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BELLE II Aerogel RICH R&D Group

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## Introduction

Silica aerogel as a Cherenkov radiator

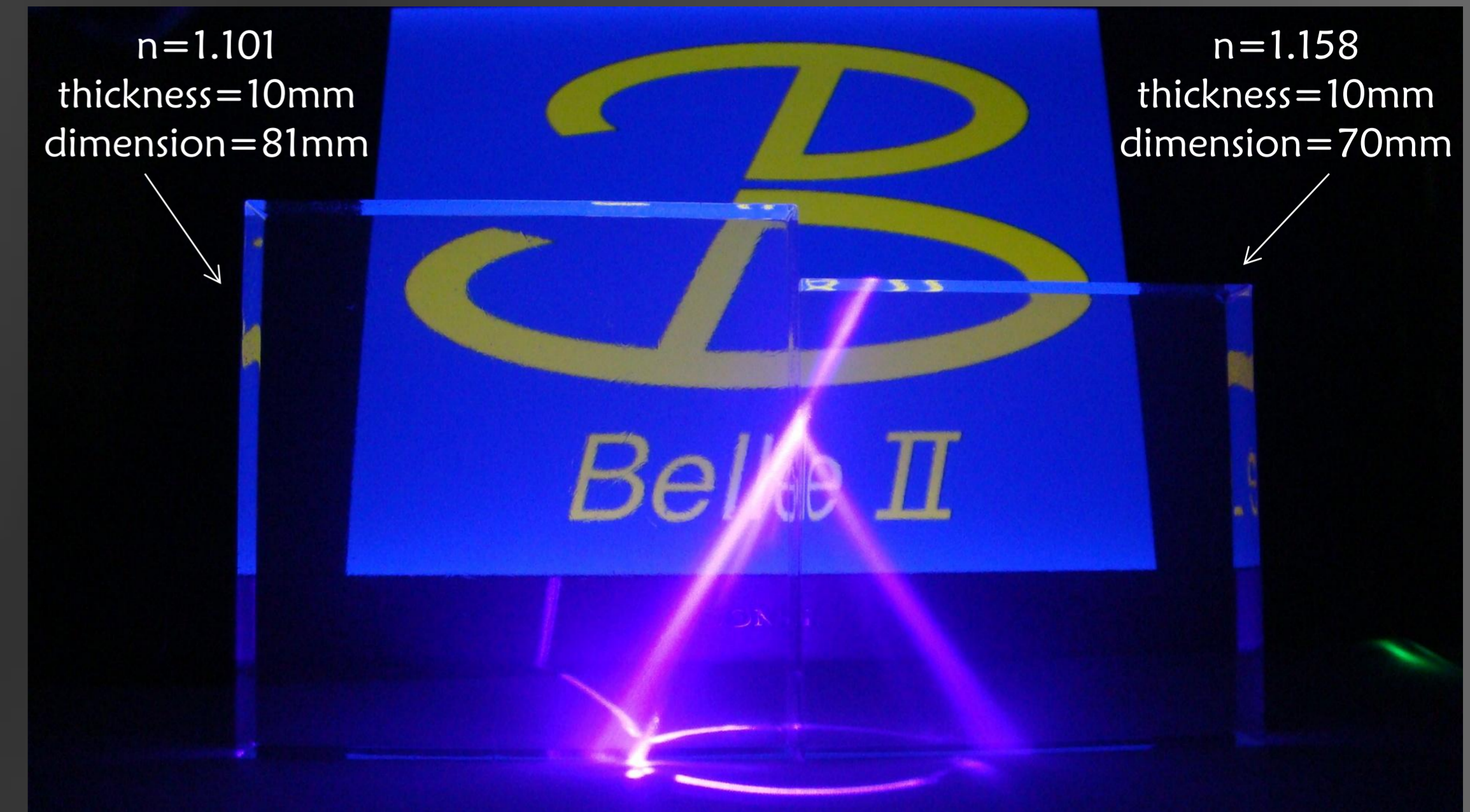
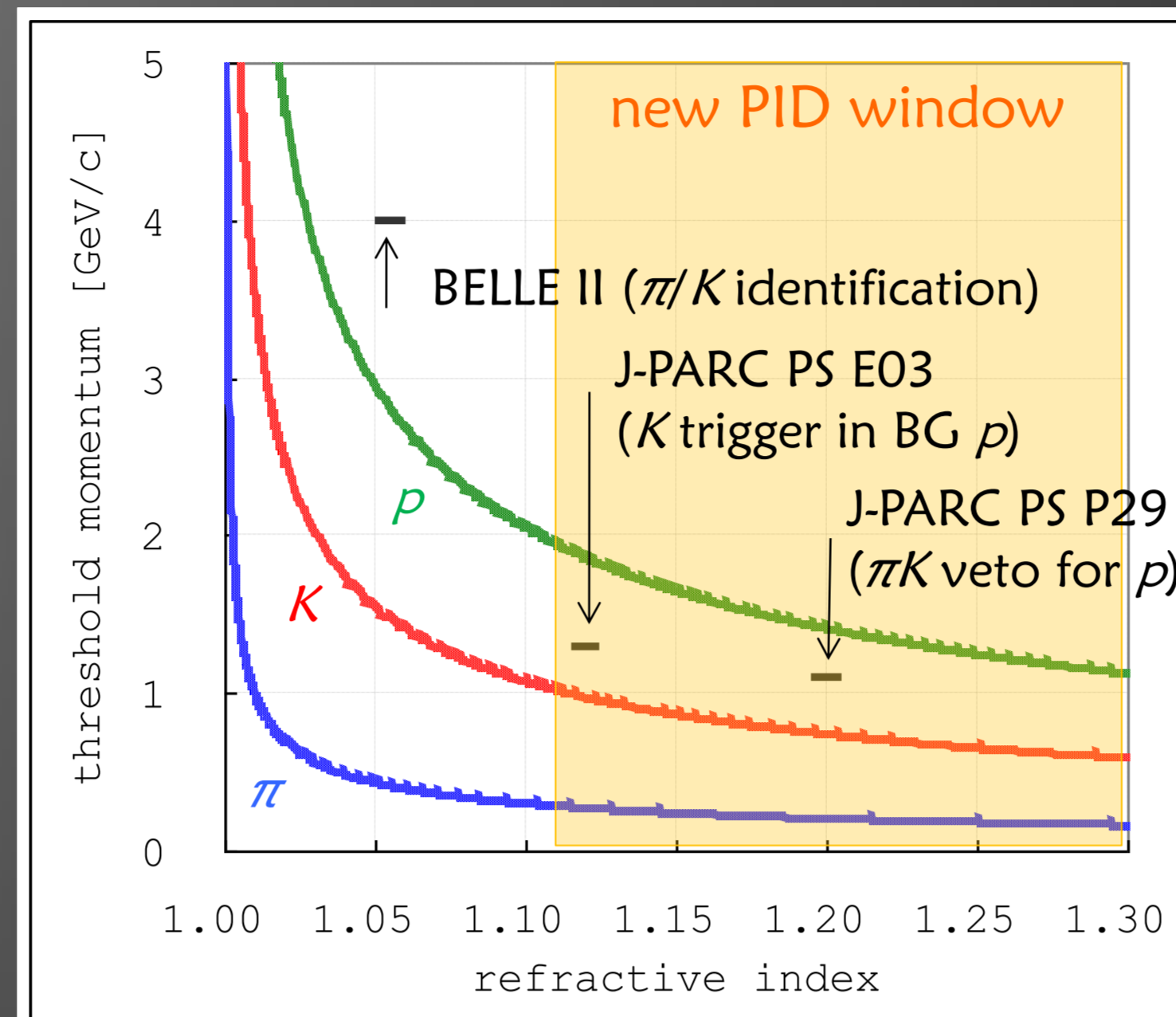
Unique refractive index

