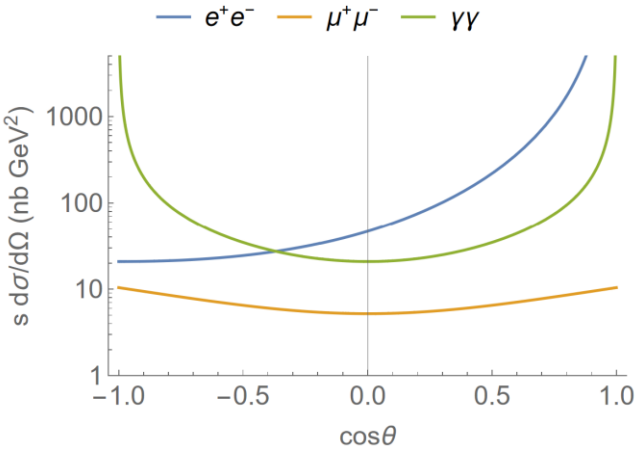
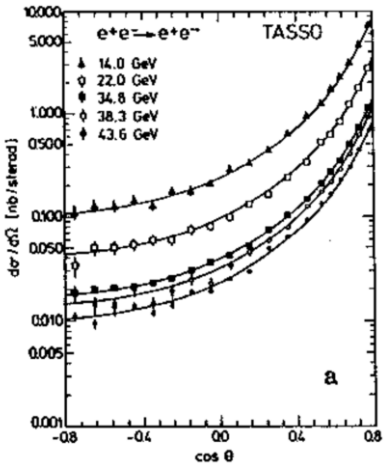
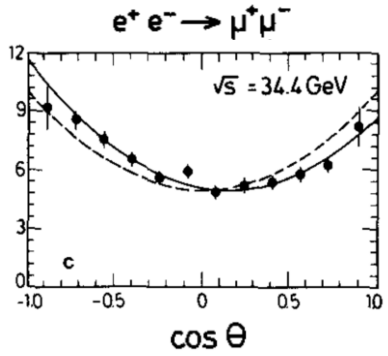
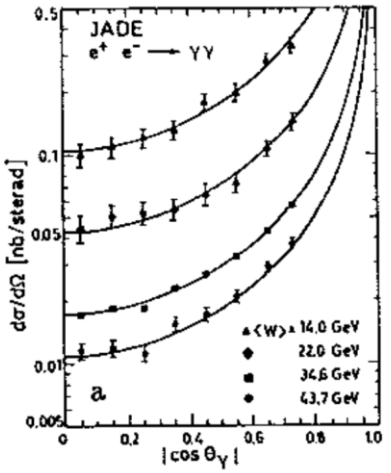
High-energy tests of QED: e^+e^- collisions









$e^+e^- \rightarrow e^+e^-$

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{16s}\frac{(3+\cos^2\vartheta)^2}{\sin^4\frac{\vartheta}{2}}$$

$$= \frac{\alpha^2}{2s}\left(\frac{u^2+t^2}{s^2} + \frac{s^2+u^2}{t^2} + \frac{2u^2}{st}\right)$$

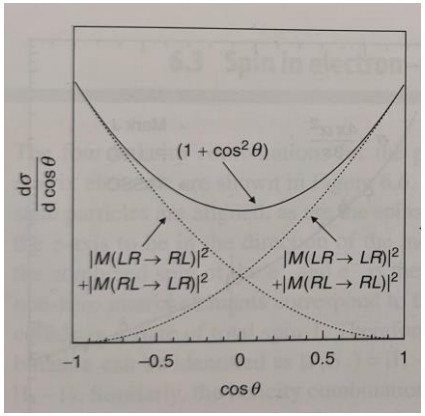
s-channel, t-channel

$e^+e^- \rightarrow \mu^+\mu^-$

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4s}(1+\cos^2\vartheta)$$

$$= \frac{\alpha^2}{2s}\left(\frac{u^2+t^2}{s^2}\right)$$

s-channel only



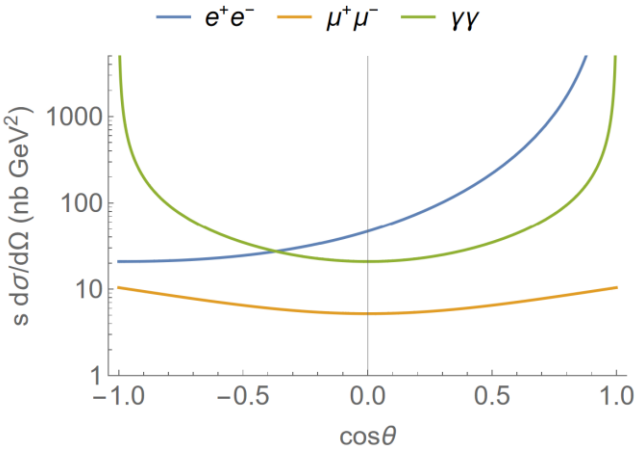
$e^+e^- \rightarrow \gamma\gamma$

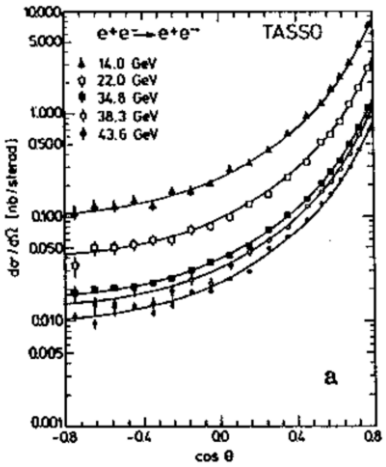
$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{s}\frac{(1+\cos^2\vartheta)}{\sin^2\vartheta}$$

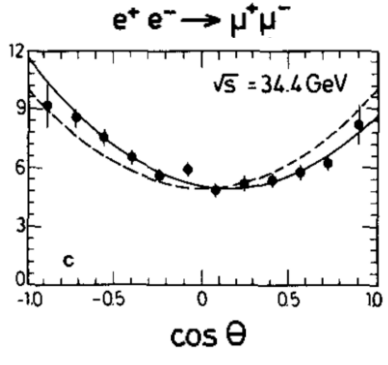
$$= \frac{\alpha^2}{2s}\left(\frac{u^2+t^2}{tu}\right)$$

