

P. Checchia  
OXFORD 21-3-99.

NON-POINTING PHOTONS  
WITH A CDR/CALIBRO-LIKE  
E.M. CALORIMETER •

- A REMINDER . . . . .
- TWO LEVELS :
  - a) DETECT A SIGNAL
  - b) MEASURE THE  $\tilde{\chi}^0$  LIFETIME
- WHICH IS THE RESOLUTION IN SHOWER DIRECTION - IMPACT PARAMETER?
- VERY PRELIMINARY
- SEE G.B.

## An electromagnetic shashlik calorimeter with longitudinal segmentation

A.C. Benvenuti<sup>1)</sup>, I. Britvich<sup>6)</sup>, T. Camporesi<sup>2)</sup>, P. Checchia<sup>5)</sup>, A. Fenyuk<sup>6)</sup>, V. Hedberg<sup>3)</sup>, V. Lishin<sup>6)</sup>, M. Margoni<sup>5)</sup>, M. Mazzucato<sup>5)</sup>, V. Obraztsov<sup>6)</sup>, M. Paganoni<sup>4)</sup>, V. Poliakov<sup>6)</sup>, F. Simonetto<sup>5)</sup>, F. Terranova<sup>4)</sup>, E. Vlasov<sup>6)</sup>.

### Abstract

A novel technique for longitudinal segmentation of shashlik calorimeters has been tested in the CERN West Area beam facility. A 25 tower c.m. calorimeter has been built with vacuum photodiodes inserted in the first 8 radiation lengths to sample the initial development of the shower. Results concerning energy resolution, impact point reconstruction and  $e/\pi$  separation are reported.

(To be submitted to *Nuclear Instruments and Methods A*)

$$\frac{\sigma_E}{E} = \left( \frac{3.6\%}{\sqrt{E}} + .5\% \right) \oplus \frac{.13}{E}$$

$$\frac{\sigma_{\pi}}{E} = \frac{0.9 \text{ cm}}{\sqrt{E}} \oplus 0.2 \text{ cm}$$

$$e/\pi: \epsilon_{\pi} = 4 \times 10^{-5} \Rightarrow \epsilon_e = 30\% \quad (\text{50 GeV } \pi)$$

<sup>1)</sup> Dipartimento di Fisica, Università di Bologna and INFN, Bologna, Italy

<sup>2)</sup> CERN, European Organization for Nuclear Research, Geneva, Switzerland

<sup>3)</sup> Department of Physics, University of Lund, Lund, Sweden

<sup>4)</sup> Dipartimento di Fisica, Università di Milano and INFN, Milan, Italy

<sup>5)</sup> Dipartimento di Fisica, Università di Padova and INFN, Padua, Italy

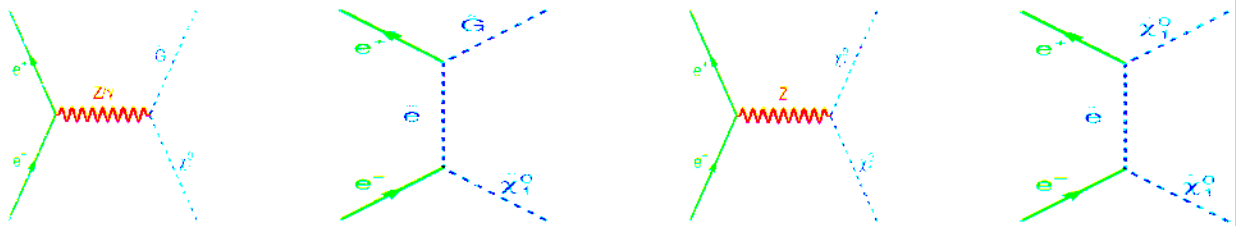
<sup>6)</sup> Institute for High Energy Physics, Serpukov, Russia



# $\tilde{\chi}_1^0$ NLSP

## - Experimental signatures

- direct production and decay:

