TRENDS IN PHYSICS ALGORITHMY

- HIGHLIGHTS OF SESSION 2

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ACAT 03 - TSUKUBA, JAPAN

5 DEC. 2003

TAXONOMY OF TALKS

33 - PAPERS WERE SCHEDULED

5 - WERE WITHDRAWN

I HAVE BROKEN THE REMAINING 28 INTO 4 CATEGORIES:

1 - 8 PAPERS

2 - 7 PAPERS

3 - 9 PAPERS

4 - 4 PAPERS

I WILL NOW DETAIL THESE. I WILL CITE AUTHORS IN THE TALK, TO GIVE THEM FEEDBACK, BUT NOT NECESSARILY IN THE PAPER EDITION.

1- PAPERS WHICH WERE INTERESTING BUT WHICH PROBABLY SHOULD HAVE BEEN IN SESSION 1.

MOTOKAI - KAMLAND (JOINT 1-2)
ADACHI - BELLE COMPUTING (JOINT 1-2)
BERINGER - PHYSICS VALIDATION GEANT 4
ASAI - GEANT 4 SIMULATION TOOLKIT
SERBO - JAS3 INTERACTIVE GUI FOR GEANT4
SERBO - JAS3 CURRENT STATUS
} GEANT4
SUZUKI - OO DATA ANAL. ENVIRON. FOR NEUTRON SCATT
HERNANDO - OO CODE TO FIT DYNAMIC TRAJECTORIES

- COMMENT: HANG I UNDERSTOOD WHAT SESSION 1 IS?

- COMMENT: SESSION 2:
"INNOVATIVE ALGORITHMS & TOOLS"

SESSION 1:
"COMPUTING TECHNOLOGY & ENVIRONMENT"

- COMMENT: I DON'T FEEL WELL QUALIFIED TO EVALUATE THE PAPERS TECHNICALLY

2 - PAPERS SHOWING SOPHISTICATED, OFTEN CLEVER USE OF "PHYSICS REASONING" AND OF MORE "STANDARD" DATA ANAL. TECHNIQUE

- LIKELIHOOD TECHNIQUES
- BAYESIAN CLASSIFICATION
- INTEGRATION OF GRID TOOLS
- INTEGRATION OF OO TECHNIQUES

} INNOVATION

- PARTICLE & FLAVOR TAGGING

TAKASHIMIZU - BAYESIAN METHOD FOR SHOWER COUNTERS

LO RE - $K^*(892)^0$ RECON. FOR ALICE

NYSTEN - γ RECONSTR. IN CMS

YAMAGA - K^0_L RECONSTR. AT BELLE

KAKUNO - NEUTRAL B FLAVOR TAGGING AT BELLE

MATSUMOTO - TAGGING WITH FULLY RECONSTRUCTED B'S

COMMENT: CATEGORIES 1 & 2 ACCOUNT FOR NEARLY HALF OF SESSION 2 TALKS. SHOULD WE BE WORRIED?

3 - INNOVATIVE ALGORITHMS AND TOOLS

CIESLING (ZIMMERMAN) – TUTORIAL ON STATISTICAL LEARNING

SOKOLOV – JET RECONST. W A "DIGITAL" HADRONIC CALORIM. USE TRACKING TO DO CALORIMETRY, USES FUZZY CLUSTERING AND NN TECHNIQUES

DSPELOV – γ COORD. RECONSTR. AT VEPP-4M USING NN IN A LQ-KRYPTON CAL

I WAS TEMPTED TO PUT THESE IN CLASS 2. HAVE NN BECOME "STANDARD"?

OIZIDES – VERY INNOVATIVE & AMBITIOUS PATTERN RECOGNITION ENGINE FOR THE ALICE HIGH LEVEL TRIGGER (HLT) DETECTOR DATA IS DISTRIBUTED VIA FIBER-OPTIC TO PC'S EQUIPPED WITH CUSTOM PCI OPTICAL RECEIVER CARDS AND FPGA-ENABLED PATTERN RECOGNITION CO-PROCESSORS. NODES COMMUNICATE VIA A HIGH BAND WIDTH NETWORK. NEW IDEAS FROM COMPUTER SCIENCE (CHOICE OF MESSAGE-LAYER PROTOCOL) AND SIGNAL PROCESSING (PREDICTIVE CODING OF CLUSTER PARAMETERS TO REDUCE BAND WIDTH) ARE BEING INTEGRATED. (COMMENT: THIS WAS A JOINT 1-2 TALK).

3- CONT'D.

BERLICH – PARAMETRIC OPTIMIZATION IN DISTRIBUTED ENVIRONMENTS.