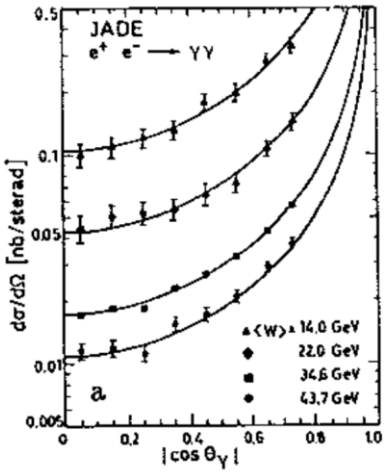
t-channel, u-channel

High-energy tests of QED: e^+e^- collisions









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s-channel only

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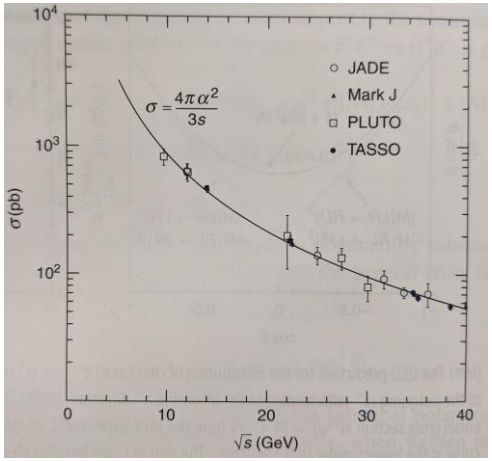
$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{s}\frac{(1+\cos^2\vartheta)}{\sin^2\vartheta}$$

$$= \frac{\alpha^2}{2s}\left(\frac{u^2+t^2}{tu}\right)$$

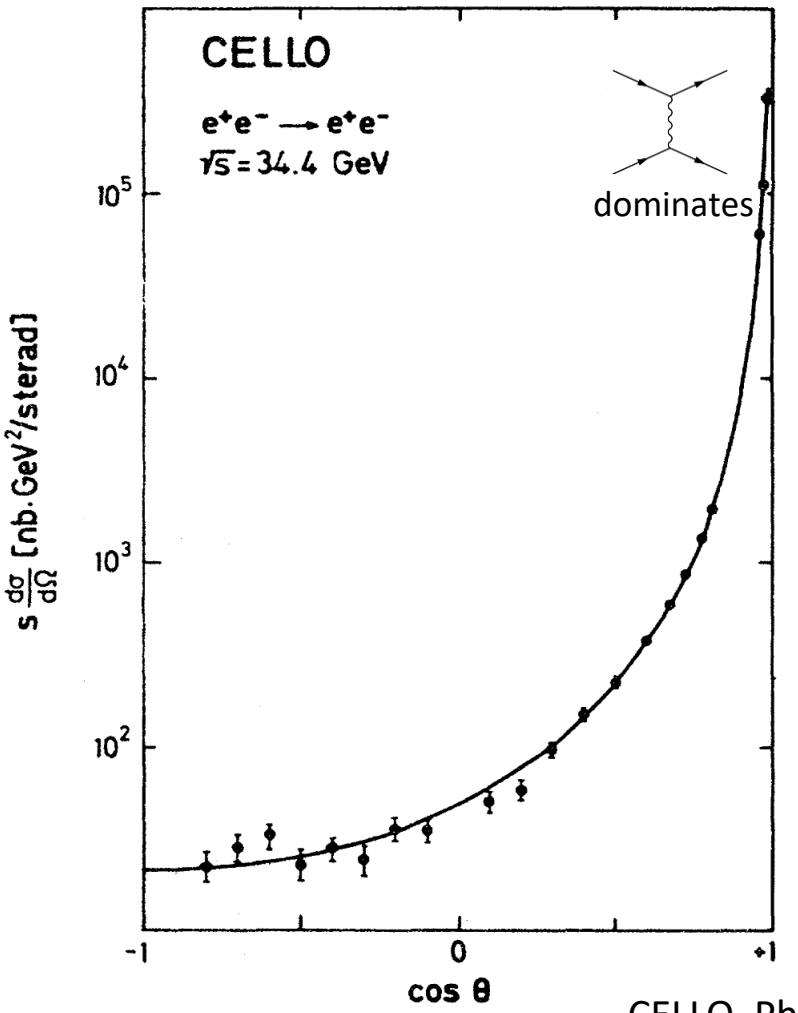
t-channel, u-channel

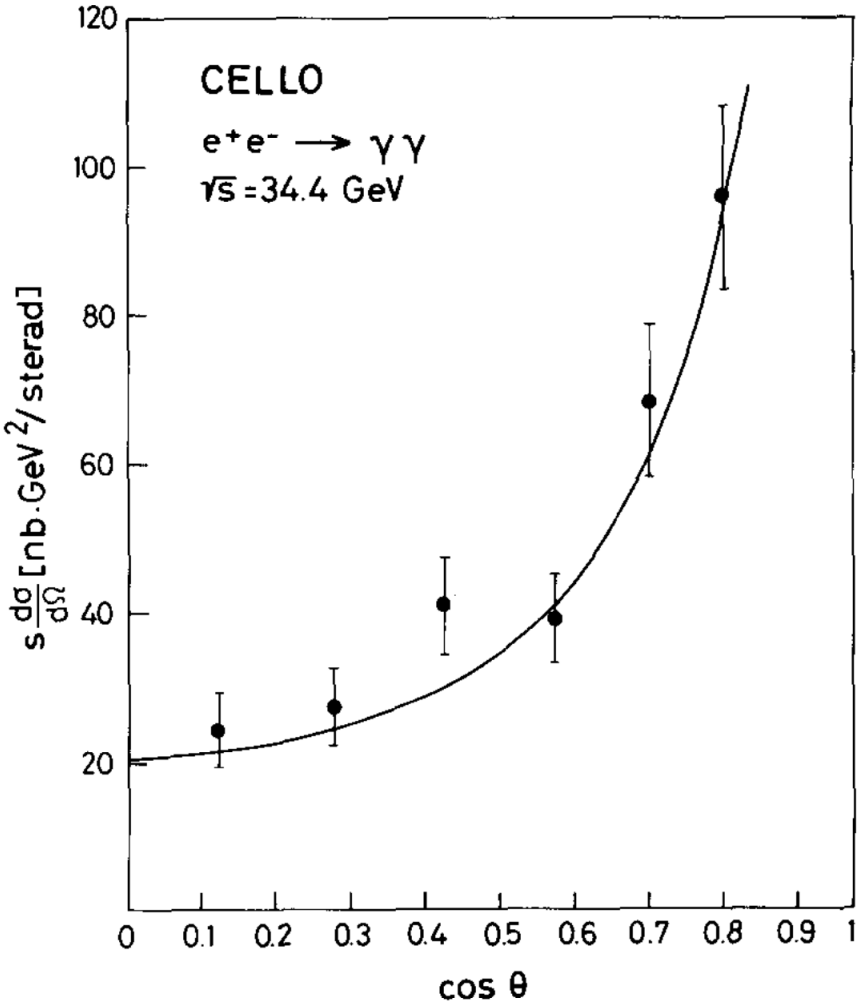


High-energy tests of QED: e^+e^- collisions

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{16s}\frac{(3+\cos^2\vartheta)^2}{\sin^4\frac{\vartheta}{2}}$$

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{s}\frac{(1+\cos^2\vartheta)}{\sin^2\vartheta}$$





