E17 Status Report

K^--^{3}He 3d→2p x-rays

Ryugo S. Hayano, Tokyo

for J-PARC E17 Collaboration

J-PARC E17 collaboration

H. Bhang[1], M. Cargnelli[2], S. Choi[1], C. Curceanu[3], O. V. Doce[3], S. Enomoto[4], H. Fujioka[5], Y. Fujiwara[6], C. Guaraldo[3], **T. Hashimoto[6]**, **R. S. Hayano[6]**, T. Hiraiwa[5], M. Iio[7], S. Ishimoto[8], T. Ishiwatari[2], K. Itahashi[7], M. Iwasaki[7,9], H.Kou[9], P. Kienle[2,10], J. Marton[2], Y. Matsuda[6], H. Noumi[4], H. Ohnishi[7], S. Okada[3], **H. Outa[7]**, F. Sakuma[7], Y. Sada[5], M. Sato[6], M. Sekimoto[8], H. Shi[6], D. Sirghi[3],F. Sirghi[3], T. Suzuki[6], K. Tanida[1], H. Tatsuno[6], M. Tokuda[9],D. Tomono[7], A. Toyoda[8], K. Tsukada[7], A. R. Vidal[3], E. Widmann[2], B. Wunschek[2], T. Yamazaki[6, 7], J. Zmeskal[2]

SNU[1], SMI[2], LNF[3], RCNP[4], Kyoto Univ.[5], Univ. of Tokyo[6], RIKEN[7], KEK/J-PARC[8], Tokyo Tech[9], Tech. Munich Univ.[10]

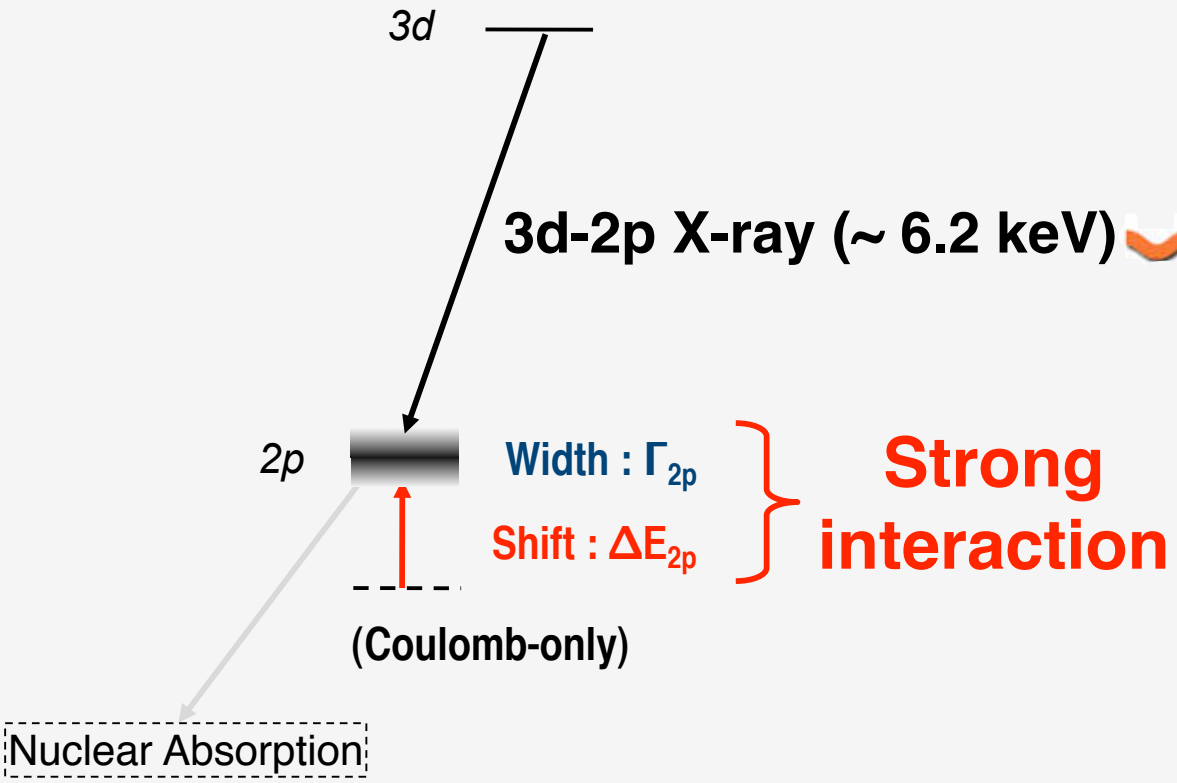
Following the 14th J-PARC PAC decision, we have allocated all the available resources (¥ & manpower) to E15.

