Introduction & Resources

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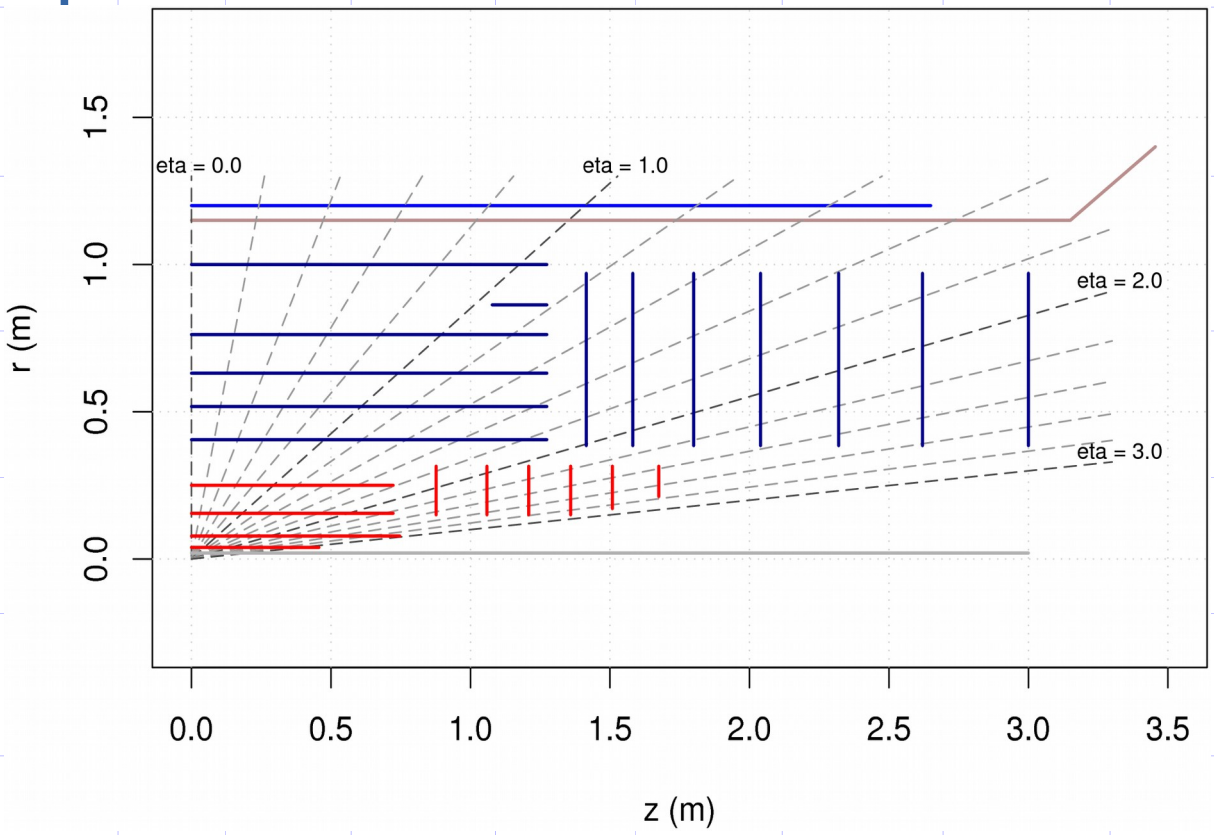
Presentations during this Review

- Introduction and Resources
  - M. Stanitzki
- Impact on mechanical & other electronics systems
  - R. Nickerson
- First year results
  - V. Fadeyev
- Second year of the program: Goals and Timeline
  - J. Dopke
- Summary