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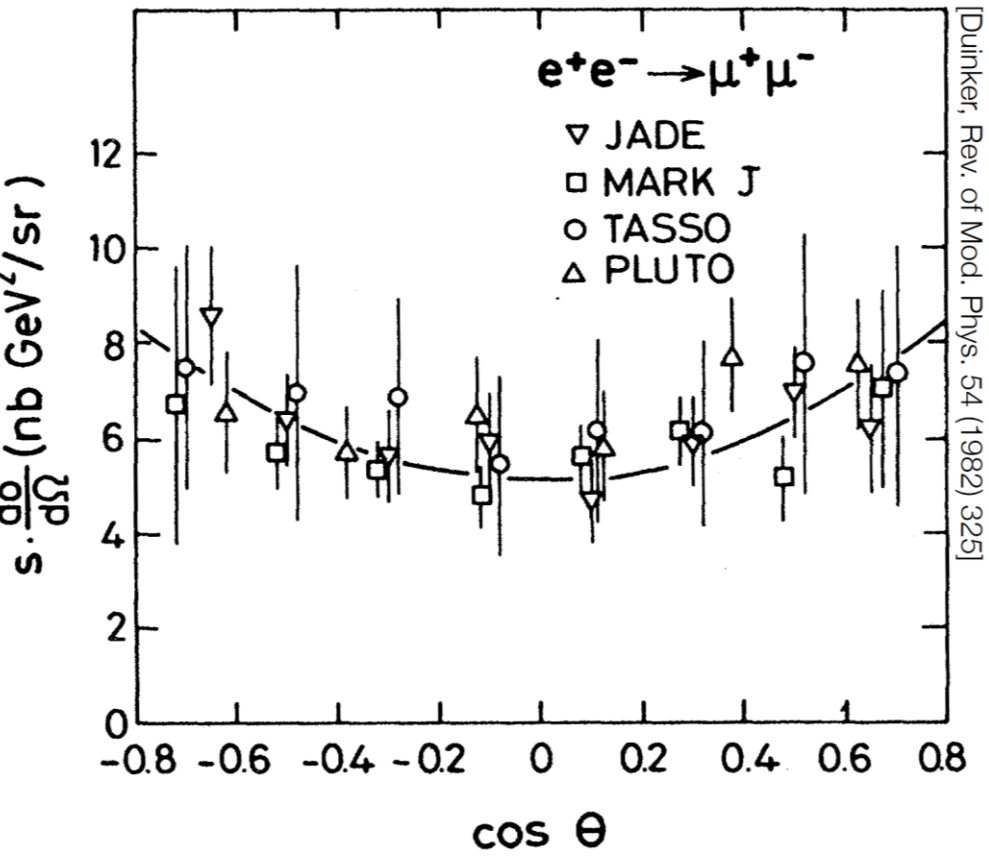
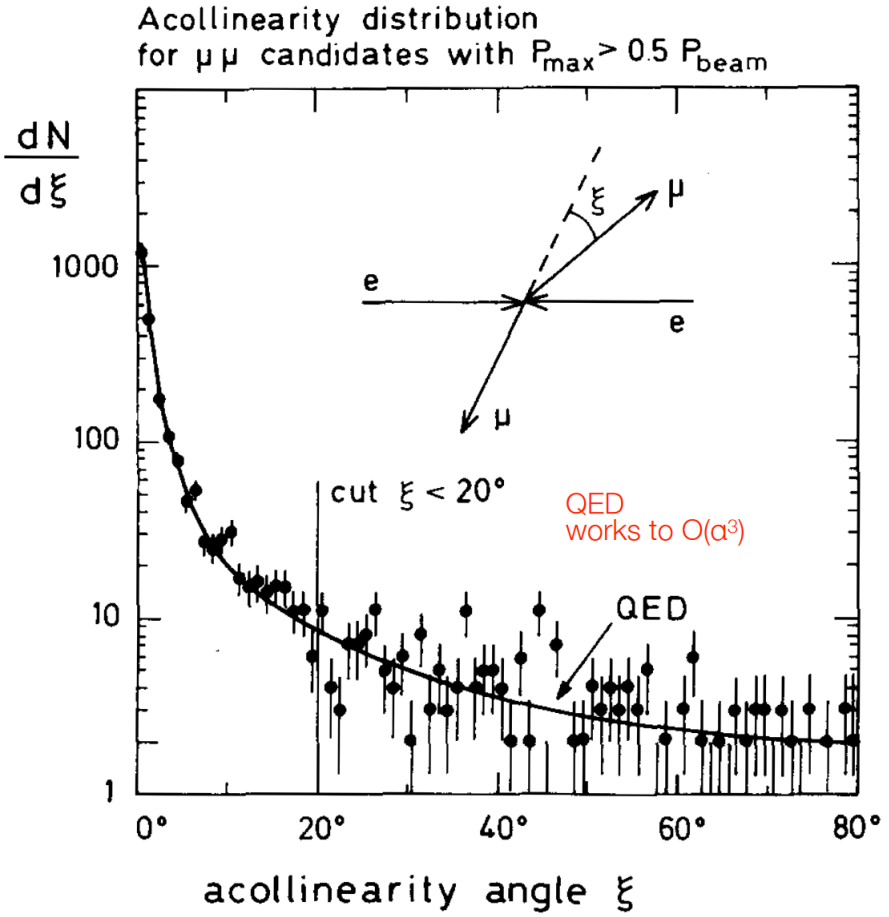
$\mu\mu$ final state

