Poster Session 3, **T11-1** (**ID 325**)

Study of ϕ mass modification with K^+K^- decay in p+A collisions at J-PARC

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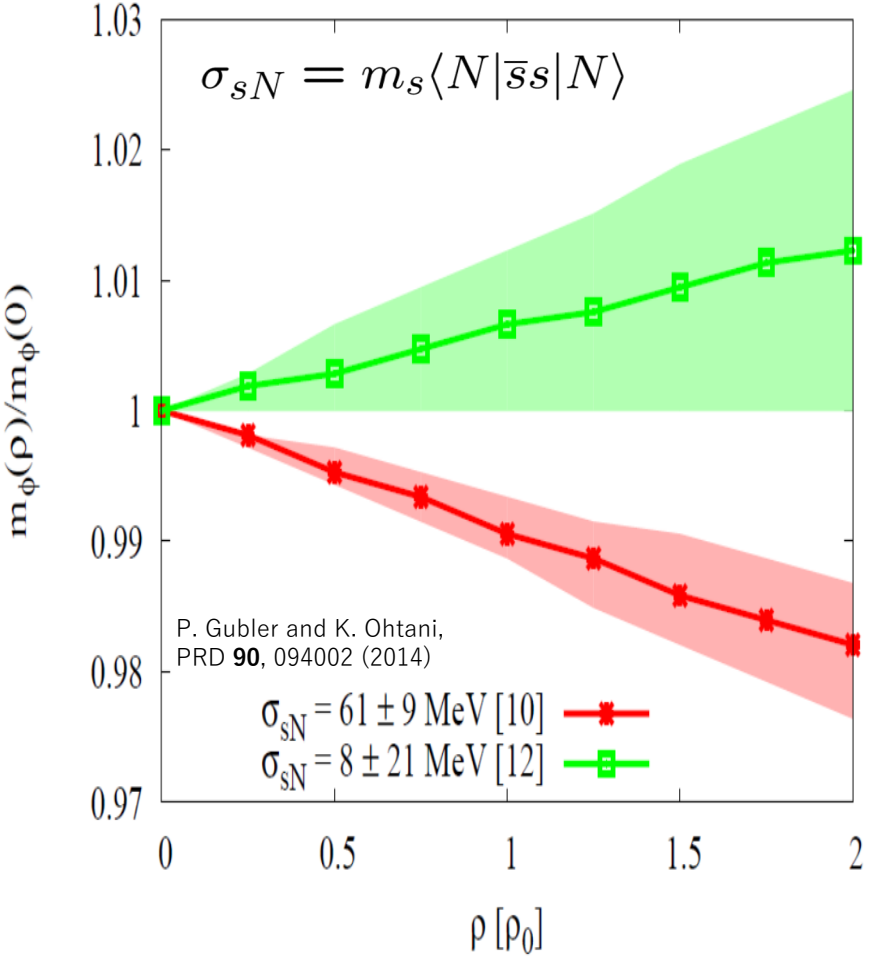
Φ mass modification

- In order to study the modification of ϕ mass in the nuclear matter, we propose to measure the $\phi \rightarrow K^+K^-$ decay in proton-nucleus (p+A) collisions, where a slow ϕ is produced inside the nucleus. We measure the invariant mass spectrum and the branching ratio of the decay.
- Since the ϕ mass is very close to the K^+K^- decay thresh- old, the branching ratio is expected to be sensitive to the change of ϕ mass.
  - the **advantages** of the K^+K^- decay is that high statistics measurement is possible due to **larger branching ratio** (49.2%) that is higher by 3 order than that of e^+e^- (2.973×10^{-4}).
  - On the other hand, the measured invariant mass is **affected by final-state interactions** with nucleons inside the target nucleus, while it is not the case for the e^+e^- decay. The change of the $\phi \rightarrow K^+K^-$ yield is furthermore influenced by the mass modifications of $K^{\pm}$ inside the nucleus. It thus includes complex physics, which needs to be disentangled and understood to properly interpret the corresponding experimental data. Therefore, the formulation of **theoretical models** incorporating information on both ϕ-N and $K^{\pm}$-N interactions will be **needed**.



