High Performance Ge X-Ray Spectrometers from an Engineer's Point of View

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- Instrument Design Goals
  - Solid angle
  - High resolution
  - High count rate
  - Robust
- Solid angle
  - Large area detectors
  - Monolithic array
  - Single Be window
- High resolution
  - Small geometry, low noise J FETs
  - Low detector capacitance
- High count rate
  - Good charge collection
  - High bandwidth preamplifier
  - Low dead time pulse processing electronics

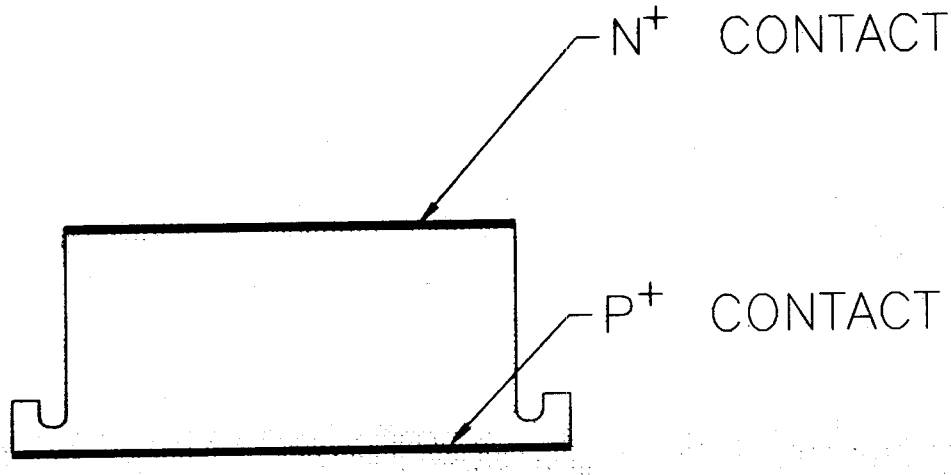
- Robust
  - Insensitive to mechanical shock
  - Insensitive to RF ambient
  - High stability pulse processing electronics
  - Easy to operate

