PROSPECTS FOR BEAUTY PHYSICS AT THE SSC

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ABSTRACT

The cross section for $gg \to B\bar{B}$ is relatively high at collider energies, so that a one year run at RHIC or TEV I might yield $> 10^{10}$ B-$\bar{B}$ pairs, and $> 10^{12}$ pairs at the SSC. The challenge to the experimenter is to trigger on and reconstruct a significant fraction of this sample. Detectors are being proposed which make extensive use of silicon vertexing, VLSI readout, and massive online numerical processing with the goal of maintaining a 1% efficiency for few-body decays to all-charged final states. If achieved at the SSC for $\mathcal{L} = 10^{32}$ cm^{-2}sec^{-1} , this would be equivalent to an e^+e^- B factory operating at $\mathcal{L} = 10^{36}$ cm^{-2}sec^{-1} and 100% reconstruction efficiency. Even at RHIC or TEV I with 10^8 reconstructible B's, the strongest signals for CP violation in the B-$\bar{B}$ system would be accessible.

PHYSICS & TRACKING AT THE SSC

① NO TRACKING ⇒ HERMETIC CALORIMETRY ② MUON TRACKING ⇒ LARGE BL^2 ③ HADRON + LEPTON TRACKING HI PT	HIGGS SECTOR H → JET + JET → $Z^0 Z^0$ → 4μ → EXCLUSIVE HADRONIC MODES
④ HADRON + LEPTON TRACKING LO PT	CP VIOLATION IN B-$\bar{B}$ SYSTEM

NATURE WANTS US TO DO B PHYSICS

- B LIFETIME = 1.2 PSEC ⇒ CAN OBSERVE DECAY VERTEX SEPARATED FROM PRODUCTION POINT

- $B_d - \bar{B}_d$ MIXING IS LARGE ⇒ PHENOMENOLOGY RICH IN QUANTUM-MECHANICAL EFFECTS

- CROSS SECTION FOR $gg \to B\bar{B}$ IS LARGE AT COLLIDER ENERGIES

- CP VIOLATING EFFECTS ARE LARGE IN MANY DECAY MODES

PREJUDICES ABOUT CP VIOLATION IN $B\bar{B}$ SYSTEM

CF: BIGI & SANDA; GILMAN; ROSNER; ... + NOTES BY B[illegible]

BEST SIGNAL IS AN ASYMMETRY:

$$A = \frac{\Gamma(B \to f) - \Gamma(\bar{B} \to \bar{f})}{\Gamma(B \to f) + \Gamma(\bar{B} \to \bar{f})}$$

BUT, CLEAN THEORETICAL INTERPRETATION ONLY UNLE[SS]

$f = \bar{f}$ = CP EIGENSTATE

$\Rightarrow$ MUST TAG OTHER B OF $B\bar{B}$ PAIR

$\Rightarrow$ SELF-TAGGING MODES LIKE $B^0 \to K^+\pi^-$ [illegible]

MIGHT BE MORE ACCESSIBLE EXPERIMENTALLY, B[UT]

THEY ARE LESS USEFUL THEORETICALLY

(PENGUINS — LIKE ϵ'/ϵ IN $K^0 \to \pi\pi$)

ALSO LARGE $A \Longleftrightarrow$ SMALL Γ IN MOST MODEL[S]

TO REACH S STANDARD DEVIATIONS IN MEASUREMEN[T] OF A FOR MODE $B \to f$ WITH BRANCH Γ, NEE[D] N PRODUCED B'S, WHERE

$$N = \frac{S^2}{\Gamma A^2}$$

EX: $S = 3$, $A = 0.1$, $\Gamma = 10^{-5}$ $\Rightarrow N = 9 \times 10^7 \approx 10^8$ RECONST[RUCTED] $B\bar{B}$

CP VIOLATION AND THE K-M MATRIX

$$V_{KM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \sim \begin{pmatrix} 1 & \lambda & A\lambda^3(\rho \ldots \\ -\lambda & 1 & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix}$$

↑ WOLFENSTEIN

$\lambda \sim$ CABIBBO ANGLE

$A \leftrightarrow$ B LIFETIME

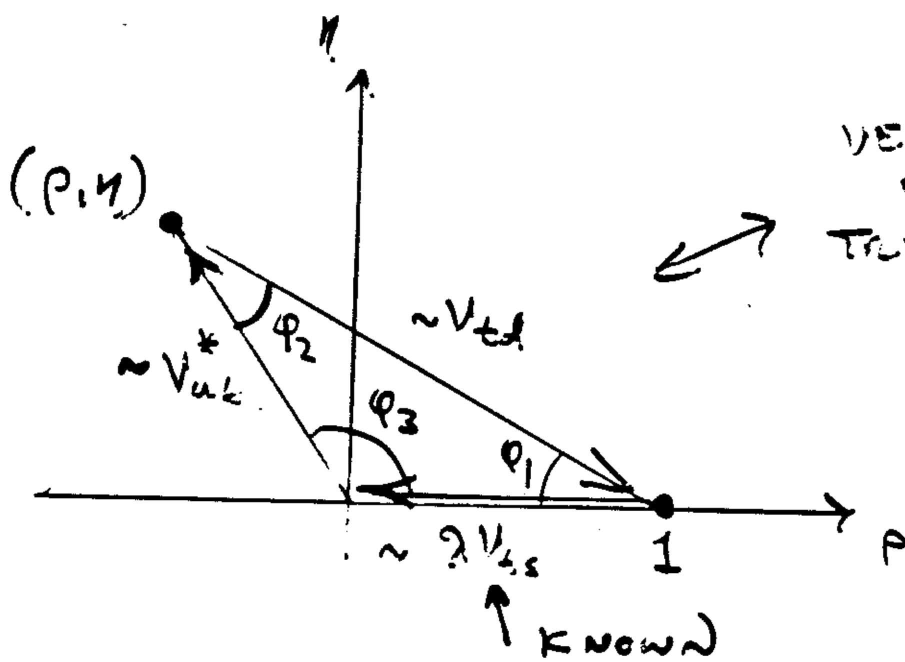
$\eta \neq 0 \leftrightarrow$ CP VIOLATION

BUT ρ, η NOT WELL DETERMINED FROM $K\bar{K}$ SYSTEM.

B PHYSICS IS THE PLACE!

BJ's TRICK: UNITARITY OF $V_{KM} \Rightarrow V_{td} + \lambda V_{ts} + V_{ub}^* \sim$ ...

⇓ VECTORS FORM TRIANGLE



(DIVIDE BY $A\lambda^3$)

SINCE V_{ts} IS KNOWN, THE CHALLENGE IS TO DETERMINE $\varphi_1, \varphi_2, \varphi_3$

THE BEAUTY OF B PHYSICS!

For $B \to f$ with f a CP eigenstate,

CP asymmetry A depends only on $\sin\phi$

$B \to \psi K_S$
$\psi K_S \pi^0$
$D\bar{D} K_S$ $\quad\quad A \sim \sin 2\phi_1$
$\psi\pi\pi$
$D\bar{D}$
$D^0 \pi^+\pi^-$
⋮

$B \to \pi^+\pi^-$ $\quad\quad A \sim \sin 2\phi_2$
$p\bar{p}$

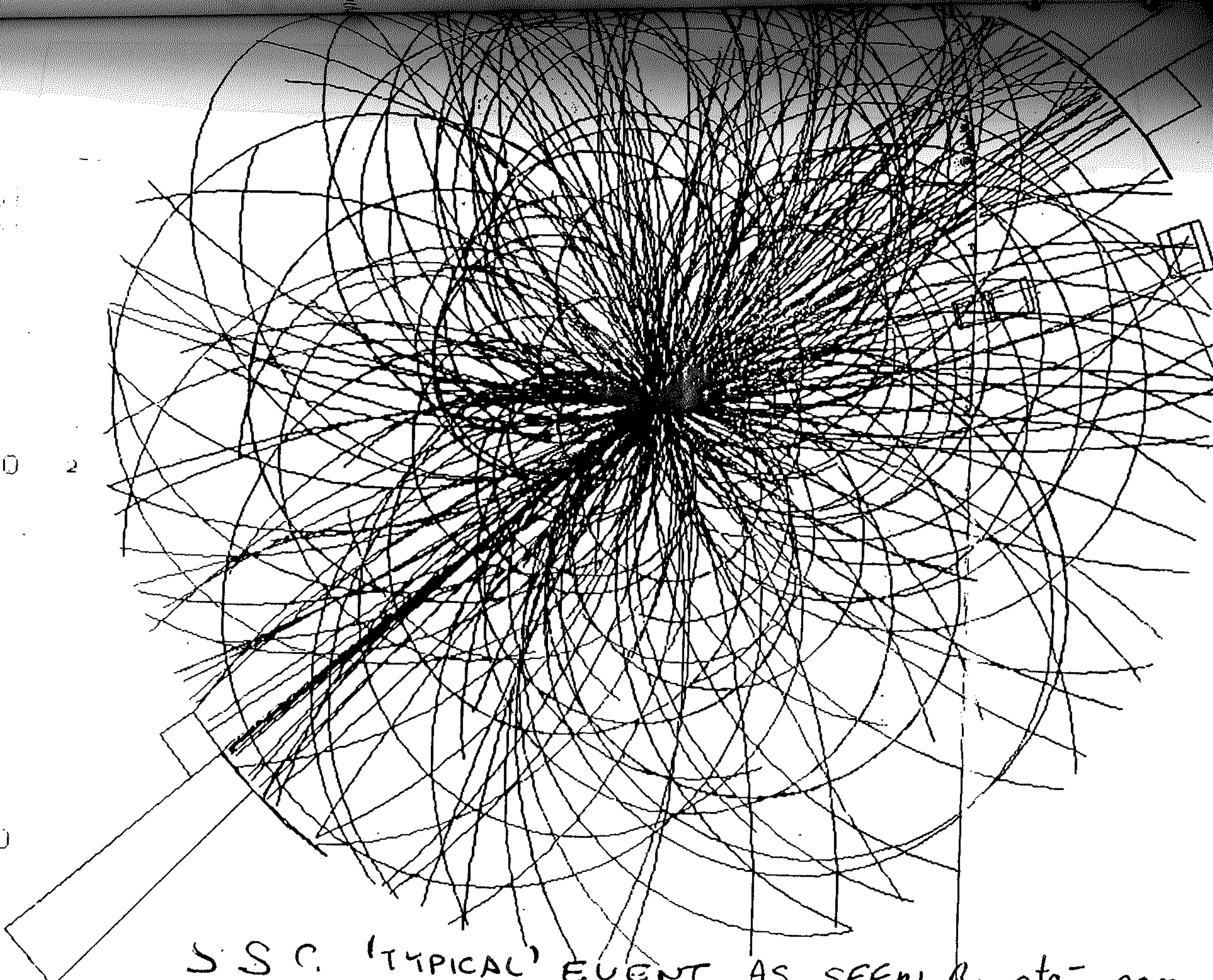
$B \to \bar{D}^{0*} K_S$ $\quad\quad A \sim \sin(\phi_2 - \phi_1)$

$\Rightarrow$ Over constrained study of (ρ, η) requi[res]

observation in <u>many</u> <u>modes</u>

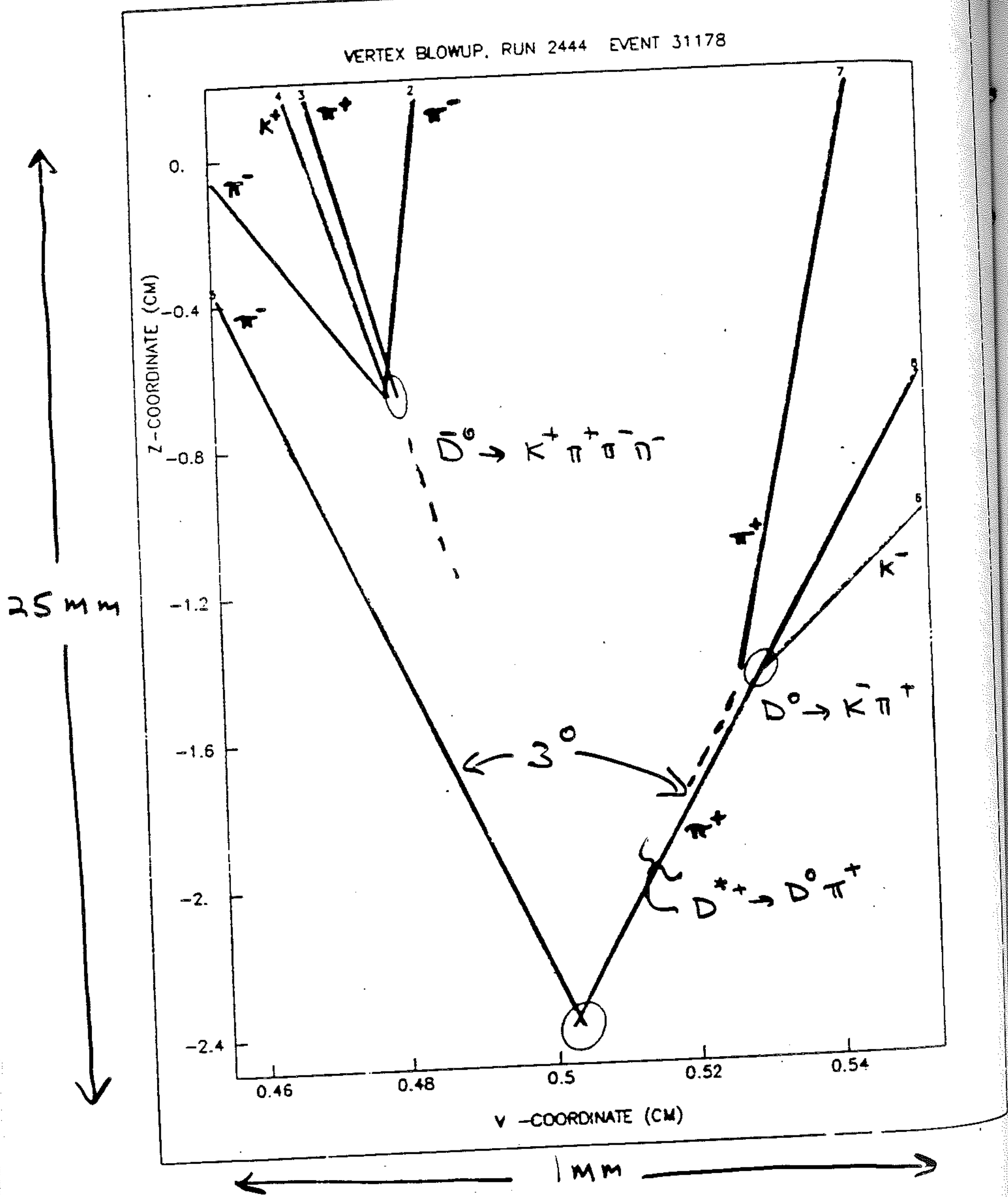
$\Rightarrow$ Need tagging of other B

Need particle I.D.

