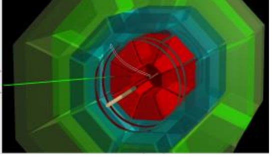
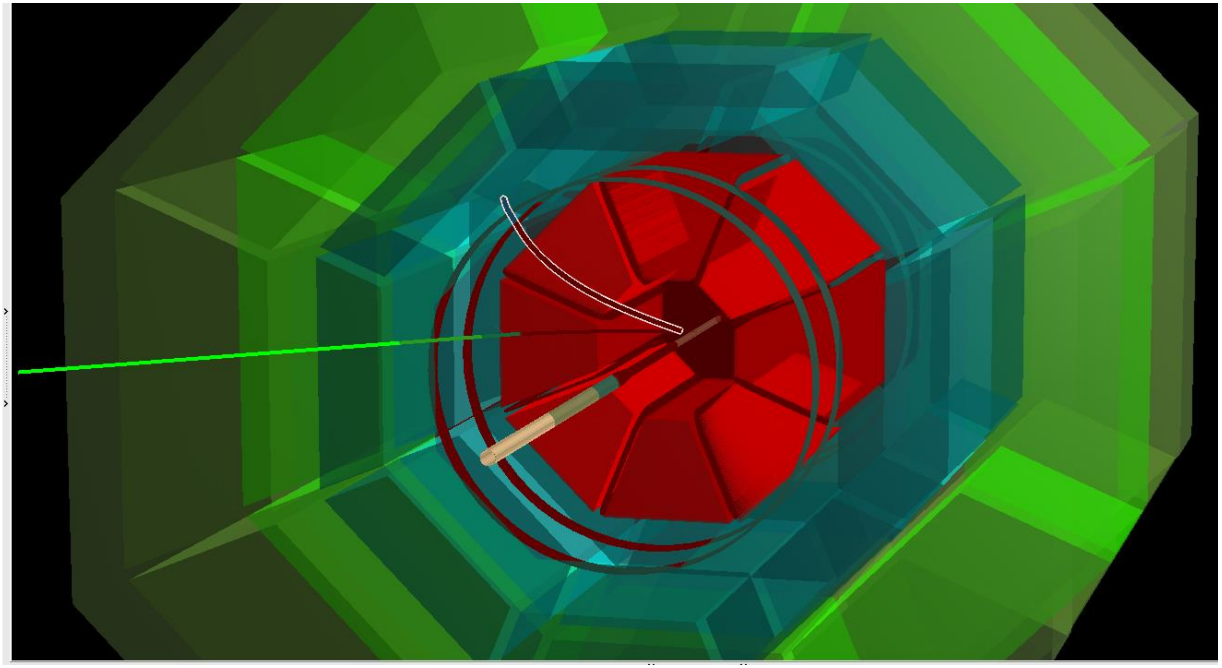
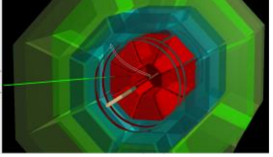


Spin physics with hyperons

Briefly will talk on the following topics:

- **Longitudinal and transverse spin transfer to hyperons in DIS and pp**
- **Experimental and analysis technics**
- **Other then $\Lambda(\bar{\Lambda})$ hyperons**
- **Non-hyperons (Λ_c)**
- **Λ reconstruction at SPD (the very first glance)**





Longitudinal spin transfer to Λ in DIS

$$\Lambda^0 \rightarrow p + \pi^-$$

Keywords: Δs, $\Delta\bar{s}(x)$ $\Delta s \neq \Delta\bar{s}(x)?$, spin-dependent FF, intrinsic strangeness of the nucleon

