Beam Background simulation for Belle and Beast

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KEK

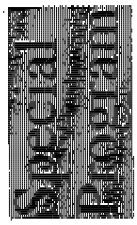
March 24, 1999

- General simulation description
- Belle simulation,
  - Production point of lost particles.
  - Movable mask effect.
  - Radiation dose.
  - Occupancy in SVD.
- BEAST simulation.
- What are the expected sources of lost particles.
- What we can check with Beast.
  - Pressure bumps.
  - Movable mask studies.
  - Multi-turn effect.
- Conclusions.

Generation Process :

- Sample the particle from a beam profile at beginning of swim.

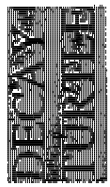
  Input parameters : Emittance ε
  α, β, η



- Swim the particle through magnetic elements until a point where it scatters.

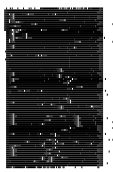
  Then at that point reset the four-momentum and resume swimming.

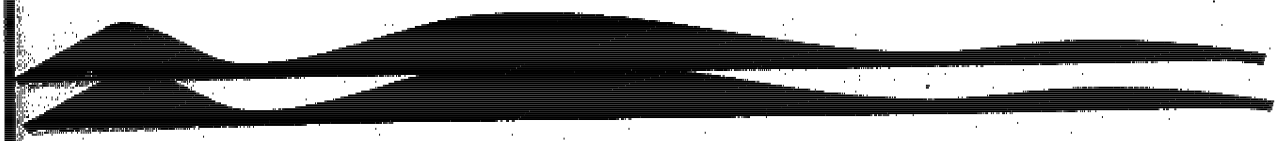
  Input parameters : Cross-sections of Physics process



- When the particle reaches the BELLE Detector (Far end of QCS), input the four momenta into Geant.

  Geant simulates the showers.





- User gets the hit info and makes his/her calculations for radiation damage/trigger rate.

Calculation of Physics Process :

Inputs : Type of Residual Gas : CO

Temperature : 298 K

Gas pressure : 1 nano-torr, input vaccum profile

Swim Length : ~~48.7~~ 150 m Electron Ring

~~19.4~~ 150 m Positron Ring

[redacted]

$$\frac{d\sigma}{d\omega} = \int_{\omega=0.05*\text{BeamEnergy}}^{\omega=\text{BeamEnergy}} \frac{\text{Constant}}{\omega}$$

$$\omega = \frac{\text{Photon energy}}{\text{Beam Energy}}$$

Calculation of Physics Process :

Inputs : Type of Residual Gas : CO

Temperature : 298 K

Gas pressure : 1 nano-torr, input vaccum profile

Swim Length : ~~48.7~~ m Electron Ring

~~19.4~~ 150 m Positron Ring

[redacted]

$$\frac{d\sigma}{d\theta} = \int_{\theta=0.001}^{\theta=\pi} \frac{\text{Constant}}{\theta^3}$$

θ = minimum angle of scattering

Belle simulation

- From where are coming the particle which hit the detector?
  - Coulomb scattering,
  - Bremsstrahlung scattering,
  - Energy deposit in SVD.
- Movable mask effect.
  - On the straight section mask we have two pairs of masks.
    - For positron beam one horizontal and vertical (around 20 and 10 meters from IP).
    - For electron beam one horizontal and vertical (around 25 and 10 meters from IP).
  - Moving masks should reduce the dose at the detector level:

Process	No masks	Vertical mask	Horizontal mask
LER Coulomb	100%	17%	100%
LER Bremsstrahlung	100%	77%	45%
LER weighted sum	100%	47%	73%
HER Coulomb	100%	66%	100%
HER Bremsstrahlung	100%	84%	98%
HER weighted sum	100%	83%	98%

- However:
  - Efficiency of masks heavily depend on the vacuum profile close to IP. As illustration for two toy vacuum profiles around IP:
    * Profile I 100 n-Torr at IP, 10 n-Torr at 10 m and 1 n-Torr at 20m

Process	No masks	Vertical mask	Horizontal mask
LER Coulomb	100%	3%	95%
LER Bremsstralung	100%	96%	70%

    * Profile II 100 n-Torr at IP, and 1 n-Torr at 10m

Process	No masks	Vertical mask	Horizontal mask
LER Coulomb	100%	95%	100%
LER Bremsstralung	100%	90%	70%

  - Coulomb scattered particles from arc sections should be also stopped by Straight section movable masks - masks are more effective (?).
- Masks on opposite side of the ring, with apparture smaller than IP, should reduce multi-turn effect beam background. - PEP-II

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発信元名	BELLE GROUP

原稿は、送信完了しました。

原稿サイズ　　Ａ４縦

BEAST Experimental Results and Estimates for Operational Background

ハワイ大学
ガーナーゲリー
Gary S. Varner

BELLE General Meeting
March 24th, 1999
1999年3月24日
(水曜日)

- Current Radiation Dose Rates
- SVD Ladders
  - Occupancy estimates
  - Noise estimates
- Integrated Dose
- Machine/backgrounnd Studies
- Projections for Roll-In Operation
  - Radiation Dose
  - Track density/trigger rates
- Future Plans

原稿枚数　：　３８枚
送信枚数　：　３８枚

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NOTE ： ECM=エラーコレクションモード

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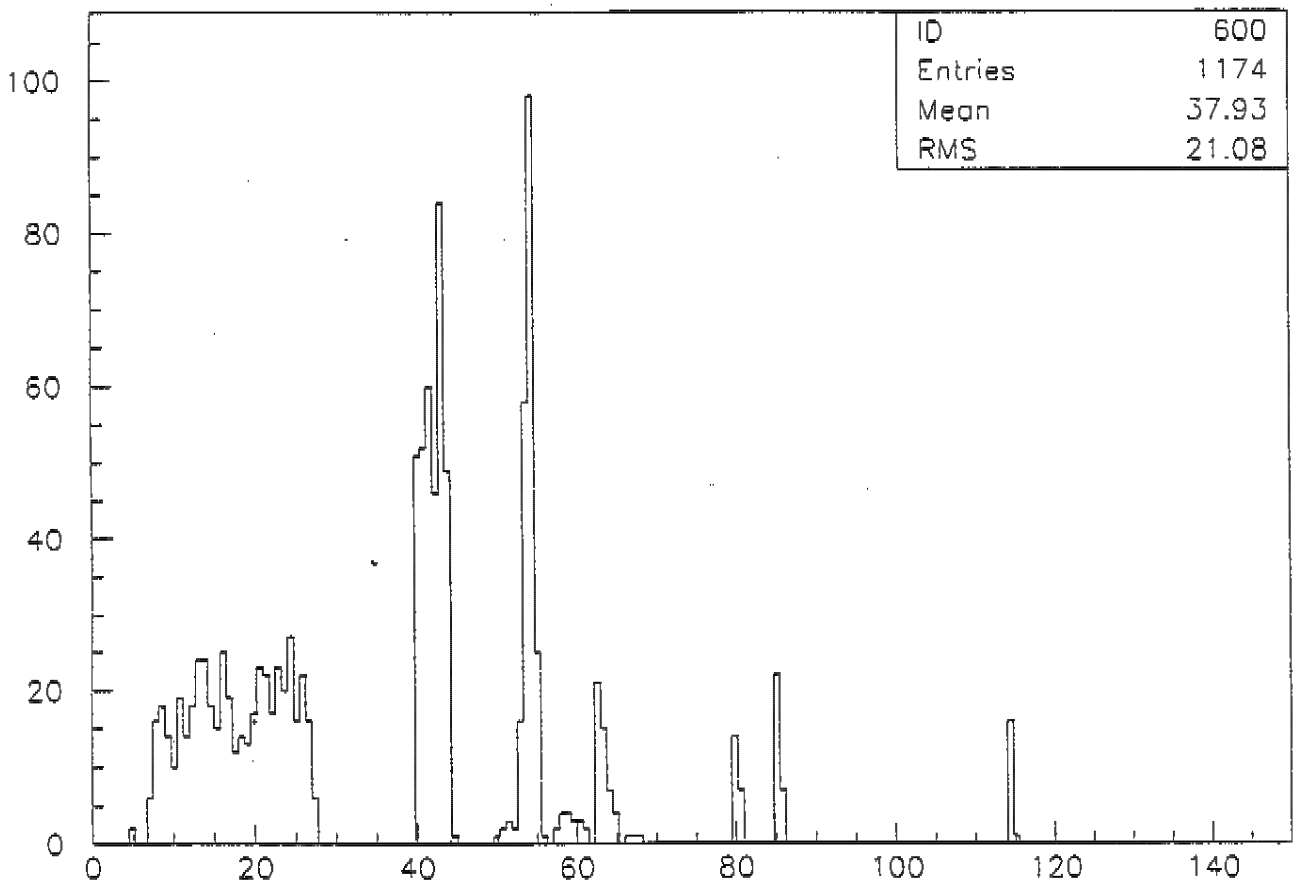
Belle simulation

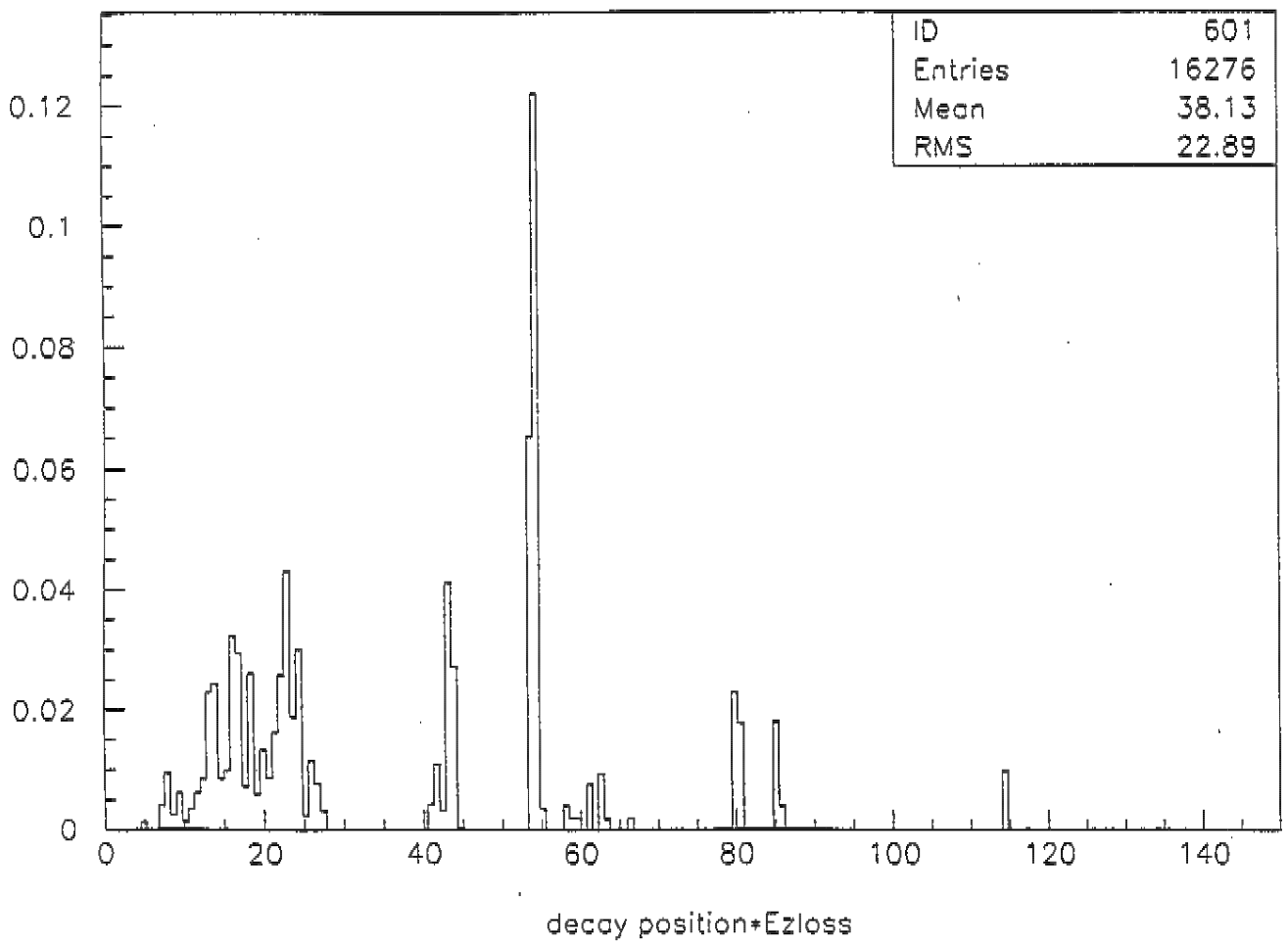
- The SVD maximum radiation dose is 25 Krad/year.
- The dose in average is around 5 Krad/year.
- The injections should add another 5 Krad/year.
- Trigger rate from CDC r/phi trigger (two charged tracks) is estimated to be around 250 Hz.
- However:
  - Vacuum profile was set to be 1 n-Torr and flat.
  - We are going to have dynamic pressure of order of few n-Torr (?)
  - Right now vacuum at IP is really bad at least 20-30 n-Torr, higher coulomb scattering component.

