2020 CENUM WORKSHOP

Cross-section measurement for K-p interactions at 1.8 GeV/c - New $\Sigma^*(1/2^-)$ searching

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New Σ*(1380)(1/2-) searching

The lowest excitation of baryons

: L = 1 excitation of a quark $(1/2^+ \rightarrow 1/2^-)$

Λ*(1405) is lighter than N*(1535)

(Unquenched models)

To solve it, put the $q\bar{q}$ components in the baryons

$\rightarrow$ N(1535)* : [ud][u$\bar{s}$]$\bar{s}$, Λ(1405)* :[ud][s$\bar{q}$]$\bar{q}$ with $qq = (u\bar{u} + d\bar{d})/\sqrt{2}$

In the penta-quark models, new prediction existence of a Σ(1380)*(1/2−)

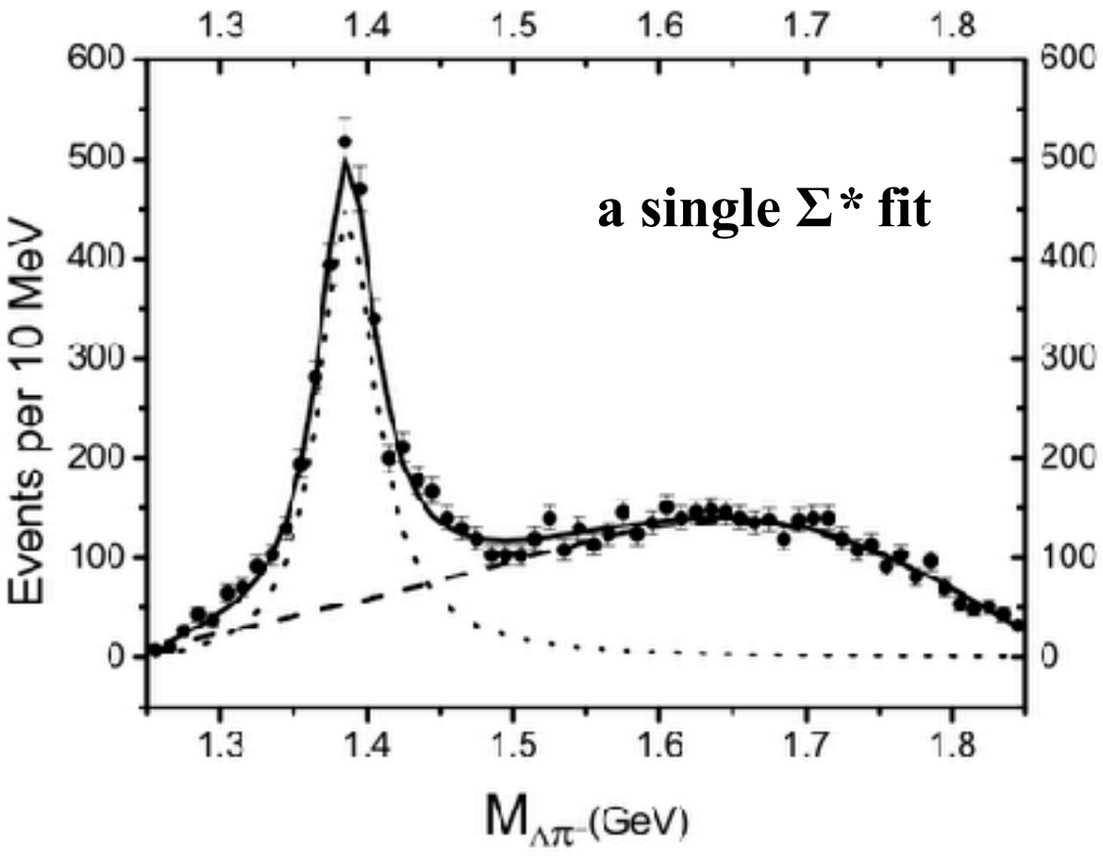
References.

C.HelminenandD.O.Riska,Nucl.Phys.A699,624(2002) [arXiv:nucl-th/0011071].

A.Zhang*etal.*,HighEnergyPhys.Nucl.Phys.29,250(2005)[arXiv:hep-ph/0403210].