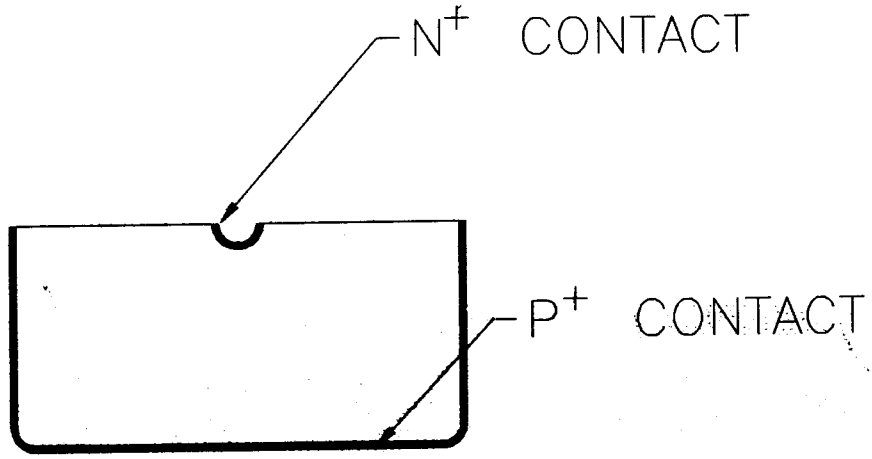
- Detector Electrode Structures

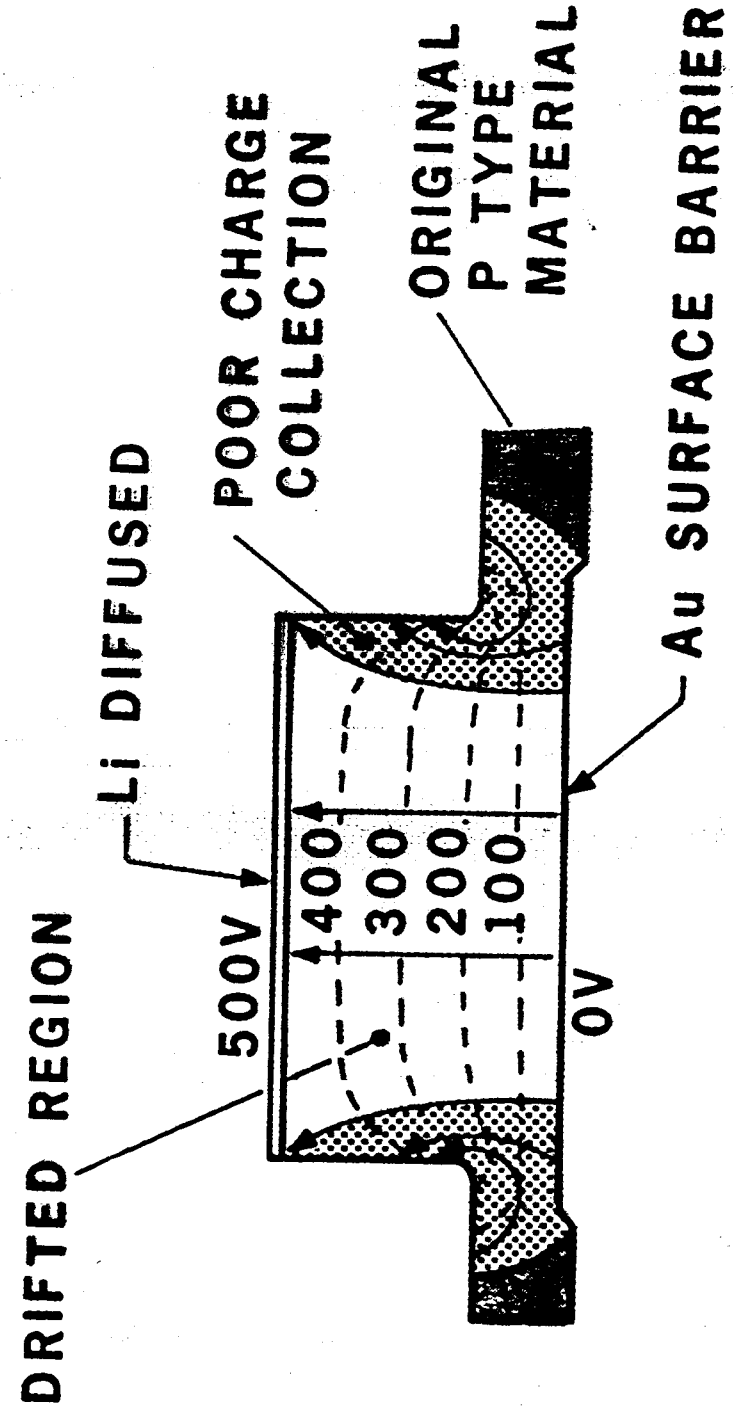
  Asymmetric vs. Planar

  - Asymmetric structure has less capacitance
  - Asymmetric structure less susceptible to poor charge collection due to surface state problems 'Surface Channels'
  - Fabrication of monolithic arrays with low interelectrode capacitance possible
  - Stringent detector material parameters
  - Lower detector yields
  - Monolithic arrays are restricted to regular repetitive patterns

