8-Jan-2016
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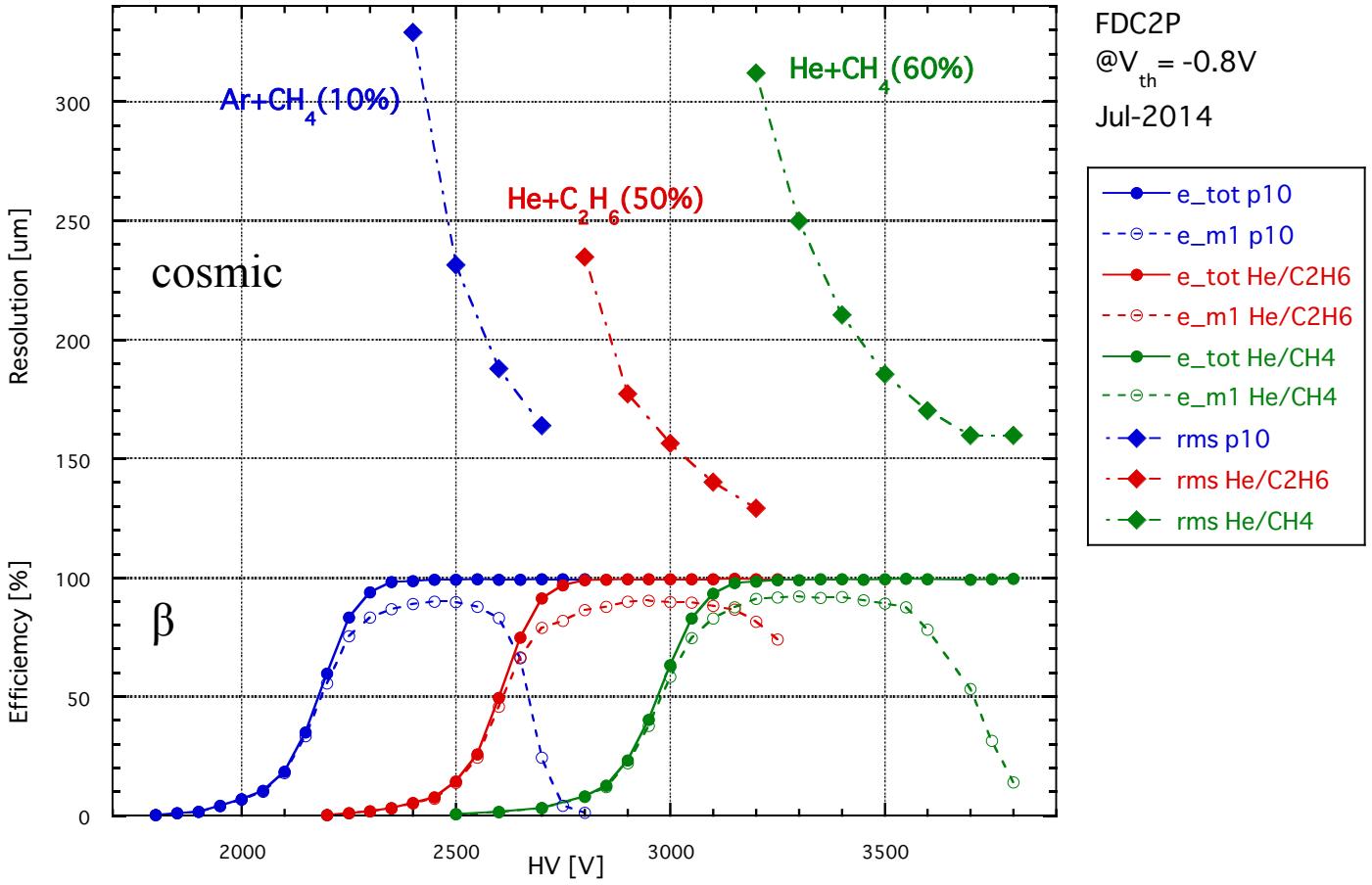
Memo

- FDC2 (PDC) Gas Mixture for light particles : Z= 1 ~ 6(?)
  - previous bench test for MIP
    - $Ar+CH_4$(10%), $He+C_2H_6$(50%), $He+CH_4$(60%)
  - $Ar+CH_4$ mixture for light particles
    - keeping position resolution < 200 um
    - more stable operation, shorter memory time, moderate HV
  - bench test : $Ar+CH_4$(10~50%)
    - data & tentative conclusion