Re-examination of old data

$K^- p \to \Lambda\pi^+\pi^-$ data of Hydrogen bubble chamber of NIMROD



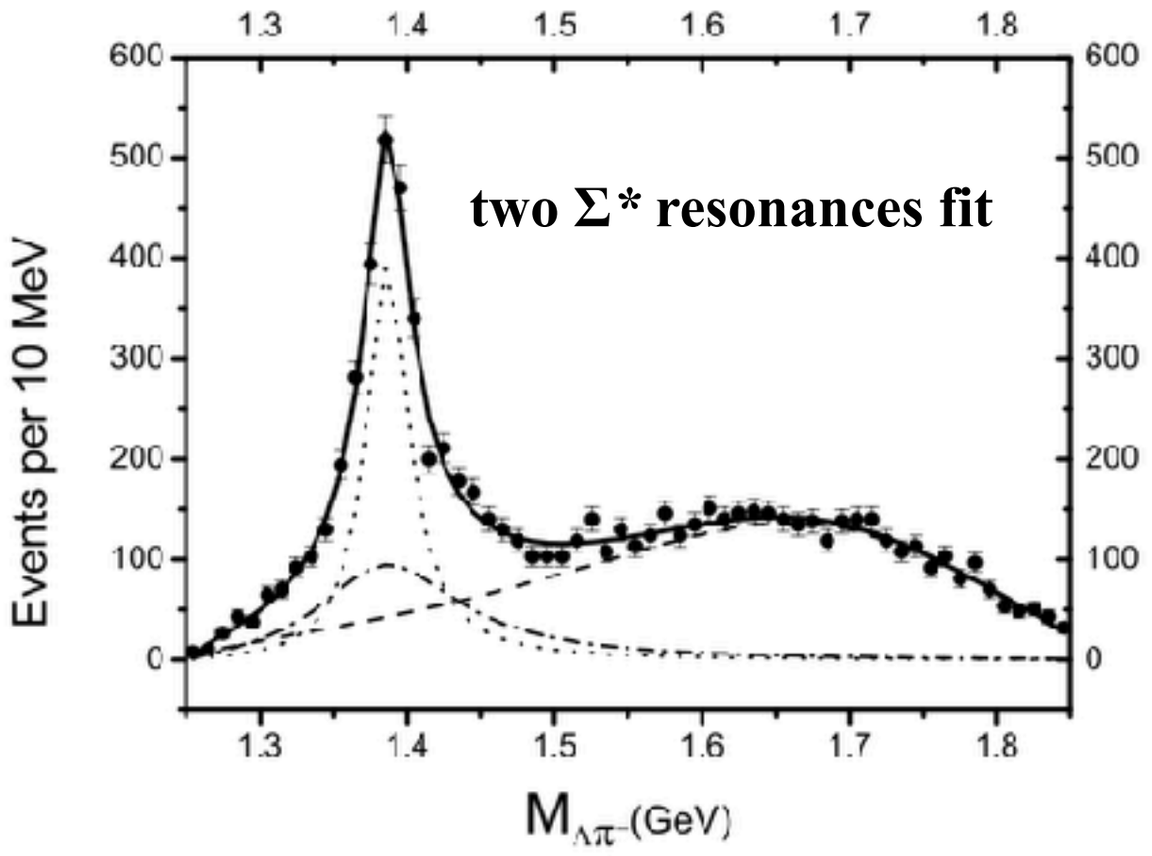


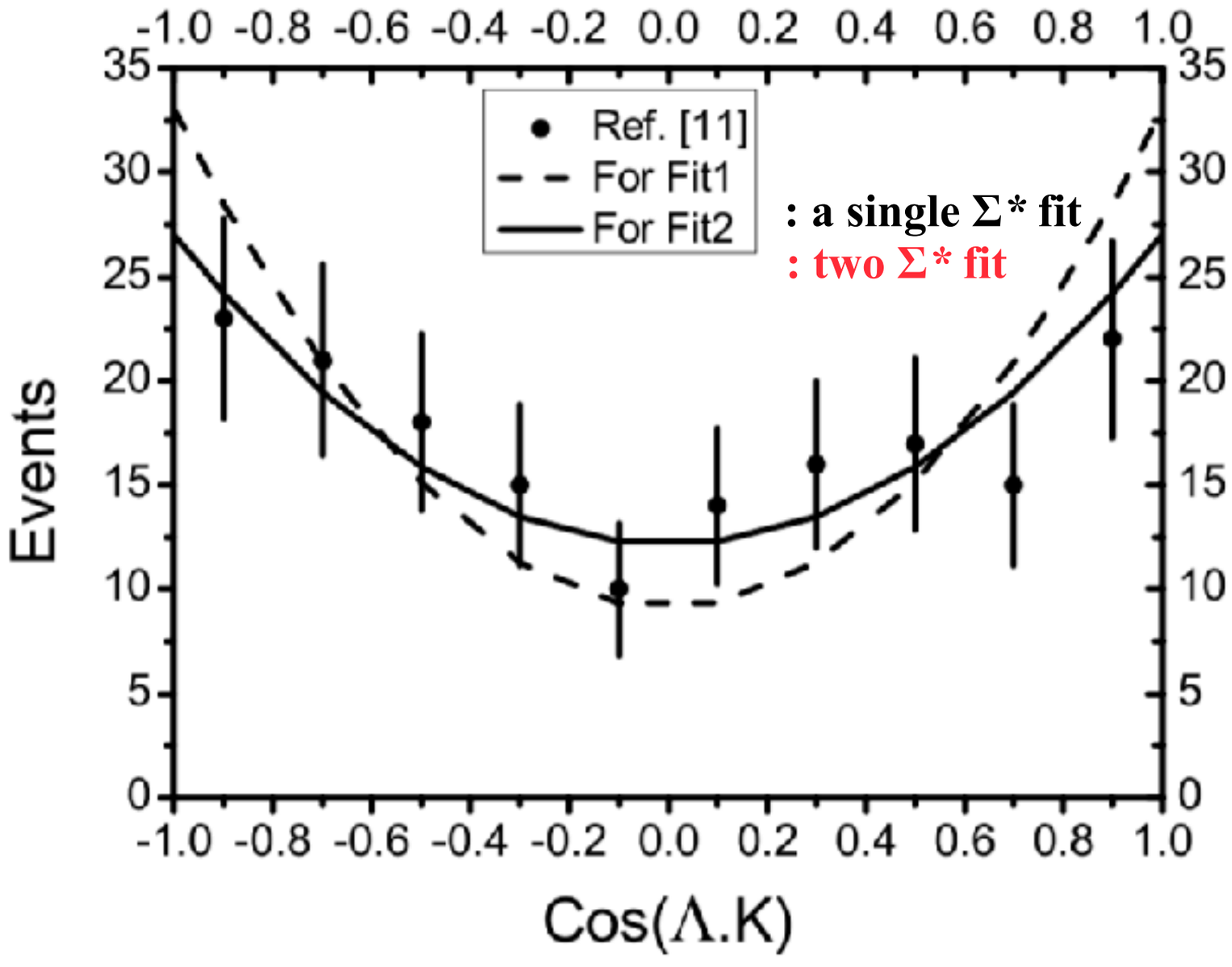
TABLE 1. Fitted parameters with statistical errors and χ^2 over number of degree of freedom (ndf).

	$M_{\Sigma^*(3/2)}$	$\Gamma_{\Sigma^*(3/2)}$	$M_{\Sigma^*(1/2)}$	$\Gamma_{\Sigma^*(1/2)}$	χ^2/ndf (Fig.1(left))
Fit1	1385.3 ± 0.7	46.9 ± 2.5			68.5/54
Fit2	$1386.1^{+1.1}_{-0.9}$	$34.9^{+5.1}_{-4.9}$	$1381.3^{+4.9}_{-8.3}$	$118.6^{+55.2}_{-35.1}$	58.0/51

Reference
J.J.Wu,S.DulatandB.S.Zou,Phys.Rev.D80,017503(2009).

