Analysis Note
JLab E12-17-003

Graduate School of Science, Kyoto University
Toshiyuki Gogami

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Comment (mass resolution in E05-115)

https://doi.org/10.1016/j.nima.2018.05.042

Table 10
Mean values of the partial differentiations in Eqs. (28)–(33) obtained in the Monte Carlo simulation. Intrinsic mass resolution $\Delta M^{\mathrm{int}}_{\mathrm{HYP}}$ which is defined by Eq. (34) is shown for each target in the last row.

	Λ	$^{7}_{\Lambda}\mathrm{He}$	$^{12}_{\Lambda}\mathrm{B}$
Assumed B_{Λ} (MeV)	–	5.5	11.37
$\frac{\partial M_{\mathrm{HYP}}}{\partial p_e}\left(\frac{\mathrm{keV}/c^2}{\mathrm{MeV}/c}\right)$	742	957	974
$\frac{\partial M_{\mathrm{HYP}}}{\partial p_{e'}}\left(\frac{\mathrm{keV}/c^2}{\mathrm{MeV}/c}\right)$	−747	−958	−975
$\frac{\partial M_{\mathrm{HYP}}}{\partial p_K}\left(\frac{\mathrm{keV}/c^2}{\mathrm{MeV}/c}\right)$	−673	−885	−902
$\frac{\partial M_{\mathrm{HYP}}}{\partial \theta_{ee'}}\left(\frac{\mathrm{keV}/c^2}{\mathrm{mrad}}\right)$	−124	−21	−13
$\frac{\partial M_{\mathrm{HYP}}}{\partial \theta_{eK}}\left(\frac{\mathrm{keV}/c^2}{\mathrm{mrad}}\right)$	−258	−51	−30
$\frac{\partial M_{\mathrm{HYP}}}{\partial \theta_{e'K}}\left(\frac{\mathrm{keV}/c^2}{\mathrm{mrad}}\right)$	109	20	12
$\Delta M^{\mathrm{int}}_{\mathrm{HYP}}$ (keV/c^2) (FWHM)	733	414	410

