Outlook and Future Pans

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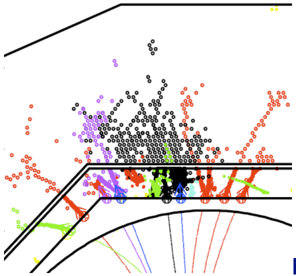
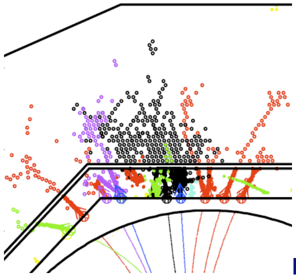
ECFA Detector Panel Review
DESY, Hamburg, November 5, 2012



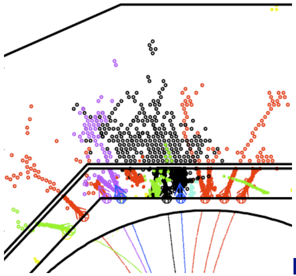
Outline

- Reminder: our goals
- Where are we?
- Future plans
- CALICE in the next R&D phase

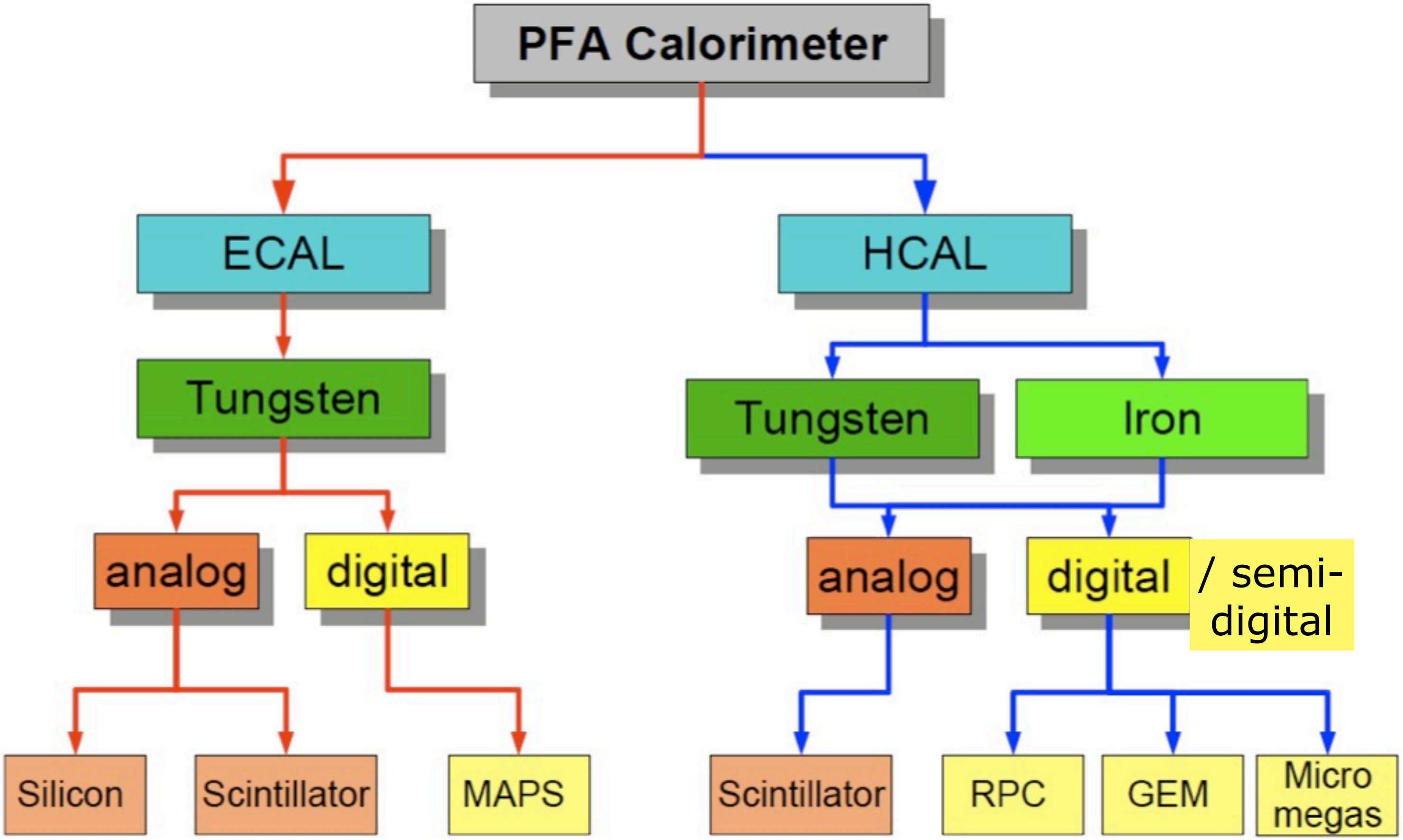


The CALICE goals

- Develop, test and establish technological solutions for highly granular particle flow calorimeters
- Explore **new** technologies for calorimeters:
  - large scale Si diode arrays, SiPMs, 2-D RPCs, GEMs, μ-megas
- Physics prototypes:
  - **test** the technologies, their robustness, stability
  - probe rate capabilities and environmental dependences
  - develop calibrations, corrections and simulations
  - **understand** systematic limitations
- Technological prototypes:
  - address the **integration** challenge
  - re-establish the performance
    - with power pulsing, auto-triggering and zero suppression
  - understand system and **scaling** issues, industrialisation and cost