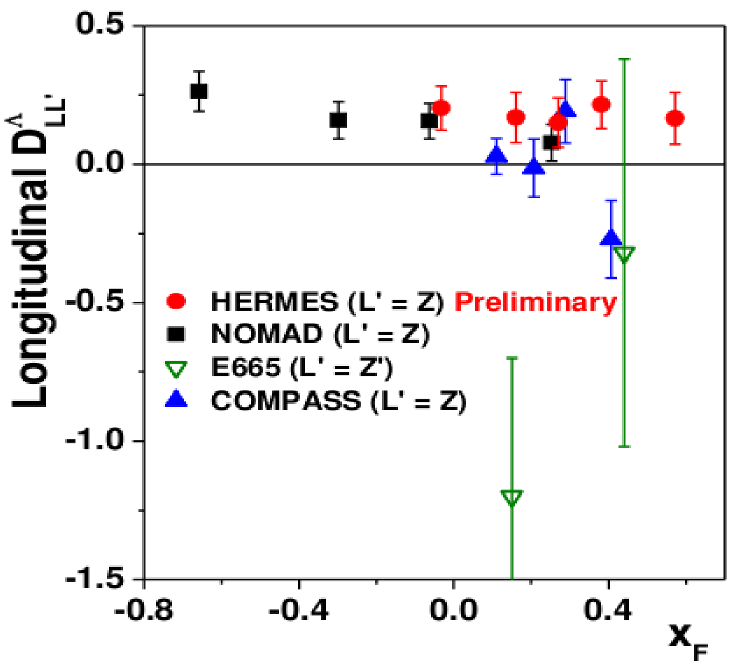
$$\frac{dN}{d\Omega_p} = \frac{dN_0}{d\Omega_p}(1 + \alpha P_{L'}^{\Lambda} \cos\theta_{pL'})$$

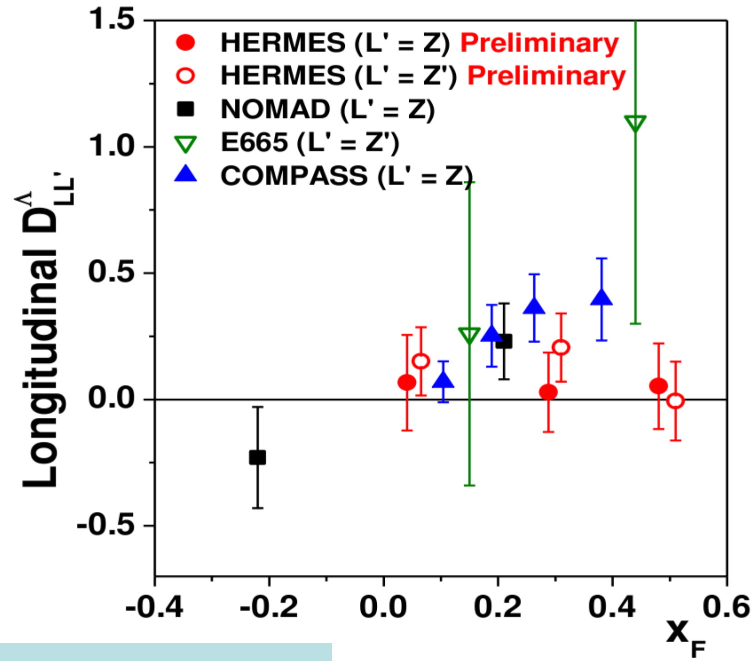
$\alpha = 0.642$ for Λ ($\alpha = -0.642$ for $\bar{\Lambda}$)

$L' \rightarrow \Lambda$ *spin direction*

$$P_\Lambda = \frac{\sum_q e_q^2 \left[P_b D(y) q(x) + P_T \Delta q(x)\right] \Delta D_q^\Lambda(z)}{\sum_q e_q^2 \left[q(x) + P_b P_T D(y) \Delta q(x)\right] D_q^\Lambda(z)}$$

$$P_L = D_{LL}^{\Lambda} \cdot P_b \cdot D(y)$$





S. Belostotski DSPIN12

Longitudinal spin transfer to hyperons in pp

Hyperon production with high pT:

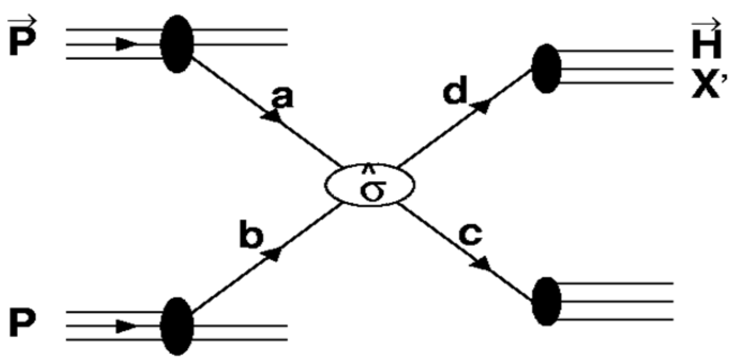
- (Un)Polarised PDFs, (un)polarized fragmentation functions,
- QCD crossections 2->2 (spin-dependent and not)
- Transmitted asymmetries give degree of final quark polarisation

