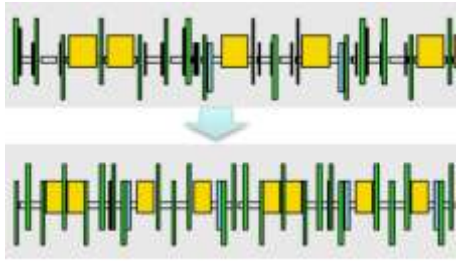
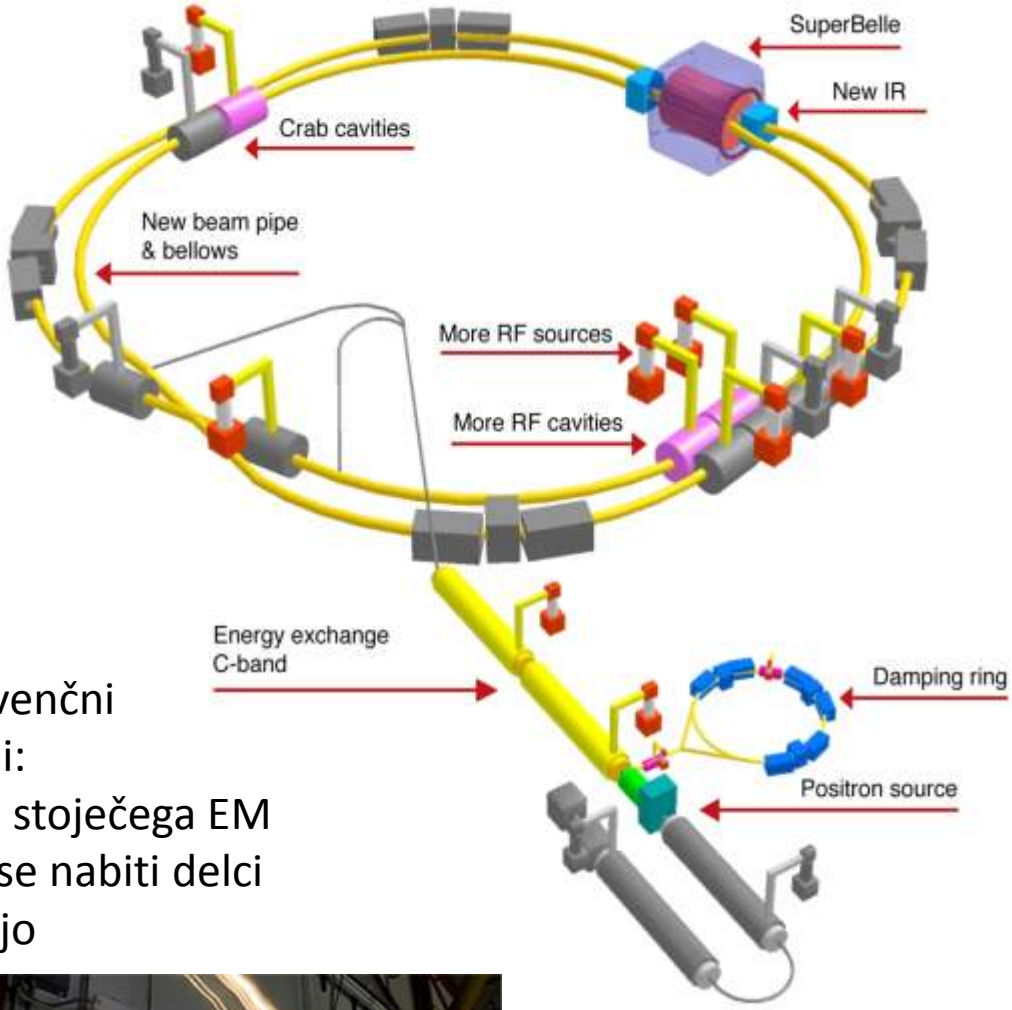
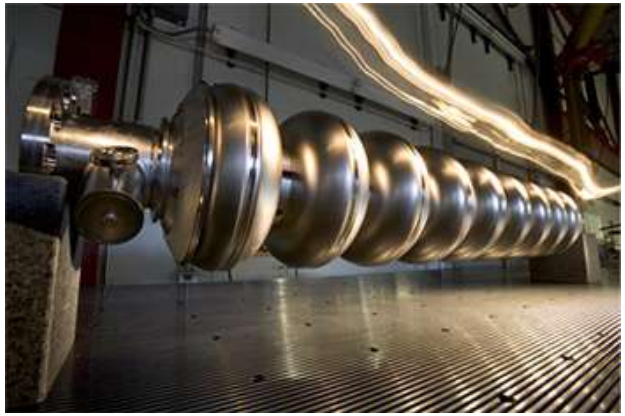
Trkalniki e^+e^-

magneti:
dipolni za ukrivljanje poti nabitih delcev
kvadrupolni, oktupolni, ...
za fokusiranje žarkov
komplicirana “mreža”, ki določa trajektorijo žarkov:

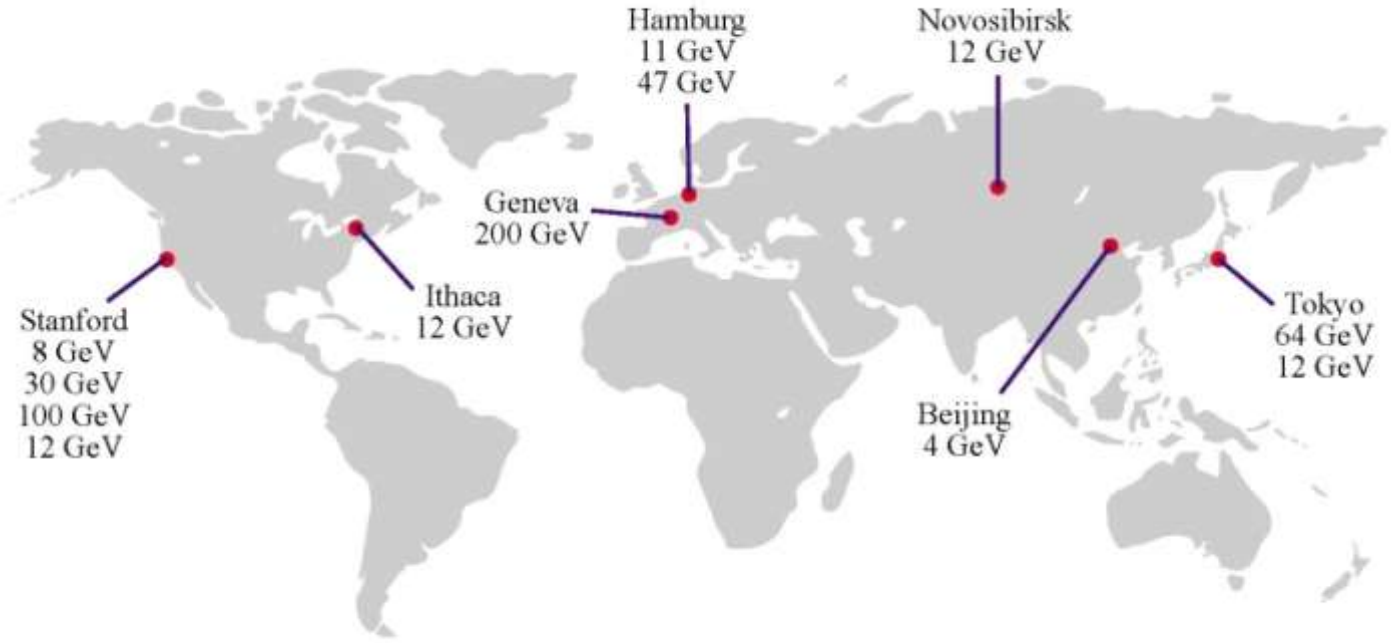




Radiofrekvenčni resonatorji:
s pomočjo stoječega EM valovanja se nabiti delci pospešujejo



Trkalniki e^+e^-



$$\text{cena} \sim a\,R + b\,E^4 / R$$

dolžina trkalnika
→ zemeljska dela, magneti, ...

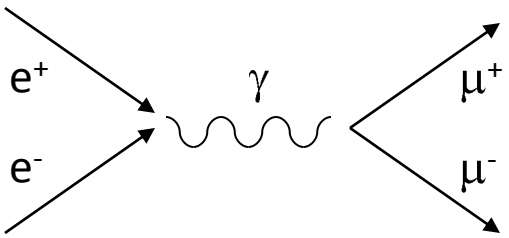
sinhrotronsko sevanje (izgube energije)
→ pospeševalni deli, intenziteta žarkov

$a \sim 1{,}2 \cdot 10^5$ \$/m
$b \sim 1{,}3 \cdot 10^3$ \$m/GeV^4

SPEAR: E=8 GeV, R=40 m, cena ~ $5 \cdot 10^6$ \$
LEP: E=200 GeV, R=4,3 km, cena ~ 10^9 \$