Ge DETECTOR ELECTRODE GEOMETRY

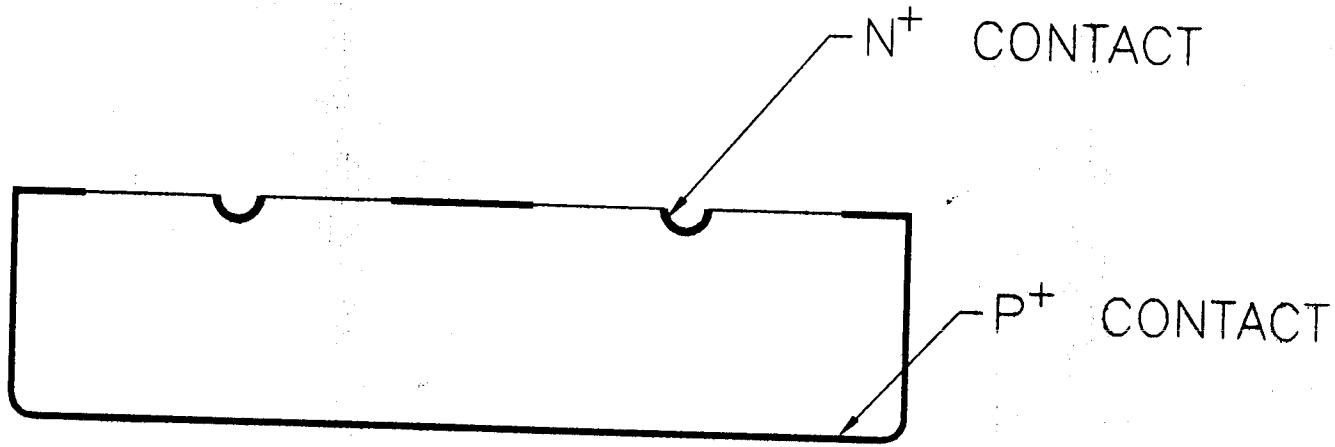


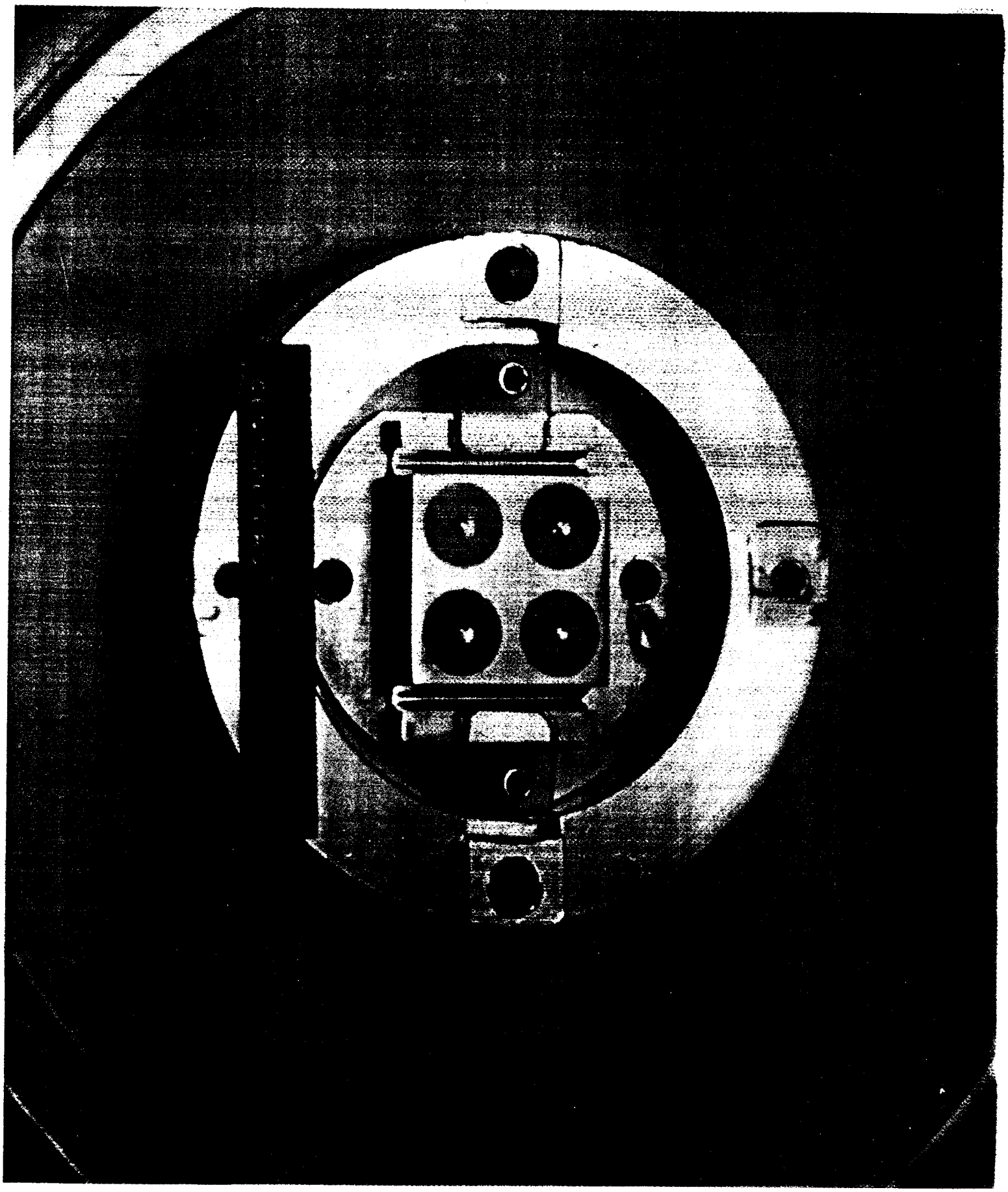



DRIFTED REGION
Li DIFFUSED
500V
400
300
200
100
0V
POOR CHARGE COLLECTION
ORIGINAL P TYPE MATERIAL
Au SURFACE BARRIER

XBL 784-7972

Ge DETECTOR ELECTRODE GEOMETRY



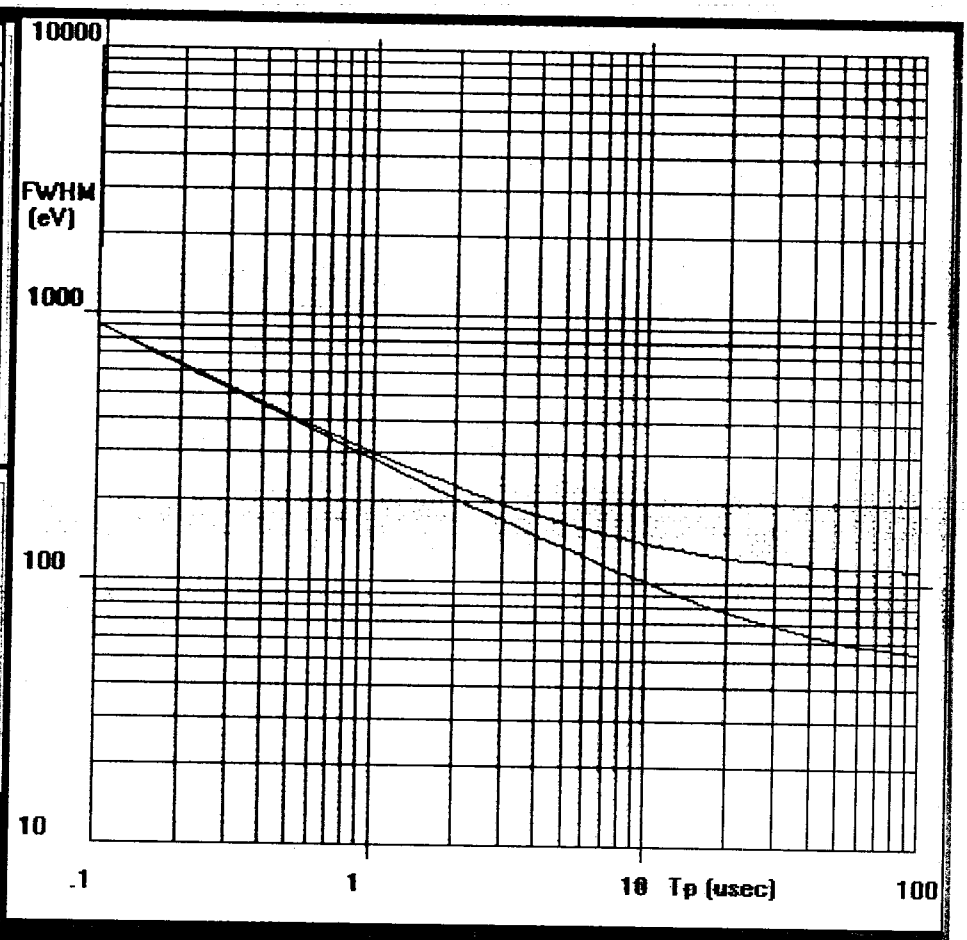


Si or Ge	Ge
Det C[pF]	2.5
Det I [pA]	.01
Fano Factor	.12
Energy [keV]	5.89
FET Gm[mA/V]	6
FET C[pF]	1.5
Series R [Ohms]	10
Det. Temp [K]	82
Parall. R [Mohm]	
A(1/f) x 1E-14	

Shaper

- [illegible]
- Parabolic Triangle
- [illegible]
- [illegible]
