

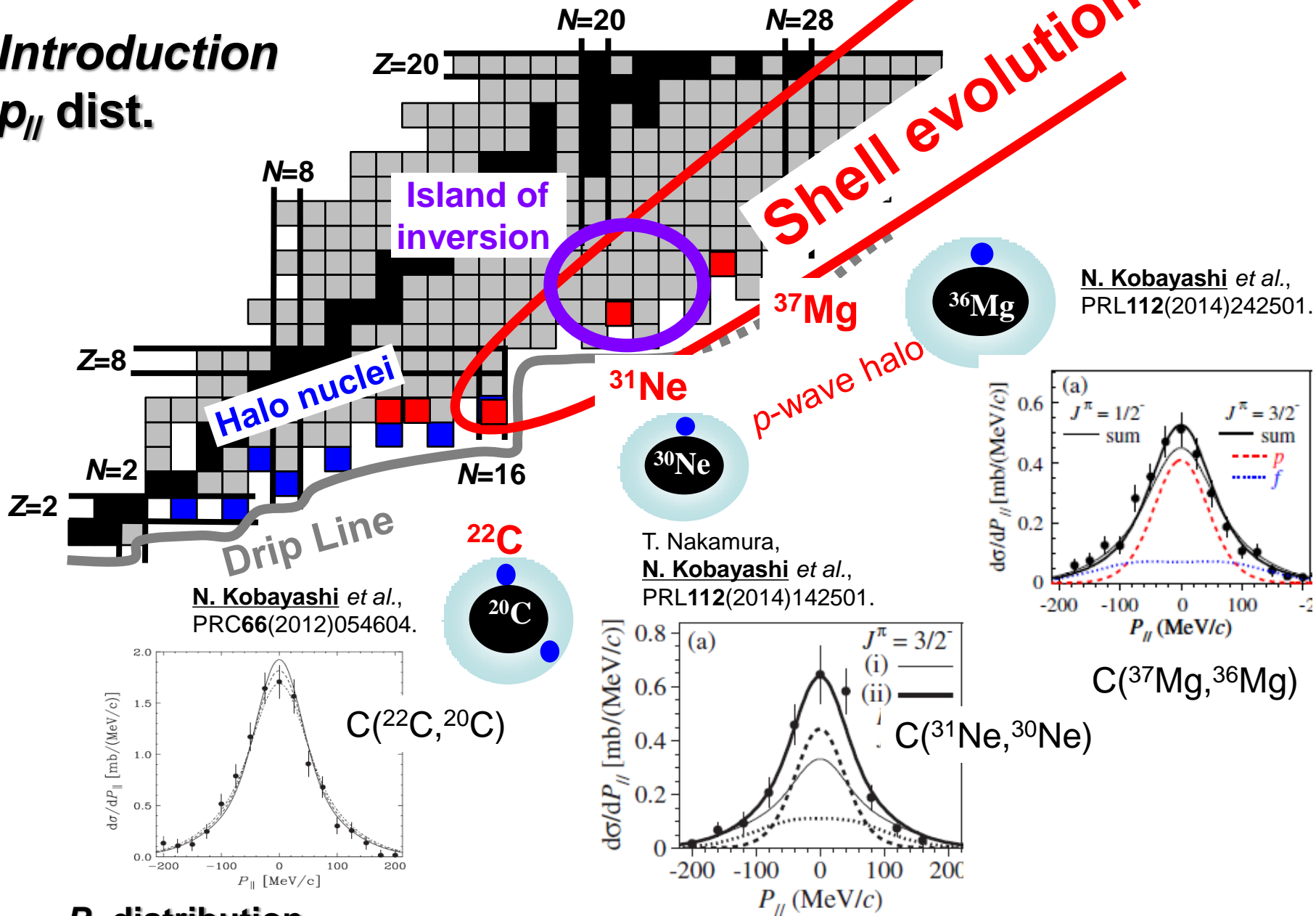
Acceptance study of ZeroDegree Spectrometer (ZDS)

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Introduction

$p_{||}$ dist.



