CALICE: Major Items Since September

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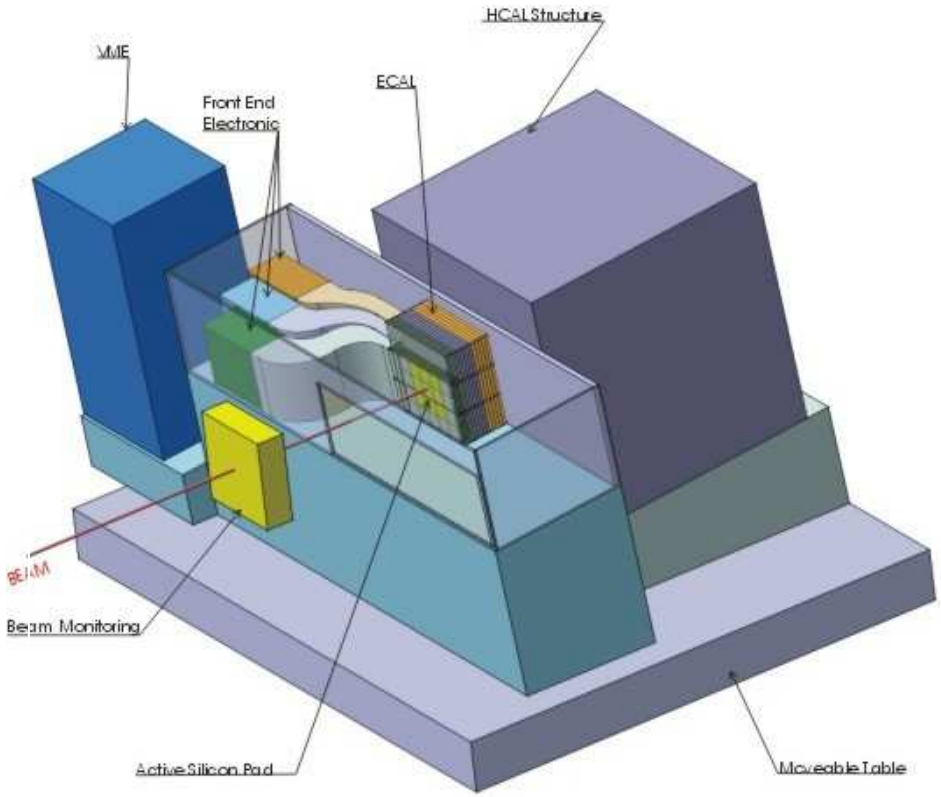
Two main items:

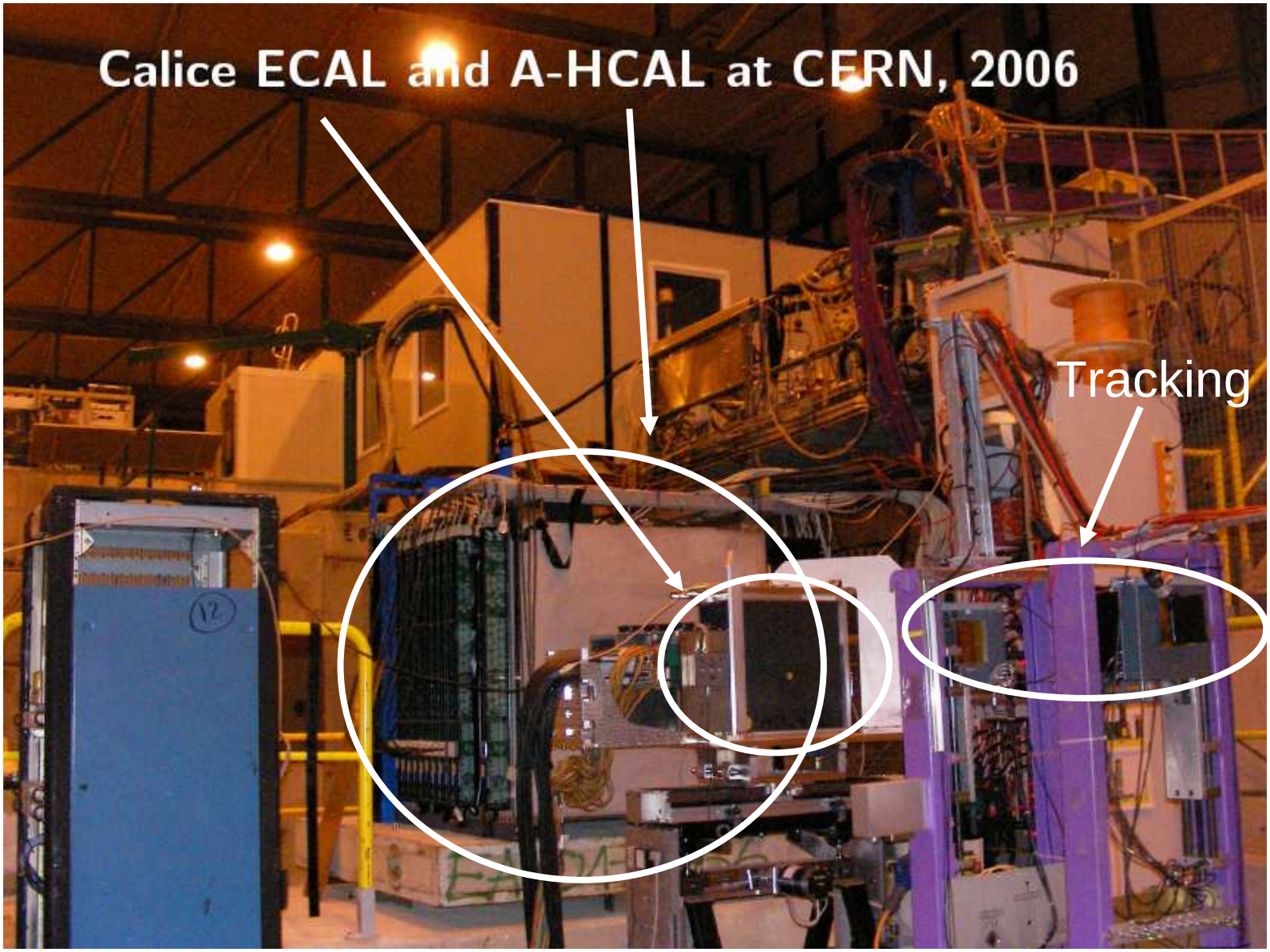
- Beam tests developments J
- MAPS developments L