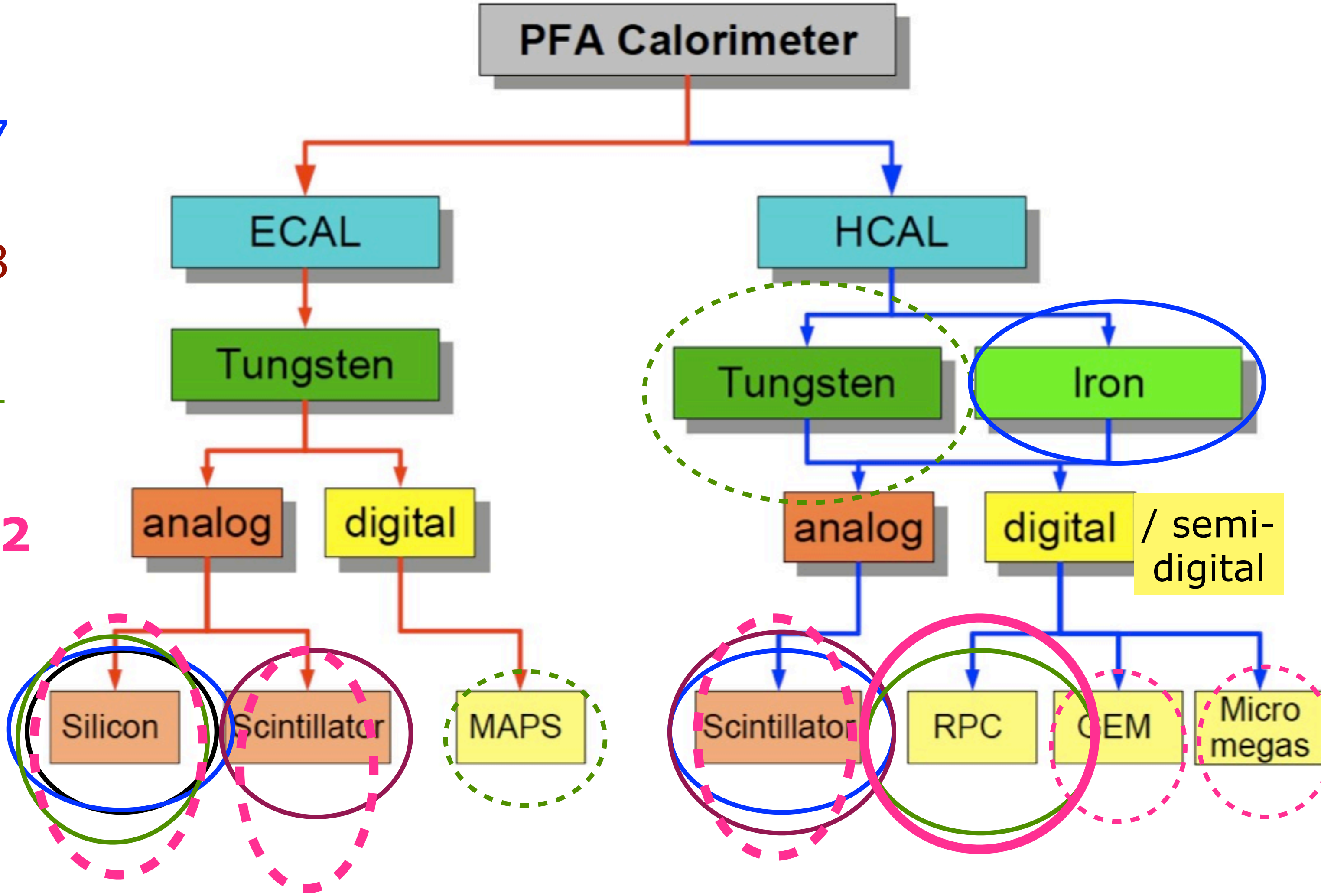


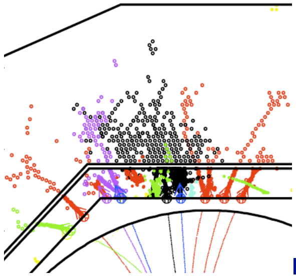
Technology tests



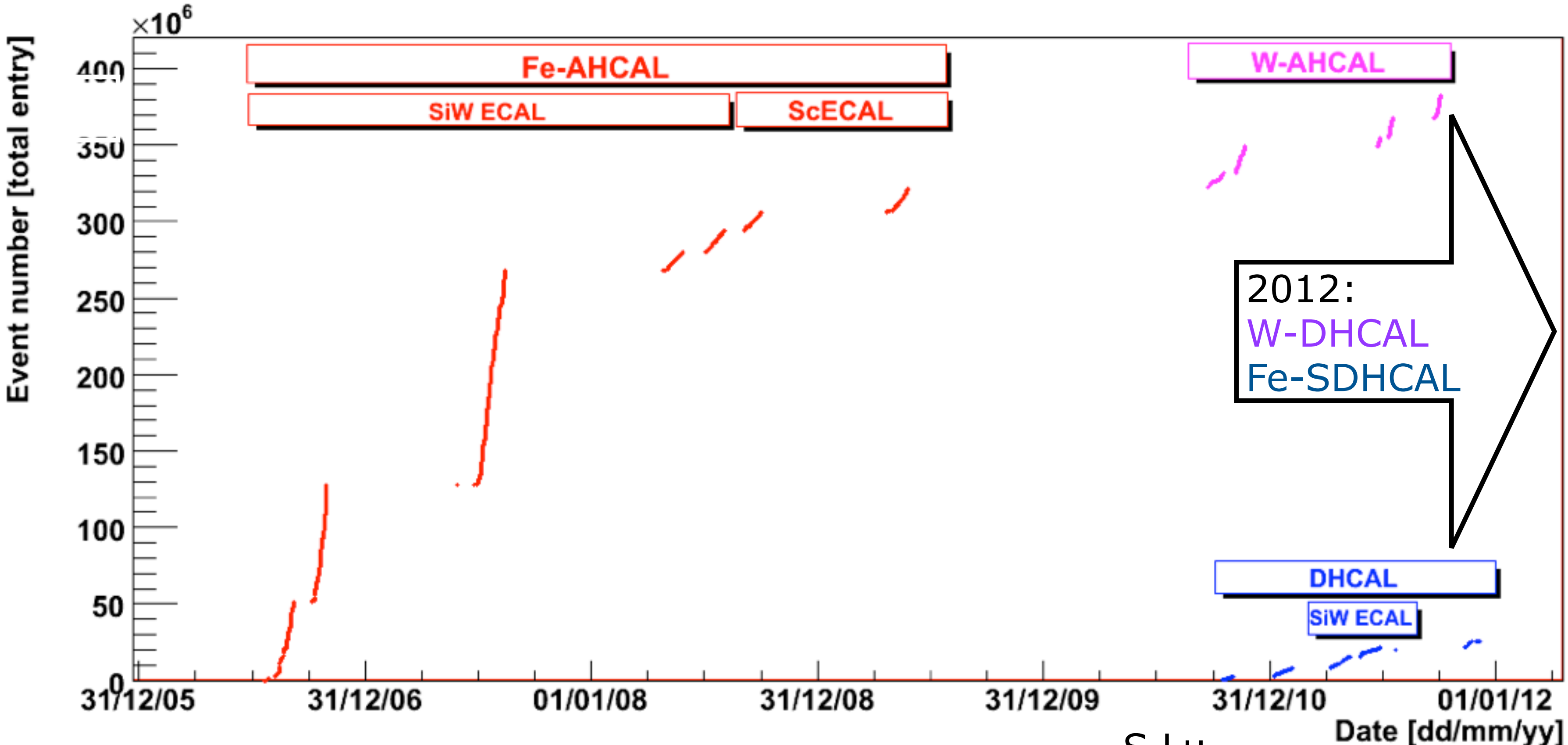
Technology tests

- 2005
- 2006-07
- 2007-08
- 2010-11
- **2011-12**





Summary of data taken



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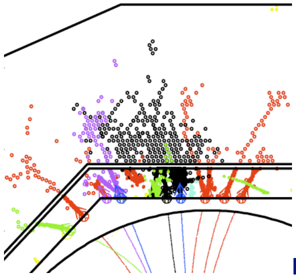
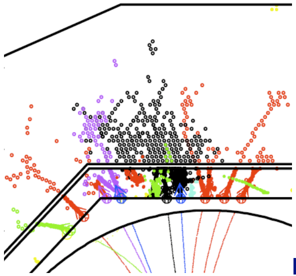
- Muon, LED and noise runs not included
- event size ~ 50kB -> 20 TB of physics data on the GRID



Where we are: Physics Prototypes

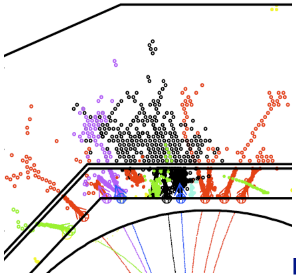
- 2012 is a milestone year for CALICE test beams
- Physics prototype **data taking** will be completed after 7 years
  - Important 2012 runs still to come this month