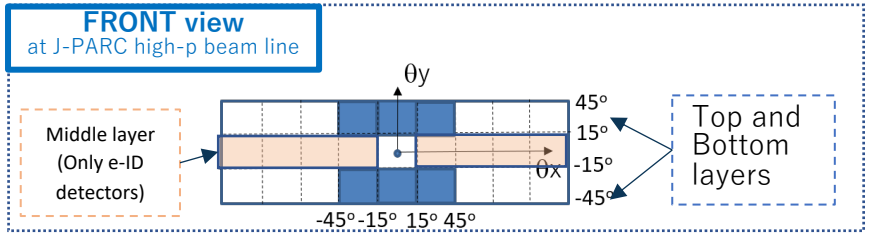
Experimental Setups at J-PARC, and Calculated mass spectra

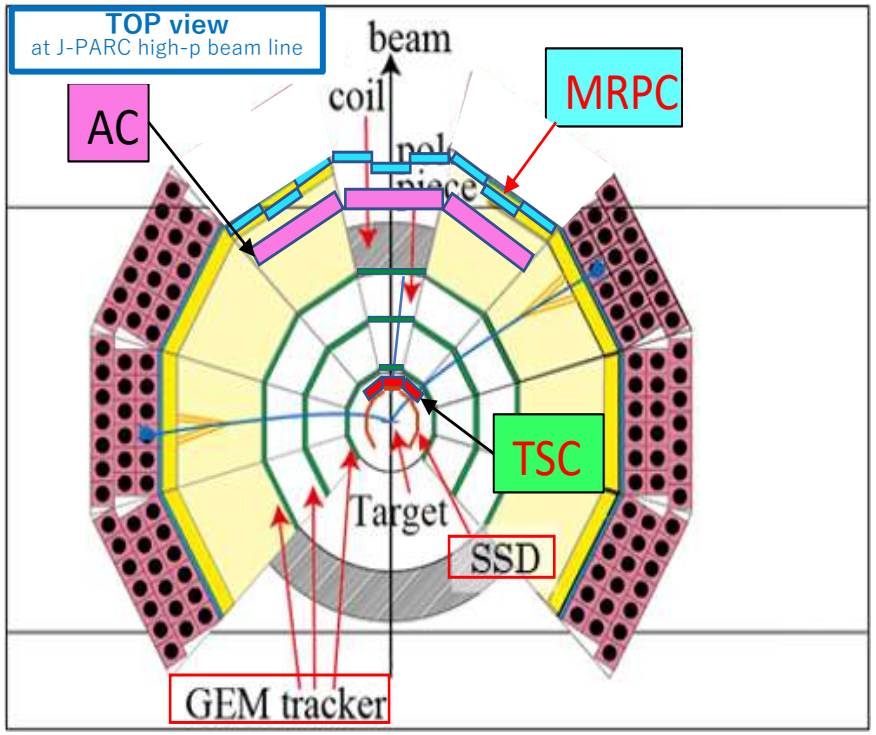
We **proposed J-PARC E88 experiment**, which is aiming for high-statistics invariant mass and yield measurements (100 x KEK-E325) for:

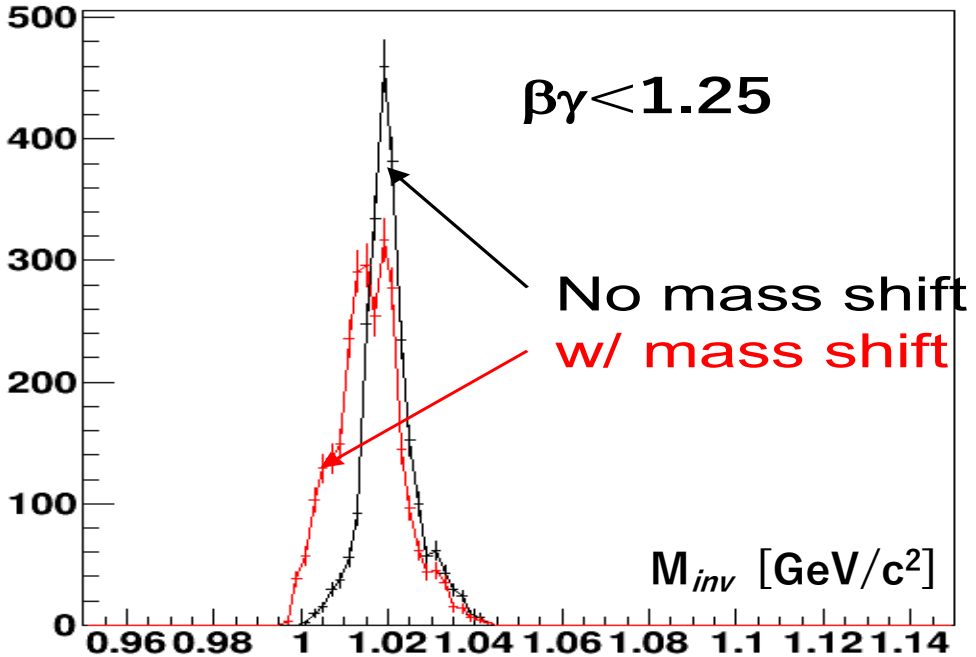
- ***A*-dependence** (C, Cu, Pb)