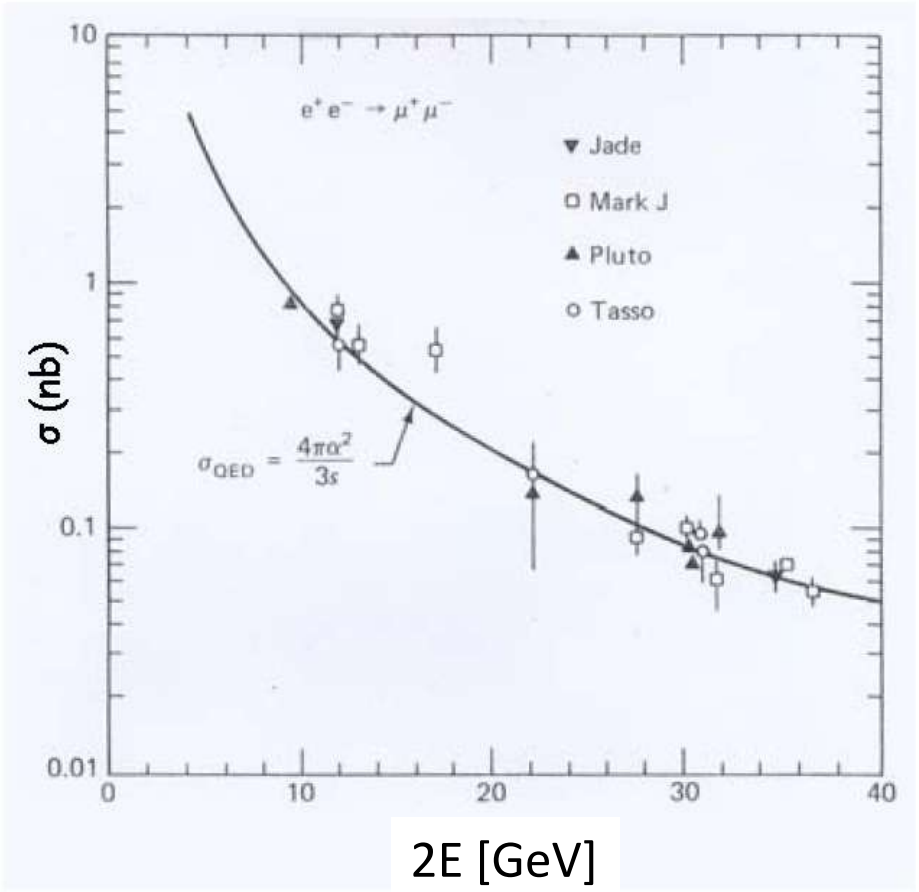
samo nekaj infrastrukturnih centov na svetu, kjer se opravljajo raziskave v mednarodnih skupinah

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

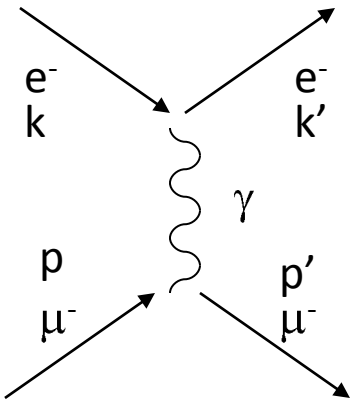


$$\left.\frac{d\sigma}{d\Omega}\right|_{QED} = \frac{\alpha^2}{16E^2}(1+\cos^2\vartheta)$$

$$\sigma_{QED} = \frac{\pi\alpha^2}{3E^2}$$

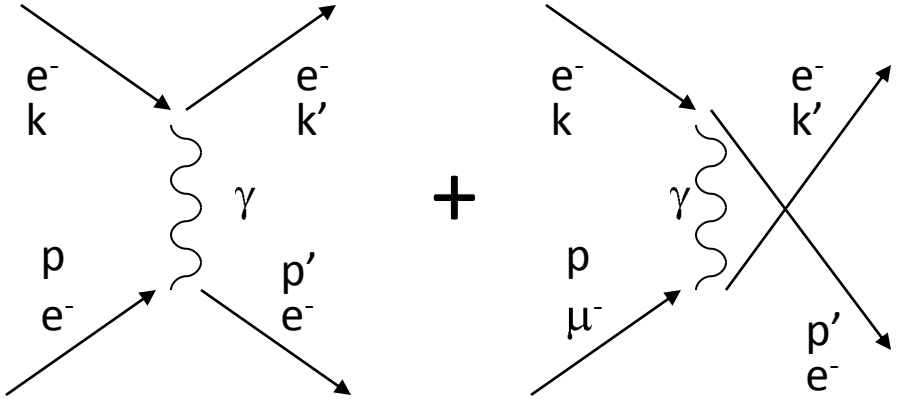


$e^-\mu^- \rightarrow e^-\mu^-$



$$\mathcal{M} \propto \bar{u}(k')\gamma^{\mu}u(k)\frac{-1}{(k'-k)^2}\bar{u}(p')\gamma_{\mu}u(p)$$