Bench test for MIP -1

- Test conditions
  - FDC2P : same cell/ super layer structure as FDC2 : xx'xx'xx'
  - pre-mixed gas : Ar+CH_4(10%), He+C_2H_6(50%), He+CH_4(60%)
  - ASD threshold: Vth= -0.8V
  - TDC(LRS3377): 1nsec/bin, 1024nsec range, multi-hit, no-trailing info.
  - measurement
    - efficiency : β (^{90}Sr)
    - resolution : μ (cosmic ray)

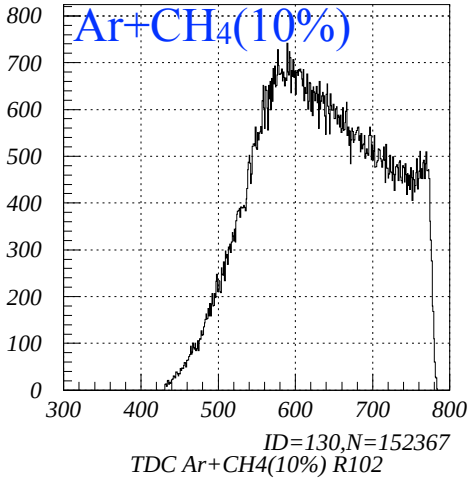
summary of bench test @2014

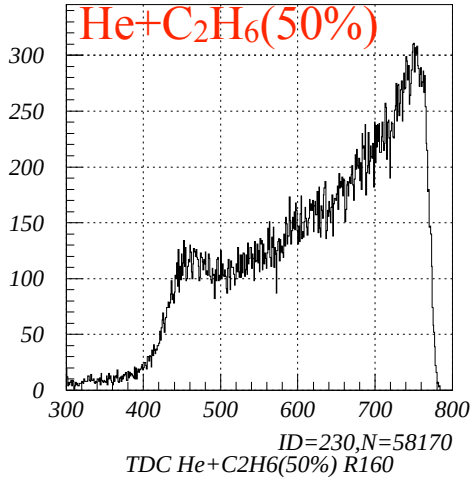


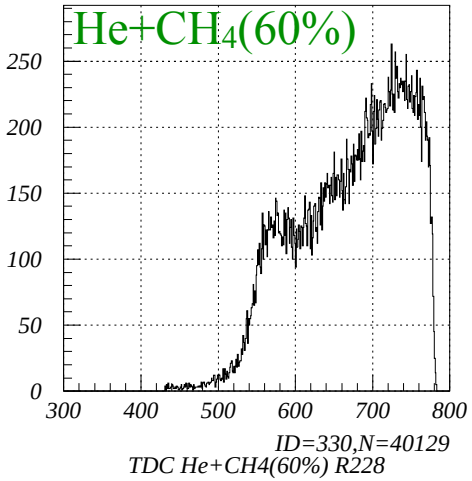
Bench test for MIP -2

@HV(σ < 200 μm)