- $n=1.0026-1.11$  (conventional production method)
- $n=1.05-1.26$  (new production method)
- cf. air (gas) :  $n=1.0003$ , water (liquid) :  $n=1.33$

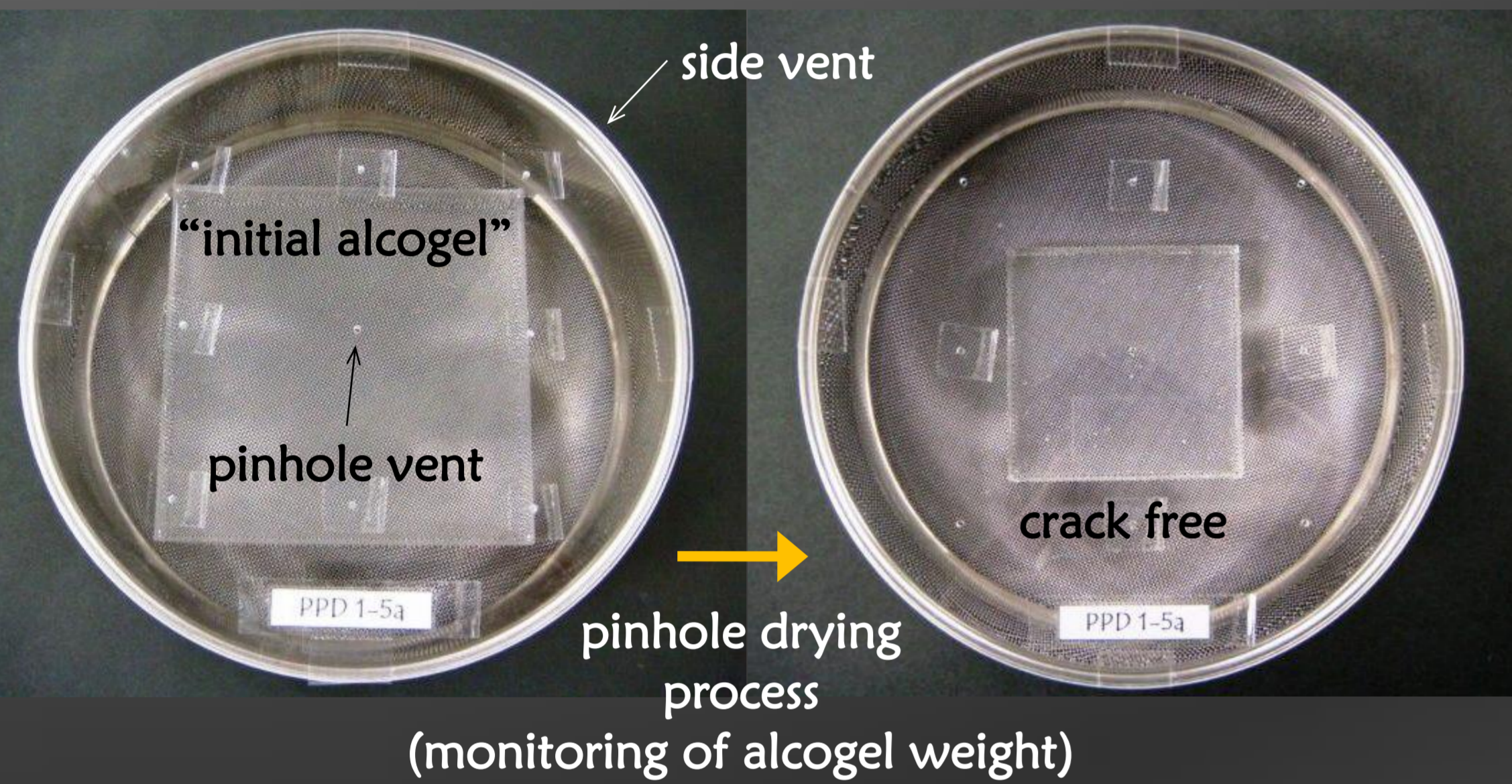
New aerogel production technique

Pinhole Drying (PD) method

- (ultra-) high refractive index → new PID window
- highly transparent → not only threshold but also ring imaging type Cherenkov counter
- hydrophobic → maintenance free



