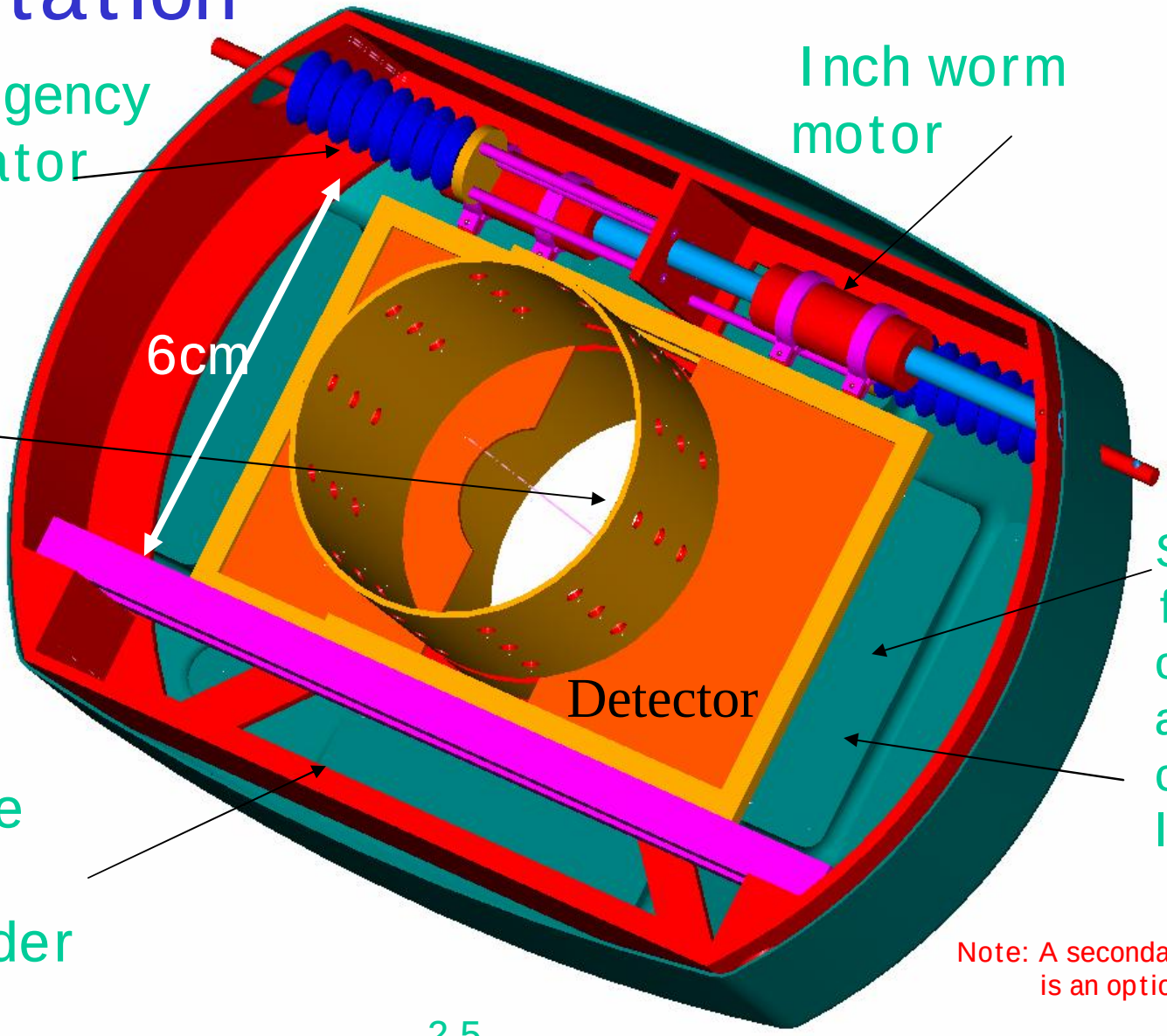
Figure: First 3-dimensional Si-detectors manufactured in Finland in cooperation with SEFO, HIP, VTT and CERN.







