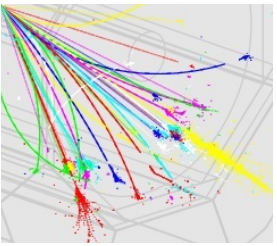
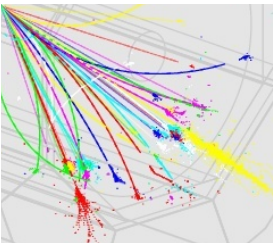
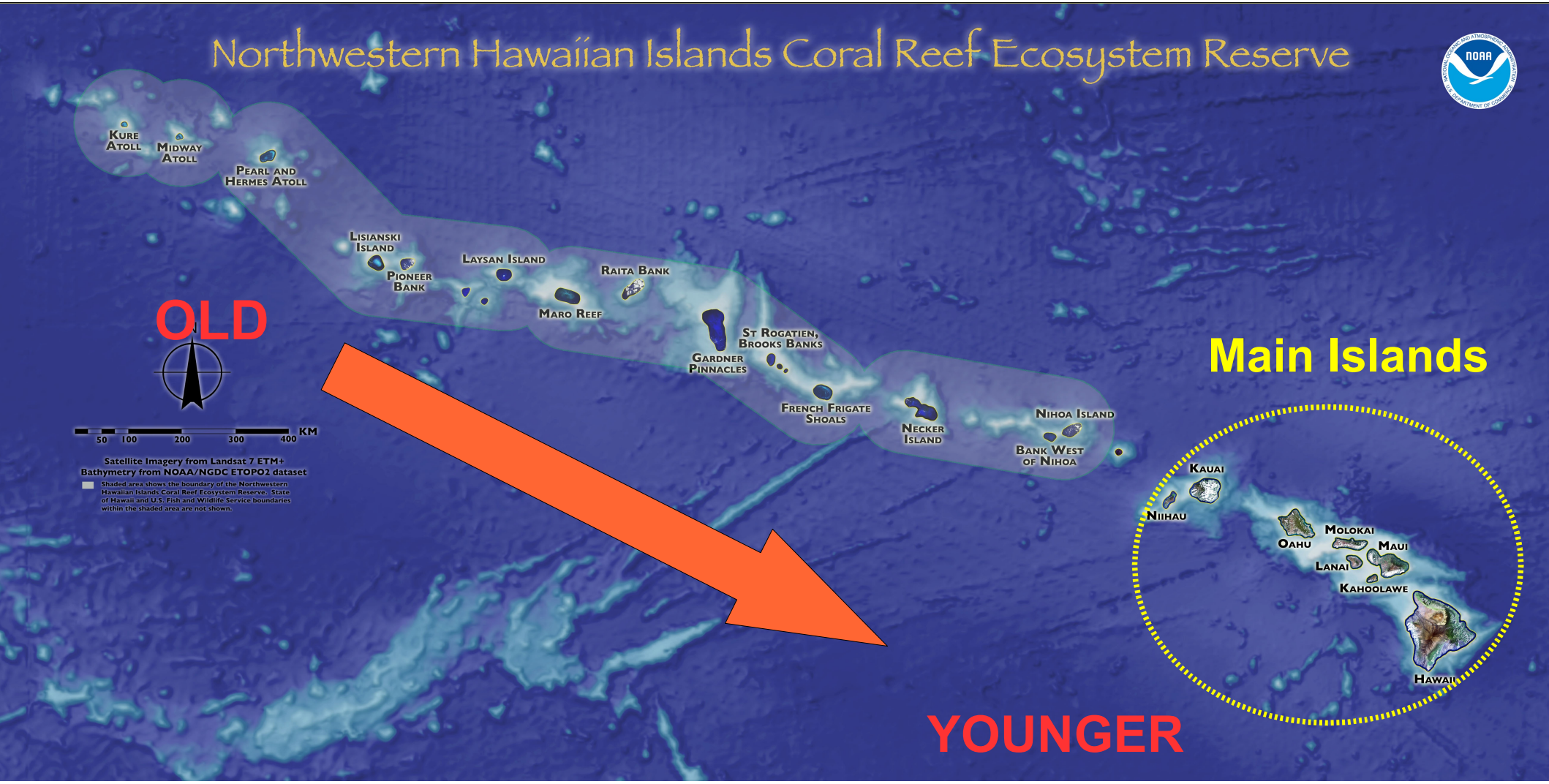


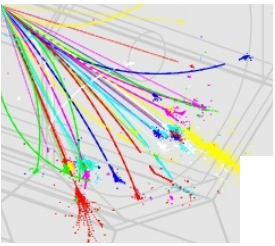
IEEE
NSS-MIC 2007
Honolulu, HI
28.10-04.11.2007

Marcel Stanitzki
STFC-Rutherford Appleton Laboratory



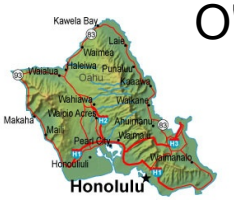
Hawai'i


Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve
NOAA
Kure Atoll
Midway Atoll
Pearl and Hermes Atoll
Lisianski Island
Pioneer Bank
Laysan Island
Raita Bank
Maro Reef
St Rogatien, Brooks Banks
Gardner Pinnacles
French Frigate Shoals
Necker Island
Nihoa Island
Bank West of Nihoa
OLD
KM
50 100 200 300 400
Satellite Imagery from Landsat 7 ETM+
Bathymetry from NOAA/NGDC ETOPO2 dataset
Shaded area shows the boundary of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve. State of Hawaii and U.S. Fish and Wildlife Service boundaries within the shaded area are not shown.
Main Islands
Kauai
Niihau
Oahu
Molokai
Maui
Lanai
Kahoolawe
Hawaii
YOUNGER