Belle simulation

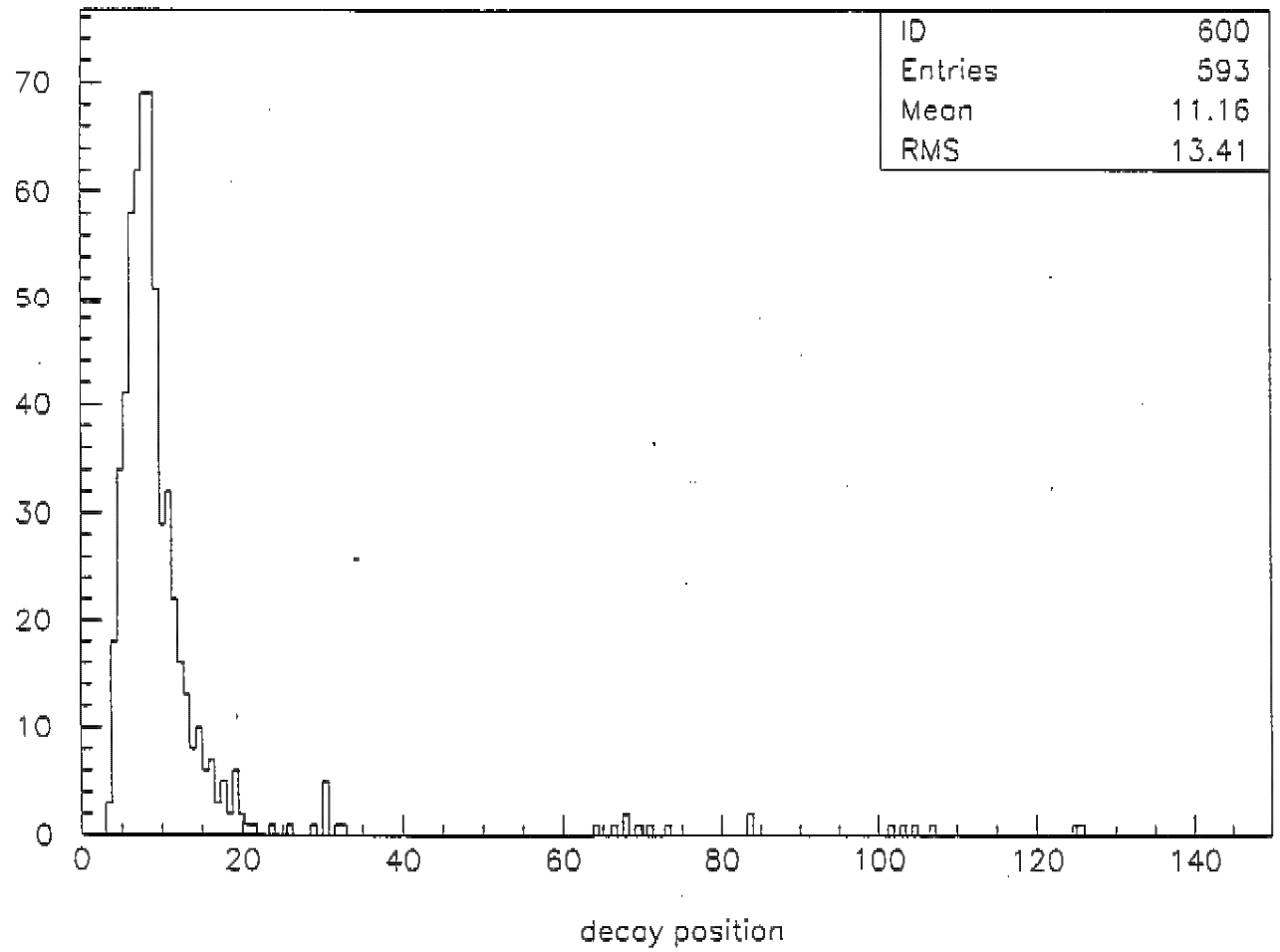
- The SVD occupancy:
  - 3% for "nominal" beam background.
  - 13.6% for five times "nominal" beam background.
- The SVD occupancy depend from sparsification algorithm used. We can change it by expense of lower efficiency in backward and forward regions - if C-DAQ cannot handle it.
- The pile up effect should be small in average 70e- per channel, but Beast result show only 300e- of increase of pedestal for $\approx$ 300 Krad/year dose.

