Luminosity Determination at COMPASS

Group Mainz 2012

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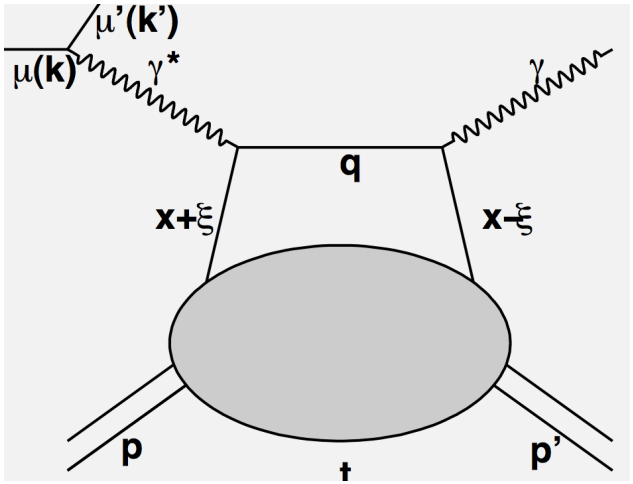
June 11th 2012

Future data taking at COMPASS

Deep Virtual Compton Scattering

$$\mu + N \rightarrow \mu' + N + \gamma$$



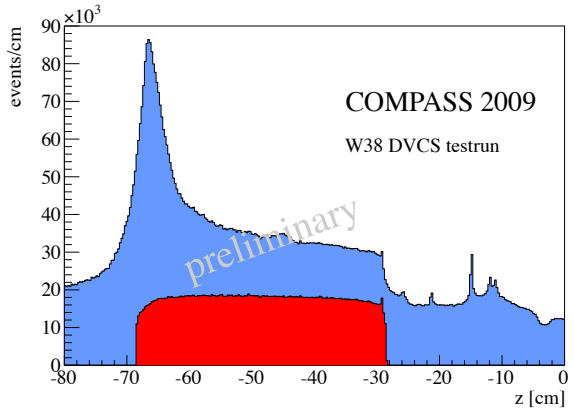
- hard exclusive photon production
- access to Generalized Parton Distribution (GPD) via cross section measurement
- Contains longitudinal parton distribution and transverse dimension

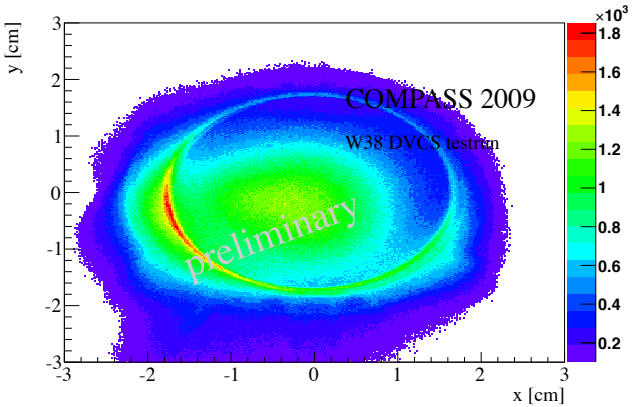
Determination of absolute cross sections

$$\sigma = \frac{N_{event}(\mathrm{DAQ,Veto})}{L(\mathrm{DAQ}) \cdot \text{Veto life time}}$$

$\rightarrow$ Luminosity measurement

Target and Luminosity





Fixed target experiment:
L = flux $\times$ target density

2009 DVCS test run:

- Liquid hydrogen target
- 40 cm long target cell
- Radius of 1.6 cm
- Density LH: 0.0745 $\frac{\text{mol}}{\text{cm}^3}$ @ 1020 mbar and 18 K
- $1.77 \cdot 10^{24} \frac{1}{\text{cm}^2}$