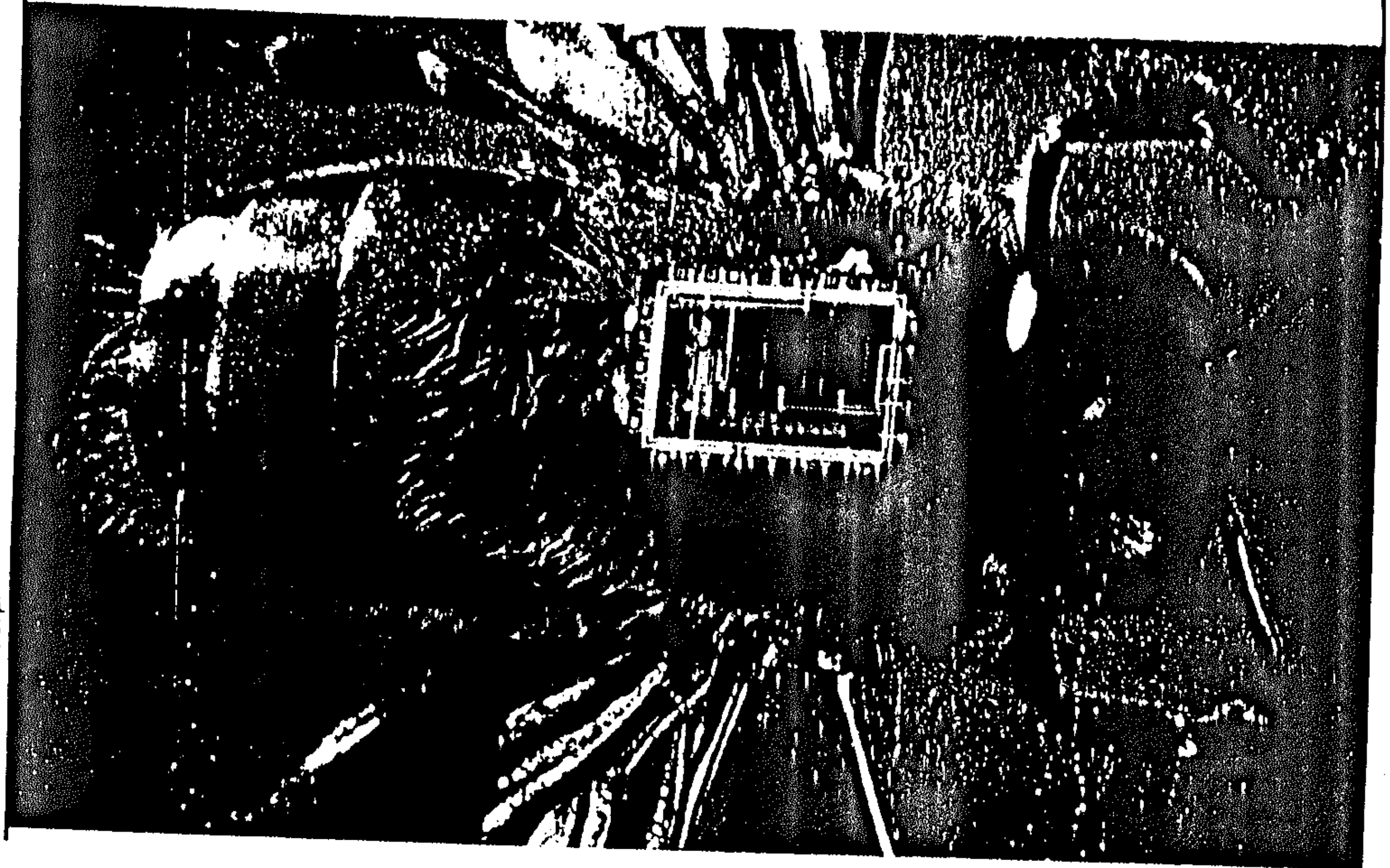


S.S.C. 'TYPICAL' EVENT AS SEEN BY e^+e^- person.

FERMILAB E-691



Bee with a chip on its shoulder



Martin Marietta Corp.

B Physics at the SSC

The SSC is a B Factory.

$\sigma_{B\bar{B}} \sim 1$ mb. $\quad \sigma_{\Upsilon(4S)} \sim 1$ nb $\quad \times 10^6$

1 in every 100 events is a $B\bar{B}$

Luminosity in B region taken as 2.1

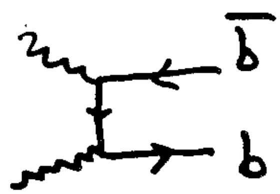
Interaction rate is 10 MHz.

Beam Size $\quad \sigma_{xy} \sim 7\mu$ very small

$\sigma_z \sim 7$cm long

Beam pipe radius ~ 1 cm good.

$\langle p_T \rangle_B \sim 6.5$ GeV/c



$\Rightarrow \langle p_T \rangle$

leptons are soft

b quarks produced predominantly forw

decay products spread this out.

"Should" cover between $\sim 1^\circ \rightarrow 75^\circ$

B PHYSICS IN THE 1990'S

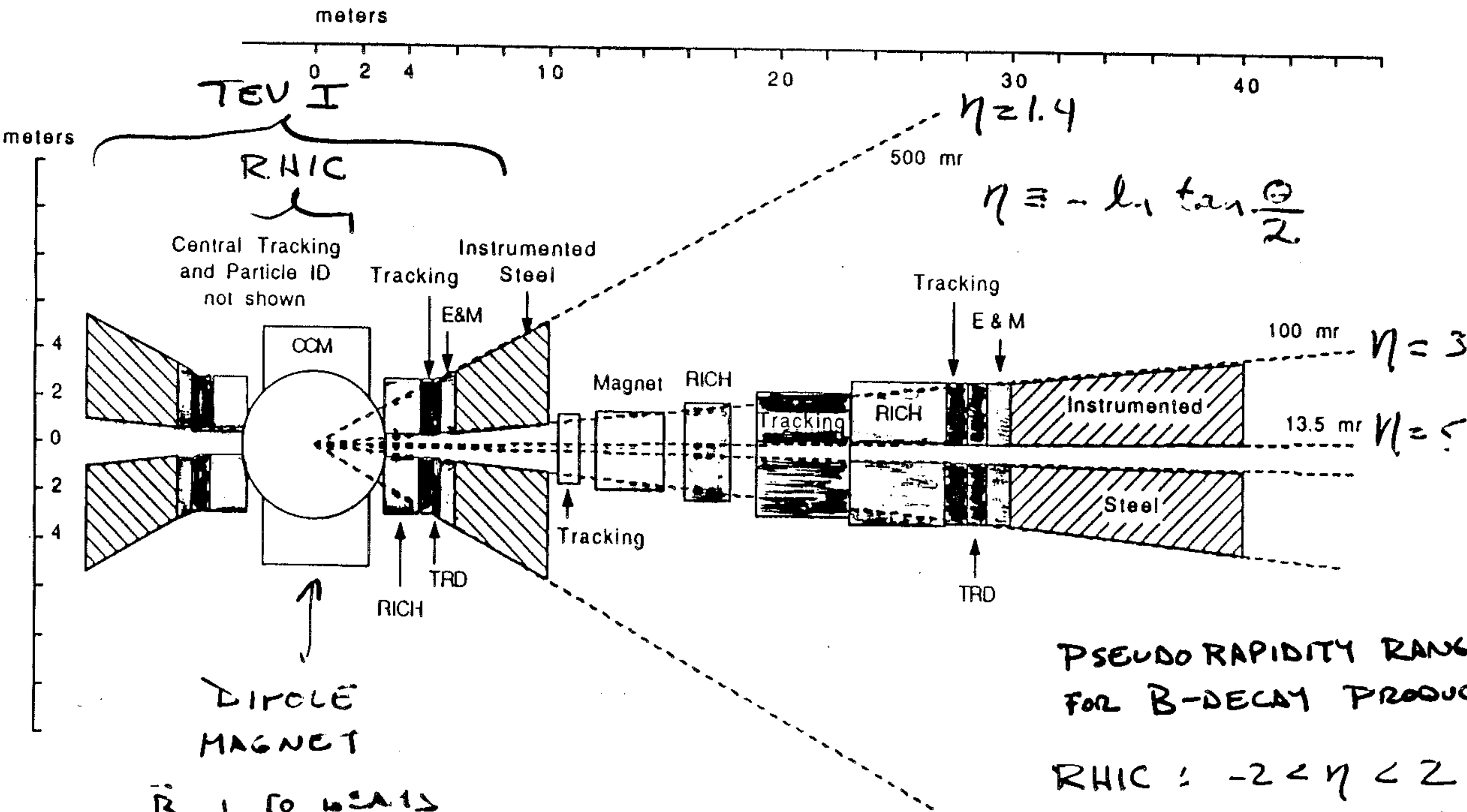
- USE $p\bar{p}$ COLLISIONS TO GET LOTS OF B'S
  $\sim 10^{12}$ $B\bar{B}$ IN 10^7 SEC @ $\mathcal{L} = 10^{32}$ AT SSC
- USE SILICON VERTEX DETECTOR TO ISOLATE B'S FROM REST OF EVENT.
- HIGH-MULTIPLICITY EVENTS ⇒ NUMEROUS DETECTOR ELEMENTS

  100 TRACKS/EVENT
  100 SAMPLES/TRACK } ⇒ 10^4 $\frac{\text{WORDS}}{\text{EVENT}}$ $\sim 10^6$ $\frac{\text{BYTES}}{\text{EVENT}}$

  10^7 DETECTOR ELEMENTS ⇒ 10^{-3} OCCUPANCY
- HIGH-RATE DATA ACQUISITION SYSTEM
  - 10 MHz EVENT RATE AT $\mathcal{L} = 10^{32}$
  - SPARSE READOUT OF THE 10^4 STRUCK ELEMENTS/EVENT

  ⇒ 100 G WORD/SEC RAW DATA RATE!
  - FRONT-END TRIGGERS REDUCE RATE TO 100 KHz
  - 'BARREL SWITCH' BUILDS 10^5 EVENTS/SEC
  - 5000 PROCESSORS, EACH 200 MIP (= 1 TIP)
    REDUCE RATE TO 1 KHz

  ⇒ ARCHIVAL DATA RATE OF 100 MBYTE/SEC
- SAME DETECTOR CONCEPT AT RHIC, TEV I, & SSC



SSC BEAUTY SPECTROMETER
(Snowmass '88; First Draft)

PSEUDORAPIDITY RANGE
FOR B-DECAY PRODUCTS

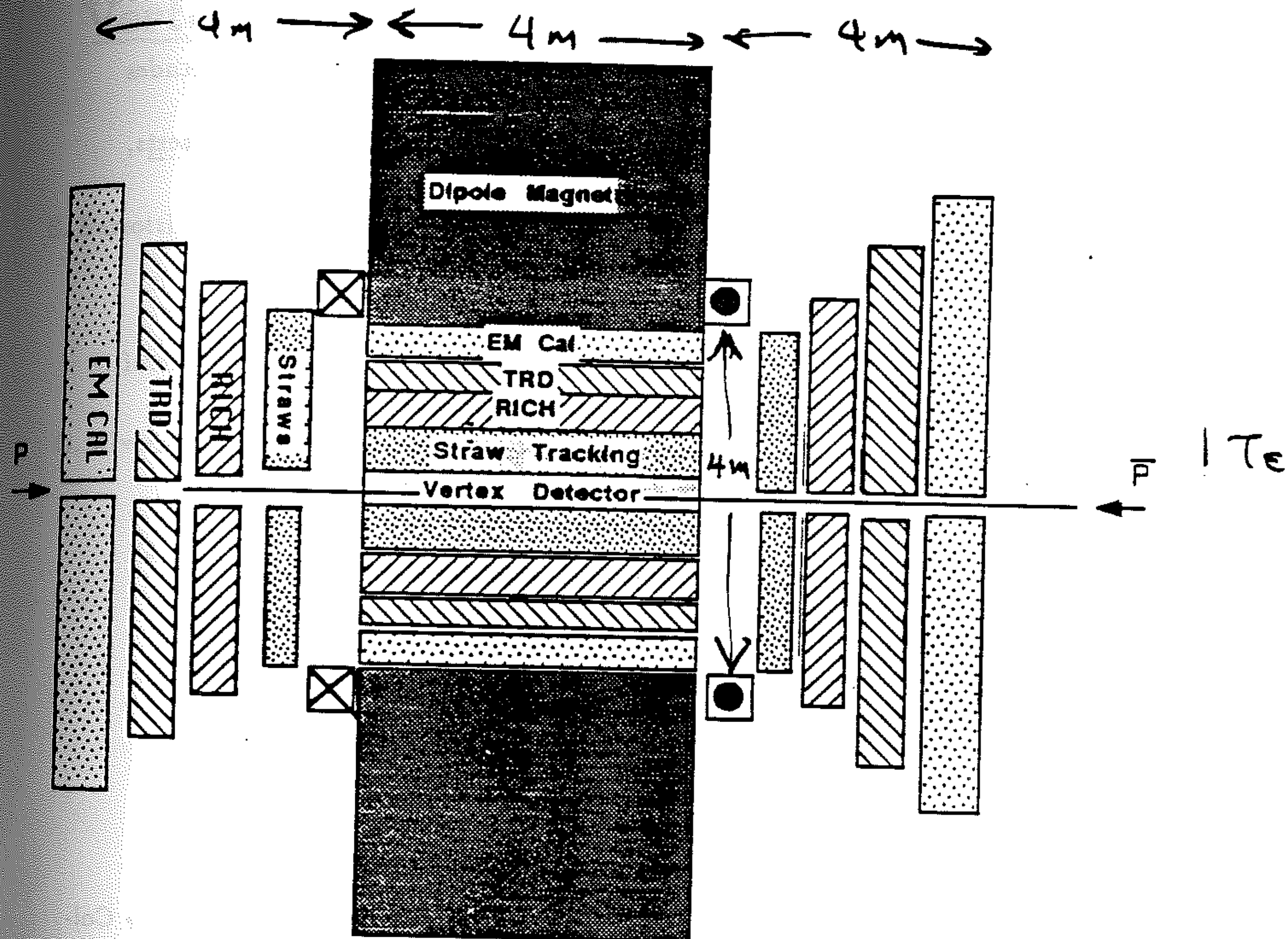
RHIC : $-2 < \eta < 2$

TEV I : $-4 < \eta < 4$

SSC : $-6 < \eta < 6$

SSC: $-6 < \eta < 6$

Bottom Collider Detector



Cyclotron-style magnet; $B = 1\,T$; Gap = 4m

Silicon Vertex Detector: 500K strips; $1.5\,cm < r < 10\,cm$
(Radiation damage? Short interaction region?)