$$\frac{d^2\sigma^{pp\to HX}}{dp_T d\eta} = \sum_{abcd}\int dx_a dx_b dz_c\, f_a(x_a,\mu^2)\, f_b(x_b,\mu^2)\, \frac{d\hat{\sigma}(ab\to cd)}{dp_T d\eta}\, D_c^H(z_c,\mu^2)$$

$$\frac{d^2\Delta\sigma}{dp_T d\eta} = \sum_{abcd}\int dx_a dx_b dz_c \Delta f_a(x_a,\mu^2)\, f_b(x_b,\mu^2)\, \frac{d\Delta\hat{\sigma}^{(\vec{a}b\to\vec{c}d)}}{dp_T d\eta}\, \Delta D_c^H(z_c,\mu^2)$$

Spin-dependent PDF

Spin dependent fragmentation function

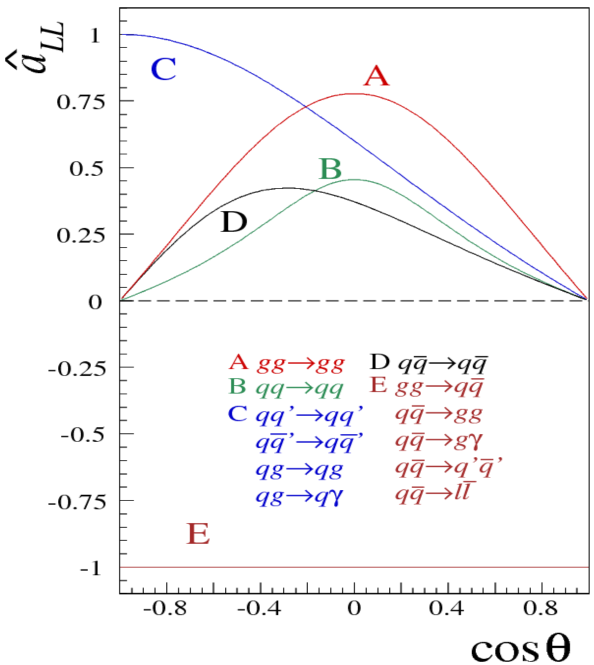


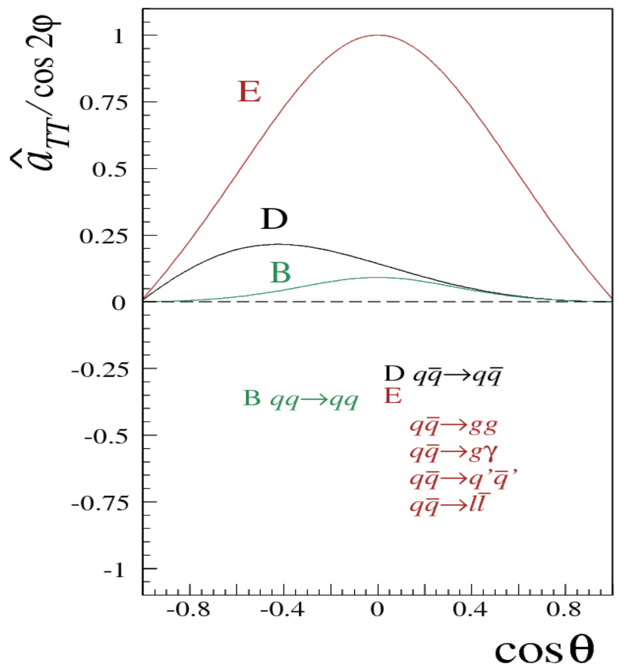
$$\vec{p}p \to HX$$

$$D_{LL} \equiv \frac{\sigma_{p^+ p\to\bar{\Lambda}^+ X} - \sigma_{p^+ p\to\bar{\Lambda}^- X}}{\sigma_{p^+ p\to\bar{\Lambda}^+ X} + \sigma_{p^+ p\to\bar{\Lambda}^- X}} = \frac{d\Delta\sigma}{d\sigma}$$