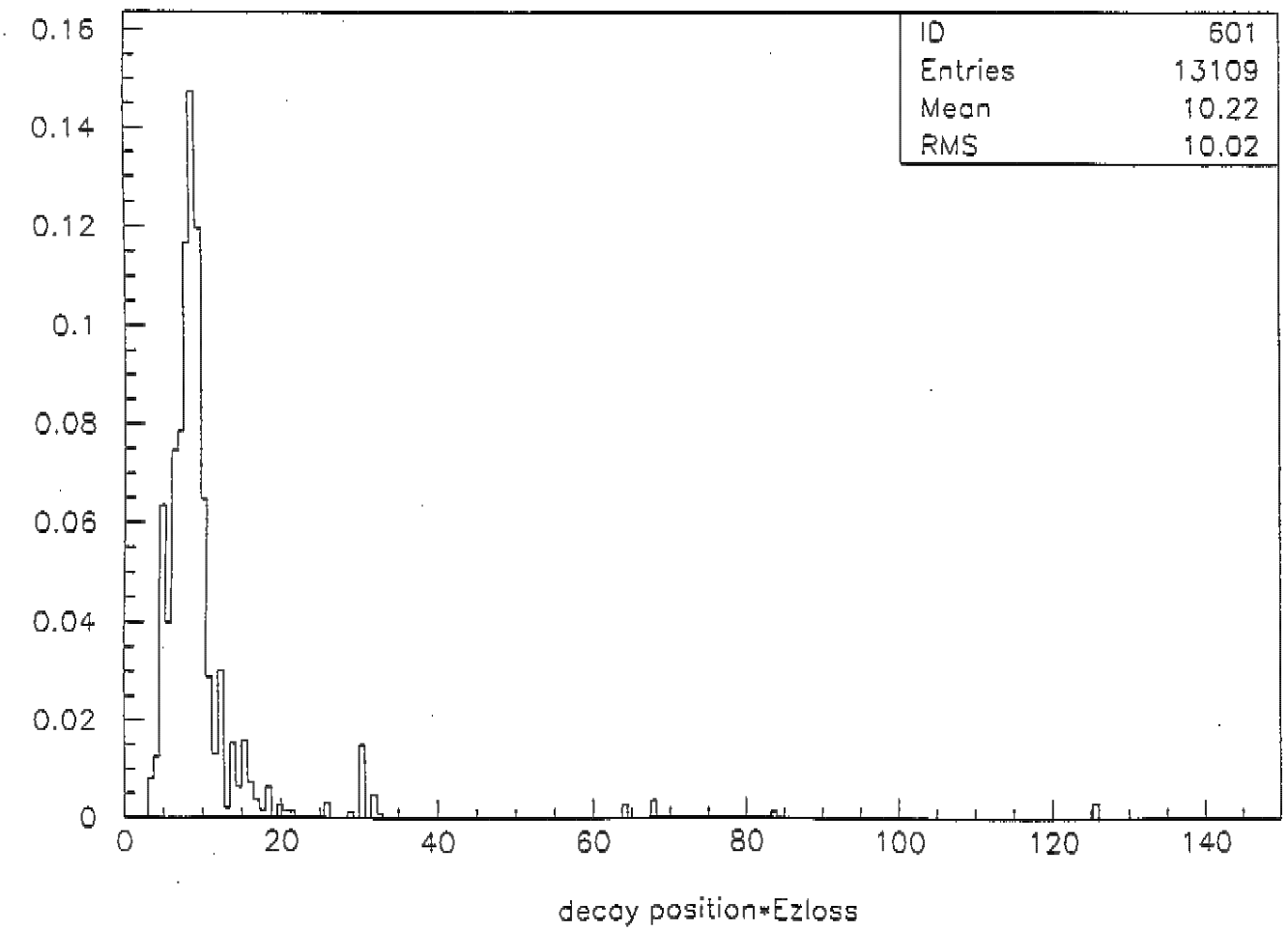
LER Bremsstralung



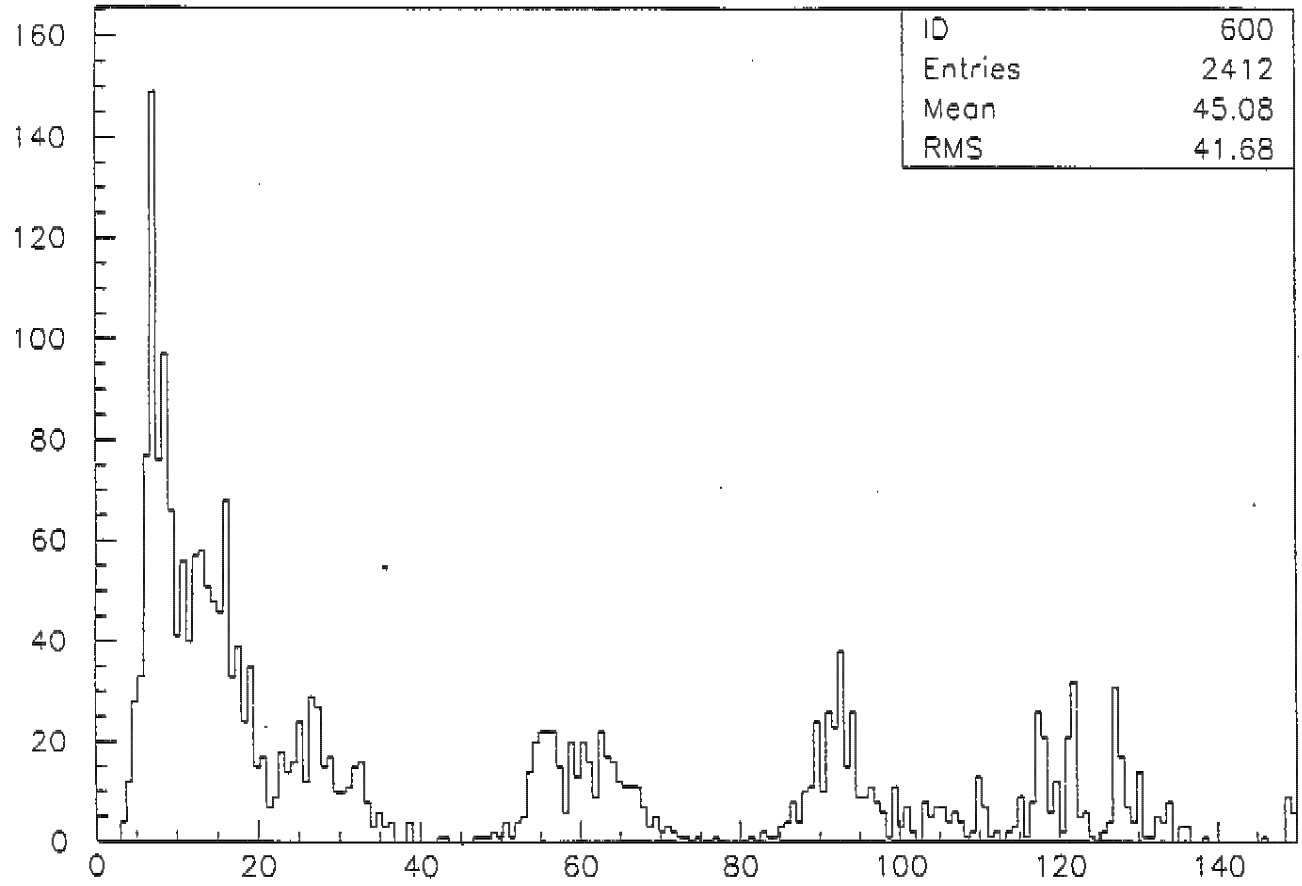


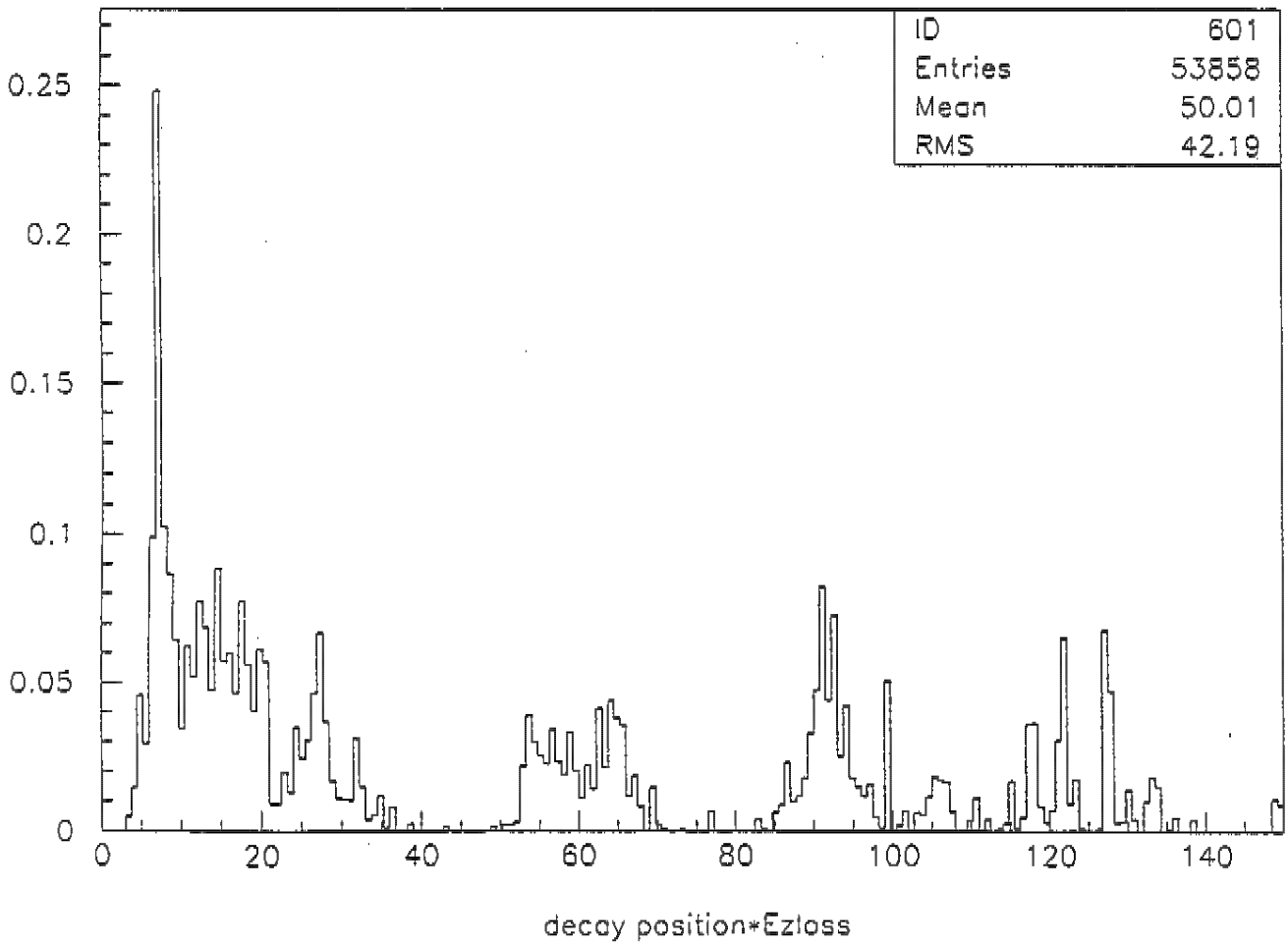
LER Coulomb scatt.