2009 Data

Three weeks of data taking in September 2009

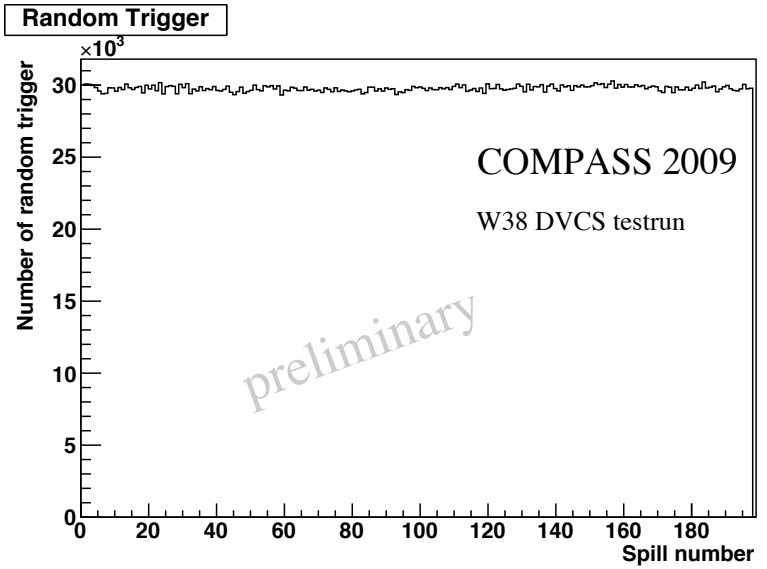
- W38
  - 160 GeV μ^+ beam
  - 58 runs
  - 4049 spills
- W39
  - 160 GeV μ^- beam
  - 6 runs
  - 885 spills
- W40
  - 160 GeV μ^+ beam
  - 109 runs
  - 8862 spills

Data quality check still ongoing

Random Trigger Method

Random trigger from radioactive source

$$\text{Flux} = \frac{\text{number of reconstructed beam tracks}}{\text{number of random trigger} \times \text{time gate } \Delta t}$$

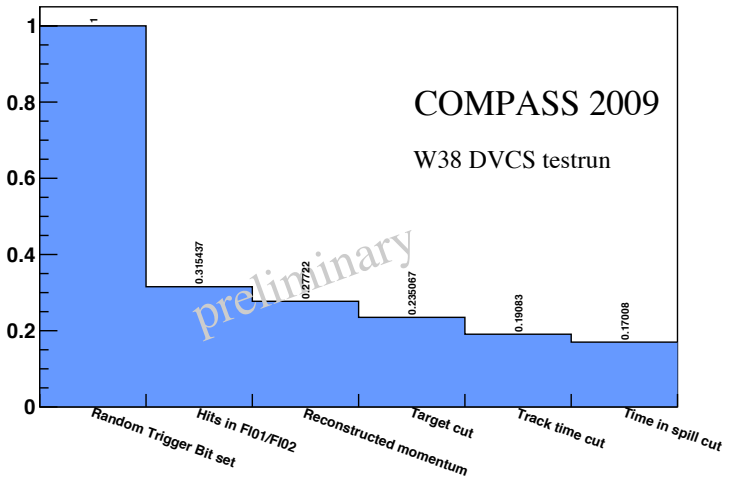


Assumption: same reconstruction efficiency for random and physiscs events

DAQ DT taken into account with this method

Track Selection

Selection of reconstructed beam tracks:

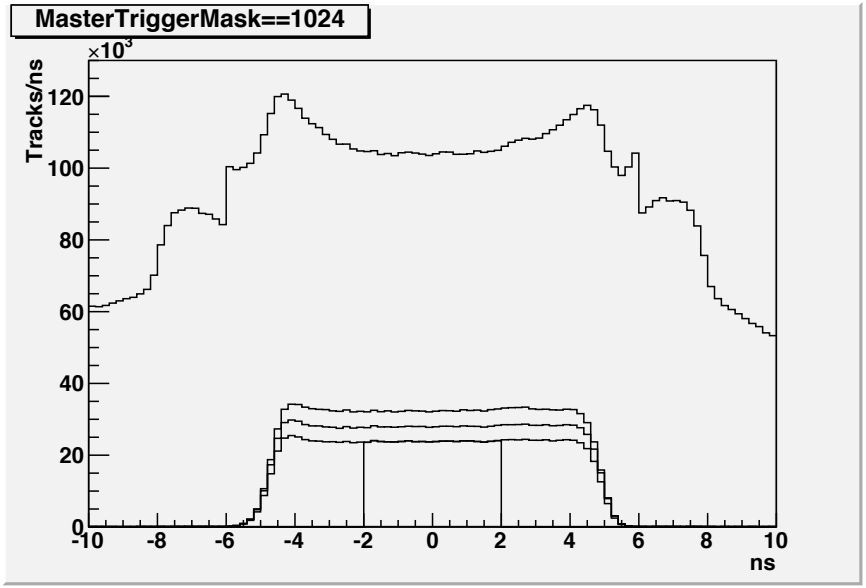


- Hits in FI01/FI02
- Reconstructed momentum
- Target cut (1.6 cm)
- Track time cut $\pm$ 2 ns
- Time in spill cut