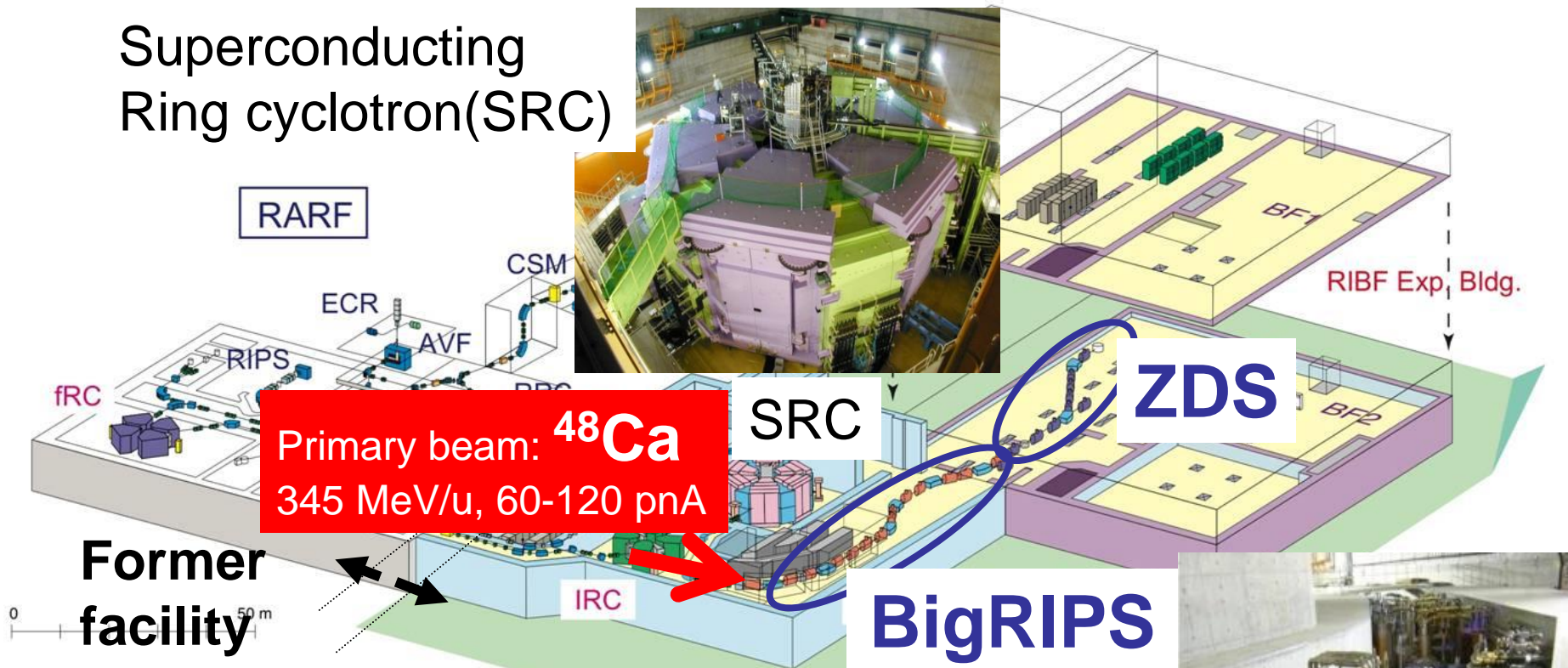
$P_{||}$ distribution

→ Orbital angular momentum ℓ of the valence neutron

← Acceptance of core fragments at ZDS? ← Calibration runs of our exp.

RI Beam Factory (RIBF) @ RIKEN

Superconducting
Ring cyclotron (SRC)