    - WDHCAL hi rate, μMs & RPC comb
  - 2013: CERN and FNAL long shutdowns
- **Analysis status**: diverse, see David's talk
  - electromagnetic performance
  - hadronic performance (HCAL)
  - topological performance: shower substructure
  - Geant4 validation
- For SiW ECAL and Sci AHCAL: nearly complete after ~5 years
  - LHC test beam analysis took similar time span
- For Sci ECAL, DHCAL and SDHCAL: at an early stage



Publication overview

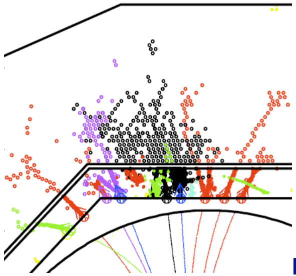
	Si ECAL	Sci ECAL	Sci HCAL	RPC DHCAL	RPC SDHCAL
Construct. & Commiss.	journal	partially in notes			
Electromag. performance		CALICE preliminary			
Hadronic performance	n/a				
Shower substructure					
Geant 4 comparisons					

- plus PFLOW validation (Si ECAL & Sci AHCAL)
- plus showers on embedded ASICs (Si ECAL)
- plus many on smaller prototypes, various technologies
- ~ 75% of "CALICE preliminary" results published by now



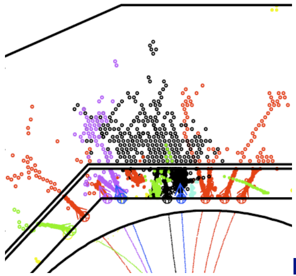
What we learnt

- The technologies "work". No show stoppers found.
- In case the analyses have been done:
- the detector simulations are verified with electromagnetic data
- the hadronic performance is as expected, including software compensation
- the Geant 4 shower models reproduce the data with few % accuracy
- shower substructure can be resolved and is also reproduced by shower simulations
- time structure is reproduced by HP simulations
- particle flow algorithms are validated with test beam data