CALICE beam tests

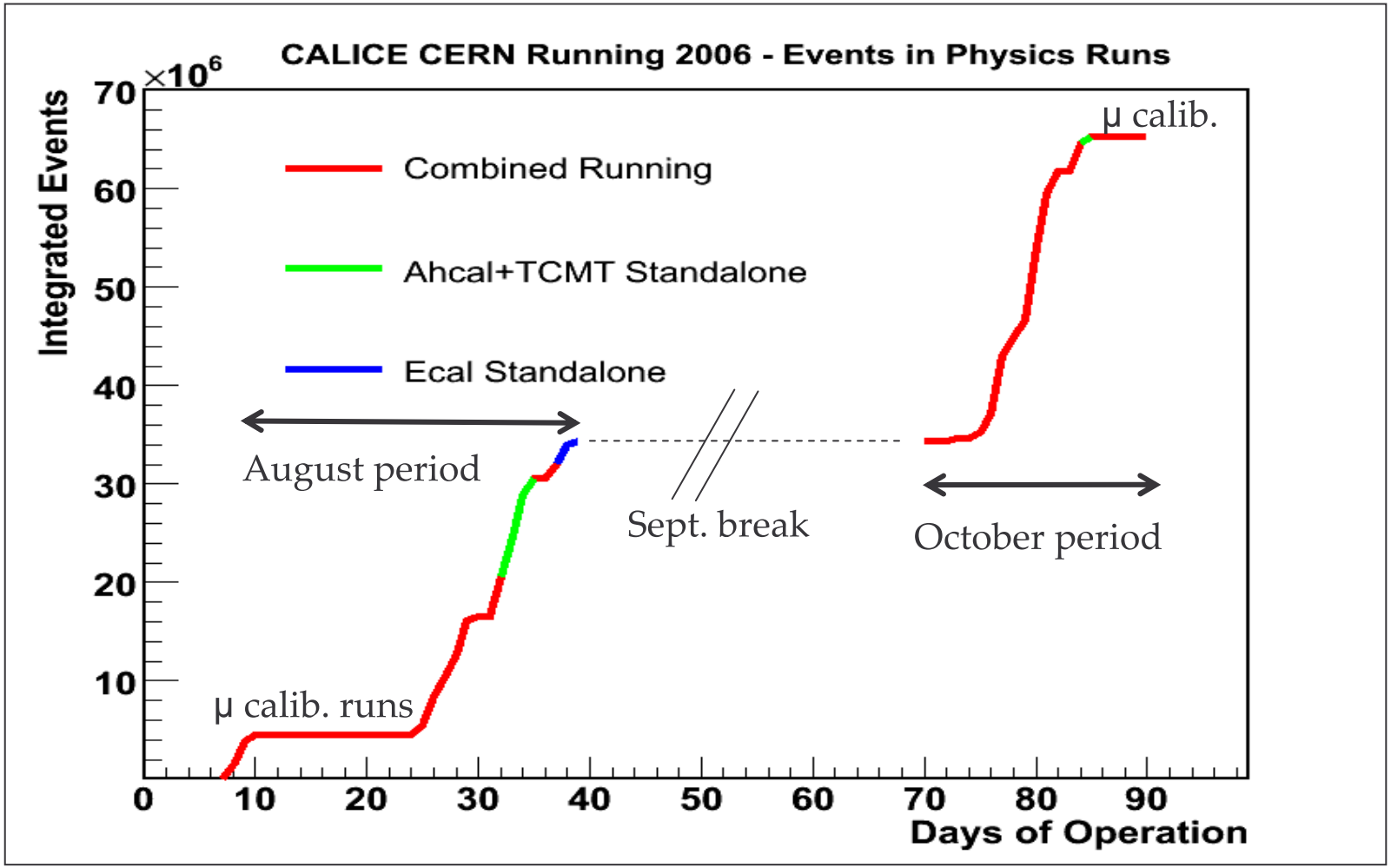
- Segment of calorimeter
  - Silicon-tungsten sampling electromagnetic calorimeter (~10k channels)
  - Scintillating tile-iron analogue hadronic calorimeter (~8k channels)
  - RPC-iron digital hadronic calorimeter (~380k channels)
  - Scintillator strip-iron tail catcher and muon tagger (~300 channels)
- Target of 10^8 events total
  - Data/MC comparisons show differences with 10^4 events
  - Need to do multiple energies, angles, particle types, A/D-HCAL
  - Aim for $>10^5$ events/configuration to allow for quality cuts