Primary beam: ^{48}Ca
345 MeV/u, 60-120 pA

Former
facility

**RI Beam Factory
(RIBF)**
19,20,22C, ^{31}Ne in 2008
 ^{37}Mg in 2010





Experimental setup

Primary Beam
 ^{48}Ca 60-120 pA
345 MeV/u

Secondary Beam
 ^{37}Mg , ^{31}Ne , $^{22,20,19}\text{C}$
Energy ~ 230 MeV/u

$^{36}\text{Mg}, \dots$

Fragments

RI Beam Factory

SRC

ZDS

ΔE

ΔE

$B\rho$

$B\rho$

TOF

TOF

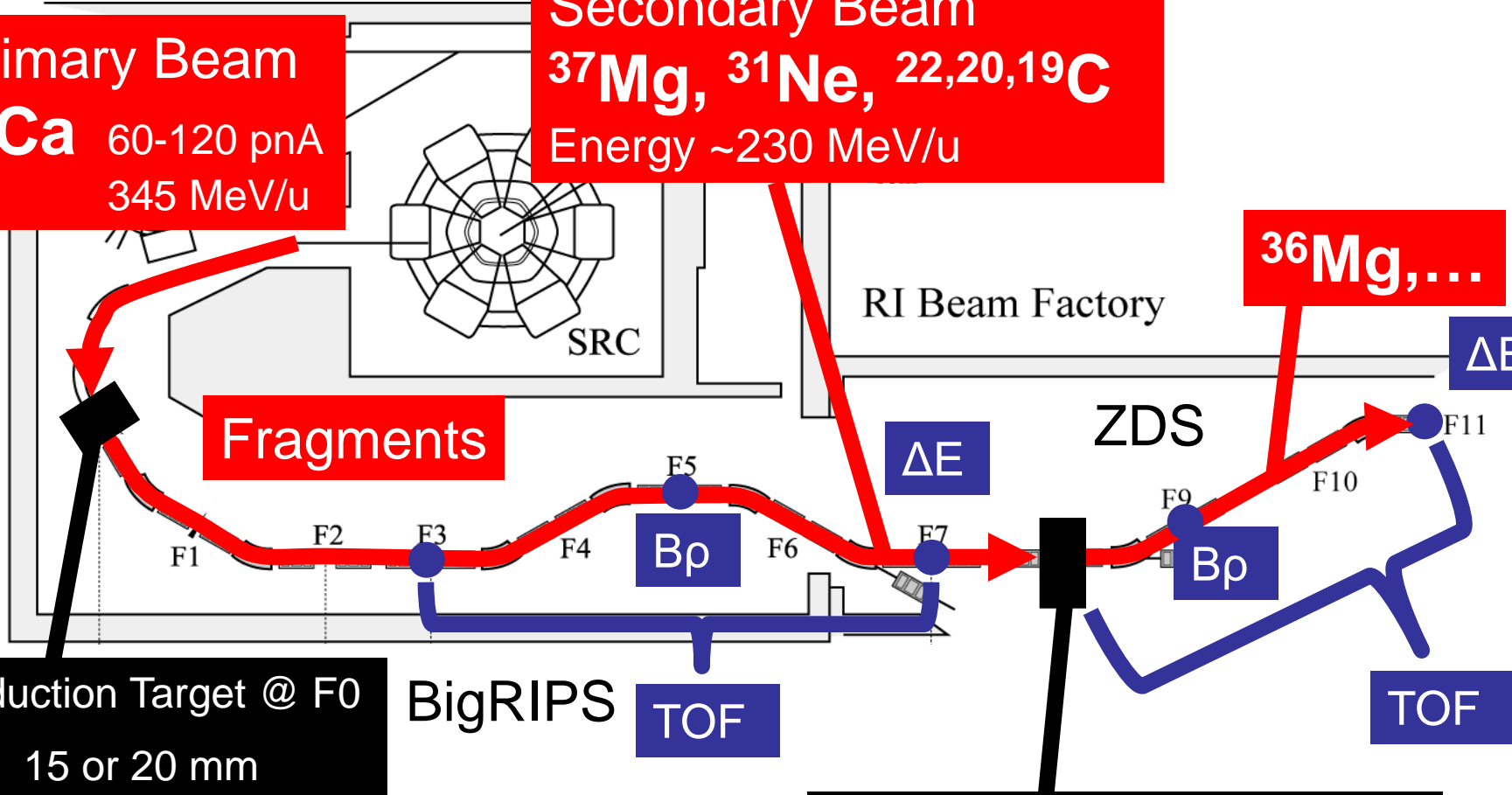
Production Target @ F0
Be 15 or 20 mm

BigRIPS

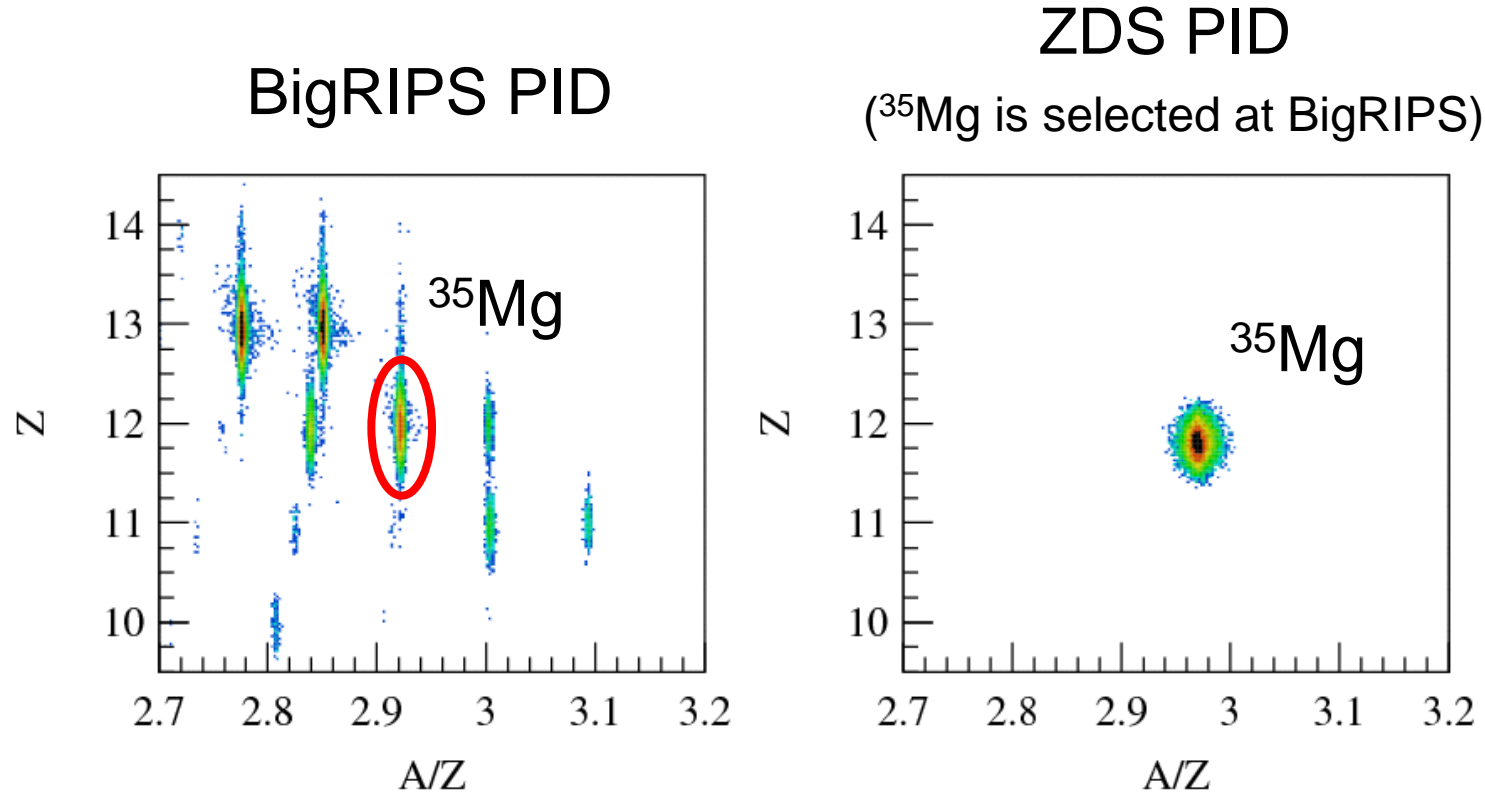
Reaction Target @ F8

C 2.54 g/cm² (for ^{31}Ne , ^{37}Mg)
4.02 g/cm² (for $^{19,20,22}\text{C}$)

