NH3 FILLING FACTOR EVALUATION

to extract absolute cross-sections, it is necessary to know the filling factor for the NH3 and ND3 targets

the filling factor can be evaluated from the real data comparing **PRODUCTION** runs with **CARBON** and **EMPTY**(= HELIUM) target runs

NH3 target = WINDOWS +
X amount of NH3 +
Y amount of HE4 +
C12 target = WINDOWS +
known amount of C12 +
known amount of HE4
MT target = WINDOWS + HE4

there are **2 unknown parameters X and Y**
but **the sum X+Y is constrained**
to match the total volume (KNOWN)

the **observed spectra** for each target can be **parametrized** as a function of the **amounts of different material**, their **density** and the corresponding **cross-section**

for example for **NH3** target and **C12** target

NH3

$$N_{NH3} = \frac{Q}{e}\left\{\frac{\rho_W x_W}{A_W} N_a \sigma_W + \frac{\rho_K x_K}{A_K} N_a \sigma_K + \frac{\rho_{NH3} x_{NH3}}{A_{NH3}} N_a \sigma_{NH3} + \frac{\rho_{He}(l - x_{NH3})}{A_{He}} N_a \sigma_{He}\right\}$$

C12

$$N_{C12} = \frac{Q}{e}\left\{\frac{\rho_W x_W}{A_W} N_a \sigma_W + \frac{\rho_K x_K}{A_K} N_a \sigma_K + \frac{\rho_{C12} x_{C12}}{A_{C12}} N_a \sigma_{C12} + \frac{\rho_{He}(l - x_{C12})}{A_{He}} N_a \sigma_{He}\right\}$$

where

σ_i	cross section on the type i nucleus (w aluminum window, K kapton fooil, ...)
ρ_i	density of the type i material
A_i	mass number of the type i material
x_i	thickness of the type i material
N_a	Avogadro number
Q	total accumulated electron charge
e	electron charge

in the Δ(1232) region the croos section on nuclei can be written as

$$\sigma_i = A_i \sigma_o$$

since the cross-section on neutron and proton are the same for isospin rules

the previous formulas becomes:

NH3

$$N_{NH3} = \frac{Q}{e} N_a \sigma_o \left\{ \rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{NH3}) + \frac{\rho_{NH3} x_{NH3}}{A_{NH3}} \frac{\sigma_{NH3}}{\sigma_o} \right\}$$

C12

$$N_{C12} = \frac{Q}{e} N_a \sigma_o \{ \rho_W x_W + \rho_K x_K + \rho_{He}(l - x_C) + \rho_{C12} x_{C12} \}$$

Based on this approach, different methos can be used to extract x_{NH3}

- WITH separation of nitrogen and proton contribution
- withOUT separation of nitrogen and proton contribution

1[th] method: NH3-C12 comparison

assuming that the cross-section on a free proton is equal to the cross-section inside nuclei

$$\sigma_{NH3} = \sigma_o$$

the previous formula become:

$$N_{NH3} = \frac{Q_{NH3}}{e} N_a \sigma_o \{\rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{He}) + \rho_{NH3} x_{NH3}\}$$

$$N_{C12} = \frac{Q_{C12}}{e} N_a \sigma_o \{\rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{C12}) + \rho_{C12} x_{C12}\}$$

$$\frac{N_{NH3}}{N_{C12}} = \frac{Q_{NH3}}{Q_{C12}} \frac{\{\rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{He}) + \rho_{NH3} x_{NH3}\}}{\{\rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{C12}) + \rho_{C12} x_{C12}\}}$$

$$\boxed{x_{NH3} = \left\{ \frac{N_{NH3}}{N_{C12}} \frac{Q_{C12}}{Q_{NH3}} \left[\rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{C12})\right] + -\left[\rho_W x_W + \rho_K x_K + \rho_{He} l\right] \right\} \frac{1}{\rho_{NH3} - \rho_{He}}}$$

2th method: N-C12 comparison

the filling factor can be obtain comparing C12 and N

this method requires the separation
of proton and nitrogen in the NH3

in this case...