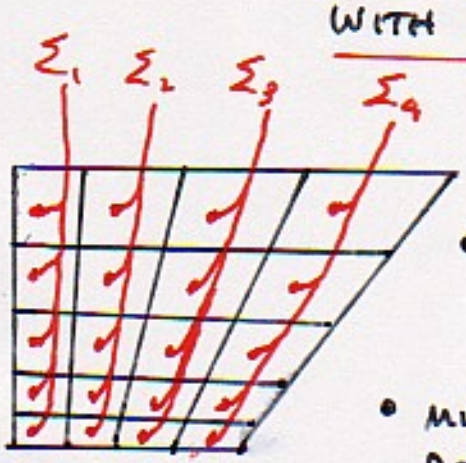
- EVOLUTIONARY ALGORITHM TECHNIQUES ARE KNOWN TO PRODUCE HIGH QUALITY SOLUTIONS
- TRADITIONALLY THEY HAVE BEEN QUITE SLOW.
- BERLICH & KUNZE HAVE SHOWN THAT IT IS PRACTICAL TO PARTITION EVOL. ALG. ONTO DISTRIBUTED SYSTEMS, E.G. UNIX CLUSTERS OF UP TO 100's OF MACHINES
- THEY SHOWED THAT SOLUTIONS MUCH BETTER THAN GRADIENT DESCENT CAN BE OBTAINED QUICKLY
- THIS CAN BE APPLIED TO ANY KIND OF PARAMETRIC OPTIMIZATION.
- A LIBRARY OF TOOLS HAS BEEN DEVELOPED.

DA SILVA – ONLINE NN TRIGGER FOR TESTBEAM CALIBRATION OF CALORIMETER MODULES

- BIG EXPERIMENTS HAVE A LOT OF CALO. MODULES TO CALIBRATE. IT IS NICE TO AUTOMATE THIS
- TEST BEAMS ARE NOT "PURE". ∃ CONTAMINATION, IT IS TIME CONSUMING ONLINE TO TAKE MORE DATA TO COMPENSATE, OR OFFLINE TO CALIBRATE
- A NEURAL TRIGGER CAN REJECT UNWANTED PARTICLES ONLINE, IMPROVING EFFICIENCY
- THE "BEAM ID" (IE. ELECTRON, PION, MUON) CAN BE USED AS TARGET FOR REALTIME LEARNING, EVEN THOUGH THEY ARE SOMETIMES WRONG, DUE TO CONTAMINATION.

3- CONT'D.

DA SILVA/RAMOS - MATCHED FILTER SYSTEM FOR μ- DETECTION WITH TILECAL (ATLAS)



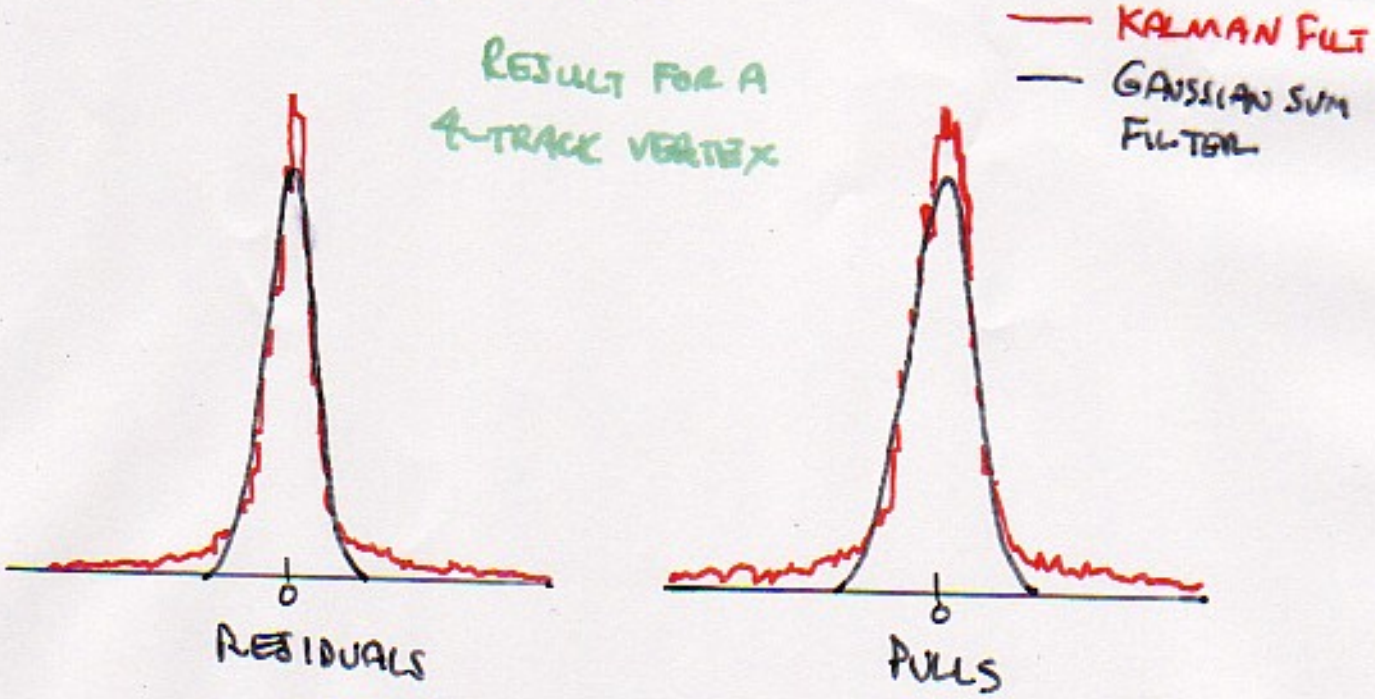
- ENERGIES ARE SUMMED AND TRIGGER TOWERS
- MUON ENERGY DEPOSITS ARE SMALL AND DETECTION IS DIFFICULT
- THE SUMMED ENERGY HAS A PULSE-SHAPED TIME DEPENDENCE WHICH IS SAMPLED AT 14 REGULARLY SPACED INTERVALS