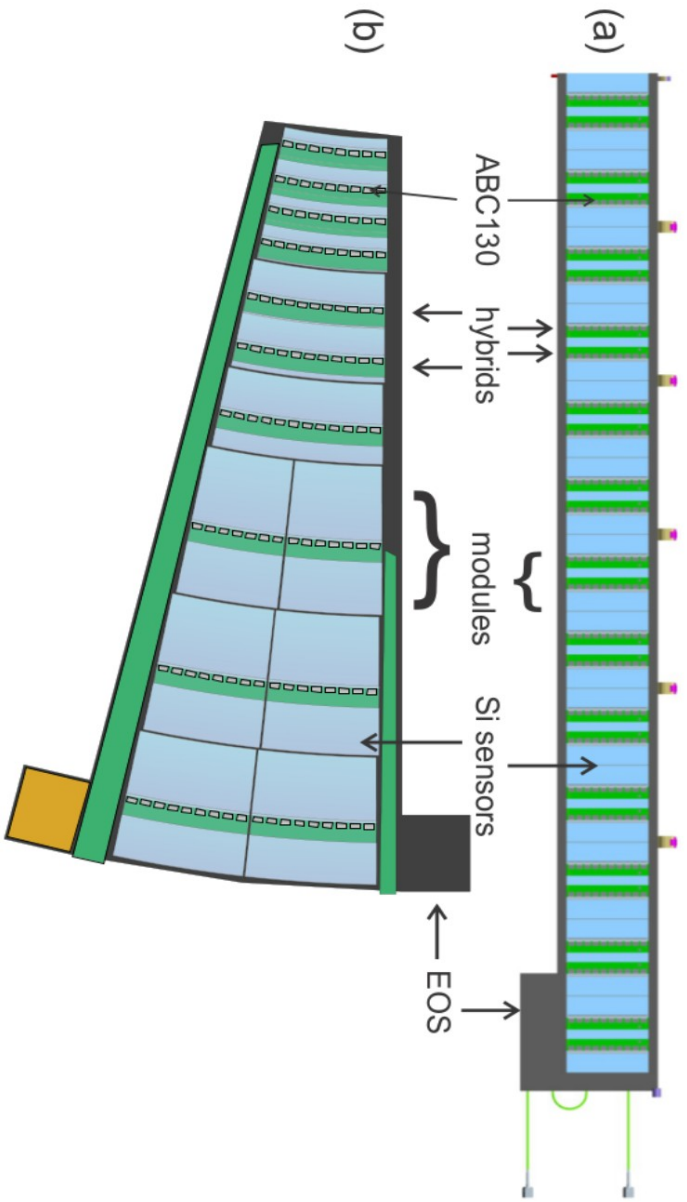
The ITk Strip Tracker Design



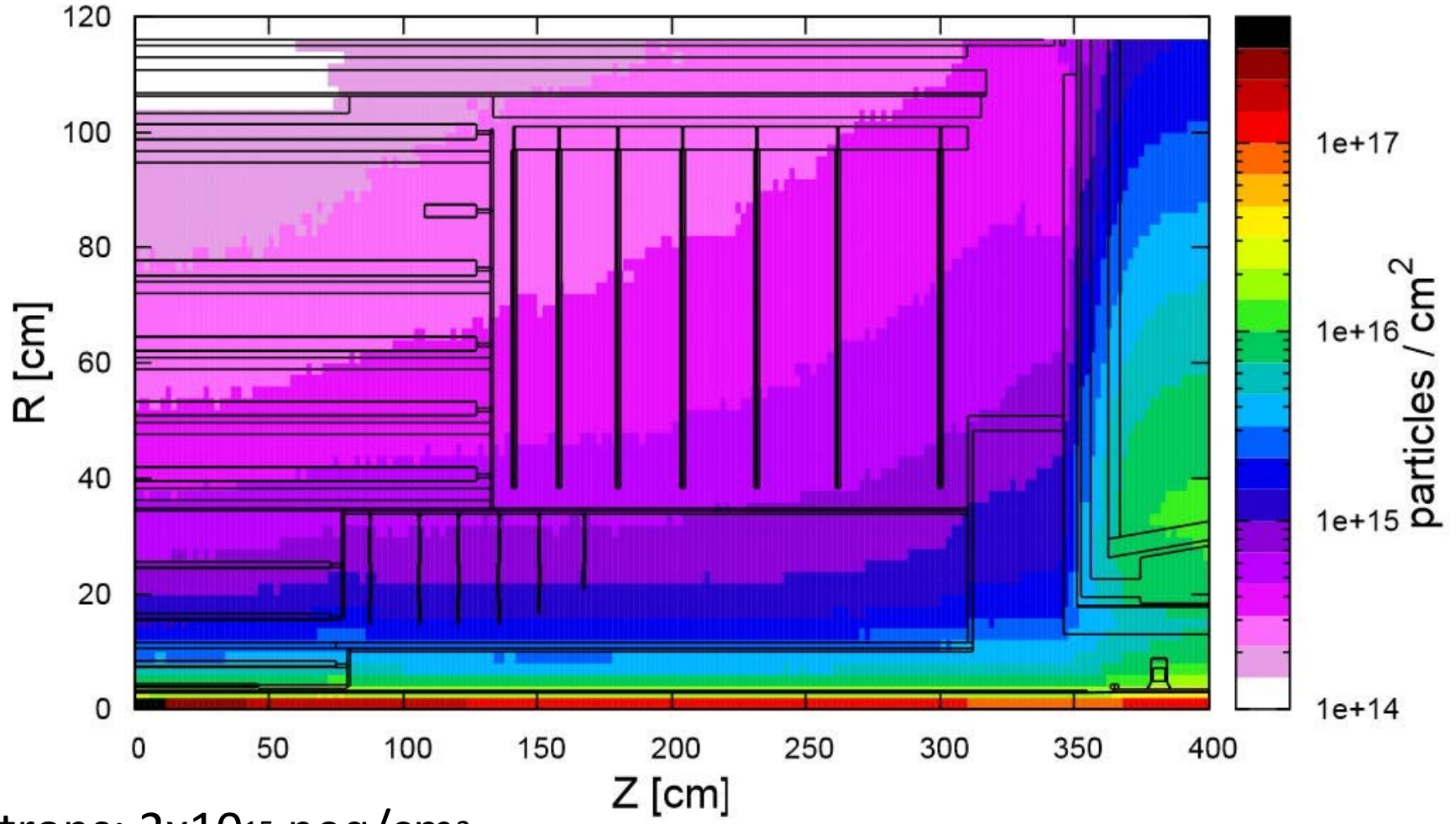
- As spec'ed in the LoI
  - And Subject to change
- Total area of ~ 200 m^2
  - 95 % of the are in the strips
- Strip Tracker
  - 5 barrel layers
  - 7 disks (per side)
- Modular building blocks
  - Staves and Petals
- Current Design being re-evaluated