$\approx$20% of the random trigger events contain at least one good beam track

Determination of Δt

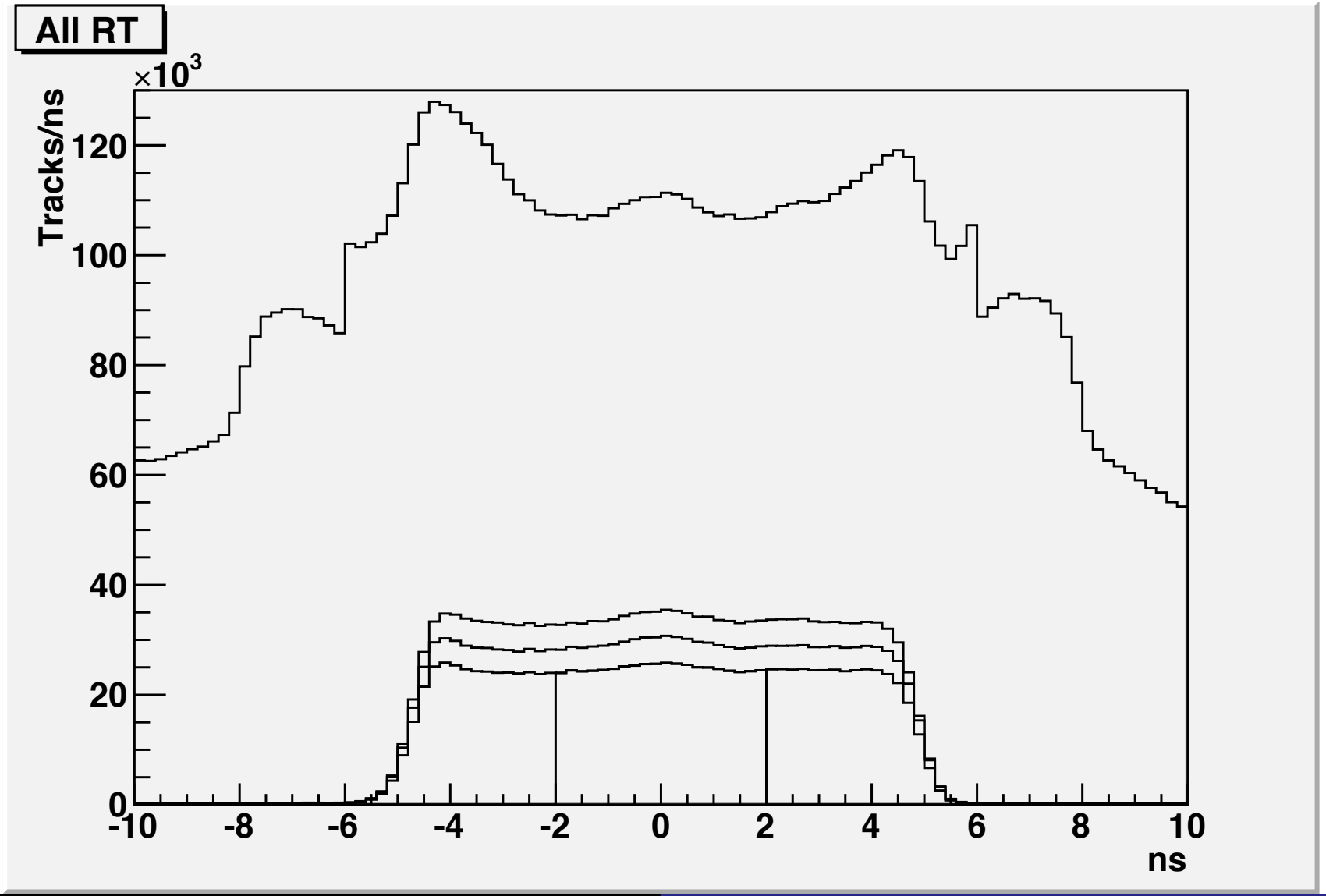
Checking track time relative to trigger time
PaEvent::MasterTriggerMask()==1024