- Focus on **slow ϕ** ($\beta\gamma<2$) : to enhance ϕ stop probability inside the nucleaus

- **Comparison** to $\phi \rightarrow e^+e^-$ in J-PARC-E16







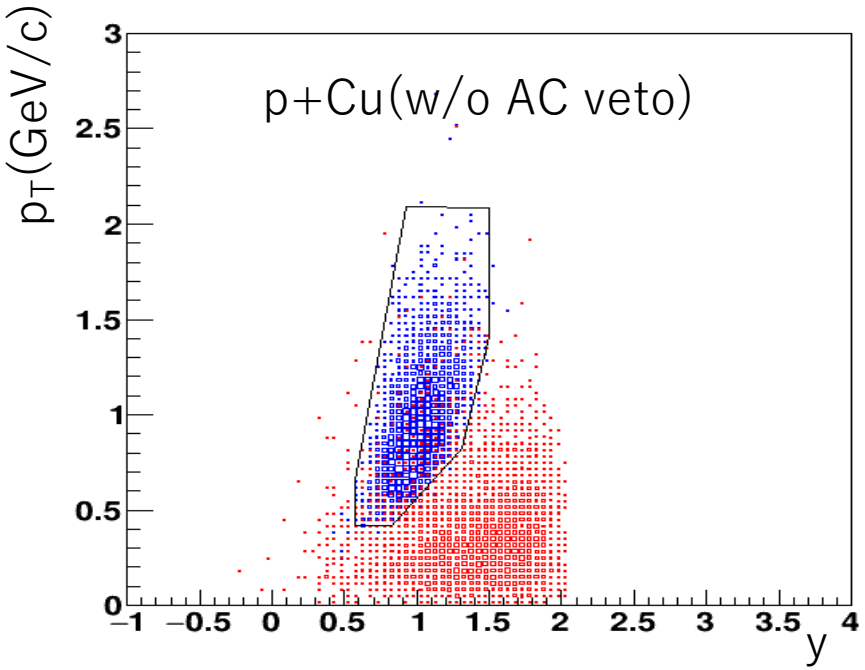
HSD model (*) **calculates** invariant mass spectrum:
- w/ GEANT4 simulation
- In acceptance
- With momentum resolution

(• 1/20 statistics of the proposal is shown)

(*)**HSD model, is developed for $\phi \rightarrow$KK calculations,**
by **P. Gubler** (JAEA), **S. H. Lee** (Yonsei Univ.), **E. Bratkovskaya**, **T. Song** (Frankfurt U./GSI)
It contained:
- K± in-medium modified spectral function
- K-N interaction based on chiral unitary model including off-shell effects
- Scattering and absorption of K± in nucleus
- ϕ spectral function of Breight-Wigner shape
- Mass shift of Δm = -34MeV ρ/ρ_0(based on KEK-E325)

Acceptance and Yield estimation

Acceptance (for ϕ -->K^+K^-, and for ϕ -->e^+e^-)



ϕ→K+K- signals			
	C	Cu	Pb
Total ϕ	159k	262k	662k
ϕ ($\beta\gamma$<1.25)	72k	113k	314k
ϕ (1.25<$\beta\gamma$<1.75)	84k	146k	340k

ϕ→K+K- rate			
	C	Cu	Pb
ϕ signal rate (/spill)	2.95	5.41	12.8
Trigger rate (/spill)	78	161	365

We performed GEANT4 simulation with JAM event generator to **estimate the yields** in the two low $\beta\gamma$ bins ($\beta\gamma < 1.25$, and $1.25 \leq \beta\gamma < 1.75$), which are **shown above table**.