The beam test reality

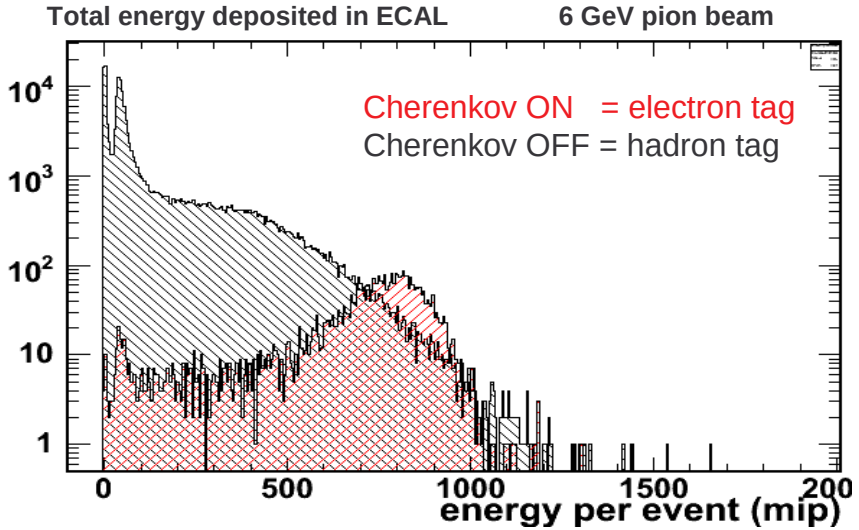


CERN beam test data-taking

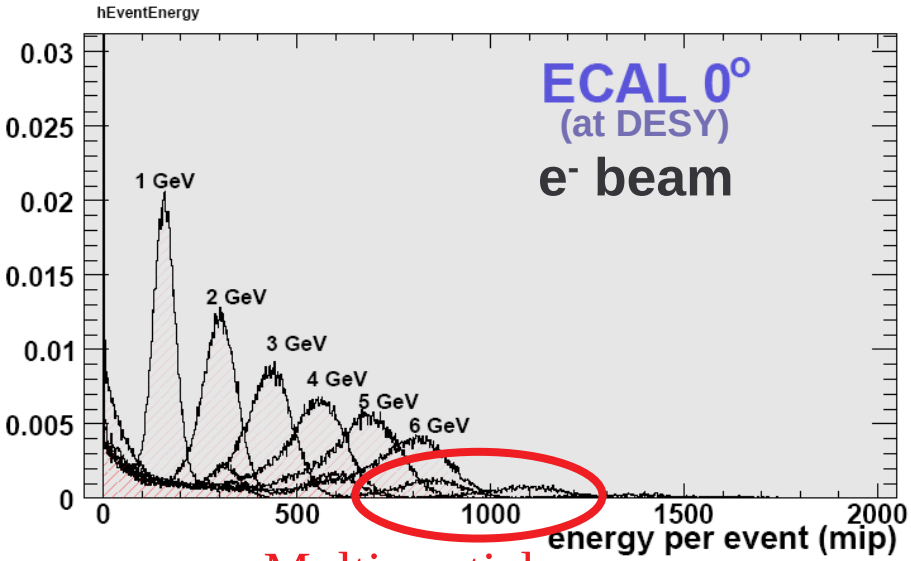


65M physics events total, plus 90M calibration events

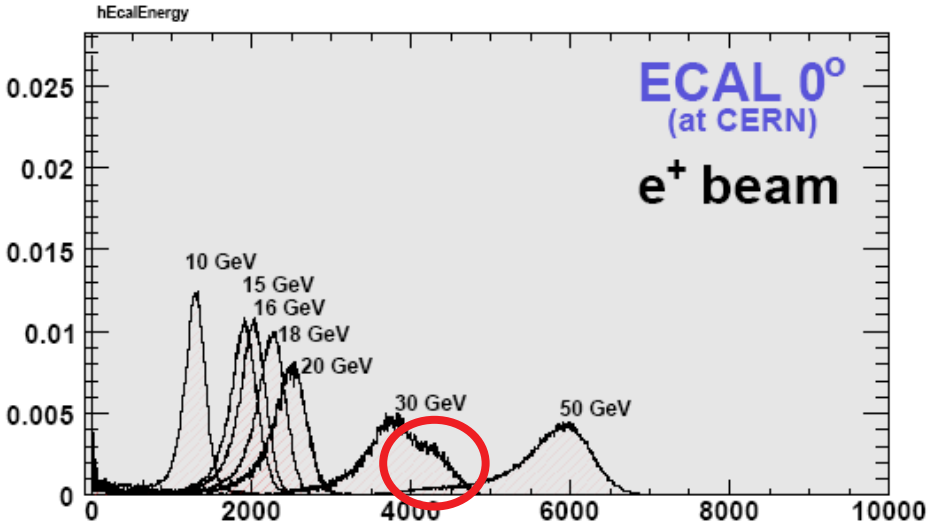
ECAL data are good quality



- Electron data at DESY; full scan of (low) energy and angle
- Hadron and electron data at CERN; large range of energy
  - Cherenkov used to clean up beam purity at CERN