- Rather flat distribution, as expected
- Choose a $\pm$ 2 ns cut

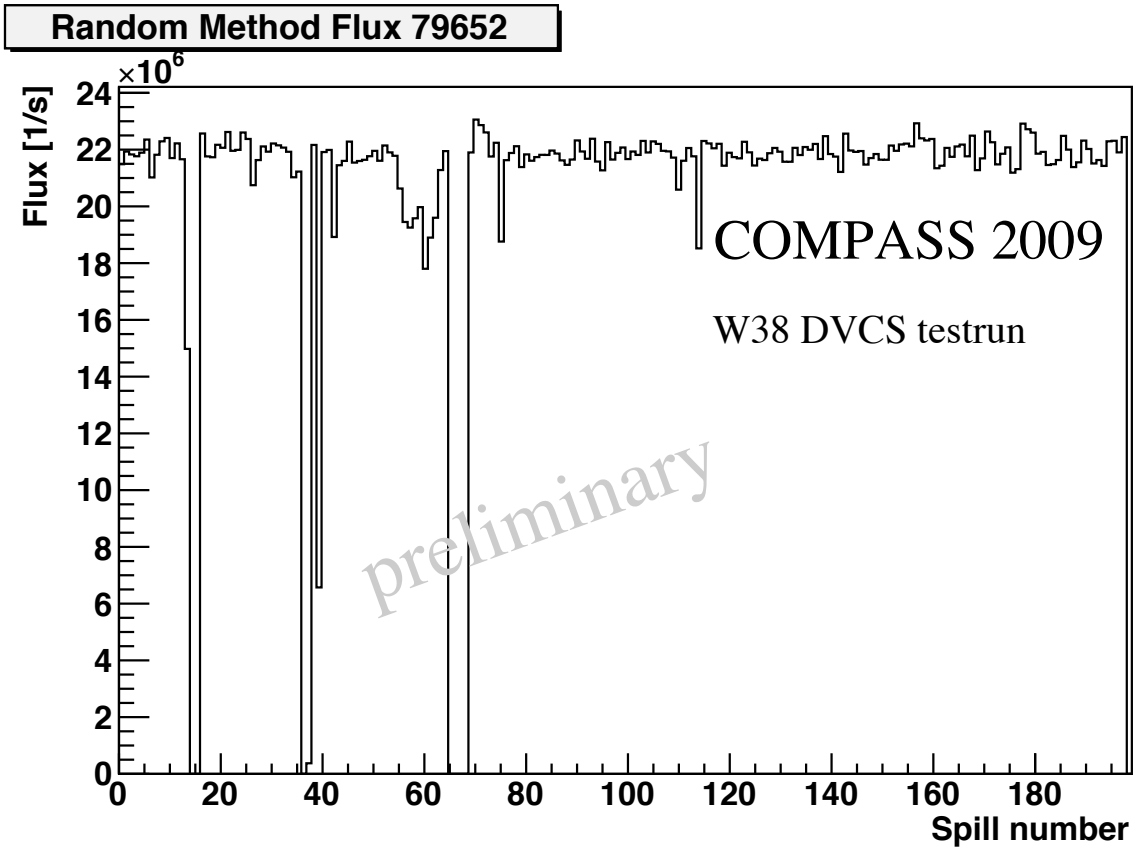
Reducing little bump at 0 ns

Reminder



Random Trigger Flux

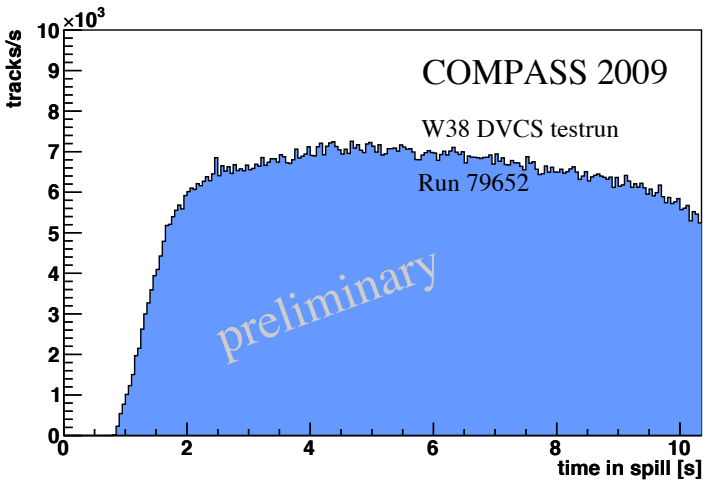
With all ingredients we obtain a flux of $\approx 2.2 \cdot 10^7$ $[\frac{1}{s}]$

