E50
Charmed Baryon Spectroscopy via the (π, D^{*-}) reactions

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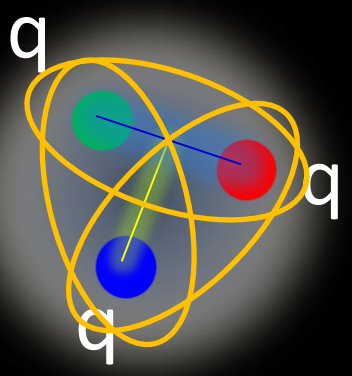
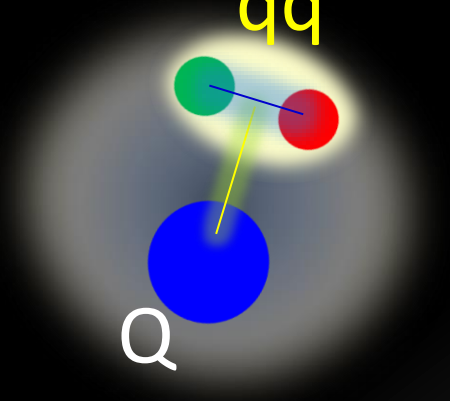
1. Introduction
2. Status Report for Detector R&D
3. Summary

Quark-quark correlation in baryons



- How hadrons are formed?
- Quark dynamics in hadrons

to understand the low-E QCD



→ The heavy Q helps to isolate "qq" motion in baryons.

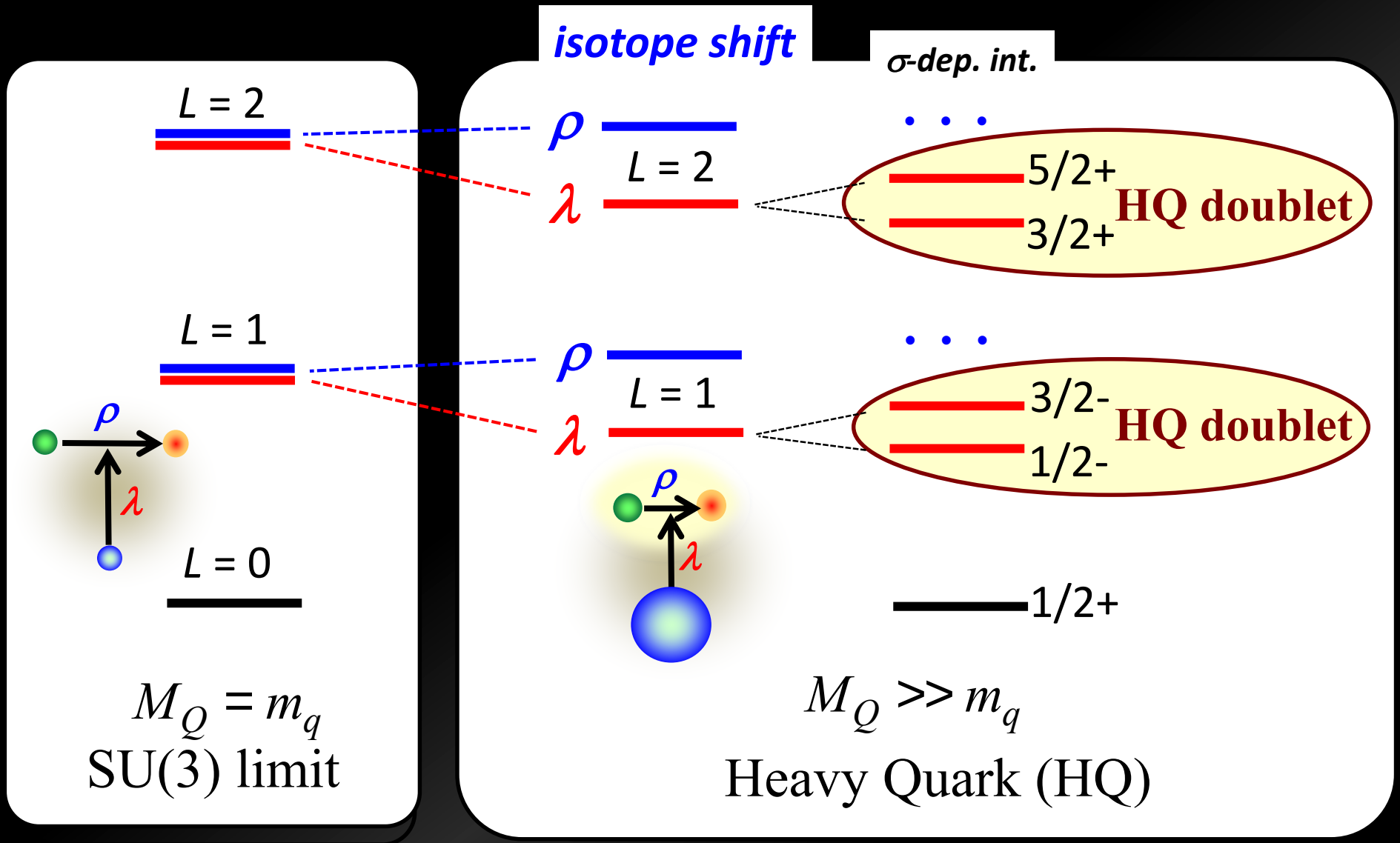
- HQ spin couples weakly to the rest.