## New Aerogel Production Technique – Pinhole Drying (PD) Method –



Production process

1. Alcogel (wet gel) synthesis
2. Aging
3. Pinhole drying
  - enclose the alcogel in a semi-sealed container
  - solvent evaporation from the alcogel body
  - shrinkage of the alcogel and increase in density (one week – a few months)

4. Solvent displacement (ethanol immersion)

5. Hydrophobic treatment

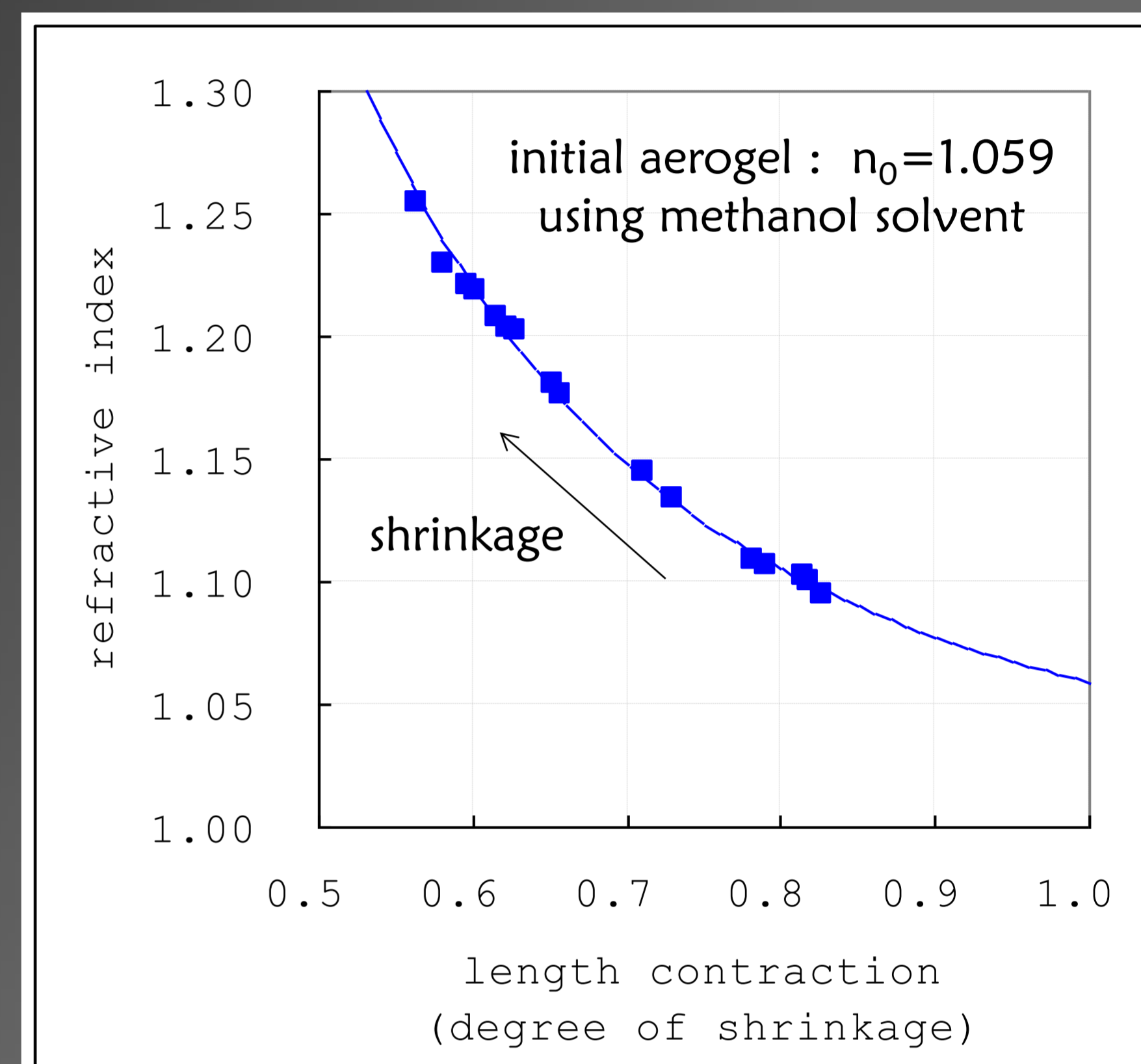
6. Rinse (ethanol immersion)