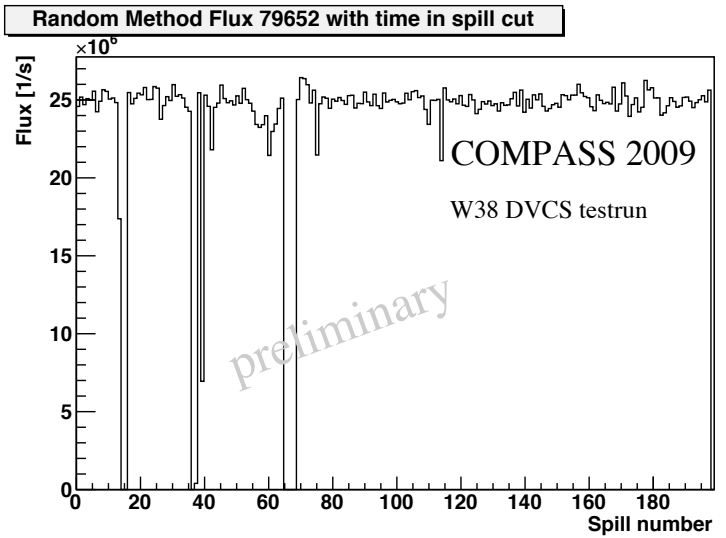


Look at time in spill...

Time in Spill

Examine spill structure:
Choosing a time in spill cut from 2 s to 10 s





Results

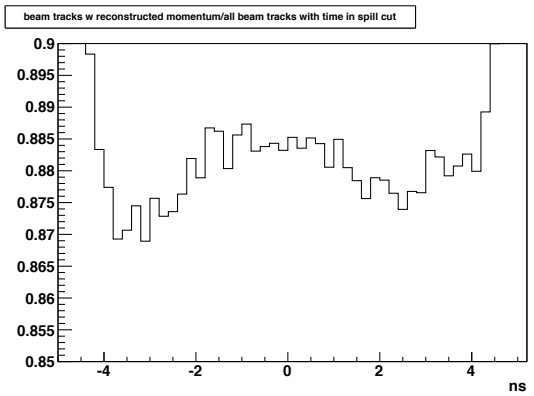
Integrated flux with time in spill cut 2 s to 10 s
Quality cuts to apply

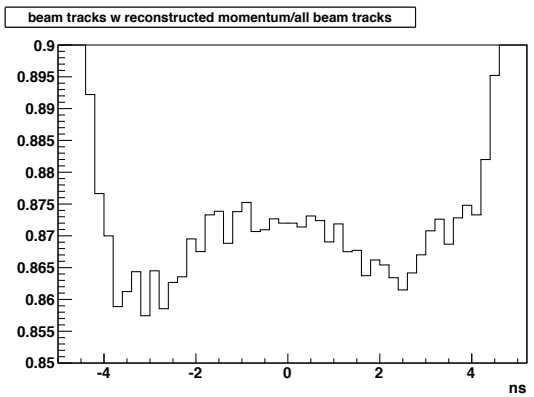
- W38 : 7.464 E+11
- W39: 7.429 E+10
- W40: 1.731 E+12