- THRESHOLDING & INTEGRATION GIVE SUB-OPTIMAL MUON DETECTION
- A WELL KNOWN RESULT FROM SIGNAL PROCESSING IS THAT THE OPTIMAL FILTER FOR DETECTING A PULSE $p(t)$ HAS IMPULSE RESPONSE $p(-t)$ (MATCHED FILTER)
- SUCH A FILTER CAN OPTIMALLY DETECT MUON PULSES.
- A "NOISE WHITENING" FILTER IS FIRST APPLIED TO RENDER THE NOISE WHITE, REQUIRED FOR THE MATCHED-FILTER CRITERION TO BE SATISFIED.

3- CONT'D

SPEER - VERTEX FITTING WITH A GAUSSIAN-SUM FILTER

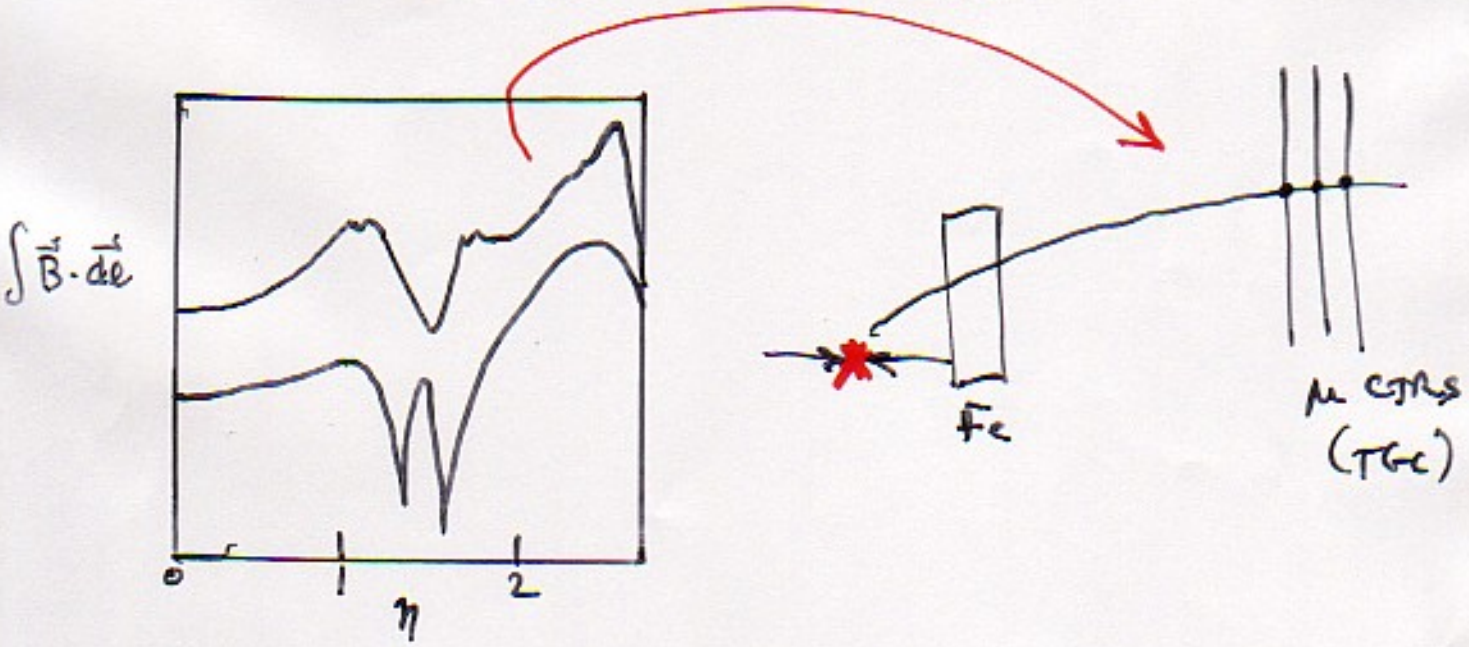
- THE KALMAN FILTER (USED FOR TRACK & VERTEX FITTING) IS EQUIVALENT TO A LEAST-SQUARES FIT.
- LEAST SQUARES TECHNIQUES ASSUME THAT ERRORS ON TRACK PARAMETERS ARE GAUSSIAN.
- THIS IS ONLY APPROXIMATELY TRUE AND NON-GAUSSIAN ERRORS SIGNIFICANTLY DEGRADE VERTEXING RESOLUTION.
- A SOLUTION CAN BE HAD BY MODELING THE ERRORS AS A SUM OF GAUSSIANS, TO TAKE INTO ACCOUNT NON-GAUSSIAN TAILS
- ONE CAN THEN APPLY A FILTER WHICH IS A WEIGHTED SUM OF KALMAN FILTERS RUN IN PARALLEL
- THE ESTIMATOR IS NON-LINEAR SINCE THE WEIGHTS DEPEND ON THE DATA: ONE DOESN'T KNOW A PRIORI IF A TRACK BELONGS TO A VERTEX OR NOT.



