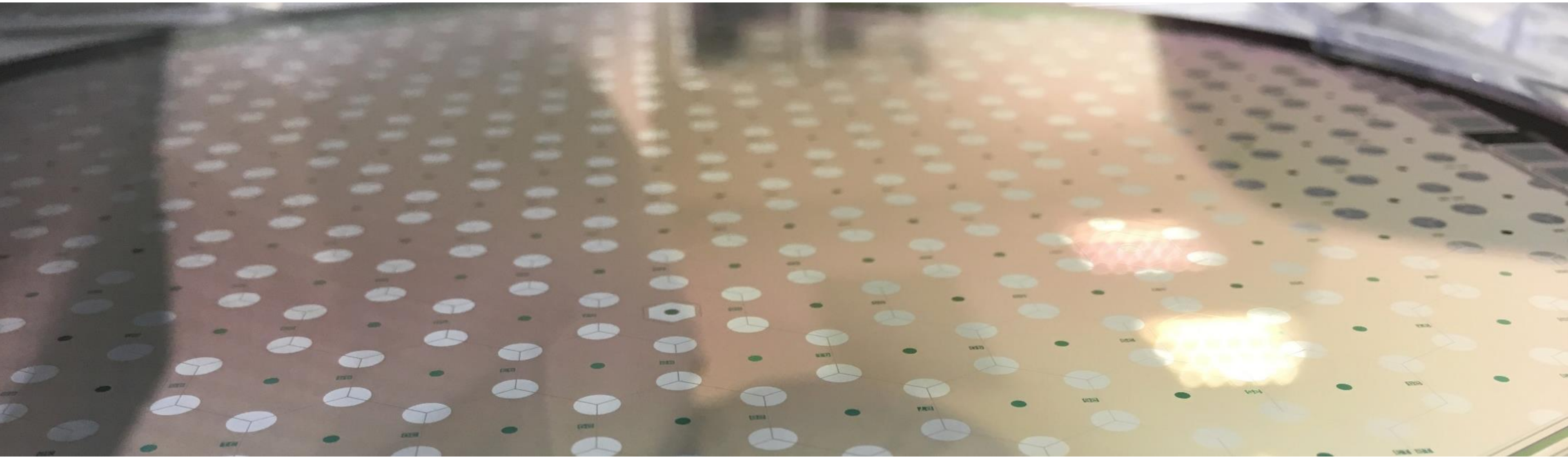

AIDA++ Open Meeting

Involving Industry in AIDA++ and beyond

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5 Sept 2019

H2020 Innovation Pilots

- **Background:** In 2020 the EC will launch a new instrument (Innovation Pilot) for advanced communities that have been supported under H2020 and previous Framework Programmes with three or more Integrating Activities, and have reached a high degree of integration at European level. [….]

- **Scope:** *Funding will be provided* to research infrastructure networks to start the implementation of a common strategy/roadmap for technological developments required for improving their services *through partnership with industry. Proposals should involve* research infrastructures, *industry and SMEs* to promote innovation and knowledge sharing *through co-creation of needed technical solutions* and make use, when appropriate, of large-scale platforms *combining R&D, integration and validation* for the technological developments.