$\Rightarrow$ 2.5518E12 muons $\Rightarrow$ 4.5166 pb^{-1}

X-checker: Marie Boer

Systematics: Δt

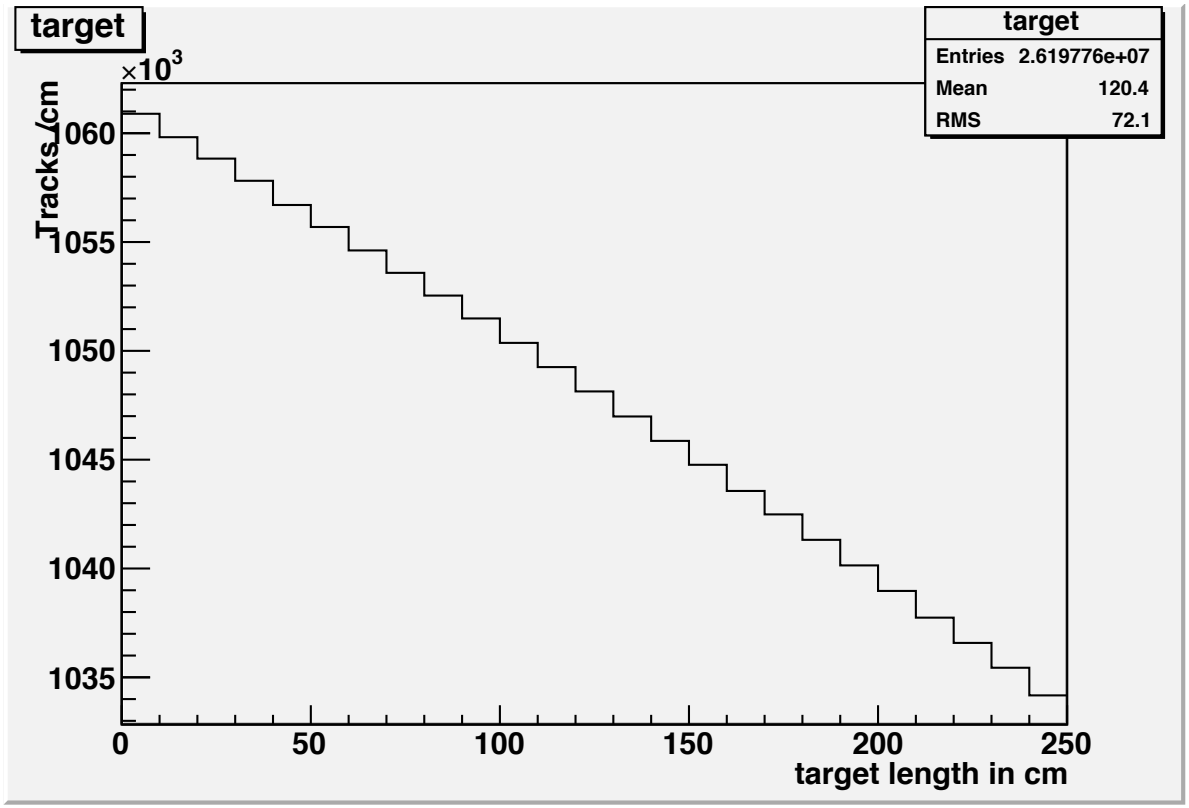




- Looking at meantime distribution wiht reconstructed muons
- $\frac{\text{all beam tracks}}{\text{all reconstructed beam tracks}} = \text{BMS effi}$
- with and w/o time in spill cut
- Time in spill dependance of BMS efficiency
- Beam debunching?

Systematics: Target

Exercise: What impact on beam tracks for the long 2012 DVCS target?
Extrapolated beam track cut on 250 cm target with the same center as the 40 cm LH_2 target of 2009