Straw-Tube Tracking: 10^5 tubes; 3 atm; $40\,\mu m$ σ per hit

RICH counter for π-K-p separation; 10^6-10^7 pixels

Transition Radiation Detectors for π-e separation: $\sim 10^6$ towers

Electromagnetic Calorimeter: $\sim 10^4$ towers w/3 longitudinal segs

No hadron calorimeter

Fast analog trigger: $\times 50$ reduction in $2\,\mu s$

Buffering of sparse readout: $\sim 10^4$ 'words'/event

High-level triggers in on-line processor farm: 10^5 VAX 780 equiv.

Letter of Intent for the BCD
A Bottom Collider Detector for the Fermilab Tevatron

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P. Yager, *University of California, Davis*
E. Barsotti, M. Bowden, S. Childress, P. Lebrun, J. Morfin, L.A. Roberts,
R. Stefanski, L. Stutte, C. Swoboda *Fermilab*
P. Avery, J. Yelton, *University of Florida*
K. Lau, *University of Houston*
R. Burnstein, H. Rubin, *Illinois Institute of Technology*
E. McCliment, Y. Onel, *University of Iowa*
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(October 7, 1988)

Abstract

A dedicated B physics experiment is proposed for the Fermilab Tevatron p-$\bar{p}$ Collider. The goal is to study the full range of physics associated with 10^{10} produced $B\bar{B}$ pairs per year. This corresponds to a run of 10^7 sec at an average luminosity of 10^{31} cm^{-2}sec^{-1}, with a $\sigma_{B\bar{B}} \sim 45$ μbarns and a ratio of 1 $B\bar{B}$ pair/1000 inelastic events. Since B decay products have typical P_T's of only a few GeV/c, this physics is not accessible to a conventional p-$\bar{p}$ detector. The proposed B detector employs a cyclotron-style dipole magnet and emphasizes charged-particle tracking, vertexing, particle identification, mass resolution, and a flexible trigger system. There is no hadron calorimetry or muon system. The detector design envisions upgrades for higher luminosities and is compatible with a p-p collider at Fermilab. We anticipate first data collection in 1994. This detector is very similar to the central part of the SSC B spectrometer presented at Snowmass '88.

Proposal for Research & Development: Vertexing, Tracking, and Data Acquisition for the Bottom Collider Detector

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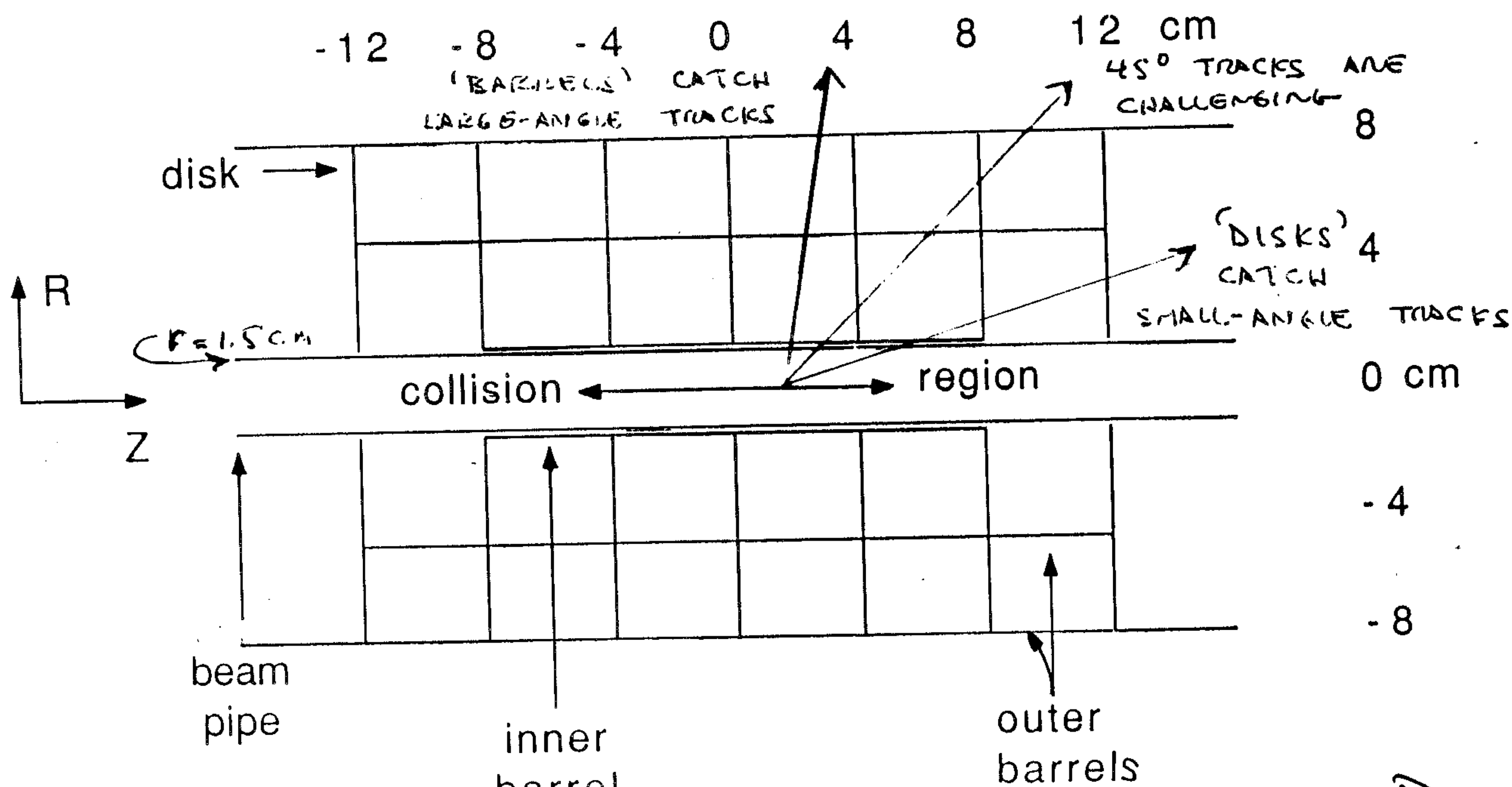
(January 2, 1989) Approved Jan. 27, 1989 Phase I, II.

Abstract

We propose a program of research and development into the detector systems needed for a *B*-physics experiment at the Fermilab p-$\bar{p}$ Collider. The initial emphasis is on the critical issues of vertexing, tracking, and data acquisition in the high-multiplicity, high-rate collider environment. R&D for the particle-identification systems (RICH counters, TRD's, and EM calorimeter) will be covered in a subsequent proposal. To help focus our efforts in a timely manner, we propose the first phase of the R&D should culminate in a system test at the C0 collider intersect during the 1990-1991 run: a small fraction of the eventual vertex detector would be used to demonstrate that secondary-decay vertices can be found at a hadron collider. The proposed budget for the R&D program is $800k in 1989, $1.5M in 1990, and $1.6M in 1991.

McDonald
Kalbfleisch

B Vertex Detector
Central Region

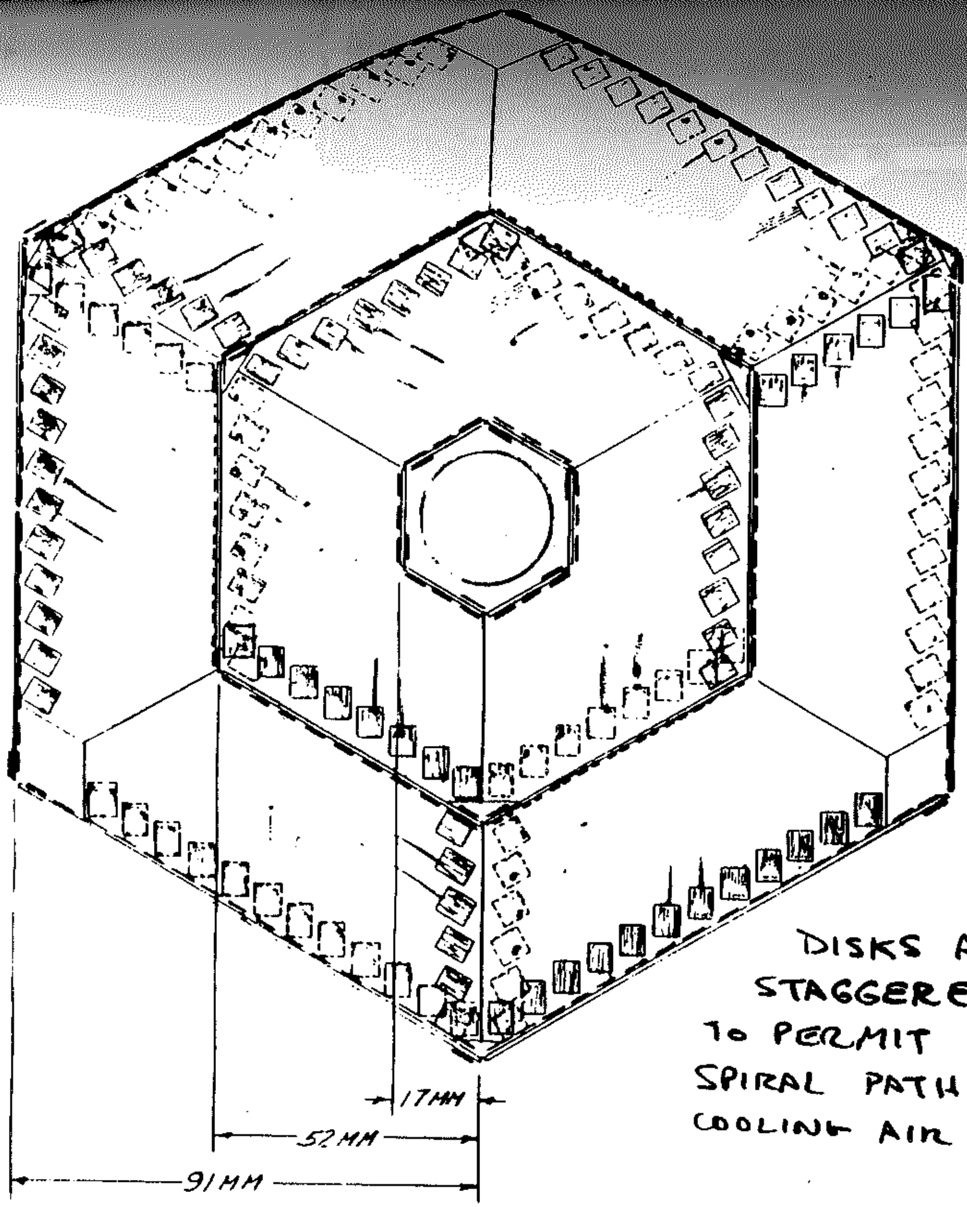


THE MICRO VERTEX DETECTOR IS PRIMARY TOOL FOR EXTRACTING THE B SIGNAL IN A CROWDED ENVIRONMENT.