7. CO<sub>2</sub> supercritical drying

Refractive index control → (A) + (B)

(A) Mixing ratio of raw chemical solutions

(B) Degree of the pinhole drying (shrinkage)



## Optical Quality of PD-aerogel

– Transmission Length and Transmittance –

Initial alcogel selection

Solvent of synthesis

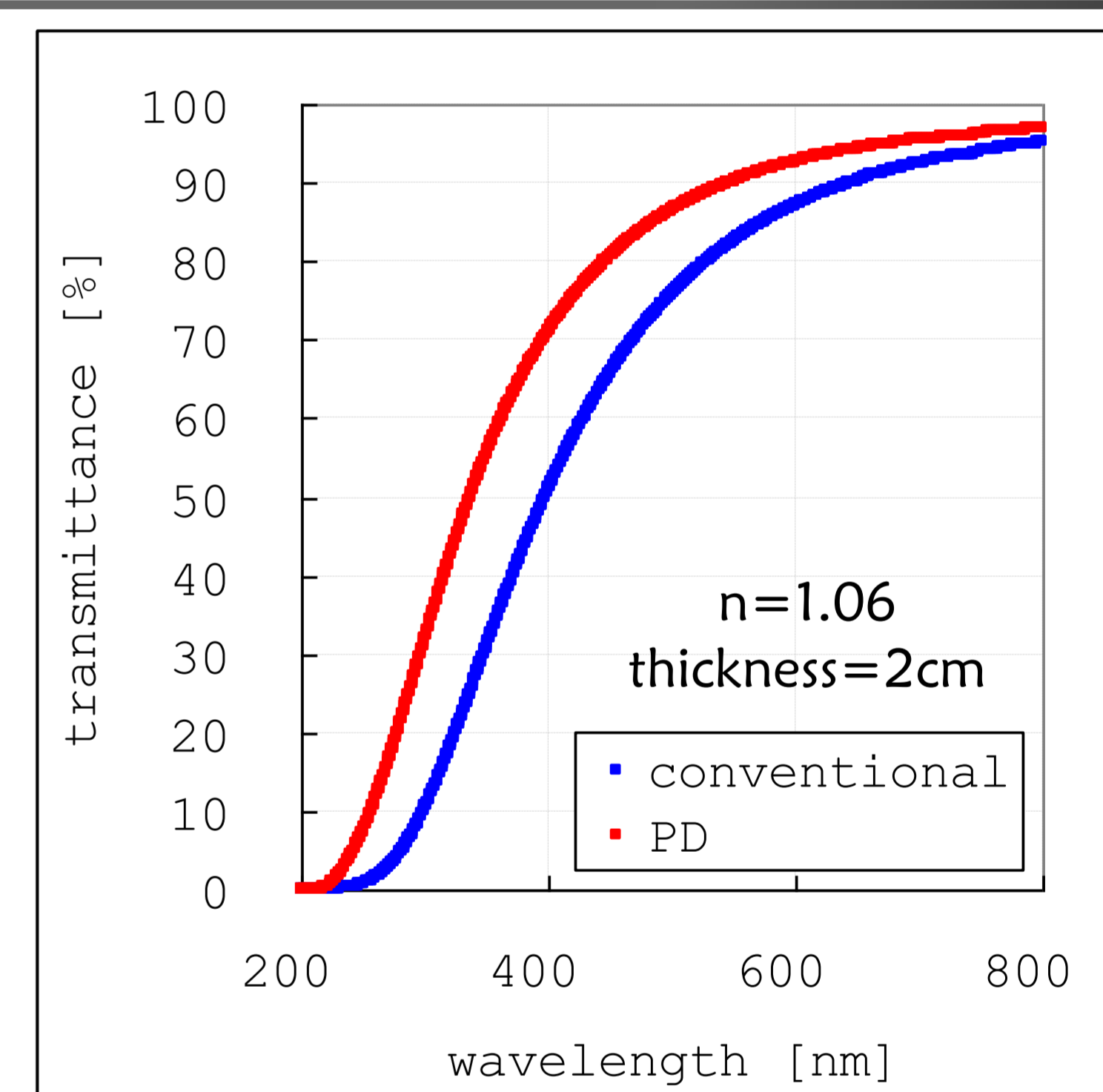
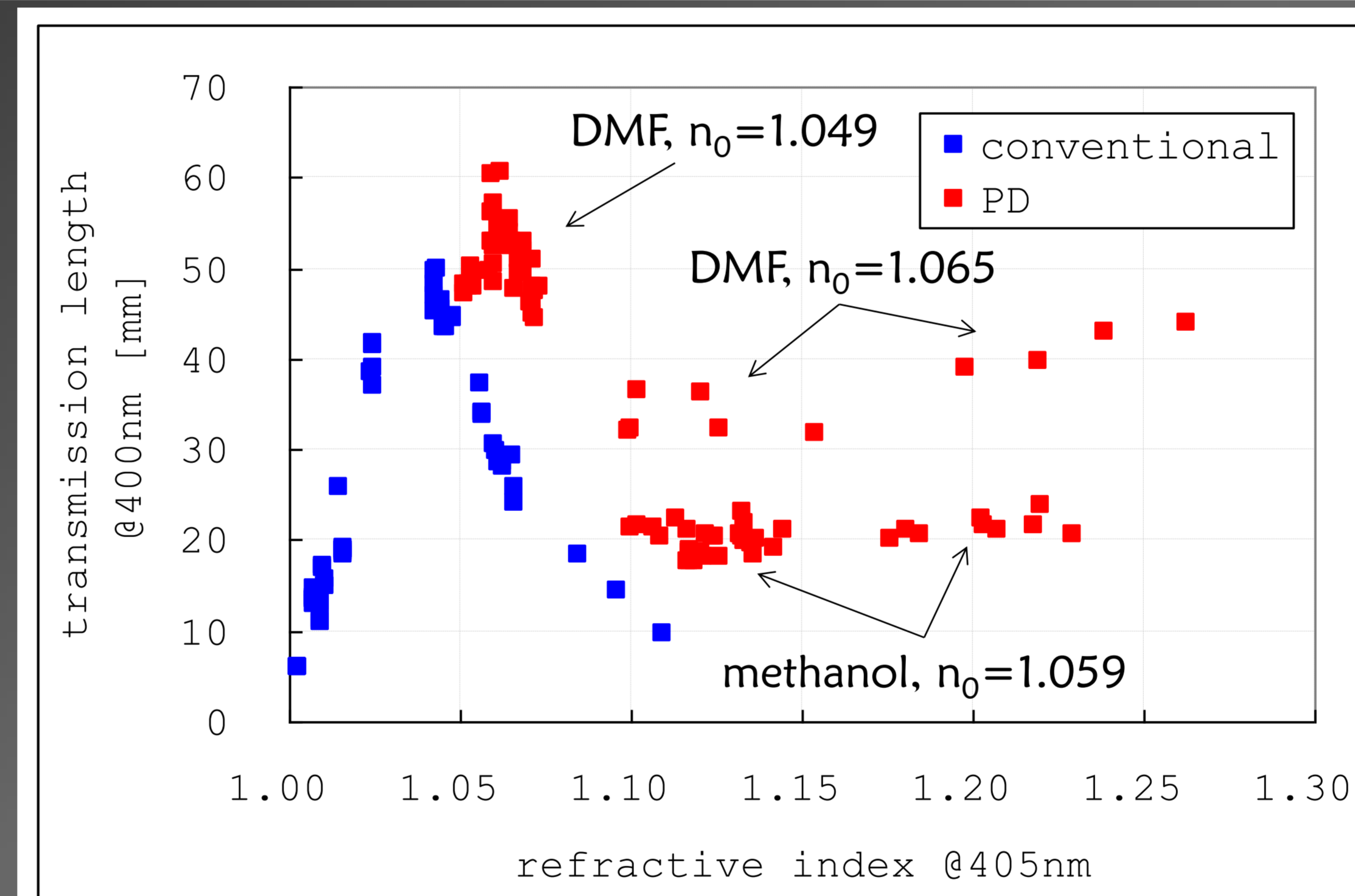
- methanol → fast production
- N,N-dimethylformamide (DMF) → high transparency