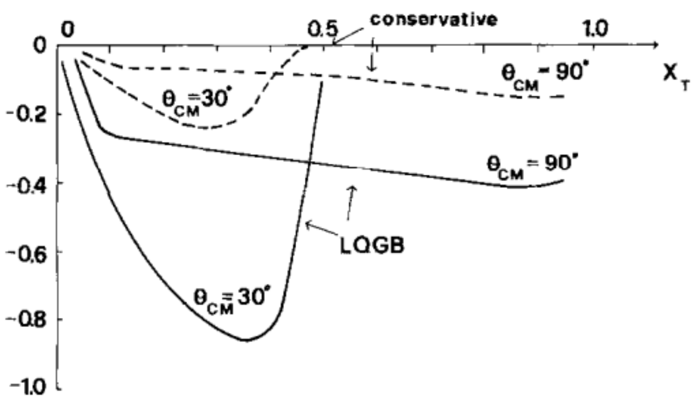
Spin transfer to hyperons in pp

Transmitted asymmetries:

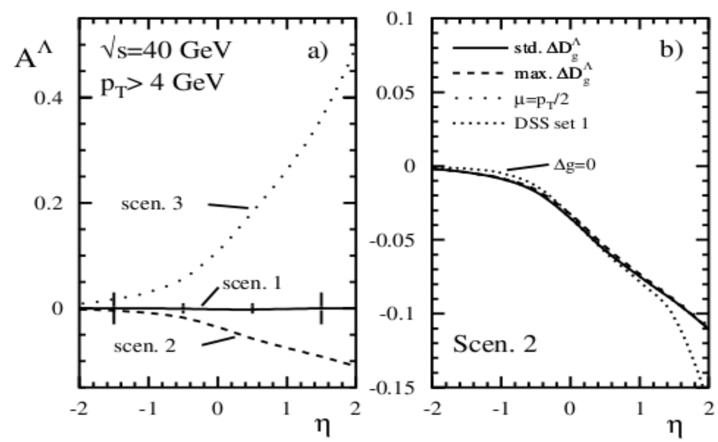




$$A^{\Lambda} \equiv \frac{d\Delta\sigma^{p\vec{p}\to\vec{\Lambda}X}/d\eta}{d\sigma^{pp\to\Lambda X}/d\eta}$$

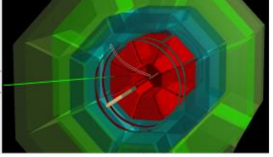


$$x_T = \frac{2p_{\Lambda T}}{\sqrt{s}}.$$



N.S. Craigie P.Ratcliffe 1983

De Florian et al 1998



D_{LL} extraction technics

$$\frac{dN}{d\cos\theta} = \frac{N_{tot}}{2} A(\cos\theta)(1+\alpha P\cos\theta)$$

A(cosθ) - acceptance, needs MC. However using beam polarization reversal (and setup symmetry in η is suitable) it is possible to extract Λ polarization without MC, or without direct acceptance determination.

- **HERMES method**

Helicity balanced data sample →

$$D_{LL'} = \frac{\sum_{i=1}^{N} P_{b,i} D(y_i)\cos\theta^i_{pL'}}{\alpha \| P_b^2 \| \sum_{i=1}^{N} D^2(y_i)\cos^2\theta^i_{pL'}}$$

- **RHIC method**

D_{LL} has been extracted from Λ counts with opposite beam polarization within a small interval of cosθ*:

-STAR, hep-ex/0512058

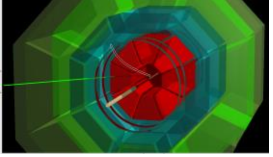
$$D_{LL} = \frac{1}{\alpha \cdot P_{beam} < \cos\theta^* >} \cdot \frac{N^+ - N^-}{N^+ + N^-}$$

, where the acceptance cancels.