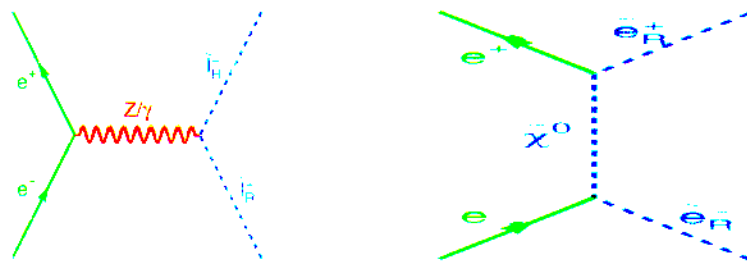


$$\tilde{\chi}_1^0 \rightarrow \tilde{G}\gamma \geq 1 \gamma + \cancel{E}$$

- excess of invisible cross section:

$$\text{Initial State Radiation} \geq 1 \gamma + \cancel{E}$$

- indirect production and cascade decay:



$$\begin{aligned} \tilde{l}_R &\rightarrow \tilde{\chi}_1^0 l && > 1 \gamma \\ \tilde{\chi}_1^\pm &\rightarrow \tilde{\chi}_1^0 W^\pm &\rightarrow qq' && j \text{ and/or } l \\ & & l^\pm \nu_l && + \cancel{E} \end{aligned}$$

GMSB at LEP



## Photon(s) + $\cancel{E}$ final states (ADLO)

- Three signatures:
- One photon pointing to the Interaction Point +  $\cancel{E}$
  - One photon non-pointing to the IP +  $\cancel{E}$
  - $\geq 2$  acoplanar photons +  $\cancel{E}$

signature	signal	background
1 $\gamma$ point.	invis. cross section + ISR	$\nu\bar{\nu}\gamma(\gamma)$ $e^+e^-\gamma$
1 $\gamma$ point.	single $\tilde{\chi}_1^0$ production long living	$\nu\bar{\nu}\gamma(\gamma)$ $e^+e^-\gamma$
1 $\gamma$ non-point.	double $\tilde{\chi}_1^0$ production	$\nu\bar{\nu}\gamma(\gamma)$
2 $\gamma$	double $\tilde{\chi}_1^0$ production	$\nu\bar{\nu}\gamma\gamma(\gamma)$



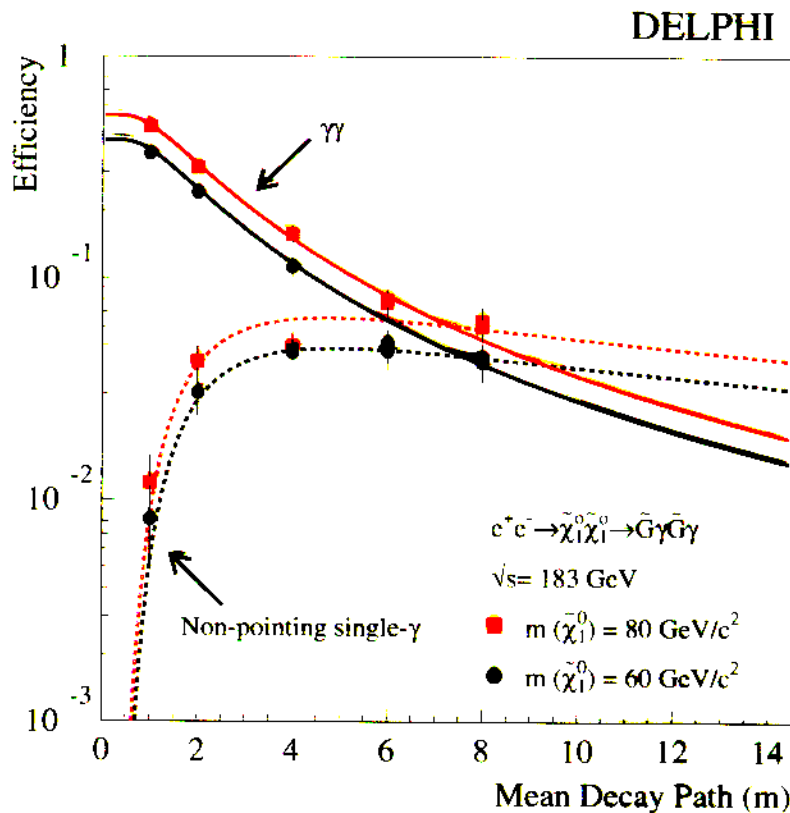
### Non-pointing photon (A D)

- The  $\tilde{\chi}_1^0$  decay length is (in  $\mu\text{m}$ ):

$$L \simeq 130 \left( \frac{m_{\tilde{\chi}_1^0}}{100 \text{ GeV}} \right)^{-5} \left( \frac{\sqrt{F}}{100 \text{ TeV}} \right)^4 (\beta\gamma)_{\tilde{\chi}_1^0}$$

- The efficiency to detect both photons goes as  $\epsilon_{2\gamma} \sim (1 - e^{-\frac{\langle L \rangle_{\text{det}}}{L}})^2$

- While to detect only one photon it tends to  $\epsilon_{1\gamma} \propto 2(1 - e^{-\frac{\langle L \rangle_{\text{det}}}{L}})$