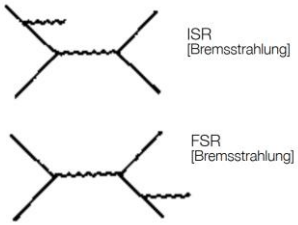


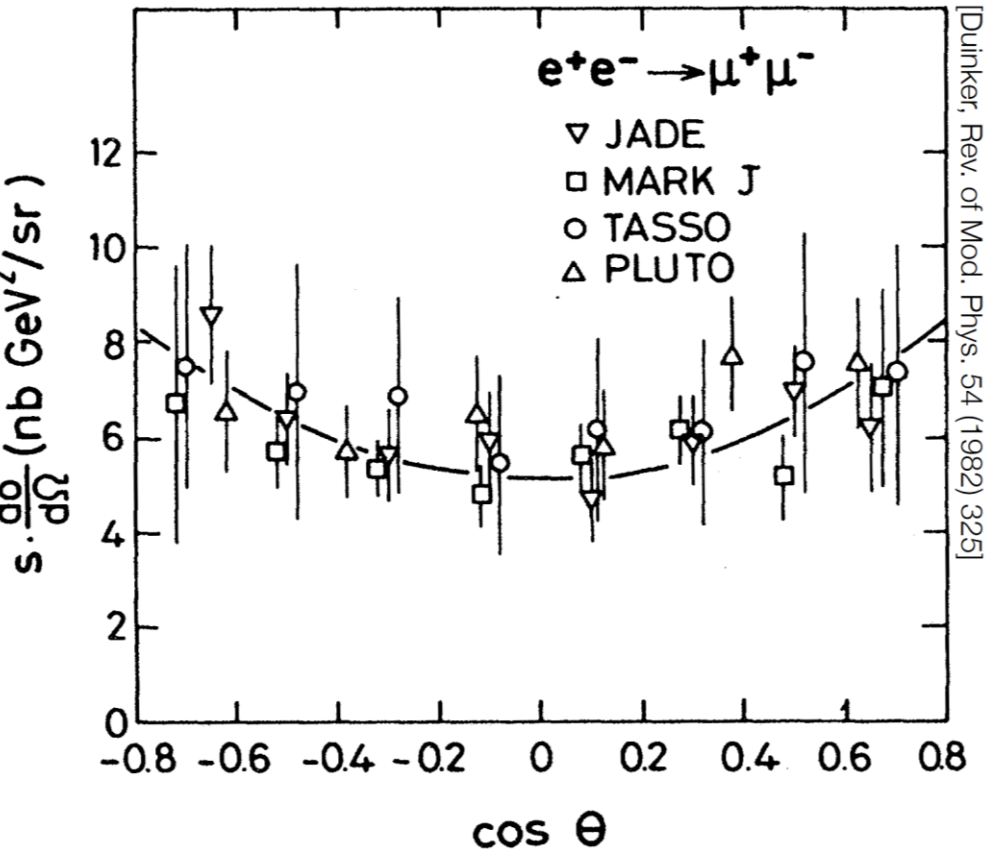


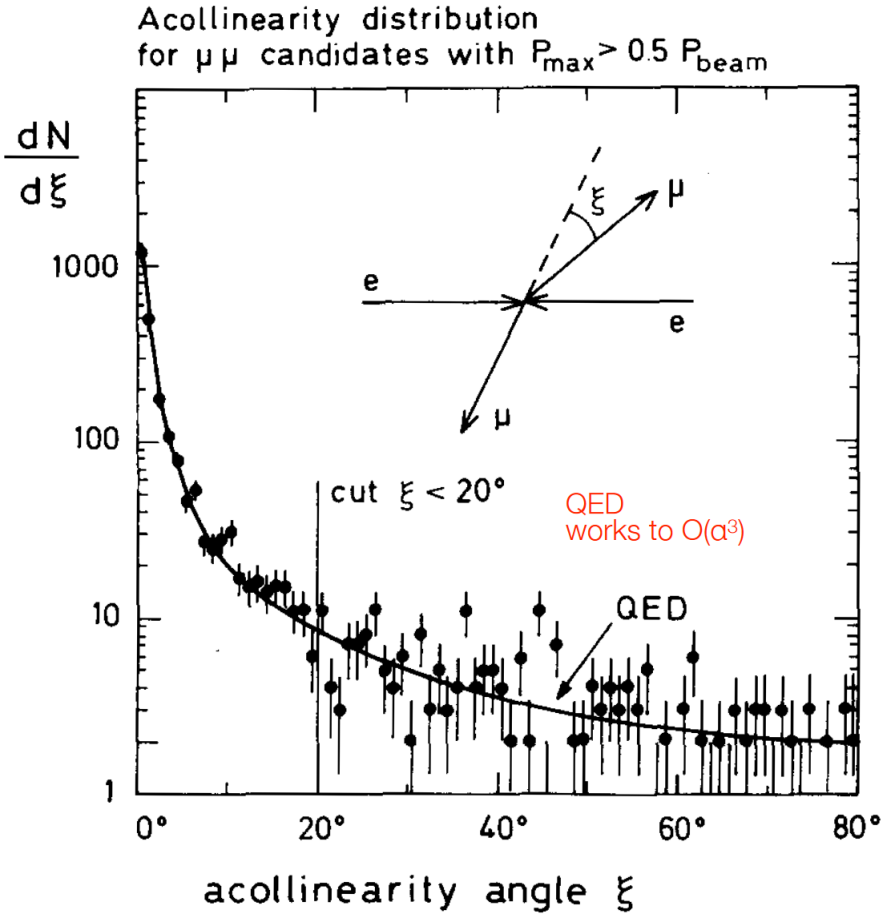
$\mu\mu$ final state

Take radiative corrections into account:

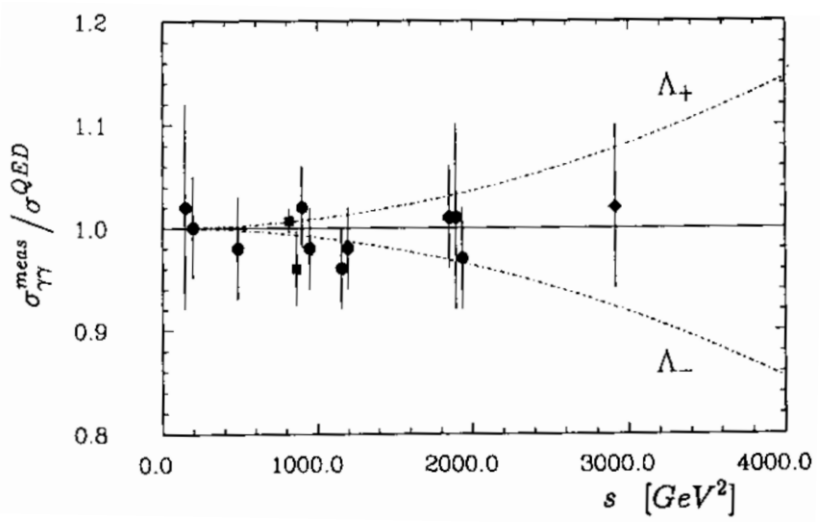
e.g.