B-DECAY VERTEX ~ 360 μm FROM PRIMARY VERTEX

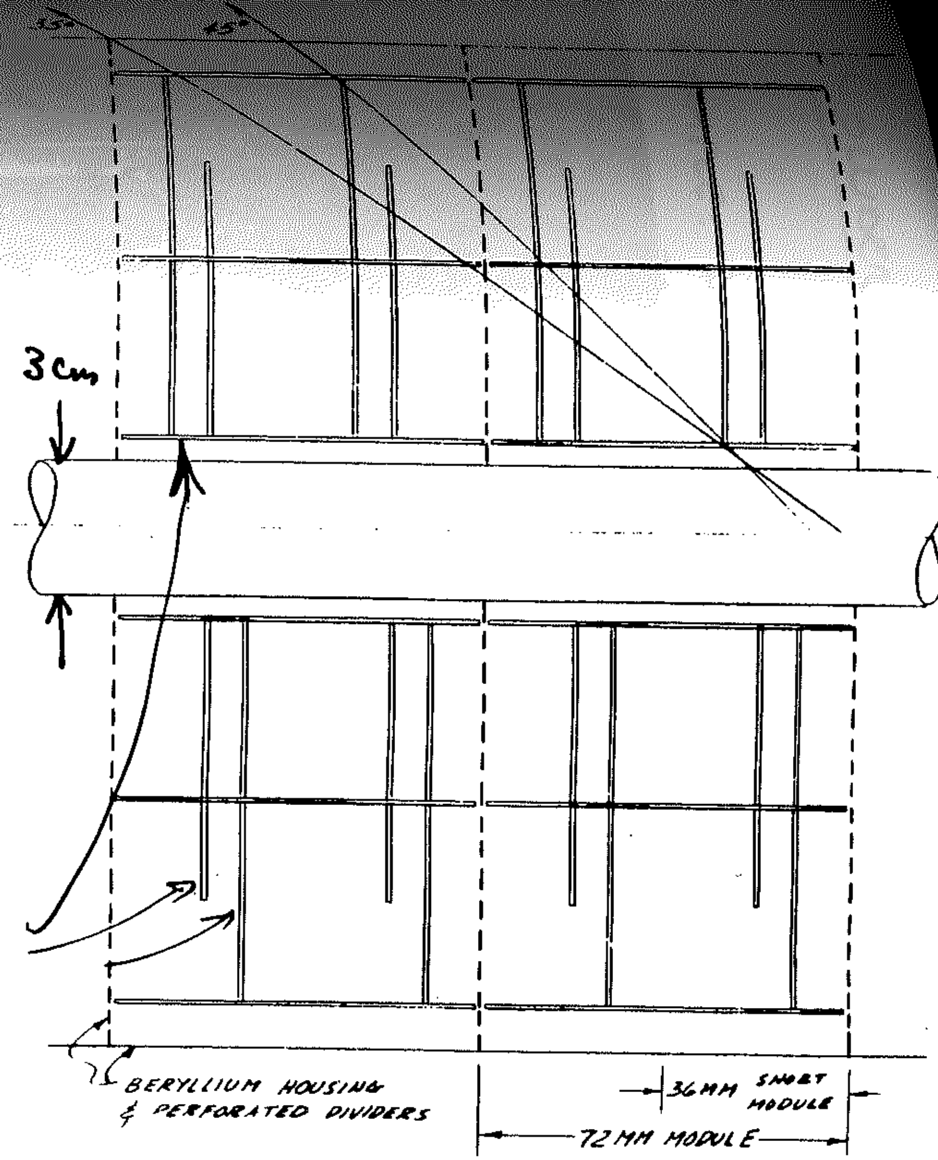
IN A CROWDED ENVIRONMENT. ~ 360 μm FROM PRIMARY VERTEX

$\tau_B = 1.2$ psec ⟹ B-DECAY VERTEX



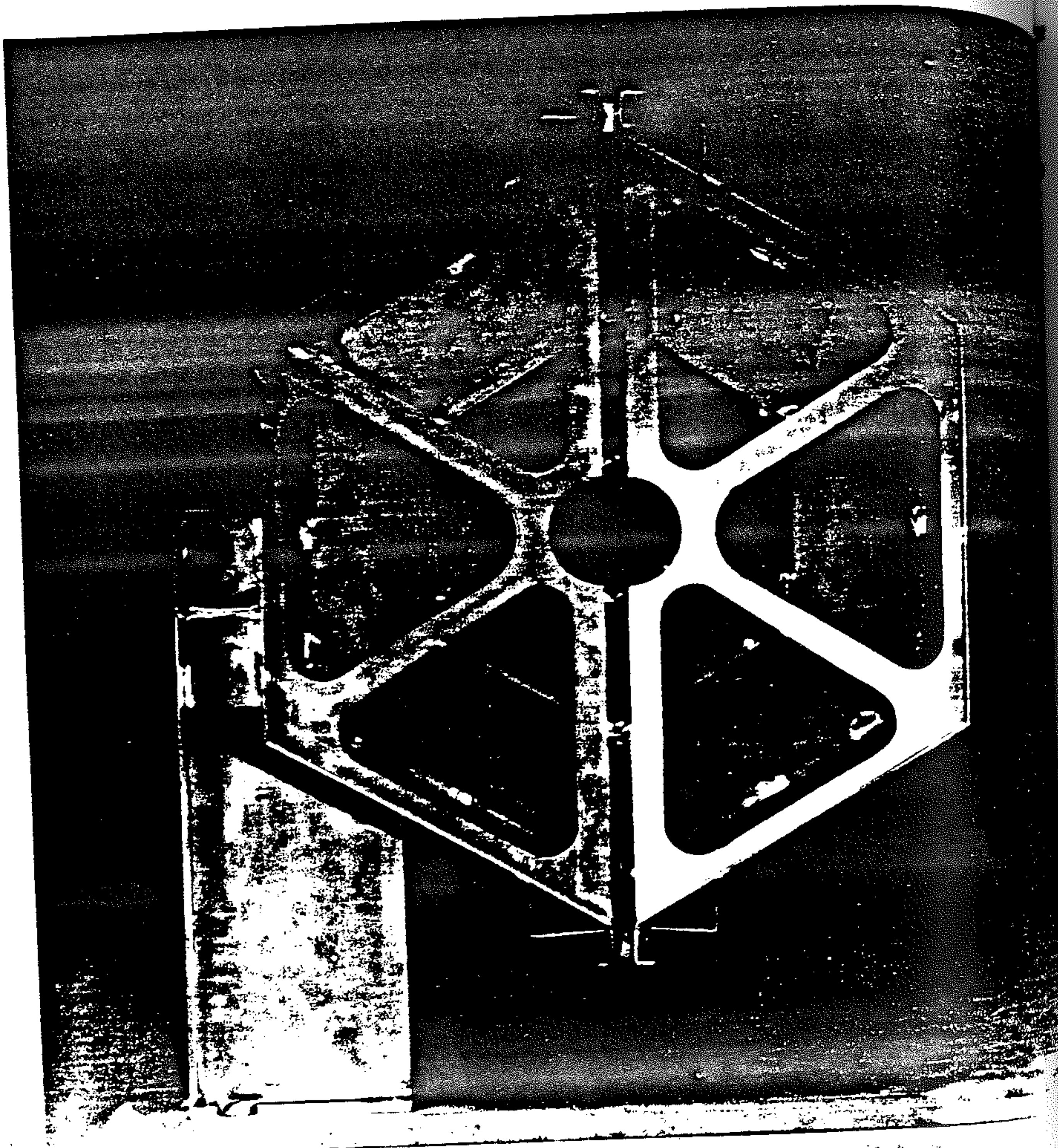
DISKS ARE STAGGERED TO PERMIT A SPIRAL PATH FOR COOLING AIR

TYPE "B"



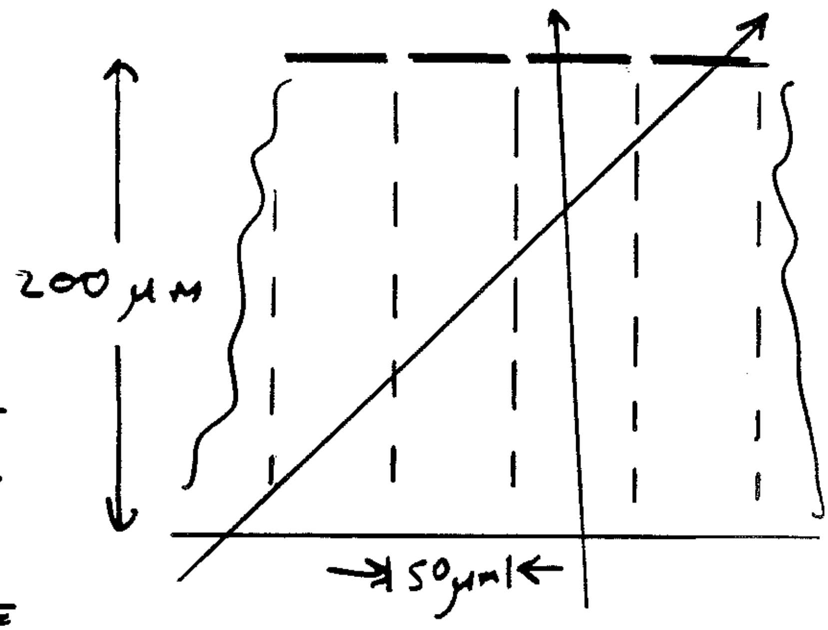
TYPE "B"

HANS JOSTLEIN
CARL LINDENMEYER - FNAL



COLLIDER CHALLENGE: 45° TRACKS

EXAMPLE: DETECTOR IS 200 μm THICK



STRIP WIDTH = 50 μm

⇒ PATH LENGTH IN STRIP
IS 200 μm FOR 0° TRACK
71 μm FOR 45° TRACK

SIGNAL IS 80 ELECTRON-HOLE PAIRS PER μm OF PATH LENGTH

⇒ 16,000 e's FOR 0° TRACK
5600 e's FOR 45° TRACK

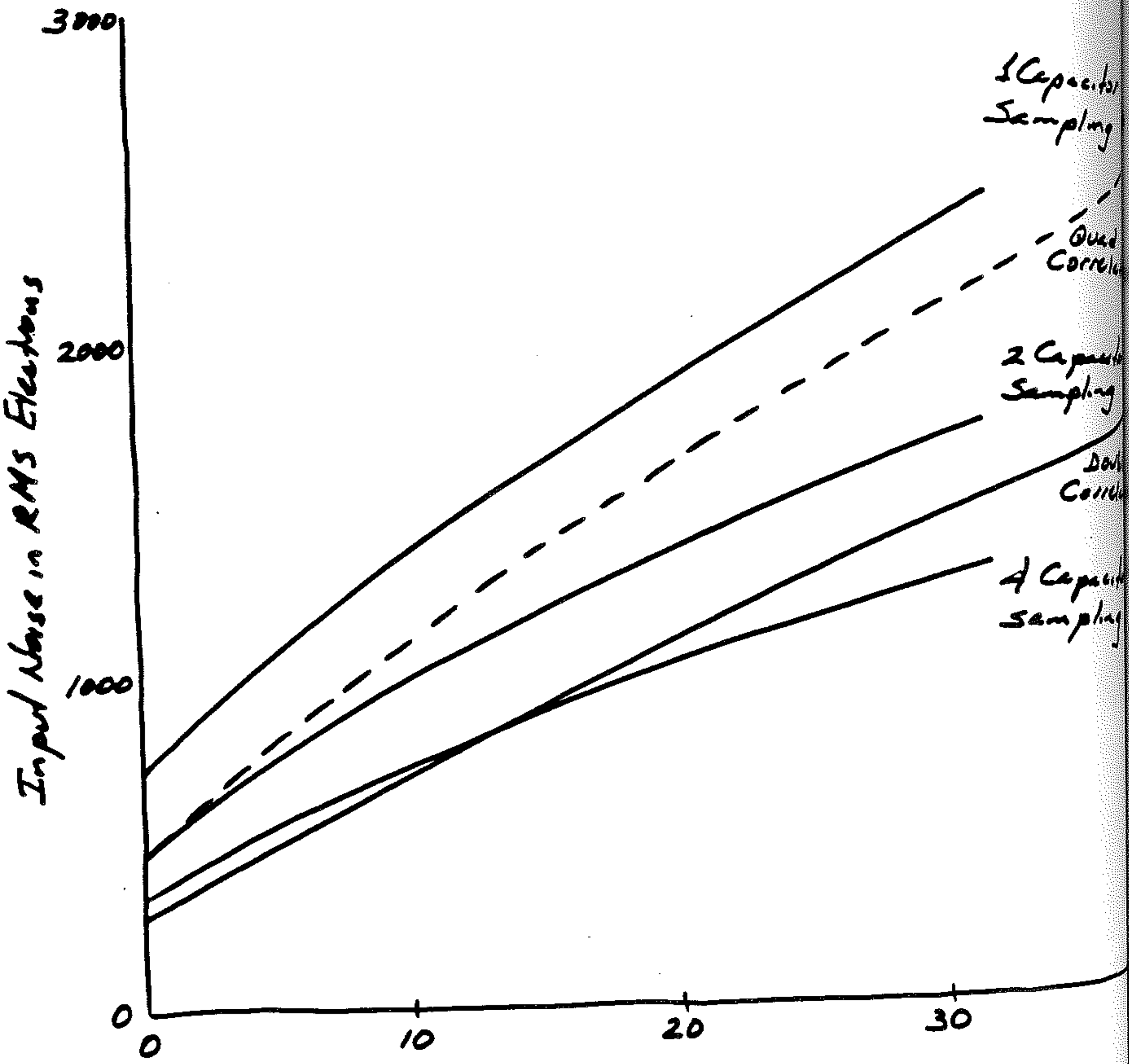
RULE OF THUMB: NEED SIGNAL/NOISE OF >10:1 FOR GOOD PERFORMANCE