- Sin^n Shaper
- Gated Int (Sin^6)
- User Defined

SAVE | PLOT | Insert
GET | PRINT | POINTS
BMPs | CLEAR | QUIT



NOTE ON TEMPERATURE CONSIDERATIONS

The temperature value is used to calculate noise in the parallel R and to set Epsilon for the detector material. FET noise has no predictable dependance. The value of Gm at the operating temperature should be used and 300K is asumed in the calculation.

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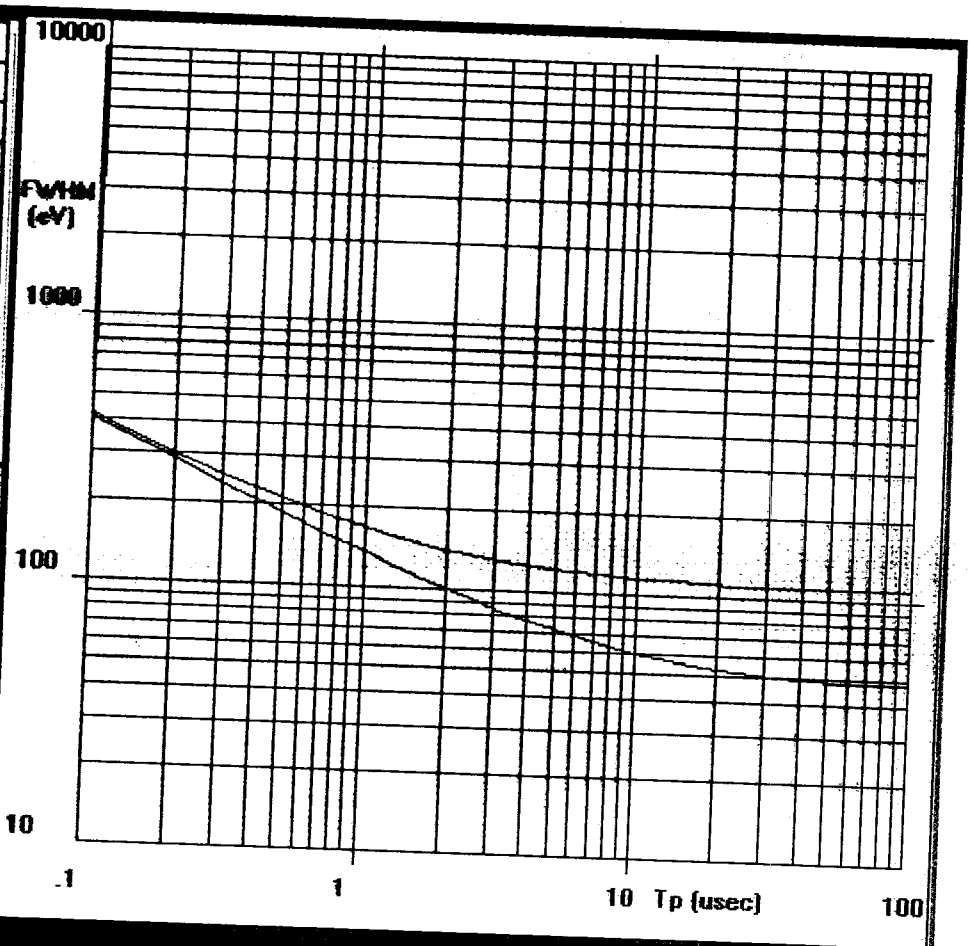
Series R [Ohms]	10
Det. Temp [K]	82
Parallel R [Mohm]	
N(1/f) x 1E-14	