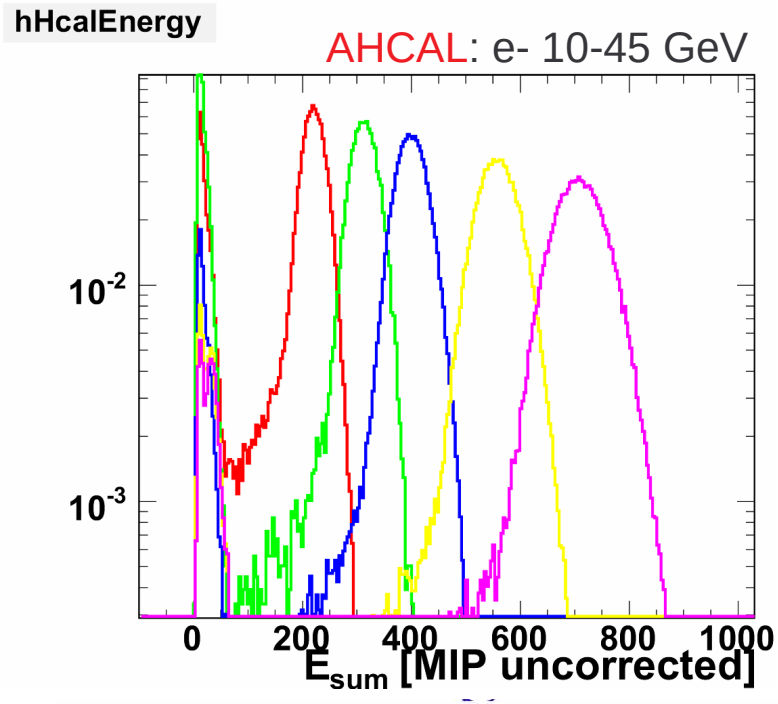


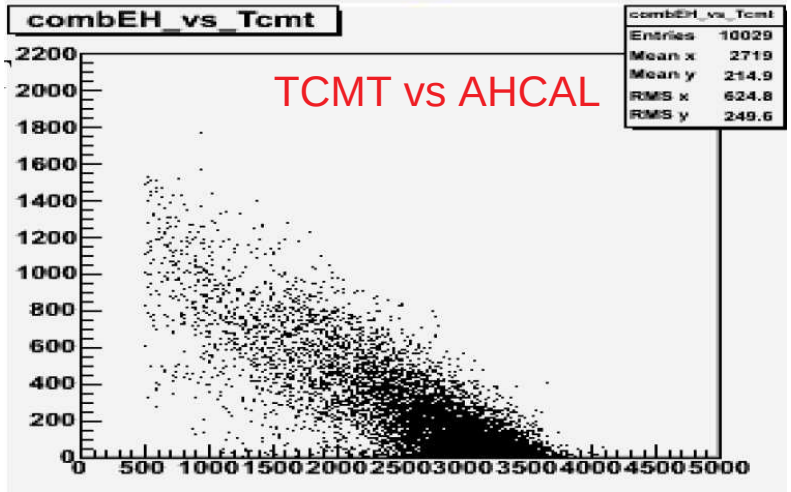
Multi-particle events



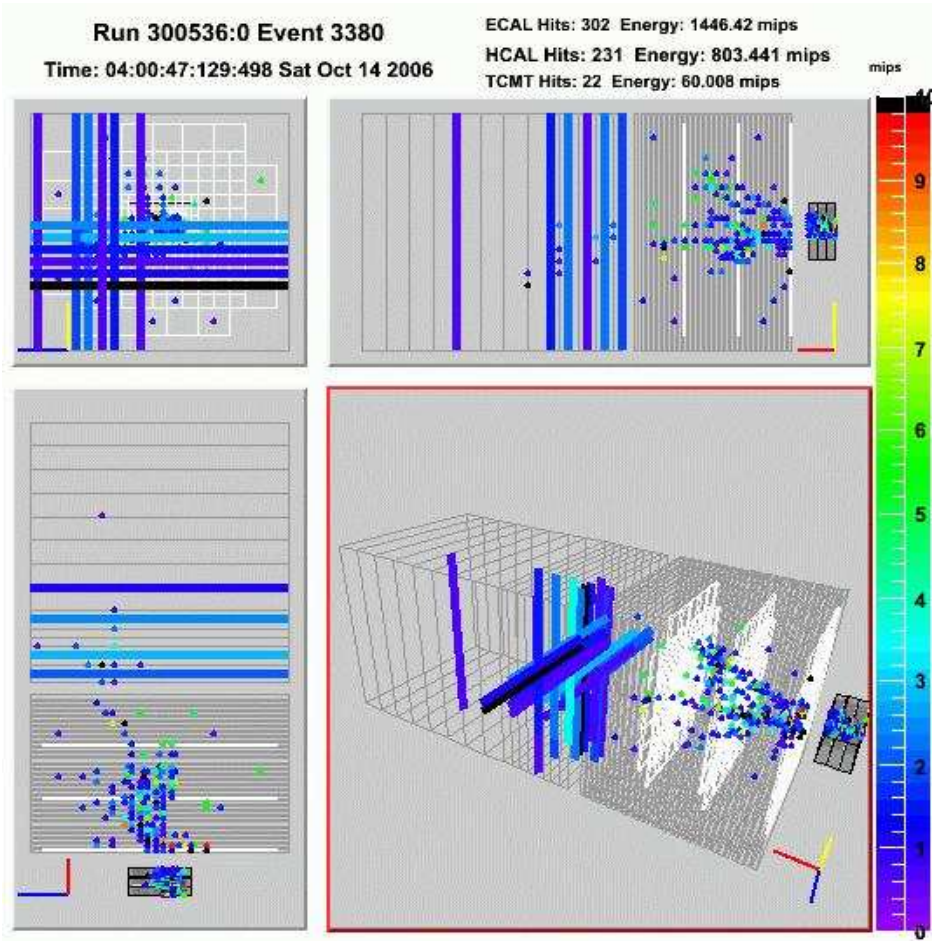
Some oddities to be understood

AHCAL and tail catcher also look good



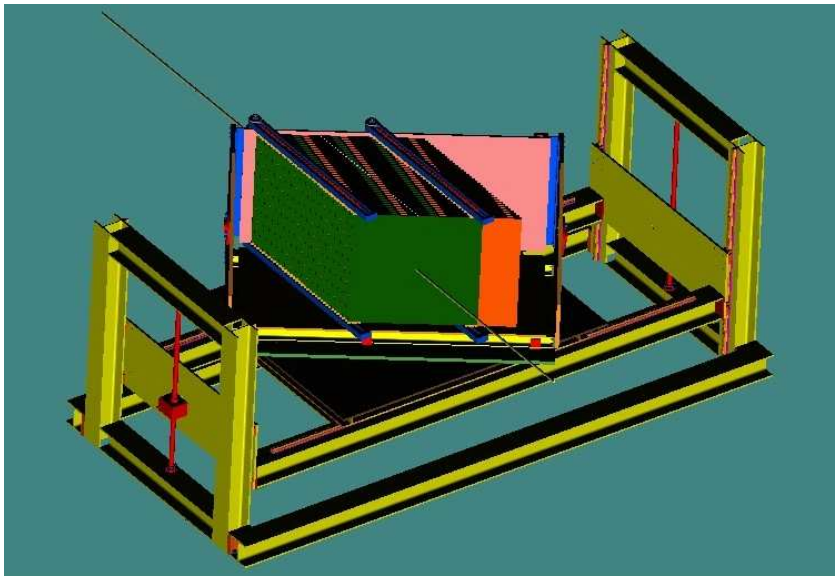


Shower from a 40 GeV π+



Future beam test plans

- By no means finished…
- Despite getting ~75M events this year
  - ECAL only 1/2 complete at DESY, 2/3 complete at CERN
  - AHCAL only at CERN, only 2/3 complete
  - No rotation for angled incidence of ECAL+AHCAL
  - No DHCAL!
- Return to CERN in summer 2007
  - Completed ECAL and AHCAL
  - Rotatable stage to hold both detectors
- Move to FNAL in autumn 2007
  - Cross check, use low energy hadrons
  - Swap AHCAL for DHCAL in same mechanical structure in winter 2007
  - Run until spring 2008