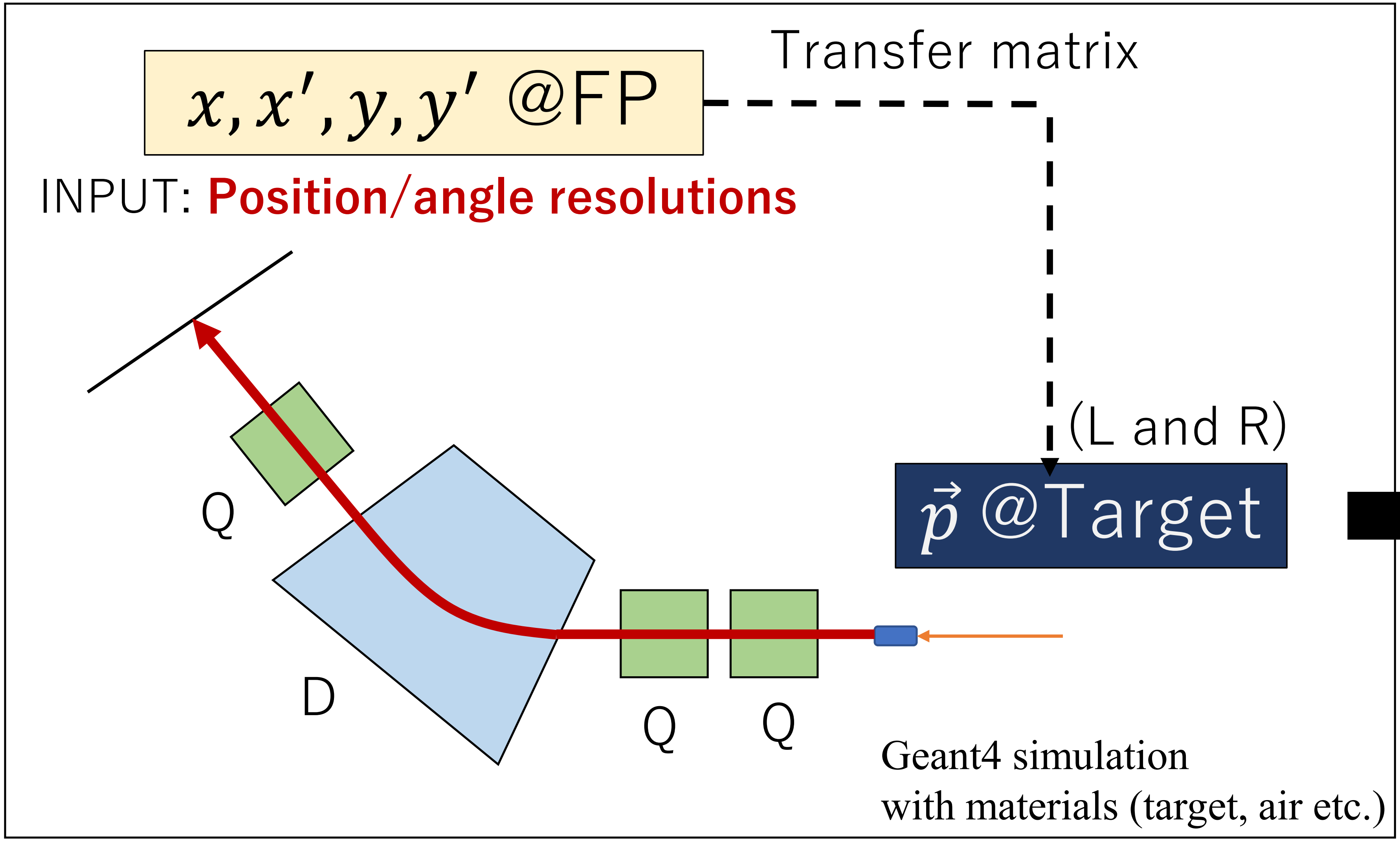
Table 11
A comparison of missing mass resolution between the Monte Carlo simulation and real data analyses for production of Λ, $^{7}_{\Lambda}\mathrm{He}$, and $^{12}_{\Lambda}\mathrm{B}$ in JLab E05-115.

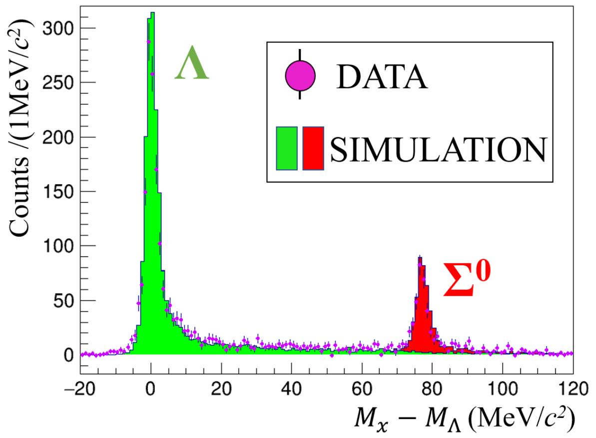
Hyperon/Hypernucleus		Λ	$^{7}_{\Lambda}\mathrm{He}$	$^{12}_{\Lambda}\mathrm{B}$
Target		CH_2	$^{7}\mathrm{Li}$	$^{12}\mathrm{C}$
Thickness (g/cm^2)		0.451	0.208	0.088
Length in z (mm)		5.0	3.9	0.5
$\Delta M^{\mathrm{int}}_{\mathrm{HYP}}$ FWHM (MeV/c^2)		0.73	0.41	0.41
$\Delta M^{\mathrm{Matrix}(z)}_{\mathrm{offset}}$ (MeV/c^2)		±0.37	±0.34	±0.09
$\Delta M^{\mathrm{eloss}}_{\mathrm{offset}}$ (MeV/c^2)		±0.31	±0.20	±0.06
ΔM FWHM (MeV/c^2)	Simulation	1.6	1.3	0.5
	Real data	1.5 (Fig. 17)	1.3 [18]	0.54 [16] (Fig. 23)