Shaper

- RC diff + n integ
- Pseudo-Triangle
- Kandiah Cusp
- Flat-top Trapezoid
- Sin x Shaper
- Gated Int (Sin^6)
- User Defined

SAVE | PLOT | Insert
GET | PRINT | POINTS
MPs | CLEAR | QUIT



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FET Gm(mA/V)	3
FET C(pF)	.8
Series R (Ohms)	10
Det. Temp (K)	82
Parall. R (Mohm)	
A(1/f) x 1E-14	

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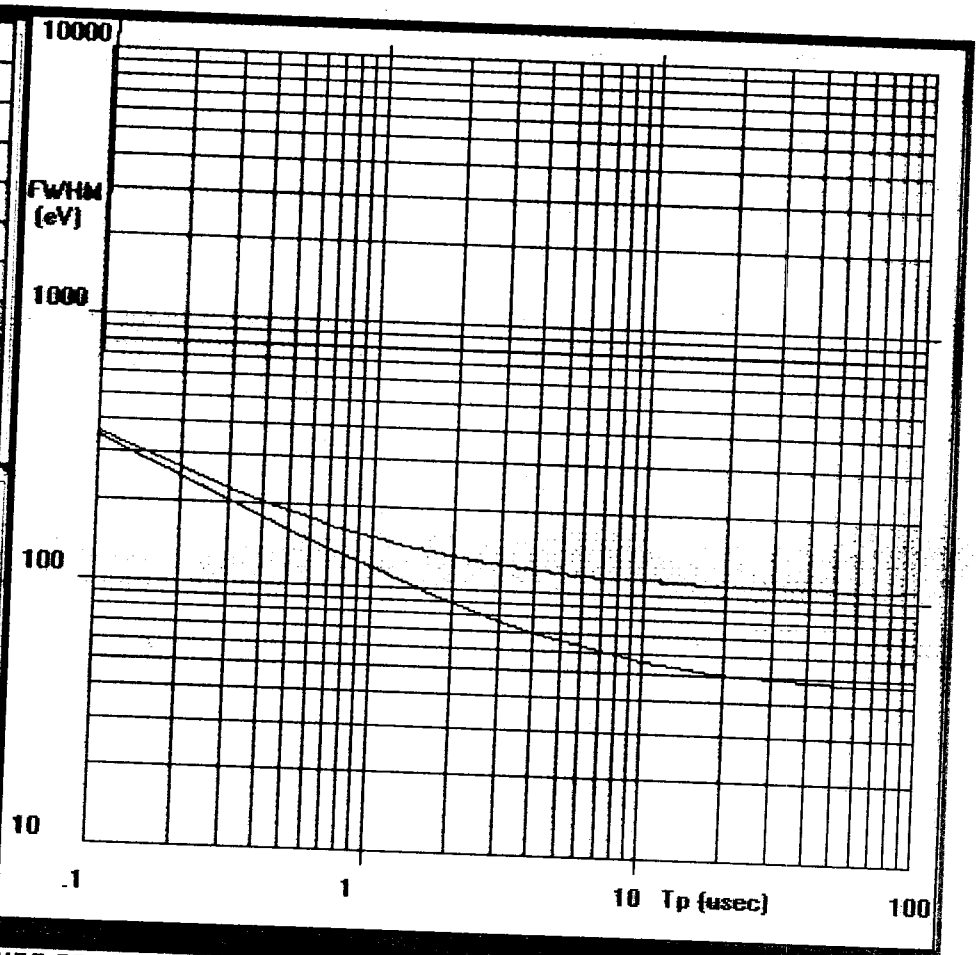