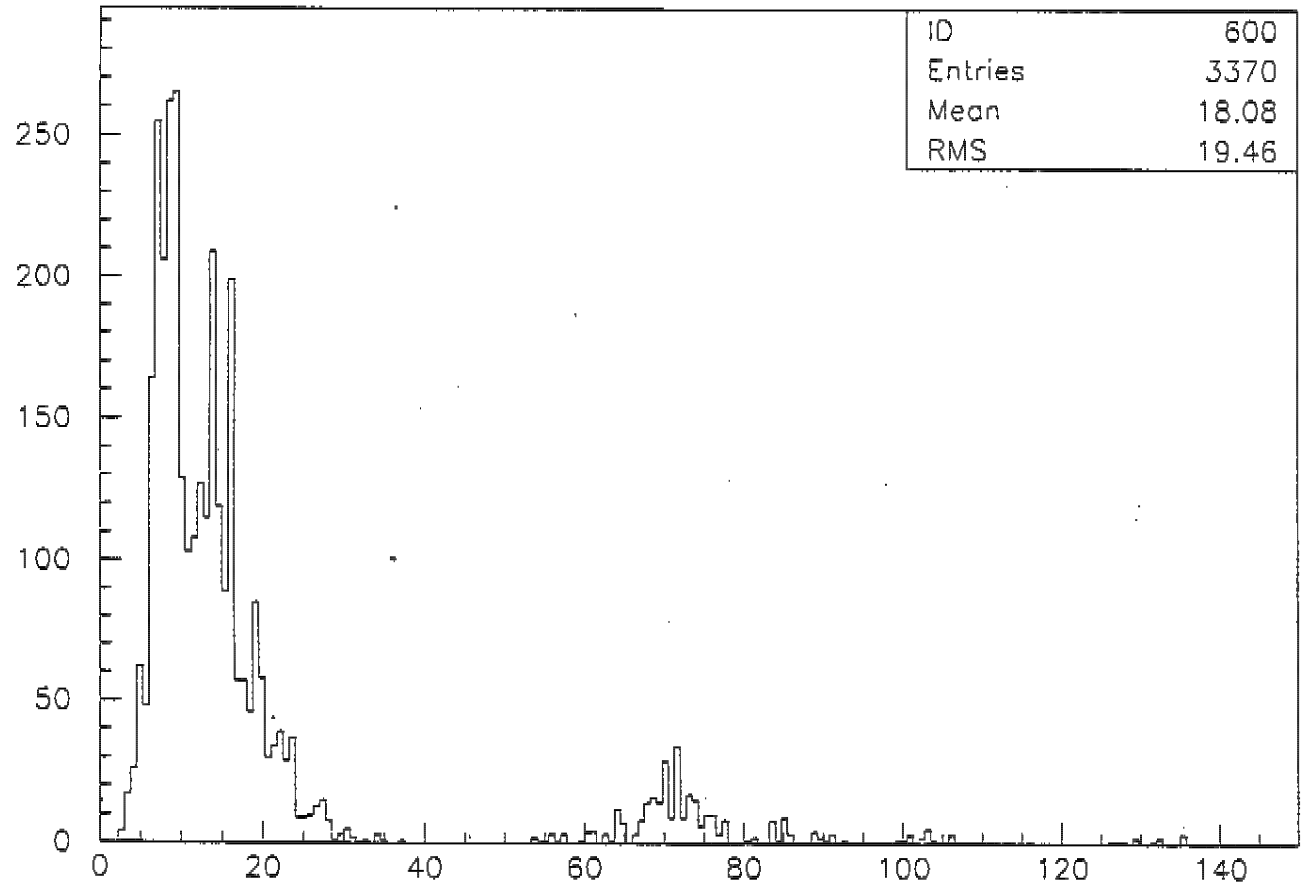


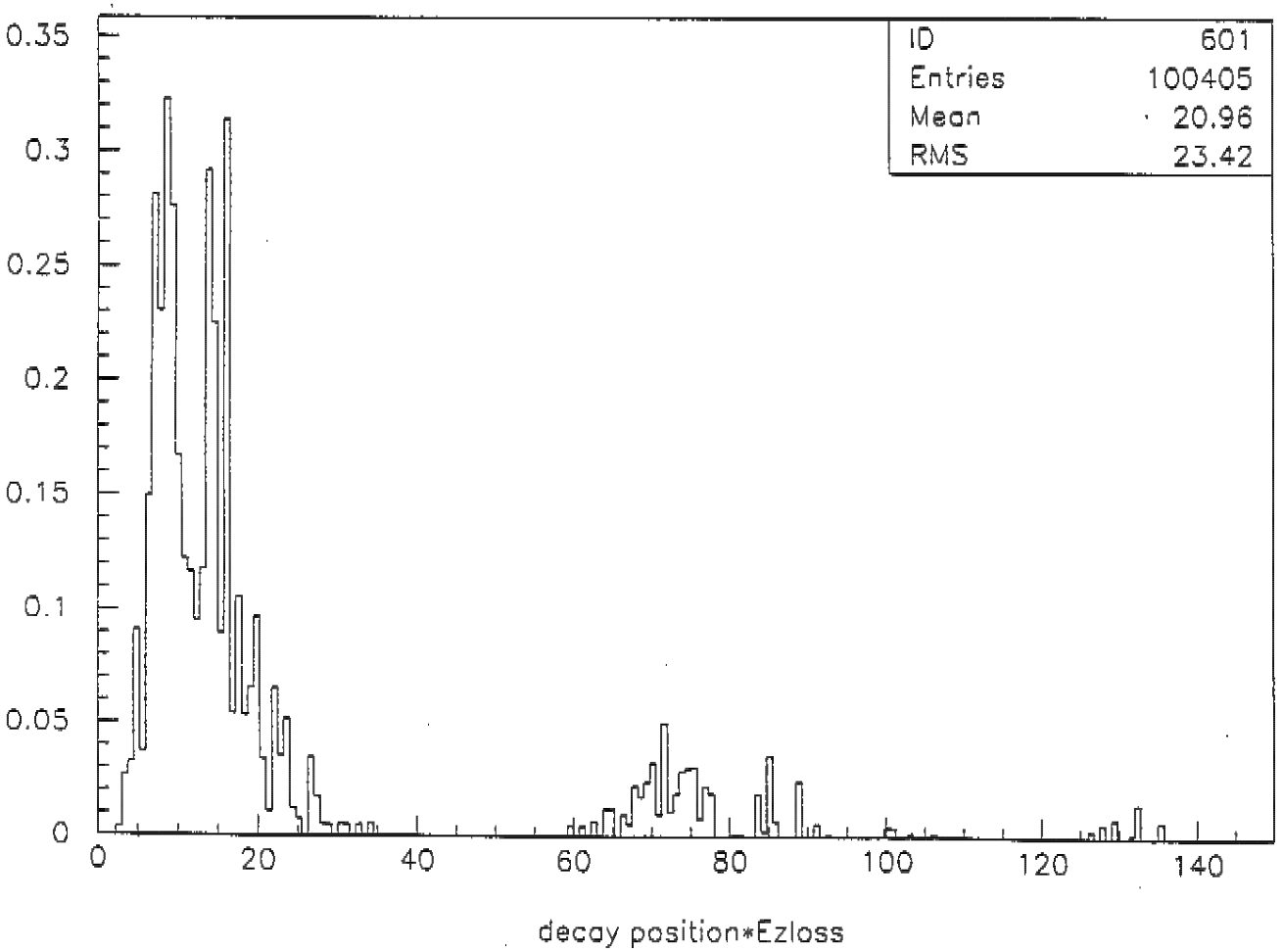
LER Coulomb scatt. (no masks)