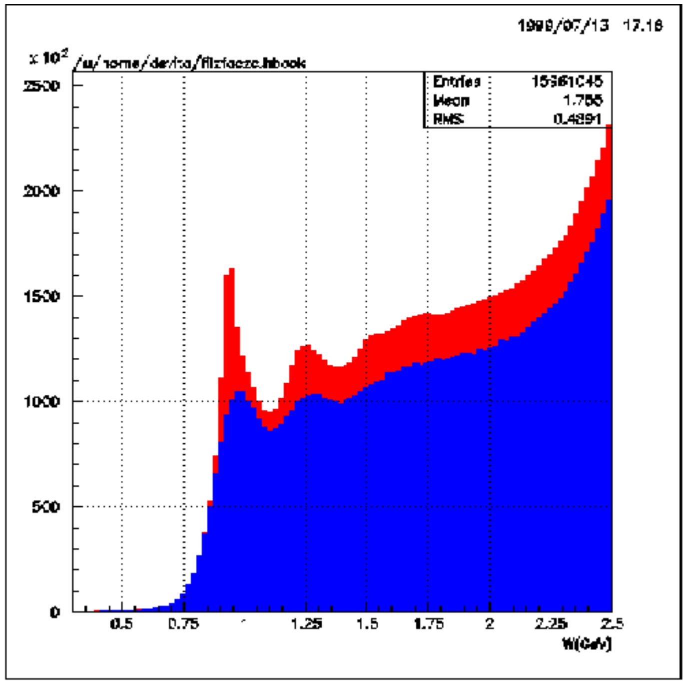
$$N_N = \frac{Q_{NH3}}{e} N_a \sigma_o \left\{ \rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{NH3}) + \frac{A_N}{A_{NH3}} \rho_{NH3} x_{NH3} \right\}$$

$$N_{C12} = \frac{Q_{C12}}{e} N_a \sigma_o \left\{ \rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{C12}) + \rho_{C12} x_{C12} \right\}$$

$$\frac{N_N}{N_{C12}} = \frac{Q_{NH3}}{Q_{C12}} \frac{\left\{ \rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{He}) + \frac{5}{18} \rho_{NH3} x_{NH3} \right\}}{\left\{ \rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{C12}) + \rho_{C12} x_{C12} \right\}}$$

$$\boxed{x_{NH3} = \left\{ \frac{N_N}{N_{C12}} \frac{Q_{C12}}{Q_{NH3}} \left[\rho_W x_W + \rho_K x_K + \rho_{He}(l - x_{C12}) + \rho_{C12} x_{C12} \right] + - \left[\rho_W x_W + \rho_K x_{.} + \rho_{He} l \right] \right\} \frac{1}{\frac{15}{18} \rho_{NH3} - \rho_{He}}}$$

in the second method the PROTON-NITROGEN separation is performed by comparison between C12 and NH3 spectra

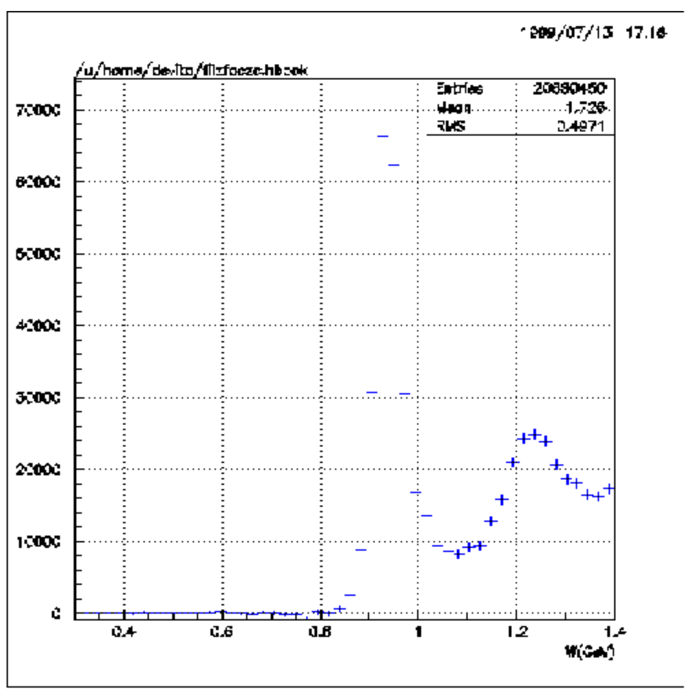


CARBON is assumed to simulate the NITROGEN contribution

the PROTON contribution is then extracted as:

$$N_P = N_{NH3} - aN_{C12}$$

where **a** is determined matching the CARBON and AMMONIA spectra <u>below 0.8 GeV in W</u>



SOME NUMBERS......