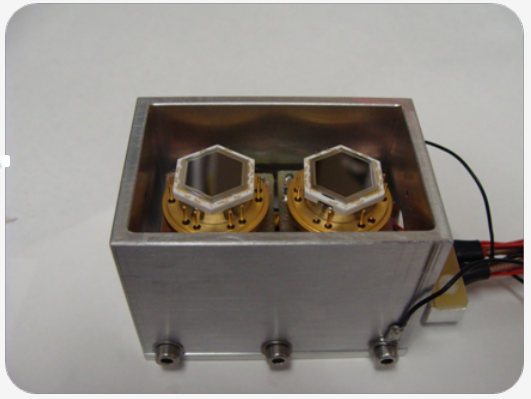
E17 : K^--^{3}He 3d→2p x-rays

related closely to E15 and other experiments studying "deeply-bound kaonic systems"

ΔE_{2p} Precision Goal: ± 2 eV (stat) ± 2 eV (syst)

Proposed in 2006





8 x SDDs
(silicon drift detectors)
~150 eV FWHM

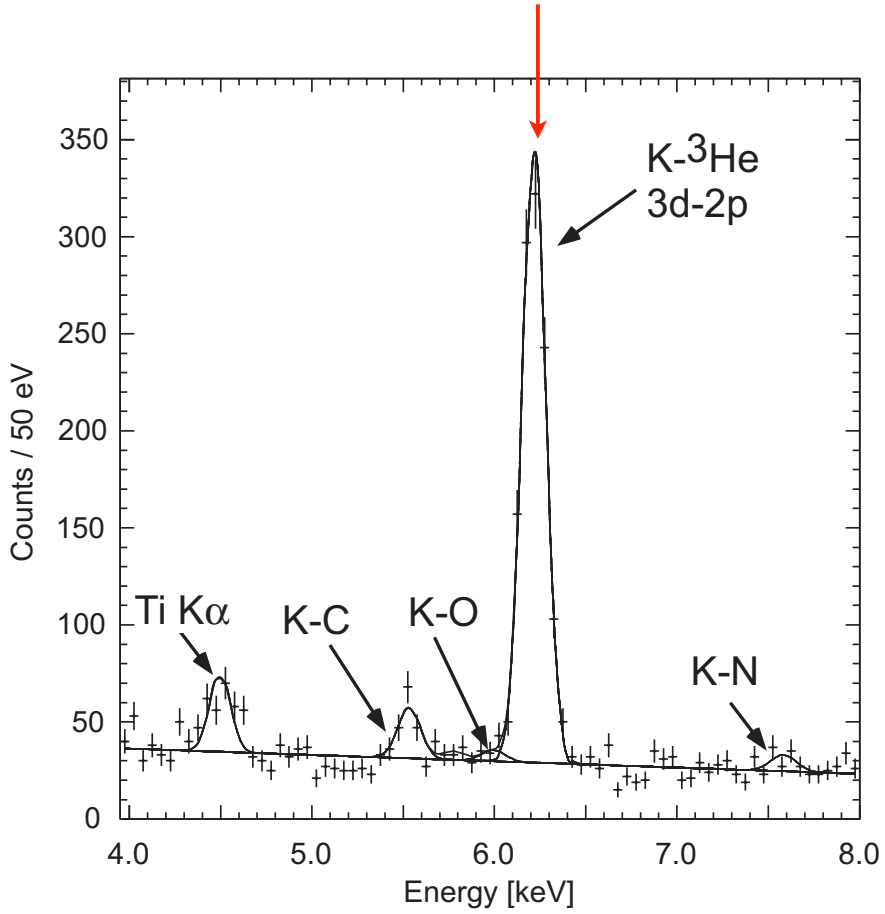
presented at PAC11

1. WHY ISOTOPE SHIFT?

E17 has been ready to run, but meanwhile...

