Luminosity spectrum measurement

1st LC Physics Study Group Meeting

22/Apr./2003 @ KEK

Y. Kurihara

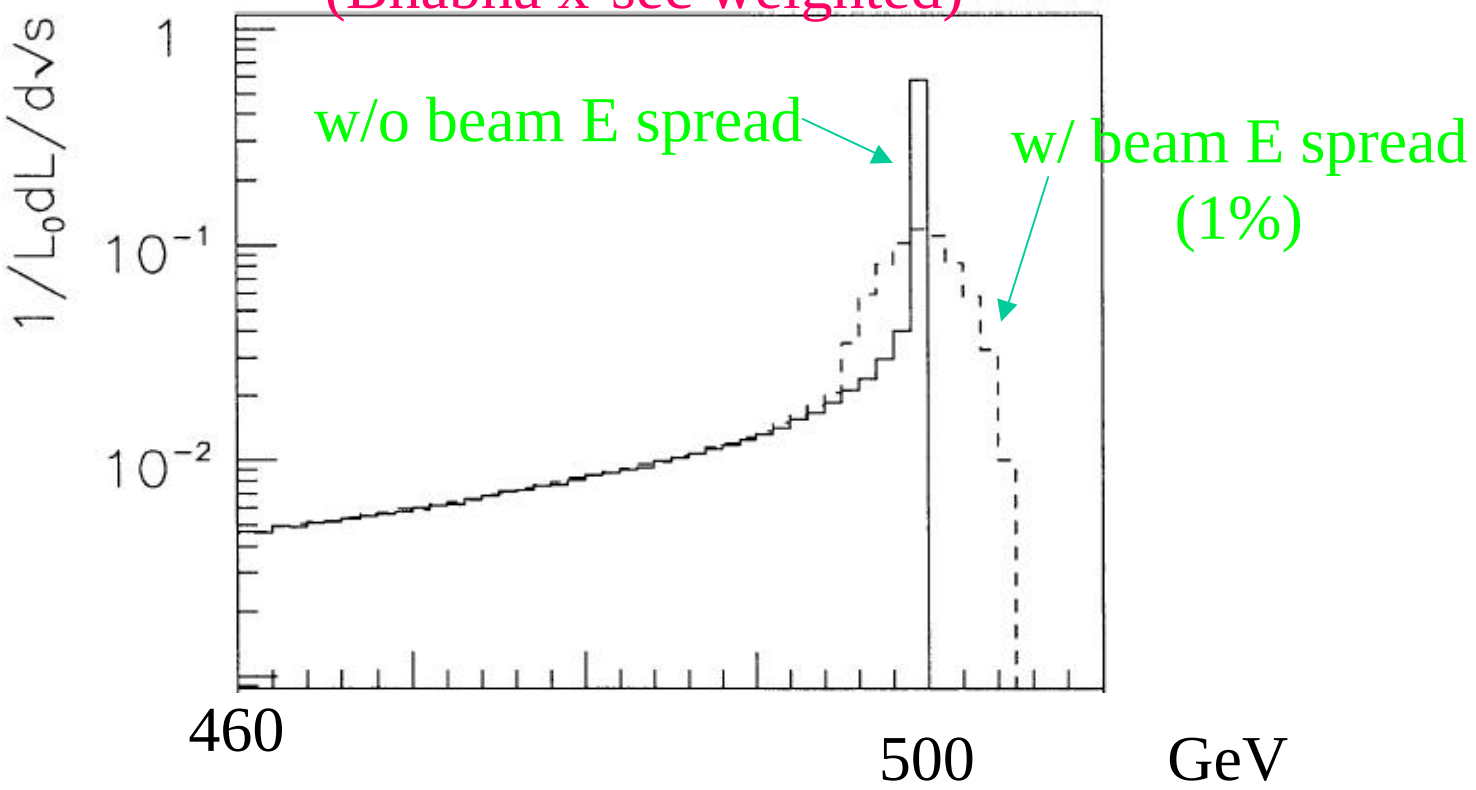
(KEK)

N. Toomi et. al., PLB249 (1998)162

Introduction

- Can you believe this w/o any measurement?