Strip Tracker Details

- Petals and Staves
  - Double-sided
  - Small-Angle-Stereo Configuration
- Basic Building Blocks
- Modules
  - sensor+hybrids + ASICS
- Shared “Core”
  - Bus tape
  - Power distribution
  - Cooling
  - High-speed Optical link
  - Mechanical support

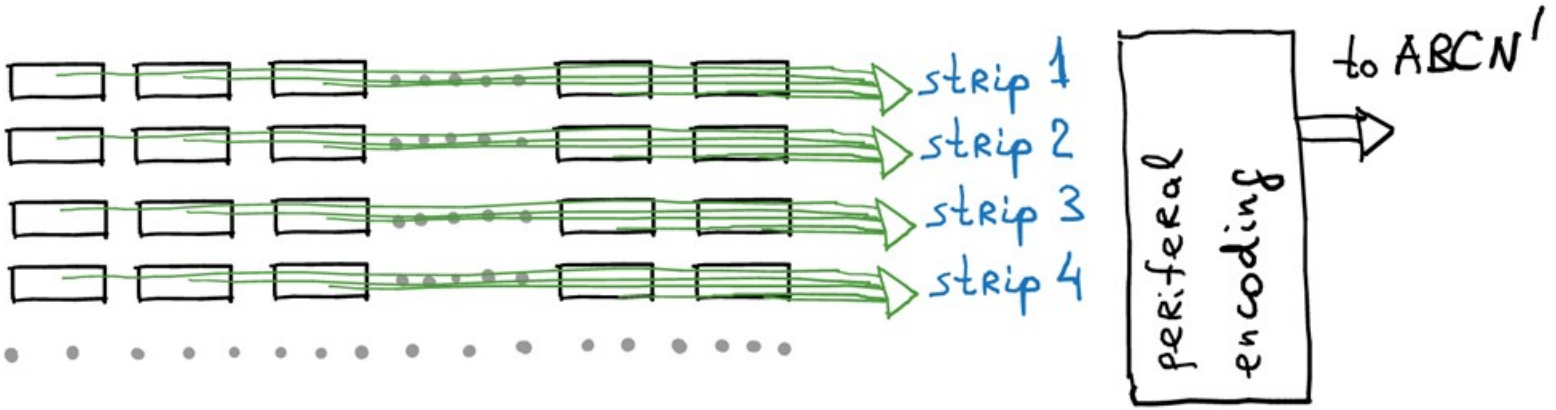


Radiation Hardness Requirements



Neutrons: 2×10^{15} neq/cm^2
Photons: 60 Mrad

The CMOS approach for Strips



- Keep everything beyond the Module
  - Minor modification may be required
- Replace Module with
  - CMOS Sensor, 40 µm pitch, 2.3 cm strip length composed of 720 µm long pixels with HL-LHC level radiation hardness
  - Digitally z-encoding
  - New ASIC (ABCN') → "ABC130 without analog front-end"