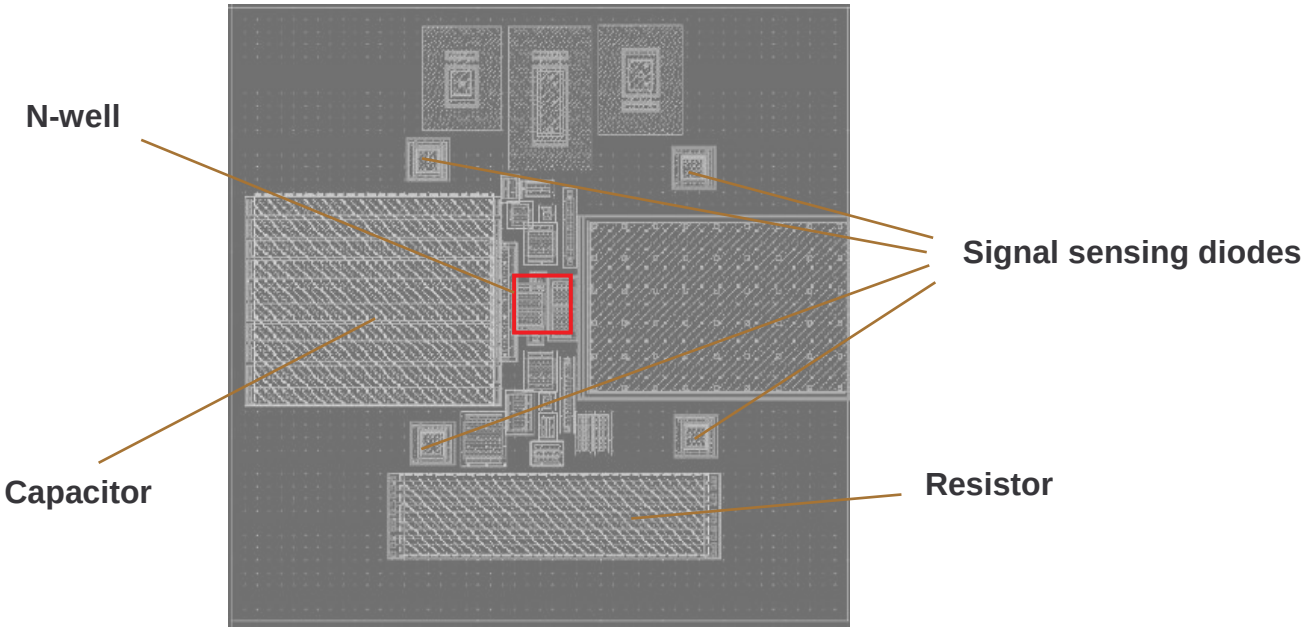


Beam test analysis

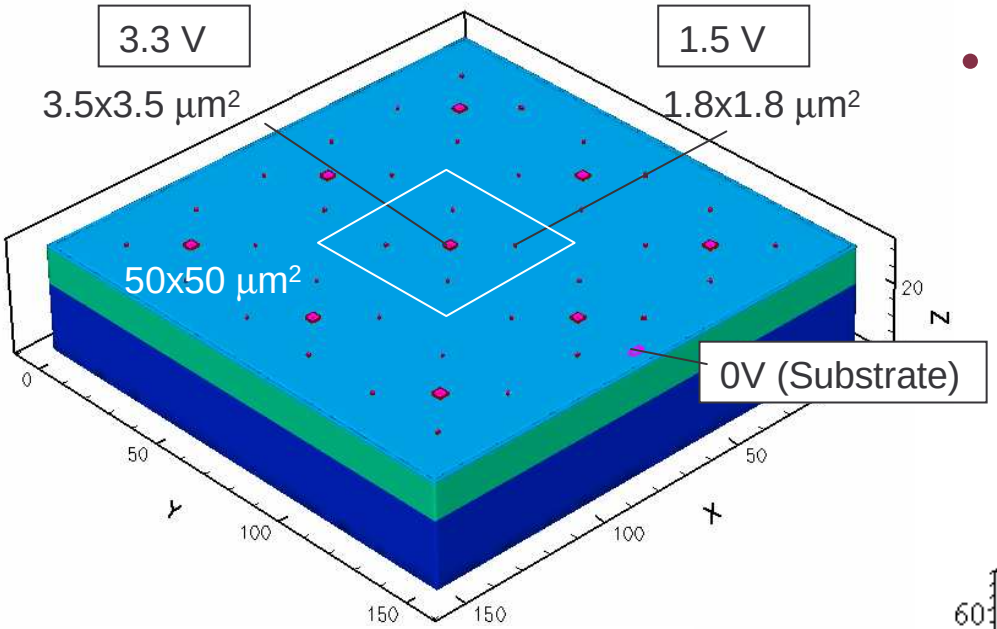
- Ongoing; many things still to be done
  - Channel-by-channel calibration
  - Tracking alignment and reconstruction
  - Selection of runs/events, rejection of multi-particles
- UK playing major role
  - Active in all of the above
  - Reflection of this is appointment of coordinators for this work
  - These were announced since the OsC document was submitted
  - David Ward – Analysis coordinator
  - Nigel Watson – Physics coordinator
- Also UK people chosen to give talks at ILC meetings
  - E.g. EFCA/Valencia: UK person gave overall ECAL talk