Necessity to involve industry

Special demand of HEP for custom products

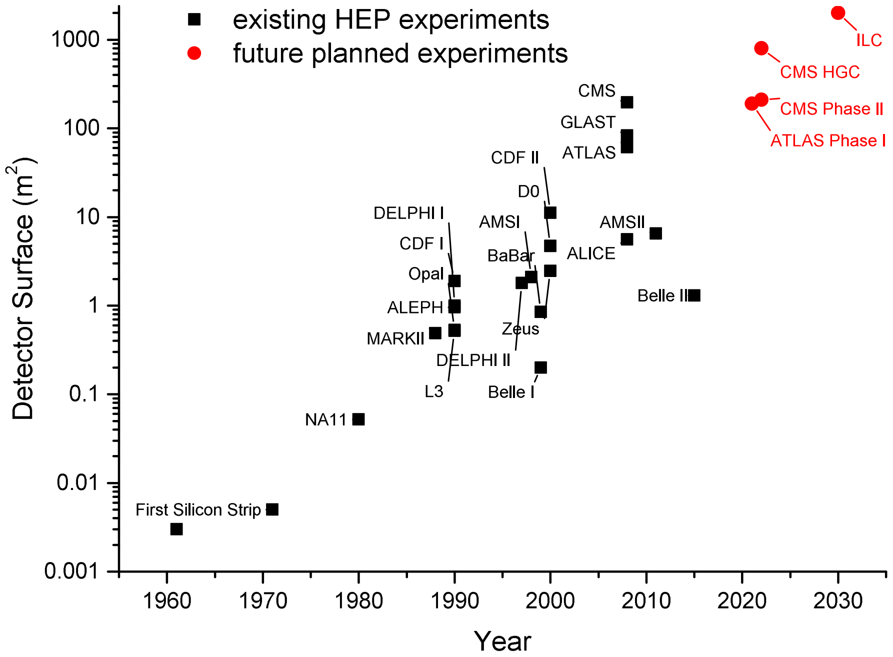
- Special operation conditions
  - Silicon chips outside “usual” operation temperatures
  - Silicon detectors in harsh radiation field
- No “industrial use case” at all, e.g. GEM foils

Different “life span” of experiments demand of experiments

- *Typical industrial product:*
  2 years R&D/design → 10 years production with continuous yield/quality improvements
- *HEP “product”:* 10 years R&D/design → 2 years production → 10 years operation

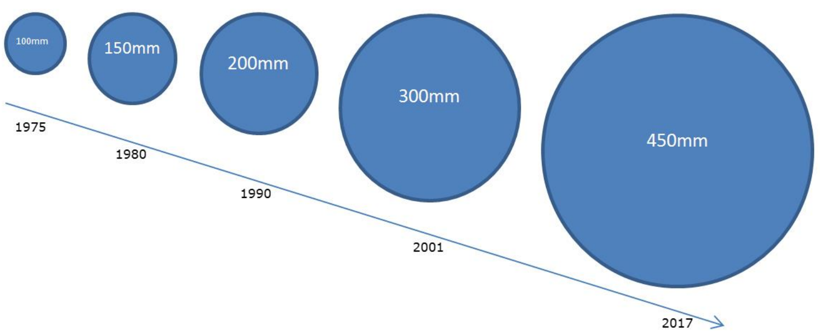
Demand on Si Sensors

- Silicon surface
  - Today: Up to 200 m^2 (CMS)
  - Similar size for the Phase-II Upgrade of CMS and ATLAS (~200 m^2 each)
  - Significant increase for CMS HGCal ~ 600 m^2
  - Longer Term: ILC, CLIC, CALICE, FCC, Chinese projects,…



- Wafer Size
  - NA11 started with 2” and 3”
  - Today 6” (150 mm) is standard (used by LHC Experiments)

→ Introduced in the Industry in the 80ies!



Vendors known to the HEP community

- Small/medium-scale Production (O(10-100) wafers per year)
  - Several institutes and companies
  - 6” available at many sites
  - Broad spectra of quality and price

- For large scale production (O(10k) wafers per year)
  - Only one producer
  - No European company

Dual Source Strategy

- To have (at least) a second option which can immediately take over in case of problems is in principle not a bad idea
  - Imagine: quality issues, bankruptcy, earthquakes,…

How to „talk" to industry?