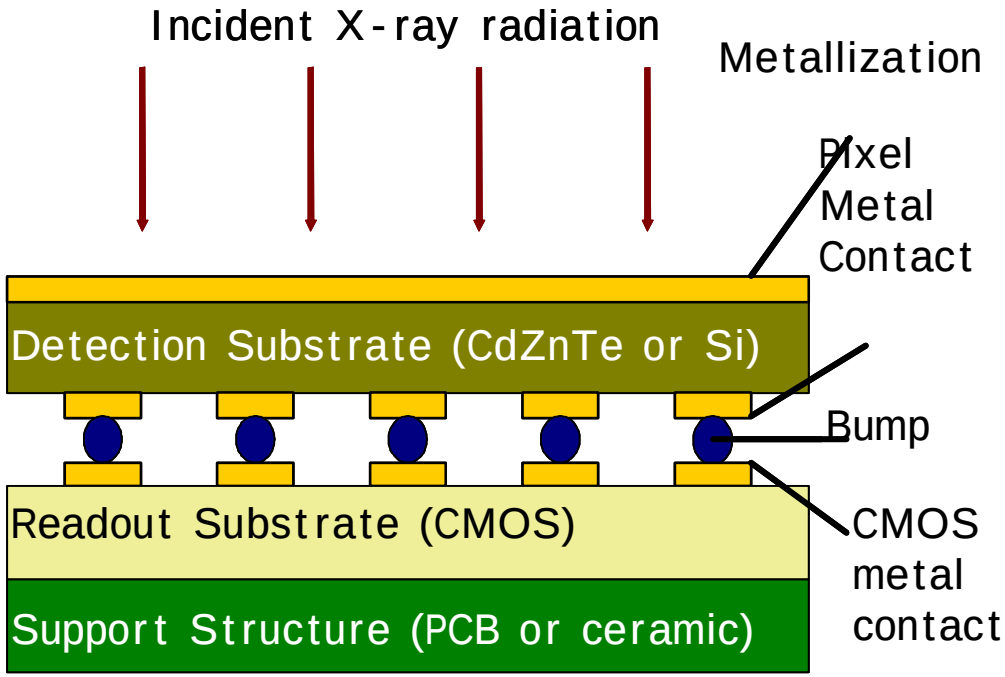
Microstation

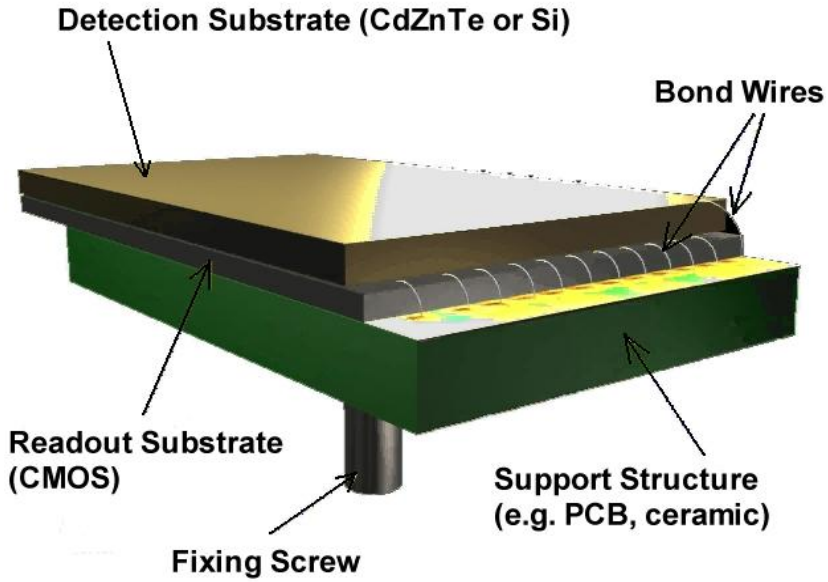


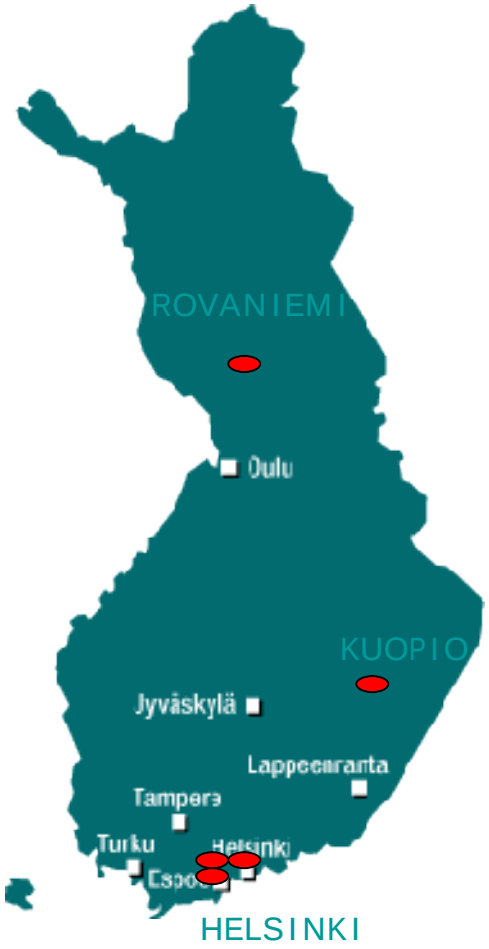
Note: A secondary vacuum is an option.

Main Idea

- Generic Design.
- Tile: modularity, scalability.
- Pixel pitch: down to 35µm.
- Dimensions: now ~ $2cm^2$.
- Detector: Si, CdZnTe, consider CdTe, PbI_2.
- CMOS ASIC: Custom made for each application.
- Seemless tiling: no software interpolation.





The Helsinki Group – Domestic Network

Institute/ Coordinator	Responsibility
Helsinki Institute of Physics (hip.fi) R. Orava	Physics and detector simulation, integration&testing, project coordination
Division of High Energy Physics, University of Helsinki (physics.helsinki.fi/~www_sefo/sefo.html) R. Orava	Physics and detector simulation, project coordination
Durham University V. Khoze	Phenomenology of Forward Physics
Iowa State University J. Lamsa	Simulation
Espoo-Vantaa Institute of Technology (evitech.fi) T. Leinonen	Software & firmware development
Pohjois-Savo Polytechnic (pspt.fi) H. Heikura & A.Toppinen	Hybrid development/RF testing/ slow controls/tests
Rovaniemi Polytechnic (ramk.fi) J. Leino	Data base/GRID
VTT Technical Research Center of Finland (vtt.fi) I. Suni, S. Eränen	Edgeless Si-detectors for microstation