The Main Islands

Kaua'i



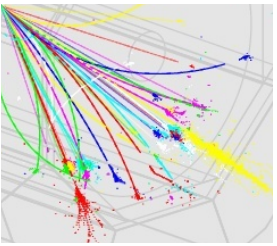
O'ahu

Moloka'i

Maui

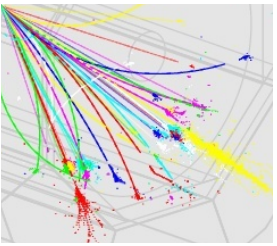
Lana'i

Hawai'i
(The Big Island)



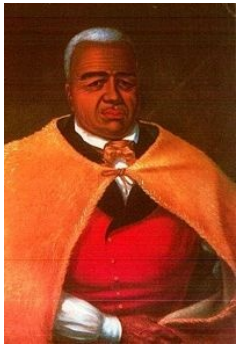
The main islands

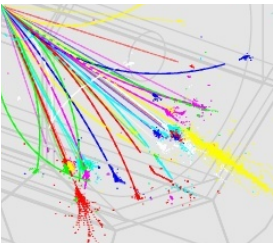
- Most remote islands besides Easter Island
- All are of volcanic origin
- Hawai'i (Big Island) still has active volcanoes
- Highest Mountain is Mauna Kea
  - 4205 meters from sea level
  - approx 10000 meters from sea floor
- Climate :
  - 31 C Summer
  - 27 C Winter



A short History

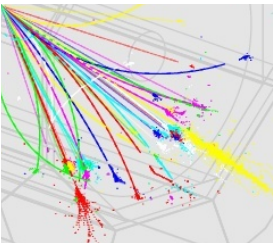
- ~1000 : Polynesians discover the islands
- 1778 : James Cook discovers the islands
- 1779 : James Cook killed on Hawai'i
- 1790 : Kamehameha becomes ruler of Hawa'i
- 1790-1810: Kamehameha conquers all islands
- 1810 : The kingdom of Hawai'i is formed
- 1898 : The USA annexes the kingdom of Hawai'i
- 1941 : Pearl Harbor
- 1959 : Hawai'i becomes the 50th state





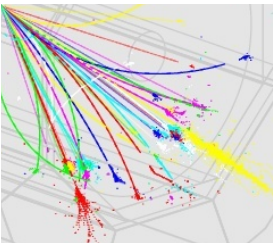
Hawai'i today

- The state capital is Honolulu (O'ahu)
  - 900.000 inhabitants
- 1.2 million inhabitants on all islands
- 42nd largest state in terms of size and population !
- Main sources of income
  - Tourism
  - Agriculture
  - Military bases
  - Movies



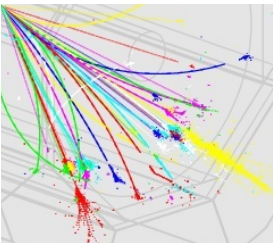
IEEE NSS-MIC 2007

- IEEE NSS-MIC:
  - Nucelar Science Symposium
  - Medical Imaging Conference
- Took place in Hilton Hawaiian Village in Waikiki
  - ~1200 participants
  - 88 oral sessions
  - ~ 400 posters
- Still the biggest conference for particle detectors
- IEEE NSS/MIC 2008 in Dresden



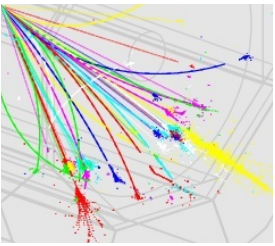
The NSS plenaries

- T. Virdee (Imperial) on LHC Status
- *J. Brau (Oregon) on ILC Detectors*
- *D. Hitlin (CalTech) on SuperB*
- C. Bebek (LBNL) on SNAP SuperNova/Dark energy mission

