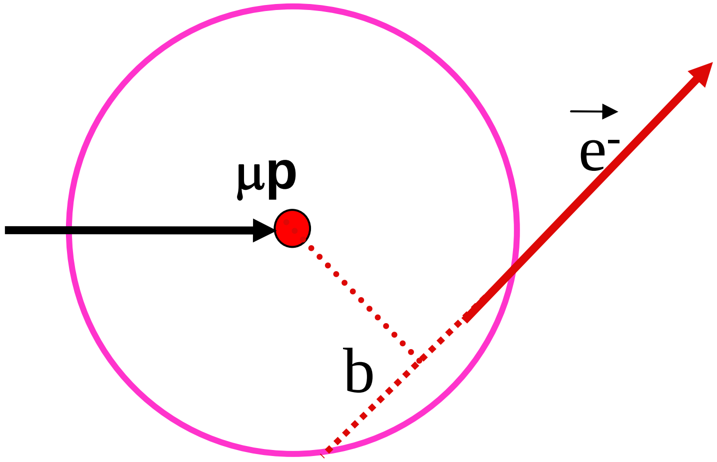
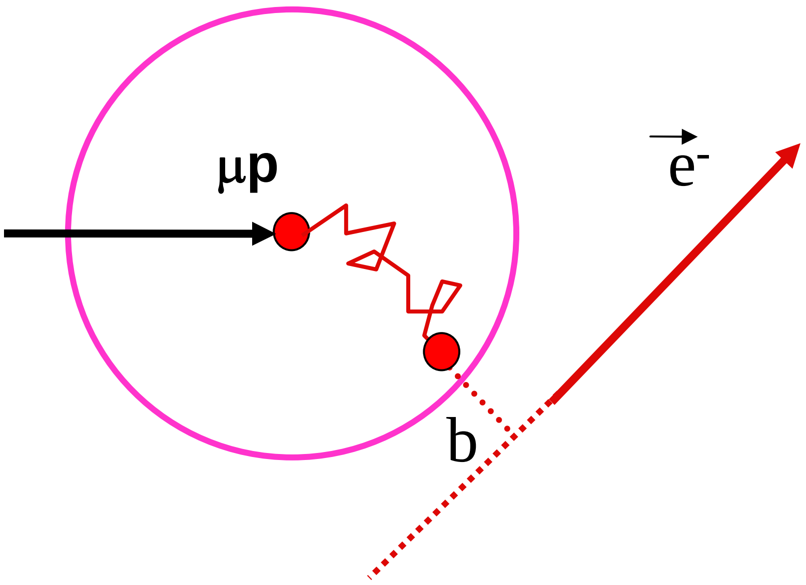
Diffusion: Overview

- Theory and simulation
- Correction procedure a'la Steve
- Run8 fits
- AMS measurements at ETH
- Result evaluation
- ToDo