→ HQ spin doublets ($\vec{S}_{HQ} \pm \vec{J}_{rest}$)

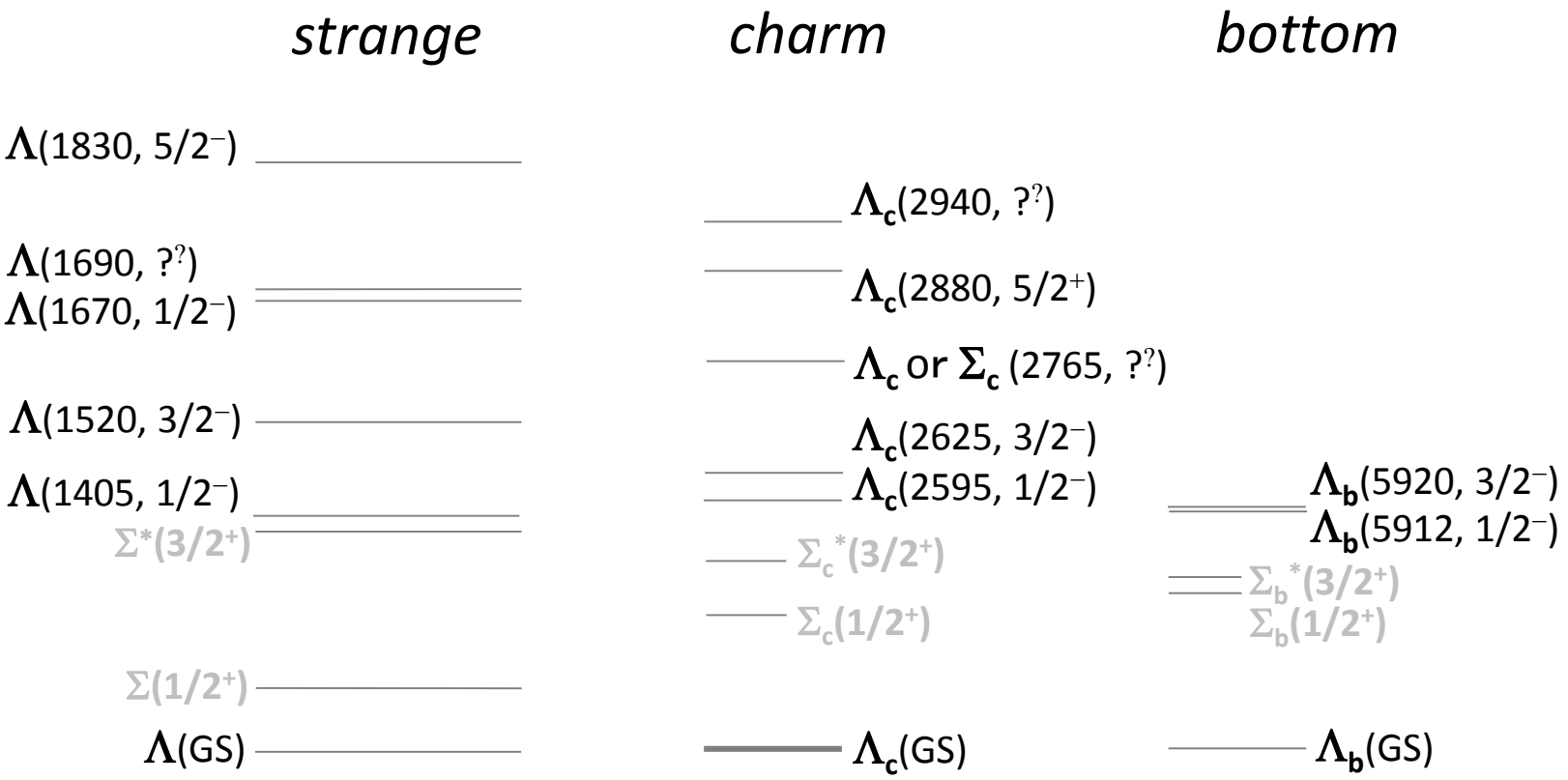
Level Structure, Production, and Decay

A heavy quark differentiates *diquark* motions = modes

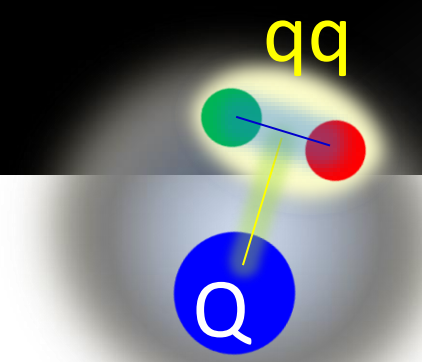
λ and ρ modes are distinct ~ *isotope shift*