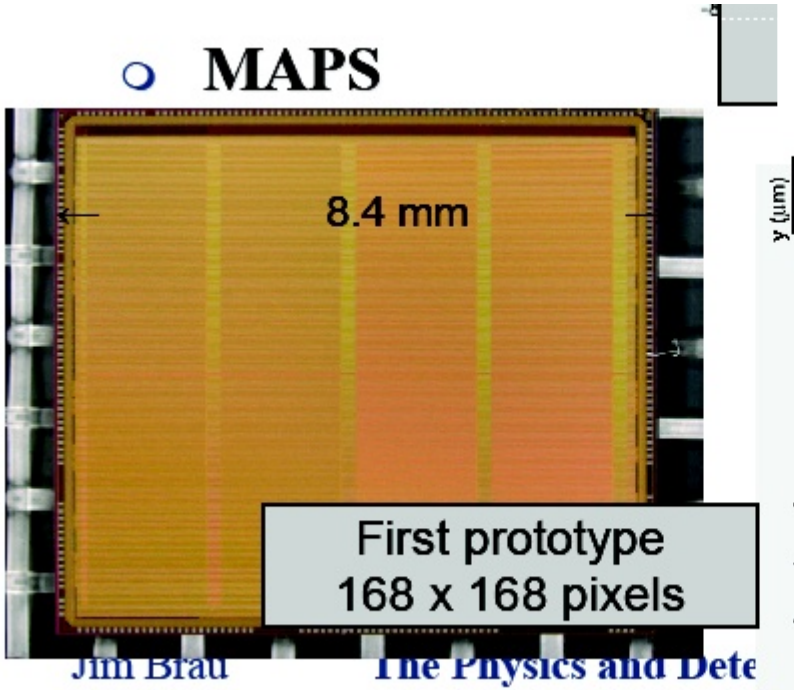


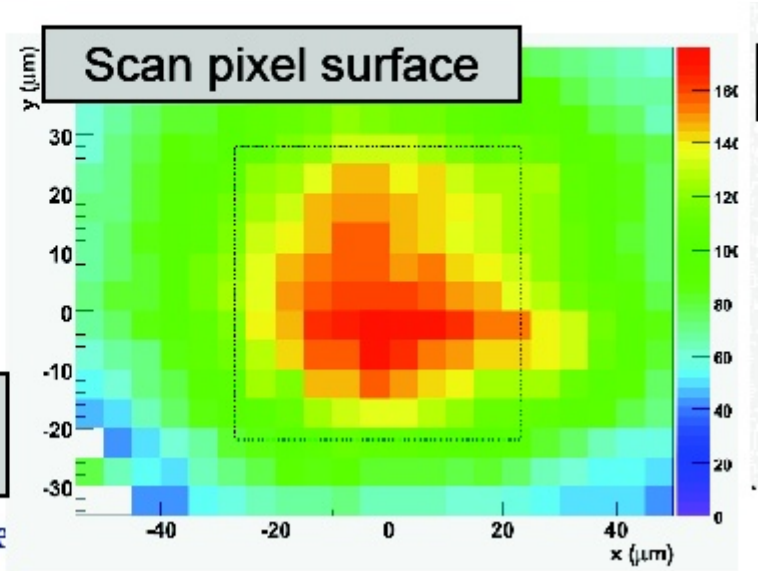
J.Brau : ILC detectors I

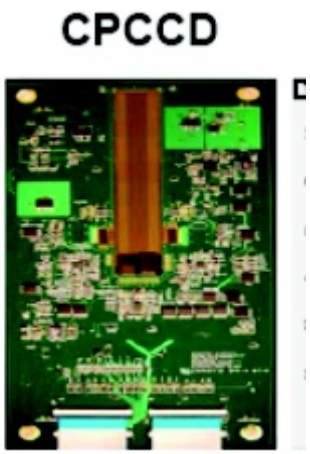
- Two-jet mass resolution comparable to the natural widths of W and Z for an unambiguous identification of the final states.
- Excellent flavor-tagging efficiency and purity (for both b- and c-quarks, and hopefully also for s-quarks).
- Momentum resolution capable of reconstructing the recoil-mass to di-muons in Higgs-strahlung with resolution better than beam-energy spread.
- Hermeticity (both crack-less and coverage to very forward angles) to precisely determine the missing momentum.
- Timing resolution capable of separating bunch-crossings to suppress overlapping of events .



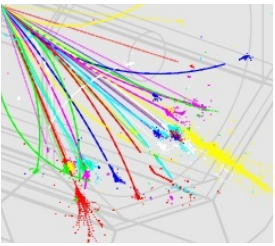
J. Brau : ILC detectors II







RAL projects were well represented in this summary !