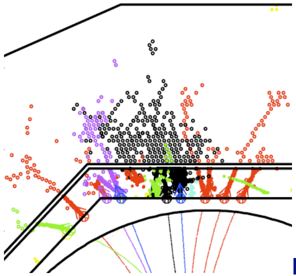
Analysis outlook

- Calibration with high granularity possible - but it has to be done
  - single channel precision requirements are moderate, thanks to the large number of cells in a shower
  - coherent systematics are more demanding, however
  - each channel read out: can (and must) combine at will
  - finding suitable averages can be intricate analysis
  - this is part of the particle flow adventure
- Simulation involves modeling of new technologies
  - SiPM saturation, RPC avalanche spread, ...
- The gaseous detectors have different sensitivity to individual shower components than e.g. (hydrogenous) scintillators
- There is still a lot to learn about technology and physics
  - but it will need time
  - and an efficient framework



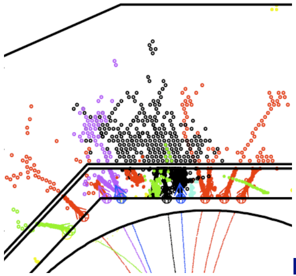
Where we are: Technological prototypes

- The phase we are now in - Status very diverse:
  - Si ECAL: 10 layers, Scint ECAL: 2 boards
  - Scint AHCAL: 1 TB layer
  - RPC DHCAL: concept, RPC SDHCAL: cubic metre
- None is a “module 0”, they address important, but not all integration issues. Embedded electronics, power-pulsing, compact, self-supporting mechanical structures - but
  - ECAL does not have the final layer compactness
  - SDHCAL has not the final geometry
  - none has integrated module level data concentrators, power distribution, gas supply or cooling (yet)
  - full lateral extension only partially addressed
  - ASICs are not final (e.g. no independent auto-trigger yet)
- Performance understanding at a very early stage



Case for completing the technological prototypes

- Main point: performance validation
  - need to establish stable operation, perform calibration and time-dependent corrections, measure linearity and resolution and understand in terms of simulation
  - auto-trigger and zero-suppresion represent new challenges
- Test and demonstrate the scalability
  - in construction, quality assurance, commissioning, calibration
- Complete the integration chain
  - data concentrators, power distribution and cooling
- Progress in industrialisation and cost
- New physics:
  - 4x higher ECAL segmentation
  - hadron shower timing
  - needs beam time to exploit the potential

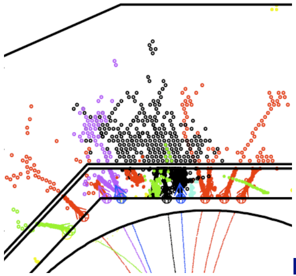


Future plans

- We must fully exploit the existing prototypes
  - more test beam data taking after LS1
- We must fully exploit the existing data treasure
  - physics analysis is involved, but rewarding

- We must proceed from single or few layer demonstrators to full-scale prototypes of the integration concepts
  - New physics possibilities: 4x finer ECAL, timing in AHCAL,...
- Time scale largely resource driven
- There will be continuous need for test beam time

- There is lots to do on system level - powering, cooling, data concentration - before we can proceed to pre-production prototypes (module 0)

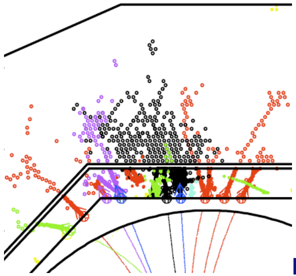


CALICE in the next phase

- For the LC, the near future is a transition period again
  - maybe few years only, but exact duration unknown
- Many boundary conditions for the future unknown
  - schedule
  - one or two detectors
  - energy range
  - participants
- One certain constant: tight funding, short manpower

- Still many common issues
  - e.g. cost-effective multilayer PCBs, ASICs
  - test beam infrastructure and combined ECAL HCAL tests

- We need to be prepared and remain flexible



Conclusion

- Successfully built and tested highly granular (SiW, scint W) electromagnetic and (scint. Fe,W) hadronic calorimeter prototypes with excellent performance
- Built and successfully operated two gaseous (digital and semi-digital) HCAL prototypes, delivered first results (Fe,W)
- Validated Geant 4 shower simulations and establish particle flow performance with real data (published)
- Alternative technologies tested: MAPS, GEMs, micromegas

- Rich amount of data still to be analysed
- Technological ECAL and scint HCAL prototypes to be completed
- Test beam time needed for the new prototypes and the completion of the semi-digital program