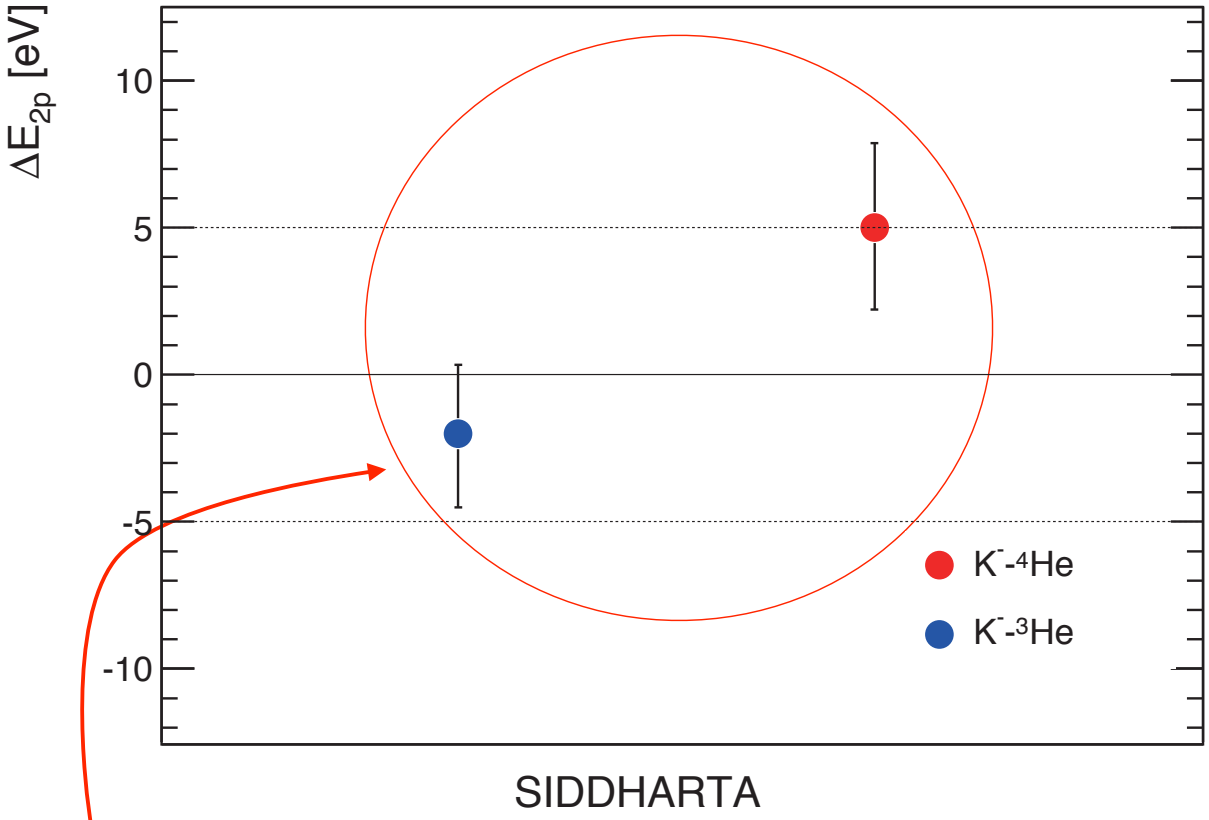
SIDDHARTA (at DAΦNE) published $K^{-3}He$

SIDDHARTA main goals:
$\Phi \rightarrow K^+K^-$, K^-p, K^-d in gas, using 144 SDDs



SIDDHARTA Collaboration, Physics Letters B 697, 199 (2011).

SIDDHARTA $K^{-3}He$ & $K^{-4}He$



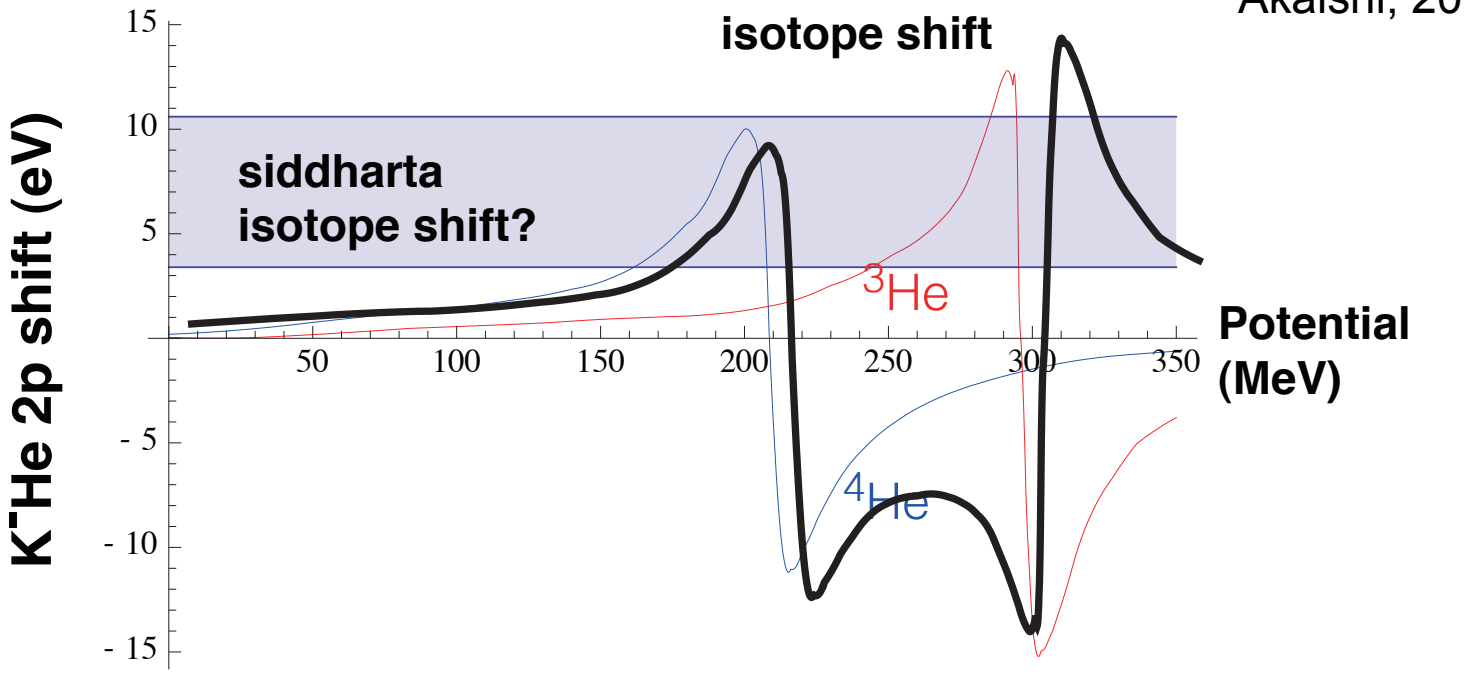
SIDDHARTA	
$K^{-3}He$	-2 ± 2 ± 4
$K^{-4}He$ (new)	5 ± 3 ± 4