Initial refractive index

- high refractive index ( $n_0 \sim 1.06$ ) → fast production
- low refractive index ( $n_0 \sim 1.05$ ) → high transparency

Test production (3 patterns of initial alcogel selections)

- DMF solvent,  $n_0=1.049 \rightarrow n=1.051-1.074$
- DMF solvent,  $n_0=1.065 \rightarrow n=1.10-1.26$
- methanol solvent,  $n_0=1.059 \rightarrow n=1.10-1.23$



## Performance of PD-aerogel

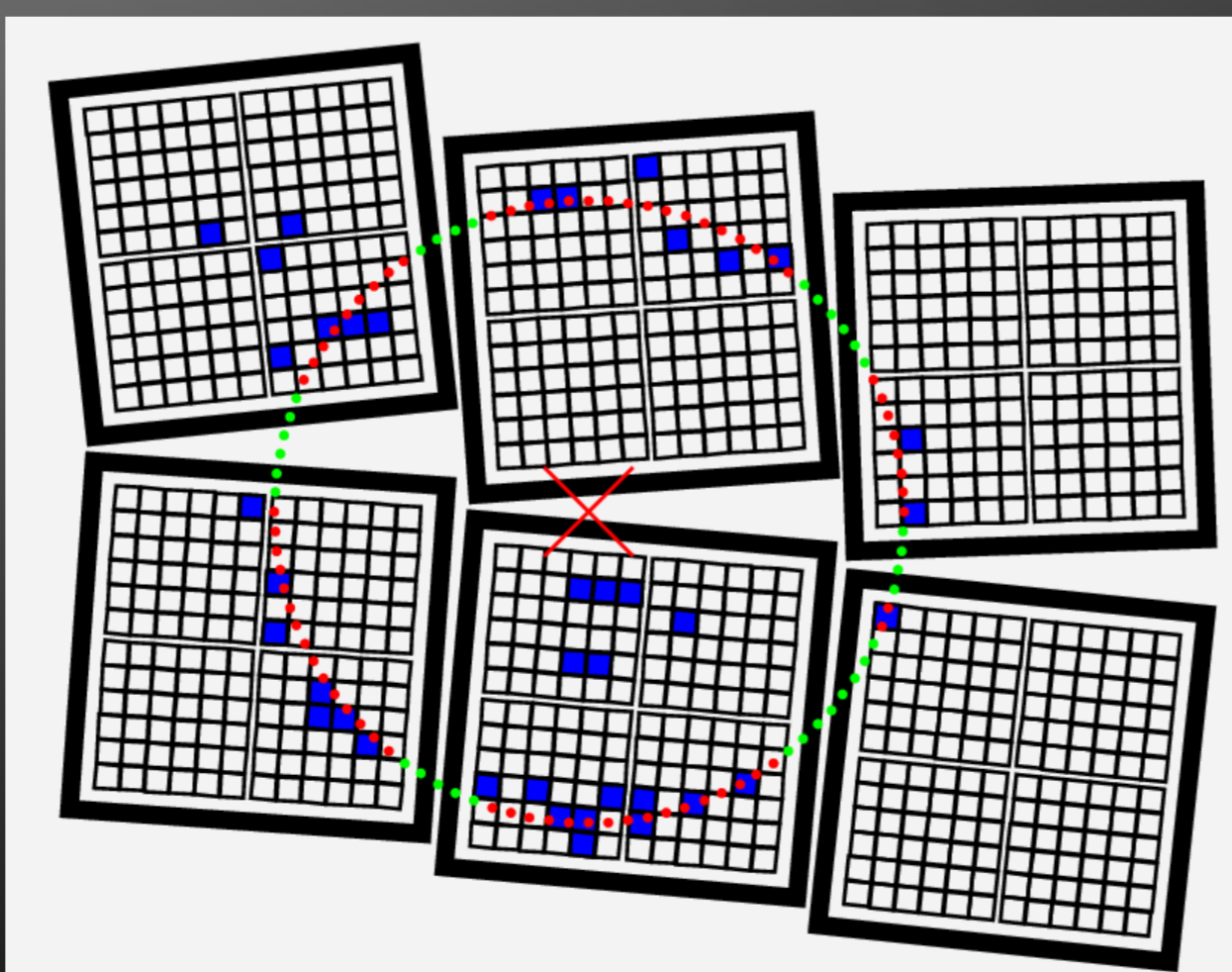
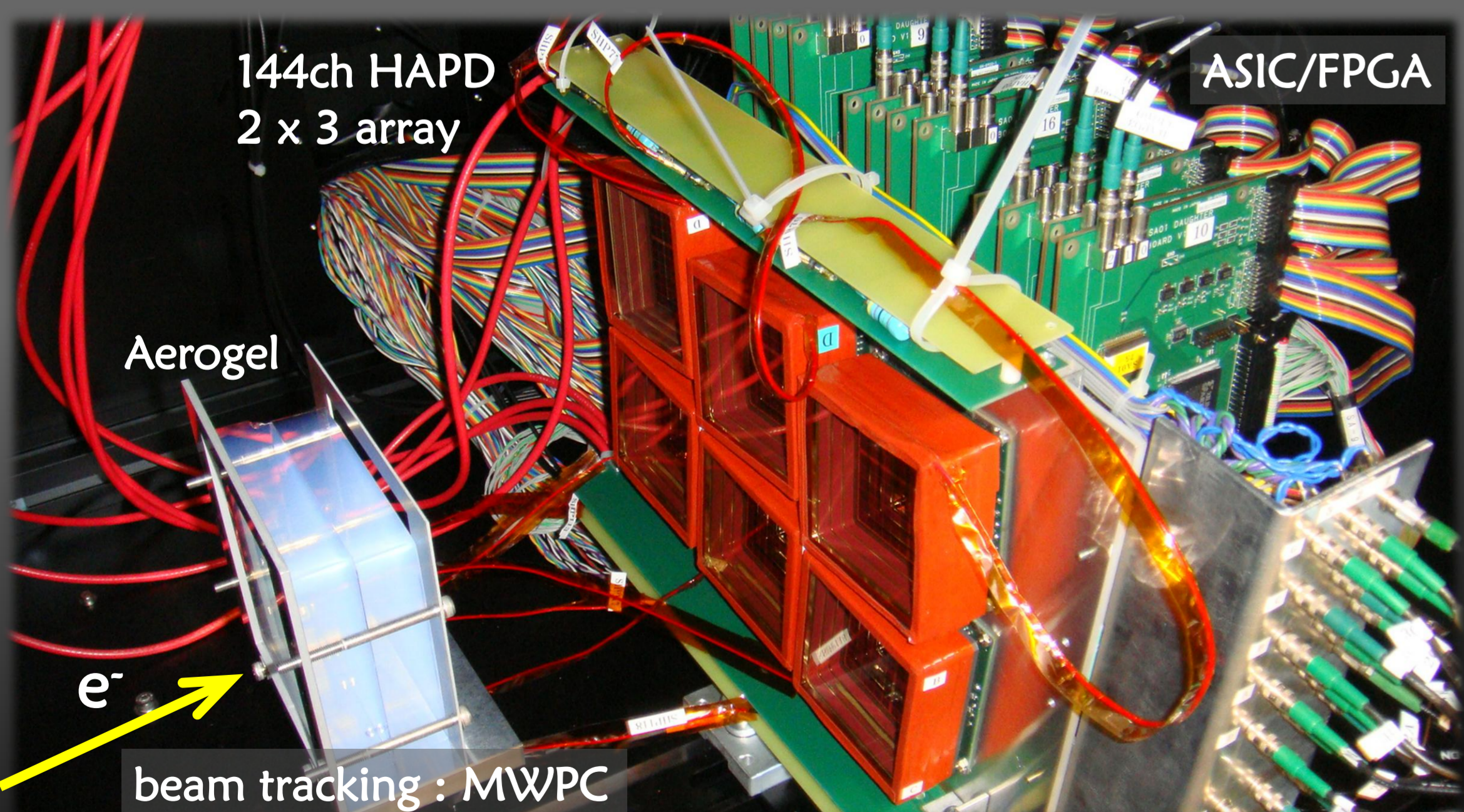
– Beam Test Results –