⇒ OK WITH 1600 e's NOISE AT 0° TRACKS
BUT NEED ONLY <u>600 e's</u> NOISE FOR 45° TRACKS

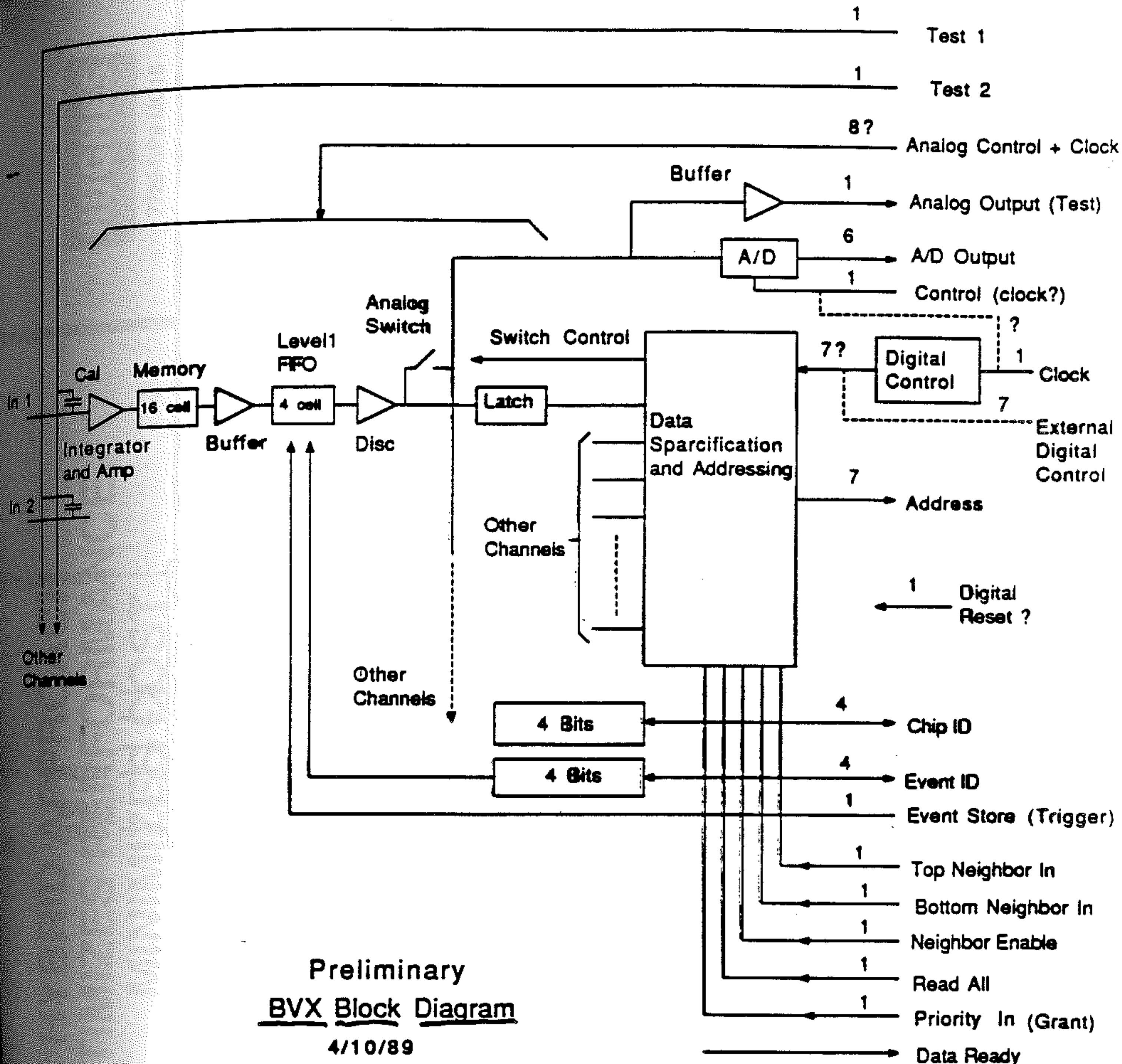
⇒ VLSI CIRCUIT DEVELOPMENT
- SHAPING TIME ~150 NS (400 NS CROSSING TIME AT TEV I)
- 600 e's NOISE UNDER CAPACITIVE LOAD OF μSTRIP
- MULTIPLEXING, SPARSE READOUT, BUFFERING
- SPEC.S SLIGHTLY BETTER THAN PRESENT BEST CHIPS

SVXD Input Noise

CAMEX 64 Input Noise



4/27/89
RJY



Preliminary

BVX Block Diagram

4/10/89

RAY YAREMA ----
FNAL

This diagram contains logic flaws. It does not try to show the final communication bus.

Problem: Must use top and bottom neighbor information to determine which channels are to be read for any given event. Must determine hit channels at time of data transfer to FIFO because chip event information is not read out sequentially. Sparcify before FIFO? Tricky.

DRAFT BVX - DCC INTERCONNECTIONS

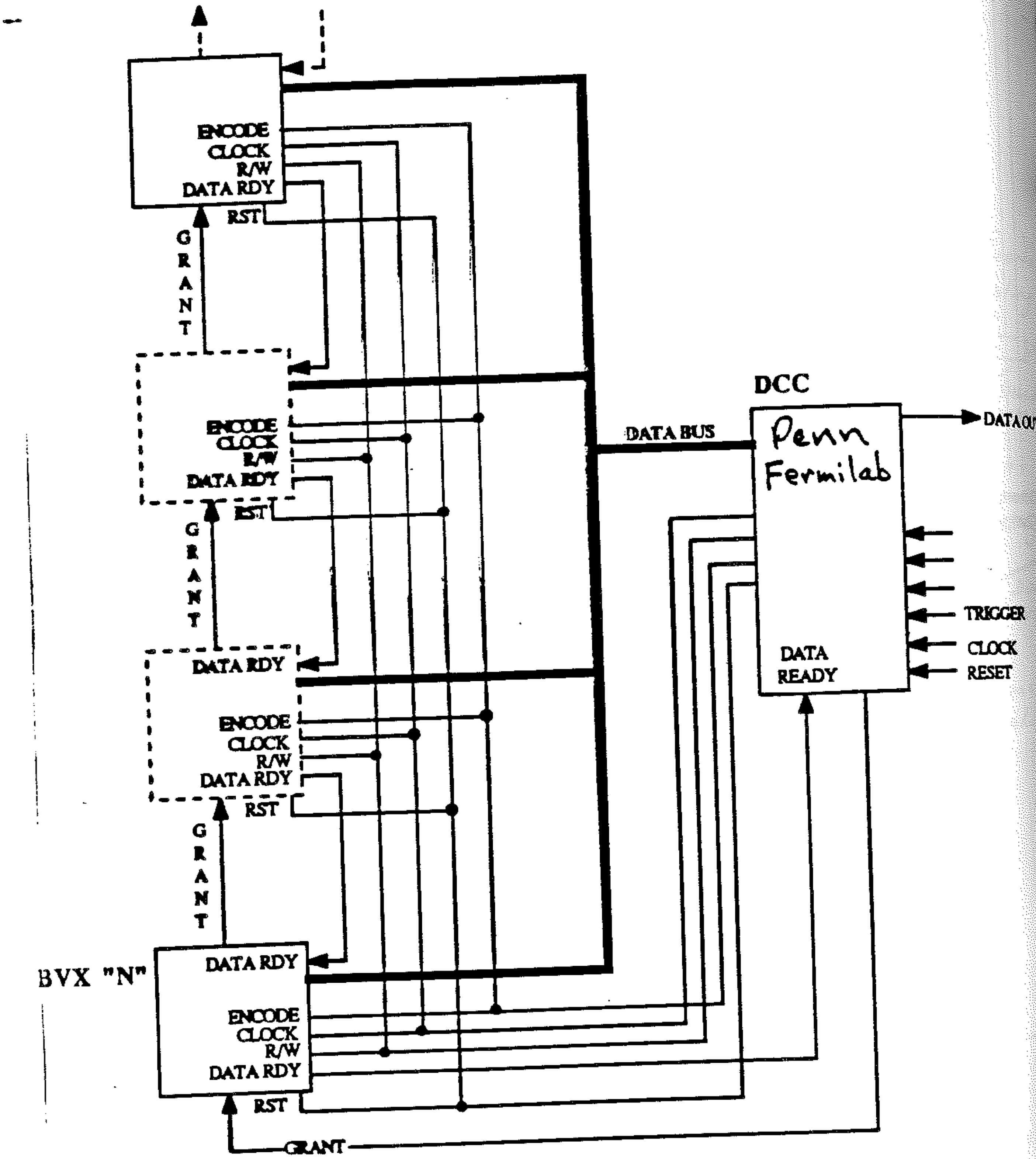
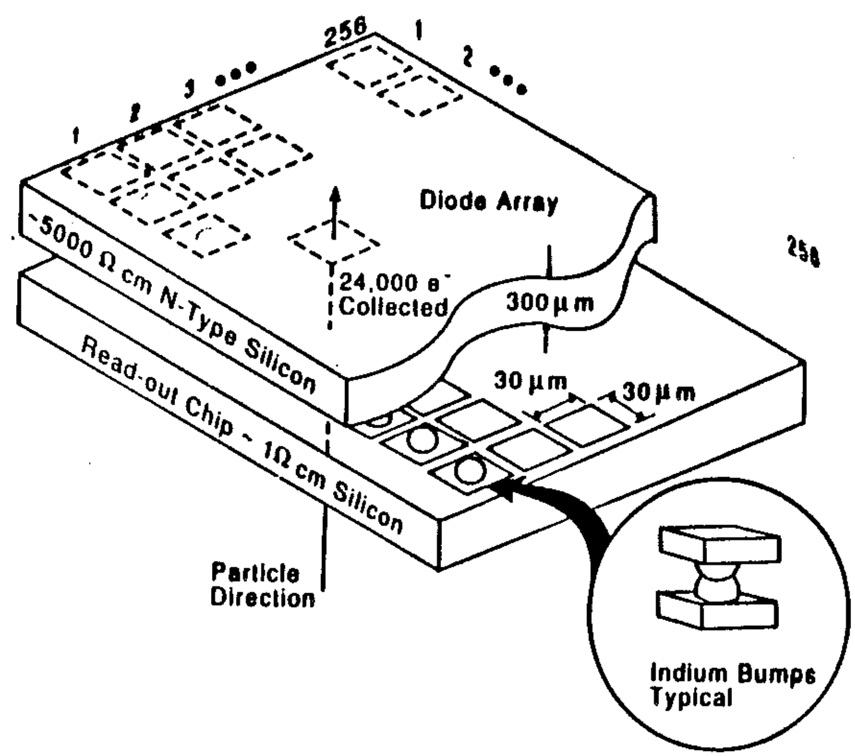


Figure 2; BVX - DCC Interconnections

HYBRID APPROACH OPTIMIZES PERFORMANCE, MINIMIZES COST

HUGHES

7729-SP9 MC18



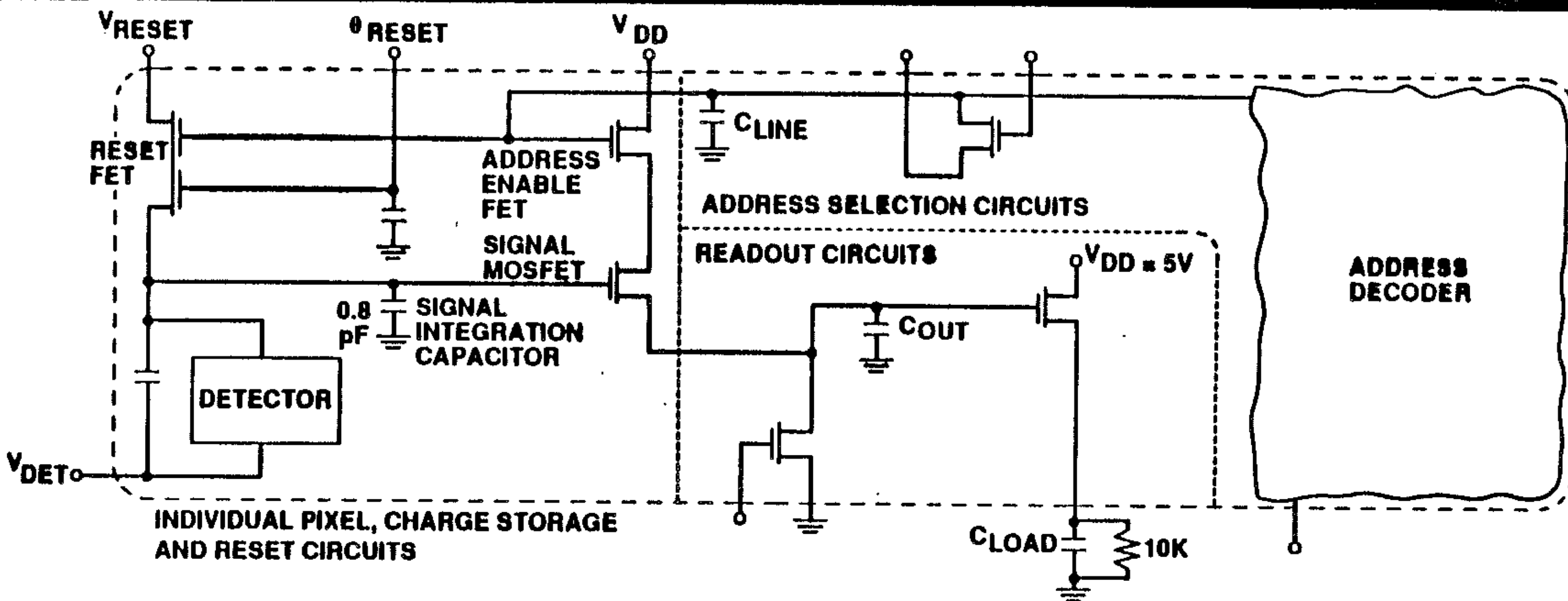
- EACH ELEMENT OF THE HYBRID CAN BE SEPARATELY OPTIMIZED
- CHANGES IN ONE OR THE OTHER ELEMENT e.g. DETECTOR OR READOUT CHIP CAN BE ACCOMODATED QUICKLY AT LOWER RISK AND COST
- YIELD LOSSES IN DETECTOR AND READOUT PROCESSING NOT COMPOUNDED

ERIC ARENS, GARRET JERNIGAN : SPACE SCIENCES LAB, UCB
STEVE SHAPIRO : SLAC

HYBRID ARRAYS PROVIDE OPTIMAL PERFORMANCE IN A VARIETY OF CONFIGURATIONS

HUGHES

7730-SP9 MC18



SUMMARY OF DEVICE PARAMETERS

ARRAY DIMENSION	10 X 64	256 x 256
PIXEL SIZE	120 MICRONS	30 MICRONS
DETECTOR MATERIAL	GERMANIUM, SILICON	SILICON
NUMBER OF READOUT CHANNELS	10	2
POWER DURING "WRITE" CYCLE	0 mW	0 mW
POWER DURING READ CYCLE	10 mW	2 mW
PERESENT CLOCK SPEED	1 MHz	2 MHz
THEORETICAL CLOCK SPEED	10 MHz	10 MHz
RADIATION HARDNESS	1 MRad	?
NOISE AT ROOM TEMP	<300 ELECTRONS	<300 ELECTRONS

TRACKING SYSTEM FOR BCD

GOALS:

- MOMENTUM MEASUREMENT FOR $1 < P \lesssim 100$ GeV/c
  - $\Rightarrow \ell \gtrsim 1$ m IN 1 T FIELD
- MASS RESOLUTION OF 20 MeV AT B MASS.
- TRACK PATTERN RECOGNITION $\Rightarrow \gtrsim 64$ SAMPLES
- FAST P_T TRIGGER
- SCINTILLATING FIBER TRIGGER (NORTHEASTERN)

WHY NOT SILICON TRACKING?