Monolithic active pixel sensors (MAPS)

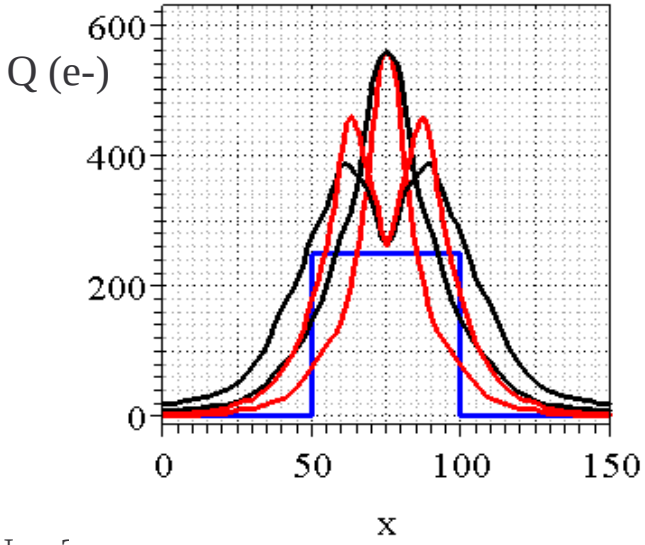
- Generic issue for MAPS sensors
  - Advantage is that readout circuitry is integrated on top of pixels
  - Disadvantage is that p-mos transistors in n-well will absorb signal charge
- Design and sensor simulation work has shown up a problem
  - Circuit needs several p-mos transistors; comparable in size to diodes
  - Simulation studies show significant signal loss