- @KEK Fuji Test Beam Line (FTBL) in Nov. 2009
- 2 GeV/c electron beams
- Aerogel based Ring Imaging Cherenkov (A-RICH) counter
  - prototype of a new PID detector for the BELLE II

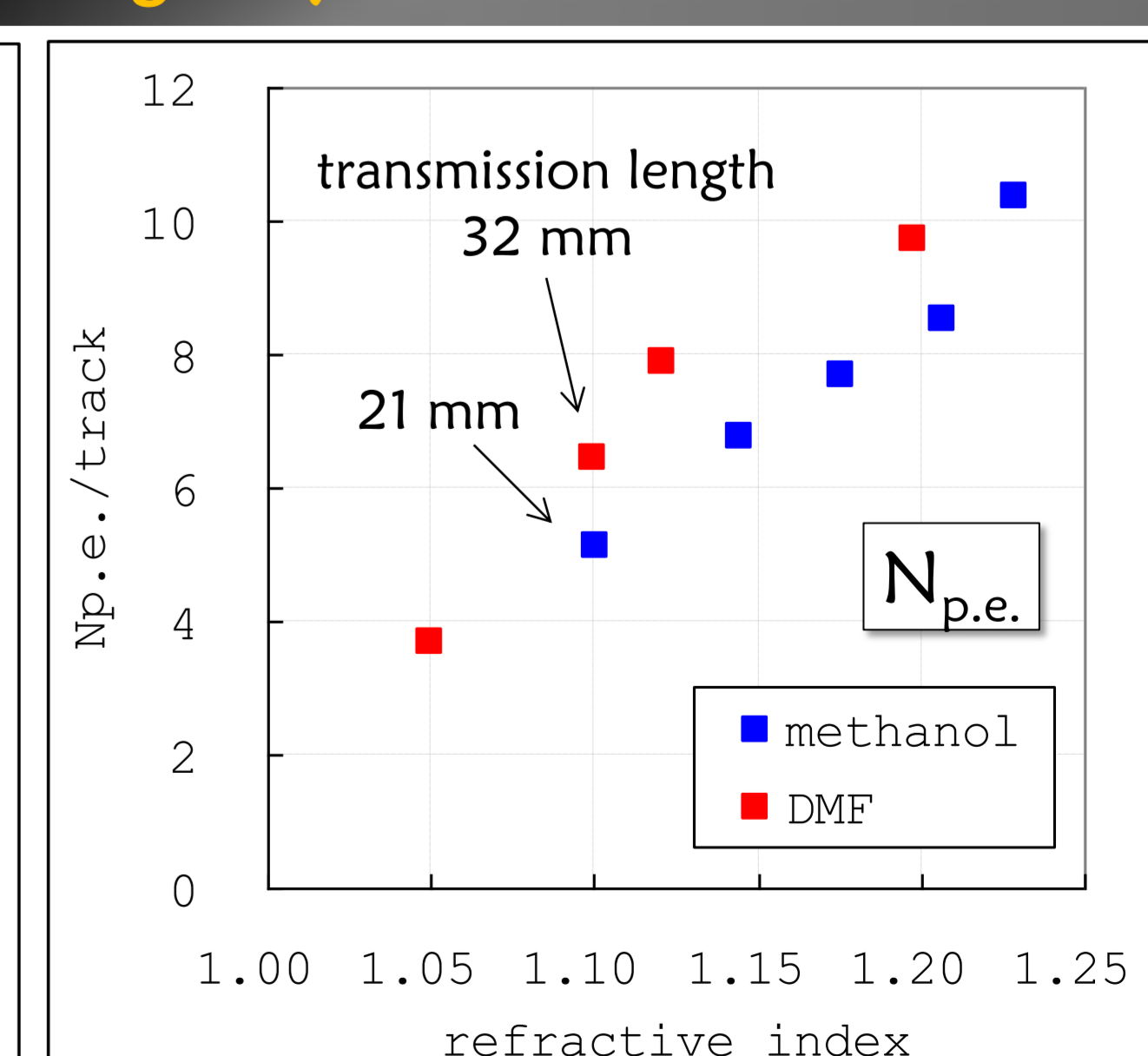
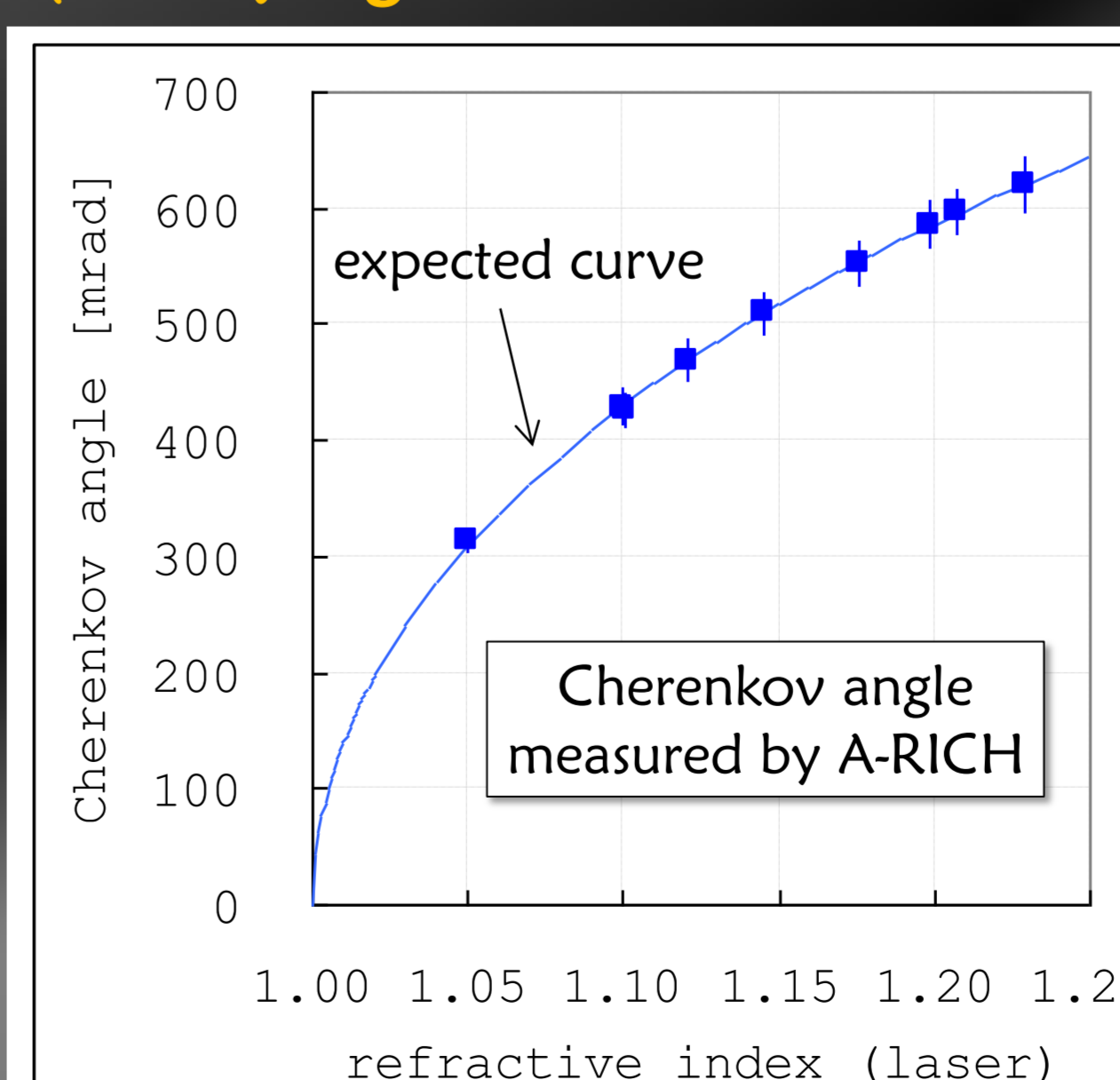
Middle refractive index : 2cm x 2 layer focusing configuration

