# Analysis of 2016 COMPASS data on DVCS

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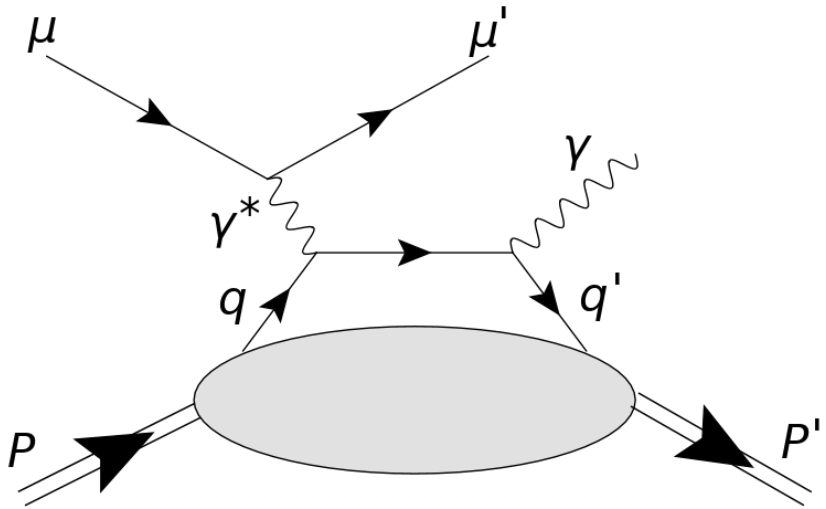
- COMPASS
  → **CO**mmon **M**uon **P**roton **A**pparatus for **S**tructure and **S**pectroscopie
  → fixed target experiment at the M2 beam line of SPS
  (**S**uper **P**roton **S**ynchrotron, **CERN**)
- 2016 measurement of **Deeply Virtual Compton Scattering (DVCS)** was performed
  → polarized positive and negative muon beam scattered off a liquid hydrogen target
- Extract **Generalized Parton Distribution Function** from cross section differences (positive/negative moun beam)
  ⇒ precise determination of cross sections neccessary

  ⇒ precise knowledge of **beam flux**
  ⇒ comparable amount and quality of data sets

# Deeply Virtual Compton Scattering (DVCS) I




**DVCS process:**

$$\mu + p \rightarrow \mu' + p' + \gamma$$

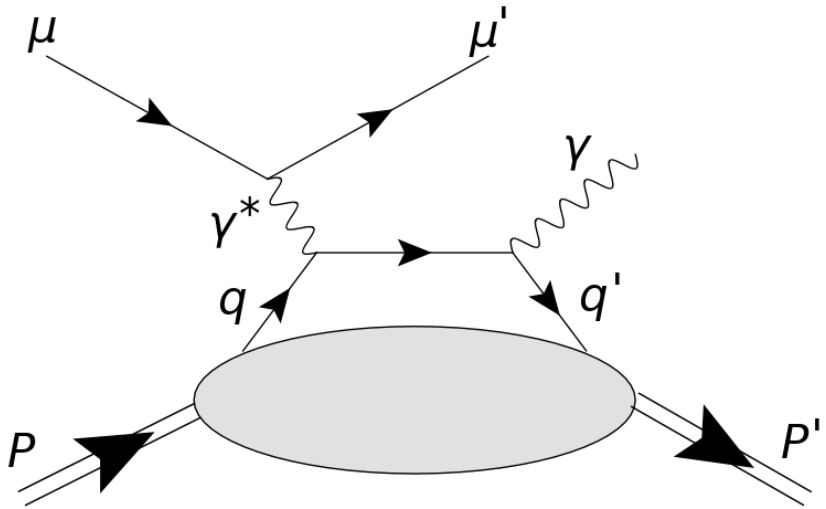
Mixture of **elastic (ES)** and **deep inelastic (DIS)** Lepton-Nucleon scattering

ES cross section parametrized via **form factors**
$\rightarrow$ only **transversal information** on nucleon structure

DIS cross section parametrized via **structure function** (via PDFs)
$\rightarrow$ only **longitudinal information** nucleon structure

$$\text{DIS} + \text{ES} = \text{DVCS} \Rightarrow \text{longitudinal} + \text{transversal information !}$$