Re-examination of old data

Predictions for the distribution of cos(Λ.K) for the reaction $K^- p \rightarrow \Lambda\pi^+\pi^-$



Expected angular distributions

$\Sigma^*(1385)$ with J = 3/2 : $(1 + 3\cos^2\theta)/2$

New Σ^* with J = 1/2 : Flat

In the Fit2, ratio of contributions

: $\Sigma^*(1385) / \Sigma^*(1/2-) \sim 1.6$

	χ^2/ndf (Fig.1(right))
Fit1	10.1/9
Fit2	3.2/9

New high statistical experiment with large angle acceptance is required!

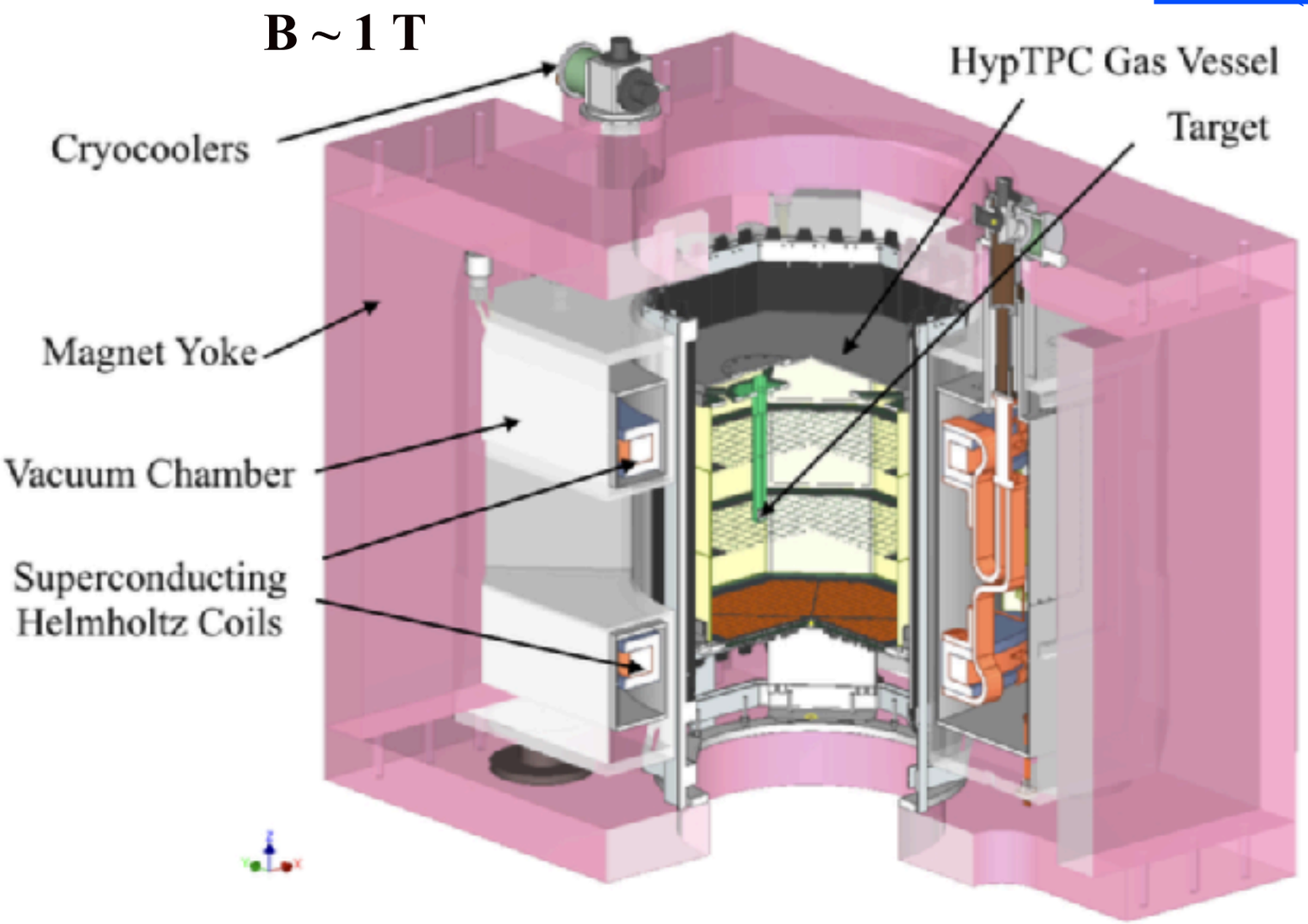
Reference. [D.O.Huwe,Phys.Rev.181,1824(1969).]

E42 Hadron experiment@J-PARC

Hyperon Spectrometer

Target: Diamond(Physics Run)

+ C2H4(12 hours Beam Commissioning)