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

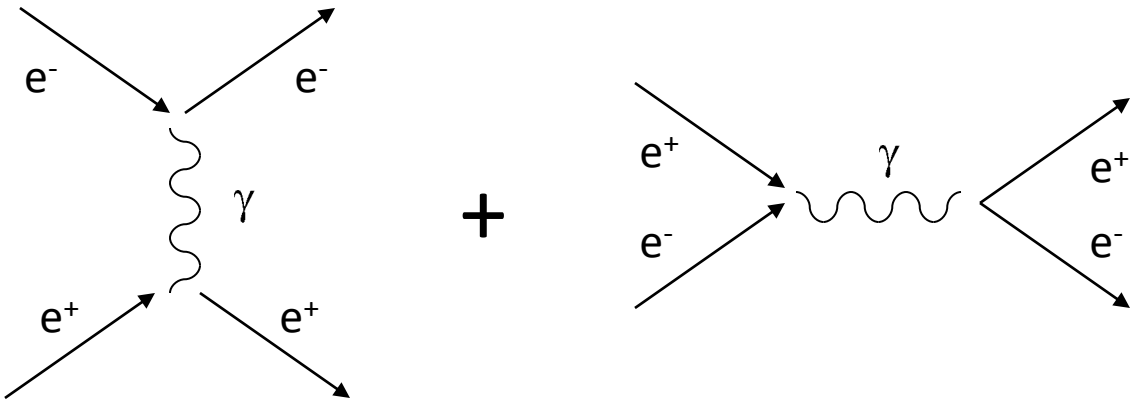


nerazločljivi delci $\Rightarrow$simetrizacija p’ $\leftrightarrow$ k’

$$\mathcal{M} \propto \bar{u}(k')\gamma^{\mu}u(k)\frac{-1}{(k'-k)^2}\bar{u}(p')\gamma_{\mu}u(p) - \bar{u}(p')\gamma^{\mu}u(k)\frac{-1}{(p'-k)^2}\bar{u}(k')\gamma_{\mu}u(p)$$