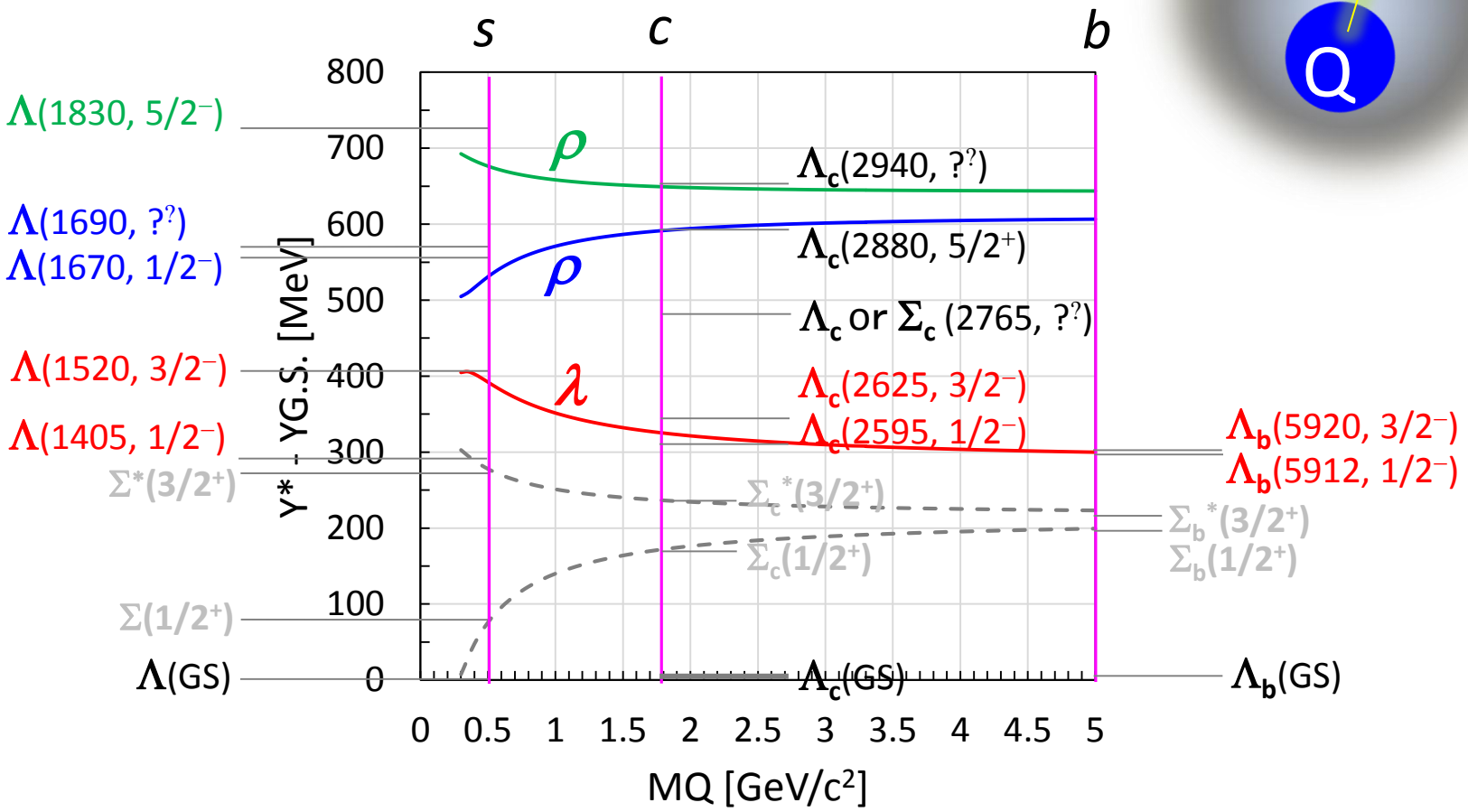


Lambda Baryons



Lambda Baryons

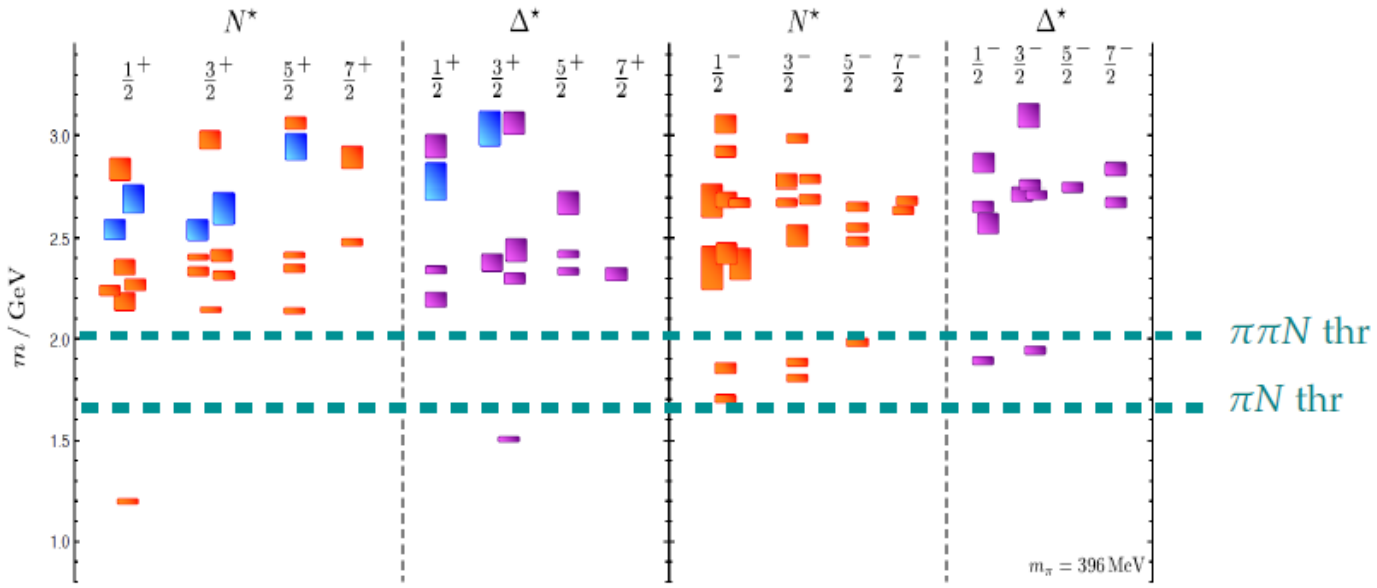




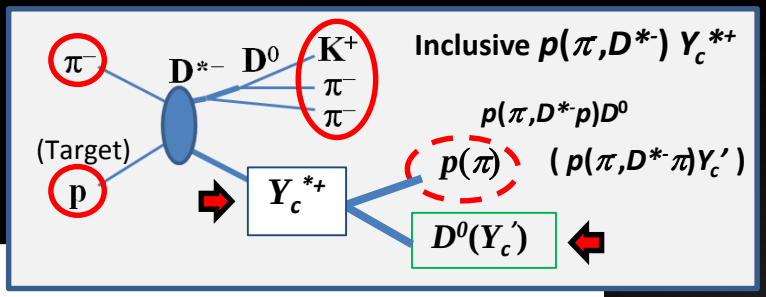
non-rel. QM: $H=H_0+V_{conf}+V_{SS}+V_{LS}+V_T$
ρ–λ mixing (cal. By T. Yoshida)