Make company understand special situation of HEP:

- Often “one-time orders” after long R&D
  - Revenue is not a monetary aspect alone
  - Need to show other advantages (see later)

- No single/simple „decision making“:
  - Company: CEO/management who decides everything
  - HEP: Taxpayers money from several funding agencies; complicated and long-lasting decision making
  - There is also no “CERN” manager; there are experiments with own bodies

- No face-to-face price negotiations
  - CERN procurement rules: Market Survey → Invitation to Tender → Competitive bidding (alignment rule for member/non-member states) is generally unknown to companies in general

- Schedule driven by accelerator/experiments
  - No time-to-market driven schedule

Whom to talk to?

- **Top-down approach**
  - Google search for suitable company
  - Contact company through sales representative
  - Project is driven by sales/business unit

- **Bottom-up approach**
  - Know (personally) engineers and/or policymakers with the power to start new R&D inside the company
  - Establish joint R&D project
    - E.g. design/verification by HEP, production by company
  - Several constraints have to fit (e.g. workload of company driven by global economy cycles)
  - Once project is large “business people” will start to intervene

Non-monetary revenue

A company (usually) cannot get rich with HEP orders only

- R&D costs too high, too little "series production"

Need to show other advantages:

- Good reputation when working with science (CERN in particular)
  - Can be used by company for advertisements,..
- Access to highly educated students as possible future employees
- Access to new technologies and characterization facilities (e.g. irradiation facilities)
- **Most important:** find other technologies as spin-off from your project to get money from, e.g. automotive, medical imaging…..

Intellectual Property

Usually science and industry are completely the opposite:

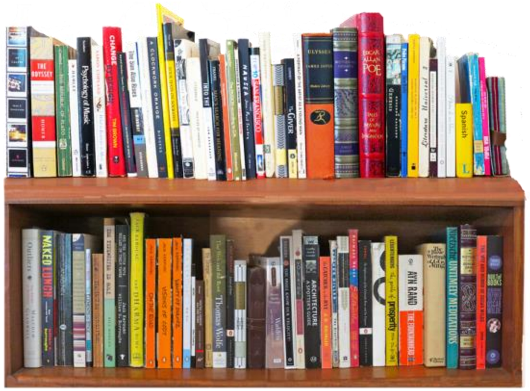
- **HEP: disseminate results in publications** („publish or perish“)
- **Industry: competition with other companies**
  - Intellectual Property (IP) as competitive advantages

Detector R&D is somewhere in-between because of technology-oriented concepts → we have to cope with both approaches

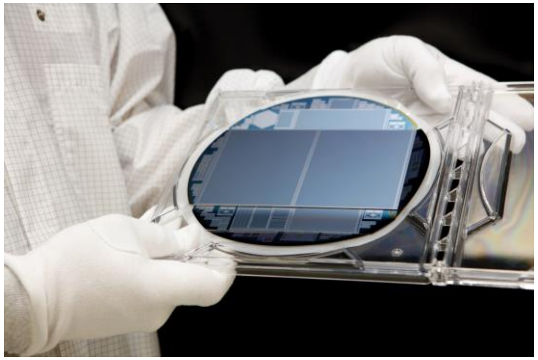
Intellectual property can be valuable and priced

- It can be sold, leased, mortgaged

Basic Research



Detector R&D



Industry

IP Dictionary

- **“Background” IP**
  - Pre-existing IP held by participants prior to the start of the project
  - Needed for carrying out the action, e.g. silicon processing
  - Information exchange under Non-Disclosure Agreement (NDA)
    - Usually a ”simple” contract that information or samples must not disclosed
    - Application: NDAs typically cover process details, design rules or libraries with “IP blocks” the company need to provide to allow us to design a silicon sensor or ASIC

- **“Foreground” IP**
  - Typically the results of the joint development
  - Ownership:
    - Model 1: “Who generates owns”
    - Model 2: Every result is jointly owned
  - Model 2 need contractual statements about licensing and royalty (use fee)

Creating Win-Win-Situations

- How can results made accessible to a broader (scientific) public while maintaining also competitive advantages for your business partner?
  - Find balance between publications and business secrets/patents