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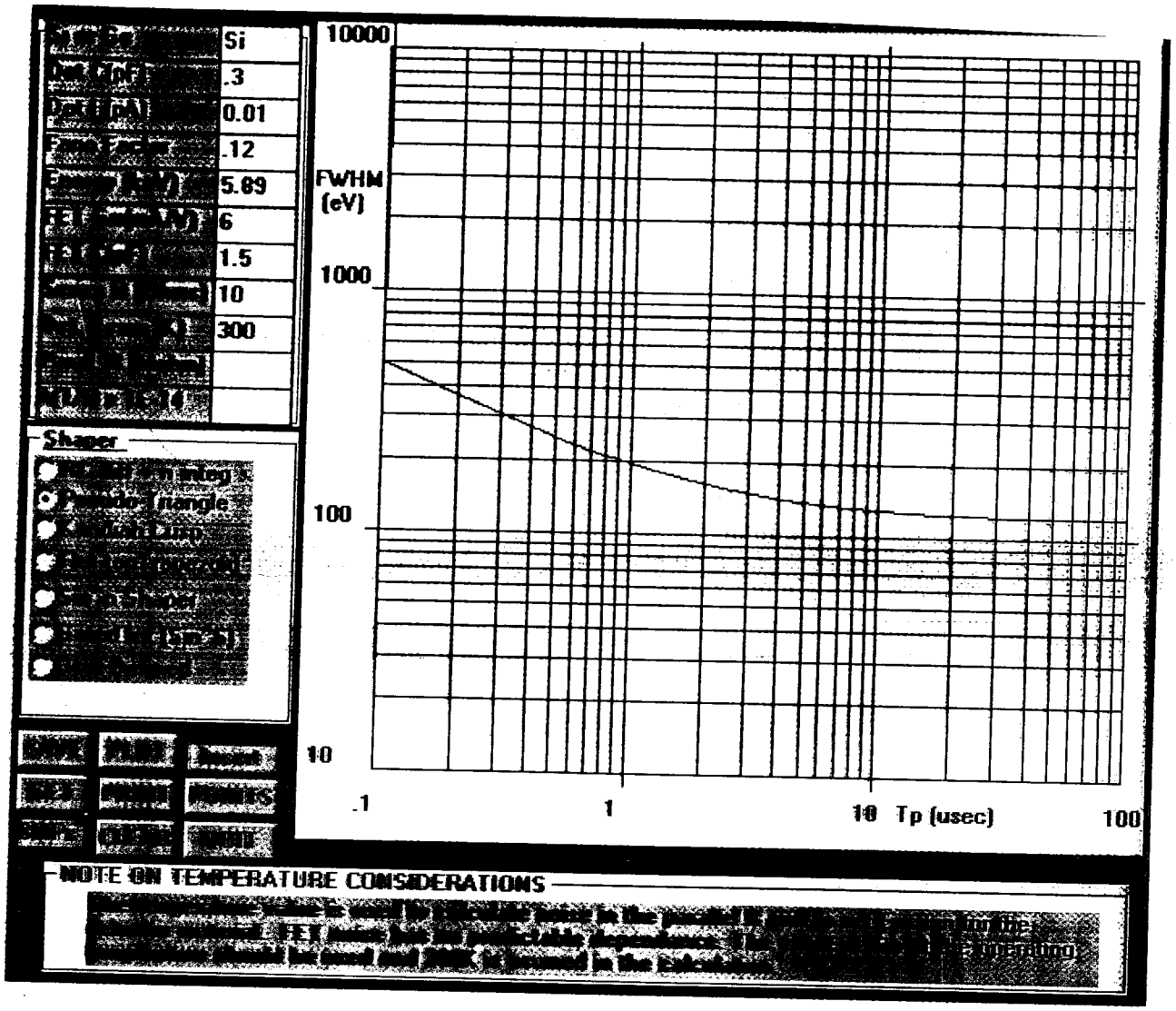
Si
.3
0.01
.12
5.89
6
1.5
10
300
Shaper
10000
FWHM
(eV)
1000
100
10
.1
1
10
Tp (usec)
100
NOTE ON TEMPERATURE CONSIDERATIONS