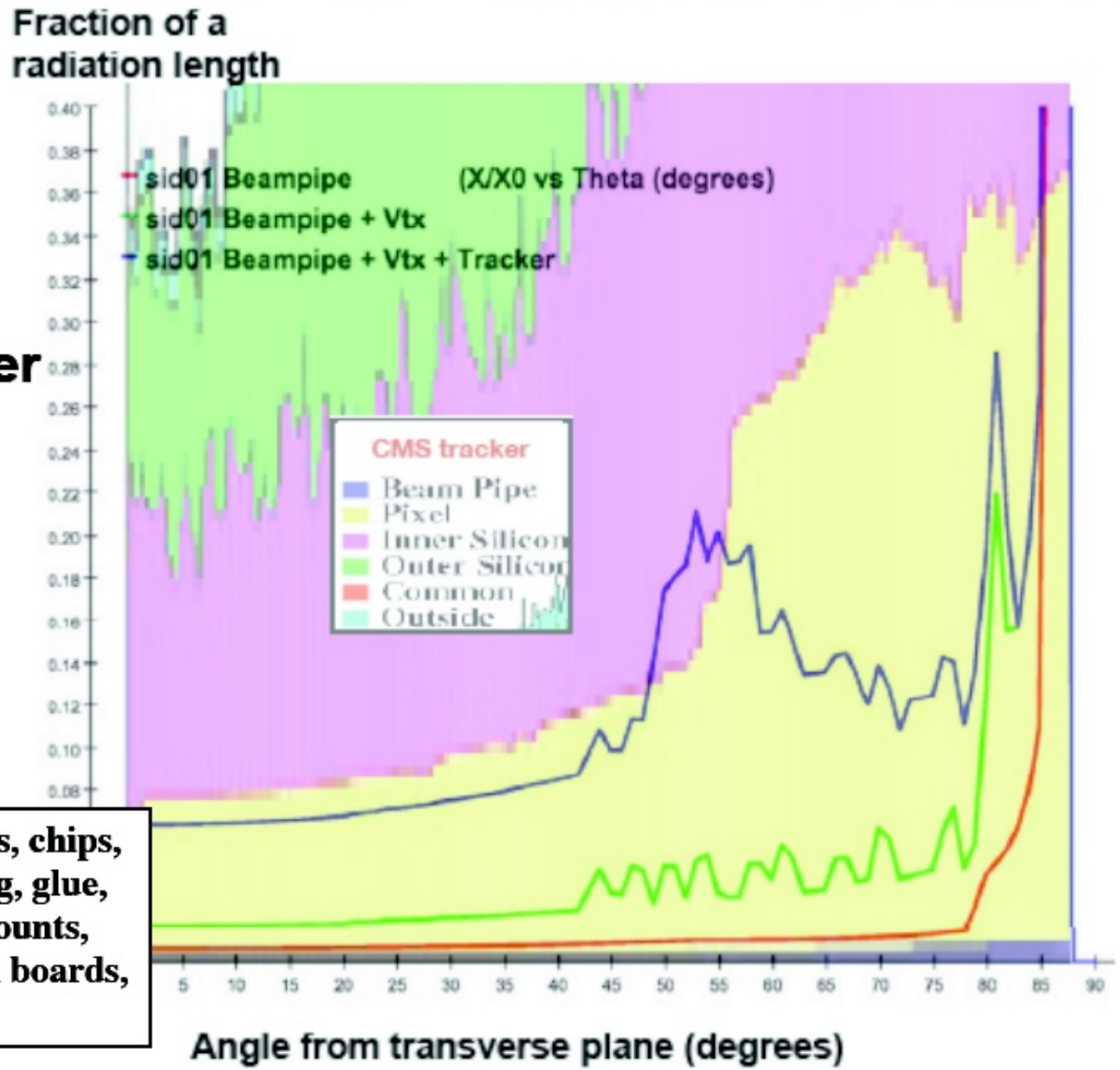


J. Brau : ILC detectors III

~ 0.9 %/layer

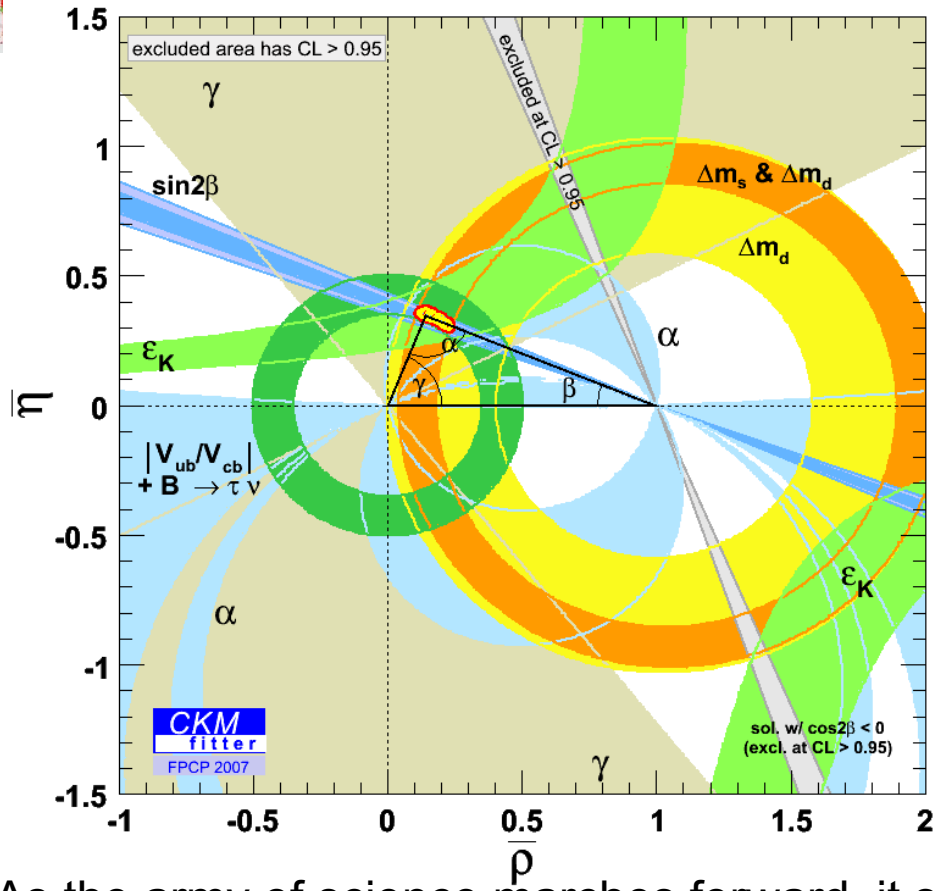
at normal incidence

- **No Cooling**
- **Reduced Readout / Power**
  - **Chips**
  - **Hybrids**
  - **Cables**
- **Minimal Support**
- **Thin Sensors**



Included in GEANT: sensors, chips, cables, connectors, bypassing, glue, module supports, module mounts, overlaps, power distribution boards, DAQ for baseline design.

D. Hitlin : SuperB



The CKM matrix passes the new overconstrained tests: the Unitarity Triangle is self-consistent

Is that the end of the heavy flavor story?

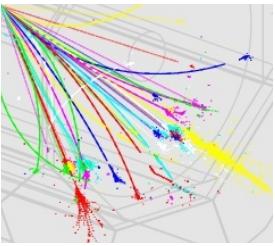
Not at all

"As the army of science marches forward, it sometimes leaves behind pockets of resistance "
W.K.H. Panofsky

Will flavor physics be such a pocket of resistance?

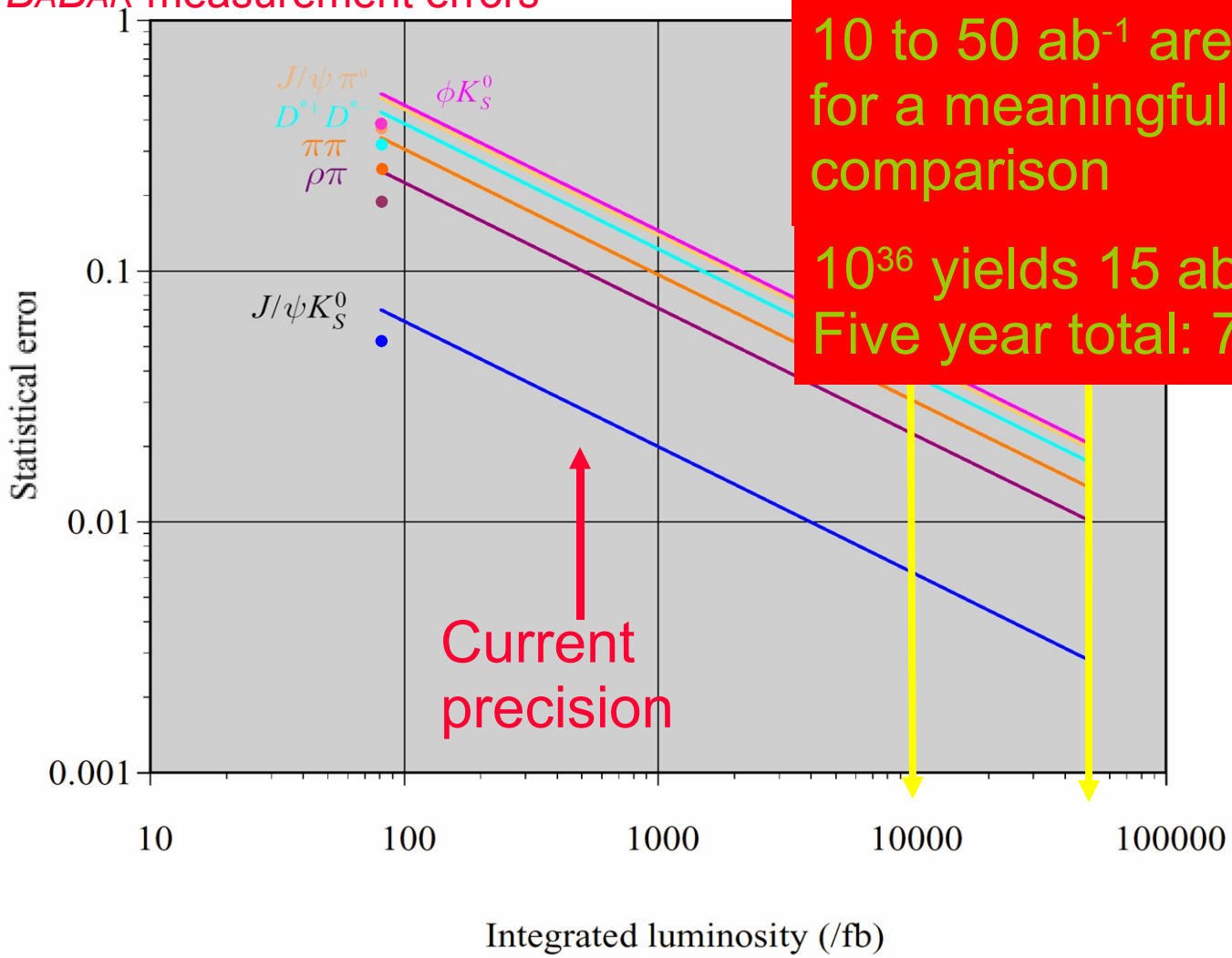
The answer to these questions clearly lies in physics beyond the Standard Model