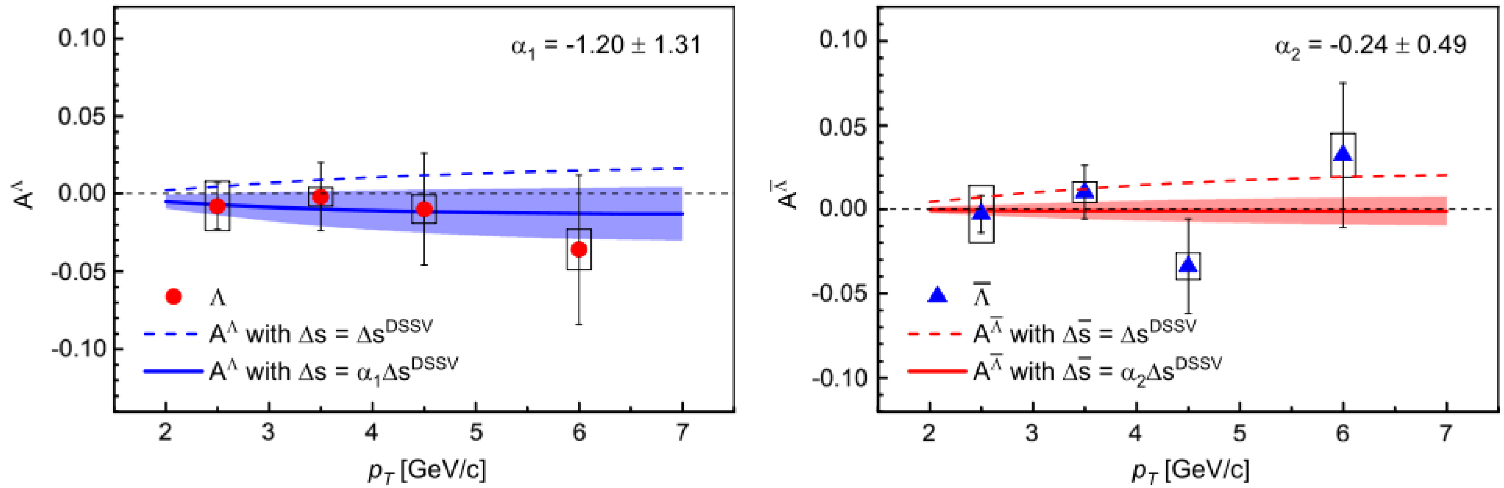
$$N_\Lambda^+ = N^{++}\frac{L_{--}}{L_{++}} + N^{+-}\frac{L_{--}}{L_{+-}}$$

$$N_\Lambda^- = N^{-+}\frac{L_{--}}{L_{-+}} + N^{--}$$

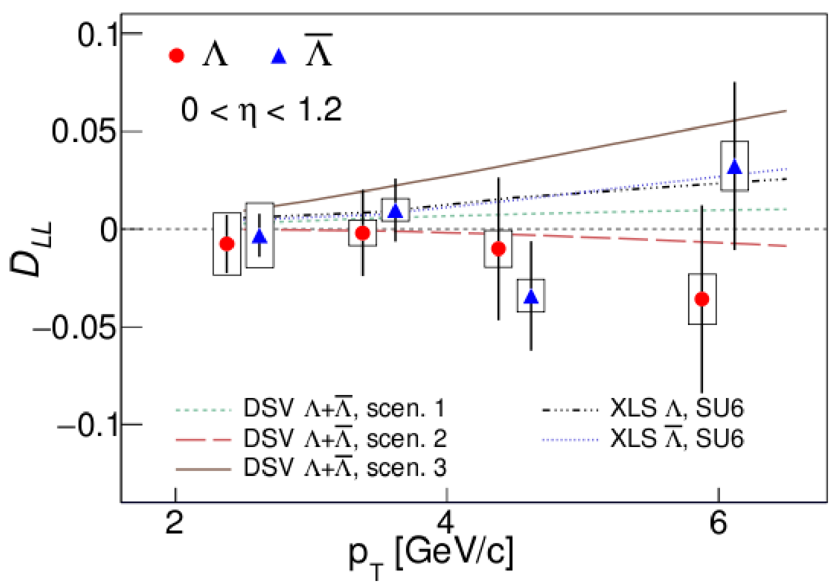
Relative luminosity ratio measured with BBC, and P_{beam} in RHIC.



RHIC results on D_{LL}



(a) Longitudinal spin transfer to Λ. **(b)** Longitudinal spin transfer to $\bar{\Lambda}$.