The simple estimation (intrinsic resolution) was not enough to reproduce mass resolutions in E05-115 as well as those in E01-011.

c.f.) Missing mass resolution report for E12-17-003 (Apr 21, 2020):
https://www-nh.scphys.kyoto-u.ac.jp/~gogami/e12-17-003/meeting/analysis/src/nnL_AnalysisNote_20200421_gogami.pdf

Geant4 simulation for the MM resolution estimation





Resolution estimation

M_{HYP}

Result will be shown by K.N. Suzuki

The angle resolution (SS + Multifoil)

Multifoil Target

DATA

The least squares method

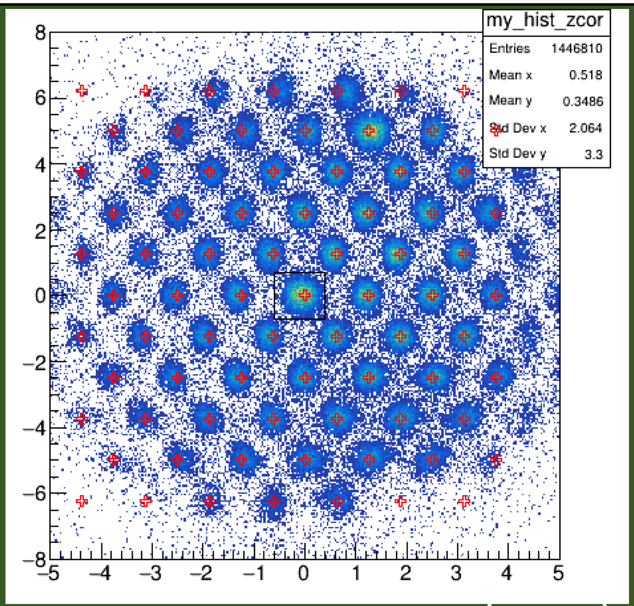
SIMULATION

$\Delta x' = 2.2 \times 10^{-3}$

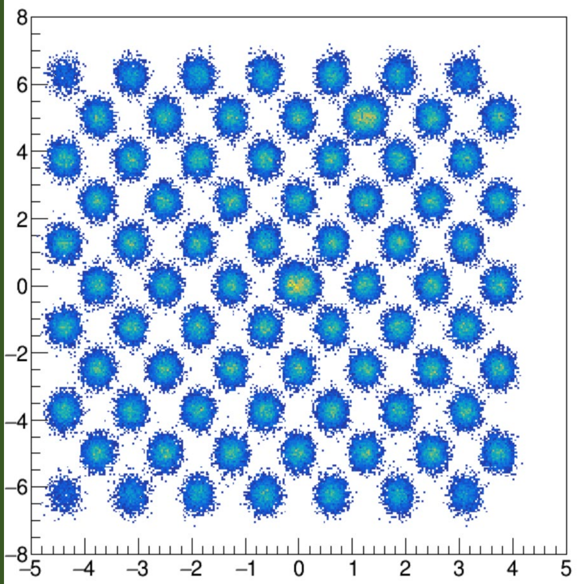
$\Delta y' = 8.0 \times 10^{-4}$

(sigma)

x (cm)



y (cm)