Further studies in the flavor sector are crucial to exploring this New Physics



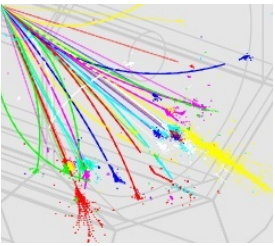
D. Hitlin : SuperB II

BABAR measurement errors



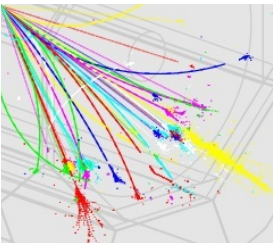
10 to 50 ab^{-1} are required for a meaningful comparison

10^{36} yields 15 ab^{-1}/year
Five year total: 75 ab^{-1}



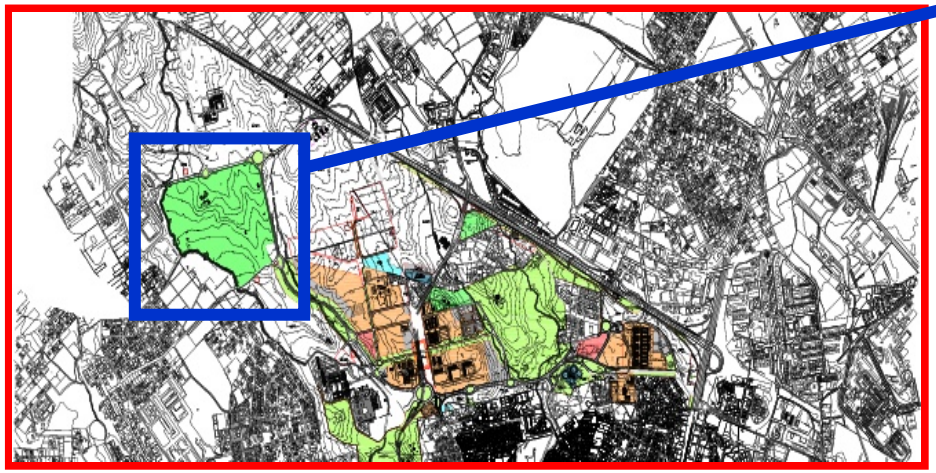
D. Hitlin : SuperB III

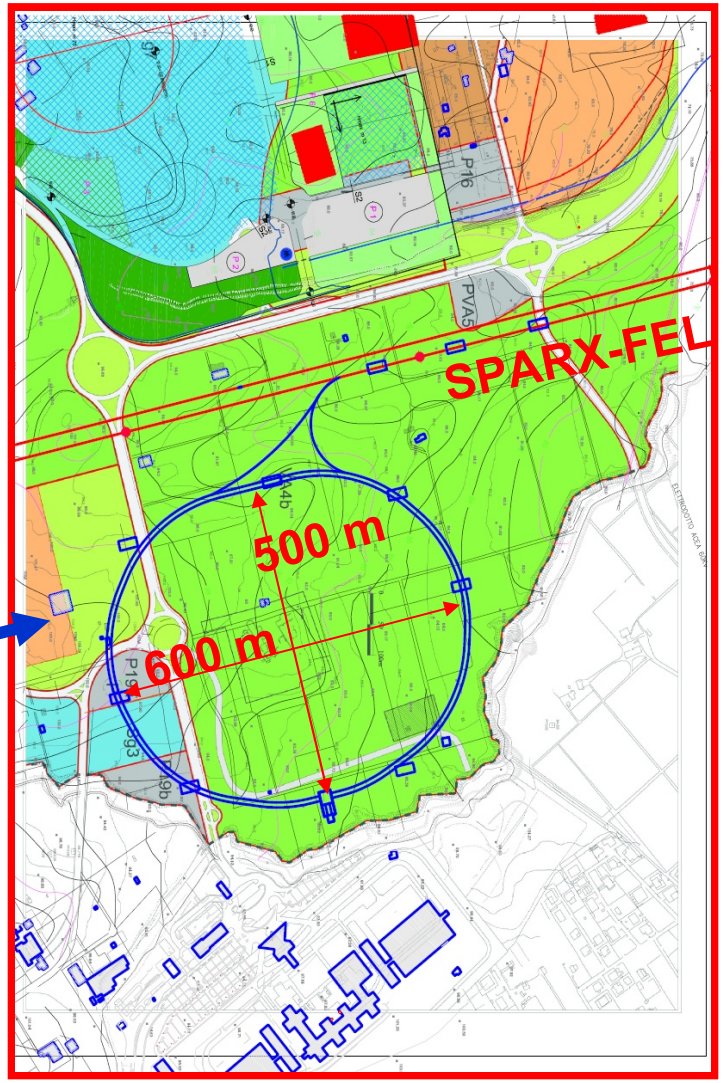
- The most straightforward approach is to extrapolate from the existing designs: more bunches, more charge/bunch, somewhat smaller beam sizes at the collision point
  - The Super PEP-II and SuperKEK-B upgrade proposals are the result
  - These have in common very high currents, requiring wall plug power or the order of 100 MW, and present very difficult problems for the associated detectors
  - It is unlikely that either of these projects will go forward in this guise
- Utilizing concepts developed for ILC, specifically the damping rings and final focus, it is possible to produce a two-order-of-magnitude increase in luminosity at a B Factory, with currents and wall plug power comparable to the current machines - "Super$B$"