- $$!
- MULTIPLE SCATTERING ($\sim 2 \times 10^{-3} X_0$ IN 200 μm)

$\Rightarrow$ SILICON VERTEX DETECTOR WITH ONLY 3-5 HITS PER TRACK

STRAW-TUBE TRACKING SYSTEM

$\sim$ 250,000 TUBES, MAINLY ALONG $\vec{B}$ (VERTICAL)

$\sim$ 4 mm DIAM.; $\leq$ 2 M LONG

- 1 MIL WALLS $\Rightarrow 2 \times 10^{-4} X_0$
- SUPERLAYER MODULES $\sim$ 8 LAYERS DEEP
- 1 ATMOS. DME $\Rightarrow \sim 40 \mu$m RESOLUTION
- CUSTOM IC'S: { BIPOLAR AMPLI/SHAPER/DISCRI; CMOS TIME TO DIGITAL }
- TUBE WALLS SUPPORT WIRE TENSION
  - $\Rightarrow$ NO MASSIVE END PLATES
- ISOLATION OF BROKEN WIRES

STRAW - TUBE TRACKING SYSTEM

2.5x10^5 TUBES

75-100 SAMPLES PER TRACK

TUBES SUPPORT WIRE TENSION WITHOUT END... (Ceramic)

3MM DIAM. - exist

30-μm WALL THICK... exist

3 ATMOS. PRESSURE

⇒ 40μm σ PER HIT

Small detectors have been made at Princeton.

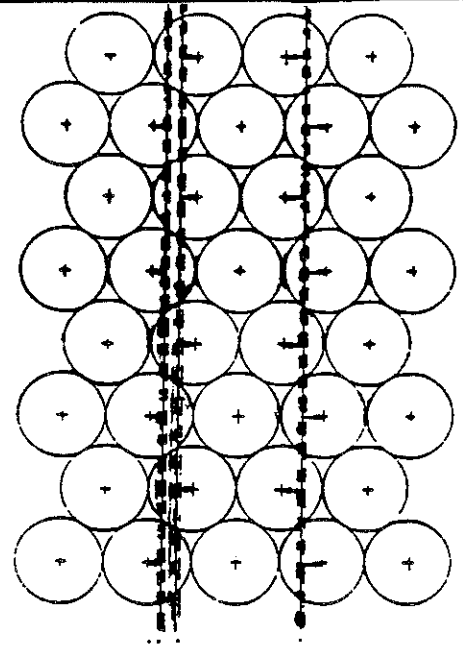


Figure 15: A "superlayer" of 8 rows of straw tubes.

- pressure test
- mass production

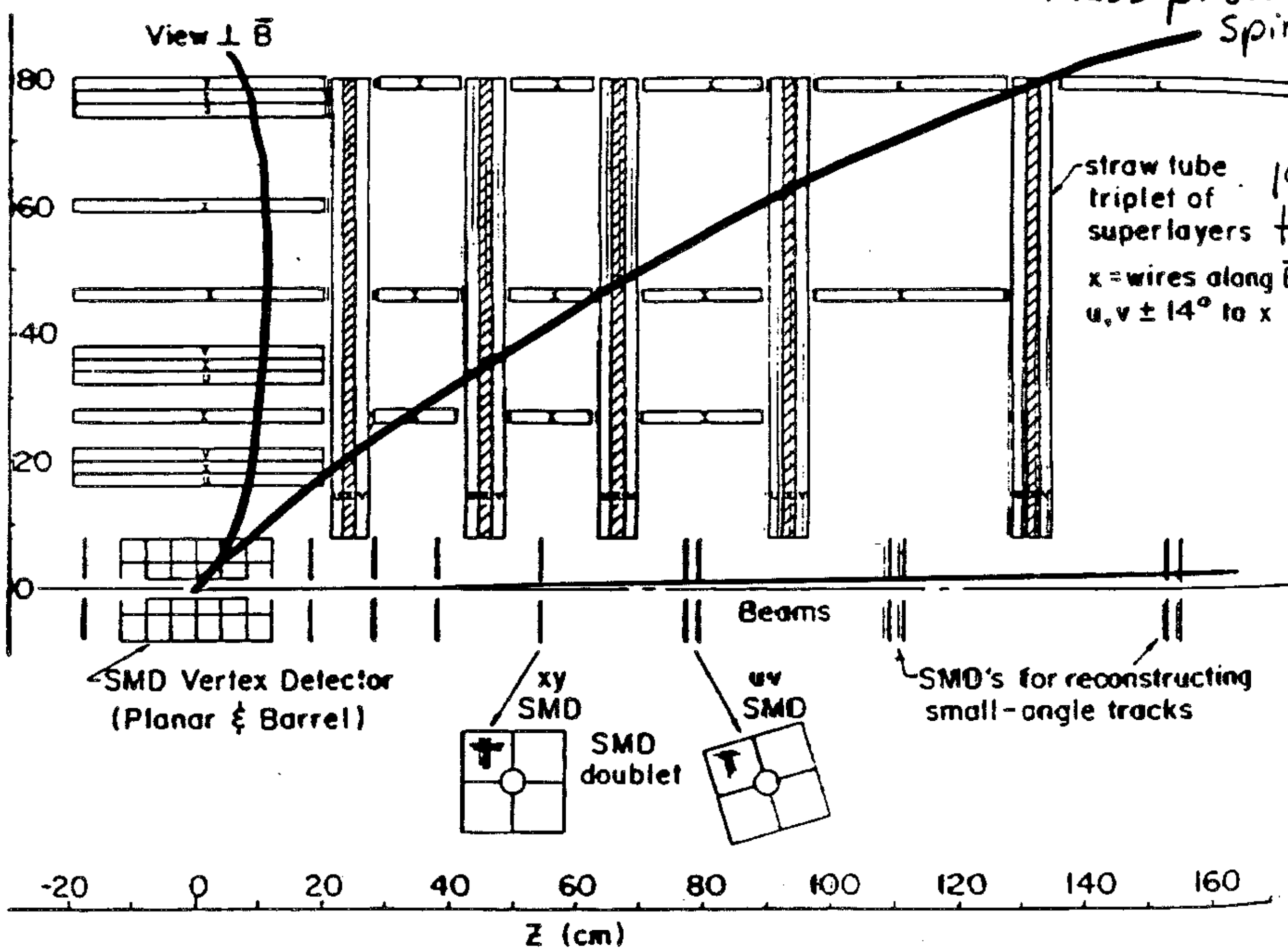


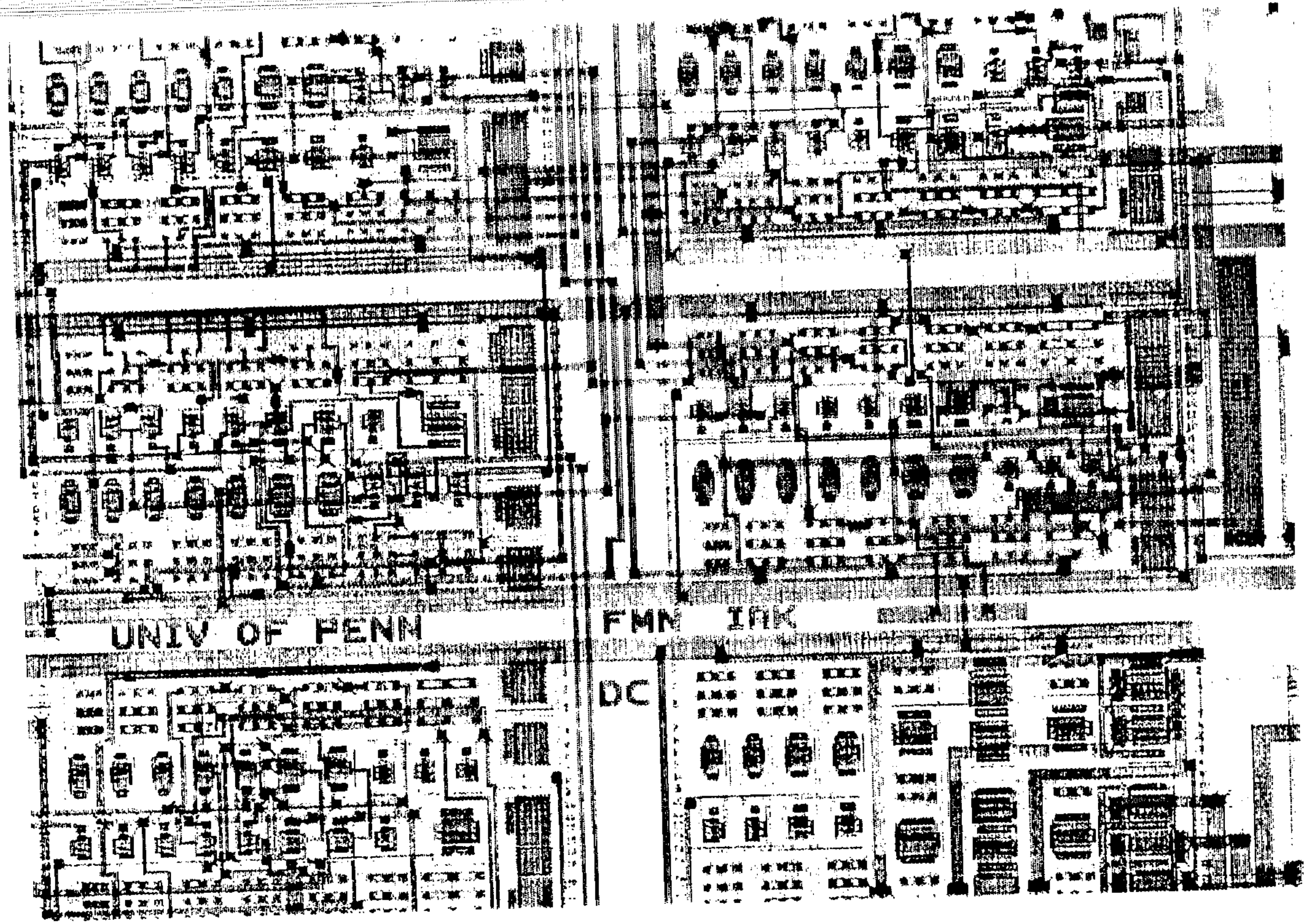
Figure 16: Plan view section through the median plane of one quadrant of the tracking system, showing the location of straw-tube panels and silicon microstrip detectors. The dipole magnetic field and the wires in the x straws are perpendicular to the page.

HARDWARE PROTOTYPES

1. 'KIT' FROM KAGAN (OSU)
2. ~ 1000 TUBES FOR FIXED-TARGET TEST (19
3. $\lesssim$ 10 K TUBES FOR Cϕ COLLIDER TEST (19

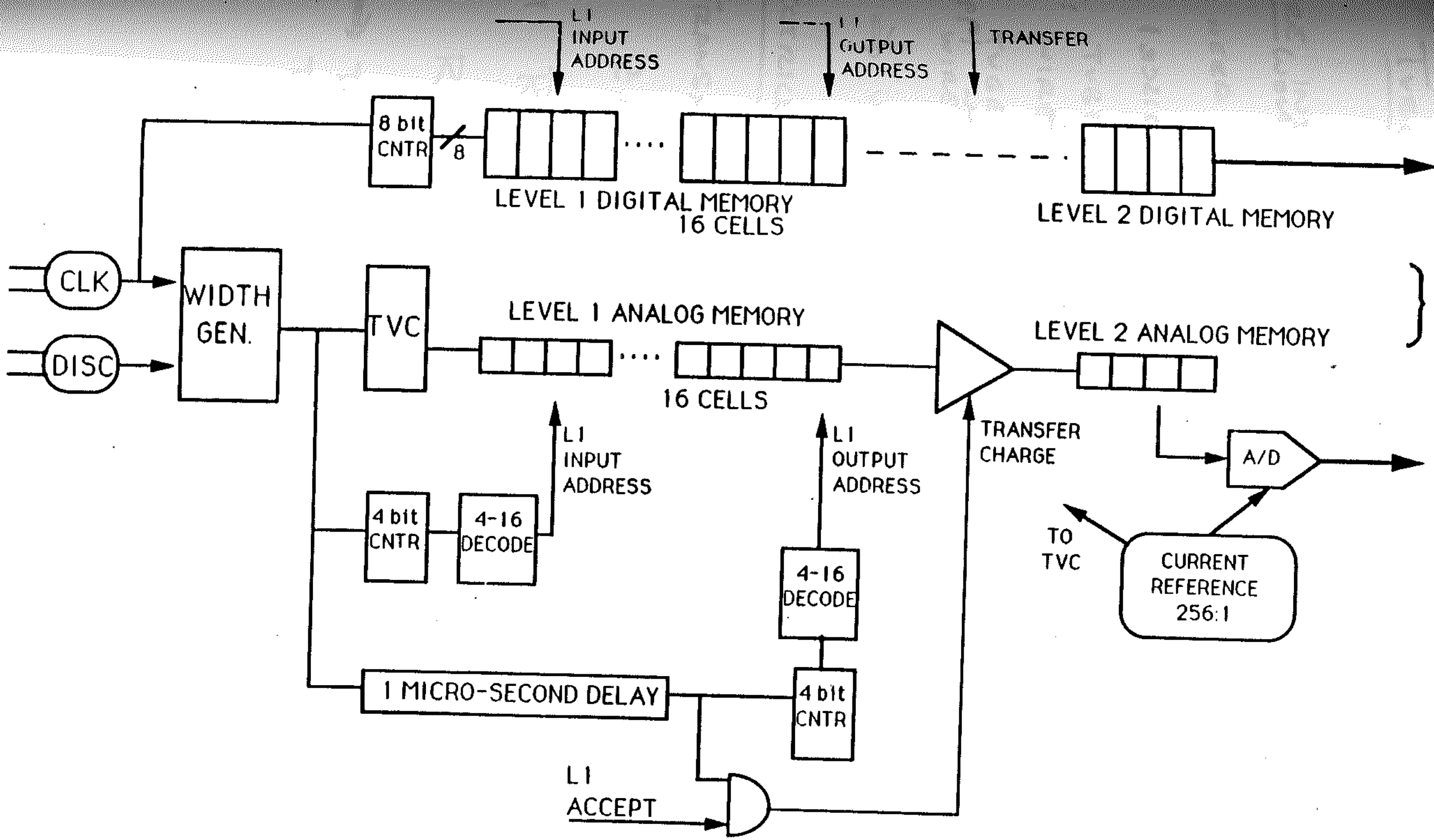
ISSUES

1. ECONOMICAL PRODUCTION OF TUBES
2. END PLUGS
3. GAS DISTRIBUTION (> 1 ATM ?)
4. LOW-MASS END PLATES (ALIGNMENT ONLY)
5. READOUT (PENN)
6. CALIBRATION ; COLLIMATED X-RAY PULSE ...