ZDS: large acceptance mode



Angular acceptance of ZDS

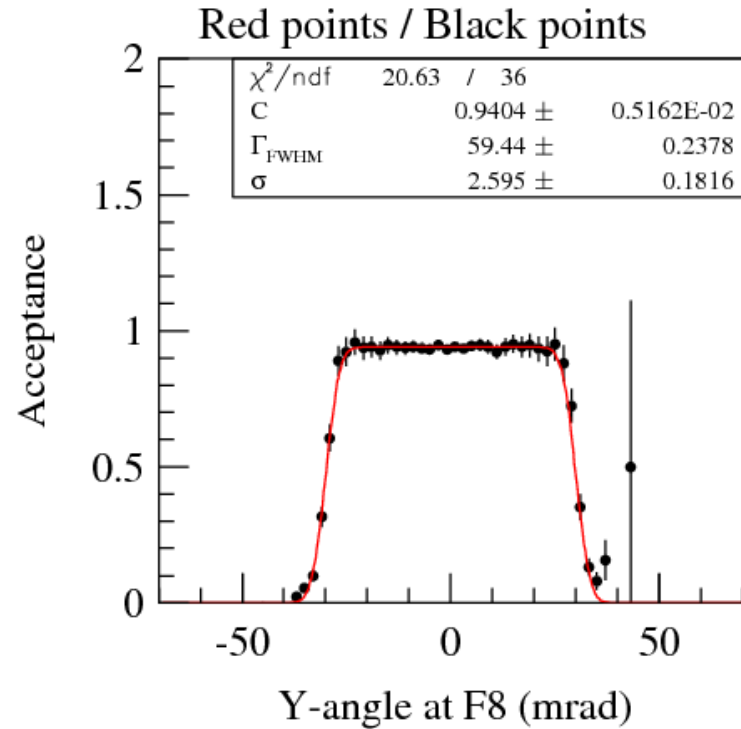
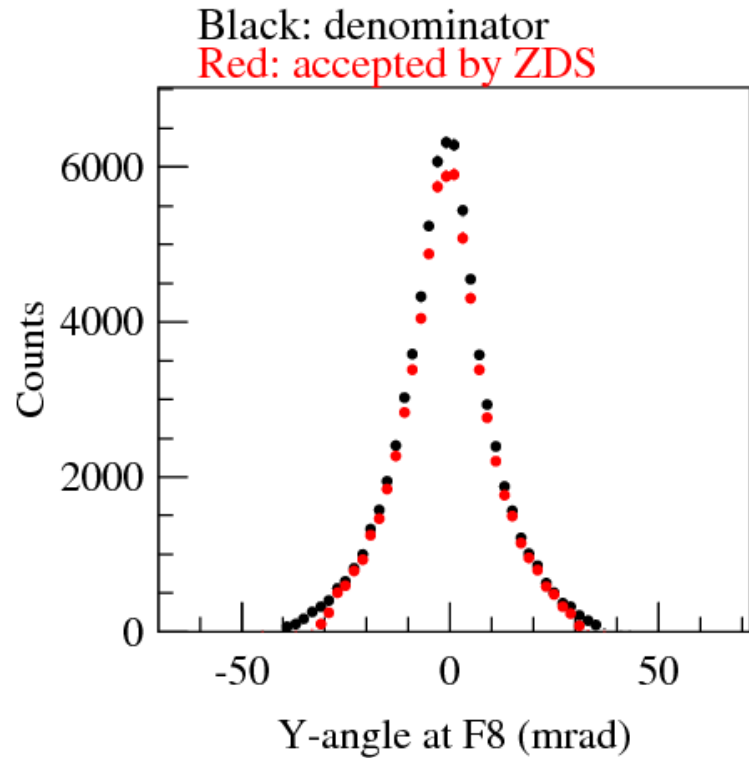


Used run : ^{35}Mg + empty target \rightarrow ^{35}Mg

The beam angle was widened at F8.

(STQ15,16 was tuned (Sumikama-san's optics).)

Angular acceptance of ZDS (vertical)



Fitting func. $f(x)$: convoluted rectangular func.

$$f(x) = C \int_{-\infty}^{\infty} \text{rect}(t) g(x-t) dt$$

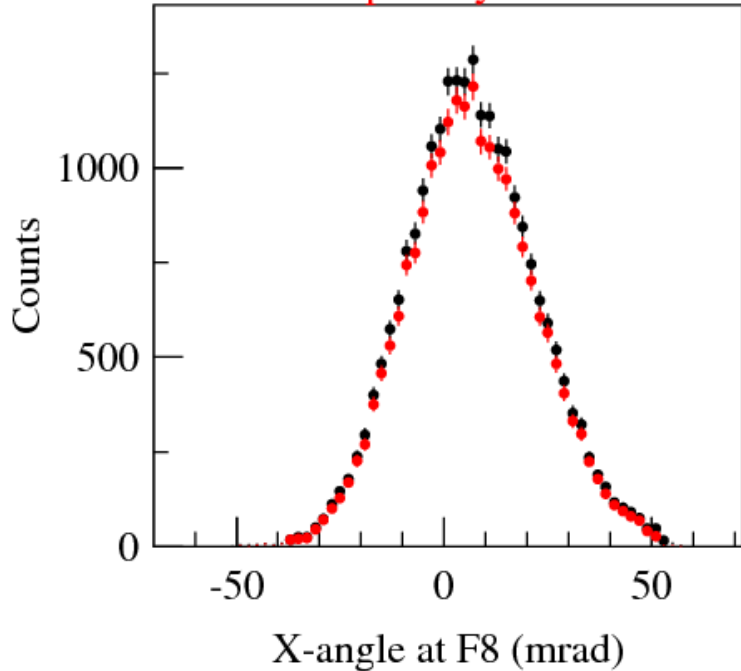
$$\text{rect}(x) = \begin{cases} 1 & \text{if } |x| \leq \Gamma_{\text{FWHM}}/2 \\ 0 & \text{if } |x| > \Gamma_{\text{FWHM}}/2 \end{cases}$$