Aluminum Windows

$$\rho_{Al} = 2.7\, g / cm^3$$

entrance window: 70μ
target back window: 20μ
exit window: 70μ
4K shield: ? (assumed 50μ)

total: $\rho_W x_W = 56.7 mg / cm^2$

Kapton Foil

$$\rho_{Kapton} = 1.42\, g / cm^3$$

foil thickness: 50μ

total: $\rho_K x_K = 7.25 mg / cm^2$

Carbon target

$$\rho_{Carbon} = 2.18 g / cm^3$$

carbon target thickness: 2.27 ±0.01mm

total: $\rho_{C12} x_{C12} = 495 mg / cm^2$

Helium

$$\rho_{Helium\ 4} = 0.145 g / cm^3$$

distance l between entrance : 15 mm
and exit windows

total: $\rho_{He} l = 217.5 mg / cm^2$

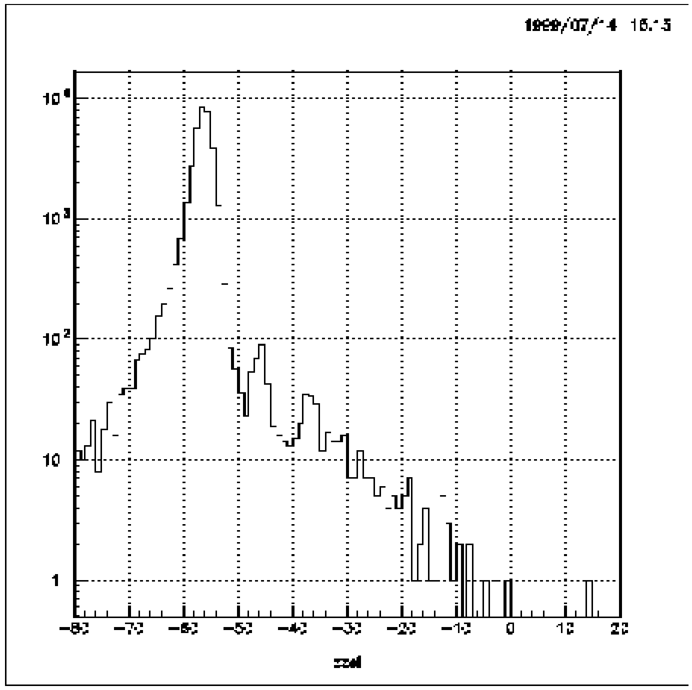
Ammonia target

$$\rho_{Ammonia} = 0.971 g / cm^3$$

CUTS

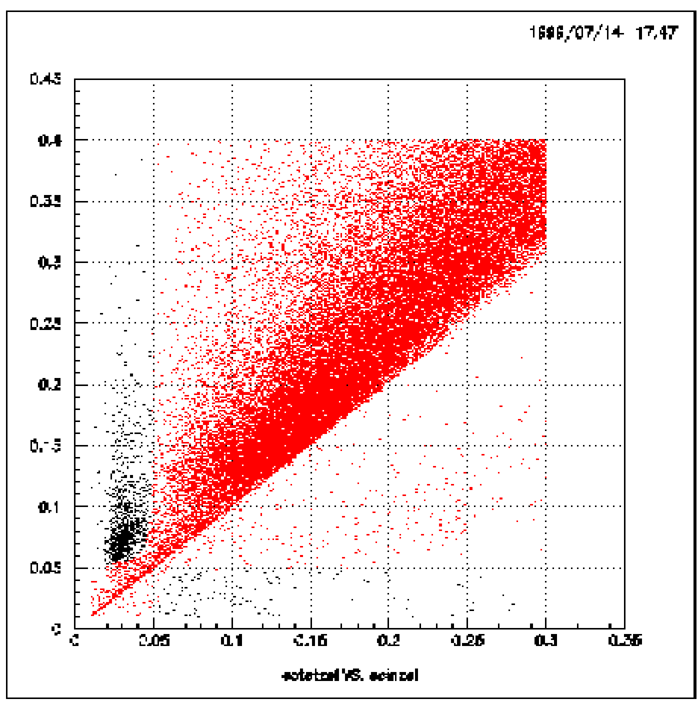
VERTEX

to remove the contribution from heat shields and vacuum window a cut on the vertex position was applied



EC ENERGY

a cut on the energy released in the EC was applied to reduce the possible contamination from misidentified pions



1th method

target	#e-	Q_gated
NH3	1.536 M	23.66 μC
C12	0.457 M	6.864 μC

$$x_{NH3} = (0.582 \pm 0.009)cm$$

2th method

target	#e-	Q_gated
N	a*C12	23.66 μC
C12	0.457 M	6.864 μC

$$x_{NH3} = (0.542 \pm 0.013 \pm 0.014)cm$$