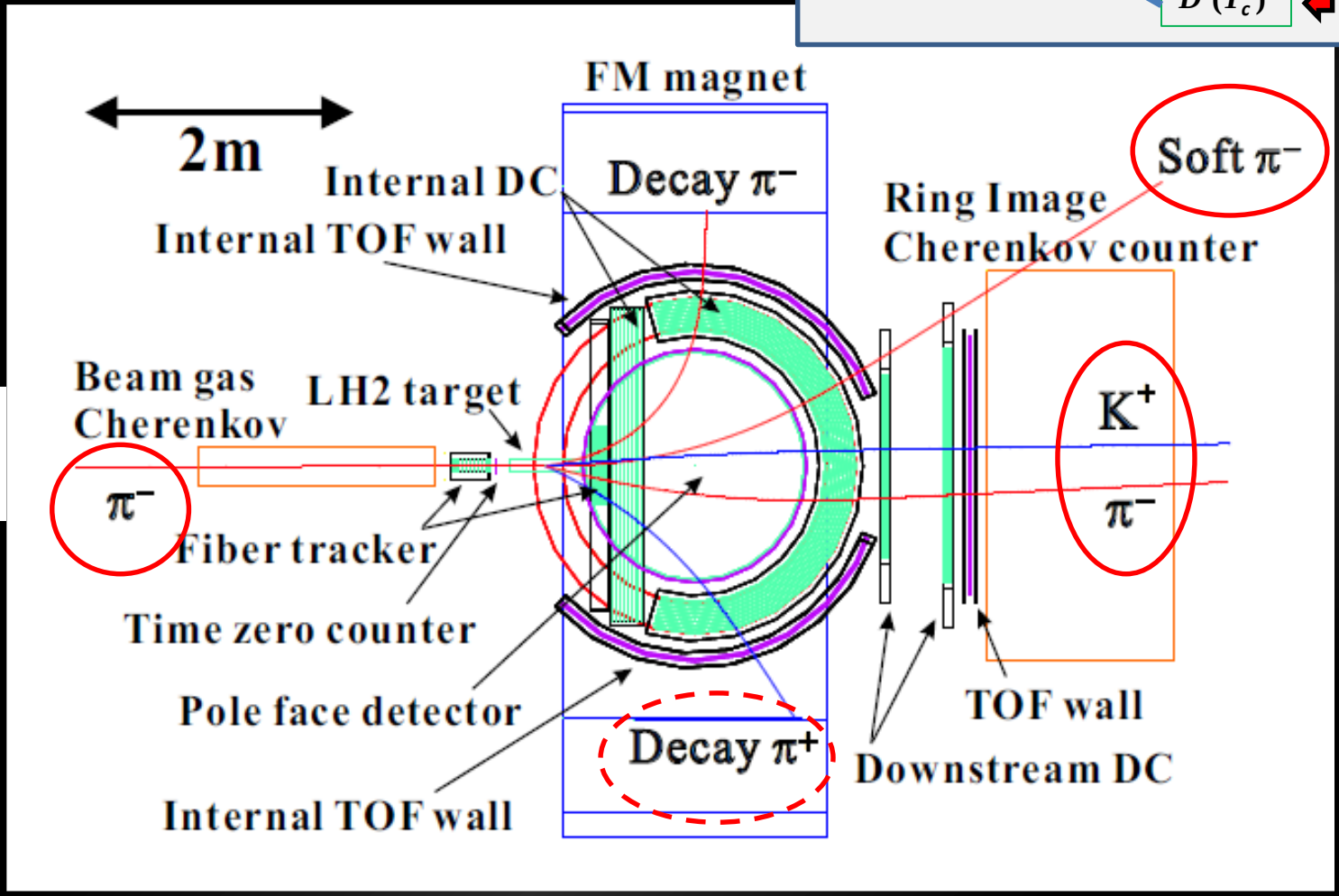
Hey, this is NSTAR - where are the baryons?

- Initial determination of spectrum with only qqq style operators — *PRD 84 & 85*
  - See rich spectrum, including hybrid-like states
  - However, no operators that look like πN or $\pi\pi N$ - missing scattering states
  - Some initial results in S11 have appeared — *GRAZ GROUP*
- Development of three-body formalism required — *HANSEN & SHARPE - MUCH PROGRESS*