All results consistent with small (~0 eV) shift, BUT

is this an indication of "finite isotope shift" of 7 ± 3.6 eV ? (~2 σ)

Isotope shift : theory

Akaishi, 2005



	2p shift (eV)	2p width (eV)
Kaonic ^{4}He	-0.3 – 0.4	1.6 – 2.3
Kaonic ^{3}He	-0.1 – 0.3	1.9 – 2.1
Isotope shift	0.0 – 0.5	

E. Friedman, talk at EXA 2011

Summary of systematic errors (shift)

uncertainties	systematic errors (eV)	
	$\Delta E(^{3,4}He)$	$\Delta E(^3He) - \Delta E(^4He)$
(1) SDD response		
Low energy tail	±0.40	~0
Pileup contamination	<+0.10	±0.10
Compton tail	±0.17	~0
Shelf		
Ener		
(2) Energ		
Linea		
Calibration accuracy	±0.14	±0.2
(3) Background shape	±0.08	±0.12
(4) E. M. value from Kaon mass	±0.2	~0
Quadratic sum of (1)–(4)	±0.72	±0.26

isotope shift measured by E17 to ±1.8 eV can clarify the situation

Systematic error of 3He/4He shift : 0.72 eV (1.0 eV)

isotope shift : 0.26 eV (1.5 eV)

(Statistical error)

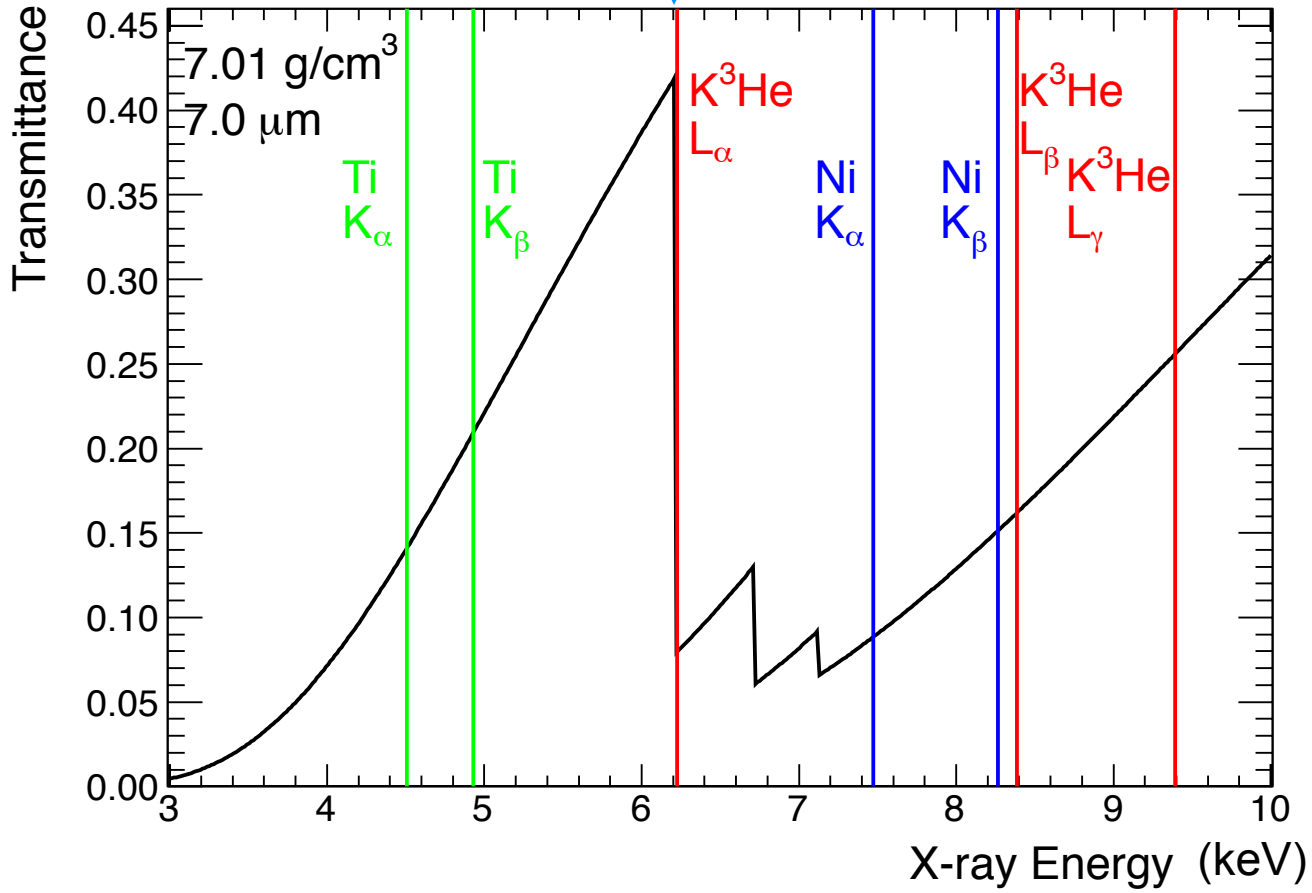
presented at PAC12
a memorandum submitted to PAC14