$$x_T = \frac{2 p_{\Lambda T}}{\sqrt{s}}.$$

At 200GeV/c, p_T=6GeV/c x_T=0.06

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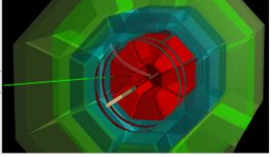
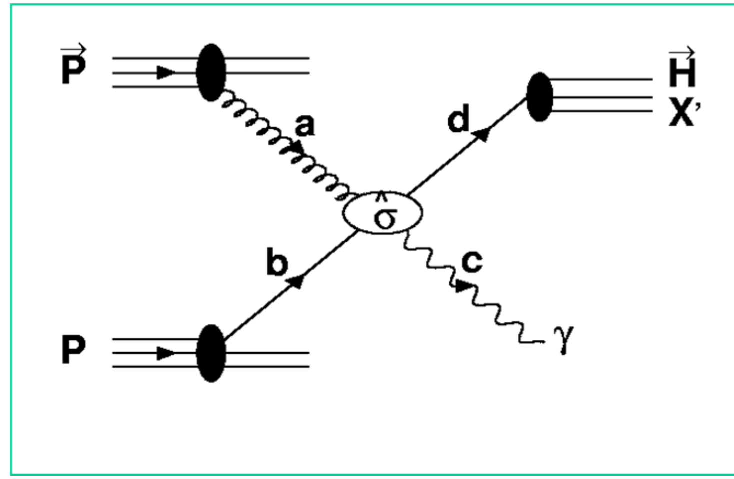


$P_{\Sigma+}$ in $\vec{p}p \rightarrow \gamma\vec{\Sigma}^{+}X$ and $\Delta g(x)$

$\Sigma+$ can be in principle used in the same way as Λ, but being uus is expected to have large contribution from u-quark polarisation wrt s-quark. However there where ideas at RHIC(Qinghua Xu) that it might have sensitivity to gluon polarisation.

- Technically it's a challenge (if at all possible), since it decays to proton pi-zero.



- **Subprocesses involved:**

$$qg \rightarrow \gamma q \qquad \textbf{(dominant)}$$

$$q\bar{q} \rightarrow \gamma g \qquad \textbf{(negligible)}$$

- **$P_{\Sigma+}$ in $\vec{p}p \rightarrow \gamma\vec{\Sigma}^{+}X$:**

$$P_{\Sigma^+} = d\Delta\sigma / d\sigma$$

(Xu, Liang, hep-ph/0406119)

$$d\Delta\sigma = \int_{p_T^{\min}} dp_T \sum_f \int dx_a dx_b dz \Delta g(x_a, \mu^2) q_b(x_b, \mu^2)$$

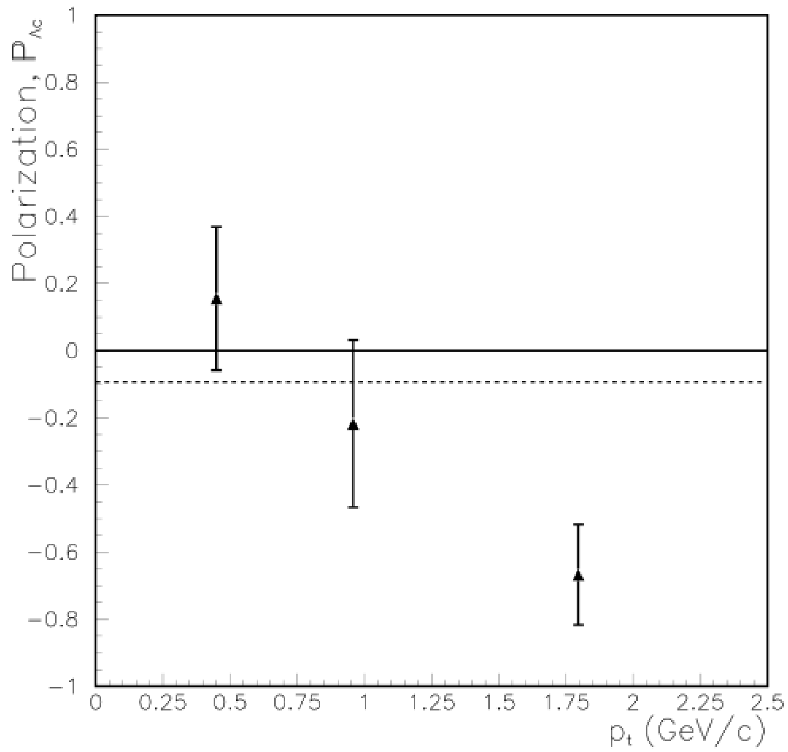
$$\cdot\, d\Delta\hat{\sigma}(\vec{g}q_f \rightarrow \gamma\vec{q}_f)\Delta D_f^H(z, \mu^2) + (g \leftrightarrow q_f)$$

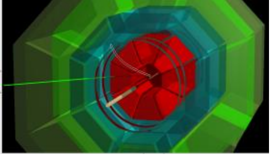
$$\vec{q}g \rightarrow \gamma\vec{q}$$

Λ_c polarisation

Transverse (spontaneous) polarization of charmed Λ barion

- Studied at BIS-2 in 80s, decay asymmetry found
- Definite result only from E791 (amplitude analysis $\Lambda_c^+ \to pK^-\pi^+$)
- Other decay modes can be also used.