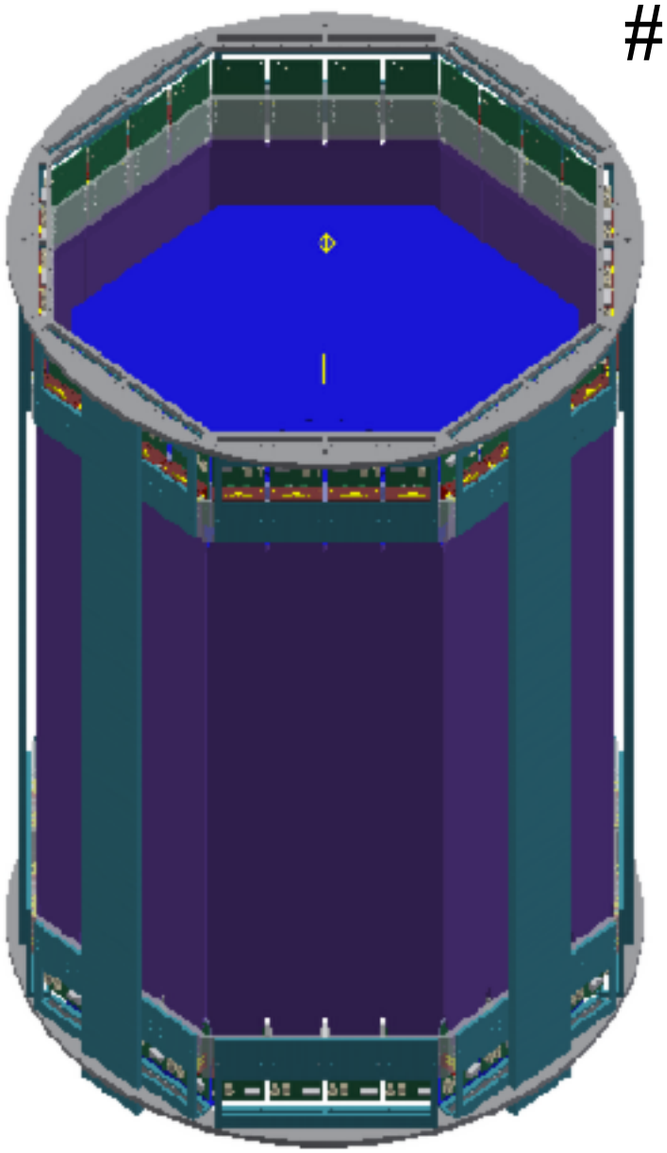
Δp/p = 1-3% for π and p

Inner target system

→ Large Acceptance

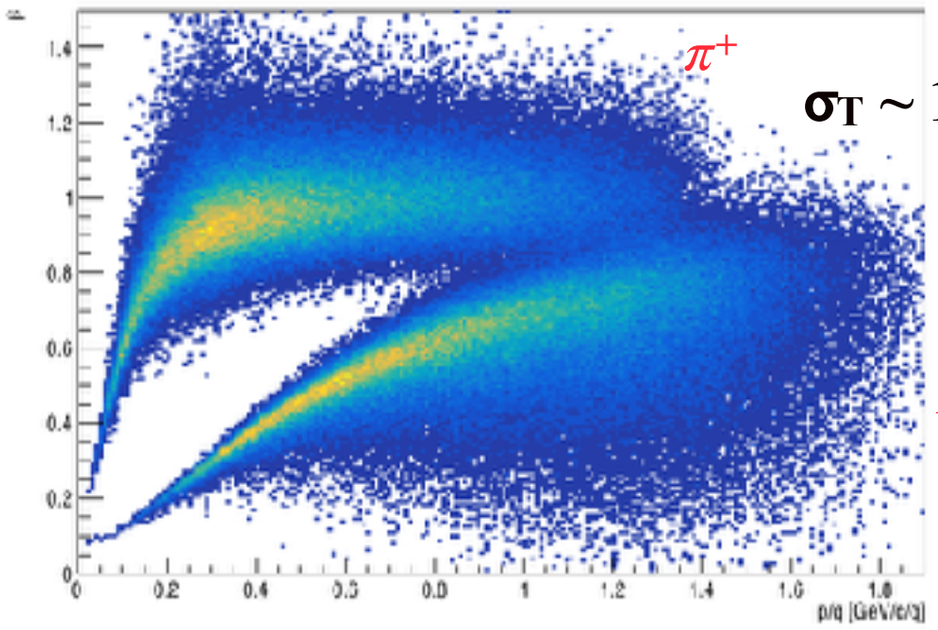
E42 Hadron experiment@J-PARC

HypTPC with the HTOF



32 Slats

PID: using dE/dx(HypTPC), TOF and p/q (HTOF)



$\sigma_T \sim 150$ ps

Trigger condition : Multiplicity > 2

Dominant reactions	Cross-sections (mb)	Multiplicity
$K^- p \rightarrow K^- p$	8.130 ± 0.310	2
$K^- p \rightarrow K^0 p \pi^-$	2.189 ± 0.139	4
$K^- p \rightarrow \Lambda \pi^+ \pi^-$	1.696 ± 0.097	4

MC study

Rough yield estimation

Assumptions

Beam flux (10^6 K^- per spill) ~ 2 x10^5
Cross-sections ~ 1.696 mb

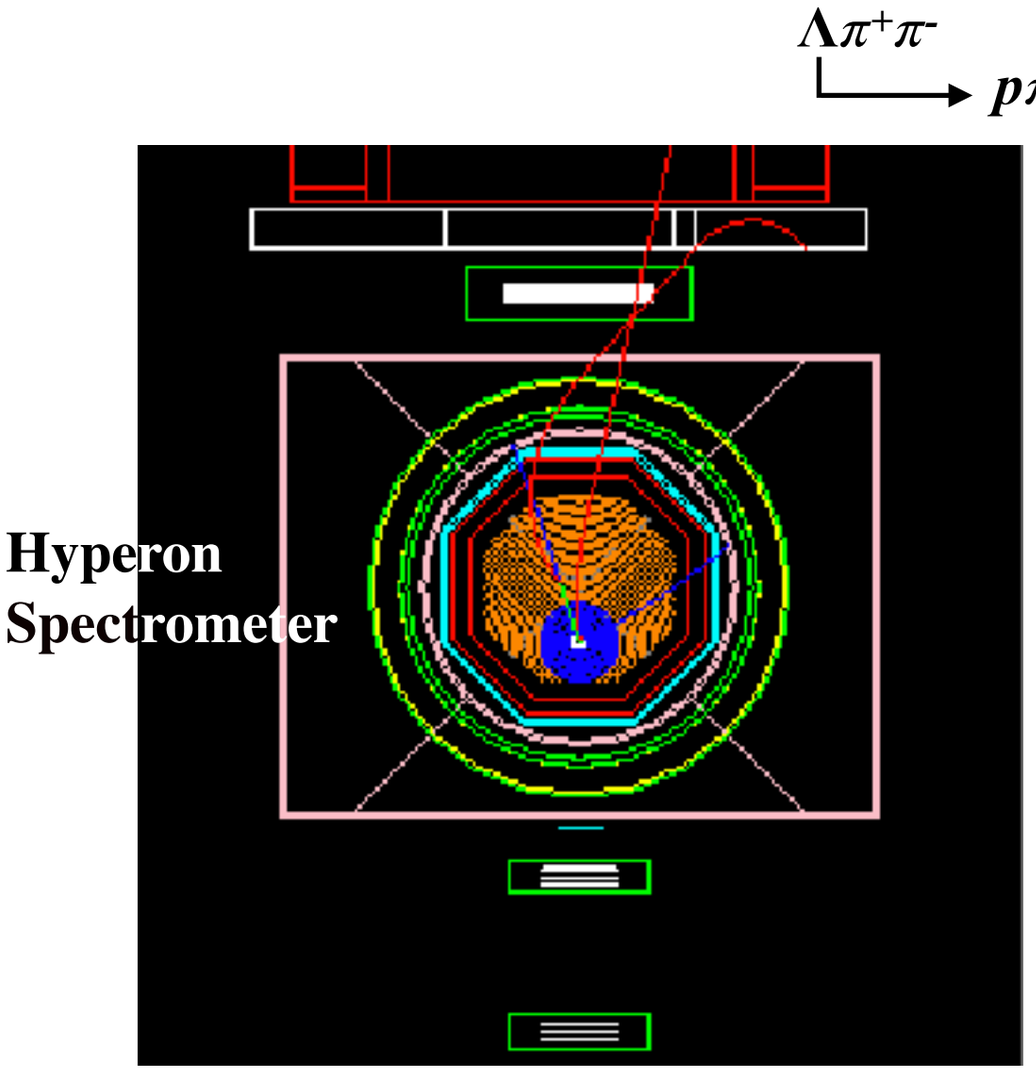
~ 35 $\Lambda\pi^+\pi^-$ events generated per s