$$g(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

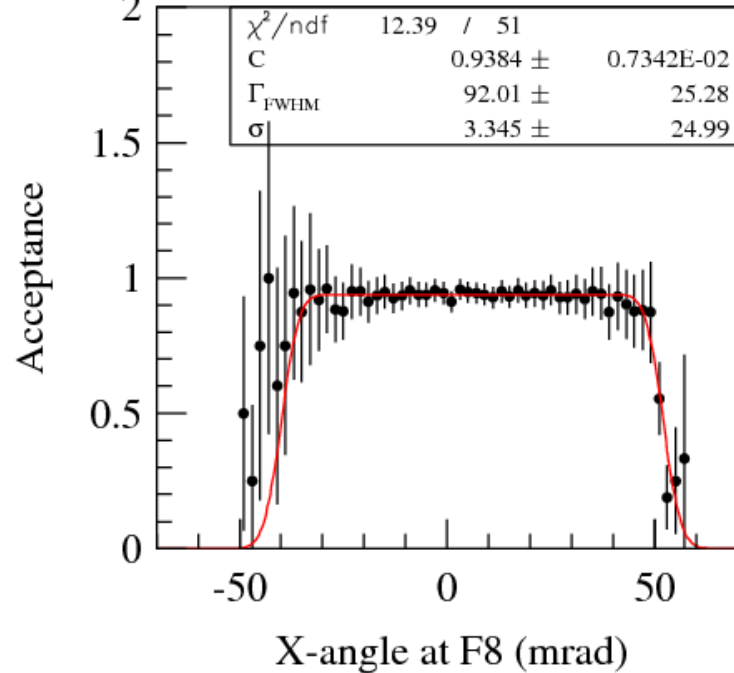
Vertical angular acceptance
+/- 30 mrad
(design value: +/- 30 mrad)

Angular acceptance of ZDS (horizontal)

Black: denominator
Red: accepted by ZDS



Red points / Black points



Fitting func. $f(x)$: convoluted rectangular func.

$$f(x) = C \int_{-\infty}^{\infty} \text{rect}(t) g(x-t) dt$$

$$\text{rect}(x) = \begin{cases} 1 & \text{if } |x - \mu| \leq \Gamma_{FWHM}/2 \\ 0 & \text{if } |x - \mu| > \Gamma_{FWHM}/2 \end{cases}$$

$$g(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

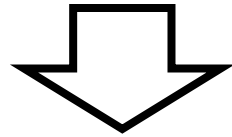
Horizontal angular acceptance
-40 ~ +52 mrad
(design value: +/- 45 mrad)

Momentum acceptance of ZDS

To estimate the mom. acc.,

$^{35}\text{Mg} + \text{empty} \rightarrow ^{35}\text{Mg}$ setting can not be used.

Because almost all ^{35}Mg particles are accepted at ZDS.



In $^{35}\text{Mg} + \text{empty} \rightarrow ^{34}\text{Mg}$ setting,

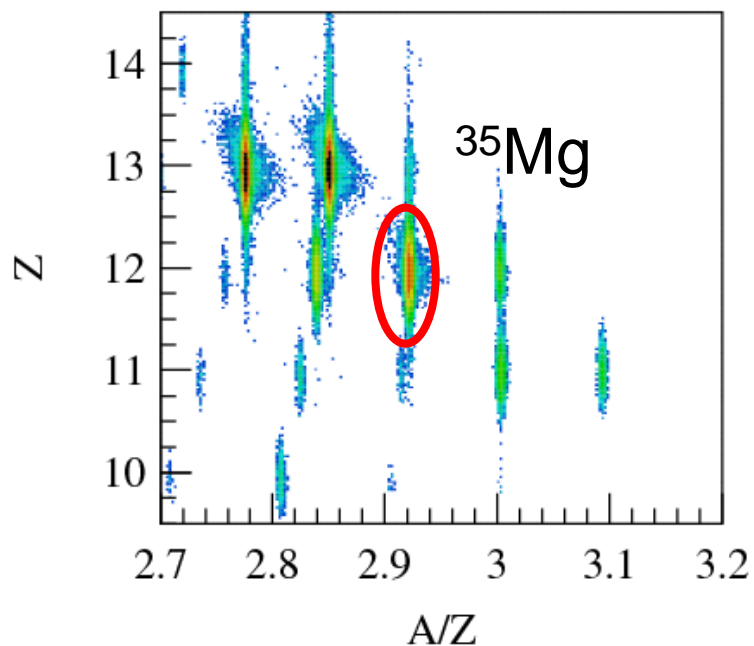
^{35}Mg dist. was checked to get upper lim. of acc.
(^{35}Mg beam hits the ZDS beam line.)

Similarly, in $^{35}\text{Mg} + \text{C} \rightarrow ^{35}\text{Mg}$ setting,

^{34}Mg dist. was checked to get lower lim. of acc..