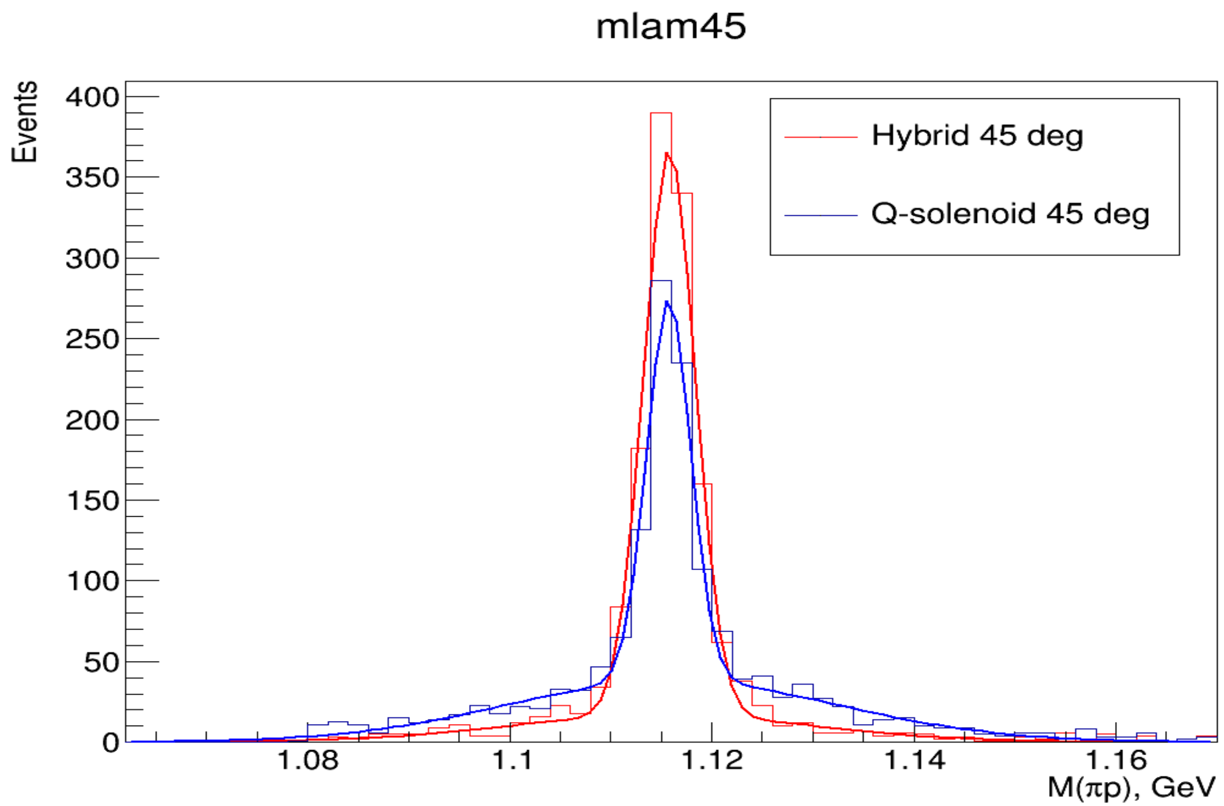


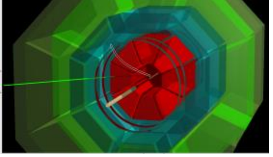


Λ reconstruction at SPD

Λ generated with isotropic generator at fixed θ angles (15-45 deg) with Pt=2GeV/c
This gives total Λ momenta 7.7-2.8 GeV/c

- **Λ decays at secondary vertex to pπ(100%) with PYTHIA6 decayer**
- **Simulations with two field configurations (Hybrid and quasi-solenoid)**
- **Ideal tracks with KF fit, track parameters from checking script, no vertexing for the moment**
- **Effective mass resolution 4-2.5 MeV (main peak), but there are tails – long ranges?**