To do & Goals

Build a MC gen. for

1. HTOF Acceptance study

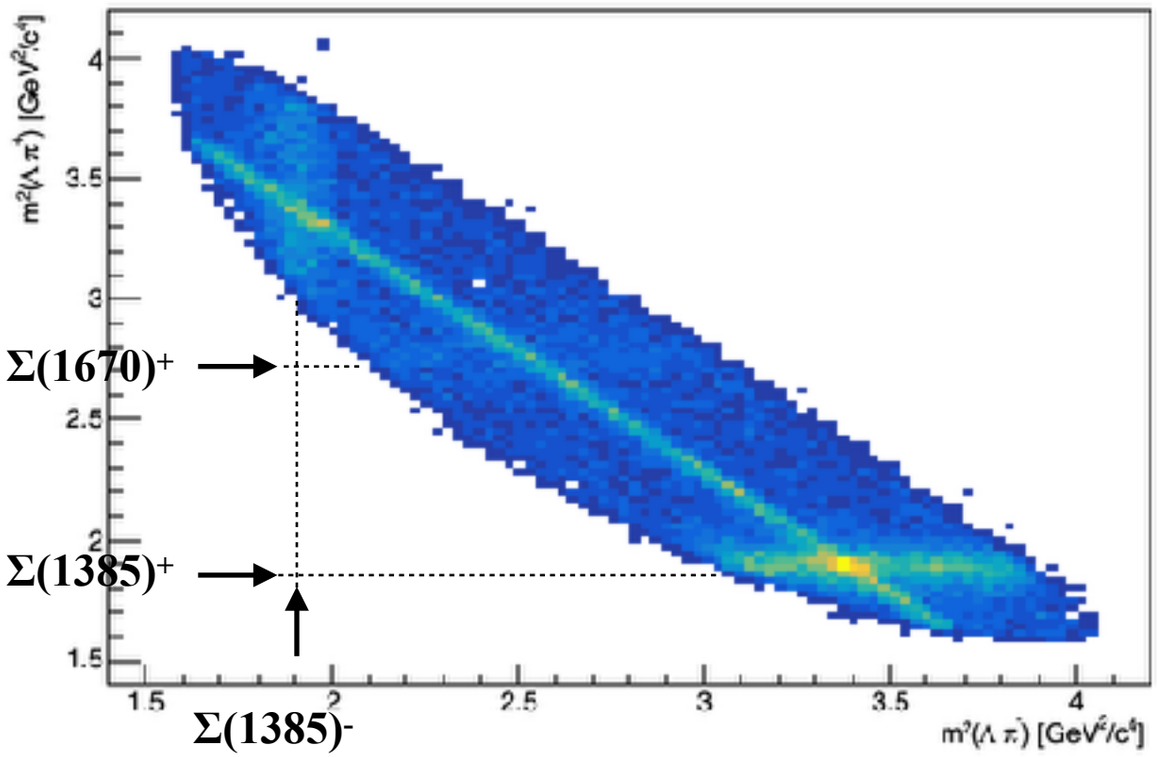
2. Generate expected diff. cross-section & cos(Λ.K) distribution