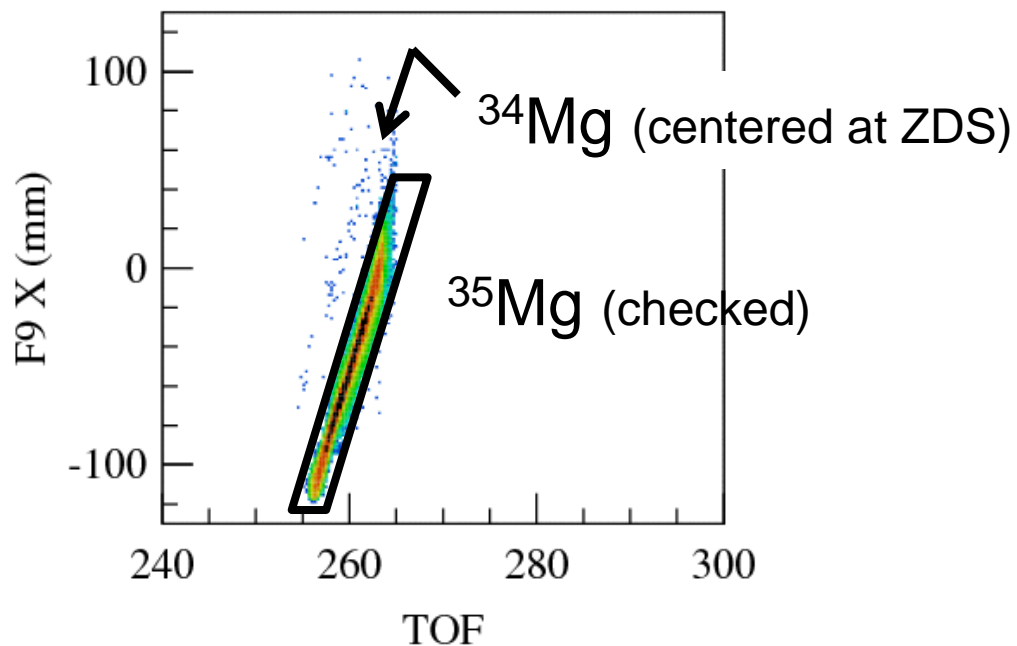
Momentum acceptance of ZDS

BigRIPS PID



ZDS PID

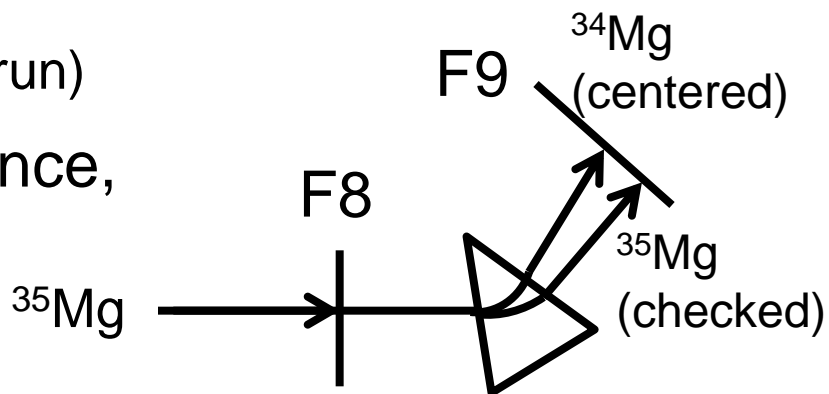
(^{35}Mg is selected at BigRIPS)



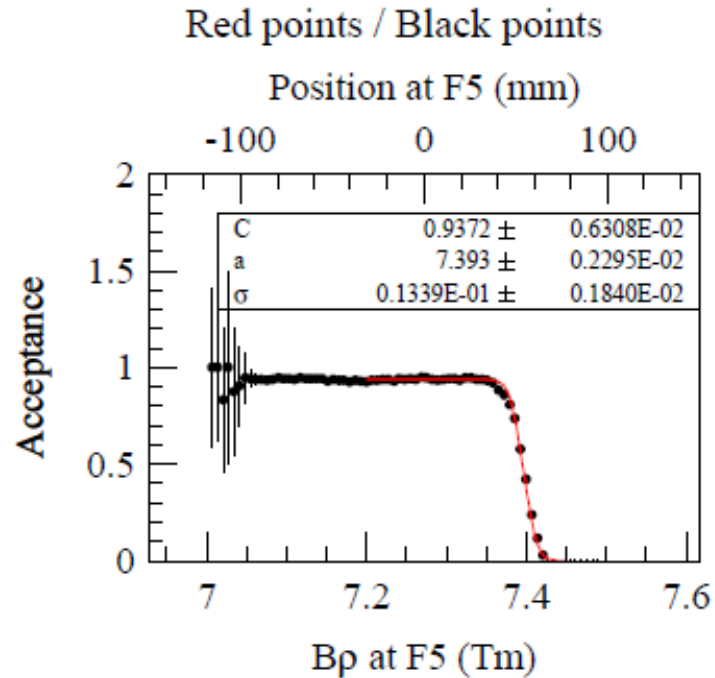
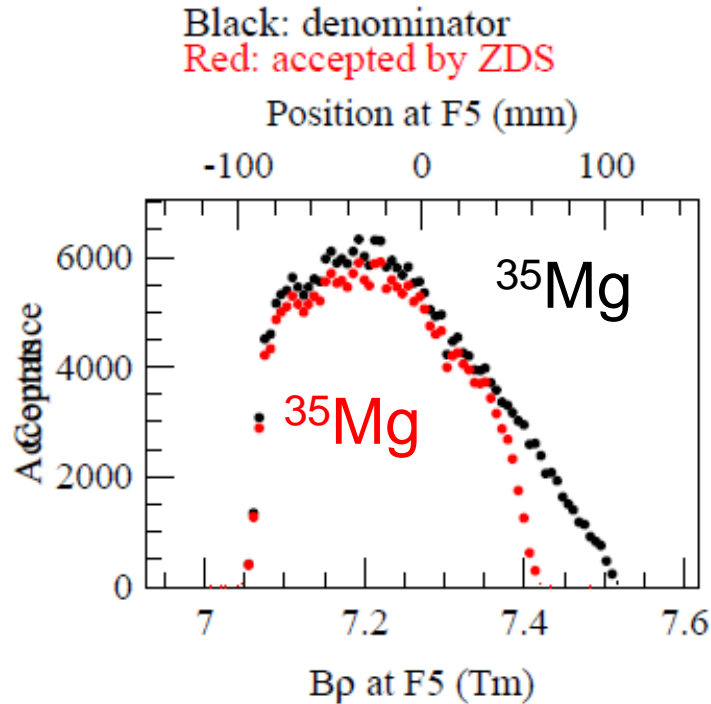
Used run:

^{35}Mg + empty \rightarrow ^{34}Mg setting (background run)

To estimate the momentum acceptance,
 ^{35}Mg dist. was checked at ZDS.