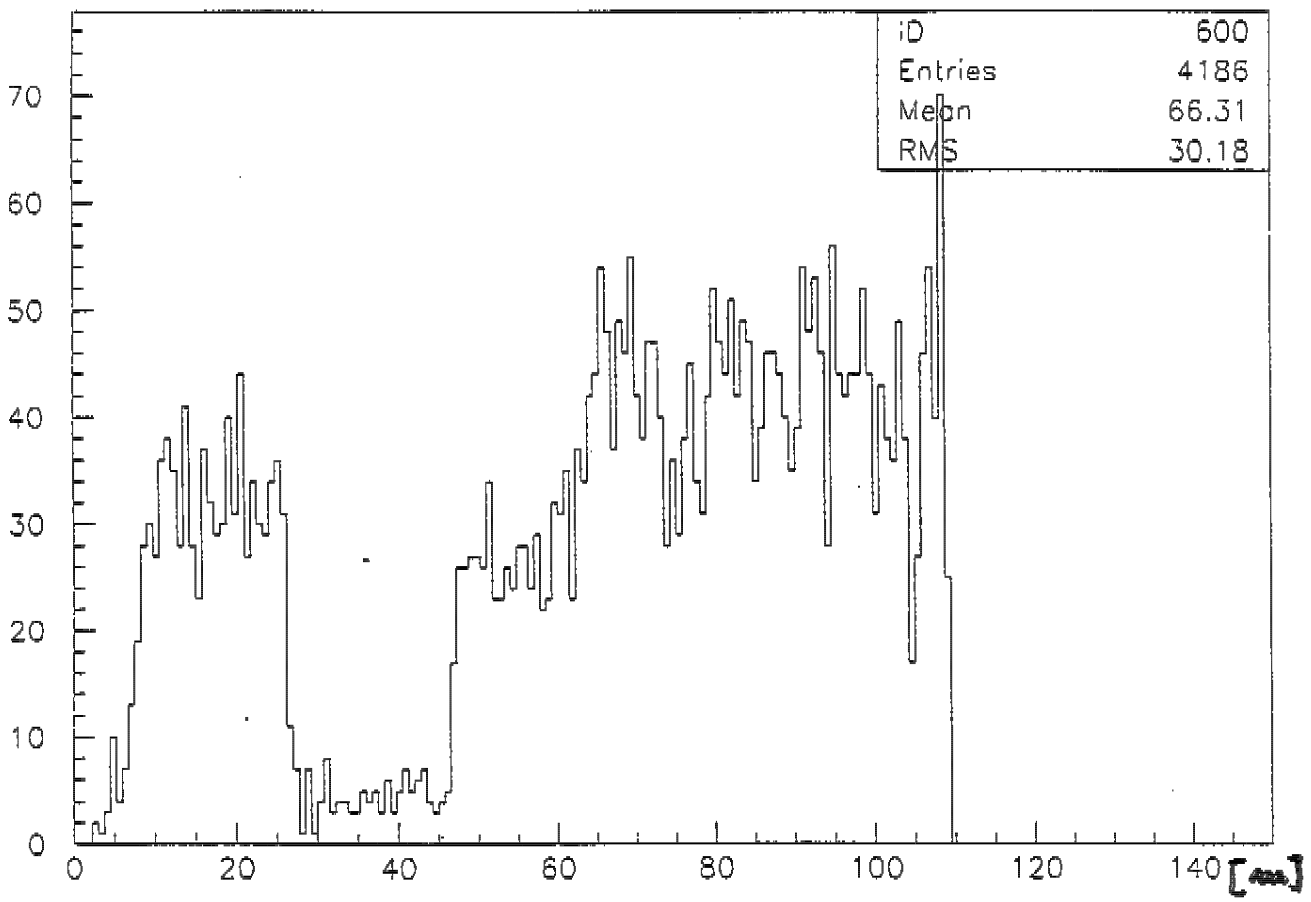


HER Coulomb scatt. (No Masks

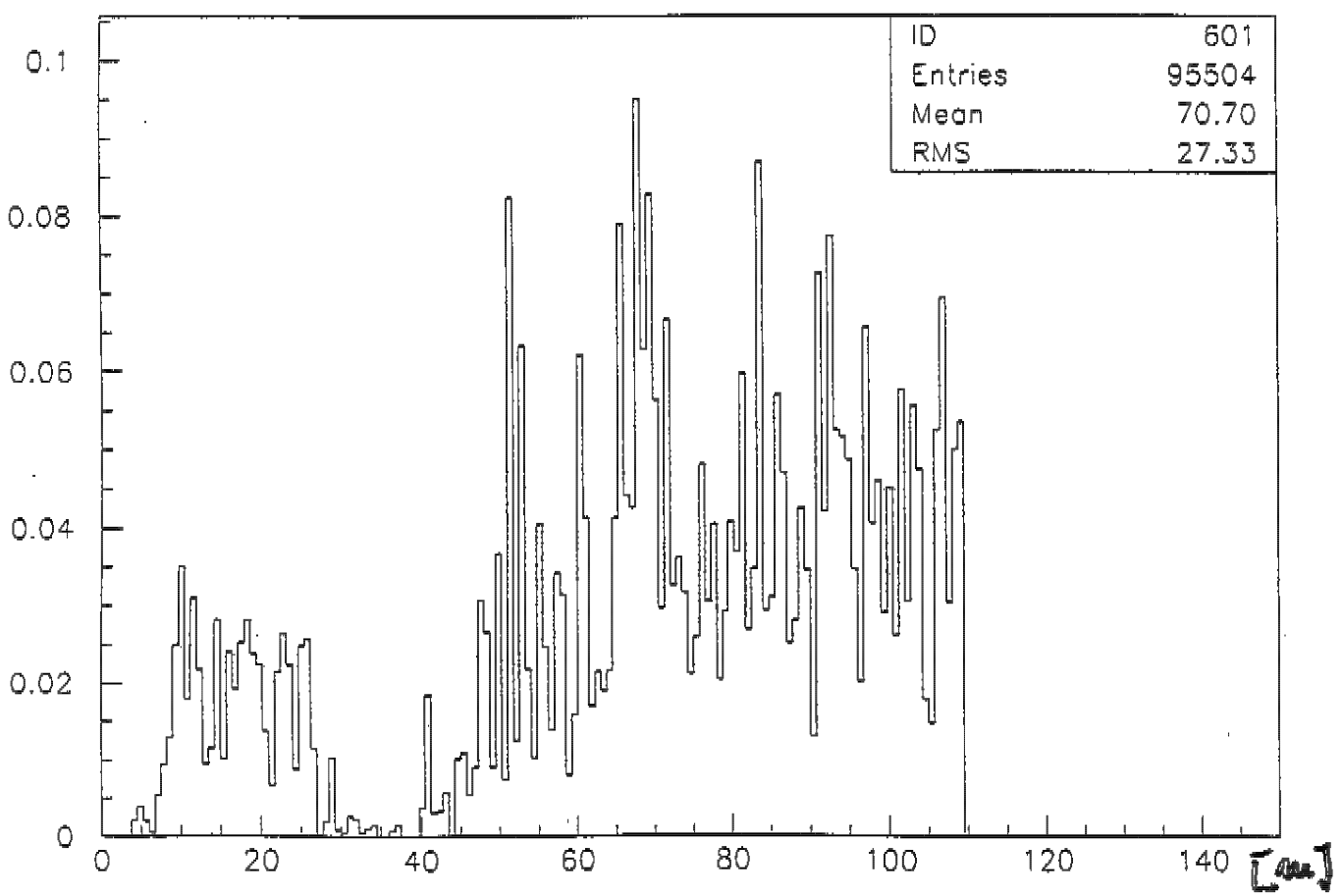




HER Bremsstralung

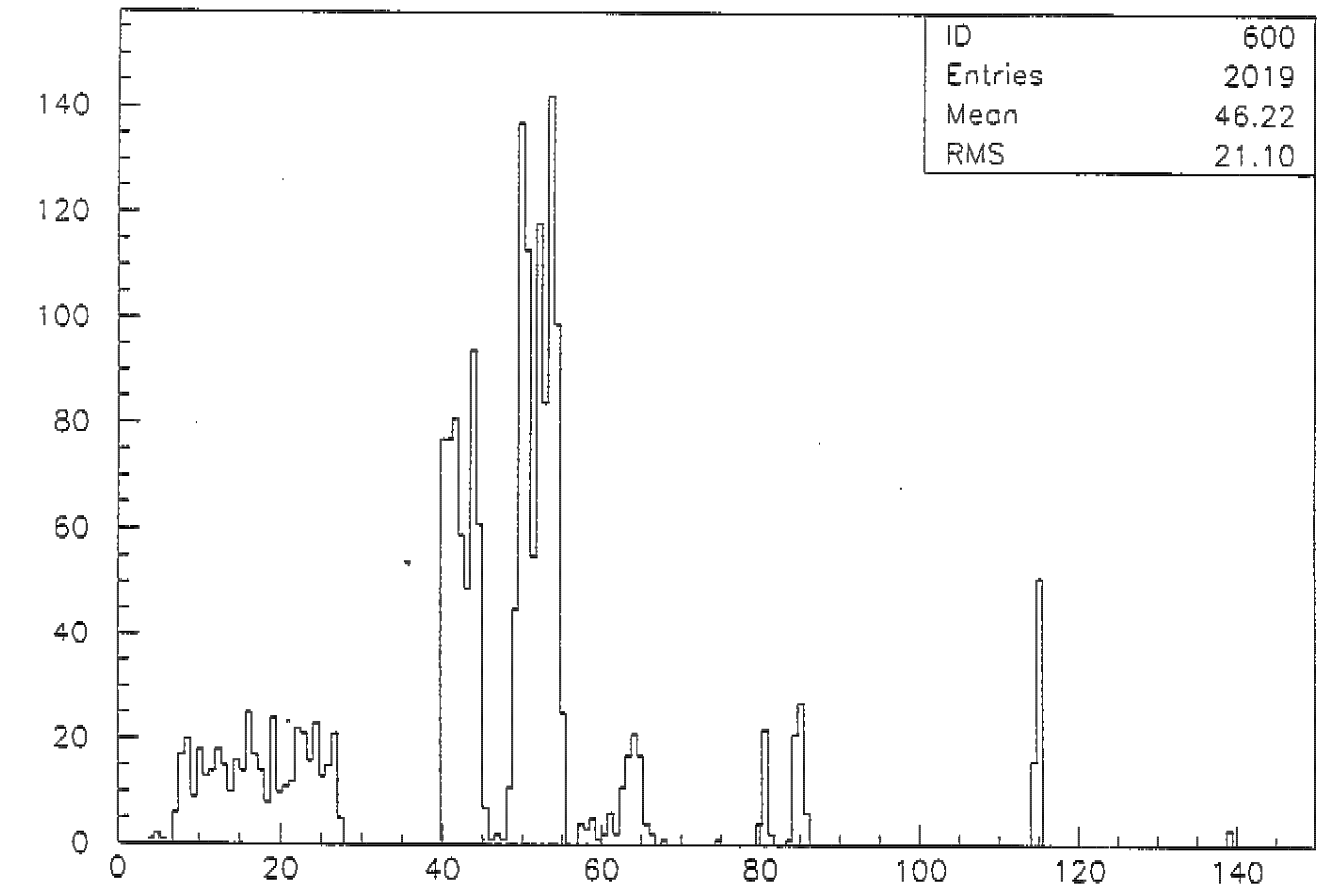


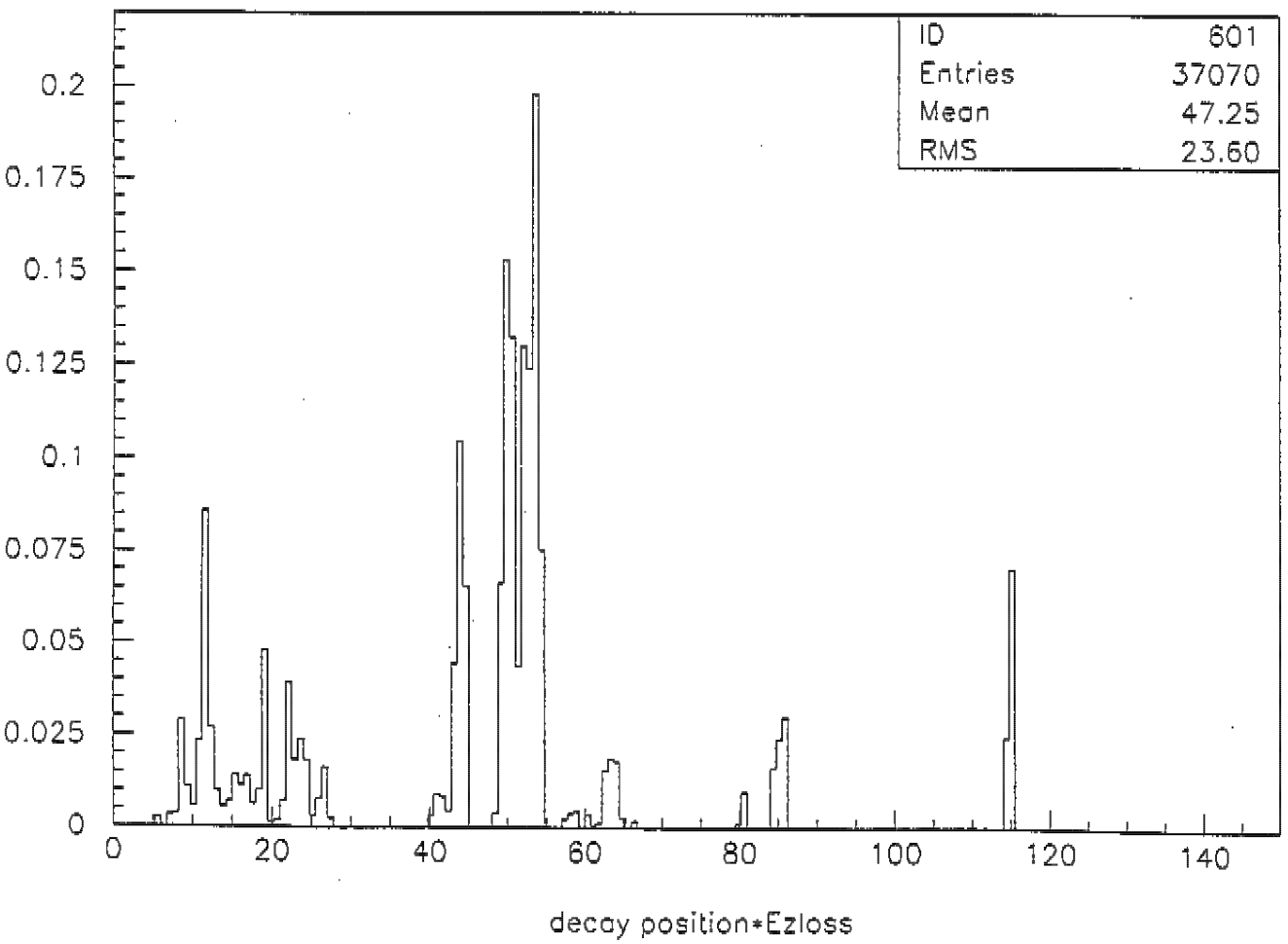
decay position



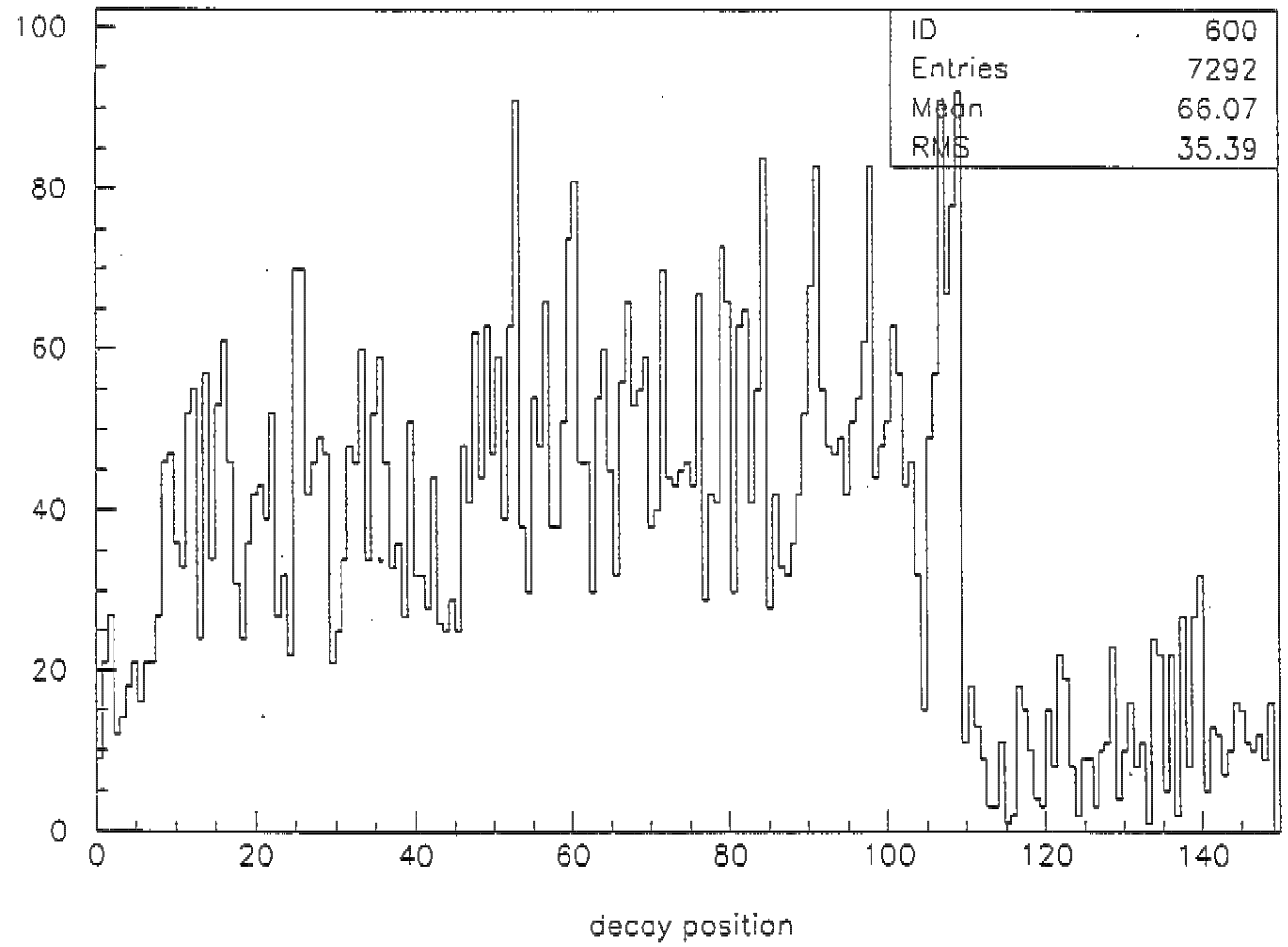