2. WIDTH in addition to shift

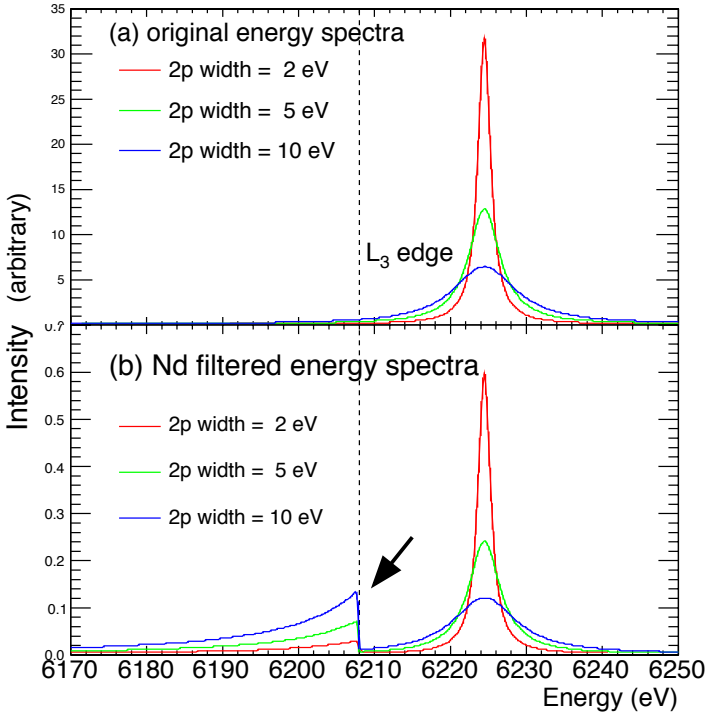
Determining the width by fitting a Voigt to the peak is impossible, unless the width is $\gtrsim$ 20 eV, but we've found a better way