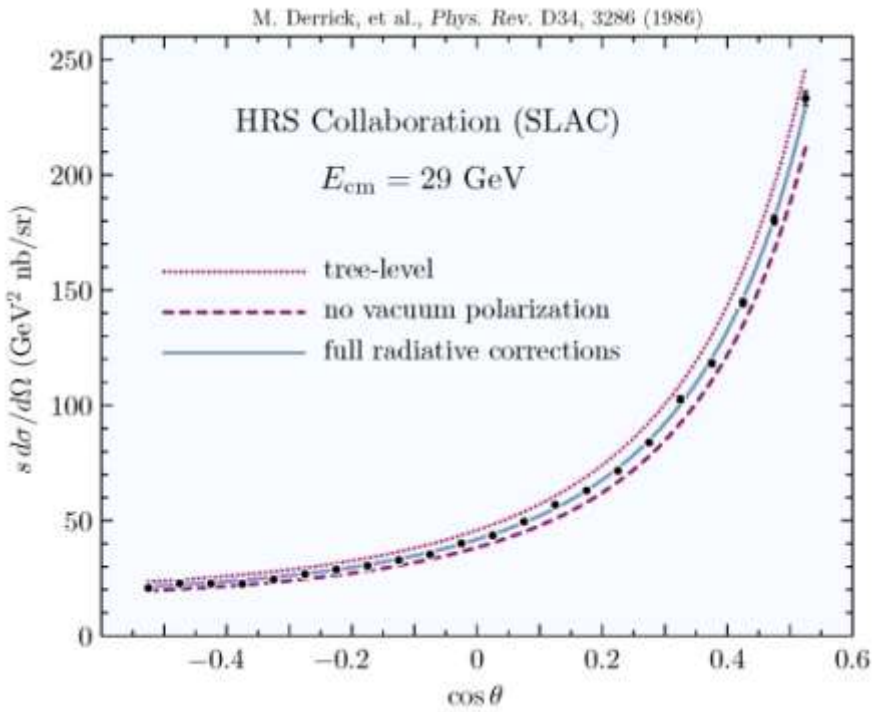
$e^-e^+ \rightarrow e^-e^+$

križanje iz $e^-e^- \rightarrow e^-e^-$

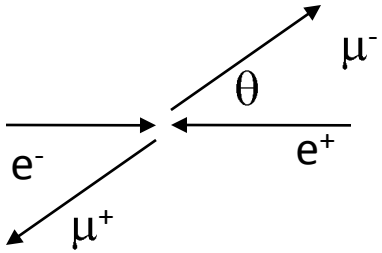


$$\frac{d\sigma}{d\Omega} = \frac{e^4}{32\pi^2 E_{\rm cm}^2}\left[\frac{1+\cos^4\frac{\theta}{2}}{\sin^4\frac{\theta}{2}} - \frac{2\cos^4\frac{\theta}{2}}{\sin^2\frac{\theta}{2}} + \frac{1+\cos^2\theta}{2}\right]$$

natančen test prispevkov višjih redov



$e^+e^- \to \mu^+\mu^-$

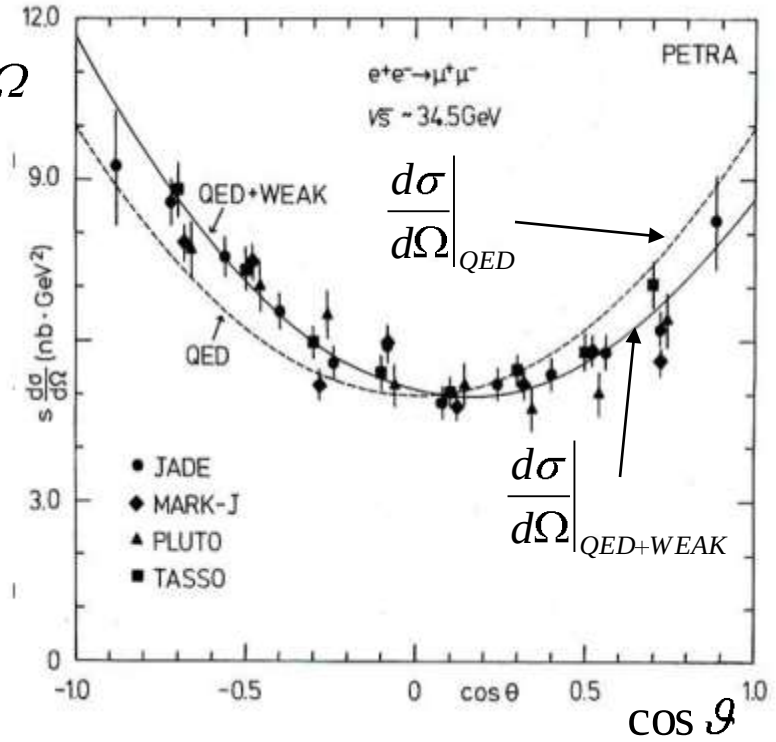


$$\left.\frac{d\sigma}{d\Omega}\right|_{QED} = \frac{\alpha^2}{16E^2}(1+\cos^2\vartheta)$$

kar $d\sigma/d\Omega$ soda funkcija θ

$$A_{FB}^{\mu} \equiv \frac{\sigma(e^-e^+ \to \mu^+\mu^-;\theta_{\mu^-} < 90^\circ) - \sigma(e^-e^+ \to \mu^+\mu^-;\theta_{\mu^-} > 90^\circ)}{\sigma(e^-e^+ \to \mu^+\mu^-;\theta_{\mu^-} < 90^\circ) + \sigma(e^-e^+ \to \mu^+\mu^-;\theta_{\mu^-} > 90^\circ)} \underbrace{=}_{QED} 0$$

$d\sigma/d\Omega$



$$\left.\frac{d\sigma}{d\Omega}\right|_{QED}$$

$$\left.\frac{d\sigma}{d\Omega}\right|_{QED+WEAK}$$

$\cos\vartheta$

$e^-e^+ \rightarrow q\bar{q}$

$$R = \frac{\sigma(e^+e^- \rightarrow hadroni)}{\sigma(e^+e^- \rightarrow \mu^+\mu^-)} = 3\sum_i |e_{qi}|^2$$

3(1/9 + 4/9 + 1/9 + 4/9 +1/9)

3(1/9 + 4/9 + 1/9 + 4/9)

3(1/9 + 4/9 + 1/9)