# Deeply Virtual Compton Scattering (DVCS) II




**DVCS process:**

$$l + N \rightarrow l + N + \gamma$$

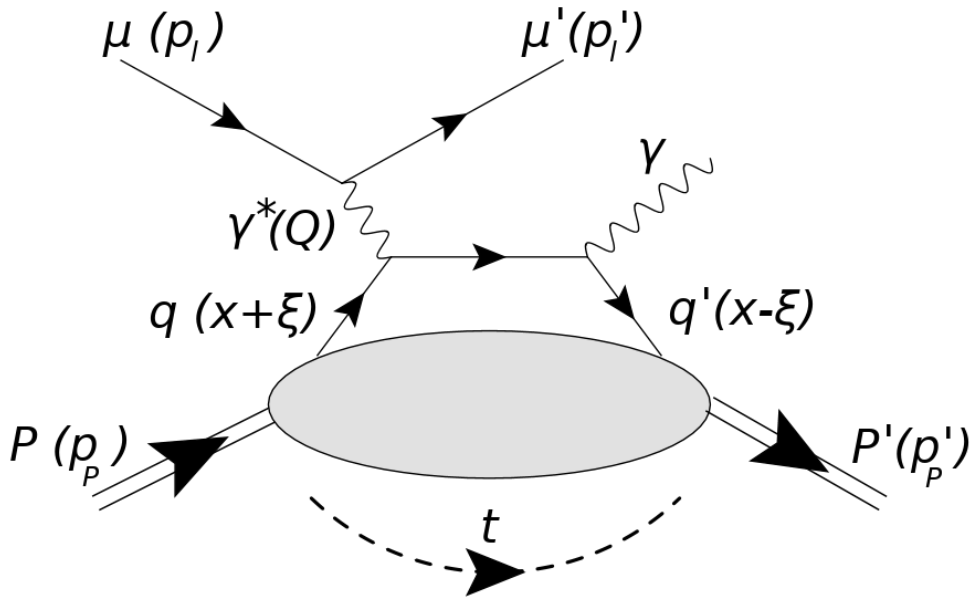
**DVCS cross section:**

$$\frac{d^4\sigma}{dx_B dQ^2 d|t| d\Phi} \propto |M_{DVCS}|^2$$

**DVCS cross section**
$\Downarrow$ *parametrized*
integrals of **Generalized Parton Distribution functions (GPDs)**
$\Downarrow$ *rewritten*
define **Compton Form Factors (CFF)**

$\Rightarrow$ CFF **experimental observable** by extracting it from **differences of cross sections** with different spin/helicity combinations of lepton/nucleon

# Deeply Virtual Compton Scattering (DVCS) III




**4 independent kin. variables needed:**

$Q^2 = (p_l - p_l')^2$ : 4-momentum transfer

$x$ : mom. fraction quark (model dependent)