D. Hitlin : Super B IV

- A site is available on the campus of Rome II University (Tor Vergata) near Frascati
- Physicists & engineers are planning the site and required infrastructure, in cooperation with the SPARX-FEL project, which is approved and funded



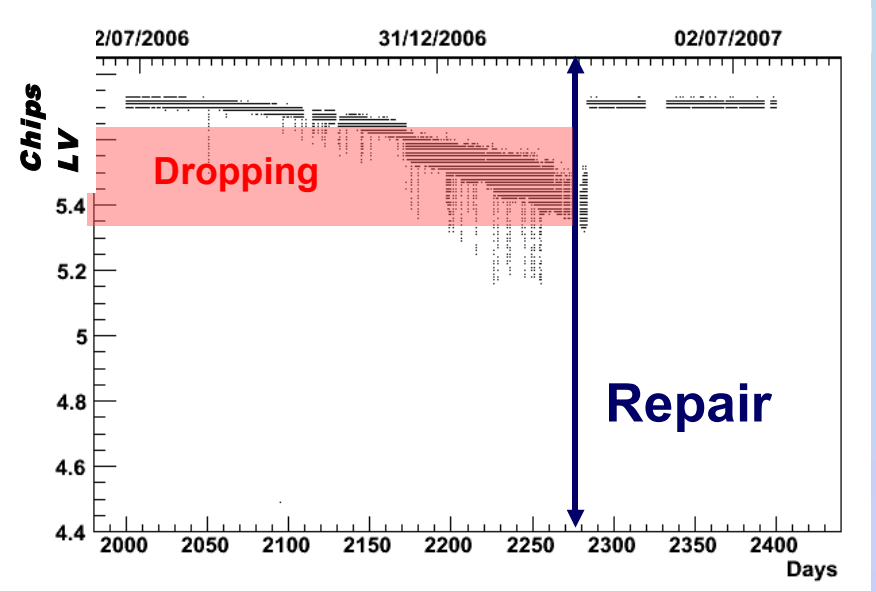


NSS 07-4 The CDF RUN II Silicon Detector: Aging Studies J.E.Garcia (INFN)

- 16 SY527 CAEN crates with 112 modules in Collision Hall
- Observed failure mode: smooth voltage drops that lead to erratic behavior.
- Aging of one capacitor in the circuit identified as source of the problem.

- All modules starting to develop failure mode have been repaired in FNAL during the 2007 shutdown.

- Repaired around half of the modules in the system.



DREAM Performance

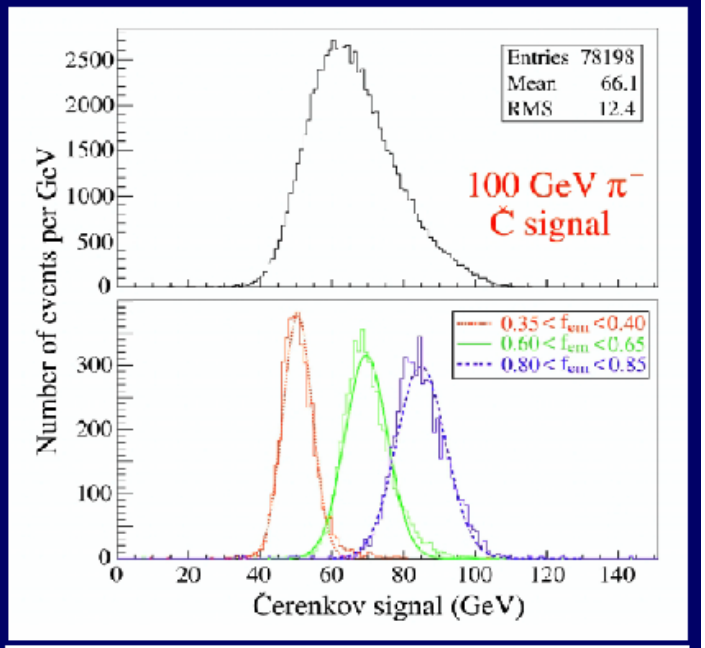
N. Akchurin et al., NIM A537 (2005)