Luminositu spectrum
(Bhabha x-sec weighted)



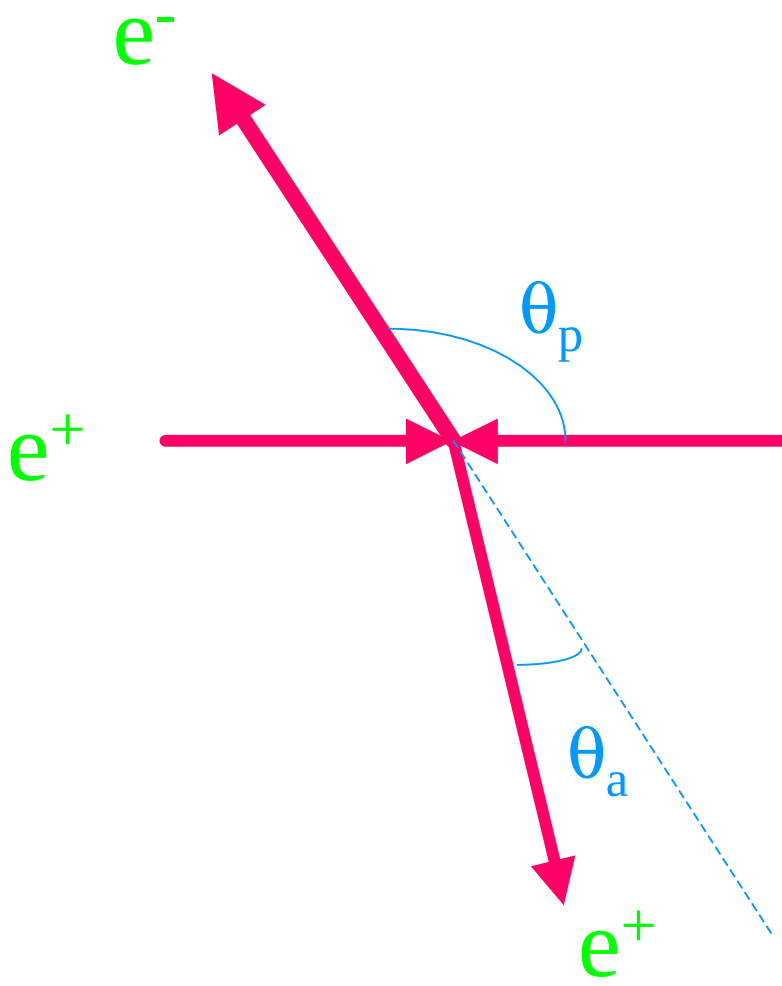
- 1% acc. Lumi meas. is not trivial ！

Accelerator parameters

E_{beam} /GeV	250	σ_x /nm	260.0
$N_{\mathrm{particles}}/10^{10}$	0.7	σ_y /nm	3.04
$\epsilon_x/10^{-6}$ mrad	3.3	σ_z/μm	90
$\epsilon_y/10^{-6}$ mrad	0.048	f_{rep}	150
β_x^* /mm	10.0	n_{bunch}	85
β_y^* /mm	0.1		