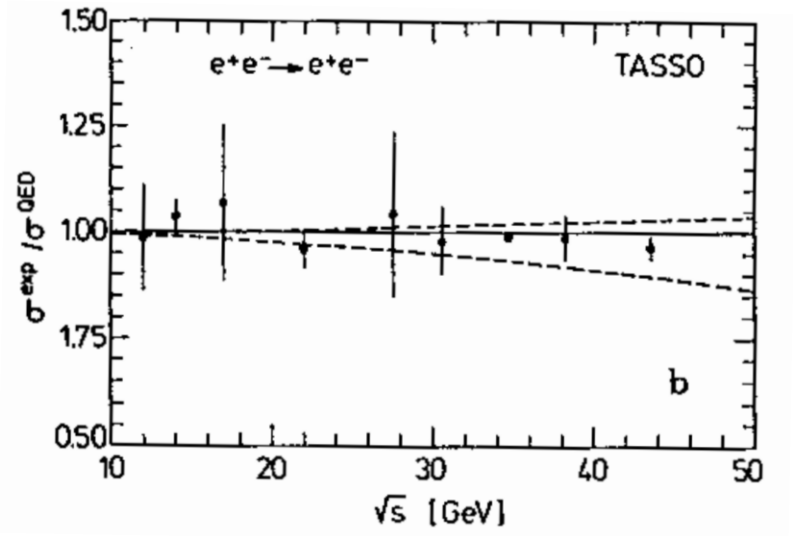


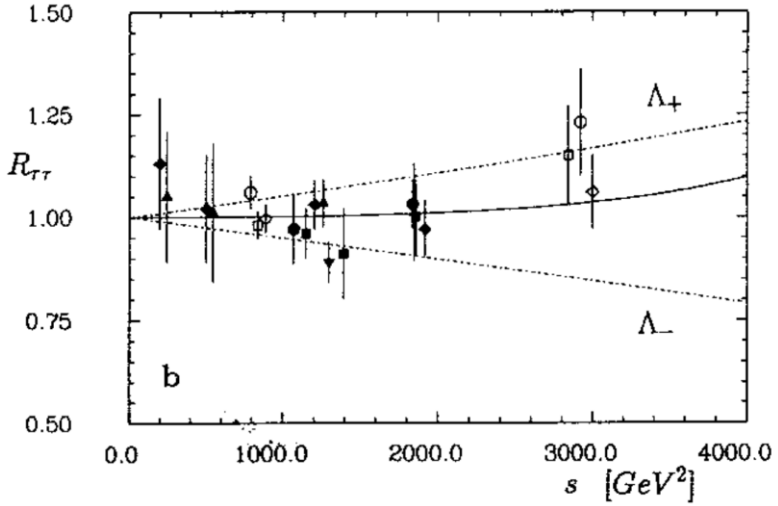


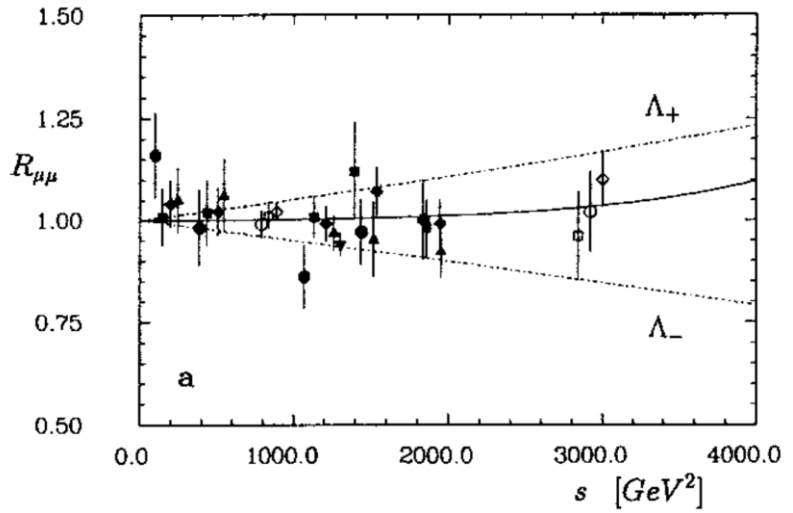


e^+e^- collisions: cut-offs and point-like structure









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Searching for lepton/quark substructure

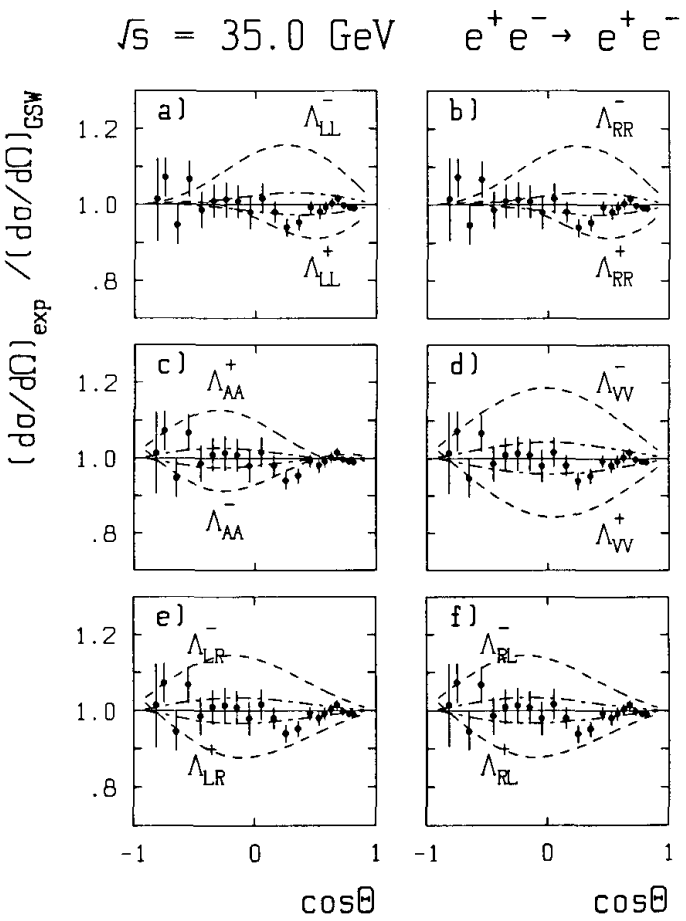


Fig. 2. Bhabha cross section at $\sqrt{s} = 35$ GeV normalized to the standard model prediction in comparison with the expectations from additional contact interactions with different types of chiral couplings (the dashed curves are for $\Lambda = 0.5$ TeV in a) and b) and for $\Lambda = 1.0$ TeV in c), d), e), f); the dashed-dotted curves are for $\Lambda = 1.0$ TeV in a) and b) and for $\Lambda = 2.0$ TeV in c), d), e), f), respectively). The common relative normalization error of 2.5% is not included in the error bars

Behrend *et al.*, Z. Phys. C Particles and Fields 51, 149 156 (1991)