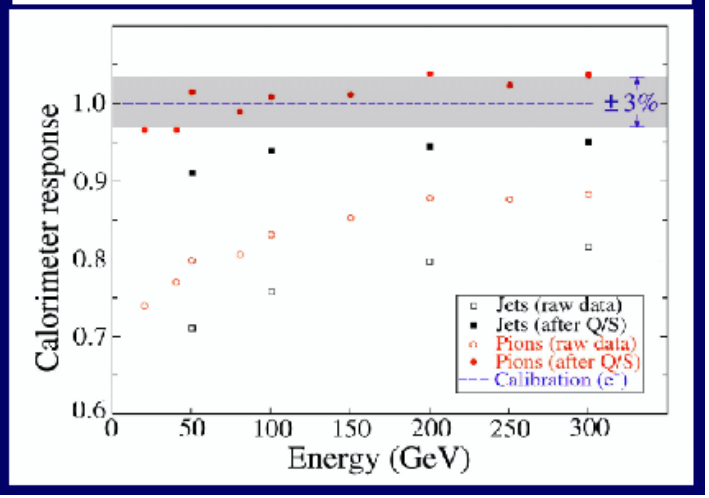
- DREAM equations:

$$\begin{cases} S = E\left[f_{em} + (e/h|_S)^{-1}(1-f_{em})\right] \\ Q = E\left[f_{em} + (e/h|_Q)^{-1}(1-f_{em})\right] \end{cases}$$

$$E = \frac{S - \chi Q}{1-\chi} \qquad \chi = \frac{1-(e/h|_S)^{-1}}{1-(e/h|_Q)^{-1}} \approx 0.29$$

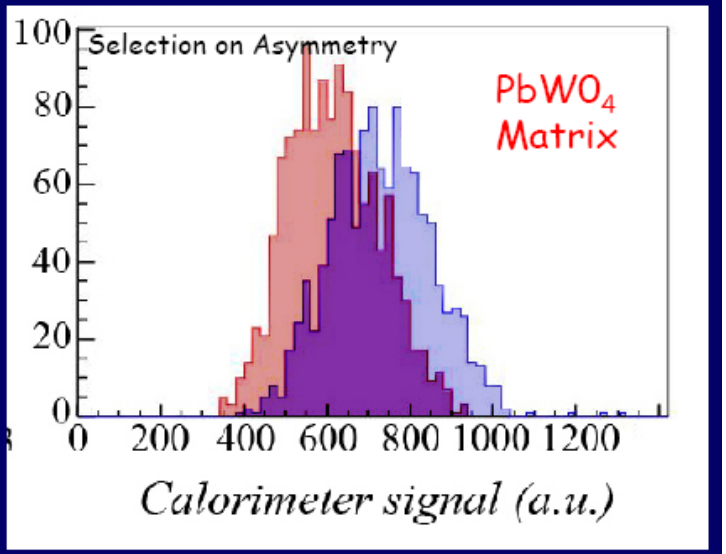
- ➔ Improved resolution, perfect scaling with $E^{-1/2}$, reduced hadronic signal non-linearity!
- The dominant limitation is the small number of Čerenkov photoelectrons (8 ph.e./GeV), arising from the very small sampling fraction ➔ limited performance on em showers
- DREAM method with a homogeneous material? This will largely increase the number of Cerenkov photoelectrons and improve performances on em showers

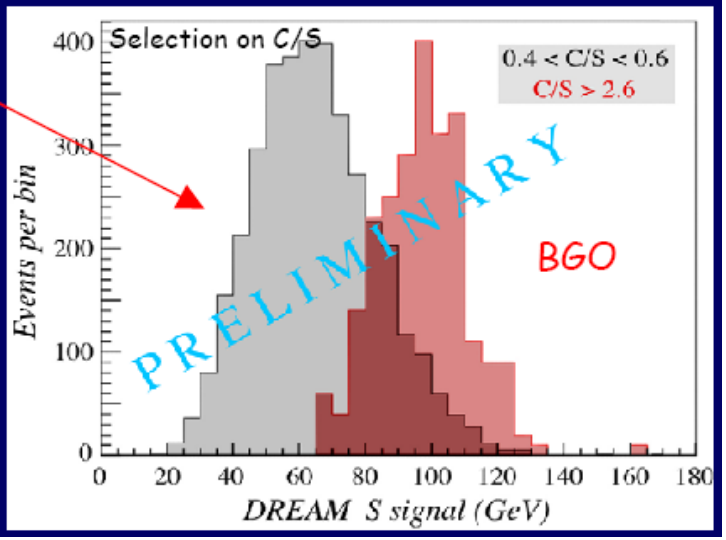


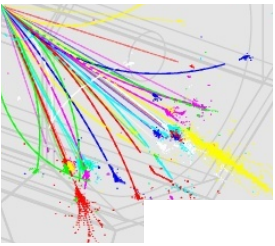


Preliminary BGO + DREAM

- A single-crystal ECAL was obtained by carefully aligning the BGO crystal with the beam axis. This crystal was positioned in front of DREAM, acting as an HCAL. Beam was 200 GeV π^+
- We found a very clear separation of the total calorimeter signal by selecting two intervals of C/S (measured in BGO), enhanced with respect to what was obtained with the $PbWO_4$ matrix
- On the basis of this promising result we are now planning to perform the same measurement on a new ECAL made of a matrix of BGO crystal, positioned in front of DREAM acting as an HCAL