- Drift time distribution

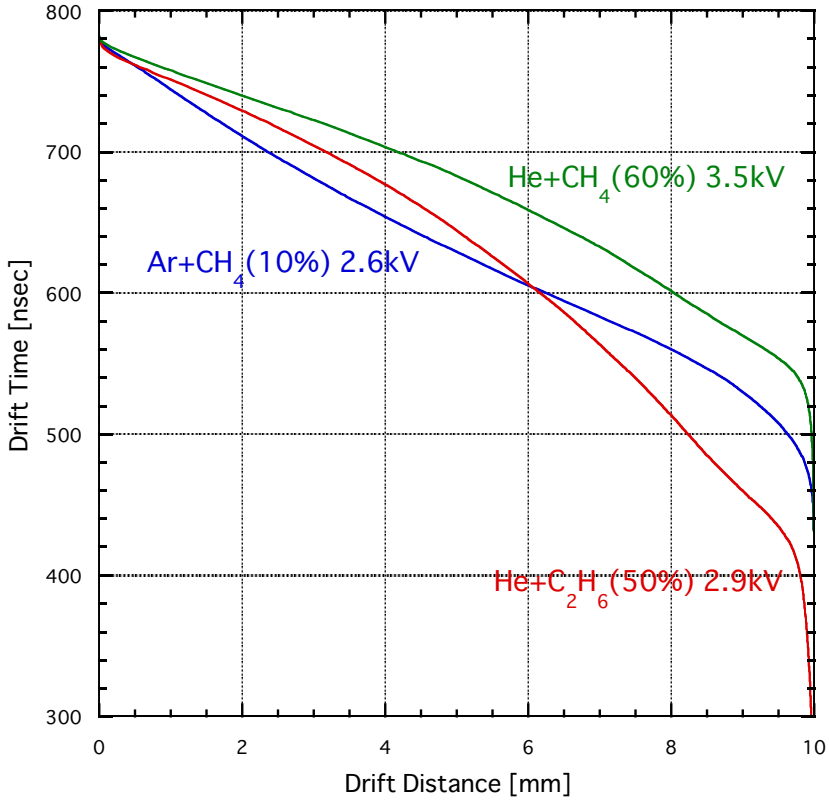




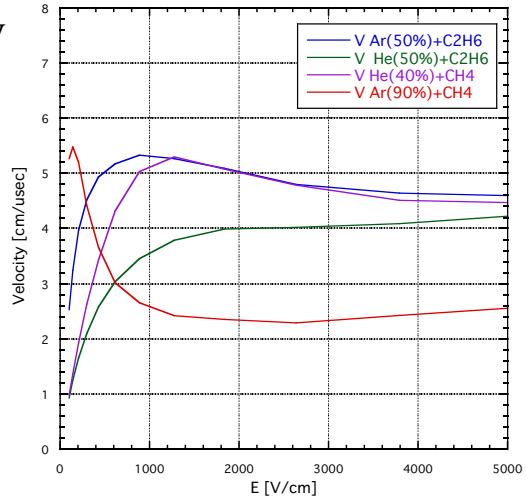


Drift time [nsec]

- Drift time - distance



- drift velocity



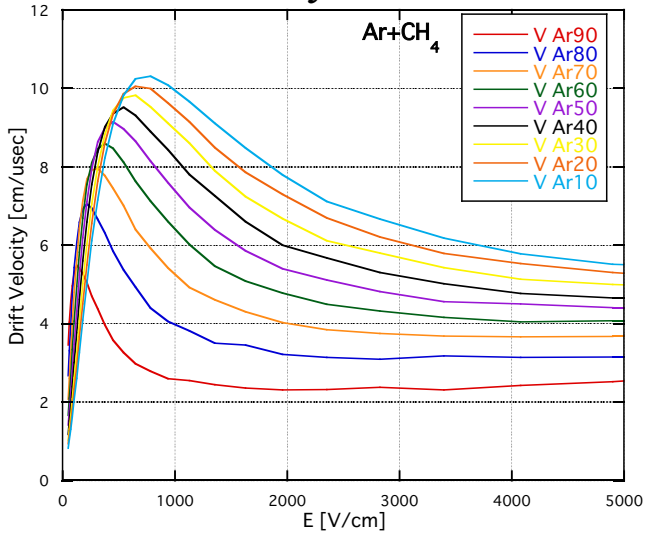
Gas mixture : comparison

- $He+C_2H_6$(50%)
  - + : good position resolution, moderate Lr (638m),
  - - : expensive (400K JPY/run), slow (FWTM~ 370nsec), low-pressure bottle (4.8 Mpa)
  - used: dayone(B, C), Otsu-exp(Be)
- $He+CH_4$(60%)
  - + : long Lr (997m), moderate(good) resolution
    relatively cheap (~200K JPY/run), high-pressure bottle (11.8 Mpa)
    moderate velocity (FWTM~ 250nsec)
  - - : high operating HV
  - used: Sasano-exp (Sn), TM-exp(Se, Zr etc), Kondo-exp (F) : mostly for heavy particles
- $Ar+CH_4$(10%)
  - + : cheap (~70K JPY/run), high-pressure bottle (14.7 Mpa),
    moderate resolution, low operating HV
  - - : short HV plateau (slightly unstable at high gain),
    slow (FWTM~ 320nsec)
    short Lr (119m)
  - used: Kubota-exp (Li, Be), Sakaguchi-exp? (He) : mostly for light particles