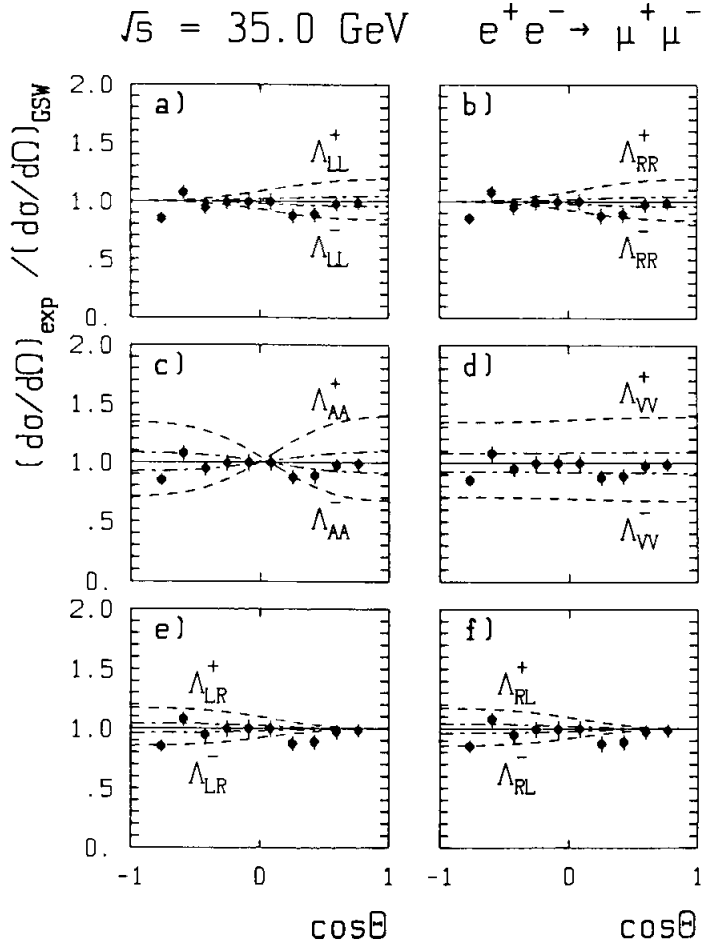
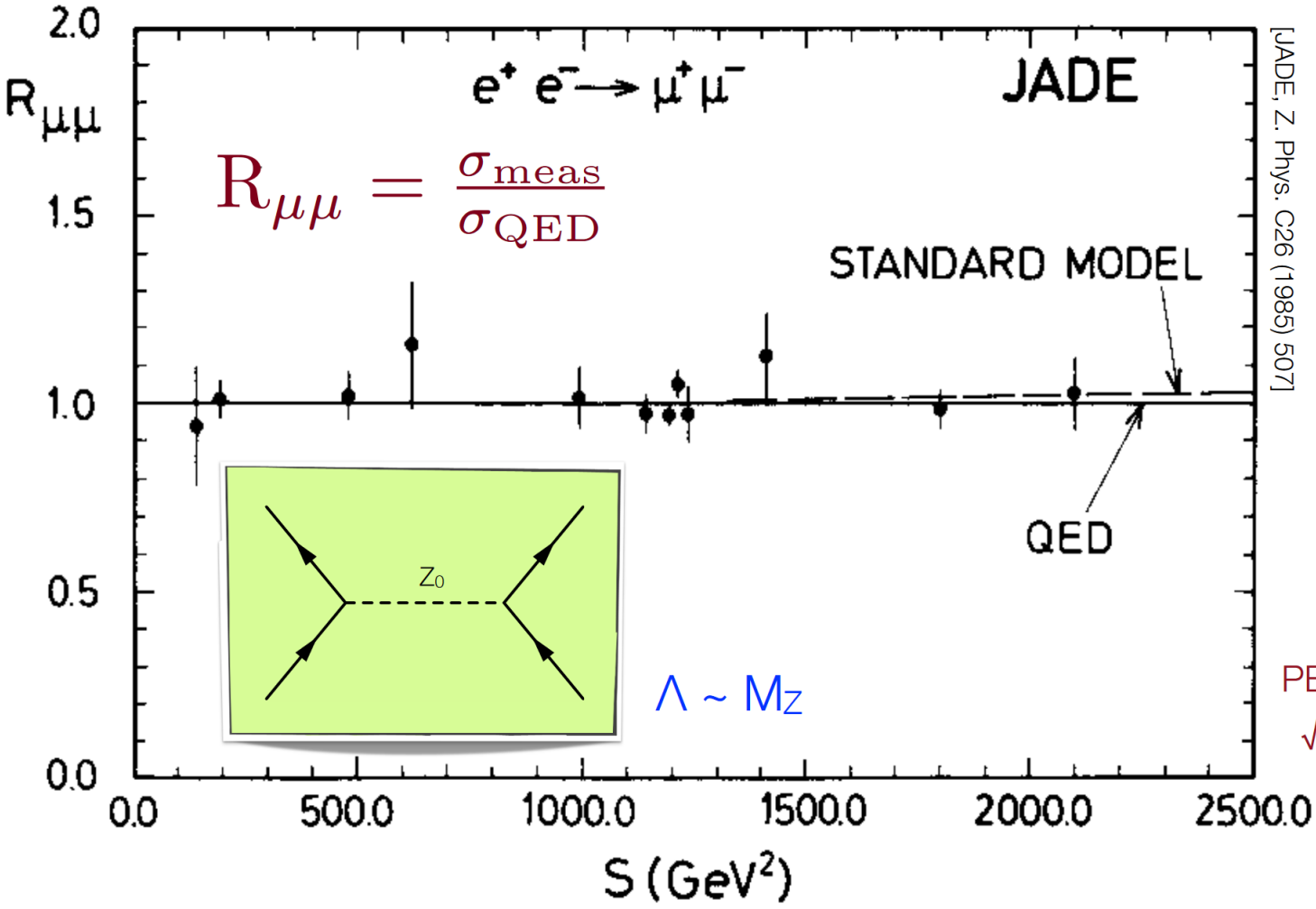


Fig. 3. Muon pair cross section at $\sqrt{s} = 35$ GeV normalized to the standard model prediction in comparison with the expectations from additional contact interactions with different types of chiral couplings (the dashed curves are for $\Lambda = 1.0$ TeV and the dashed-dotted curves for $\Lambda = 2.0$ TeV). The common relative normalization error of 5.0% is not included in the error bars