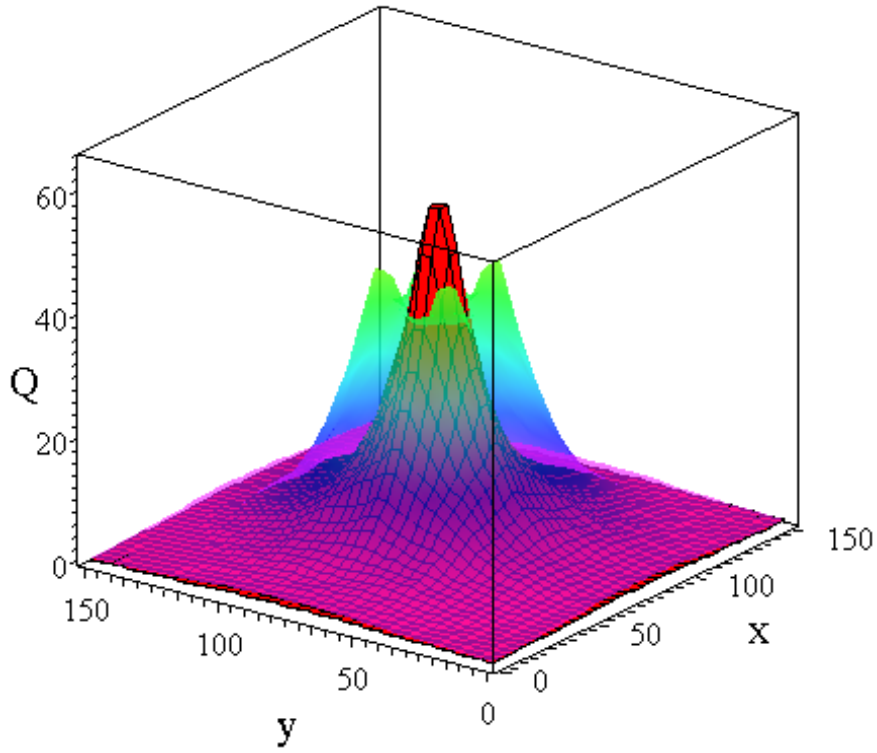


MAPS charge diffusion simulation



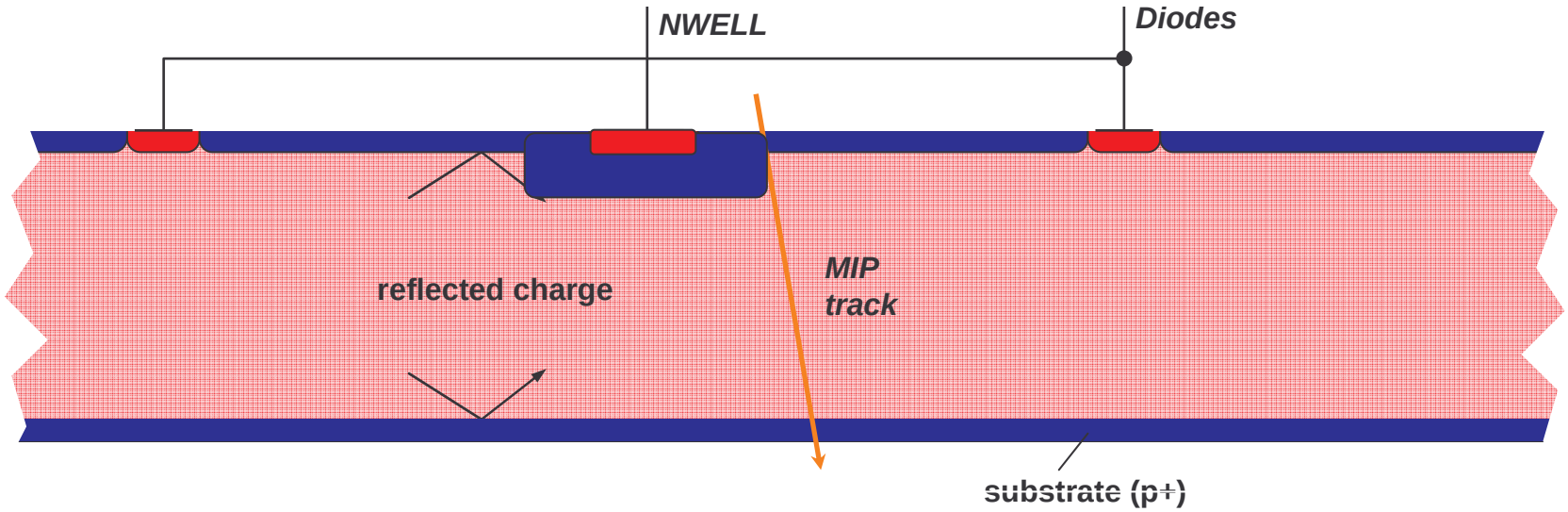
- Sensor simulations done in 3D
  - 3×3 array of pixels
  - Central n-well absorbs around half the charge
  - S/N lowered to ~10 so marginal





Triple p-well

- Solution is to cut off n-well from epitaxial layer
  - Build a "triple p-well" under the n-well transistors



- Non-standard CMOS processing step
  - Triple n-well (i.e. complementary structure) is common but not p-well
  - Foundry will develop and qualify similar process for us at cost of ~£65k; they consider it straightforward
  - RAL/EID will pay £35k; useful for other MAPS projects
  - Cost to CALICE will be ~£30k, assumed to be a call on the WA

MAPS schedule implications

- Original schedule had
  - Interim Design Review 4 Oct 06
  - First submission Design Review 29 Dec 06 (nominal!)
  - First fabrication submission 22 Jan 07 (fixed date for MWP run)
- Now have to fabricate in next MWP run; three months delay
  - Interim Design Review 18 Dec 06
  - First submission Design Review 28 Mar 07 (nominal)
  - First fabrication submission 17 Apr 07 (fixed date for MWP run)
- End date fixed; try to reabsorb delay in test periods
  - Shorten first round detailed tests by one month
  - Shorten second round beam tests by two months
- Initially only had beam test for second fabrication round
  - But first round test period now overlaps with FNAL beam test
  - Possibility of “parasitic” beam test of MAPS
  - Much higher rate for MIPS than cosmics

MAPS effort costs

- RAL/EID effort being charged is higher than expected
  - A lot of effort to determine cause
  - Bottom line is that costing used in grant did not include correct NI rate
  - RAL costs for grant used 18.2%, now charging 29.4%
  - Gives overall cost increase around 10% higher than budgeted
  - Equivalent to ~£8k/year, or ~£25k total over grant period
- We are still "discussing" this with RAL
  - Clearly their error in original costing...
  - …but unclear yet if they will make up the difference
- If cost falls on us, then two choices
  - Reduce effort used by engineers; very risky at this stage of the project although feasible later if things happened to go well
  - Use WA to cover the shortfall; has to be the working assumption for now

Conclusions

- CERN beam tests were successful
  - A lot of data were taken
  - Analysis only just starting but already clear quality is high
  - Have bid for further round at CERN in summer 2007 with complete calorimeters
  - Move to FNAL in autumn 2007 for DHCAL tests
- MAPS project has found (and potentially solved) a problem
  - Small signal size due to loss into integrated circuit in pixel
  - Solution requires processing step to be designed by foundry
  - Cost to CALICE is ~£30k from WA
  - Three months delay, potentially compensated in part by parasitic beam run during FNAL tests
  - RAL/EID staff costs also ~£25k higher than expected
  - Any use of WA only needed in FY08/09 for final fabrication round