The method: X-ray absorption spectroscopy

L_3 edge of Nd	6209.4 eV
K ^{3}He L_α (EM energy)	6224.6 eV
difference	15.2 eV



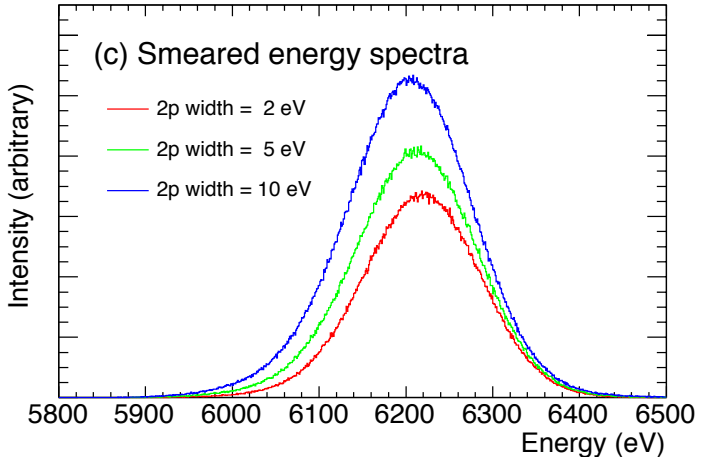
The attenuated L_α counts → width



raw spectra for
width 2, 5, 10 eV

Nd-filtered spectra for
width 2, 5, 10 eV

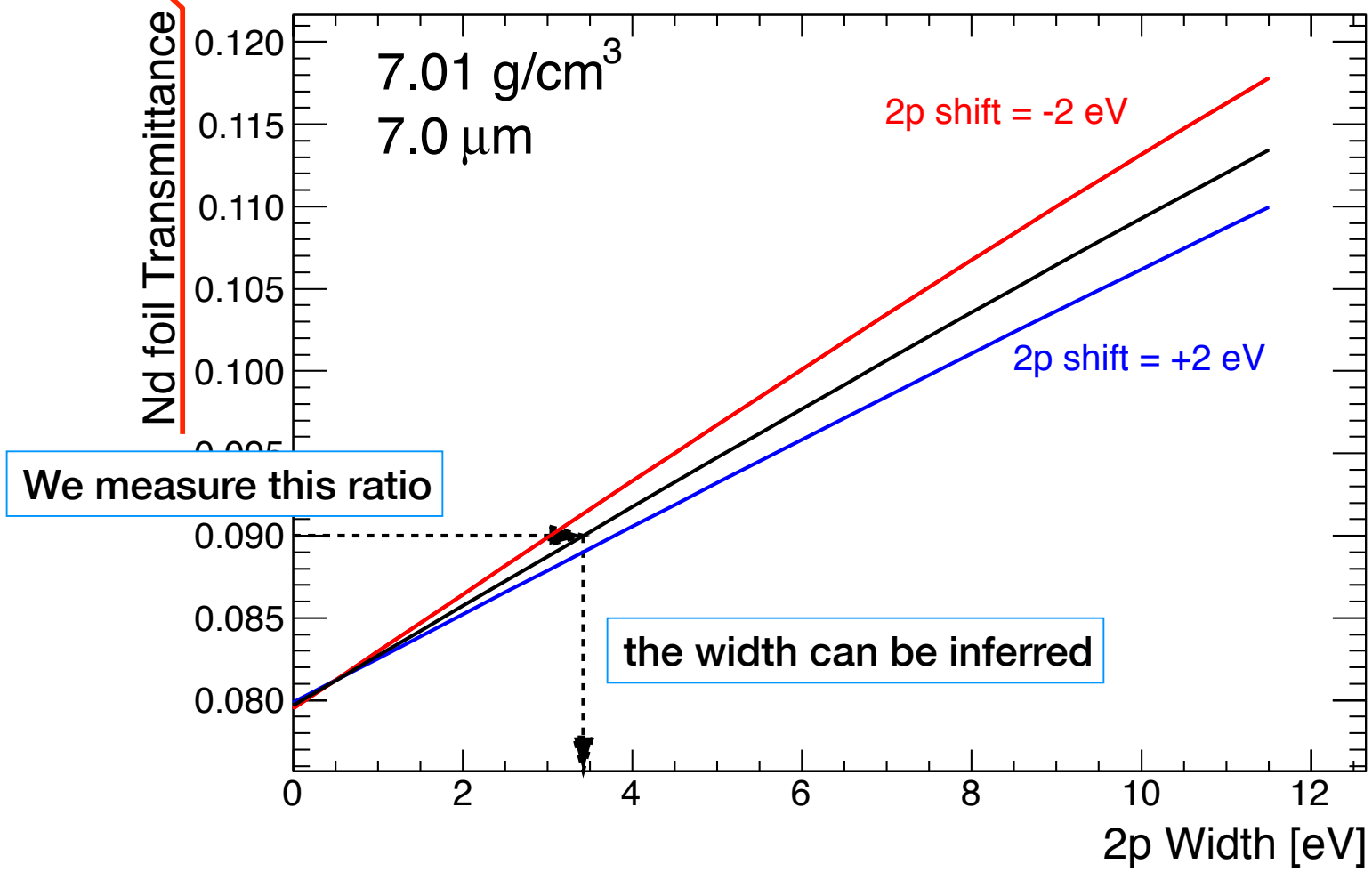
larger width → less attenuation below the Nd L_3 edge



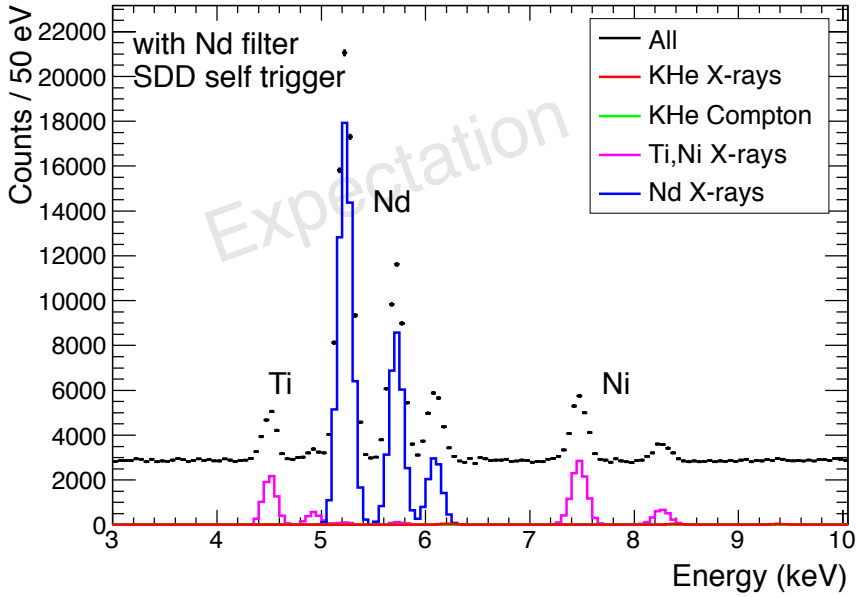
Nd-filtered spectra measured with SDD
width 2, 5, 10 eV