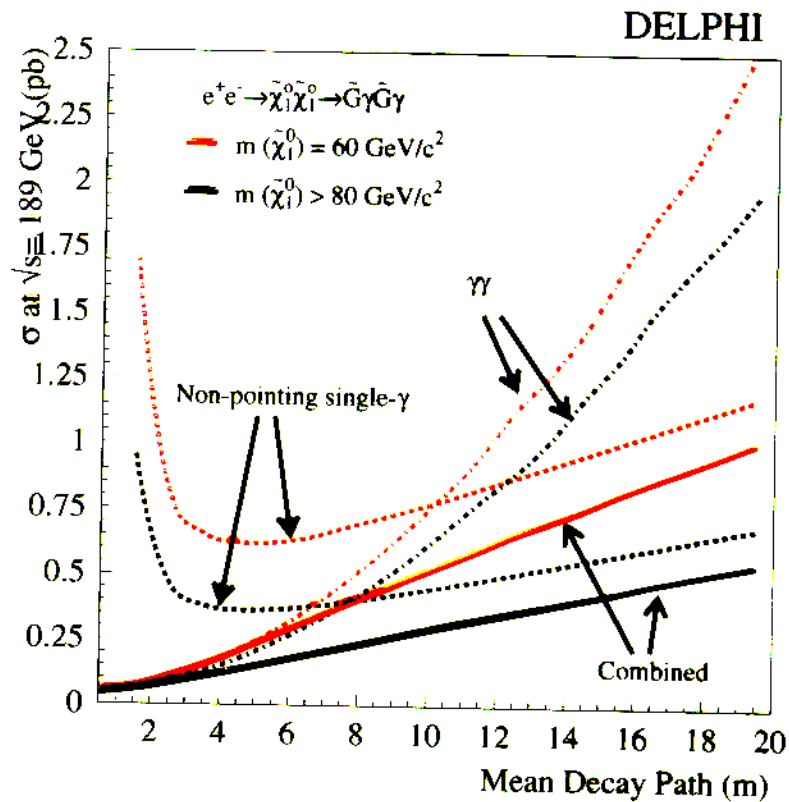


GMSB at LEP



- Single photons dominated by  $\nu\bar{\nu}\gamma(\gamma)$
- Removed by impact parameter cut ( $> 40$  cm) if photon direction measured

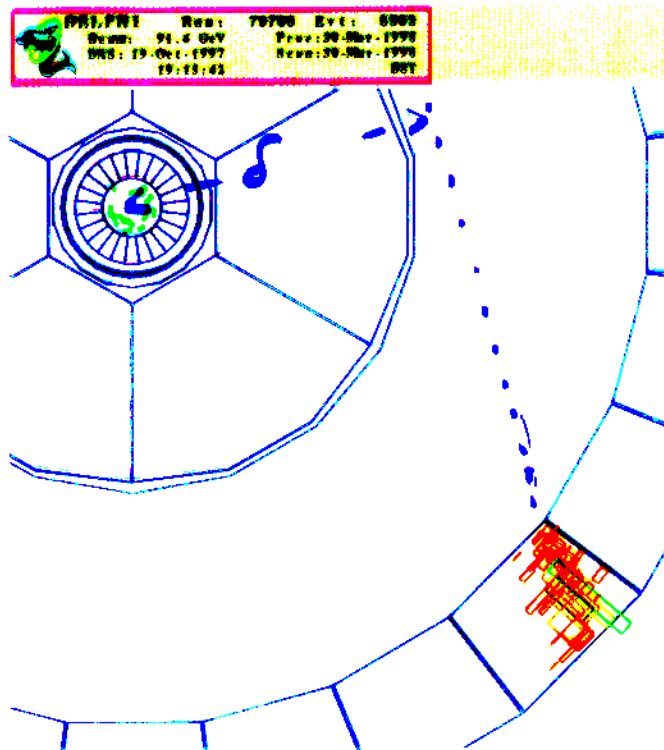
$\sqrt{s}$ (GeV)(D)	expect.	Data
$\leq 172$	1.01	2
183	1.65	0
189	5.2	4
189 (A)	0.6	0