Momentum acceptance of ZDS



Fitting func. $f(x)$: convoluted rectangular func.

$$f(x) = C \int_{-\infty}^{\infty} \text{rect}(t) g(x-t) dt$$

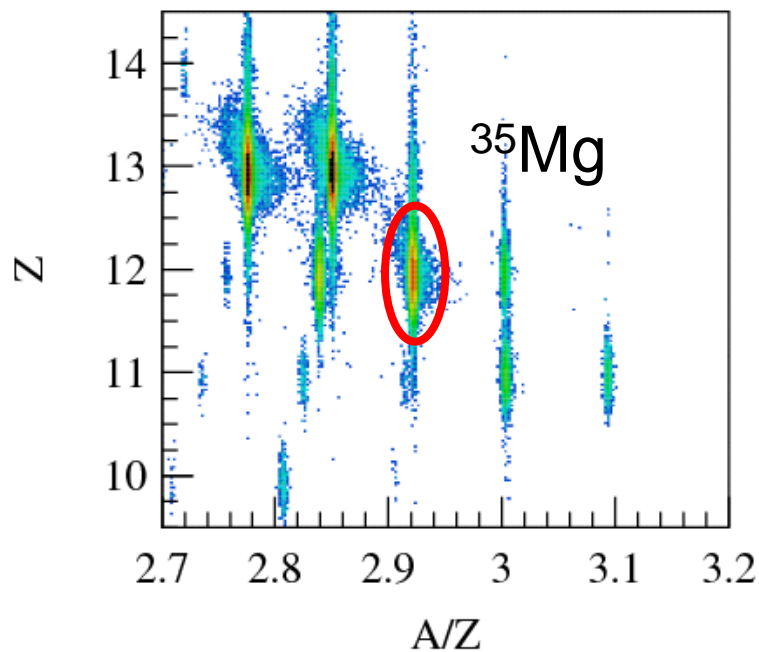
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$$g(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

Momentum acceptance
< +4.8 %

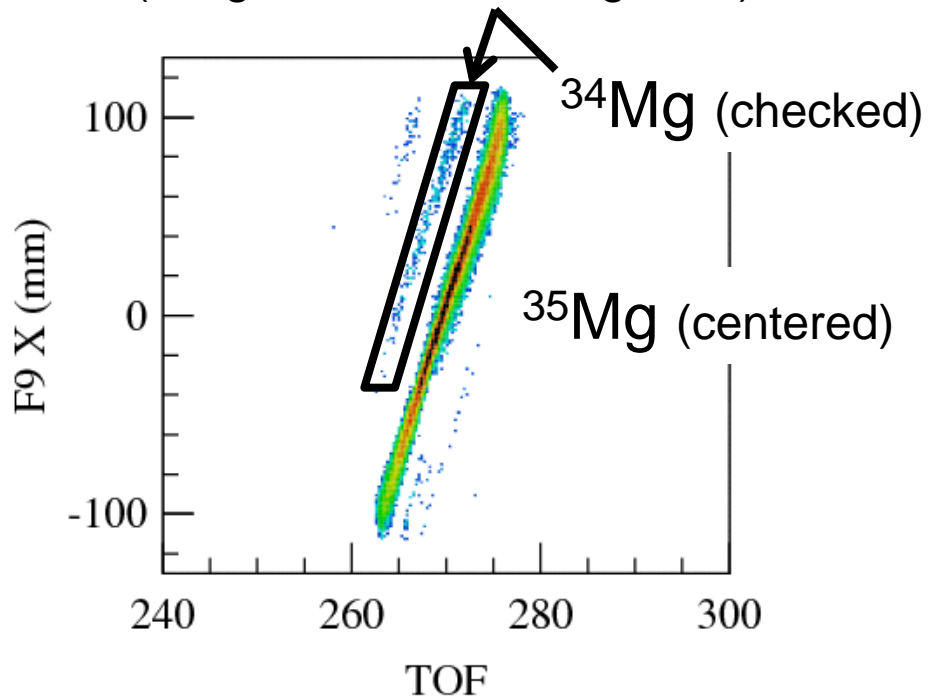
Momentum acceptance of ZDS

BigRIPS PID



ZDS PID

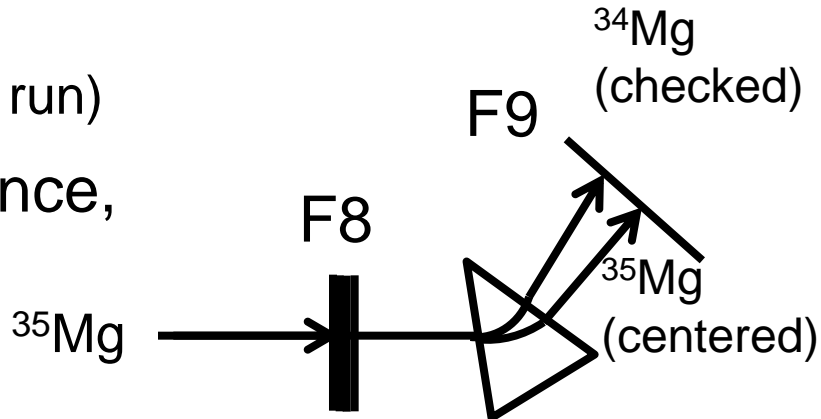
(^{35}Mg is selected at BigRIPS)