decay position*Ezloss

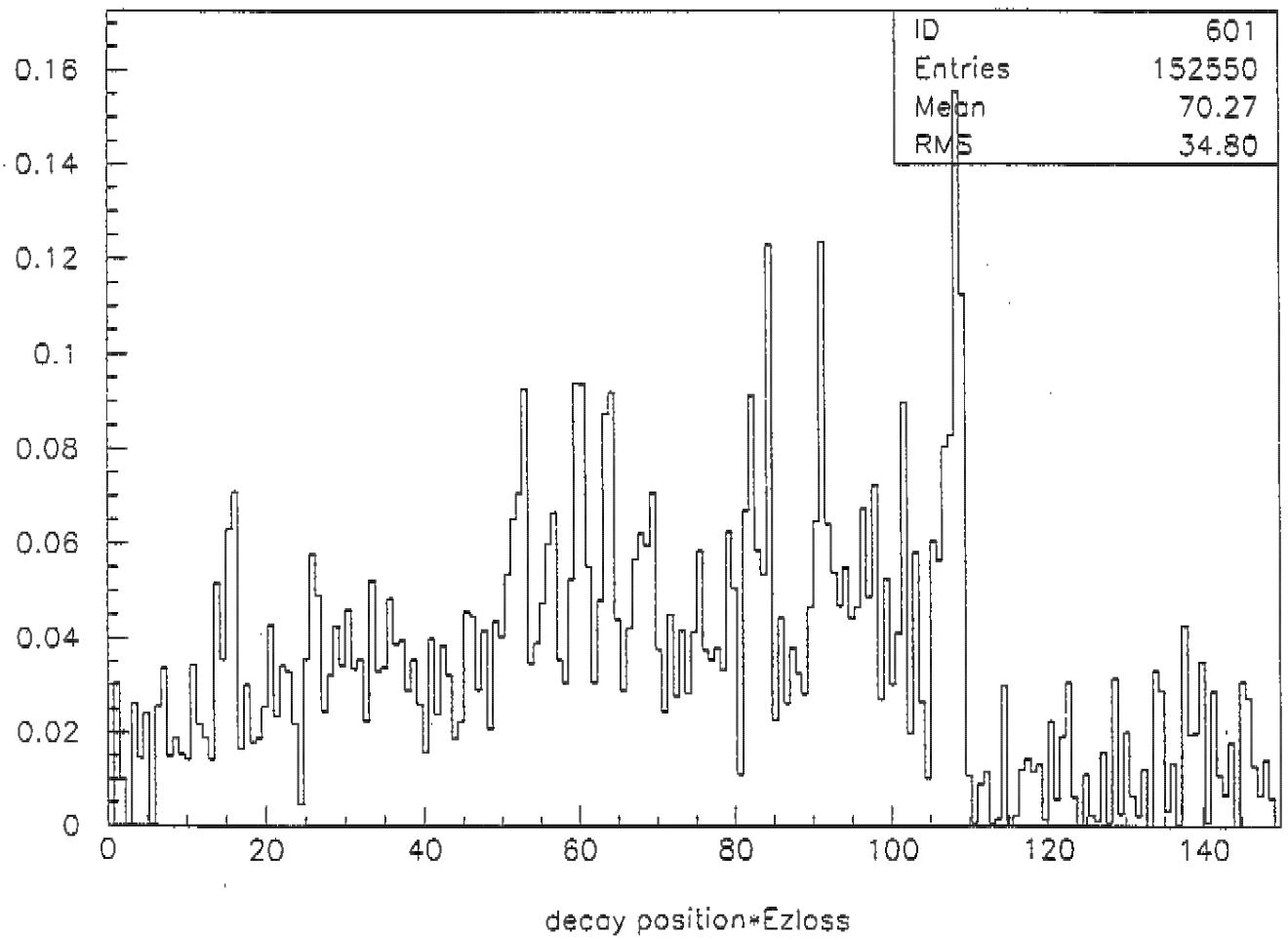
LER Bremsstralung (no masks)





HER Bremsstralung (no masks)





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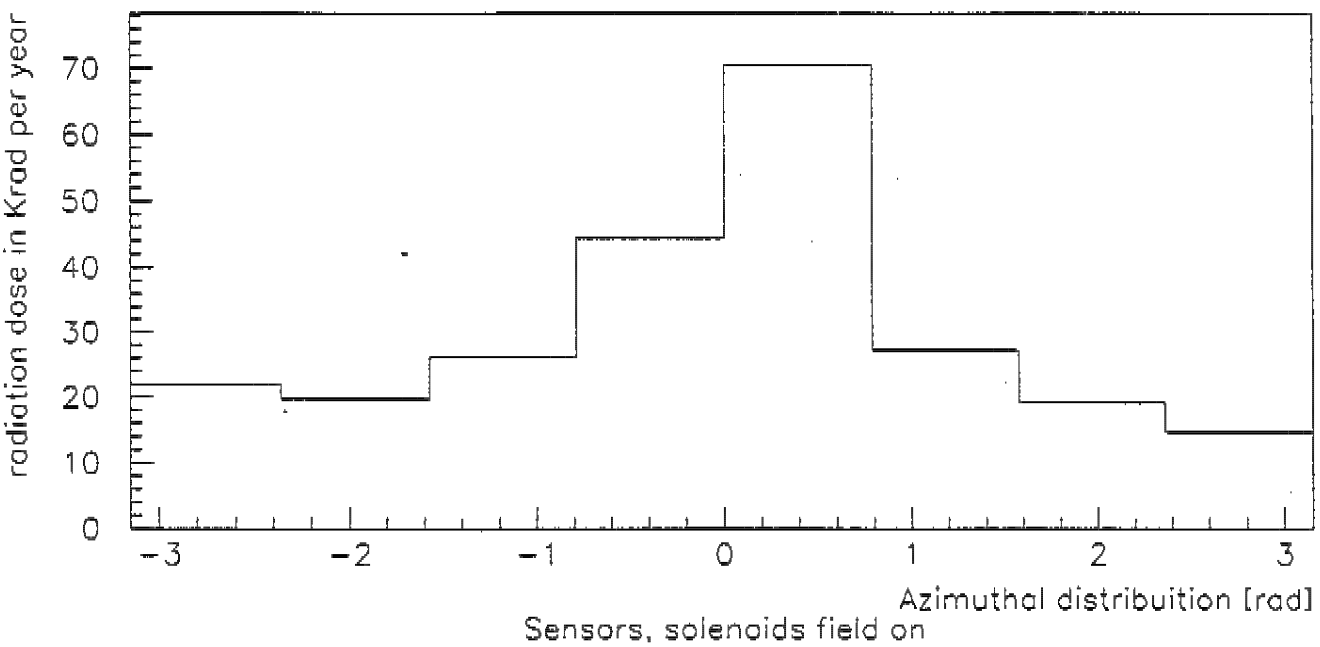
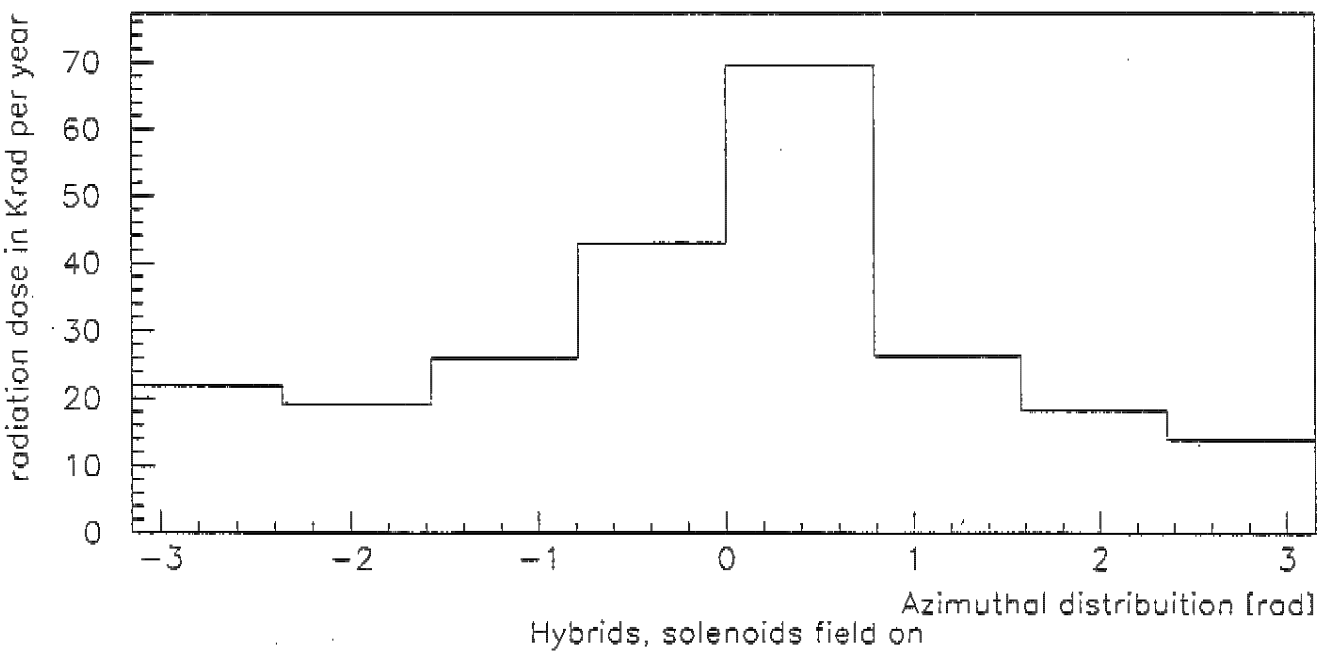