Aerogel configuration (refractive index)	Angular resolution (per single photon)	Photon yield ( $N_{p.e.}$ )	Angular resolution (per track)	$\pi/K$ separation @4GeV/c
1.046 + 1.055	14.5 mrad	9.2	4.8 mrad	4.7 $\sigma$
1.045 + 1.051(PD)	15.3 mrad	12.1	4.4 mrad	5.3 $\sigma$
1.051(PD) + 1.059(PD)	14.8 mrad	13.6	4.0 mrad	5.4 $\sigma$

(Ultra-) high refractive index : 1cm single layer



A-RICH Event Display



## Summary

- New production method of silica aerogel has been developed: Pinhole Drying (PD) method.
- Refractive index of aerogel is controlled in a range of up to 1.26 by the PD method.
- The PD method can produce highly transparent aerogel (a transmission length of up to 60 mm).
- Performance of PD-aerogel as a Cherenkov radiator has been demonstrated by the beam test.
- PD-aerogel will be utilized in the next generation of particle and nuclear experiments: KEK BELLE II ( $n \sim 1.06$ ), J-PARC 50 GeV PS P03(E03) ( $n=1.12$ ) and P29 ( $n \sim 1.20$ ).

## References

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- I. Adachi, et al., Nucl. Instr. and Meth. A 553 (2005) 146.
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- S. Nishida, et al., Nucl. Instr. and Meth. A 610 (2009) 65.
- S. Shiizuka, et al., talk in this conference.