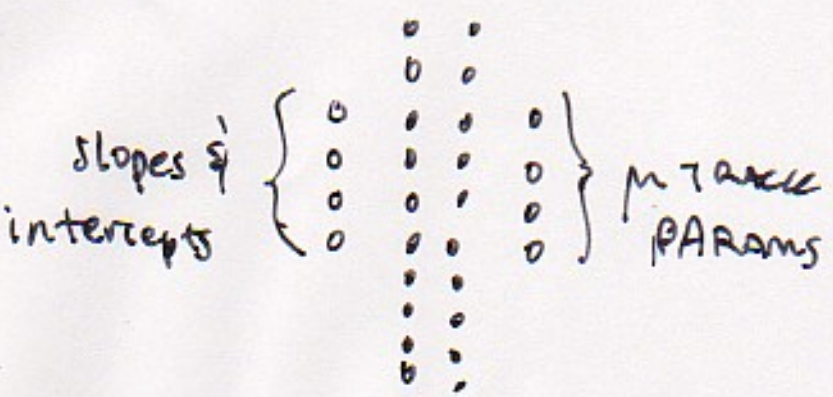
3- CONT'D.

ETZION – NN APPROACH TO μ TRIG IN ATLAS

- $\vec{B}$-FIELD IS VERY INHOMOGENEOUS FOR ATLAS μ-TRIGGER ⇒ TRIGGERING IS DIFFICULT
- PROPOSE NN TO MAP HITS IN MUON CHAMBER TO μ TRACK PARAMETERS FOR TRIGGER



- MLP 4-10-10-4 GIVES BETTER PERFORMANCE THAN "COINCIDENCE MATRIX" CONVENTIONAL TRIGGER.
- FAST HARDWARE EXECUTION IS POSSIBLE