BIPOLAR FRONT-END PREAMP FOR STRAW-TUBES

(ATT 'QUICK-CHIP')



STRAW-TUBE FRONT-END ELECTRONICS

CMOS DIGITAL SECTION

Penn

READOUT ELECTRONICS

- SAMPLE BIPOLAR AMPLIS AVAILABLE NOW
  (PENN DESIGN ; ATT PROCESS)

- HYBRID PACKAGE OF AMPLI + SHAPER + DISCRI
  FOR SPRING 1990 ; 1K CHANNELS
  ⇒ 2 ATT CUSTOM RUNS ⟷ \$120K

- BIPOLAR + CMOS PACKAGE FOR SPRING 1991
  ⇒ DIGITAL OUT ONLY
  - 10K CHANNELS
  ~ \$200K

TUBE CHARACTERISTICS

WIRE INSTABILITY

NEED $$V\,[kV] \lesssim 20\,\frac{D}{L}\,\ln\left(\frac{D}{d}\right)\sqrt{T\,[gm]}$$

EX: TUBE DIAMETER $D = 4\,mm$
WIRE DIAMETER $d = 20\,\mu m$
TUBE LENGTH $L = 2\,m$
WIRE TENSION $T = 50\,gm$

$\Rightarrow V \lesssim 1.5\,kV$

$\Rightarrow$ USE THICKER WIRE

ELECTRICAL RESISTANCE

TRANSMISSION LINE IMPEDANCE : $Z = 60 \ln \frac{D}{d}\ \Omega$

$Z \sim 320\,\Omega$ FOR ABOVE EXAMPLE

BUT $R_{WIRE} = 200\,\Omega/\text{METER}$ FOR $d = 20\,\mu m$

$R_{CATHODE} \sim 60\,\Omega/\text{METER}$ FOR $1000\,\text{Å}$ ALUMINUM

$\rightarrow$ THICKER WIRE
THICKER AL COATING

GAS GAIN

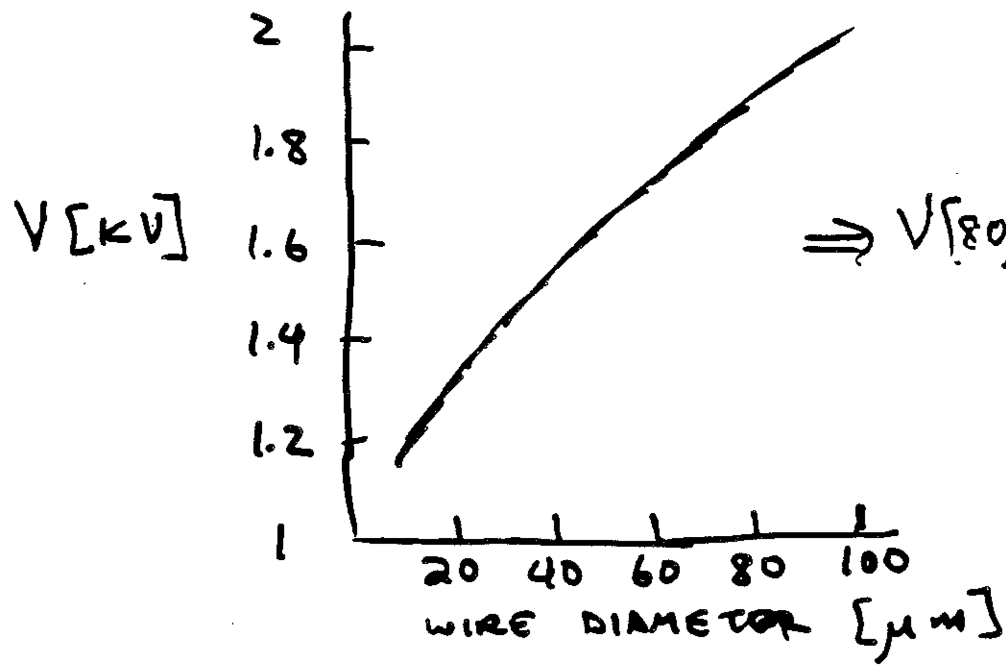
FRONT-END NOISE $\sim 1500\,e$

$\Rightarrow$ GAIN $\lesssim 5 \times 10^4$ OK

GAIN VS. WIRE THICKNESS ?

$$\frac{dN}{dx} = \alpha(E) \qquad \text{(TOWNSEND)}$$

$$\alpha = kE \qquad \text{(DIETHORN)}$$



$\Rightarrow V[80\,\mu m] \sim 1.5$

GAS TYPE

LARGE SYSTEM ⇒ LEAKS ⇒ RUN AT ~1 ATMOS

WANT GOOD RESOLUTION ⇒ DME

- PURITY?
- REACTION WITH CHAMBER MATERIALS
- SLOW DRIFT SPEED

THICKER WIRE ⇒ HIGHER E ⇒ FASTER DRIFT

$$E = \frac{V}{r \ln D/d}$$

~1.5

EX:

$D = 4\,mm$
$d = 20\,\mu m$
$V = 1.35\,kV$

$$\Rightarrow E = \frac{0.25}{r}\left[\frac{kV}{m}\right]$$

$D = 4\,mm$
$d = 80\,\mu m$
$V = 1.9\,kV$

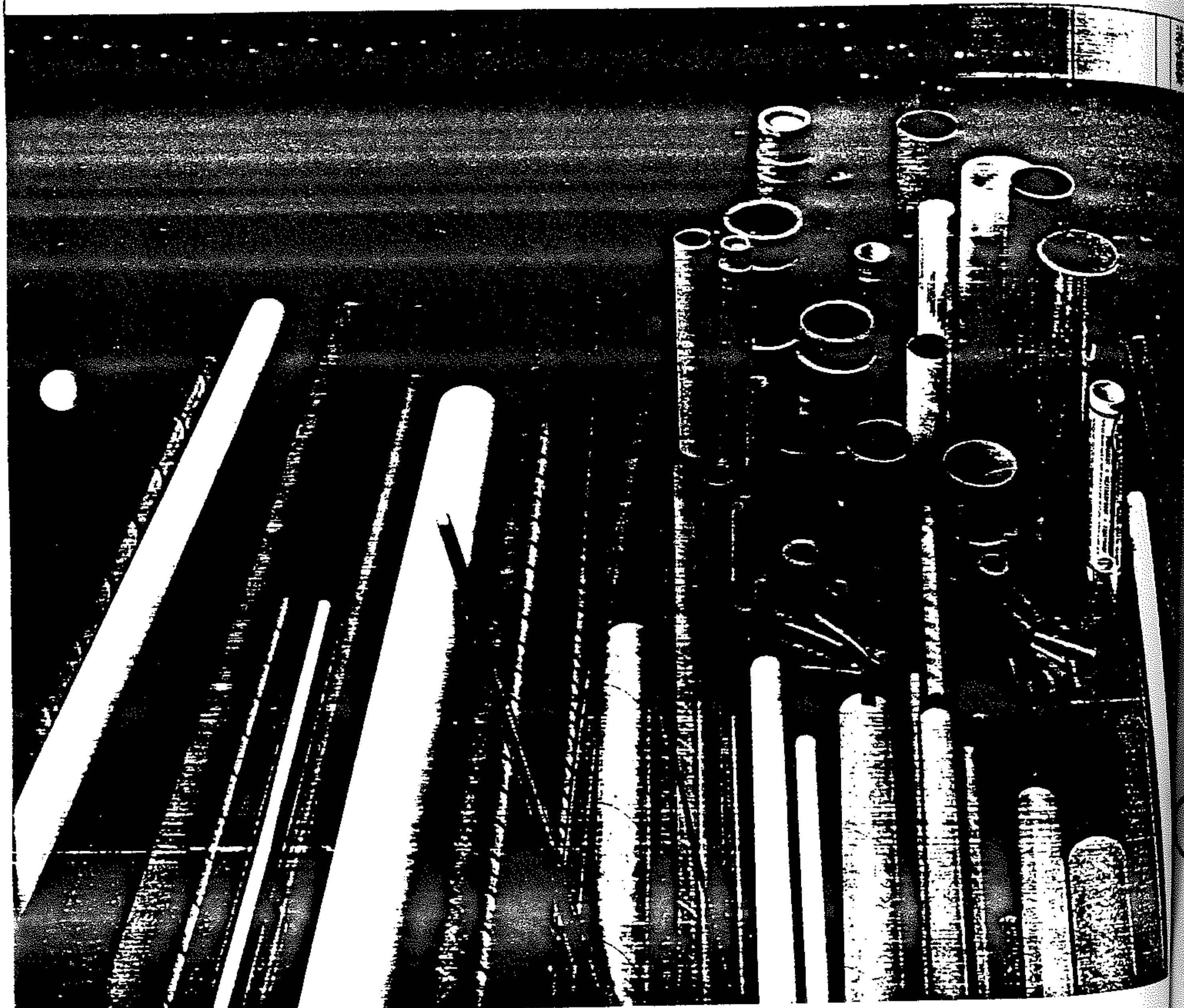
$$\Rightarrow E = \frac{0.50}{r}\left[\frac{kV}{m}\right]$$

Customated Spiral-Wound Products

Stone Industrial/a member of the CLARCOR precision products group

The first spiral-wound product was the drinking straw. It was patented by Marvin Stone in 1888. Thus began what is now the Stone Industrial Division. Today we make thousands of small diameter spiral tubes that serve as packaging protection and/or insulation against electrical, thermal, chemical, physical or atmospheric phenomena. Essentially these tubes are laminations of plastic films, papers and other substrates, with or without resin impregnation . . . alone or in virtually every known combination. To insure meeting your exact need, we "Customate" these products through a full spectrum of services customized to take them from concept to quality volume production as expeditiously as possible.

Stone Industrial
a member of the CLARCOR precision products group
51st Avenue & Cree Lane
College Park, MD 20740
301/474-3100
JOE DeSILVI



electrolock, inc.