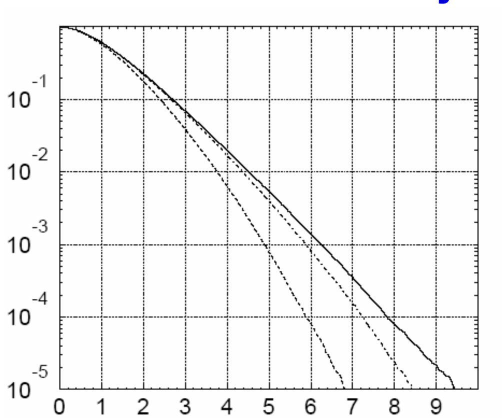




Theory and simulation

- Cross sections see [hfs transition]
- pμ+p

Andrzej



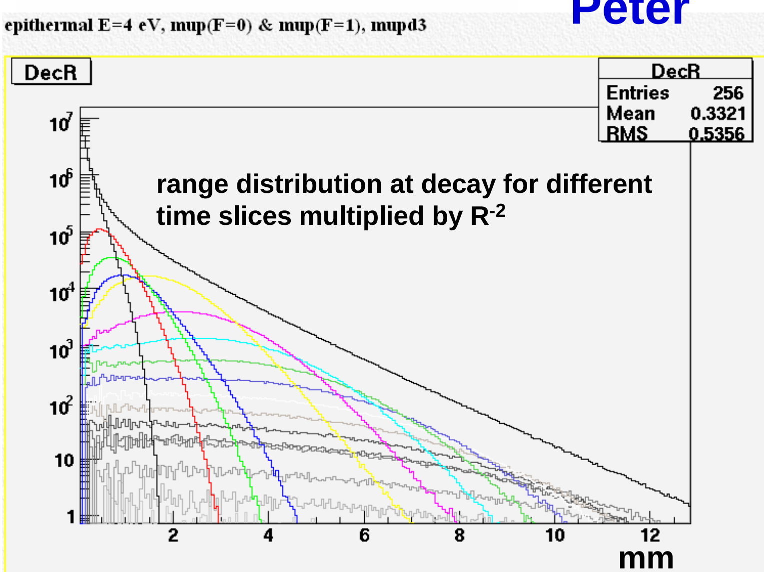
Steve

The two-dimensional distribution function with phase-space included is

$$F_{\mu p}(R_d) = \frac{R_d}{\sigma_t^2} e^{-\frac{R_d^2}{2\sigma_t^2}}$$

with $\sigma_t = k\sqrt{t}$. k is something like 0.7 mm$/\sqrt{\mu s}$ for μp under MuCap conditions;

Peter



t1	t2
0.00	0.20
0.20	0.40
0.40	0.60
0.60	0.80
0.80	1.00
1.00	2.00
2.00	3.00
3.00	4.00
4.00	5.00
5.00	6.00
6.00	7.00
7.00	8.00
8.00	9.00
9.00	10.00
10.00	12.00
12.00	14.00
14.00	16.00
0.00	**16.00**

check and compare with MC, include initial non thermalized behaviour

Theory and simulation

- **transfer: pμ + d → dμ + p (134 eV)**

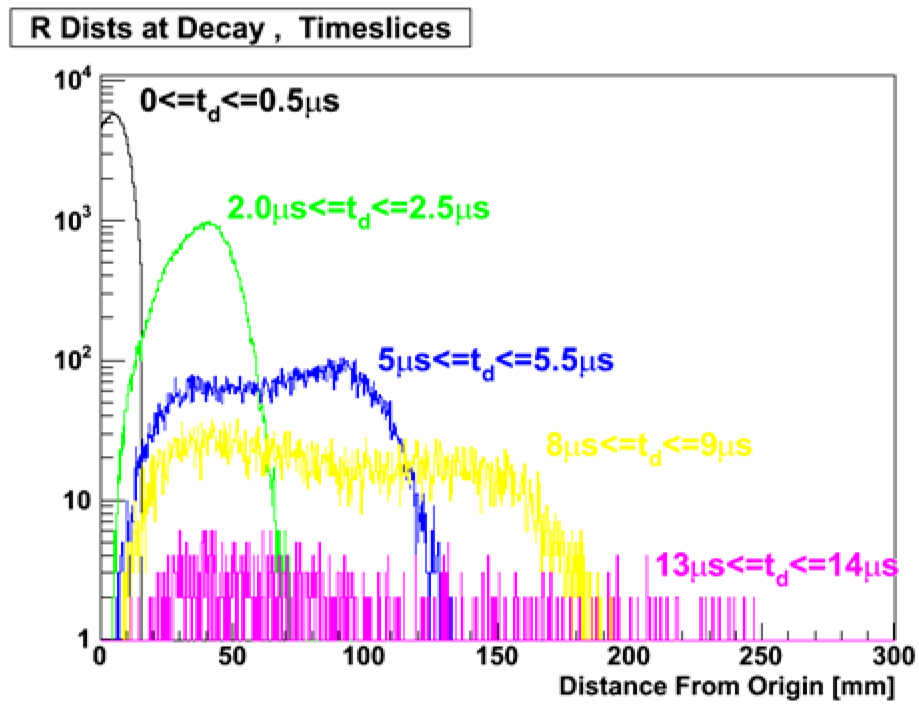
$\Lambda_d = \phi\, c_d\, \lambda_d = 150/s \, {}^* c_D(ppm)$