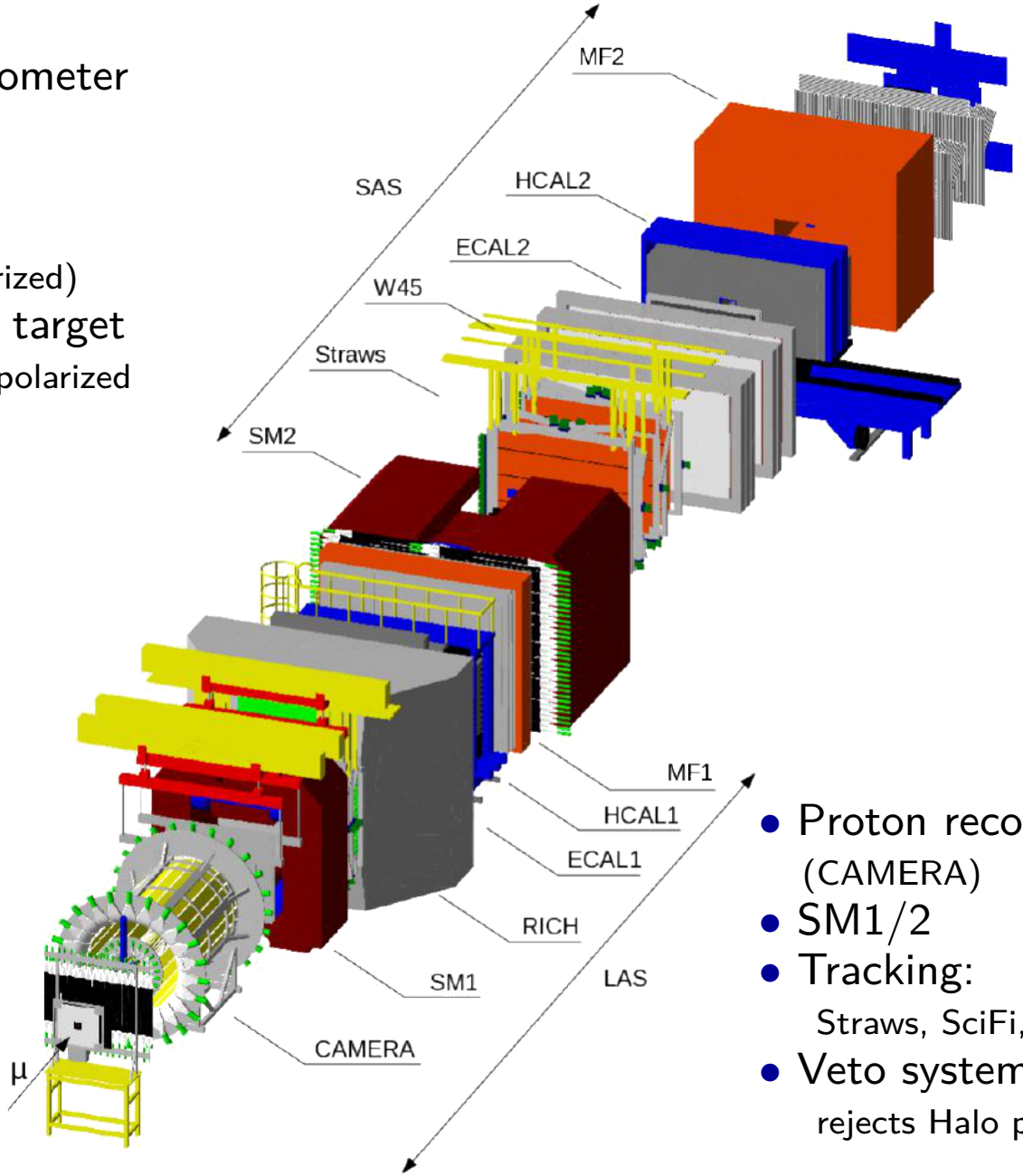
$x_B \to \xi = \frac{x_B}{2-x_B}$ : mom. fraction

} **longitudinal**

$t = (p_p - p_p')^2 = \Delta^2$ : 4 mom. transfer proton **transversal**

# COMPASS Aufbau 2016

- 2 staged spectrometer
  SAS $\leq$ 30 mrad
  LAS bis 180 mrad
- $\mu^{\pm}$ beam
  (E=160 GeV, polarized)
- liquid hydrogen target
  (2.5 m length), unpolarized




- Proton recoil detector
  (CAMERA)
- SM1/2
- Tracking:
  Straws, SciFi,...
- Veto system
  rejects Halo particles

**Experimental cross section:**

$$\sigma = \frac{\text{measured number of events/acceptance}}{\text{integrated luminosity } (\mathcal{L})}$$

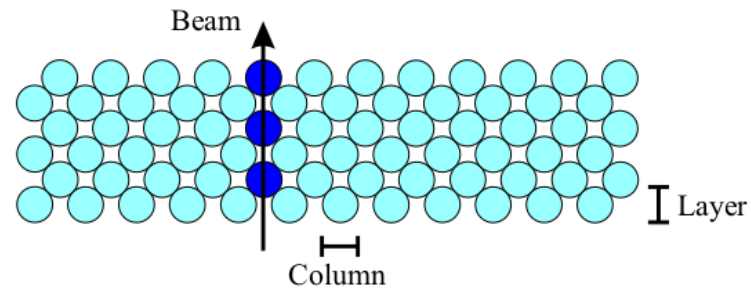
**Luminosity:**

$$\mathcal{L} = \text{flux of beam particles through fiducial volume} \times \text{number of nucleons in fiducial volume}$$

Using two methods at COMPASS:

1. Using scintillating fibre (FI) detector and counting the hits (Scaler method)
2. Counting the number of reconstructed beamtracks in random trigger (RT) events (RT method)