Designed Spectrometer



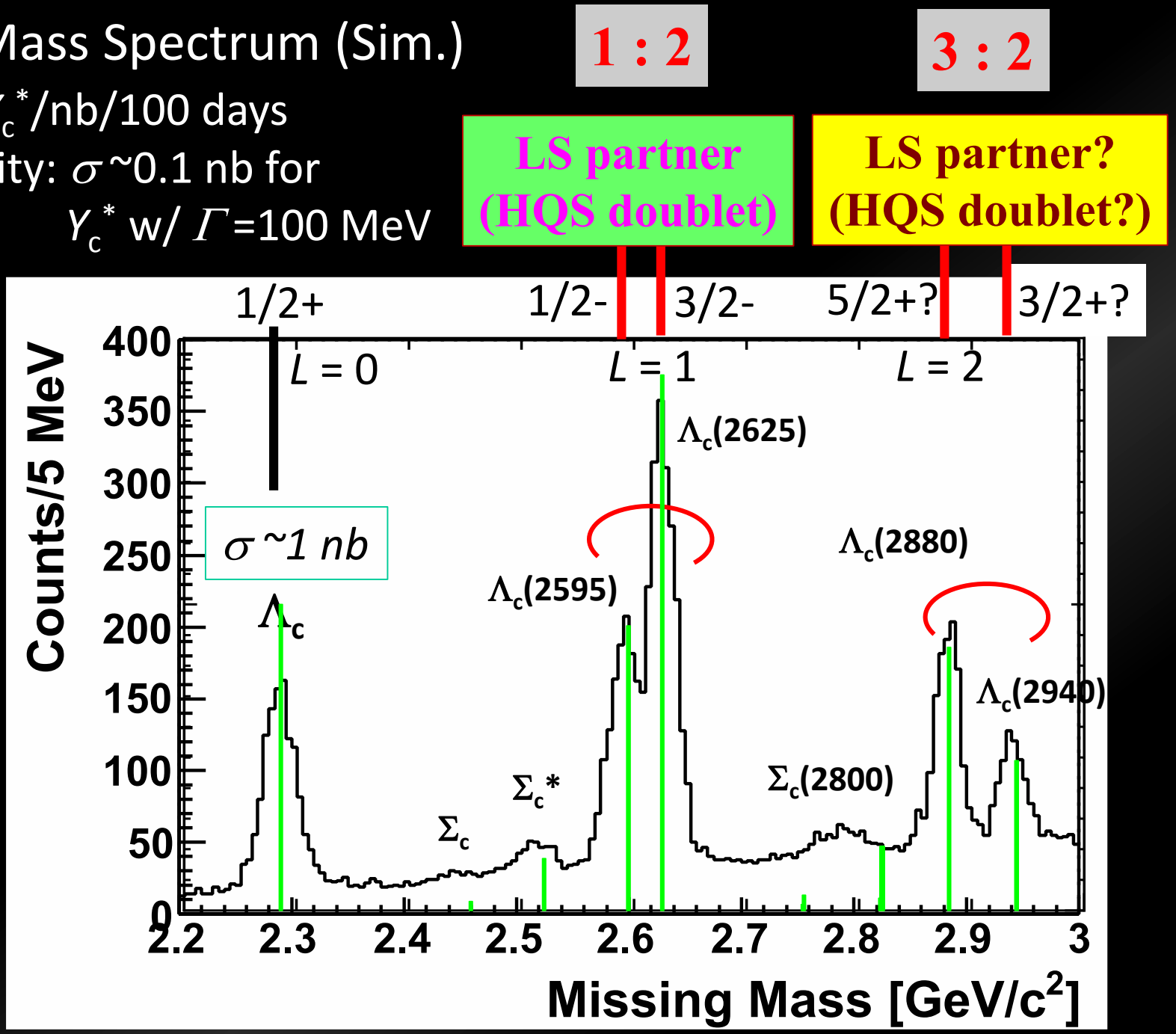


20 GeV/*c*
Beam π^-

Large acceptance ~ 60% (for *D), ~85% (for decay π^+)**
Good resolution: $\Delta p/p$~0.2% at ~5 GeV/*c*

Missing Mass Spectrum (Sim.)

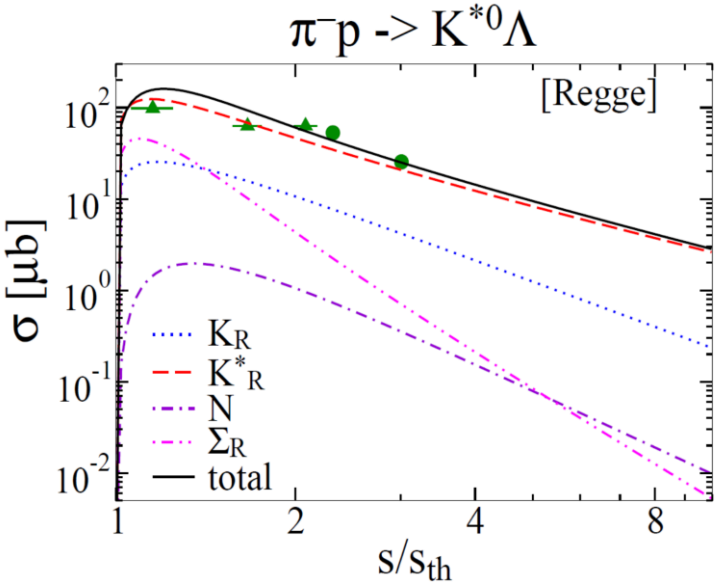
- ~1000 Y_c^*/nb/100 days
- Sensitivity: σ~0.1 nb for Y_c^* w/ Γ=100 MeV

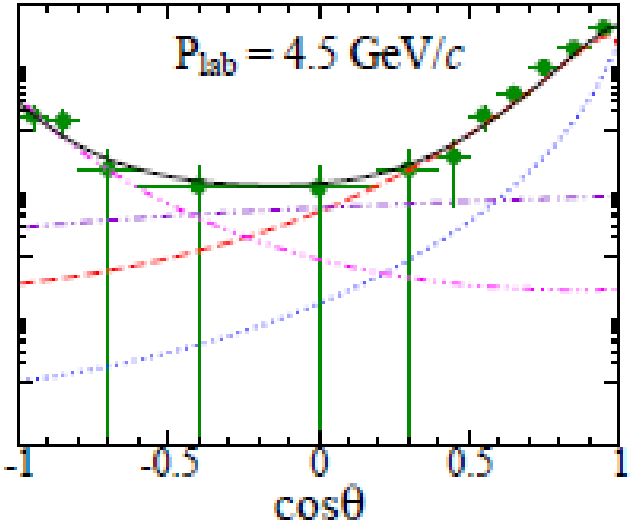


The PAC noted

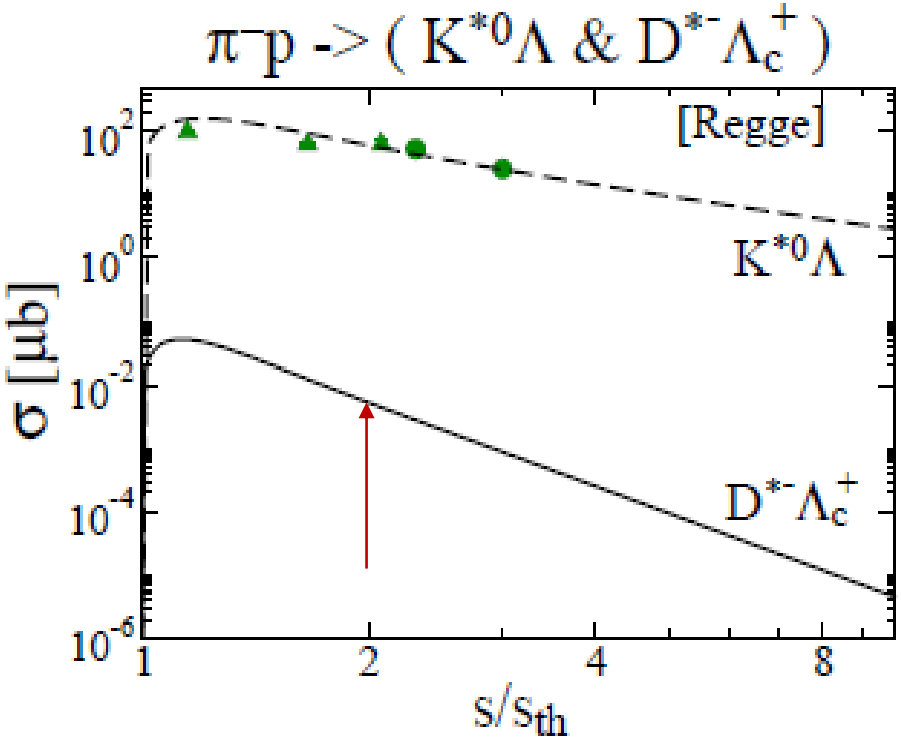
1. The collaboration should not underestimate the difficulties posed by the detection of the tiny charmed-baryon signal via the missing-mass technique, which should remain the main goal of the experiment.
2. The PAC emphasizes the importance of collaborative work with lattice QCD theorists to establish a coherent picture of excited hadrons with charm and strange quarks.