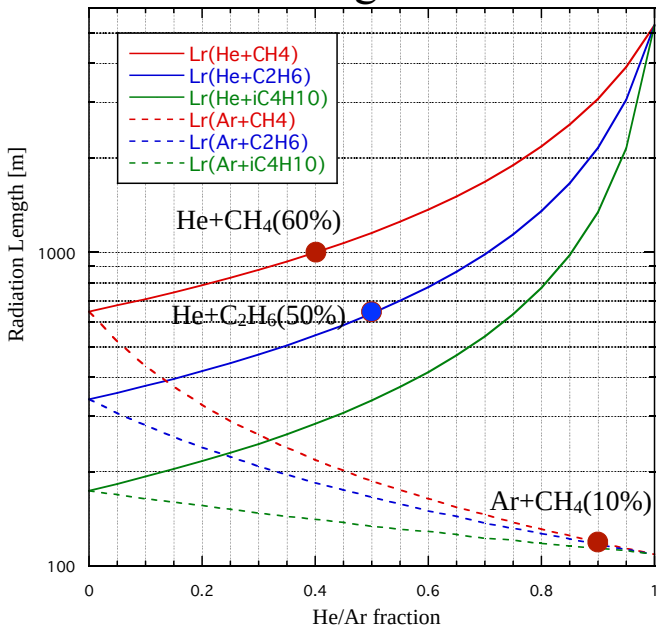
Motivation

- Ar+CH_4 -based gas mixture for FDC2 & PDC, light particles
  - Ar+CH_4 : cheap, high-pressure-mixed gas
  - for light particles (& high A/Z) : large ΔE
  - moderate position resolution : σ < 200 μm
  - long HV plateau : stable operation at high gain (charge)
  - (shorter) Lr : less multiple scattering
  - faster drift velocity : shorter memory time, higher rate
- for larger CH_4 (quencher) fraction
  - drift velocity : faster
  - diffusion : smaller
  - radiation length (Lr) : longer
  - energy loss : smaller
  - more stability
  - ?
    - HV plateau length, stability at higher gain ?
    - position resolution ?
- Conditions for FDC2P bench test
  - Ar + CH_4 mixture using MFC
  - ASD V_{th}= -0.8V
  - TDC (LRS3377) : 1 nsec/bin, 1024nsec range, multi-hit, no trailing-edge info.