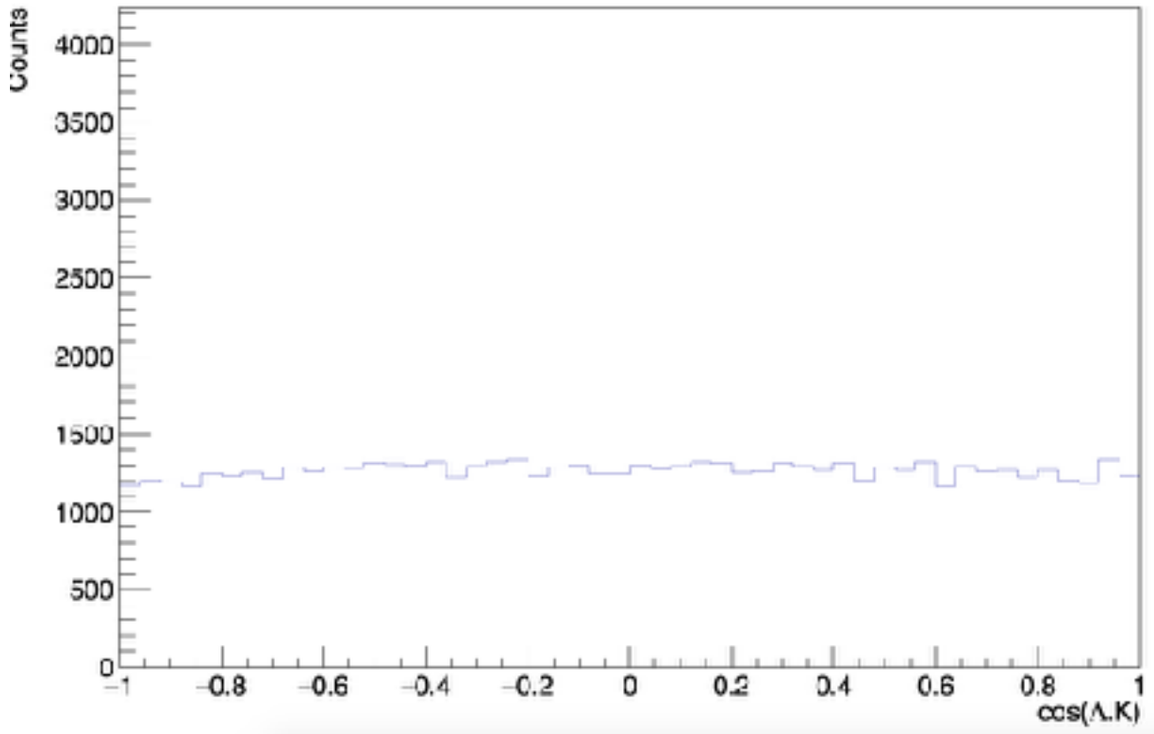


Geant4 event display

Current status

For a test, events were generated assuming flat angular distributions





At this step, planning to study angular distribution of trigged events and check the coverage and acceptance of HTOF.

SUMMARY

- **There is prediction existence of a new $\Sigma^*(1/2-)$ around 1380 MeV**

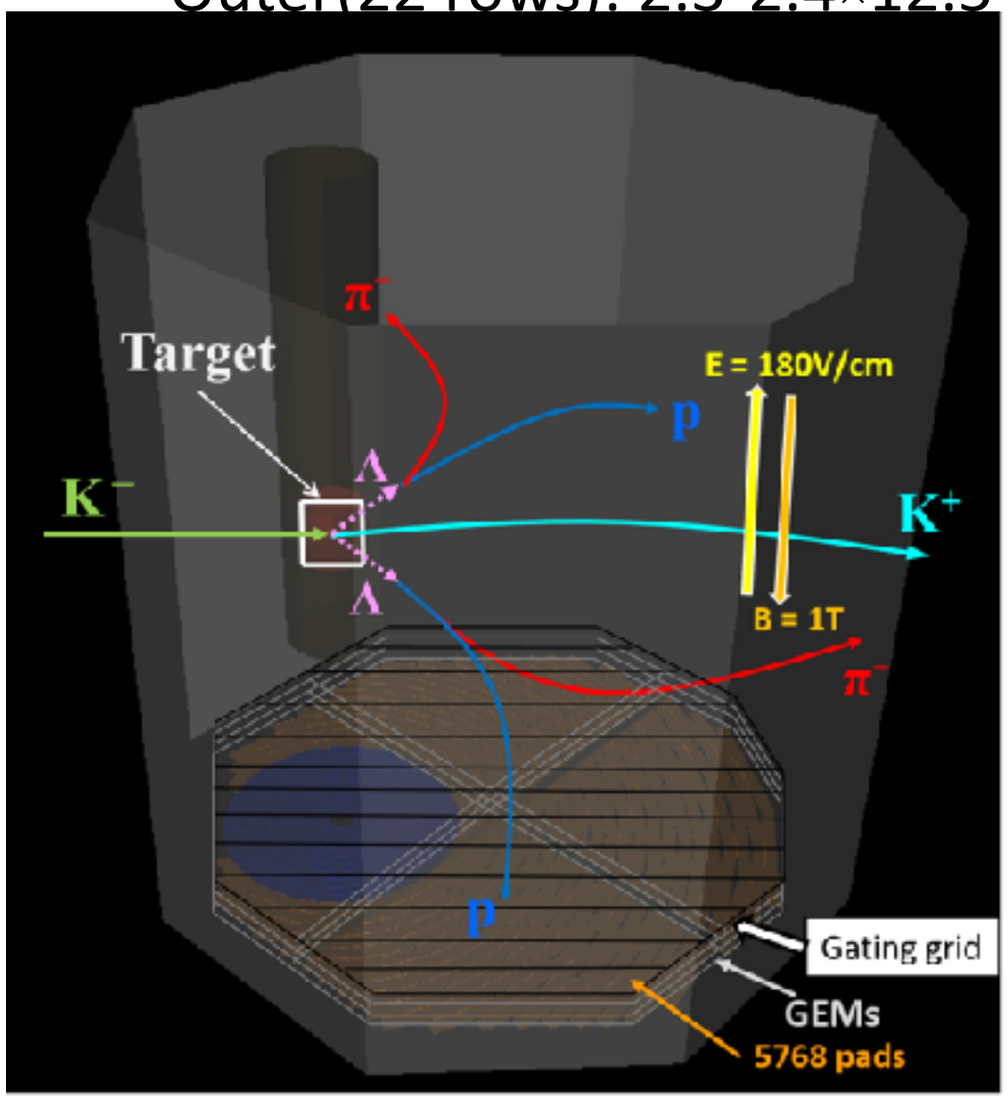
- **At J-PARC, we have a plan to do amplitude analysis of Σ^***