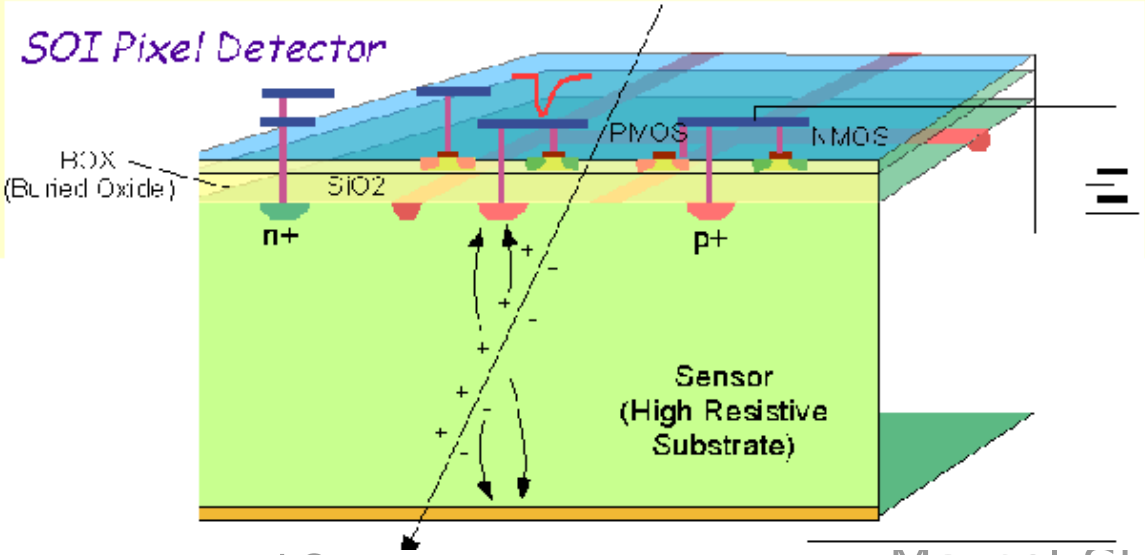




N20-2, SOI Pixel Developments in a 0.15um Technology Y. Arai

Features of SOI Monolithic Pixel detector

- Bonded Wafer (High Resistive Substrate + Low Resistive Top Si).
- Standard CMOS Electronics (NMOS, PMOS, MIM Cap etc.).
- Monolithic Detector, No Bump Bonds (Lower cost, Thin Device).
- High density (Smaller Pixel Size is possible).
- Small capacitance of the sense node (~10fF, High gain V=Q/C)
- Industrial standard technology (Cost benefit and Scalability)
- No Latch Up
- Low Power
- ...

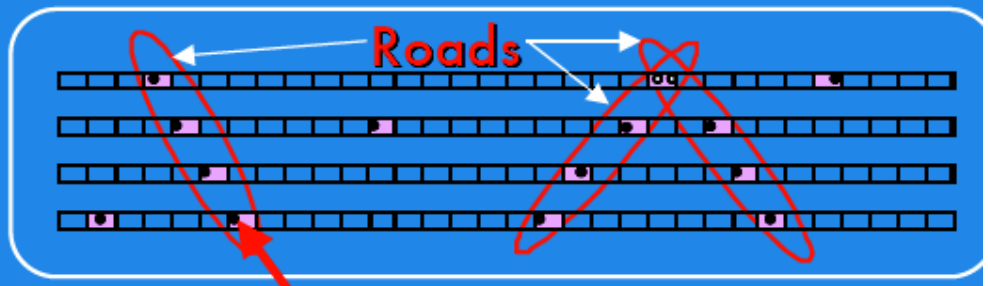


On-Line Tracking: the SVT way

A two steps Algorithm

Pattern Recognition (AM)

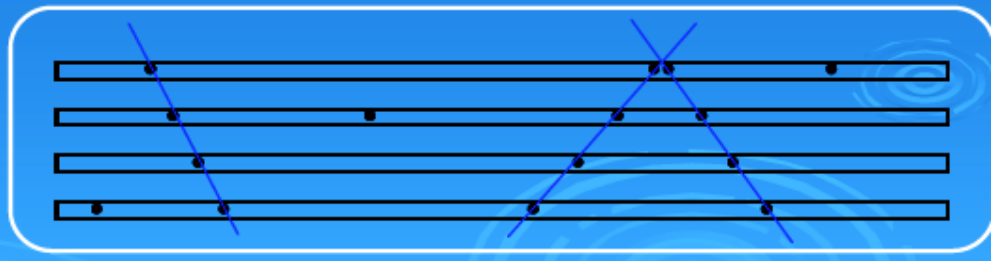
1. Find low resolution track candidates called "roads". Solve most of the pattern recognition



Super Bin (SB)

Track Fitting (TF)

2. Then fit tracks inside roads. Thanks to 1st step it is much easier



2007 NSS, Honolulu P. Catastini 3

Track Fitter Algorithm

- Linear expansion in the hit positions x_i reduces track fitting to *scalar products*:

$$p_i = \vec{f}_i \cdot \vec{x} + q_i$$

- p_i : track parameters (P_t, ϕ_0 and Impact Par.)
- $\vec{f}_i$, q_i: know constants.
- $\vec{x}$: vector of hit positions

- hit → 18 bits.
- Old FPGA → at maximum 8x8 multipliers. → Large Memory corrections
- Scalar products splitted in two terms:

Pre-calculated term:
One for each Road

On-line evaluated with
8x8 bit multipliers

$$p0_i = \vec{f}_i \cdot \vec{x}_0 + q_i$$

$$\delta p_i = \vec{f}_i \cdot \vec{d}$$

The GigaFitter core

- Technology improves, of course…
- Today new FPGAs equipped with many 25x18 bit multipliers are available, like the:

Xilinx VIRTEX 5: 65 nm- 550 MHz devices
XC5VSX95T: 160 x 46 CLB Array (Row x Col)

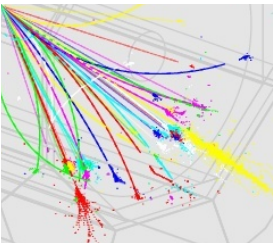
244 39kbits BlockRams or *Fifos*+ *640 DSP Slices* (organized in columns)

It allows to come back to the original scalar product with the full hit positions using 18x18 bit multipliers

$$p_i = \vec{f}_i \cdot \vec{x} + q_i$$

No need for pre-calculated terms (stored in big memories)

2007 NSS, Honolulu



N40-4 Readiness of the CMS Detector Simulation V. D. Elvira

- GFlash model based on probability density functions and used for parameterizing showers of electrons, positrons and photons in CMS barrel and endcap EM calorimeter allows speed up without compromising simulation accuracy
- Infrastructure is now in place to tune hadronic showers to data in order to improve accuracy beyond that provided by Geant4.

Comparisons between GFlash-based and Geant4 simulation

- Energy deposits as well as shower profiles of parameterized and full simulations compare well