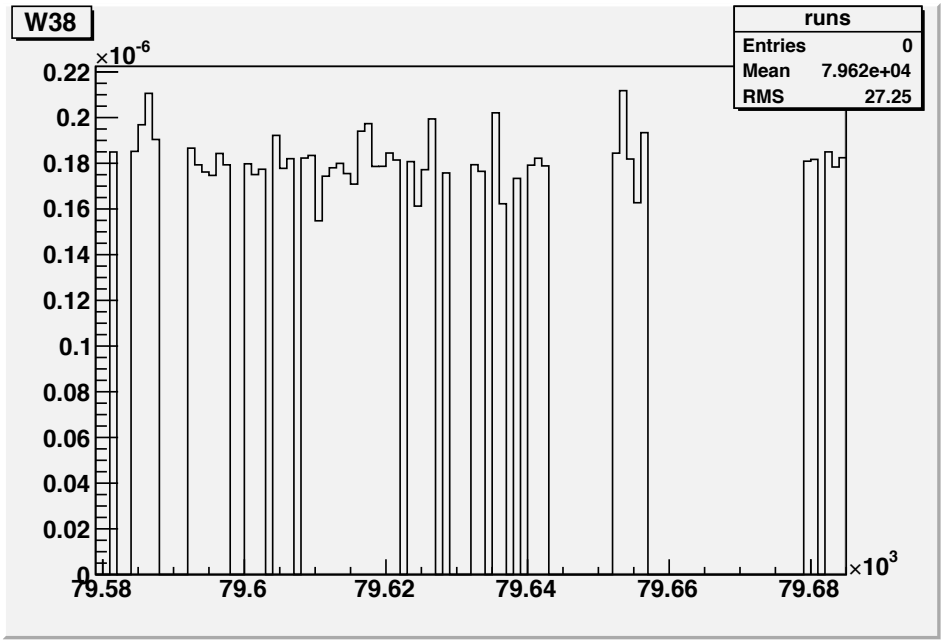
Idea: Systematics target density

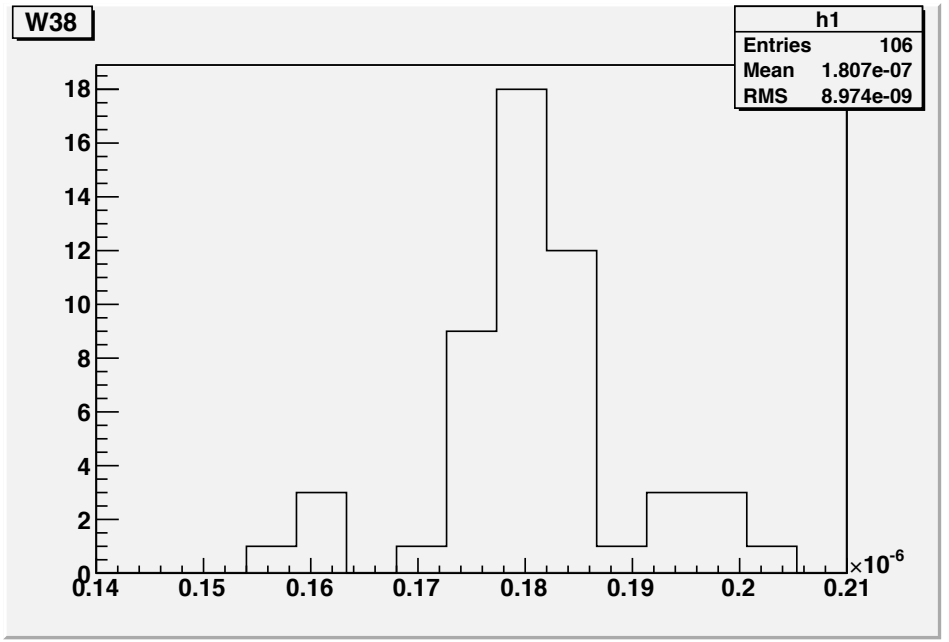
The target density of the LH_2 can only be estimated
But with know DIS cross section it can be monitored

$$\sigma_{DIS} = \frac{N_{DIS}}{\text{target density} \cdot \text{flux} \cdot \text{Veto life time}}$$

with standard DIS cuts (Q^2>1, 0.2<Y<0.85, reconstr. μ')
σ is known therefor 1
Veto life time from Scaler
Flux from Random Trigger Method
Acceptance ignored as assumed constant for each period