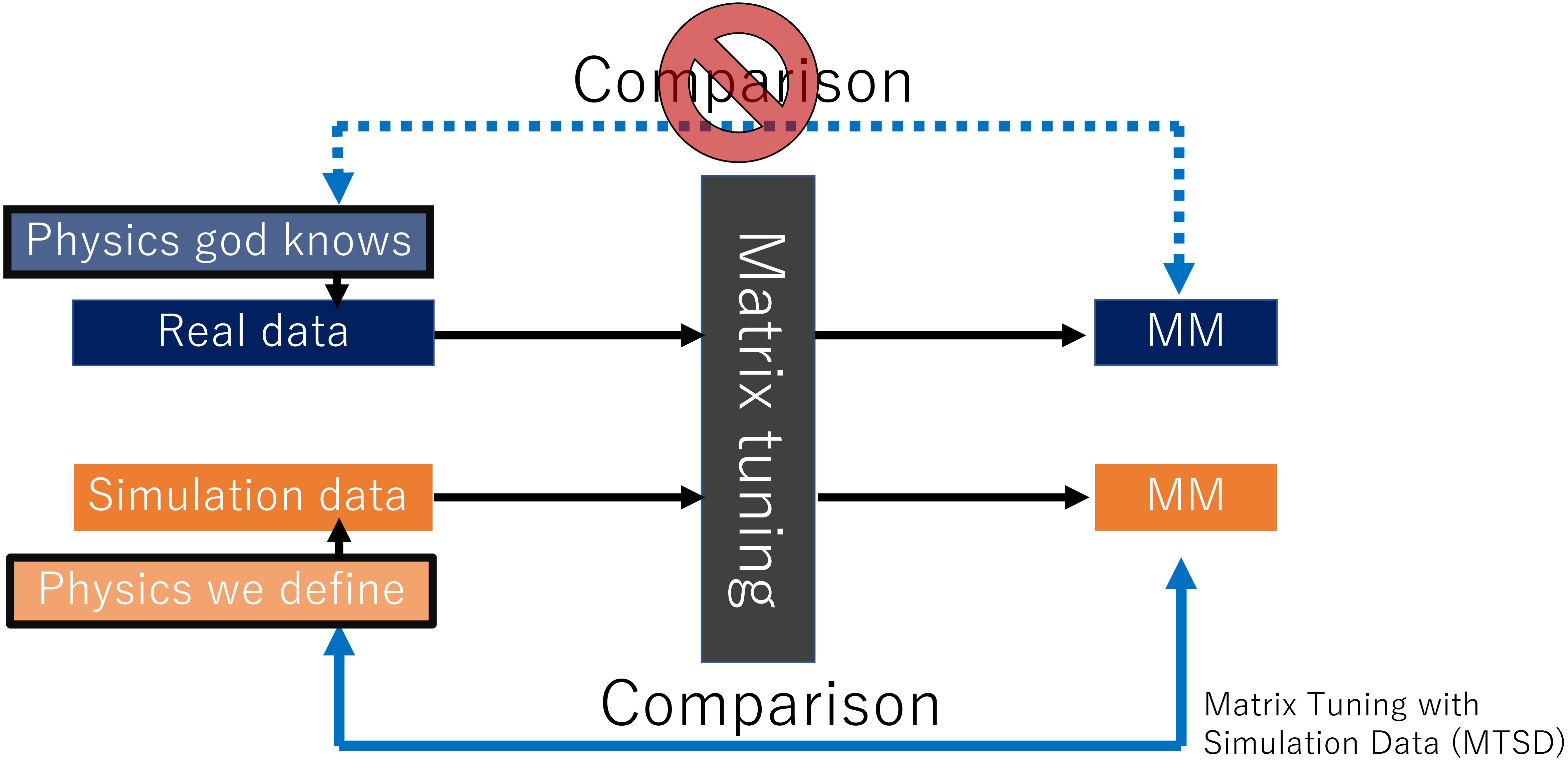
https://www-nh.scphys.kyoto-u.ac.jp/~gogami/e12-17-003/meeting/analysis/src/nnL_AnalysisNote_20200501_gogami.pdf