Drift velocity

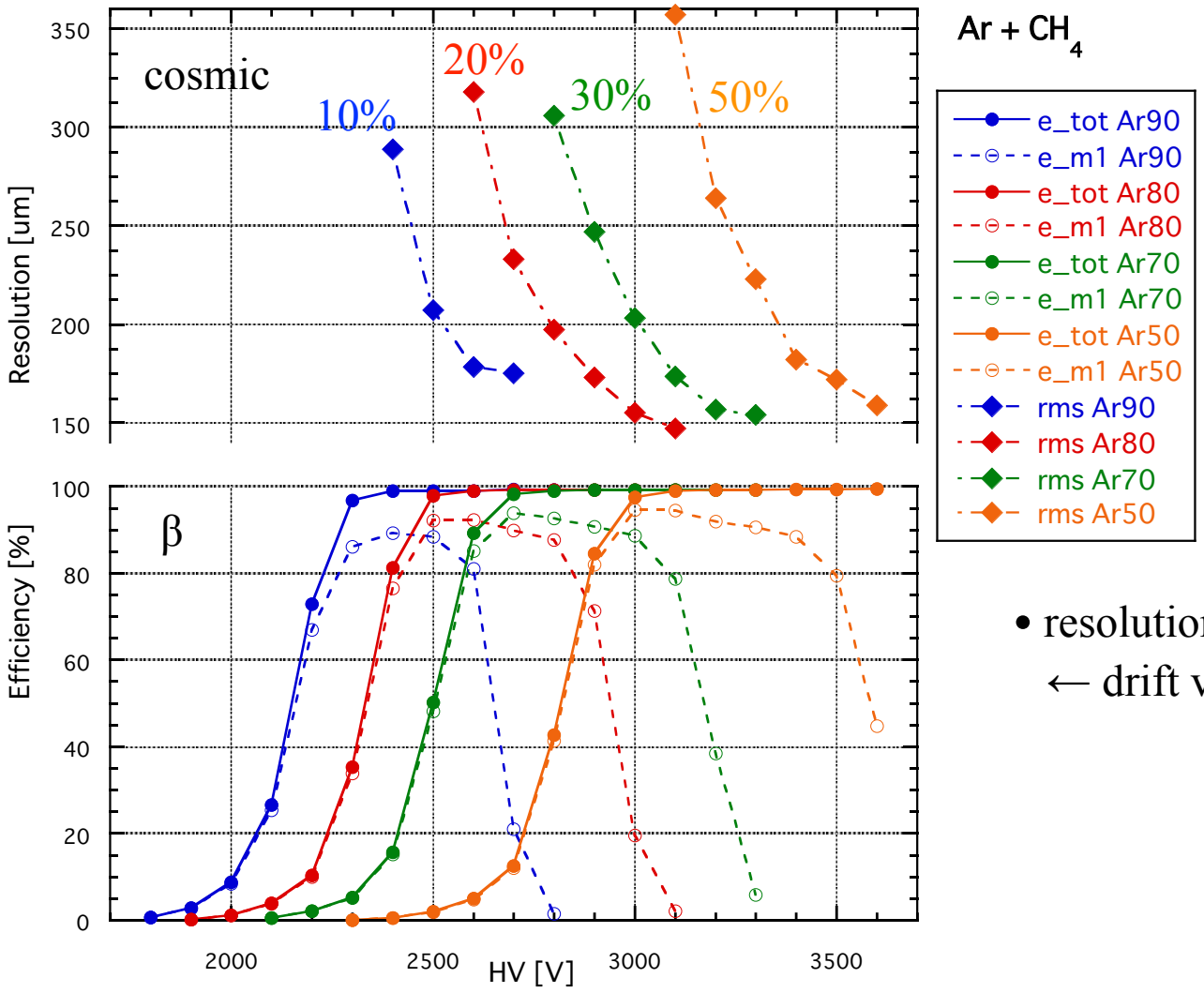


Radiation length



Ar + CH_4 mixture -1

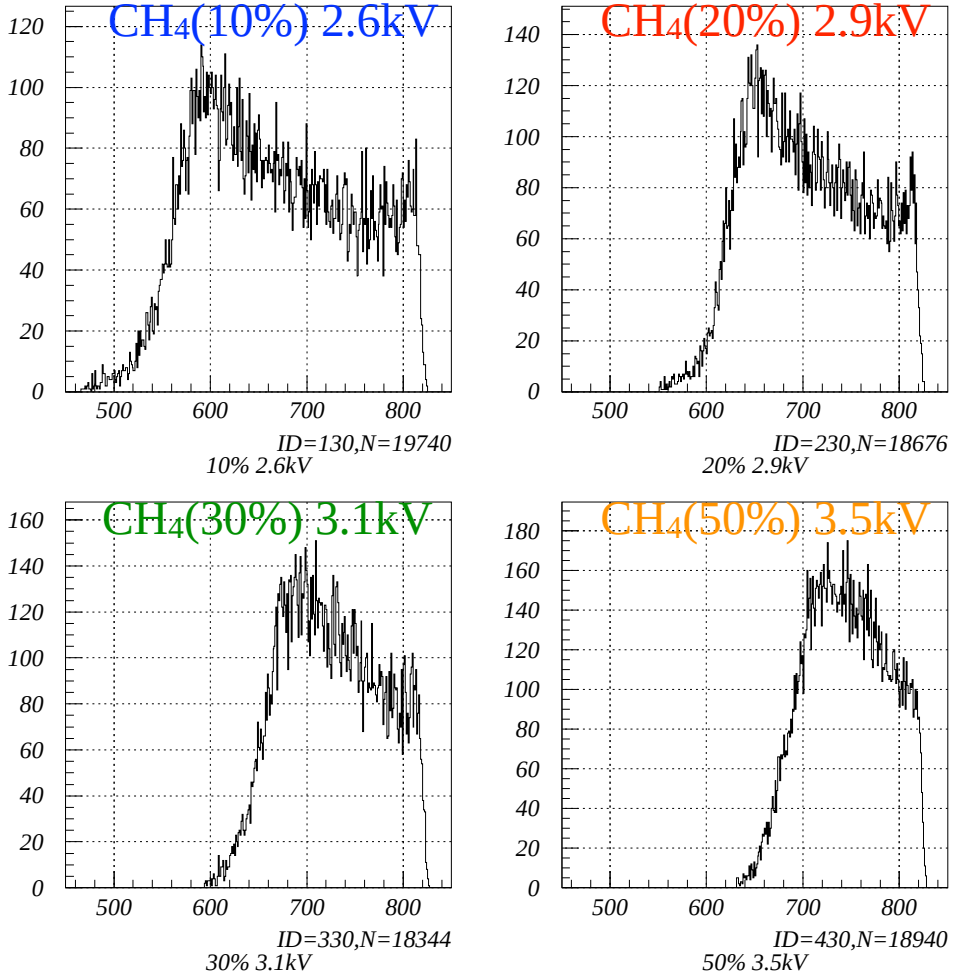
- Efficiency & Resolution



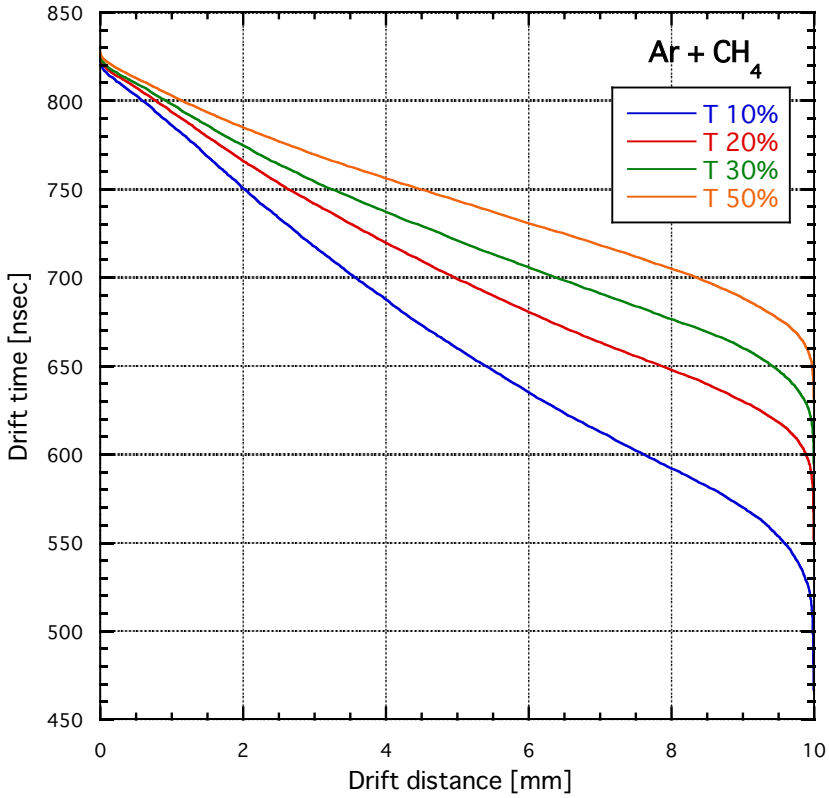
- resolution $\sigma < 200$ μm possible
  ← drift velocity, time resolution, etc

Ar + CH_4 mixture -2 HV @σ~175um

- Drift time



- Drift time - distance



- width: @FWTM

  ~300nsec (10%), ~230nsec (20%)

  ~200nsec (30%), ~170nsec (50%)

memory time : higher for higher CH_4 fraction

Ar + CH_4 mixture -3

- Ar + CH_4 (10% ~ 50%) tested
  - efficiency
    - ΔHV(ε~50%, 100%) ~200V/10%
    - longer HV plateau for higher CH_4 fraction
  - position resolution
    - function of diffusion, drift velocity, time resolution (TDC) etc
    - $\sigma < 200\mu m$ in stable part of HV plateau
  - drift time
    - memory time (max. drift time) : shorter for higher CH_4 fraction
    - FWTM width : 300nsec @10% → 170nsec @50%
    - probably better for higher rate
  - price of pre-mixed gas : Ar+CH_4(50%) 47L bottle. 11.8Mpa ~37K JPY
    - probably cheaper for Ar+CH_4(20%) ?

- Tentative conclusion : Ar+CH_4 for FDC2
  - efficiency, stability, resolution, HV value etc.
    - Ar+CH_4(20~30%) seems to be a reasonable choice (?)
    - plan to take data also at CH_4(15%) & CH_4(25%)
  - other application
    - PDC : also useful for proton detection: stability, longer plateau, higher rate
    - ICB : shorter signal rise time using cheap gas, control energy loss