Production Cross Section





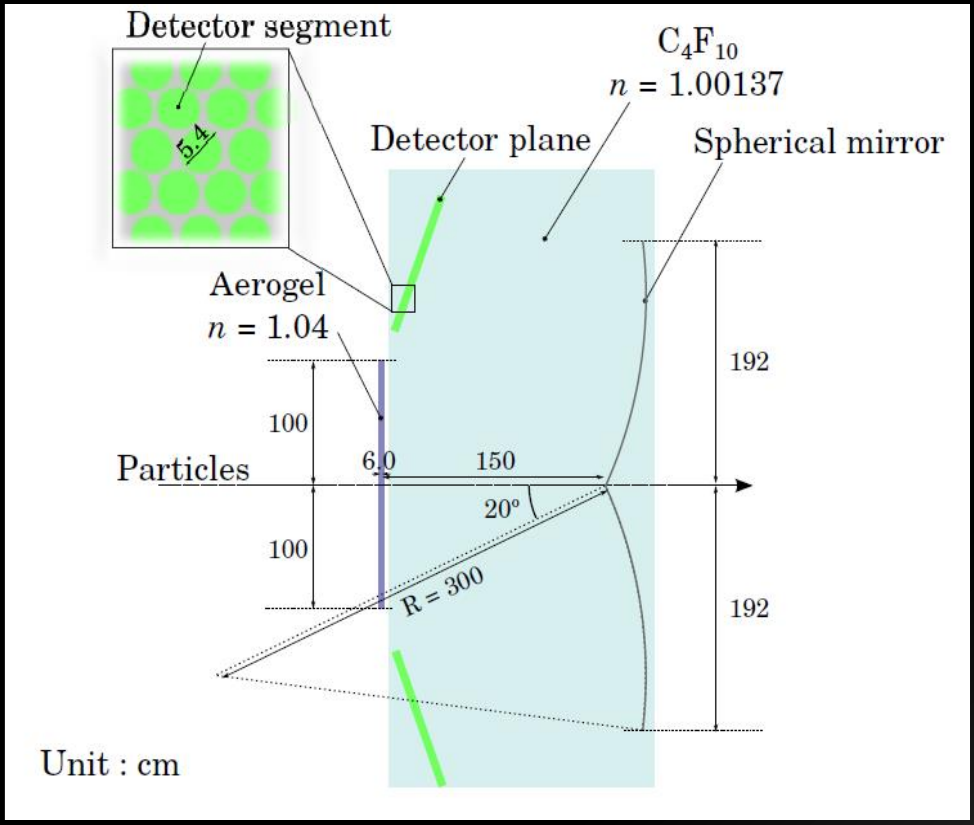
S.H. Kim, A. Hosaka, H.C. Kim, and HN(TBP)
S.H. Kim, PhD Thesis (under defense)

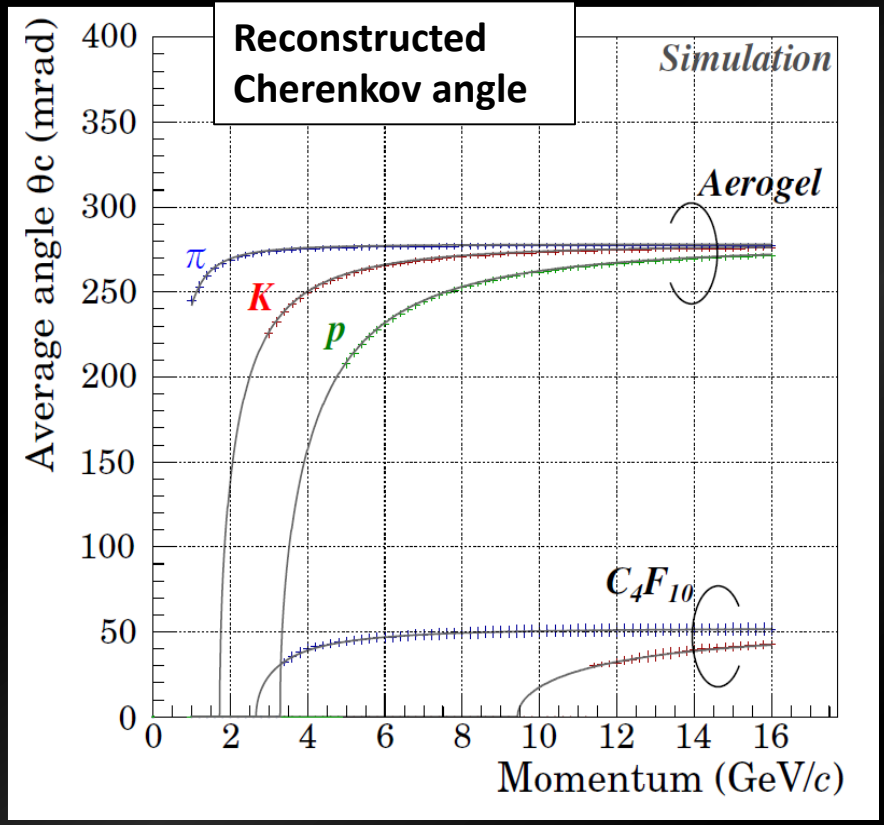


R&D for Key Devices

- Particle Identification (RCNP/Kyoto/Tohoku/RIKEN…)
  - Ring Image Cherenkov Detector (RICH)
- High rate tracker (Tohoku/Osaka/RCNP…)
  - Scintillating Fiber Tracker (SFT)
  - Developed in experiments at K1.8
- High-speed DAQ system (RCNP/Osaka/Taiwan/KEK…)
  - PC cluster-based DAQ scheme
    - Flexible “trigger”: not only (π^-,D*) but also (K^-,K*),…
  - Grand designing is in progress