	Resolution σ (/)	
Target	Multi foil	T2 + Cigar cell
$\frac{x}{X_0}$	2×10^{-3}	20×10^{-3}
Estimation	Simple MC	**Geant4 MC**
$\Delta x'$	$\mathbf{2.2 \times 10^{-3}}$	$\mathbf{2.5 \times 10^{-3}}$
$\Delta y'$	$\mathbf{0.8 \times 10^{-3}}$	$\mathbf{1.2 \times 10^{-3}}$
$\Delta \theta_{e'}$ (rad)	$\mathbf{1.6 \times 10^{-3}}$	$\mathbf{1.7 \times 10^{-3}}$

Note: $\tan^2 \theta = (x')^2 + (y')^2$

Details will be talked by K.N. Suzuki

Validity check of our matrix tuning

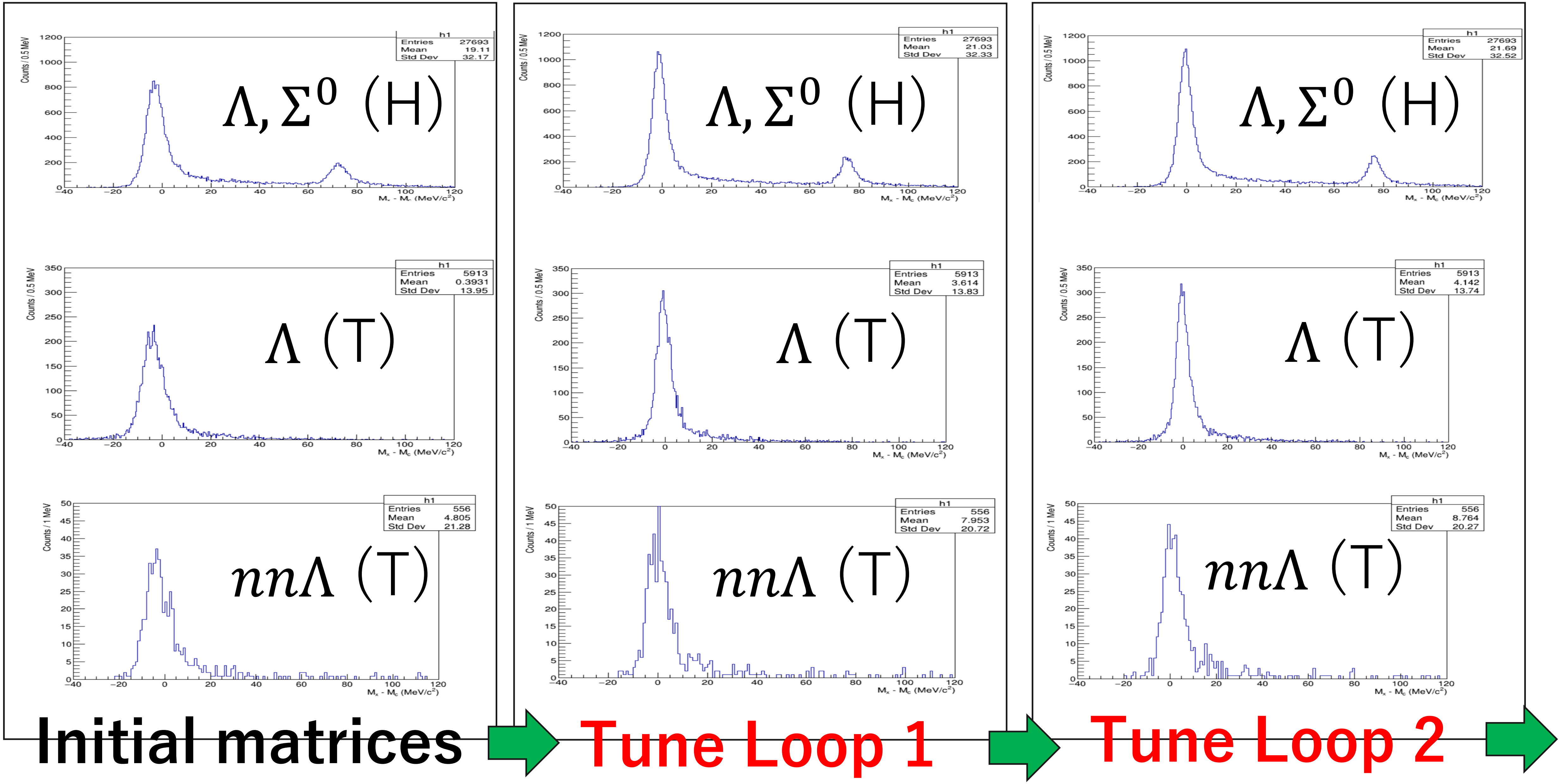


Conditions of the first trial (MTSD)

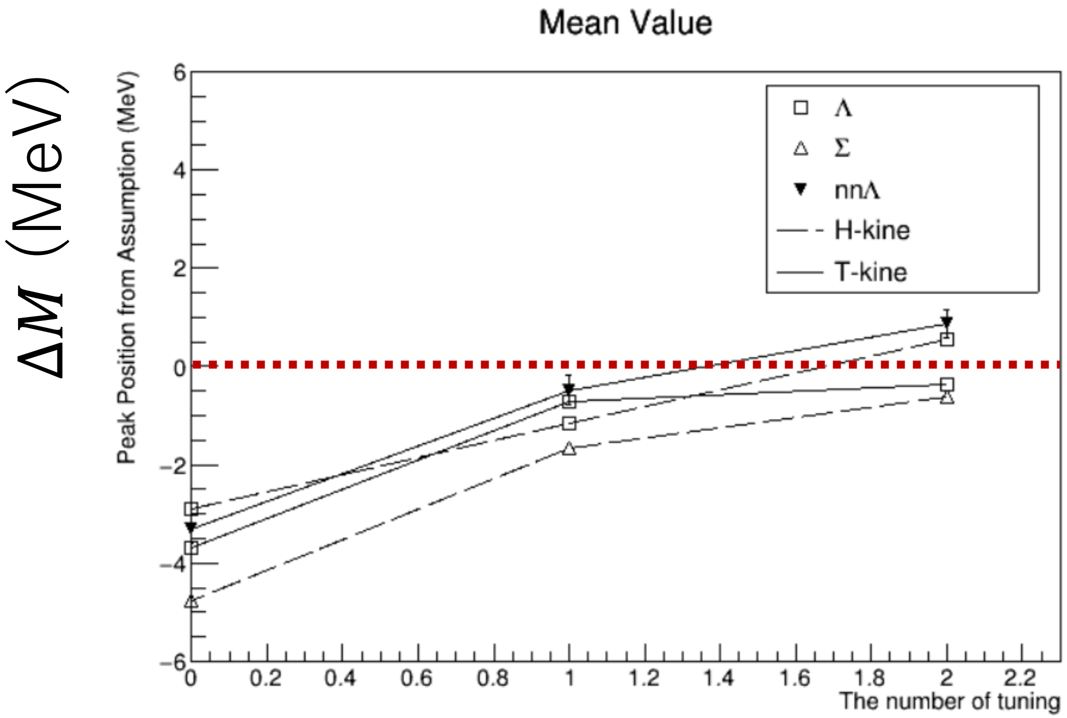
- Matrices (momentum for LHRS and RHRS)
  - Prepared based on the Geant4 optics (with some distortion manipulation)
  - Up to 5th order for x, x', y, y' @FP
  - Up to 2nd order for zt @FP (others were set to zero)

    252 → 232 parameters for each spectrometer
- Angle and z_t resolution
  - Randomly deteriorated based on realistic resolutions
- Events used for the matrix tuning
  - Λ (H-kine): 3000
  - Σ (H-kine): 1500
  - Λ (T-kine): 1500
  - 3/22—23 (two loops were done)
- Tuning parameters
  - Not optimized at all (event selection, step size, weight etc.)