The assumptions are:

(i) Beam time: 30 days with **30 GeV proton** beam at **1 x 10^9 /spill**, and

(ii) **Target** of **C**(0.1%int.) + **Cu**(0.1%int.) + **Pb**(0.1%int.).

Key Detectors R&D (MRPC : for PID via time-of-flight)

For hadron-identification (pi/K/p), the **MRPC** time-of-flight detector, **with heating-system** is *being developed*.

- Time resolution **is improved, by raising the temperature** from 19[deg.C] to 30[deg.C] , increase of gain and improvement of detection efficiency <--- High-rate tolerance will be expected.

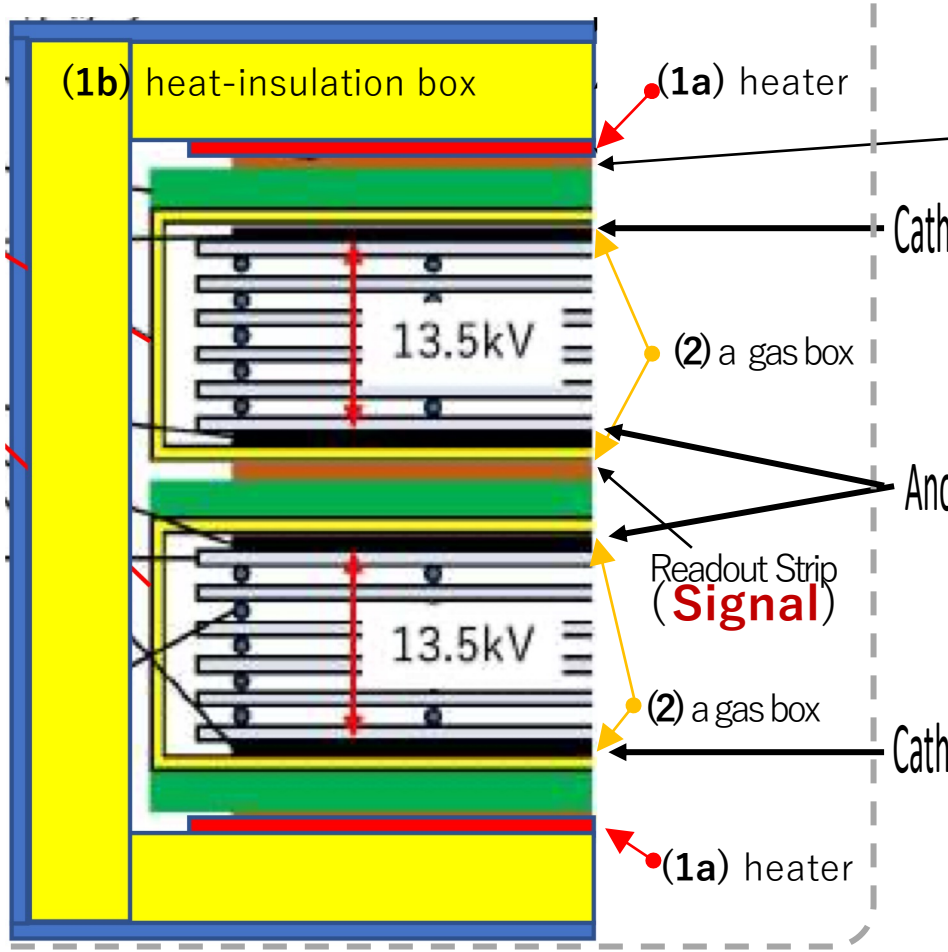
- Time resolution (so far is 130ps) will be **simply improved by much the gas tightness** at the inlet towards the poly-carbonate gas enclosure case.

- Detection efficiency is ~99%

New Design (2022Apr)
(*side cross section*)

(1)Timing-performance improvement by heating glasses via
- **(1a) heater**
- **(1b)** heat-**insulation box**

(2) Add two **gas-tight boxes** enclosing the cathode &anode



Previous Design
(*side cross section*)