RICH: Design





- High-momentum PID
  - Mom. range: 2-16 GeV/c

⇒ Hybrid RICH
  - Aerogel + C_4F_{10} gas
  - MPPC detector plane
  - Spherical mirror

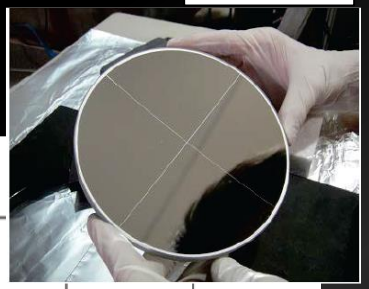
- Design Performances
  - Efficiency: ~99%
  - Wrong PID: 0.10~0.14%

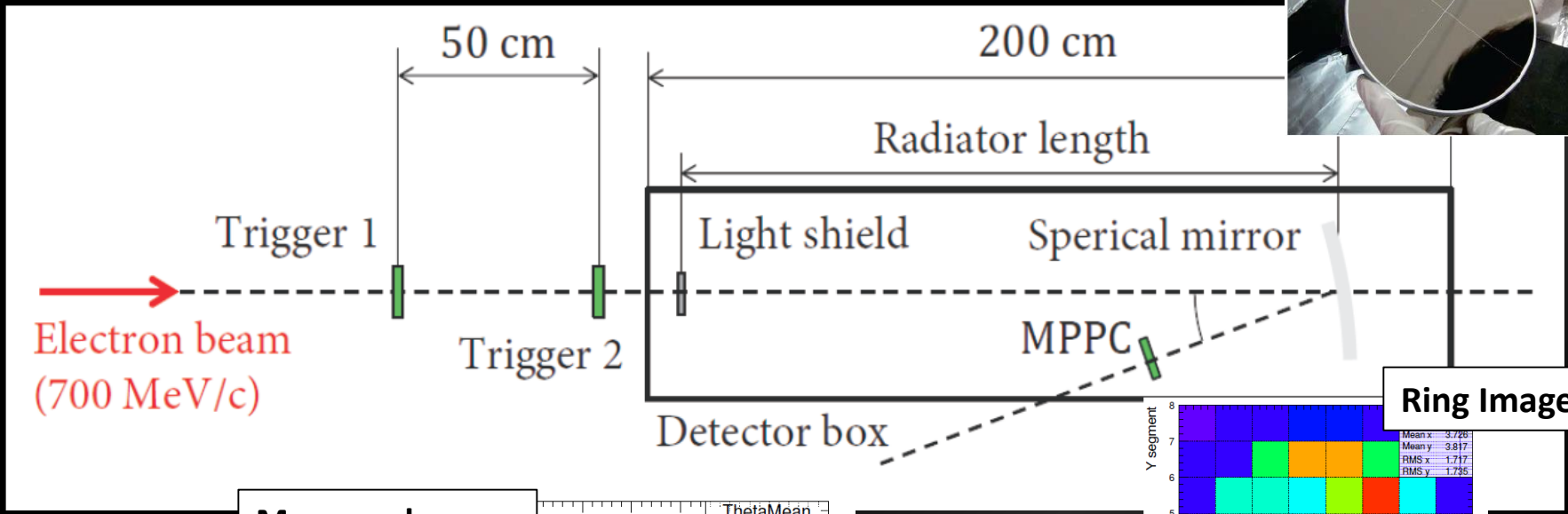
⇒ Background level × 1.05

RICH: Test Exp. at Tohoku/ELPH

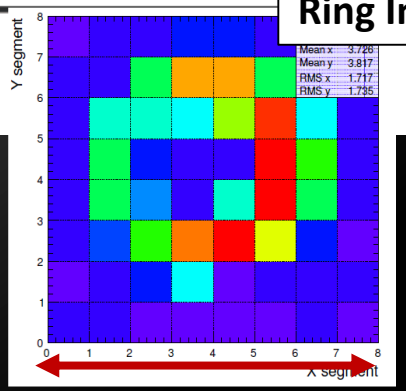
e-Beam + Air 1.5m

Mirror



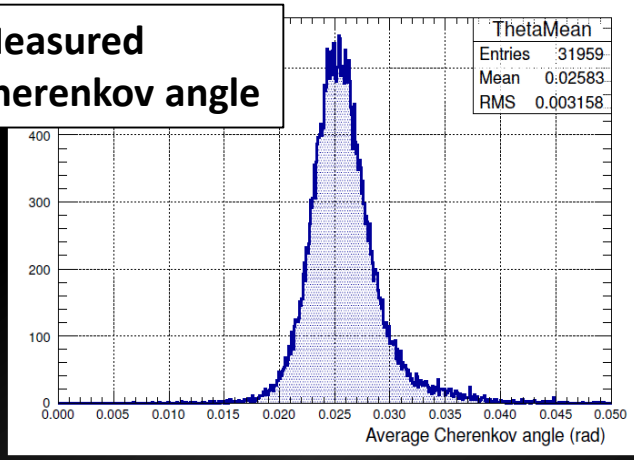


Ring Image



24 mm

Measured Cherenkov angle



σ_θ ~ 3.1 mrad < 4 mrad (requirement)