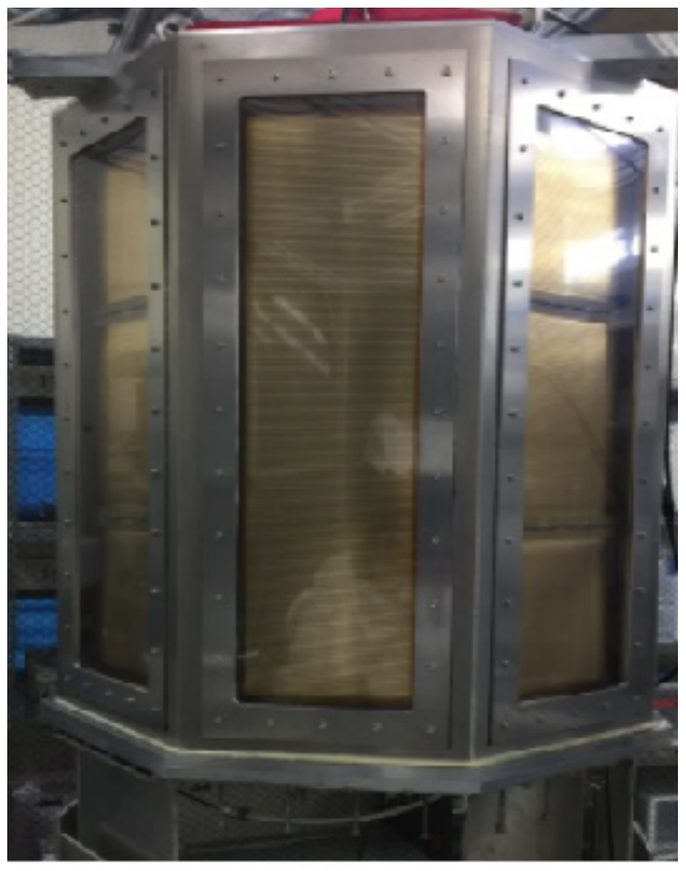
- **Going to generate the expected experimental results for future study**

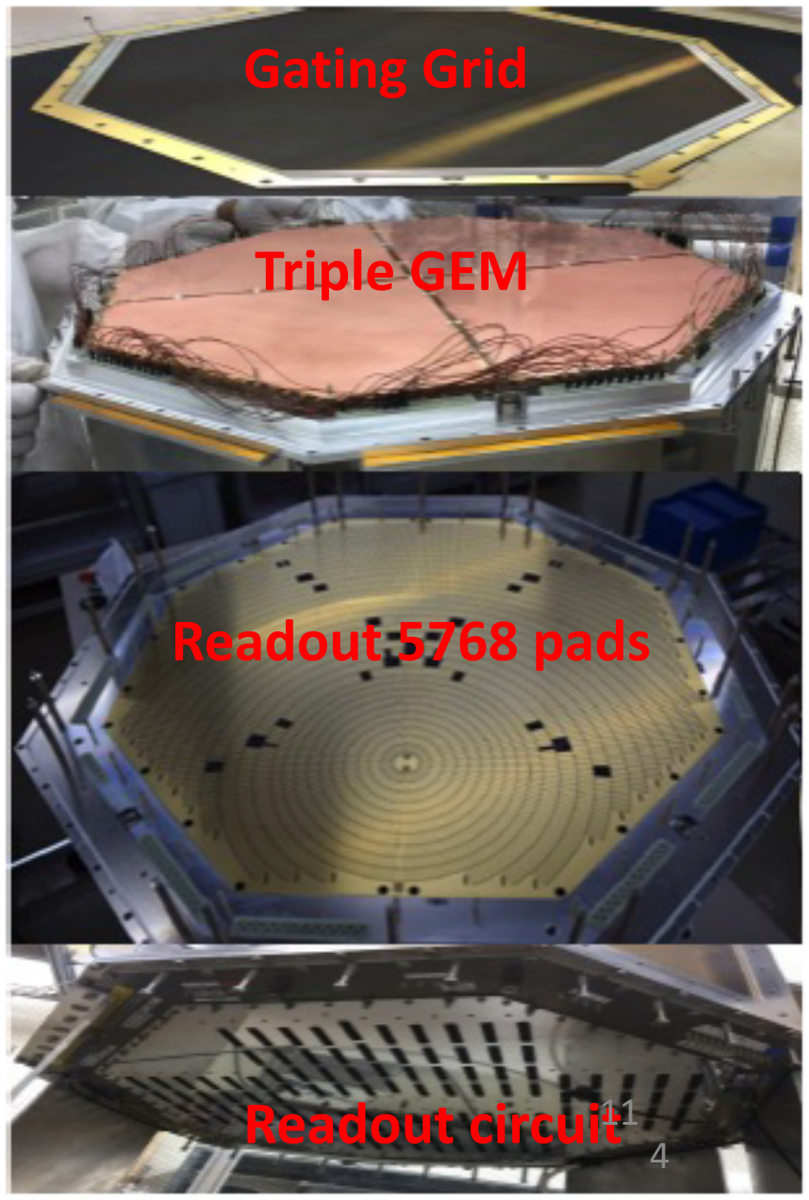
BACKUP

Time Projection Chamber "HypTPC"

- Octagonal prism field cage
- Inner target system → Large Acceptance
- Triple GEM layers
  (50 + 50 + 100 μm)
- 5768 readout pads
  - Inner(10 rows): 2.1-2.7×9 mm^2
  - Outer(22 rows): 2.3-2.4×12.5 mm^2
- Gating grid: ϕ50 μm, 1mm space
- Gas: P-10 (v_{max} ~ 5.3 cm /s)
- Gain ~ 10^4
- Position resolution < 300 μm
- Δp/p = 1-3% for π and p