Sensors, solenoids field on



Hybrids, solenoids field on

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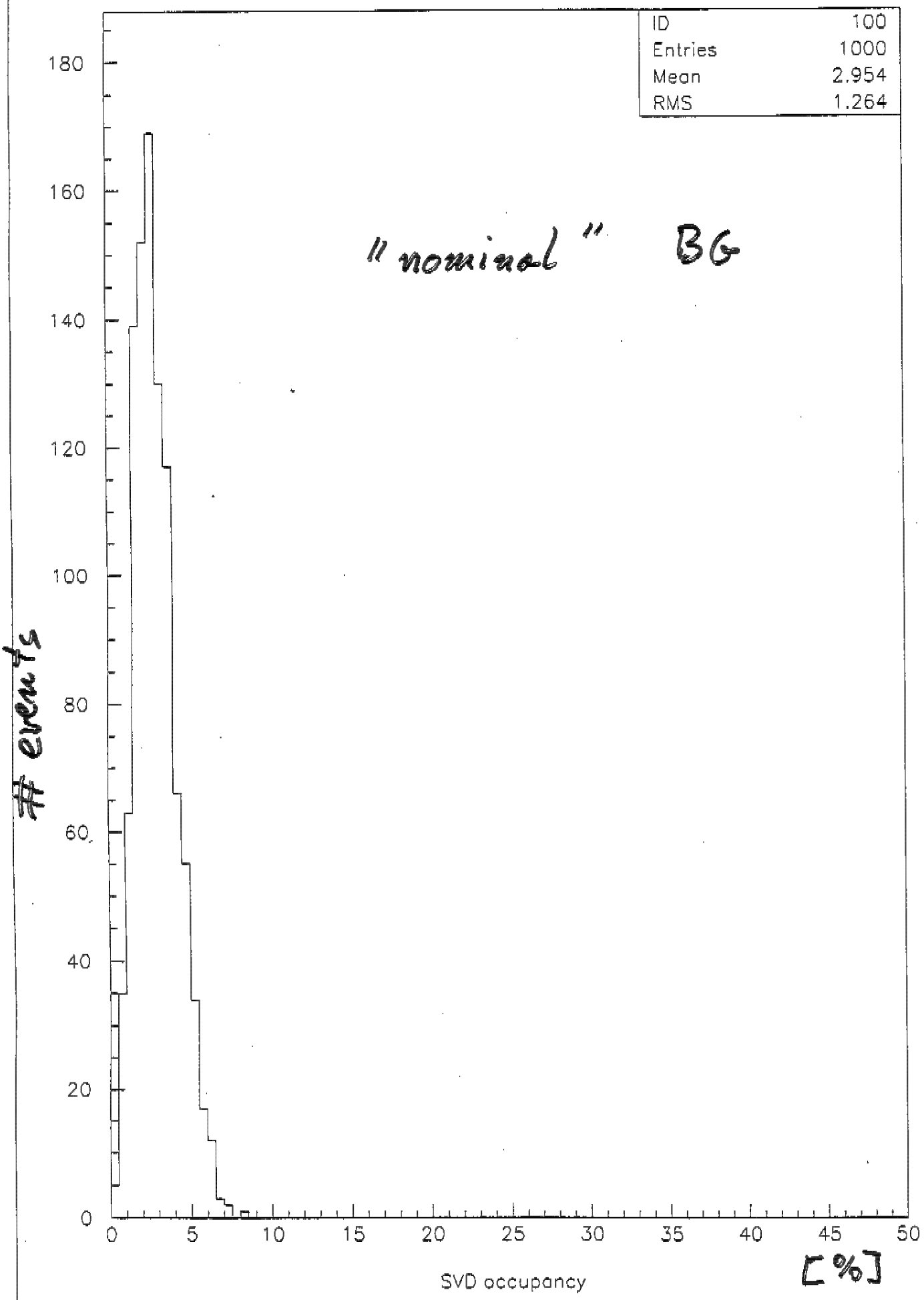
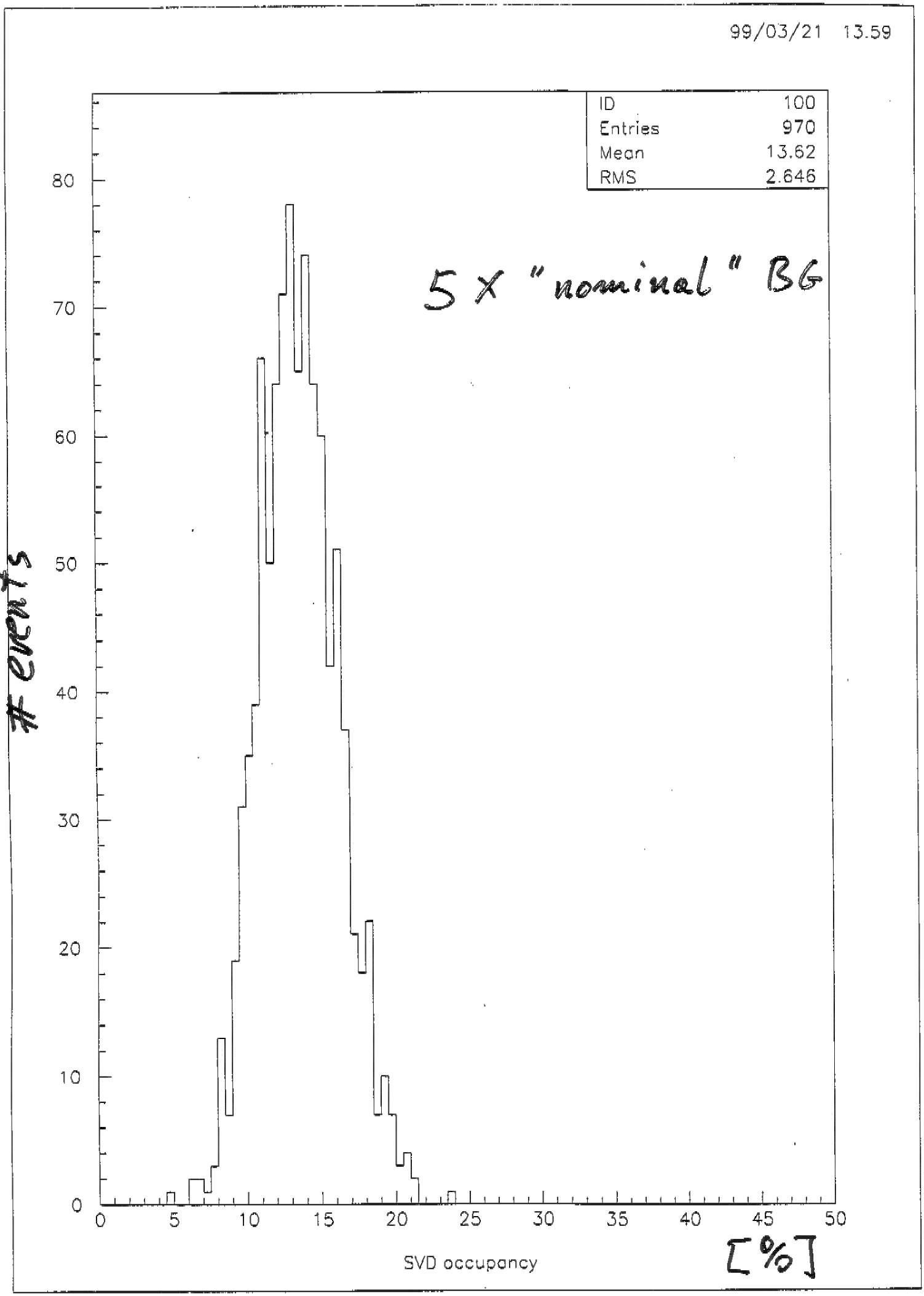

ID 100
Entries 1000
Mean 2.954
RMS 1.264
"nominal" BG
events
SVD occupancy
[%]
0
20
40
60
80
100
120
140
160
180
0
5
10
15
20
25
30
35
40
45
50

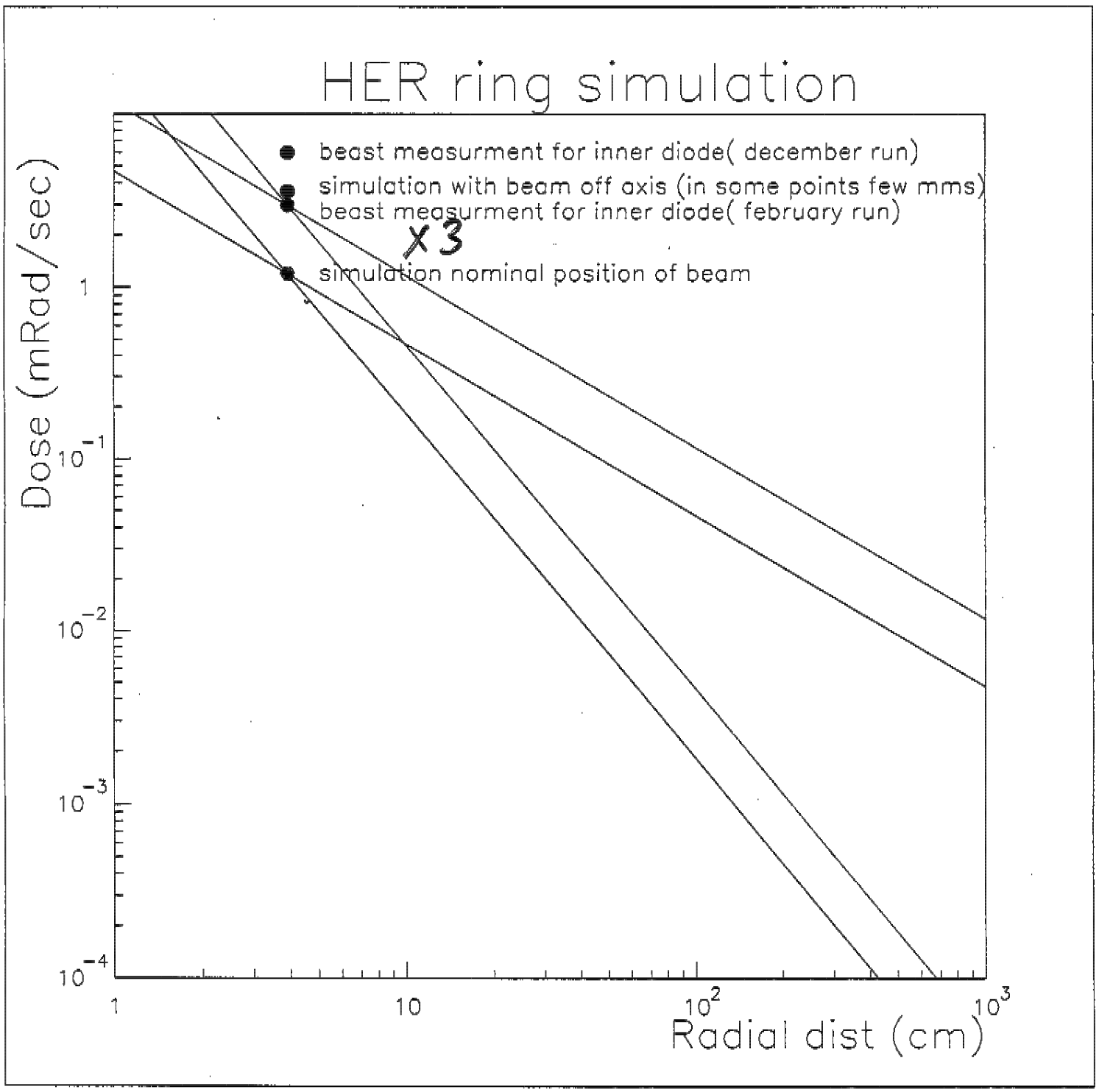

99/03/21 13.59
ID 100
Entries 970
Mean 13.62
RMS 2.646
5 x "nominal" BG
events
0
10
20
30
40
50
60
70
80
0
5
10
15
20
25
30
35
40
45
50
SVD occupancy
[%]