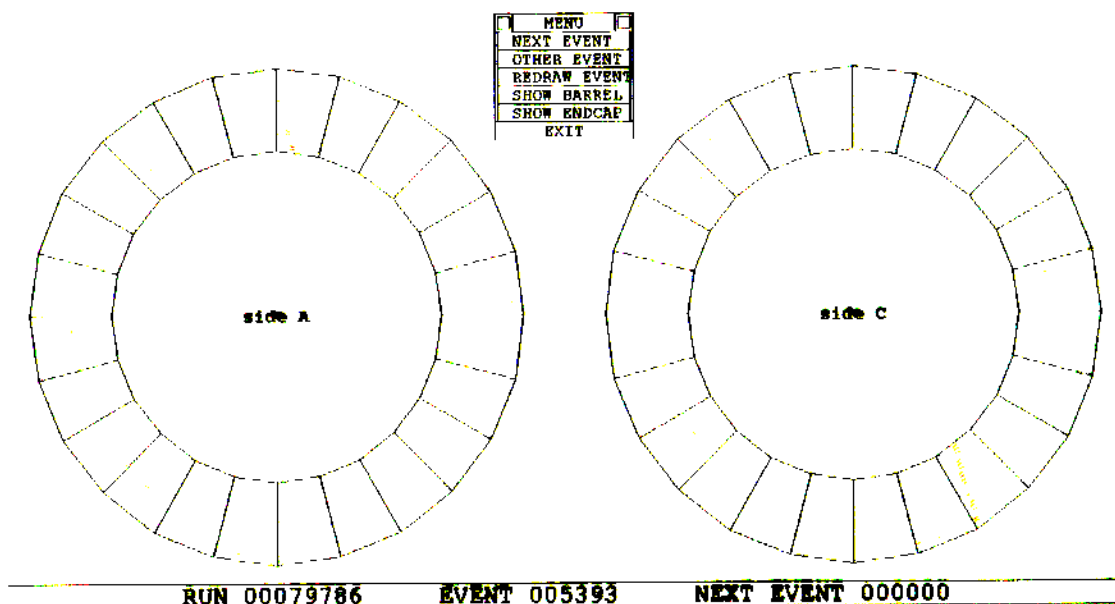
# Neutralino search with photons

Long lived Neutralino: Search for “non pointing” photons (0 cand., 0.4 exp.)

Possible candidate: HPC:

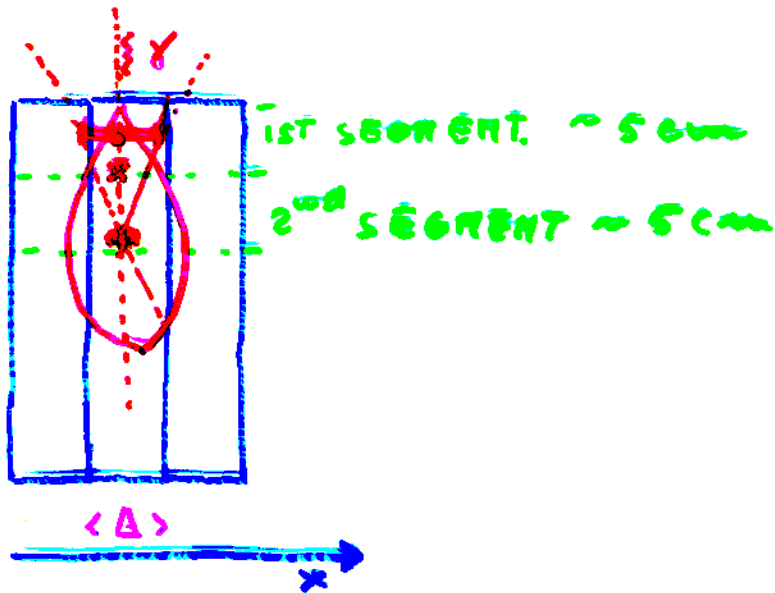


HCAL cathode readout:



SUPPOSE . . . (COR/CALEIDO)\*

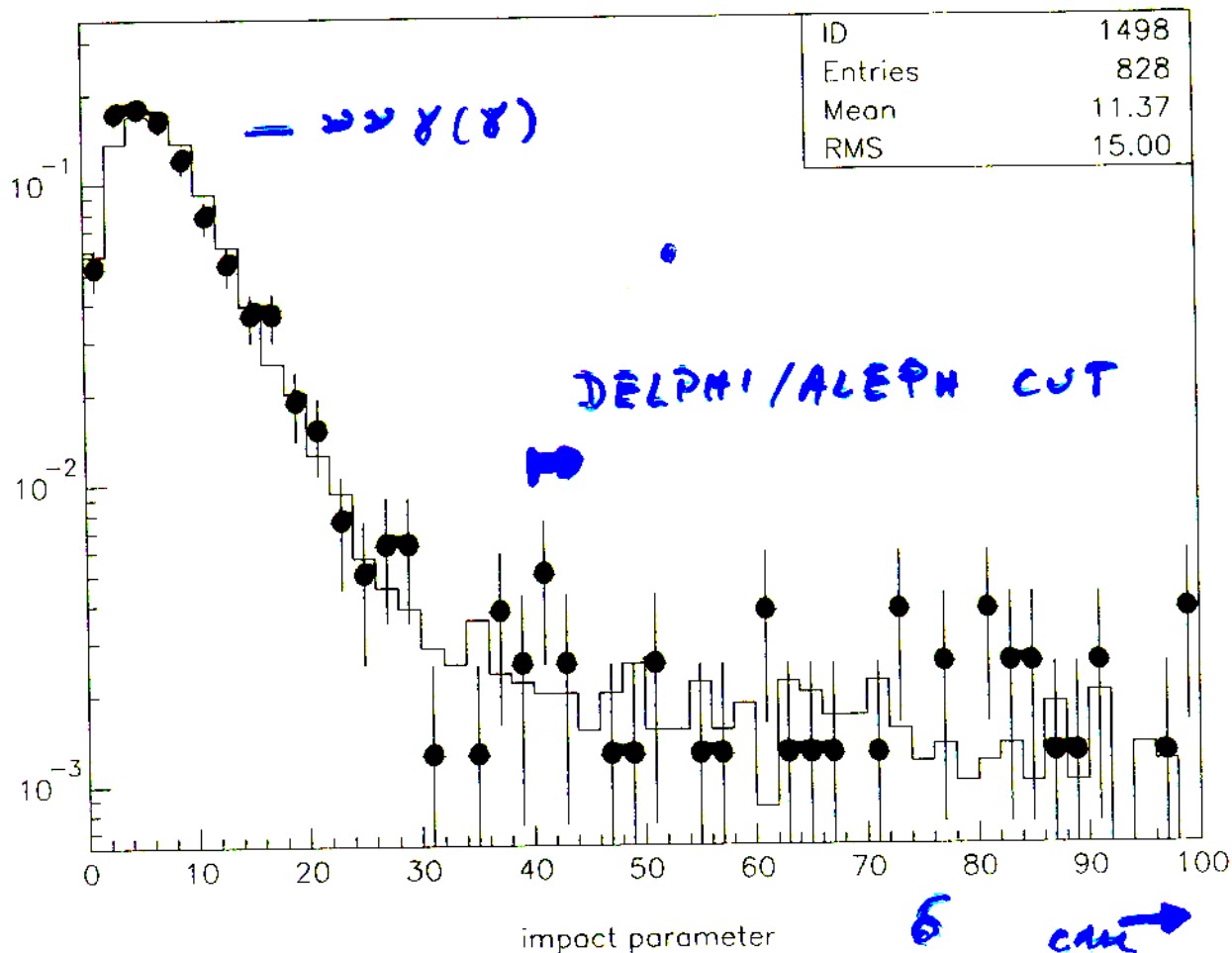
- A COUNTER MATRIX WITH A CELL SIZE  $\Delta$  AND 3<sup>RD</sup> LONGITUDINAL SEGMENTATION



- COMBINATION OF 3 MEASUREMENTS OF THE SHOWER IMPACT CENTROID AT DIFFERENT DEPTHS.
- 1<sup>ST</sup> LAYER: ALMOST ONLY ONE COUNTER ABOVE THRESHOLD  $\Rightarrow \sigma_x^{1ST} \sim \frac{\Delta}{\sqrt{12}} \sim \begin{matrix} 2.9 \text{ cm } \Delta=5 \\ .85 \text{ cm } \Delta=3 \end{matrix}$
- 1<sup>ST</sup> + 2<sup>ND</sup> LAYER: BETTER RESOLUTION  
 $\sigma_x^{1ST+2ND} \sim .95 \text{ cm } \Delta=5$  BUT LOWER LEVER ARM
- TOTAL COUNTER ENERGY \*

\* NB. NO PRESOWER

# AT LEP...



# AT LC

- SUPPOSE : ER. CAL 2m FROM I.P  
 $90^\circ \gamma$   
 $E_\gamma > 40 \text{ GeV}$

$\Delta$	5 cm	3 cm
* $\gamma$ (cm)	$\approx 50$	$\approx 30$

(IMPROVES AT HIGHER  $\gamma$  ENERGIES)

- NOT IMPOSSIBLE BUT DIFFICULT  
 (IMPROVEMENTS WITH OTHER VARIABLES)

IF PRESAMPLER: MUCH EASIER

\*VERY CRUDE TOY MC