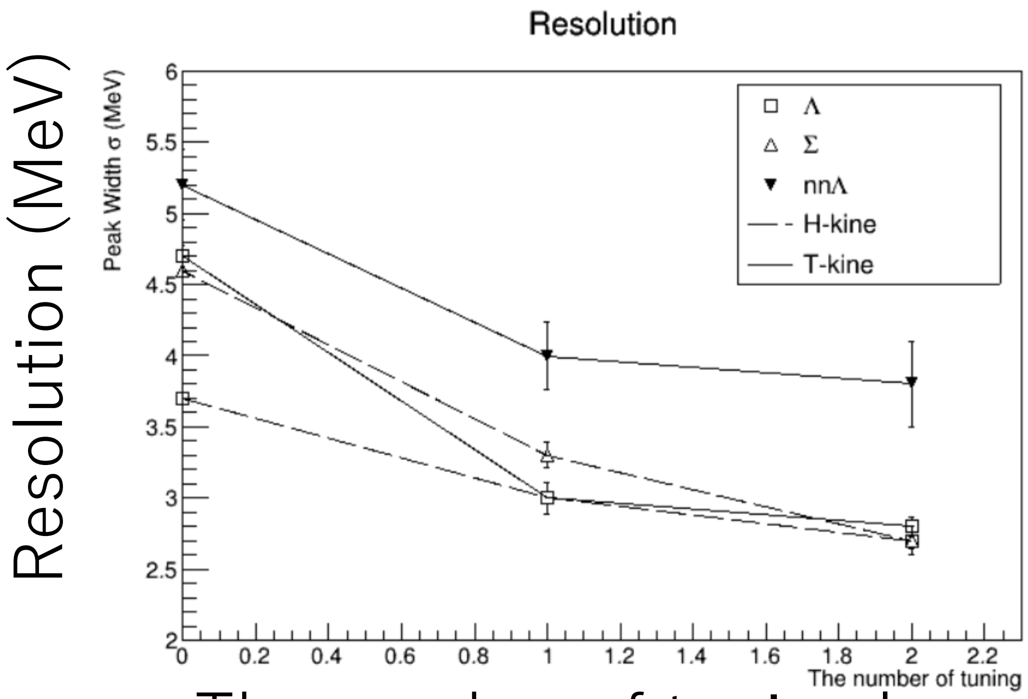
Matrix tuning by using only $\boldsymbol{\Lambda}$ (H), $\boldsymbol{\Sigma^0}$ (H), and $\boldsymbol{\Lambda}$ (T)



Result of the first trial (MTSD)



The number of tuning loop



The number of tuning loop

Tuning with Λ (H-kine), Σ (H-kine), Λ (T-kine)

$nn\Lambda$ follows the Λ and Σ^0 → No issues for A = 3 were found so far (not high precision yet though)

Backup

Documents in the past

Angle resolution (Summary of Suzuki's study):
https://www-nh.scphys.kyoto-u.ac.jp/~gogami/e12-17-003/meeting/analysis/src/nnL_AnalysisNote_20200501_gogami.pdf

Missing mass resolution (Fake peak study by Itabashi is found in the last part):
https://www-nh.scphys.kyoto-u.ac.jp/~gogami/e12-17-003/meeting/analysis/src/nnL_AnalysisNote_20200421_gogami.pdf

Comments on the missing mass resolution：
https://www-nh.scphys.kyoto-u.ac.jp/~gogami/e12-17-003/meeting/analysis/src/JLabMeeting_20200424_gogami.pdf

How to treat angle resolution for the intrinsic resolution estimation (here, the worse resolution for angle is used compared to the recent values)：
https://www-nh.scphys.kyoto-u.ac.jp/~gogami/e12-17-003/meeting/analysis/src/JLabMeeting_20200416_gogami.pdf

The expected resolution, the number of events, items to be reexamined (p. 31, 32)
https://www-nh.scphys.kyoto-u.ac.jp/~gogami/e12-17-003/meeting/analysis/src/JLabMeeting_20200313_gogami.pdf