Headquarters • P.O. Box 368
16838 Park Circle Drive
Chagrin Falls, OH 44022
(216) 543-6626 • FAX: (216) 543-4399
STEVE CASTLEBERRY

#1 Marcus Drive • Roper Mountain Business Center
Greenville, SC 29615
(803) 297-9830 • FAX: (803) 297-8555

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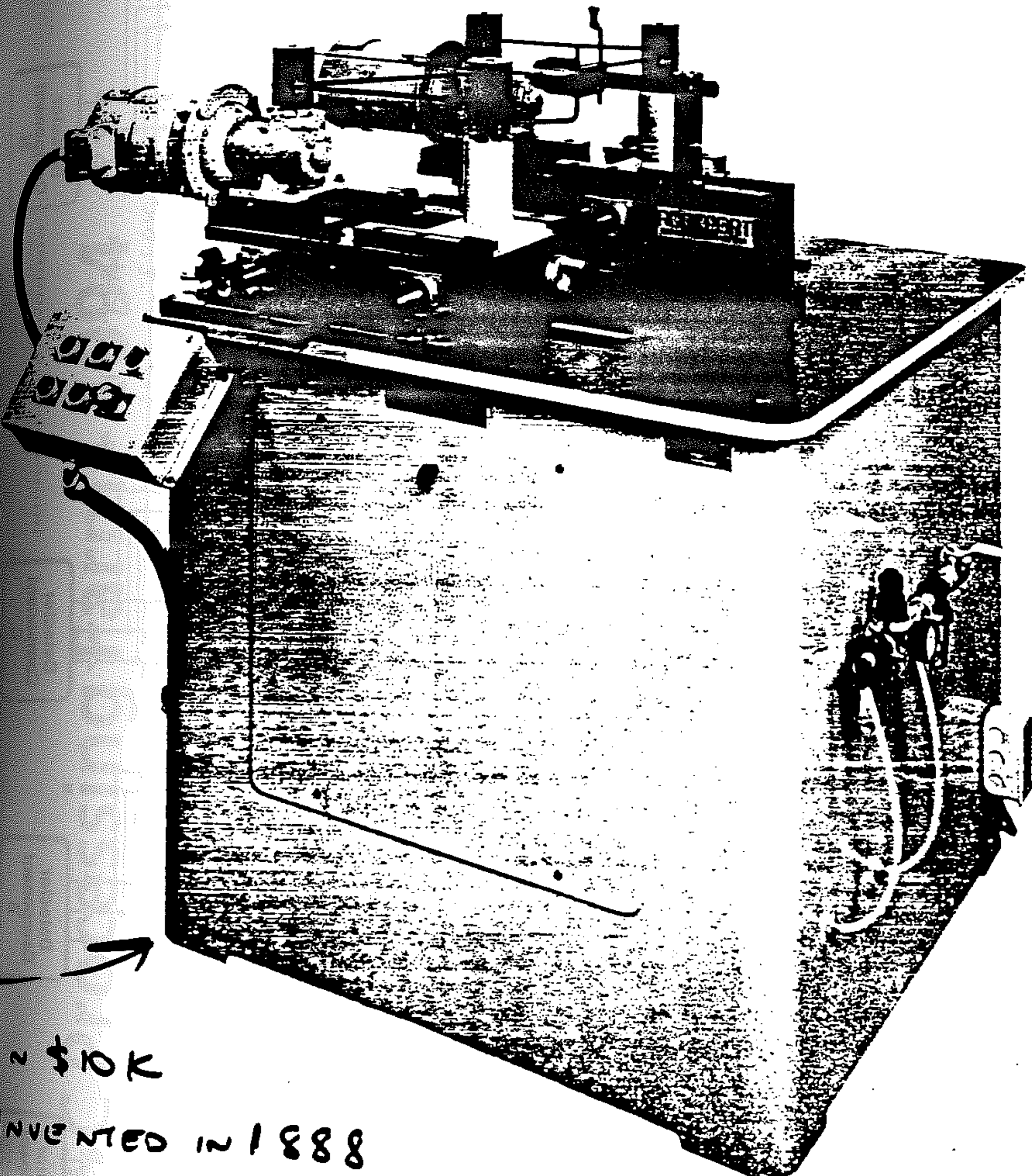
Industrial
of the CLA
venue & C
e Park, MD
74-3100
E DeS

ROCKPORT

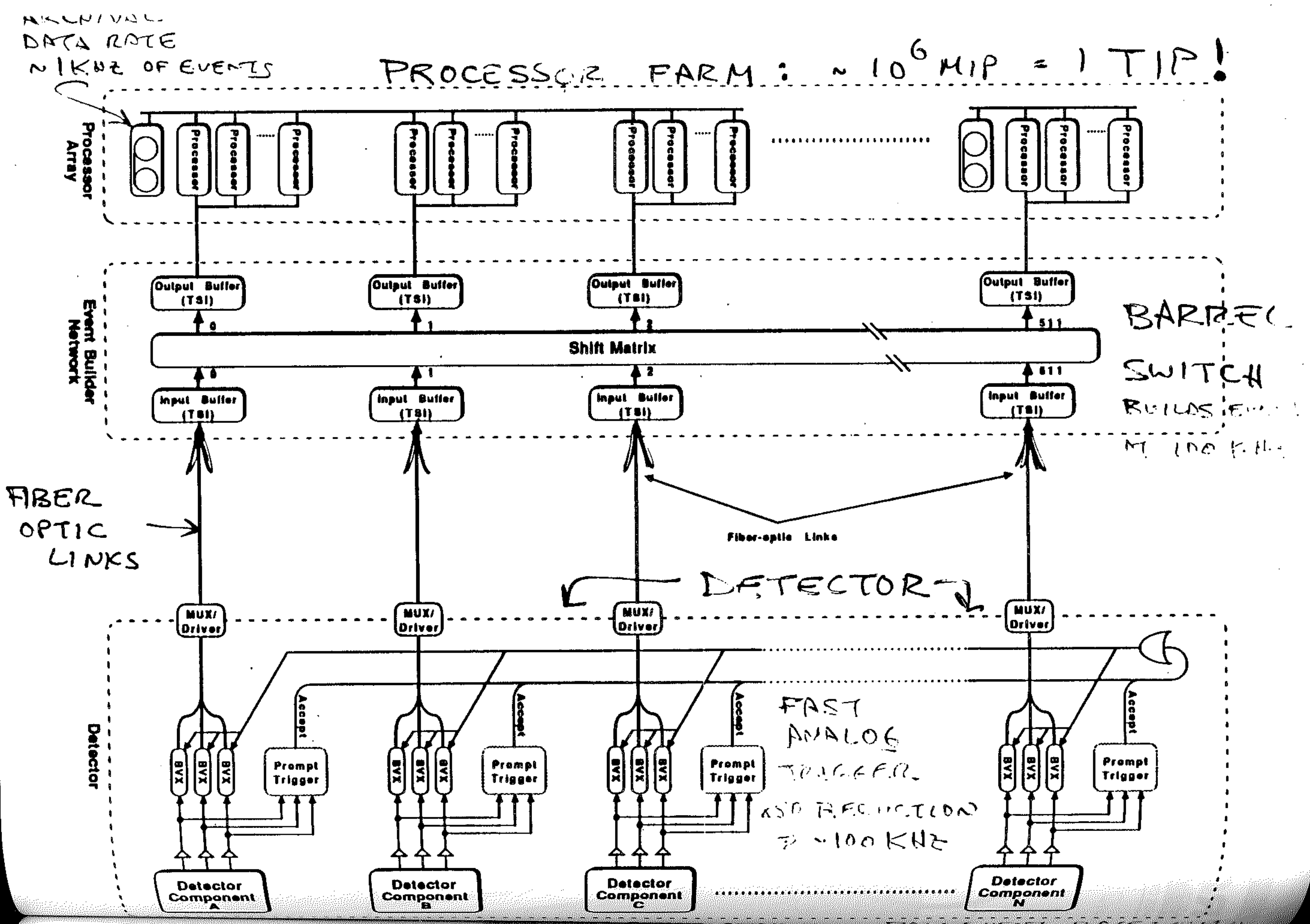
TUBE WINDING SYSTEMS



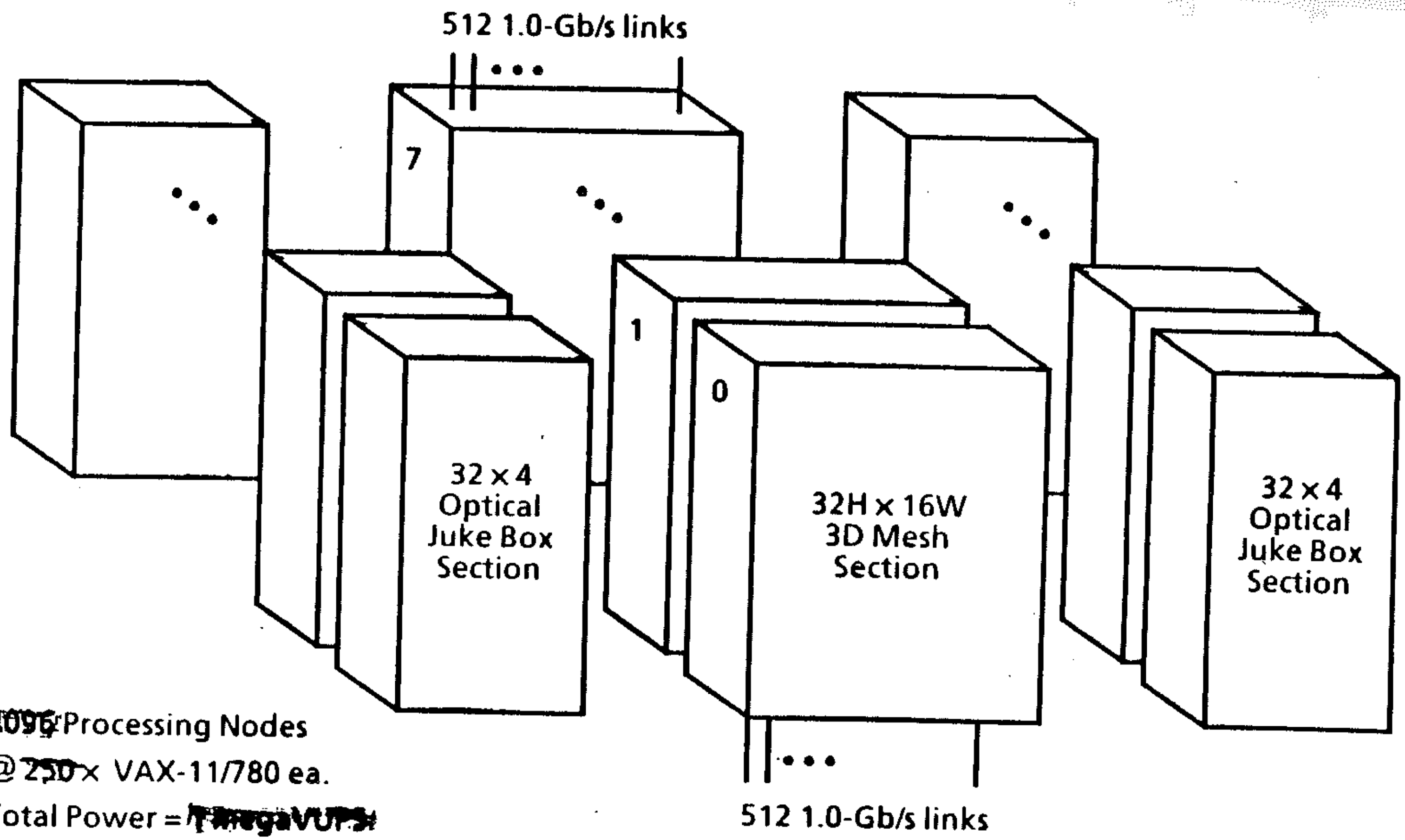
~ $10K
INVENTED IN 1888

ness Center

ROCKPORT MACHINE & TOOL COMPANY
1366 Park Row, Cleveland, Ohio 44107
(216) 221-0169 Telex: 980234LITZCOCLE


ARCHIVAL
DATA RATE
~1KHz OF EVENTS
PROCESSOR FARM: ~10^6 MIP = 1 TIP!
Processor Array
Processor
Processor
Processor
Event Builder Network
Output Buffer (TSI)
Input Buffer (TSI)
Shift Matrix
0
1
2
511
BARREL
SWITCH
FIBER
OPTIC
LINKS
Fiber-optic Links
DETECTOR
MUX/ Driver
Detector
Accept
Prompt Trigger
BVX
FAST
ANALOG
TRIGGER
Detector Component A
Detector Component B
Detector Component C
Detector Component N

SSC Processing Farm - 1994

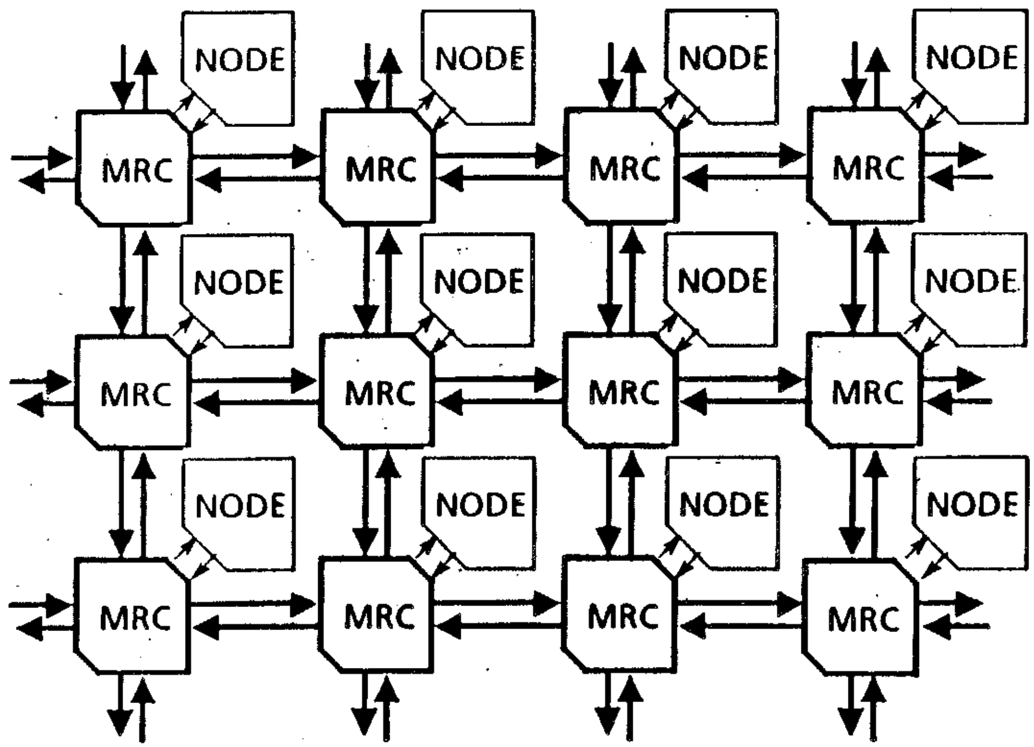


4096 Processing Nodes

@ 250 x VAX-11/780 ea.

Total Power = [redacted]

Touchstone Interconnect



2D (3D) mesh topology

wormhole routed

scalable to 4K (65K) nodes

low latency (40 ns/hop)

high bandwidth (>100 MB/s)

self-timed design

a VLSI mesh router chip (MRC)

FIELD TRIP TO INTEL (PORTLAND, OREGON)

WED, JULY 26

FLY TO PORTLAND @ 8:30AM ON SKYLINK 802

RETURN TO VANCOUVER @ 8:15 PM ON UA 2462/12[illegible]

050589-06

intel Scientific Computers

DARPA Touchstone