# Scaler method




**Specifications:**

- 96 single fibres
- 6 bundle (16 fibres) each read out by one PMT
- each PMT read out by scaler card

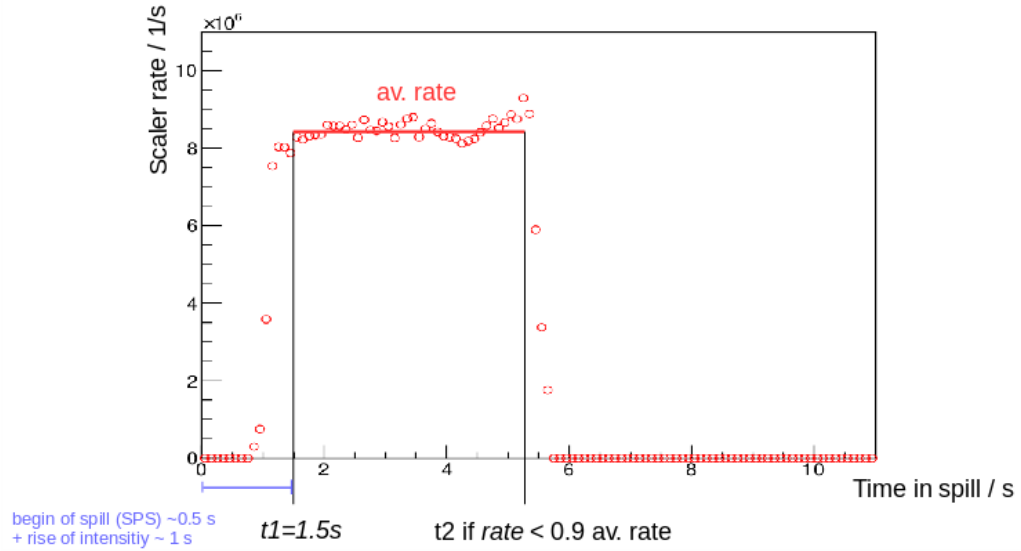
⇒ **counting the hits for every spill**

$$\textbf{Flux per spill} = \frac{\text{number of hits}}{\text{time interval of spill}}$$

→Only interrested in **effective flux through the target cell**

⇒ **Correction** needed

$$C = \frac{\text{n. of tracks which cross target + FI}}{\text{num. of tracks cross FI}}$$

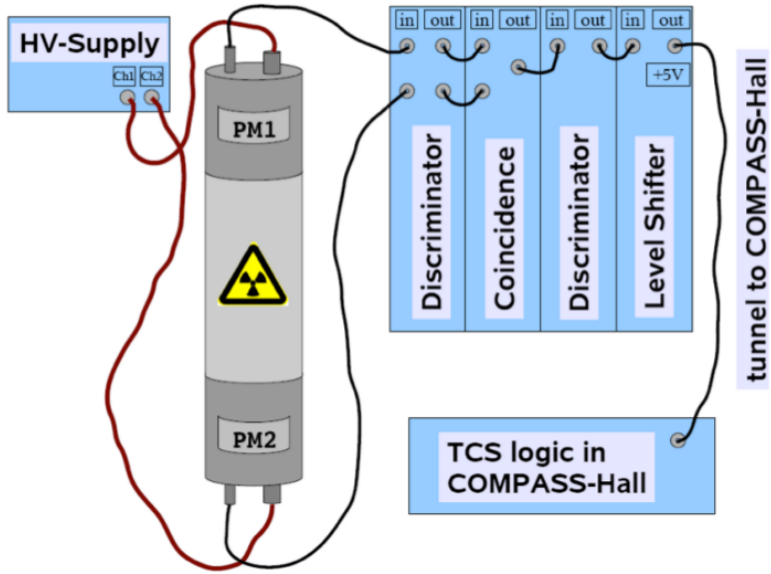


# Random Trigger method

What is the **Random trigger (RT)**?