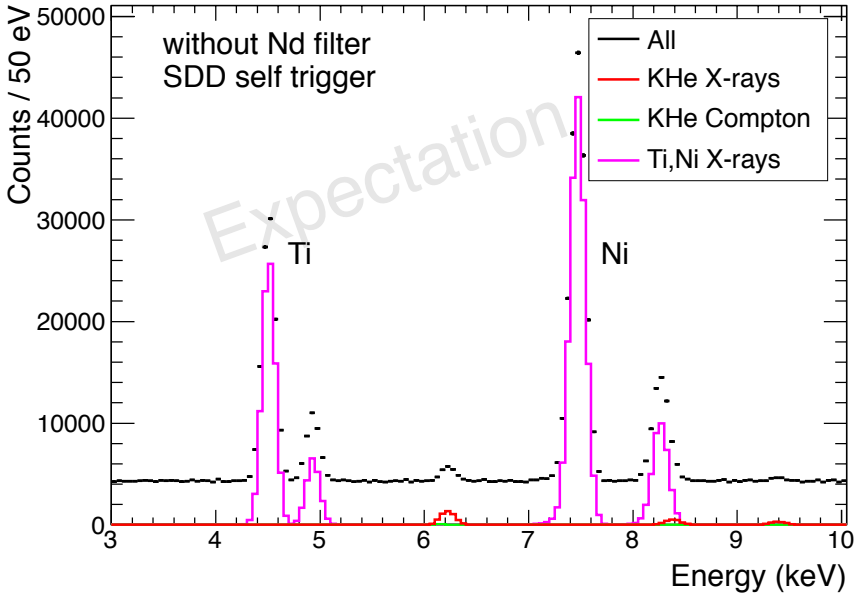
Yield depends on the width

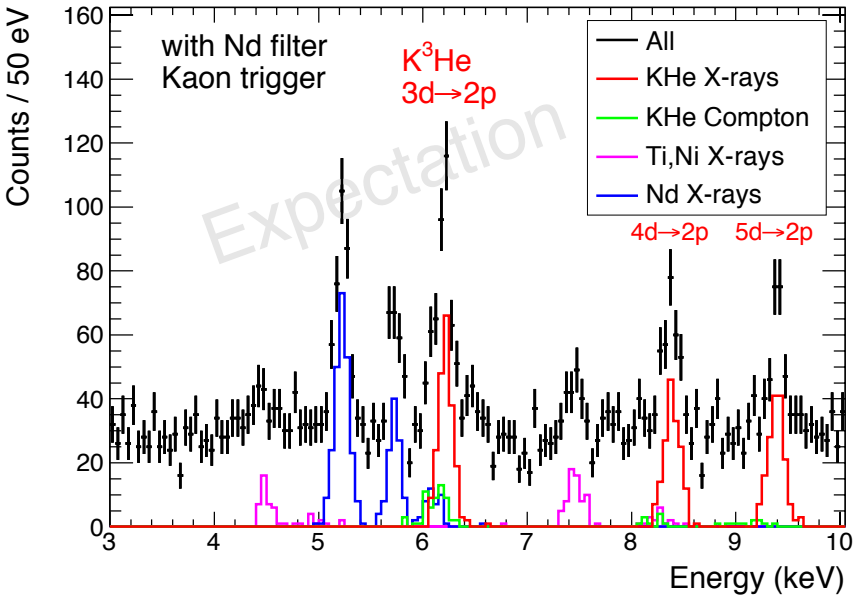
(counts with foil)/(counts without foil)