CMOS Advantages

- Three main benefits compared to the baseline silicon strip approach
- Reduction of material
  - Thinner sensors
  - Elimination of Small-Angle-Streo
- Improved resolution
  - Finer sensor pitch
  - Less material
- Cost savings
  - Reduction of the silicon area by ~ 50 % → ~ 30% cost saving
  - Reduction of assembly time (non-core costs)
  - Cost reduction for the Silicon itself (commercial process)

For Reference

Parameter	Planar Sensor	StripCMOS Sensor
r-φ resolution	20 µm – 23 µm	11 µm
z-resolution	850 µm	280 µm
Two hit resolution in r-φ	160 µm-240 µm	80 µm
z-element length	2.5 cm	720 µm (2.4 cm / strip)
Fraction of two hit clusters	15% - 20%	2%-3%
Geometry inefficiency on stave	~0.7%	~1%
Radiation Lengths per stave	1.8%	1%
Insensitive crossings after a hit	1 BC	0.3 BC (1/32 of strip is dead for 10 bunch crossings)
Number of Signal Wire bonds	O(5100)	O(1100)

The StripCMOS Collaboration

- Main Goal
  - Develop a replacement sensor for the ATLAS ITk strip tracker
- The collaboration
  - 49 authors from 13 institutions
- Both ATLAS & non-ATLAS members
- RadHard CMOS Technologies
  - Interest also beyond ATLAS

The StripCMOS Collaboration

The Three Year Programme

- ATLAS started three-year programme to study CMOS as alternative for the base strip tracker solution
  - Clearly defined breakpoints after each year
- Phase 0
  - Mid 2014
- Phase 1
  - June 2014 - June 2015
- Phase 2
  - June 2015 - June 2016
- Phase 3
  - June 2016 - June 2017

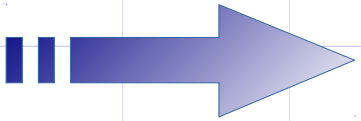
Phase 0

- Define programme and identify Resources
- Establish Group with CMOS strip tracker goal which does not significantly impact planar preparations

Break Point 1 Mid 2014
Group established, resources secured for Phase-1

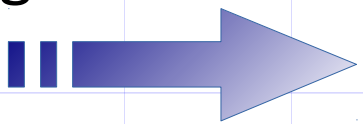
Phase 1

- Goal: Demonstrate Feasability of CMOS
- Sensor:
  - Relevant foundries selected ✔
  - Radiation hardness evaluated
  - Pixel Characterization
  - Boundary electronics architecture understood
  - Cut lines, stitching, multi-reticule possibilities at foundries evaluated.
  - Common read-out selected



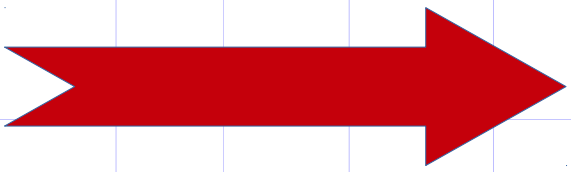
Vitaliy's Talk

- Architecture
  - Decision for Digital Z-encoding ✔
- Physics requirements
- Integration in the baseline design



Richard's Talk

Breakpoint 2 – We are here

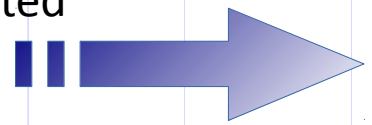


Break Point 2 Mid 2015 –

- **basic technology demonstrated to be acceptable**
- **Foundries selected, architecture selected**
- **Layout and performance found to be compatible**
- **Requirements Established**
- **Resources for phase-II identified**

Phase 2

- Goal :Large size Sensor and ABCn' demonstrated
  - Large scale sensor with close to full functionality fabricated
  - Bulk and Surface Radiation hardness evaluated
  - Pixel fully characterized
  - Boundary electronics architecture tested
- Mechanics