$\mu\mu$ final state



PETRA:
$\sqrt{s} < 50$ GeV

$\mu\mu$ final state

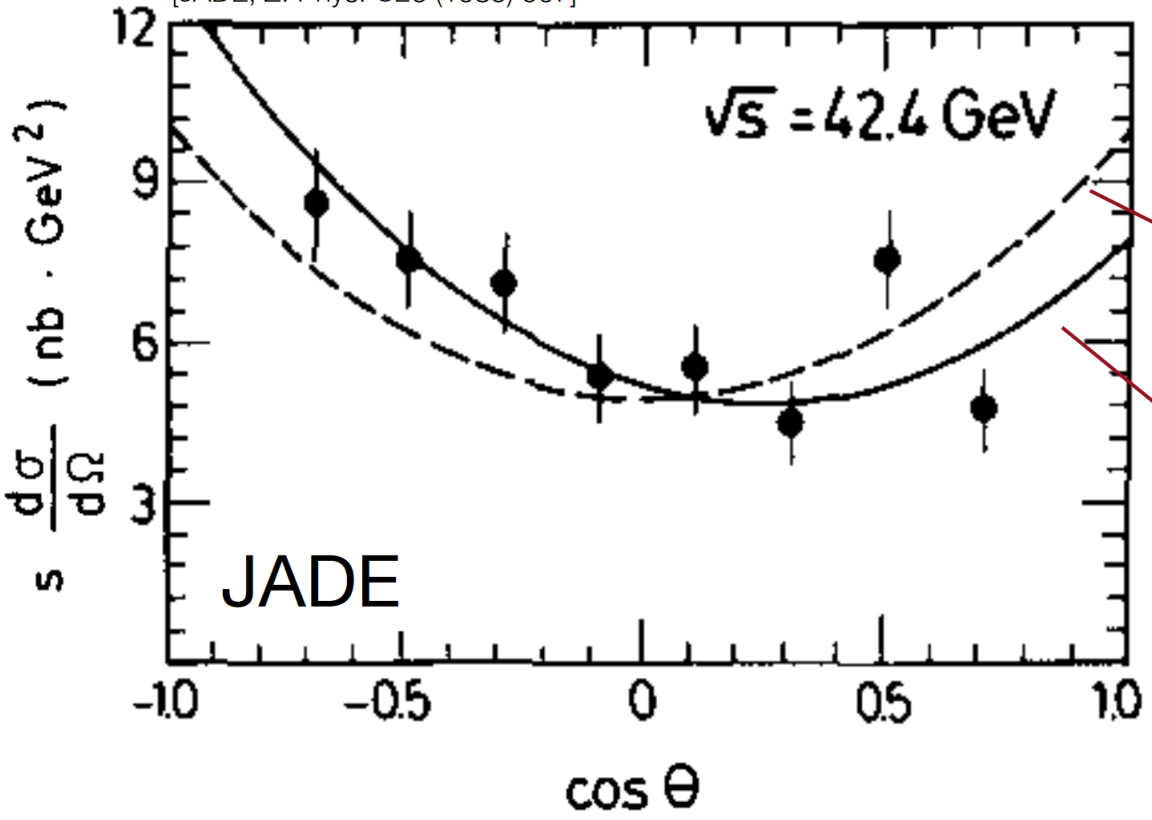
$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4s}(1 + cos^2\theta + Acos\theta)$$

[γ + Z]

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4s}(1 + cos^2\theta)$$

[γ only]

[JADE, Z. Phys. C26 (1985) 507]



QED

QED
+ Z-exchange

effect of
γ/Z interference

$\mu\mu$ final state

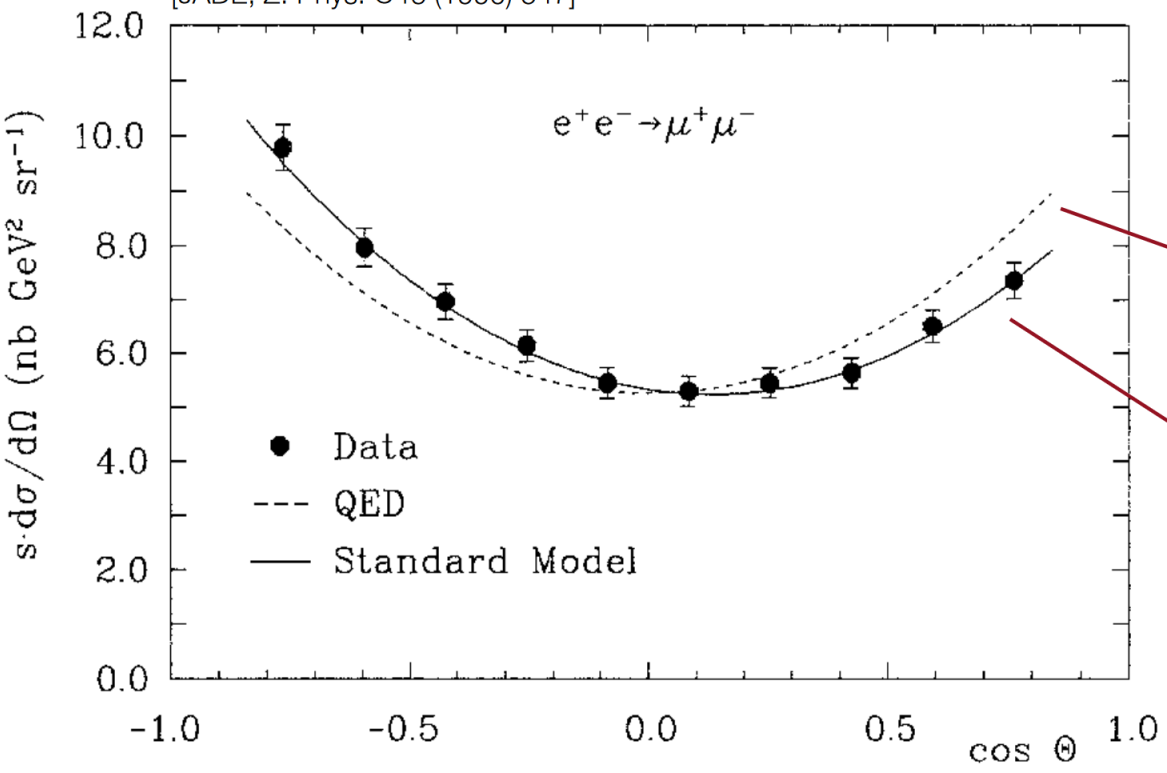
$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4s}(1 + cos^2\theta + Acos\theta)$$

[γ + Z]

$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4s}(1 + cos^2\theta)$$

[γ only]

[JADE, Z. Phys. C46 (1990) 547]