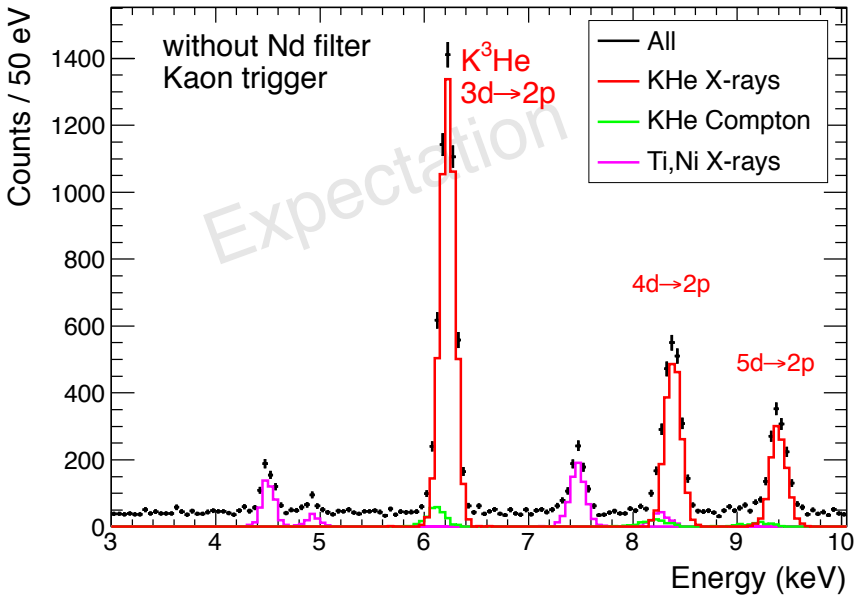


Expected K-^{3}He x-ray spectra w/wo Nd foil

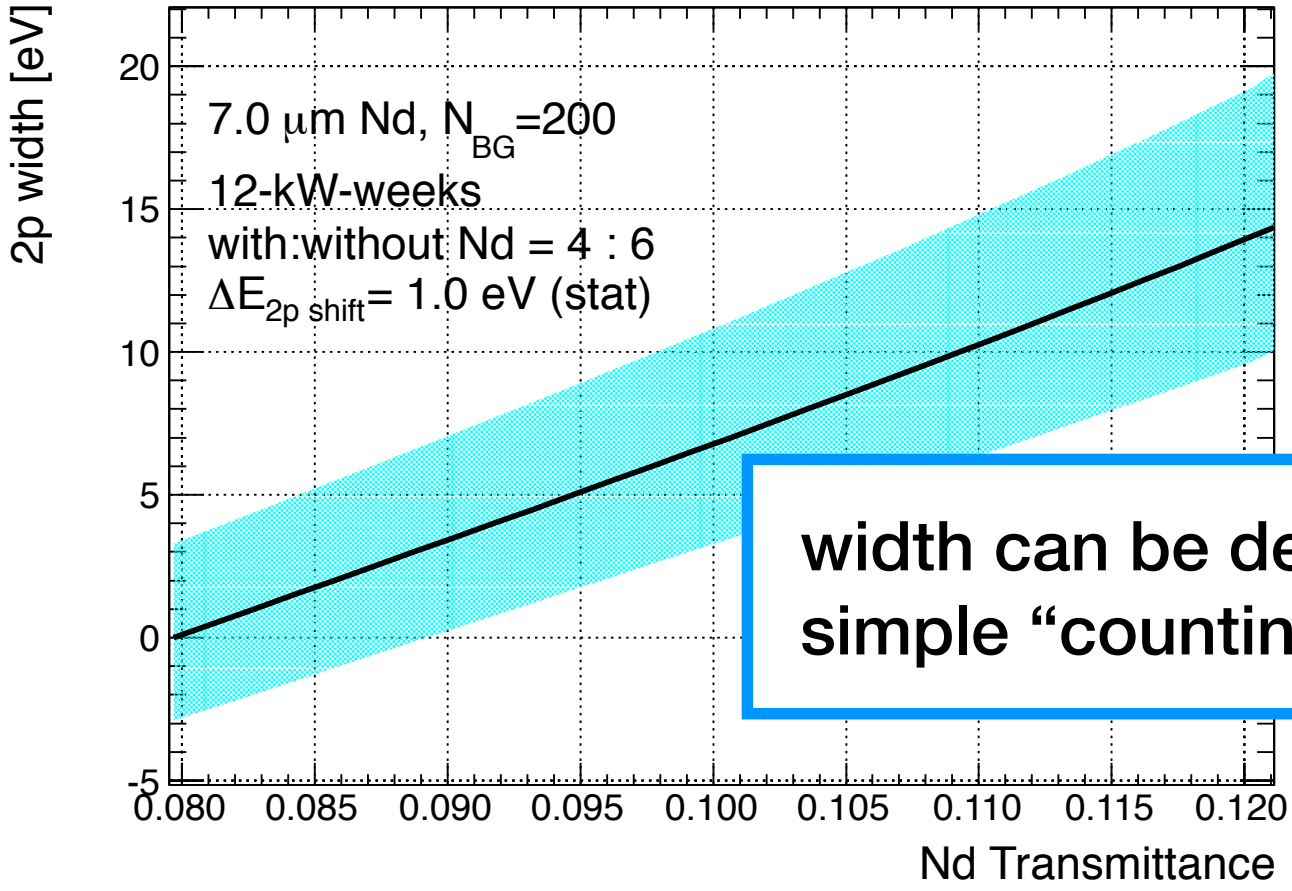








Width can be determined to 3 eV precision



width can be determined by a simple “counting” experiment.

some possible issues

- Stop-K rate re-estimate … in progress
- Nd foil was found to have a short “lifetime”
- Target cell needs to be exchanged & SDDs needs to be installed (E15-17 change-over time ~ 3 mo)
- (optional) SDD operation with magnetic field?

E17 Conclusions

1. E17 is ready to run & can be completed in 20 kW-weeks

insensitive to the spill structure

2. Beamtime request

		beam intensity	duration
	Reproducibility check for 0.9 GeV/c beam	$\sim$ 1 kW	5 days
	Range measurement (K^- stop tune)	$\sim$ 3 kW	3 days
	Full commissioning with ^4He target	$\sim$ 3 kW	3 days
	Production		
①	K^4HeX measurement	10 kW	4 days
②	K^3HeX measurement *without* Nd	10 kW	6 days
③	K^3HeX measurement *with* Nd	10 kW	4 days

c.f. original E17 proposal requested 5 weeks at 27 kW = 135 kW・weeks

2. Expected physics outputs

①&② → kaonic ^{3}He-^{4}He ISOTOPE SHIFT determined to 2 eV

②&③ → kaonic ^{3}He WIDTH measured to 3 eV

(independent of the resolution function of the SDD x-ray detector)