Systematics: Target density W38

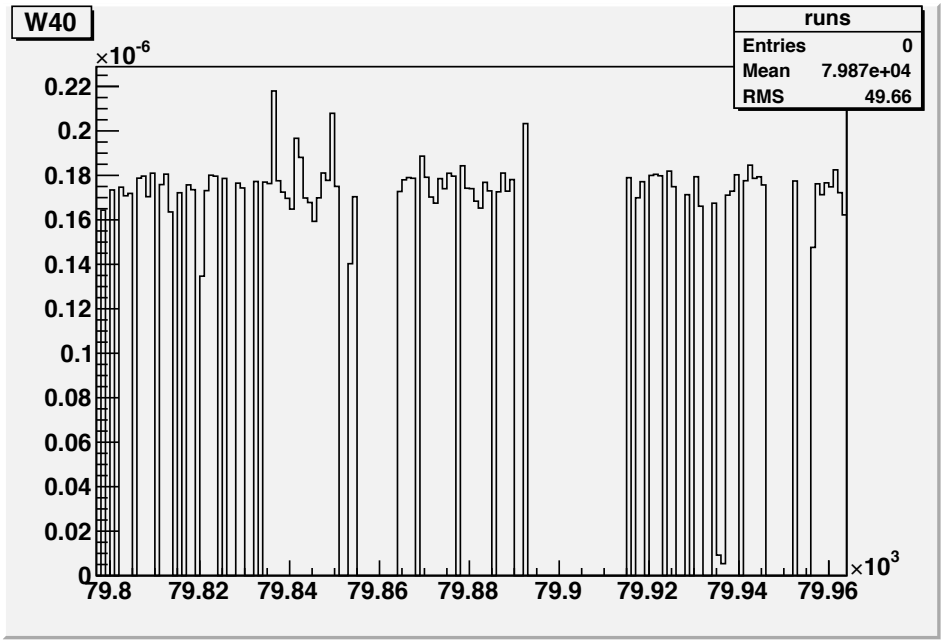


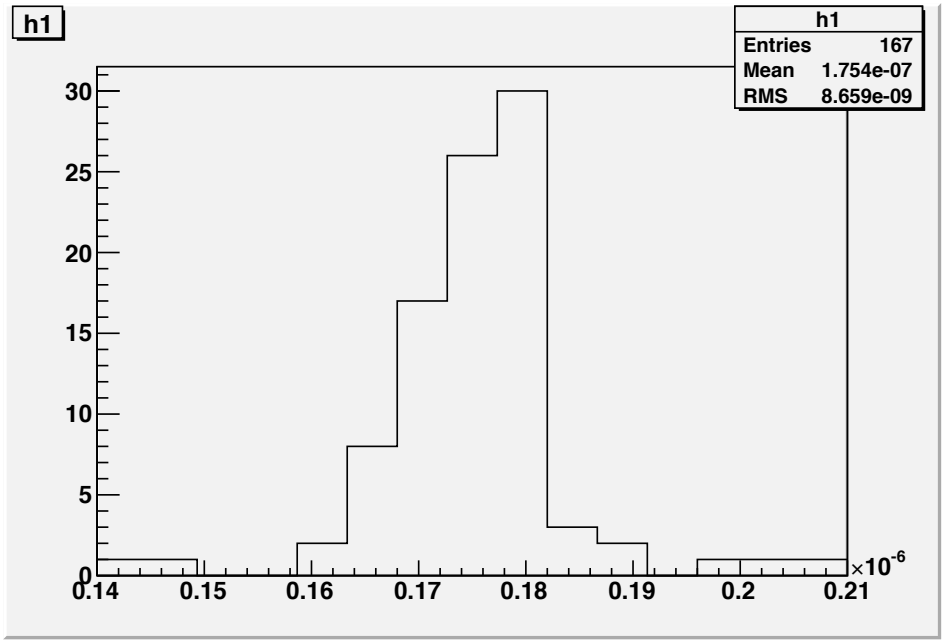


mean: 1.807E-7

sigma: 8.974E-9

Systematics: Target density W40





mean:1.754E-7
sigma:8.659E-9

Outlook

Precise measurment of F_2^p exsiting
Reminer: F_2 is proportional DIS cross section:

$$F_2(x_{Bj}, Q^2) = \frac{d^2\sigma}{dQ^2\, dXbj} \frac{x_{Bj} \cdot Q^4}{4\pi\alpha^2} \cdot$$
$$\left\{1 - y(x_{Bj}, Q^2, E) - \frac{Q^2}{4E^2} + (1 - \frac{2m^2}{Q^2}) \cdot \frac{y(x_{Bj}, Q^2, E)^2 + Q^2/E^2}{2(1+R(x_{Bj}, Q^2))}\right\}^{-1}$$

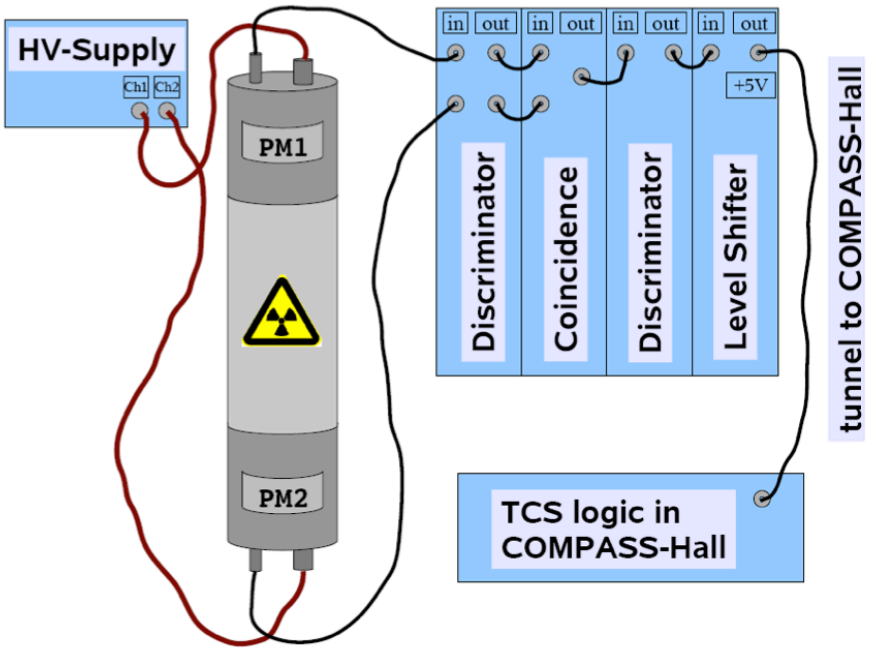
Luminosity can be calculated

Monte Carlo studies for acceptance corrections

Further systematic studies on going

True Random Trigger at COMPASS

- Radioactive β^+source
- Away from experiment
- Decay of ^{22}Na measured
- Coincidence rate $\approx$ 3kHz in 2009



$$^{22}Na \rightarrow ^{22} Ne + e^+ + \nu_e$$