Si or Ge	Ge
Det C(pF)	.3
Det I (pA)	.01
Fano Factor	.12
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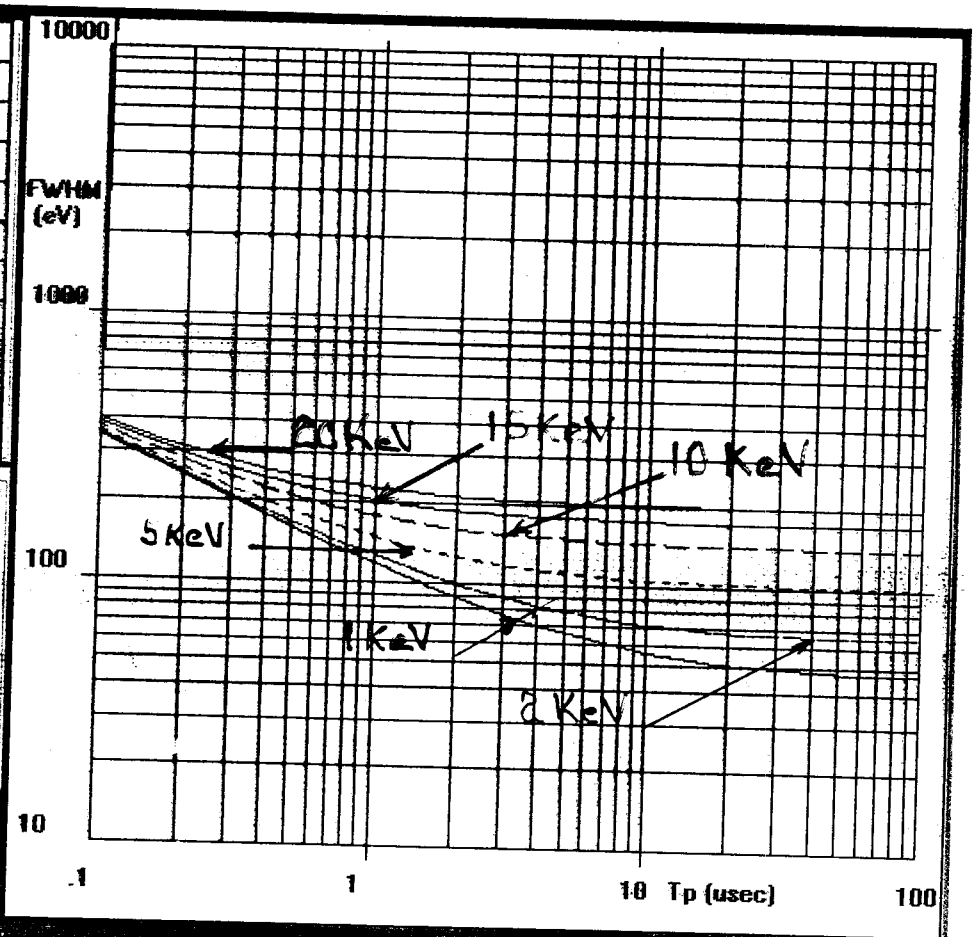