QED

QED
+ Z-exchange

effect of
γ/Z interference

qq vs $\tau\tau$ final states at TASSO

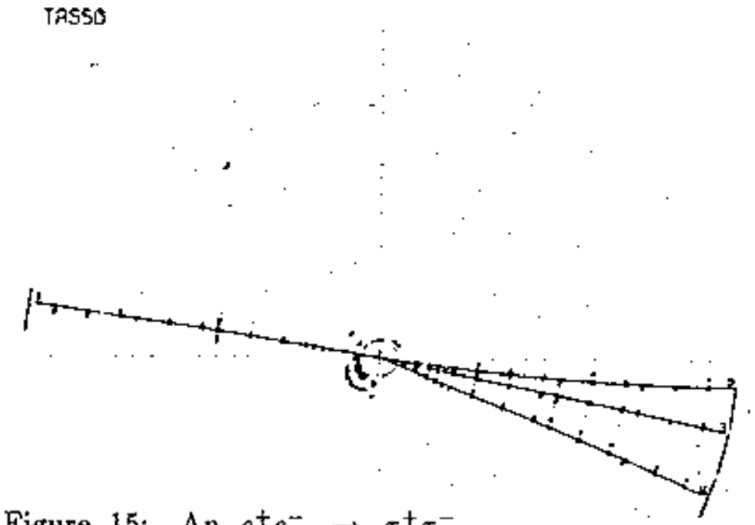
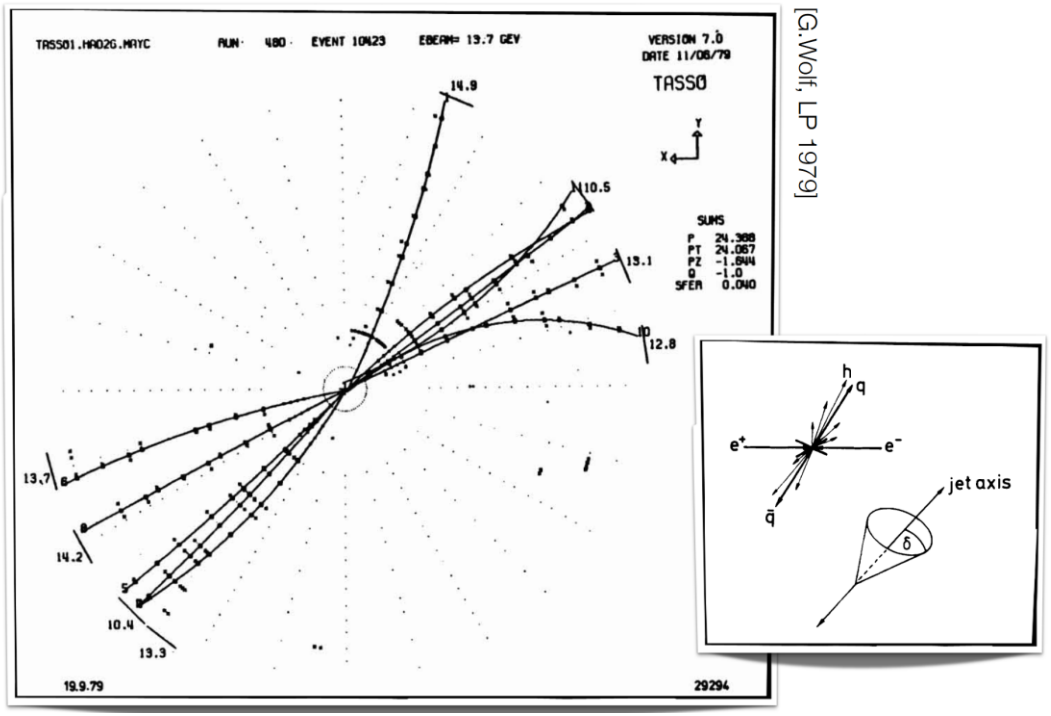
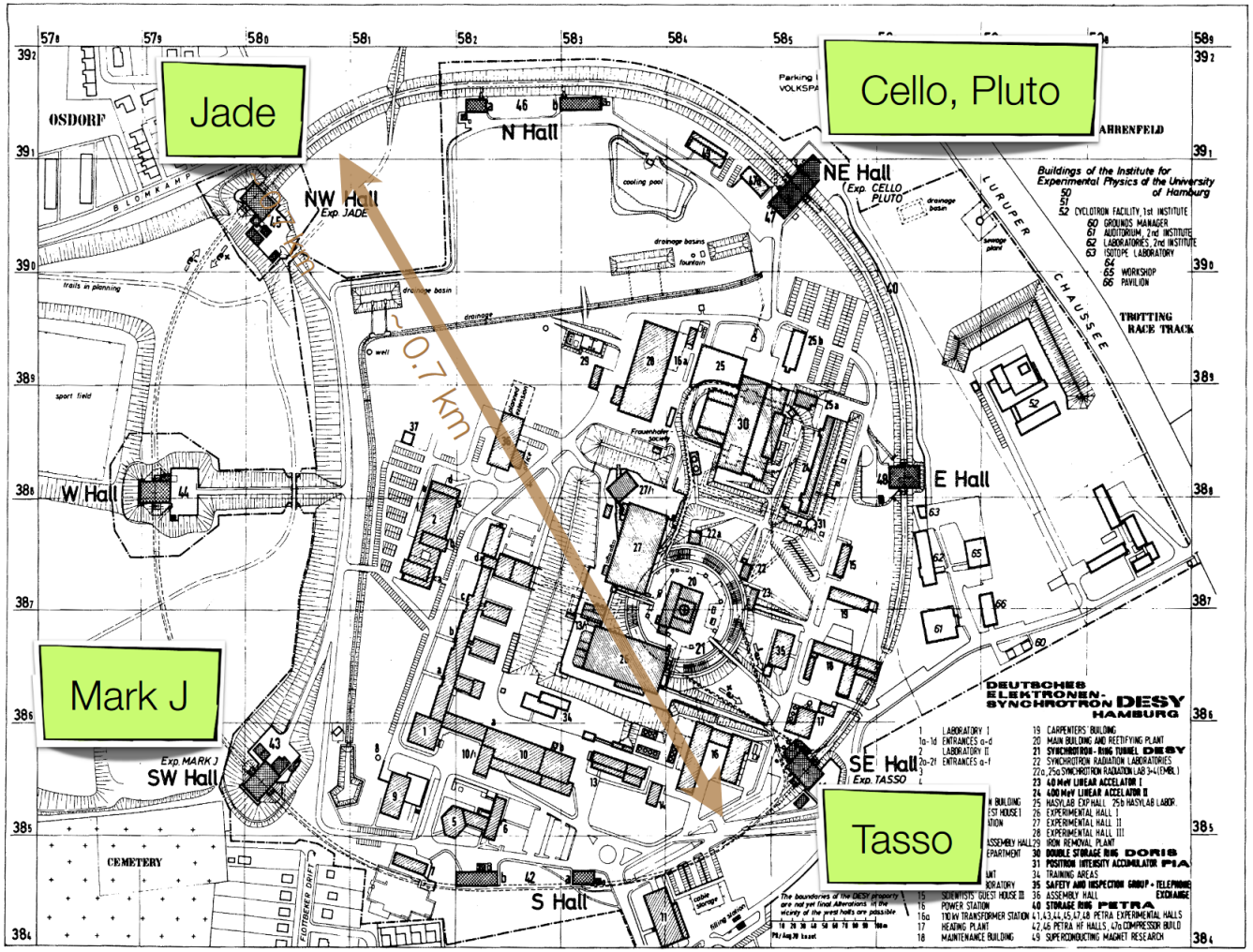


Figure 15: An $e^+e^- \rightarrow \tau^+\tau^-$ event observed in the TASSO detector at $\sqrt{s} = 35\,GeV$ (view perpendicular to the beams). The one-prong decay is identified as $\tau^- \rightarrow \mu^-\bar{\nu}_\mu\nu_\tau$, the three-prong decay as $\tau^+ \rightarrow (3\,hadrons)^+\nu_\tau\,(n\,\gamma)$



[G.Wolf, LP 1979]

High-energy tests of QED: e^+e^- collisions



Thanks, H-C Schultz-Coulon!