Fiber Tracker

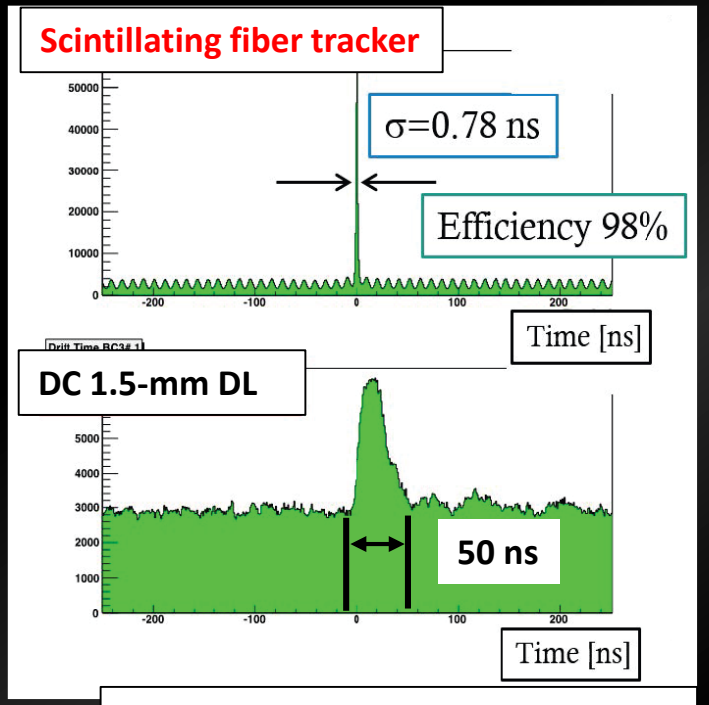
∗ J-PARC beam: time structure

⇒ Narrower time gate is more essential to suppress accidental hits.

- E50: 60 M/spill (30 MHz)

- Requirements
  - 1 MHz/1 mm fiber
  - Tracking efficiency: ~99%
  - Thin material thickness

- Focal plane & Beam tracking
- Target downstream tracking
  - Detector design
  - Simulation study
  - Readout electronics development



E10: 12 M/spill (6 MHz) beam

High-speed DAQ system

- Event Rate and Data Reduction

		Rate [event/spill]	Data [GB/spill]
Beam		60 M	
Reaction	H_2 TGT (4 g/cm^2)	3.63 M	50
	Filtering Condition (On-line Data Reduction)		
C1	$[TOF \geq 2] \otimes [ITOF(negative) \geq 1]$	(1.1-2) M	15-28
C2	$C1 \otimes [SFT \geq 3] \otimes [RICH = \pi]$ $\otimes [AC = K \cup p(p > 3GeV/c)]$	160 k	2.2
C3	$C2 \otimes [Momentum\ Analysis\ w/$ DC and FT]	(15-23) k	0.2-0.32

Total # of Channels: ~30,000

- Tracker >17,100 ch
- RICH: 10,000 ch
- Hi-Res Timing/TOT: ~500 ch

High-speed DAQ system

Streaming DAQ(~50 GB/spill)

Frontend modules
- ∗ Signal digitalization
  - – Pipelined system

Buffer PCs
- ∗ Data accumulation
  - – Several 10 GB memories

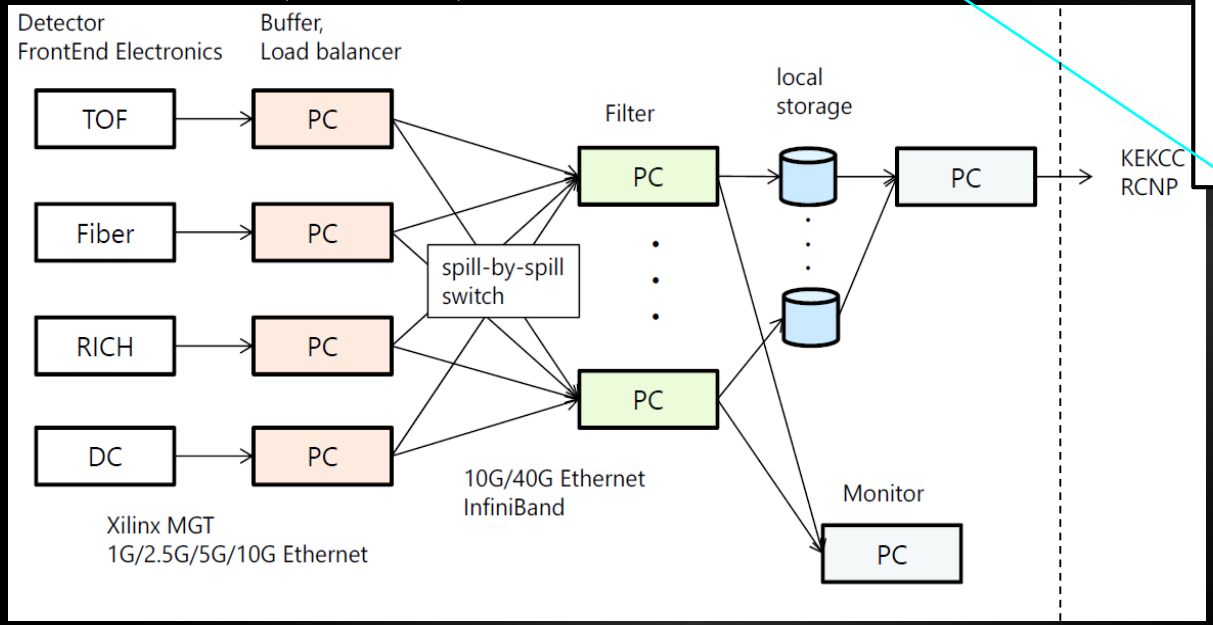
∗ High-speed data link (Local)

~50 GB/spill

Filter PCs
- ∗ Event reconstruction
  - – 100–200 CPUs

<0.5 GB/spill

Storage
- – Local storage
- – Transferred to KEKCC/RCNP



SUMMARY

- We keep close discussions with theorists
  - Production cross section
  - Level Structure
  - Decay width (under progress)
    - ρ/λ mode dependence
- R&D Works for key devices are in progress
  - RICH
  - SFT
  - High-speed DAQ system