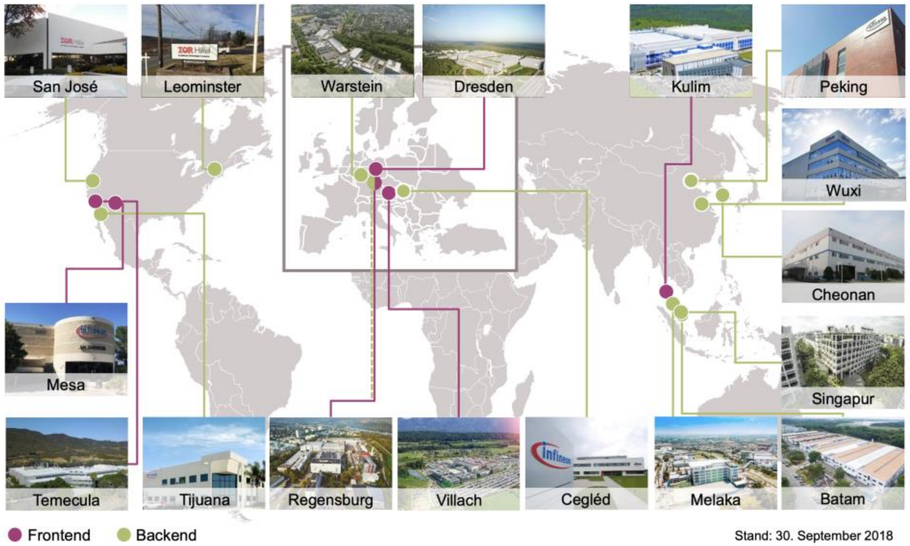
- What is the commercialization potential?
  - Find other types of applications which could potentially give high revenues

Detector Development with Infineon

AN EXAMPLE

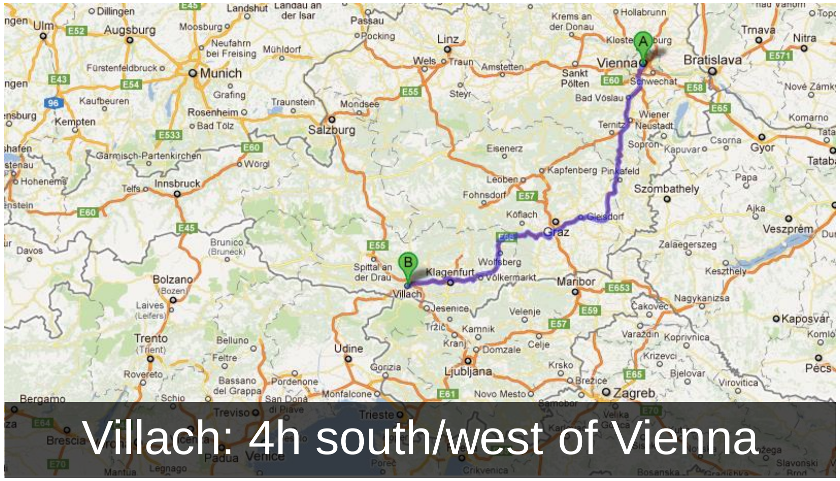
Company profile Infineon

- Infineon is one of the major players in the semiconductor business
  - 40,000 employees worldwide
- Main target markets
  - Automotive, Power, Chip Card
- Villach (Austria): R&D and "frontend" production
  - 4,200 employees (1,800 in R&D)
  - Production in clean room of class 1 with 20,000 m^2 area



Infineon and HEPHY

- In **April 2009** a small delegation from HEPHY visited Infineon Villach
  - **Privately organized** by me together with former HEPHY colleague who moved to Infineon earlier
  - We enjoyed a **tour of the production facilities**
- We discussed and agreed on the possibility of a **joint development**
  - At that time the production was running at 20% load because of economical crisis
- Since the beginning of 2010 we held **weekly telephone conferences**
  - We were discussing all technical details **directly with the engineers**