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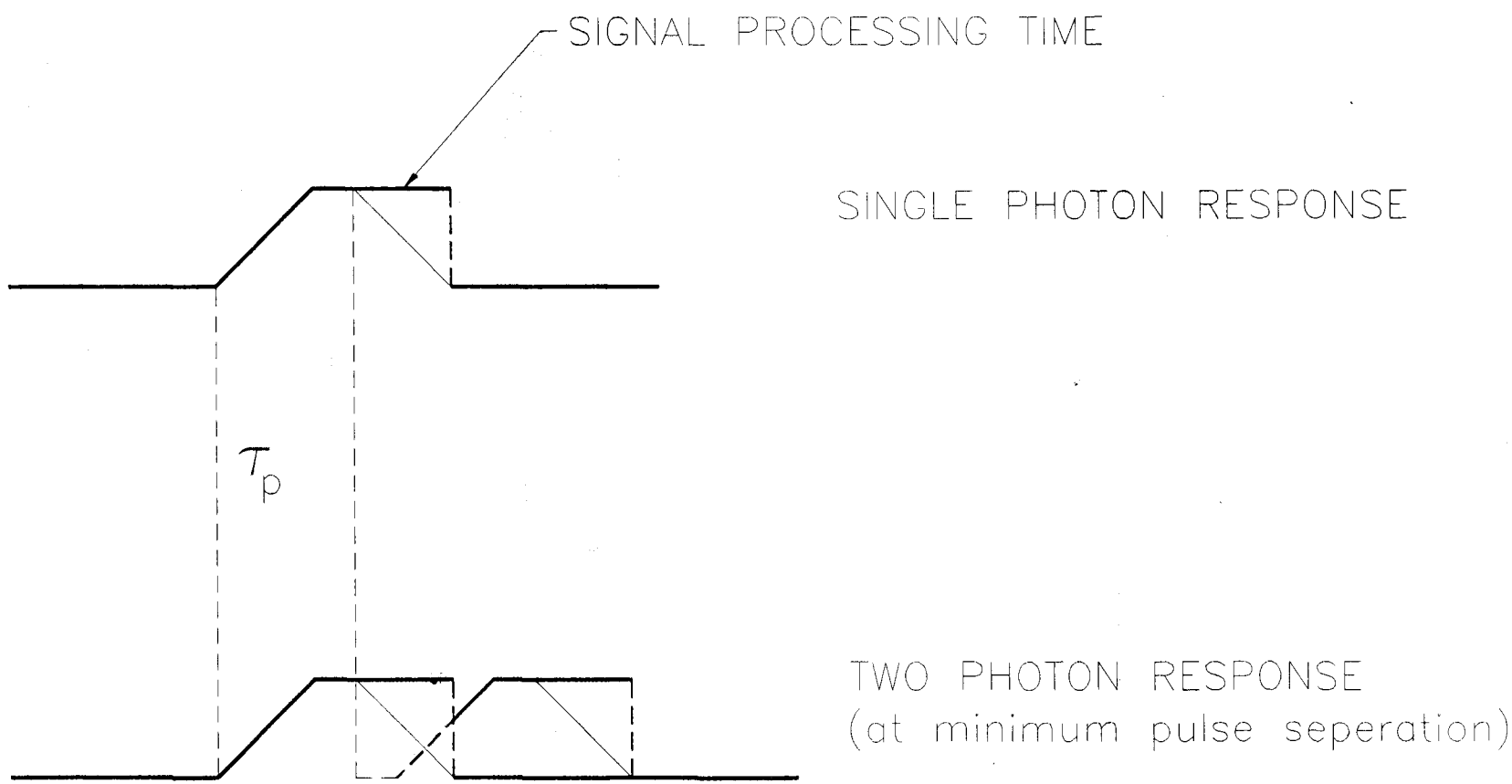
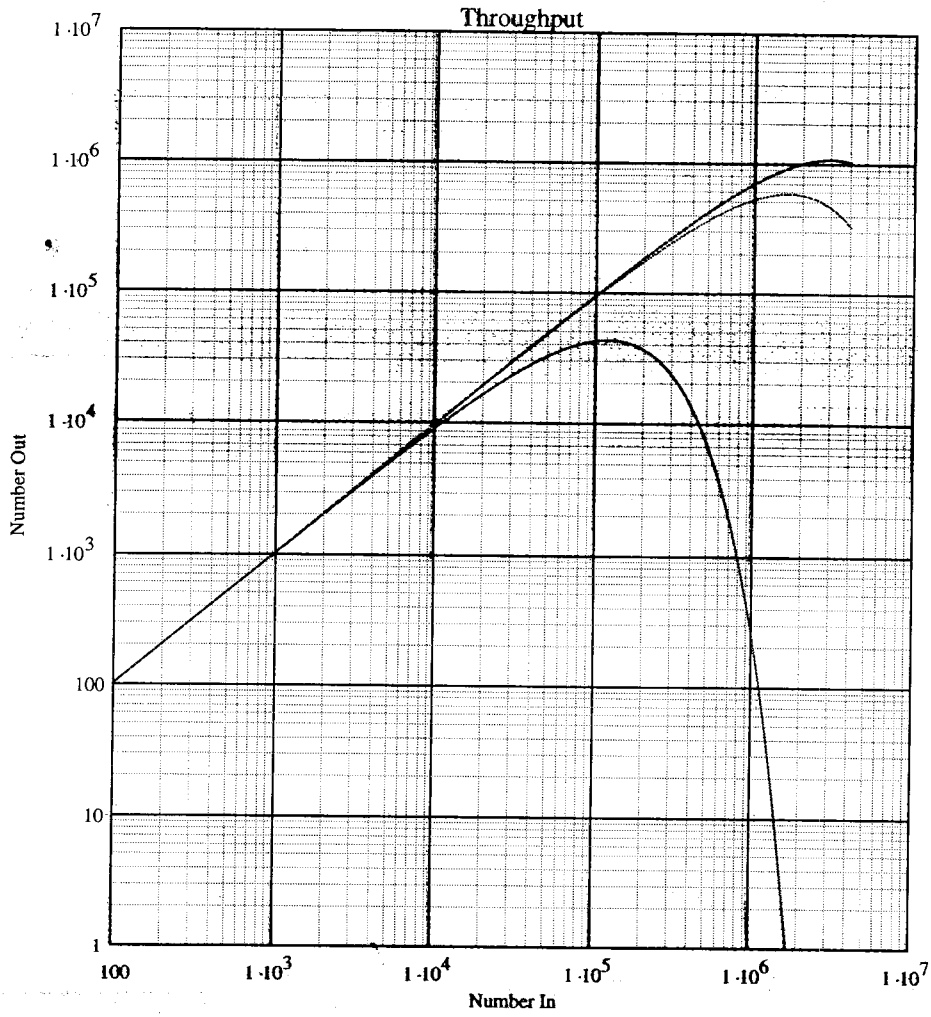
IDEAL HIGH RATE SIGNAL PROCESSING




Throughput
Number Out
Number In
1·10^7
1·10^6
1·10^5
1·10^4
1·10^3
100
10
1
100
1·10^3
1·10^4
1·10^5
1·10^6
1·10^7