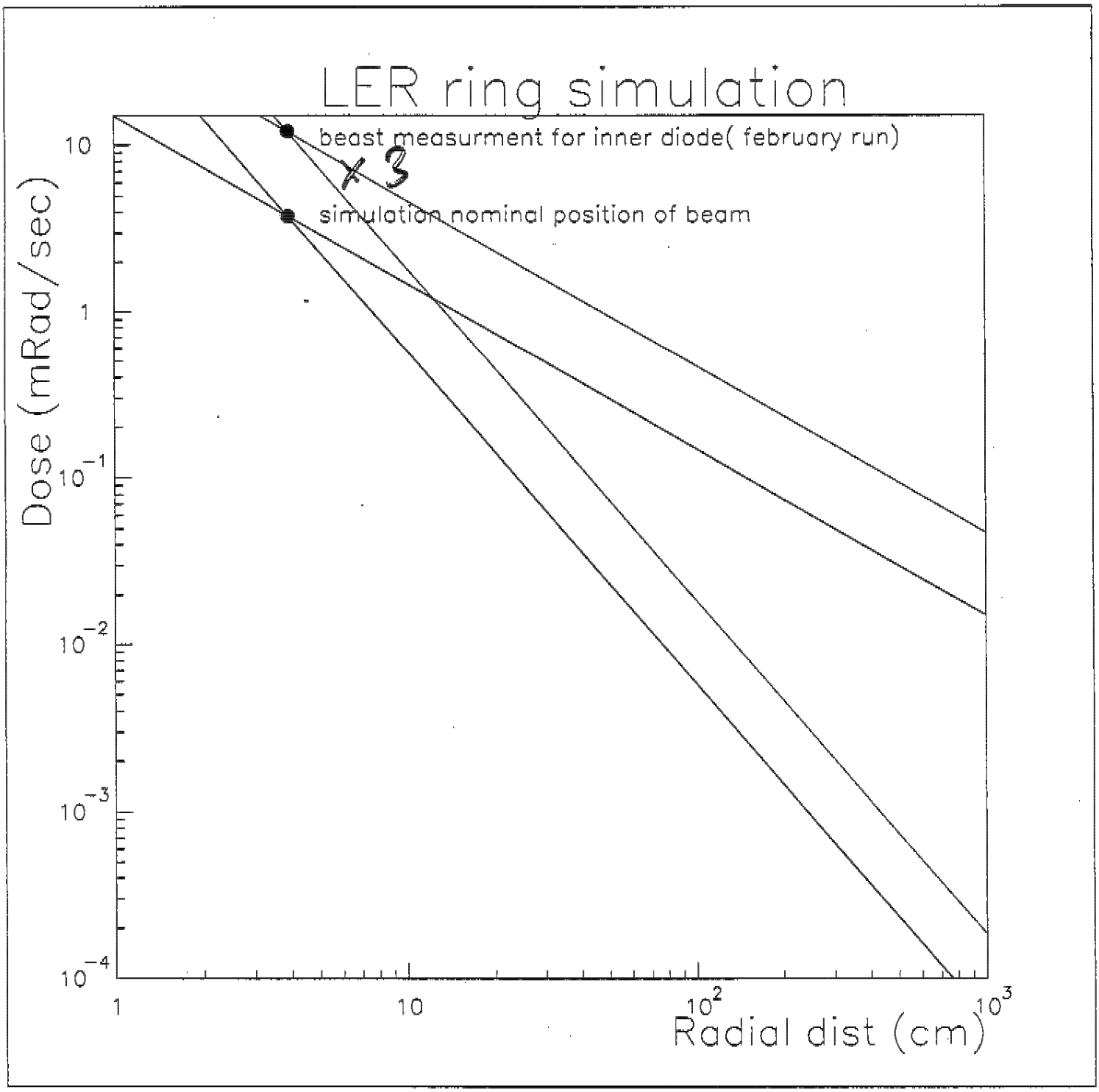
Beast simulation

- There is very little clean machine data.

- We are working in an extreme background environment and we have to make large extrapolations to the expected KEK-B operating conditions.

- Normalized to 1A current and 1 n-Torr pressure our simulations differ by factor three from measured dose.
  - The vacuum profile at the IP was much worst than in the other part of the beam.
  - The azimuthal distribution is consistent which much higher contribution of coulomb scattered lost particles.


HER ring simulation
beast measurment for inner diode(december run)
simulation with beam off axis (in some points few mms)
beast measurment for inner diode(february run)
X3
simulation nominal position of beam
Dose (mRad/sec)
1
10^-1
10^-2
10^-3
10^-4
1
10
10^2
10^3
Radial dist (cm)


LER ring simulation
beast measurment for inner diode(february run)
x 3
simulation nominal position of beam
Dose (mRad/sec)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
1
10
10^2
10^3
Radial dist (cm)

What are the expected sources of lost particles.

- The coulomb scattered particles from the straight sections of the beam.
- The bremsstralung scattered lost particles from the straight sections.
- The coulomb scattered particles from outside the straight section.
- The multi-turns effect, usually slightly off energy bremsstralung scattered particles.
- The beams tail lost on the masks edges.

What we can check with Beast.

- Bressure bumps:
  - close to IP → relative ratio of close coulomb lost particles,
  - straight section far from IP → relative ratio of bremsstralung lost particles,
  - pressure bump on arc → do we have coulomb lost particles from outside of straight section.
- Movable mask studies:
  - close masks effect should be large → beast results are not conclusive,
  - vertival mask are able to remove part of the arc coulomb scattering.
- Multi-turn effect
  - should be remove efficiently by mask with small aperture far from IP.
- Blow out (surprise?)

Conclusions

- Beast results are higher by three than simulation.
  - could be explain but higher pressure around IP.
- Movable mask studies required
- Update our simulation as the vacuum pressure improves .

LER Co mo Masks

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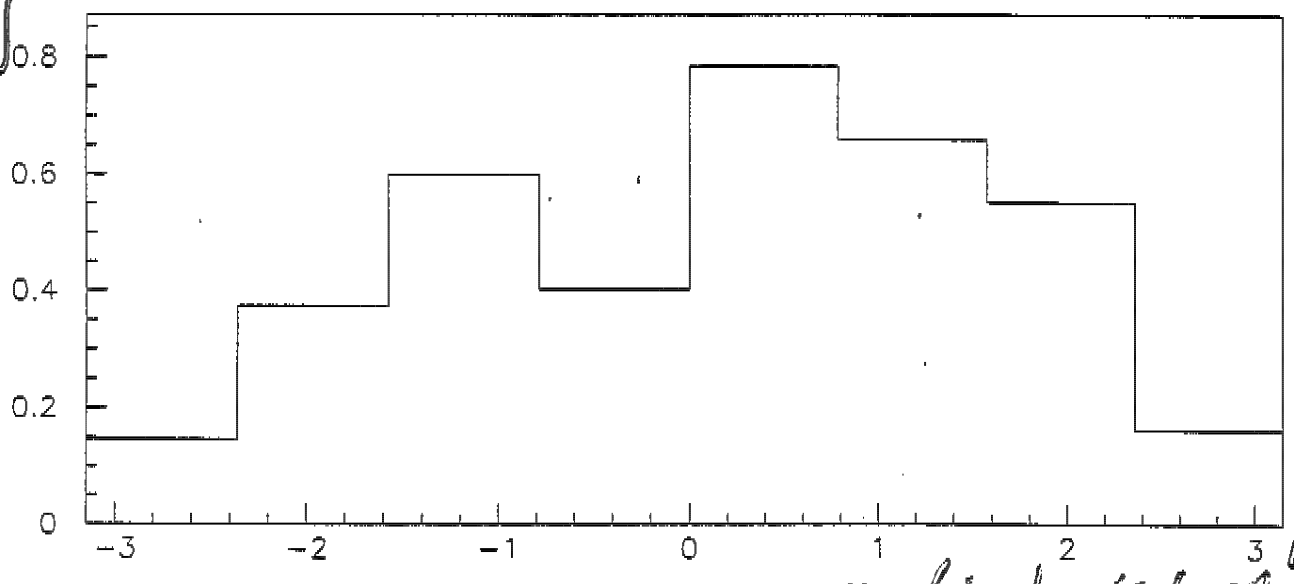
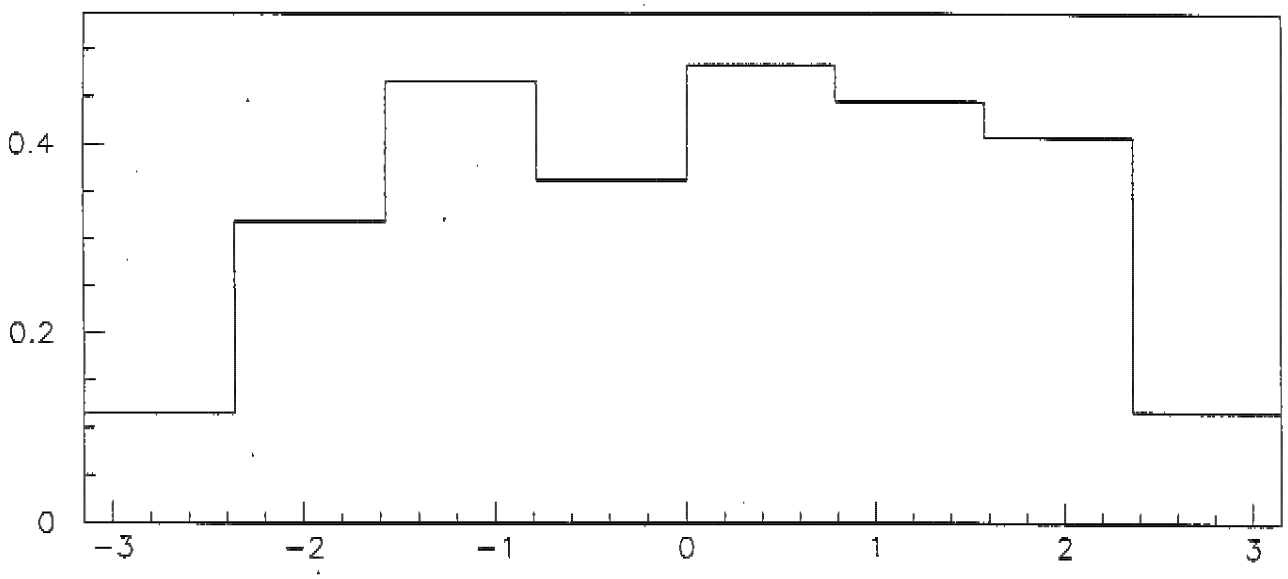


SVD layer 1 radial distribution



SVD elec 1

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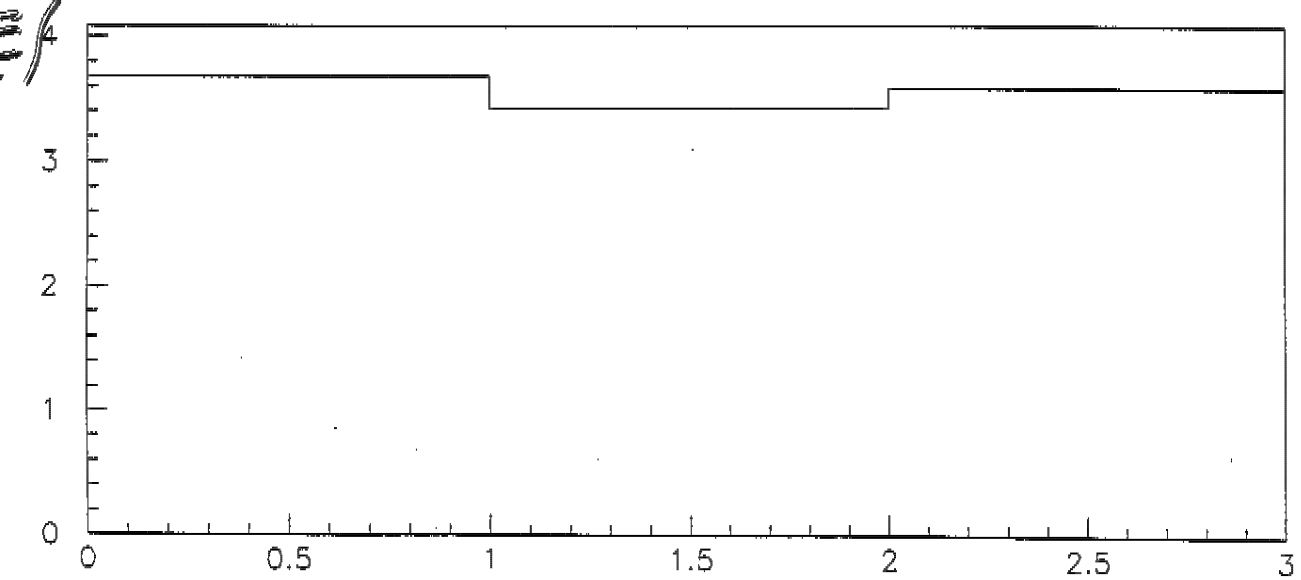

SVD layers