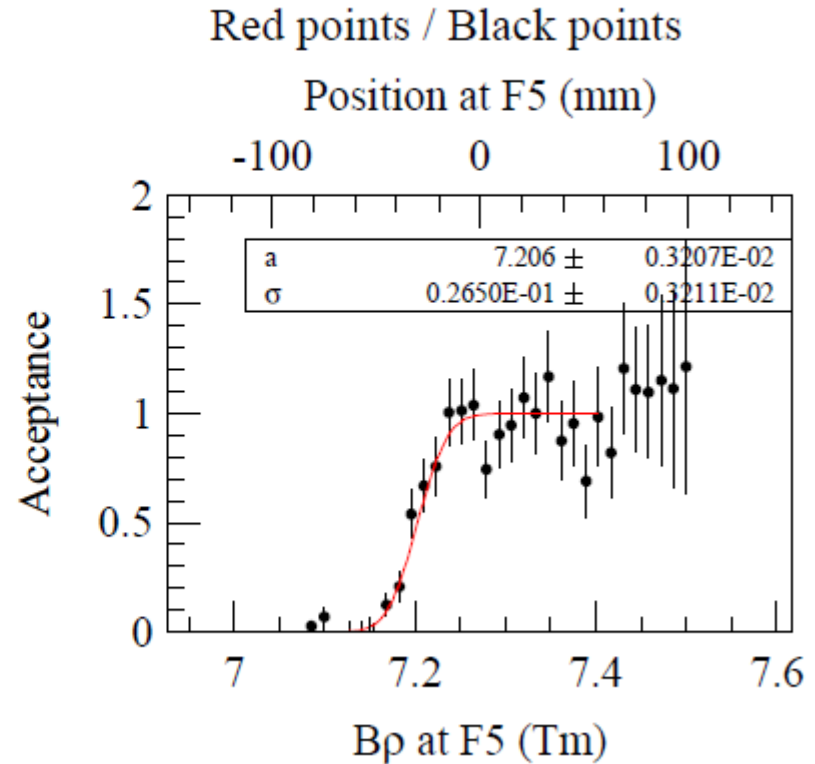
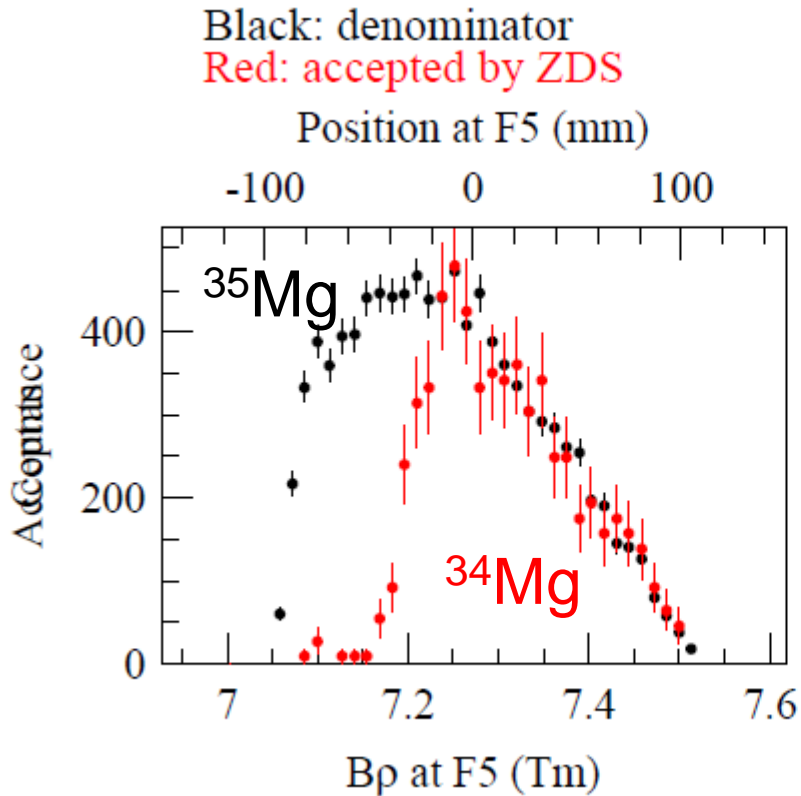
Used run

$^{35}\text{Mg} + \text{C} \rightarrow ^{35}\text{Mg}$ setting (resolution survey run)

To estimate the momentum acceptance, ^{34}Mg dist. was checked at ZDS.



Momentum acceptance of ZDS



Fitting func. $f(x)$: convoluted rectangular func.

$$f(x) = C \int_{-\infty}^{\infty} \text{rect}(t) g(x-t) dt$$

$$\text{rect}(x) = \begin{cases} 1 & \text{if } x \geq \Gamma_{\text{FWHM}}/2 \\ 0 & \text{if } x < \Gamma_{\text{FWHM}}/2 \end{cases}$$

$$g(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

Momentum acceptance

--> -4.3 %

-4.3 ~ +4.8 %

(design value: +/- 3%)

Summary

Experimentally, acceptances were obtained to get $p_{//}$ dist. & absolute cross sections.

x-angle: -40(?) to +52 mrad

y-angle: -30 to +30 mrad

momentum: -4.3 to +4.8 %

Outlook

Error?

Can we obtain the acceptance theoretically?

(from the ion optics and trajectories?)

Who will do?

Backup