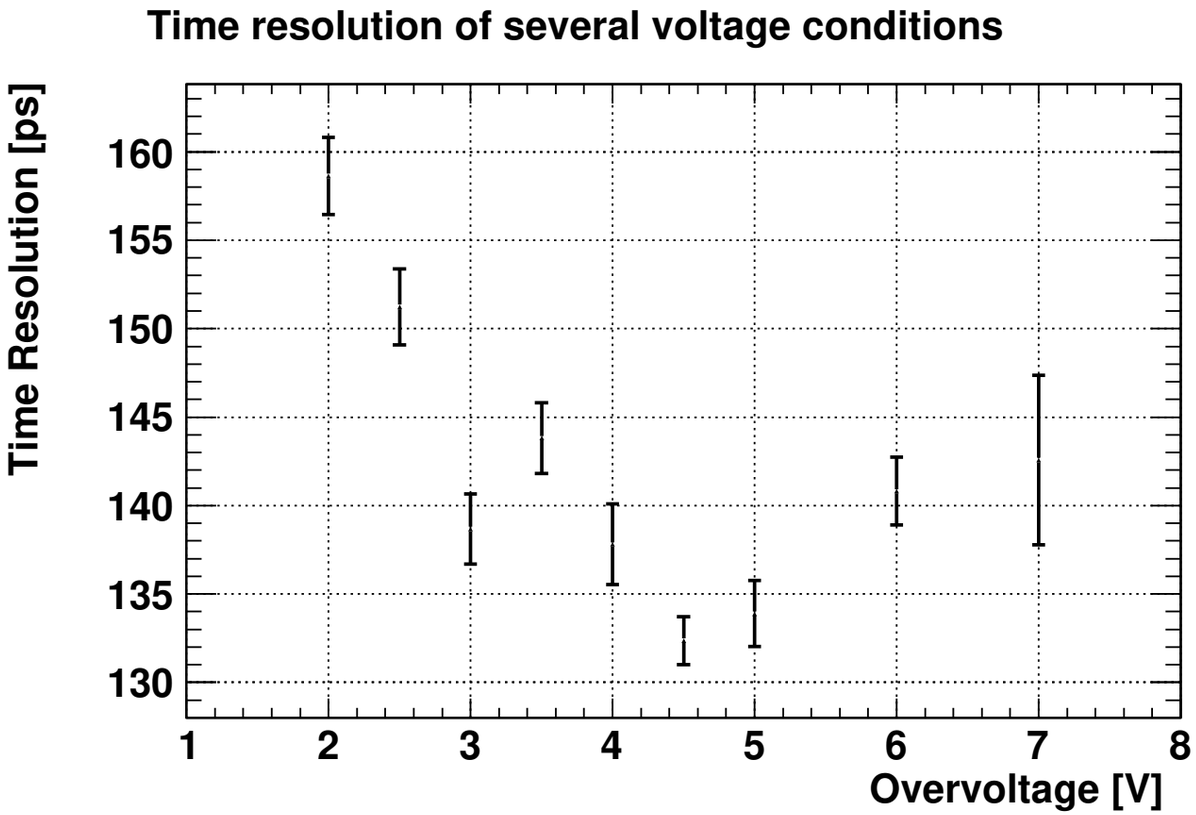




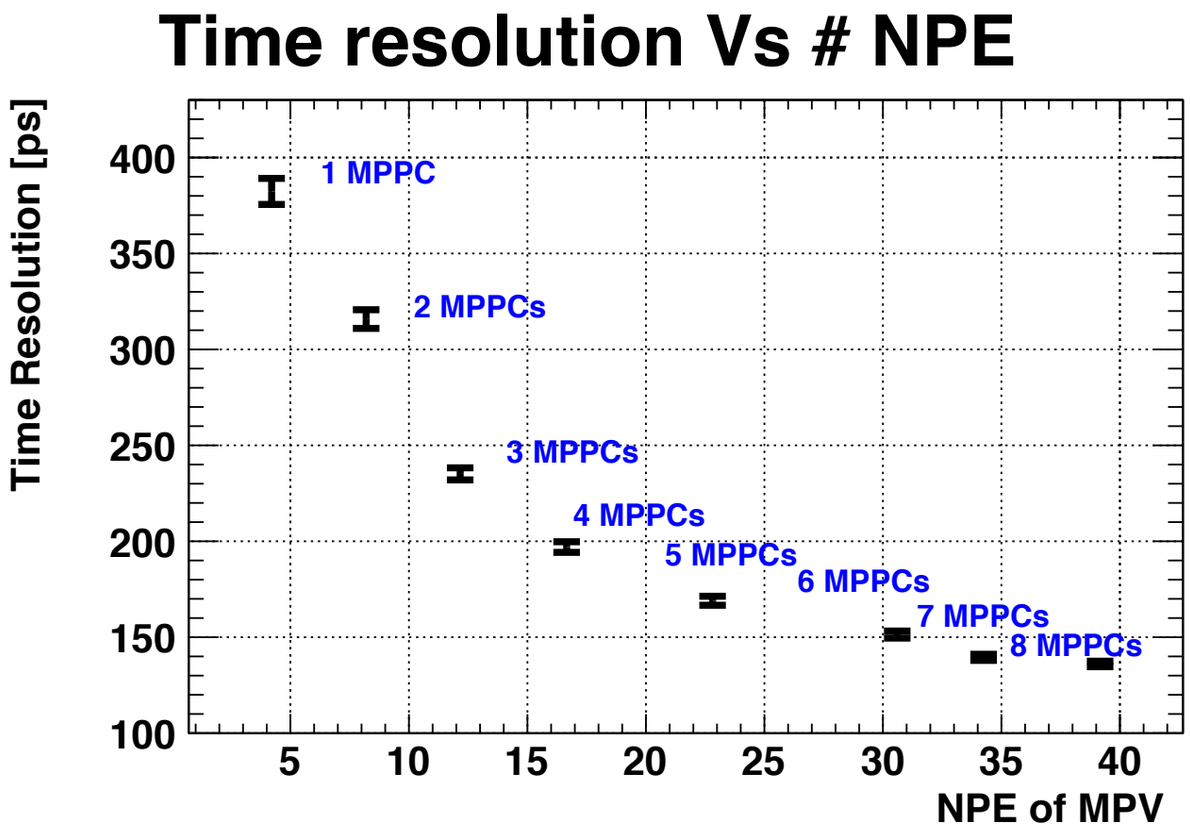


HTOF

Bias voltage dependence



Number of MPPC dependence



Scintillator & Light-guide study

	Time resolution* (ps)		
Scintillators	EJ-200	EJ-230	EJ-232
Without Light-guides	174 ± 1	156 ± 1	132 ± 1
With Light-guides		125 ± 1	117 ± 1

* Measured value. Errors are statistical only.

Scintillators	EJ-200	EJ-230	EJ-232
Scintillation Efficiency (photons/1 MeV e^-)	10,000	9,700	8,400
Rise Time (ns)	0.9	0.5	0.35
Decay Time (ns)	2.1	1.5	1.6