Sorry for old parameters

Spectrum Measurement



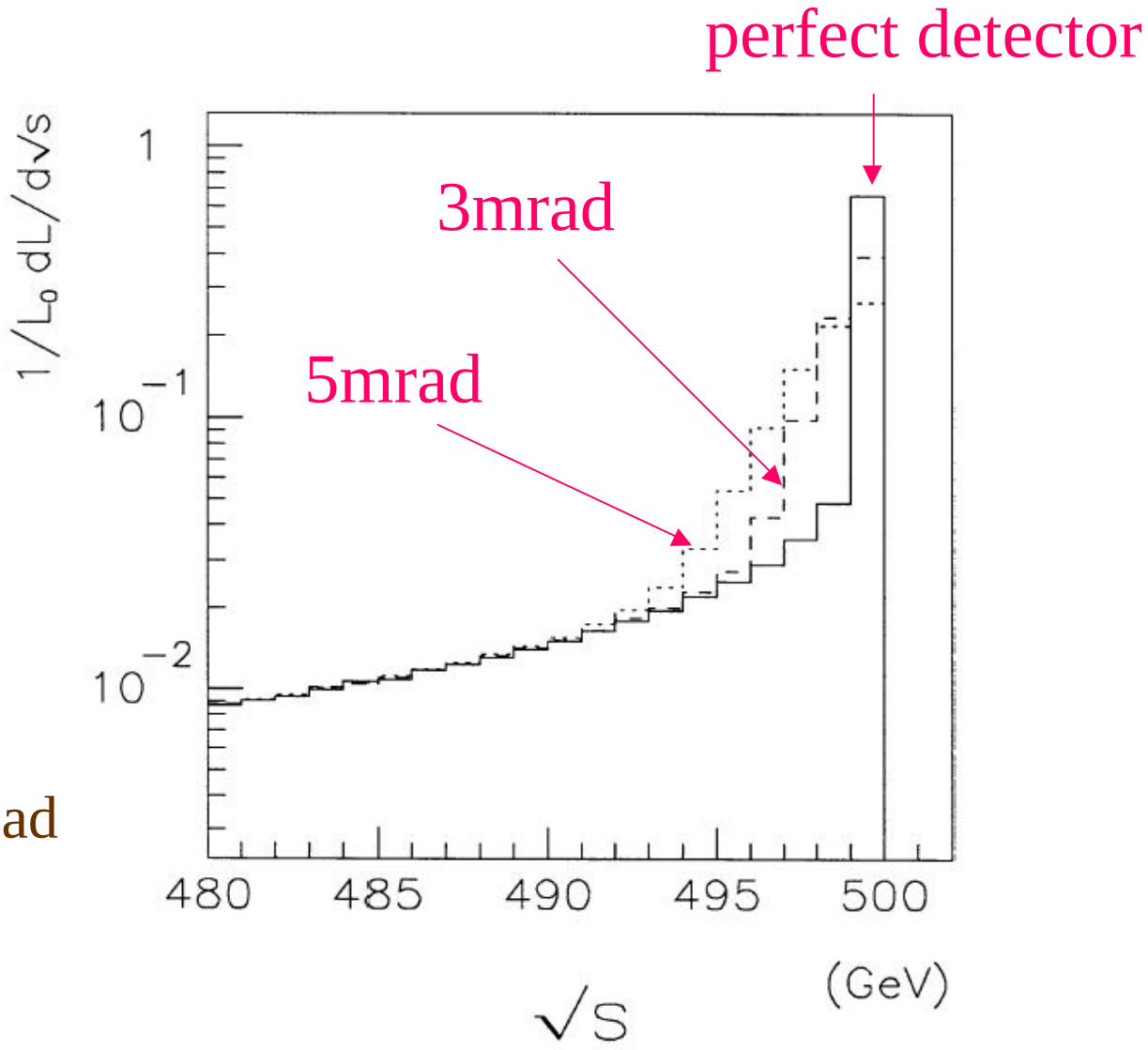
$$\Delta P \approx \theta_a \, P_b / \sin\overline{\theta}_p$$