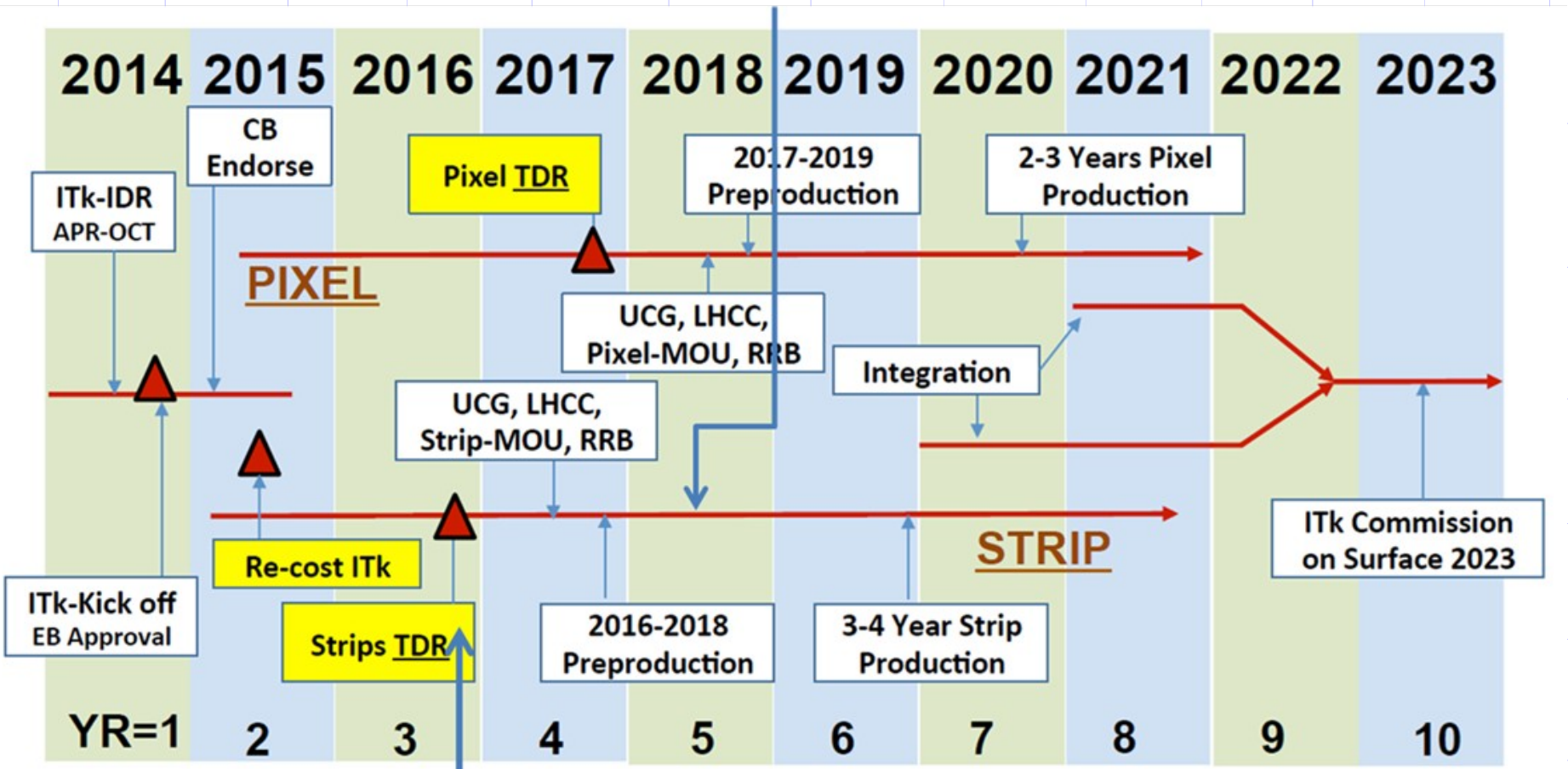
Jens' Talk

  - Any substantive changes required in mechanics evaluated
  - Test parts fabricate for any essential new elements
  - Consideration given to service module alterations.
  - Service tapes redesigned to accommodate new module configurations
- ABCn'
  - ABCn' designed and test chips fabricated in multi-project run
  - Hybrid designed

Phase 3

- Goal : Full sized multi-sensor object demonstrated & Feasibility of use evaluated
- ABCn'
  - Tested with sensor prototypes from phase II
  - Fabricated in significant quantities
  - Optional: ABCn'' designed and fabricated in multi-project run
- Sensor
  - Full scale sensors designed and fabricated and characterized
  - Sensors and ABCn'' operated in module-like configuration
  - >1 module operated together on a service tape
- Mechanics
  - Changes to accommodate new layout and stave/petal designed
  - Assembly protocols and series production planning considered

Overall ATLAS Timeline



For strip CMOS to be plausible there needs to be good to compelling evidence that it has a good chance of being real by the time of the TDR – late 2016

Resources and Effort

- For year 1
  - Dedicated group of people with fractions of their time
  - Many things happened “in spare-time”
  - But: Already had dedicated ”New Effort” for Chip design
  - Secured the necessary funds for chip submissions and support electronics
- For year 2
  - Already secured funds for first large chip submission
  - First estimate of resources made

Submission Costs