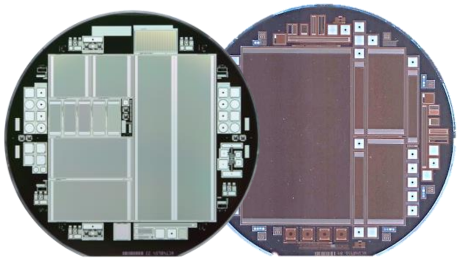
Villach: 4h south/west of Vienna

Ready to enter clean rooms

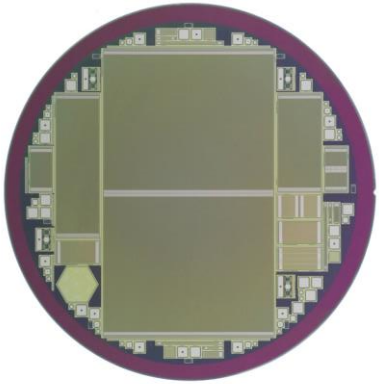
Collaboration Details

- **2011**: First milestone: first layout and process plan set up
- **2012**: First production of 6” p-on-n sensors
  - Goal: re-produce the current CMS tracker sensors
- **2014**: Started to work on 8” n-in-p process for CMS tracker phase II upgrade
  - First 8” Si-strip sensors for HEP
  - 2S sensors for CMS tracker module prototypes
- **2015**: Started development of 8” hexagonal pad sensors for CMS High-granularity calorimeter
  - Driving the effort of moving to 8” sensors as baseline for TDR
- **2016/17**: Infineon participated in common ATLAS/CMS Market survey for the delivery of strip and pad detectors for Phase-II Upgrades
- **2018**: Infineon decided to quit the development because of economic reasons ☹

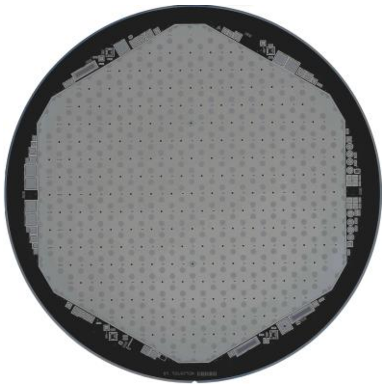
6” strips



8” p-type strips



8” p-type pads



Collaboration with Infineon

- The project started from the engineers in an bottom-up approach
  - Manpower at IFX was kept at minimum in the first few years
  - Spare time hobby project of two – three engineers with support from middle to top management
  - Only since 2015 the "business unit" was involved and main coordinator at IFX was promoted to lead the project full time → **creating costs**
  - Regular visits of CMS representatives to Infineon

- Task sharing
  - HEPHY: Design, TCAD-Simulations, electrical characterization, beam tests, irradiation, dissemination by publications, costs of wafers
  - Infineon: Set-up of production flow, actual processing (and associated costs)

Collaboration with Infineon

Reason for premature end of collaboration:

- Since they treat our project as "one-time order" all development costs needs to be taken into account for calculating their business case (need to make profit)
  - Development costs increased to address the only remaining problem (IV breakdowns)
  - The costs of the sensors increased by an factor of 4 w.r.t original CMS planning

- **Infineon decided to quit the development program of HEP sensors for economic reasons in summer 2018**
  - Unfortunate decision after 9 years of fruitful collaboration
  - Nevertheless the project was a success
    - Project was very visible within local funding agencies and academic environment
    - We learned a lot about commercial production of silicon devices
    - Infineon gained insights in HEP community, device irradiations and received highly trained manpower

Lessons learned:

- ✔ Start your project in bottom-up approach and talk to engineers rather than business men
- ✔ Keep your project on a technical basis as a joint development project as long as possible before economist take over
  - ✘ Be fast in identifying possible problems and find mitigation measures early
- ✘ Find (direct!) alternative applications of the product which can bring additional money into the project

The End.