$$\sqrt{S}_{meas} = \sqrt{S}_0 - \Delta P$$

$\sqrt{S}_0$

Effect of angular resolution

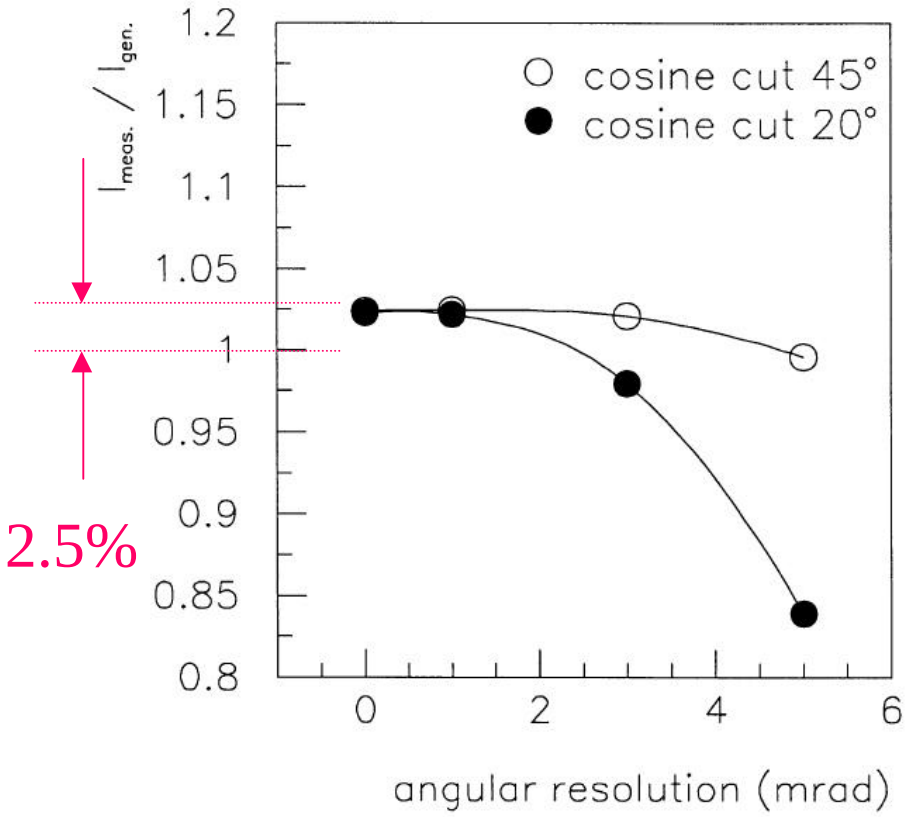
Measured spectrum from acoll. angle



No beam E spread

Effective Luminosity

$$I = \int_{495}^{\infty} \frac{d\mathcal{L}(\sqrt{s})}{d\sqrt{s}} \sigma(\sqrt{s})\, d\sqrt{s}$$



2.5%

Smaller angle

Higher statistics

Bad resolution (1/sinθ)

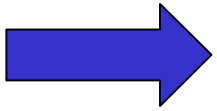
Constant resolution

Beam-parameter fitting

- Three independent parameters based on the Yokoya empirical function

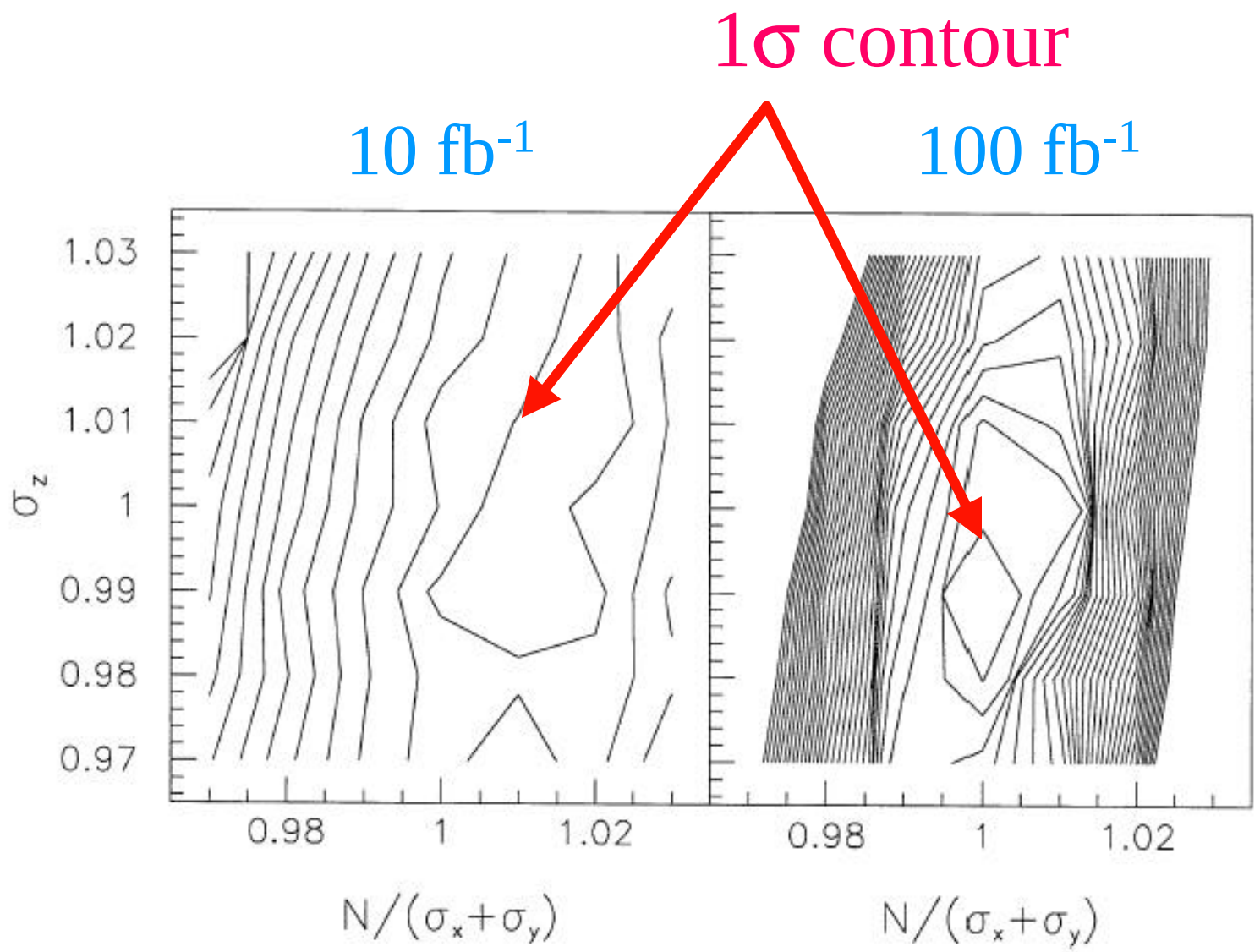
  1. $N/(\sigma_x+\sigma_y)$
  2. σ_z
  3. ΔE