Not part of spectrometer

2 scintillator + PMT
→ measuring annihilation photons due to $\beta^+$ decay of $^{22}$Na
→ both signals are measured in coincidence
⇒ **Trigger signal**




**Flux by RT method:**

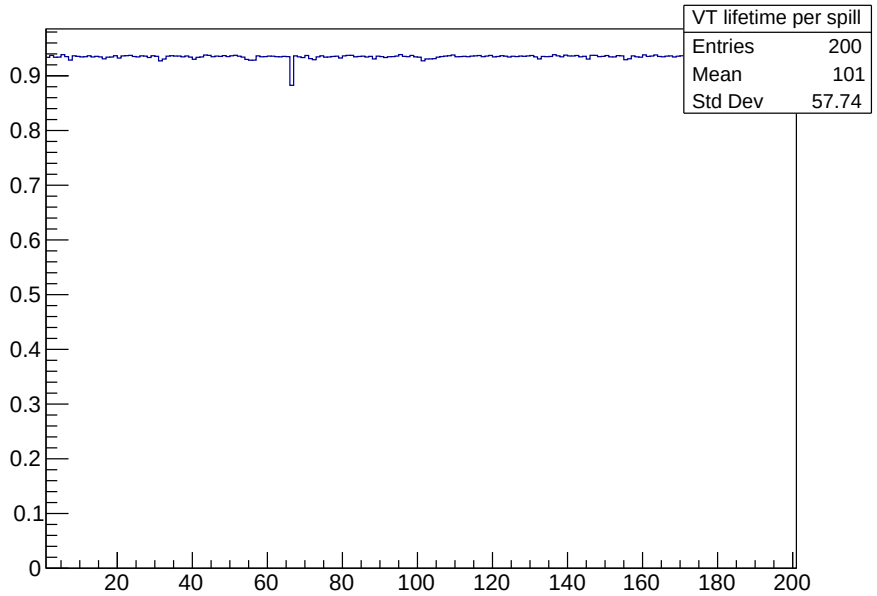
$$F_{RT} = \frac{\text{num. of reconstructed beam tracks with RT}}{\text{num. RT attemps} \cdot \text{time gate of RT}}$$

**num. of reconstructed beam tracks with RT** determined by **data selection**
e.g. beam particle crosses the target, time intervall of spill.

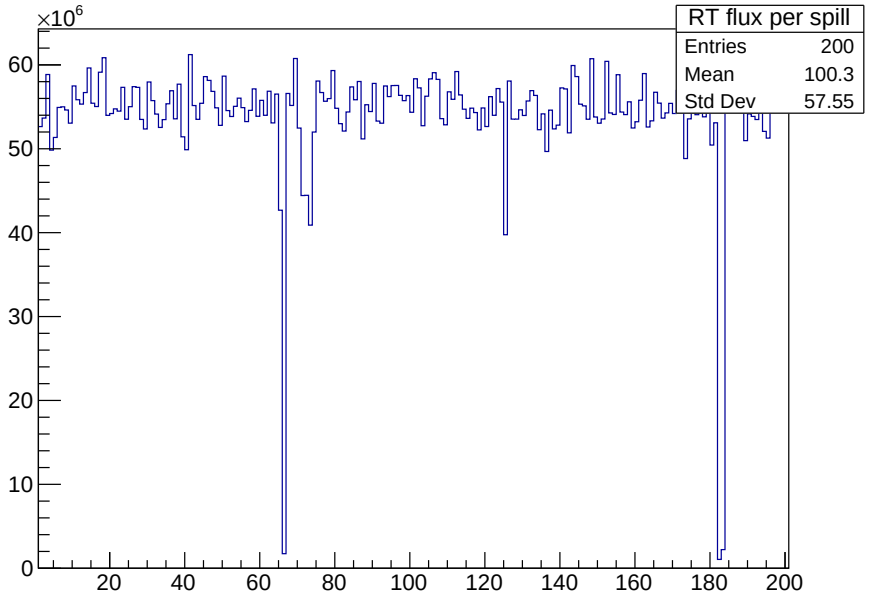
→ Correction needed which is taking into account the **Veto deadtime**

**Veto deadtime:** Time the Veto system needs until it is available again

**VT lifetime per spill:**




**RT flux per spill:**




Flux per day: $20 - 28 \cdot 10^{10}$ muons

# Outlook

Taking data with positive and negativ muon beam (opposite polarization)

$\Rightarrow$ checking that there are no discrepancies between both data sets

- Draw different kinematic distributions (e.g. $x_{Bj}$, $Q^2$, ...) for each data set
- Calculate the ratio of both sets
  $\Rightarrow$ systematic search for discrepancies

# Thank you for your attention