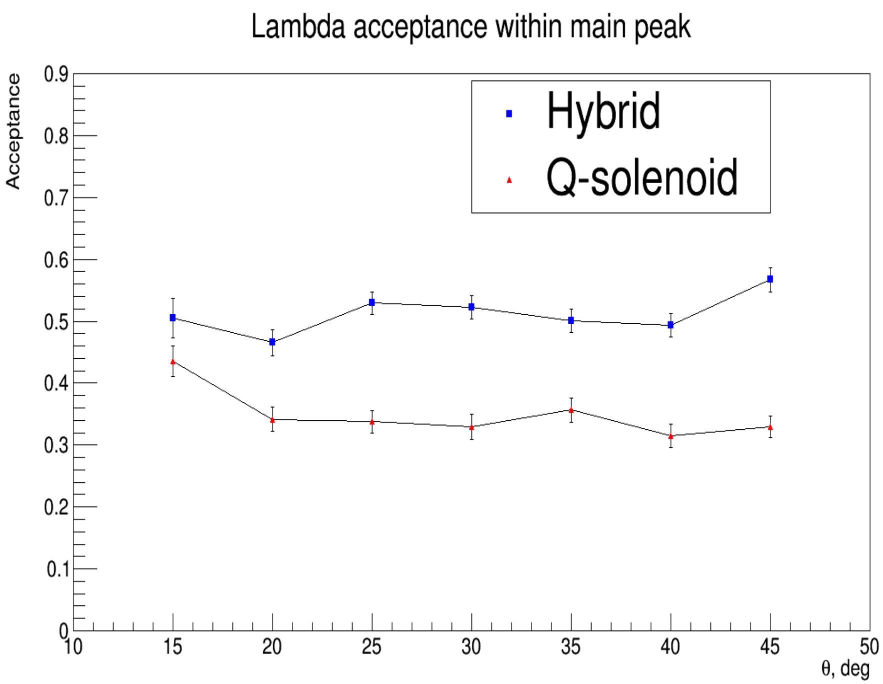


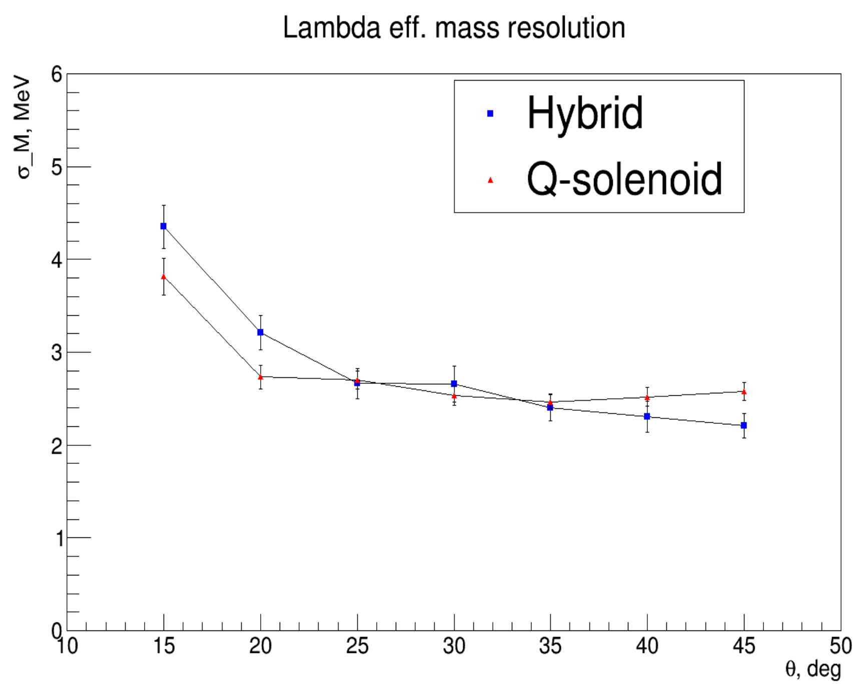


Λ reconstruction at SPD

Acceptance is defined as ratio of the integral under main peak to the total number of events. Effective mass resolution is sigma of the main peak.

- **Resolutions look similar both both field configurations**
- **However acceptances are different because of different tail fraction. Reasons of the tails will be studied separately (decay length, material, etc.)**





Conclusion

First attempt to see Λ in SPD MC was done

- ❑ **Effective mass resolution looks reasonably good for the generated sample**
- ❑ **Further studies will be done to understand the reason of tails in effective mass**
- ❑ **Secondary vertex finder should be developed**
- ❑ **…**