- Test "experimental data"
  1. Parameters in the table
  2. Integrated Lum. of 10 fb^{-1} or more.
  3. $45° < \theta_p < 135°$



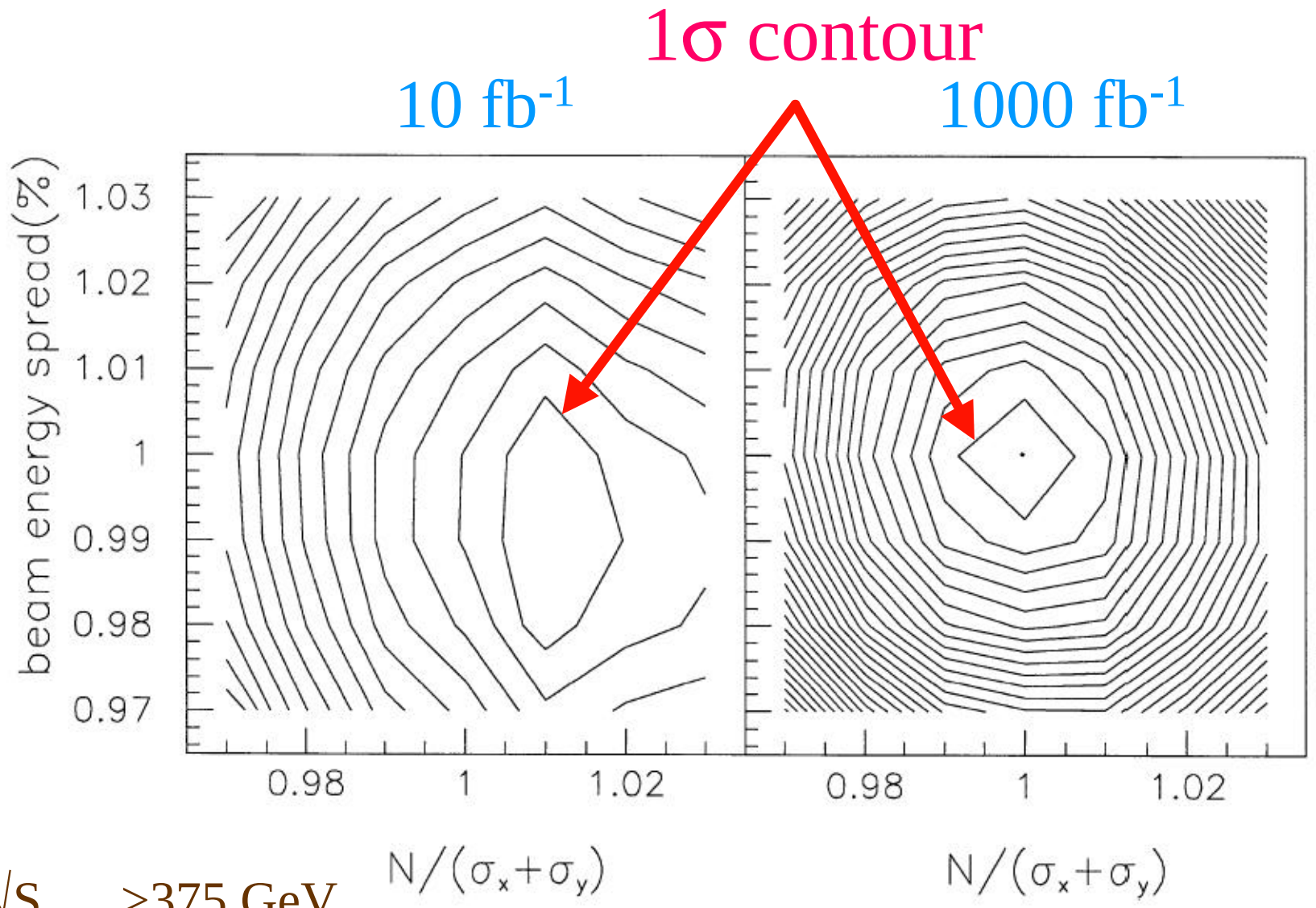
Likelihood fitting on $\sqrt{S}_{meas}$

σ_z VS. $N/(\sigma_x+\sigma_y)$



$\sqrt{S_{meas}}$ >375 GeV

ΔE vs. $N/(\sigma_x+\sigma_y)$



$\sqrt{S_{meas}}$ >375 GeV

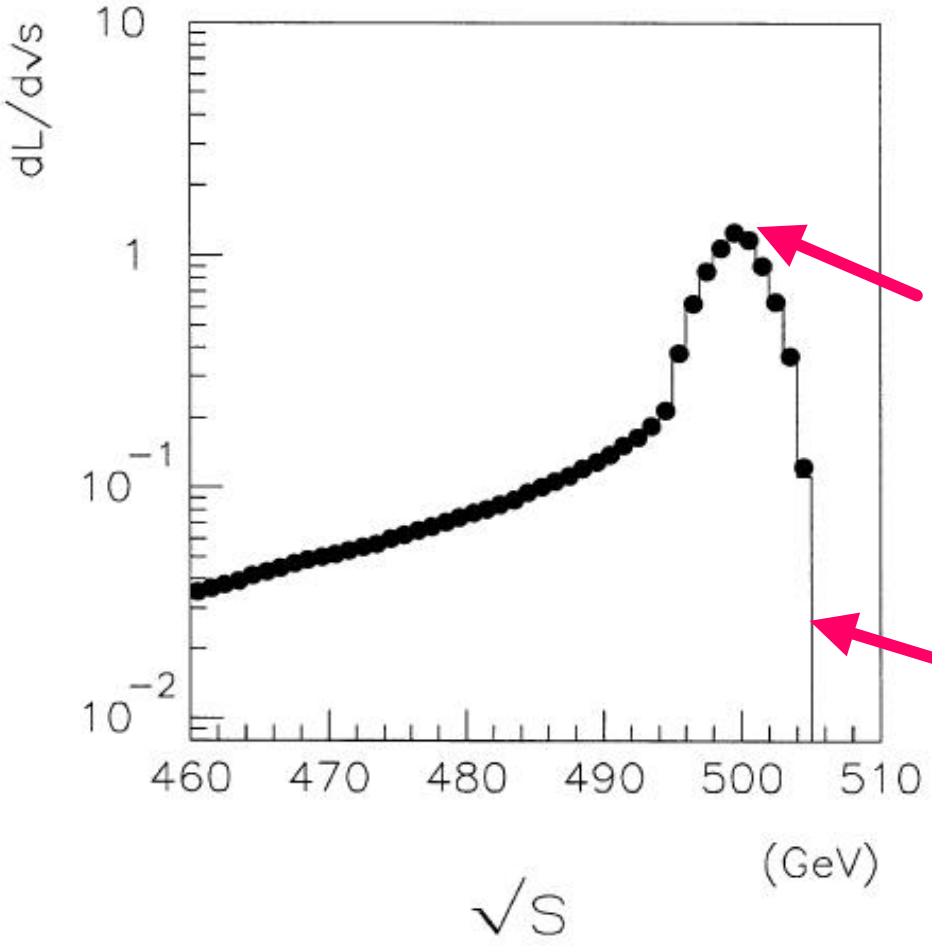
Luminosity measurement

$$\mathscr{L} = N_{\text{events}} \sum_{i=1} \mathscr{P}_i(B^{\text{meas}}, \Delta E^{\text{meas}}) / \sigma_i$$

- N_{event} : the observed #events
- $\mathscr{P}_i$: probability density (Yokoya func.)
- B^{meas} : measured $N/(\sigma_x+\sigma_y)$
- ΔE^{meas}: measured E spread
- σ_i : Bhabh cross section in each bin

$L^{\text{meas}} = 9.990 \pm 0.070$ fb^{-1} (input 10fb^{-1})

Luminosity measurement



Obtained from measured parameters

Input distribution

Future plan

- Realistic detector effect
- More precise Bhabha cross section
- Completely new idea
  1) full likelihood fitting
  2) Bayesian statistical method (Shibata-san)

$$\sum_{j=1}^{n} \ln \frac{d\mathscr{L}(\sqrt{s})}{d\sqrt{s}} \frac{d\sigma(\sqrt{s})}{d\Omega} \otimes \boldsymbol{F}^{\mathrm{detec}}(\sqrt{S},\Omega)$$