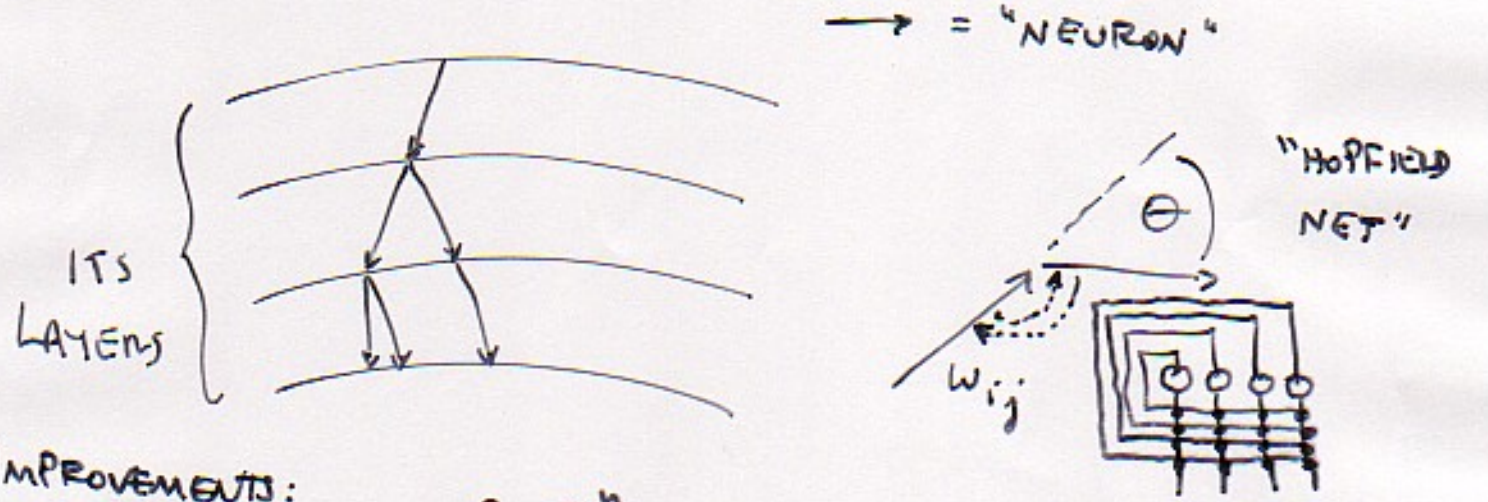


3 - CONT'D.

ARDERA – NEURAL TRACKING IN ALICE

- STD. ALGORITHM = KALMAN FILTER, USES ITS (INNER TRACKING SYSTEM) + TPC.
- MAY WISH TO TRACK ONLY IN ITS FOR TRIGGERING (FAST) OR REMOVE TRACKS FOUND IN TPC TO FIND DECAYS OR INEFFICIENCIES IN ITS VOLUME

THEY HAVE APPLIED THE FAMOUS "DENBY-PETERSON" NEURAL TRACKING (1987)



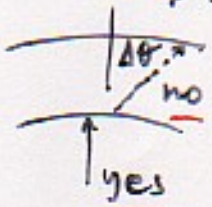
IMPROVEMENTS:

1) $W_{ij} = \frac{\cos\theta^n}{r}$ DENBY-PETERSON

$W_{ij} = \frac{(1-\sin\theta)^n}{r}$ ALICE

⇒ BETTER DIRECTIONALITY FOR HIGH P_T TRACKS

2) Δθ cut



3) CONVERGENCE: DIVIDE INTO AZIMUTHAL SEGMENTS TO SPEED UP CONVERGENCE OF NET (MEMORY REQUIREMENTS)

3- CONT'D.

BARBERA- CONT'D

- TESTED ON Pb-Pb COLLISIONS. GIVES $\epsilon \sim 70-60\%$, FAKE RATE ~ 4-10 %.
- THIS IS THE FIRST TIME DENBY-PETERSON HAS BEEN MADE TO WORK IN A REAL EXPERIMENTAL SITUATION

4- PAPERS I DIDN'T UNDERSTAND

ITYUKOV - DISTINGUISHABILITY OF HYPOTHESES

ITYUKOV - EXP. TEST OF PROBABILITY DENSITY (BOSTER)

ARIMOVA - GENETIC ALGORITHM FOR SIGNAL ENHANCEMENT

ANKOWSKI - OPTIMAL JET FINDER.

COMMENT: THESE MAY WELL BE THE MOST IMPORTANT TALKS IN OUR SESSION

COMMENT: THE AUTHORS SHOULD TRY HARDER TO MAKE THEIR TALKS COMPREHENSIBLE TO NON-EXPERTS AND TO BE SURE TO SHOW APPLICATIONS

CONCLUSION / SYNTHESIS

- THERE WERE SEVERAL GOOD "CORE" TALKS
- SOME MEMBERS OF SESSION 2 WERE A BIT PERPLEXED BY "SESSION 1" TALKS & "STANDARD METHOD" TALKS
- INNOVATIVE ALGORITHMS SEEM TO BE MOST USED IN DETECTOR-LEVEL PATTERN RECOGNITION AND IN TRIGGERS
- "TRADITIONAL" METHODS SEEM TO BE PREFERRED FOR FINAL PHYSICS ANALYSIS
- SEVERAL TANTALIZING TALKS "FROM LEFT FIELD." WE SHOULD BE OPEN TO THESE, BUT ENCOURAGE AUTHORS TO BETTER TARGET THEIR AUDIENCE

ARIGATO GOZAIMASTA !