i.e. 3x precision goal at 0.1 ppm

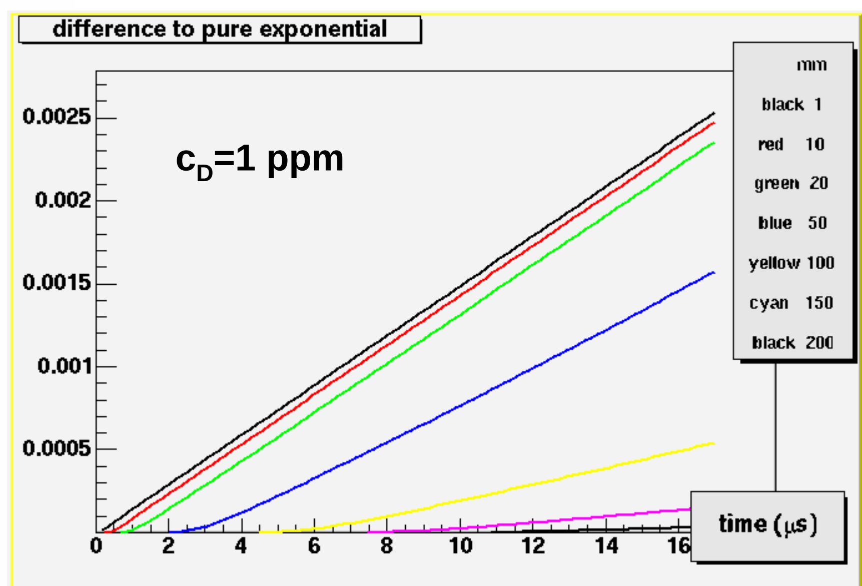
Geometry study not finished.
Where do dμ stop?

- **dμ+p**

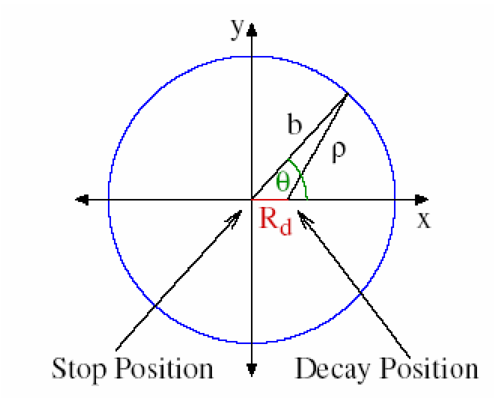
Radial distributions for μd starting at t=0



deviation from pure exp as funct of impact par cut



Correction procedure a'la Steve



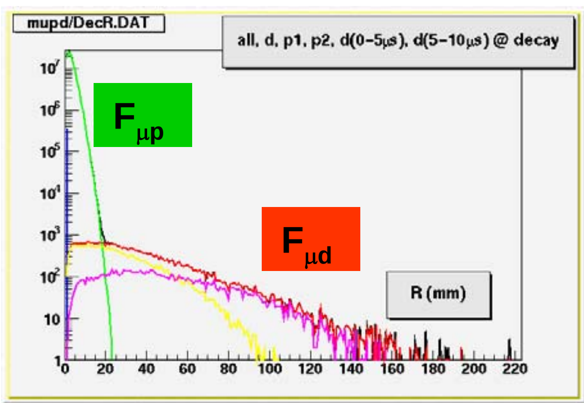
$$\epsilon_{bcut}(R_d) = \int_0^{b_{cut}} db \int_0^{2\pi} b\, d\theta \frac{F_b(\rho)}{2\pi\rho}$$

where ρ is found from the cosine law to be

$$\rho = \sqrt{R_d^2 + b^2 - 2R_d b\cos\theta}$$

$$\epsilon(b_{cut}) = \int_0^{\infty} dR_d\, \epsilon_{bcut}(R_d) F_{\mu p}(R_d).$$

$F_{\mu p}(R_d)$

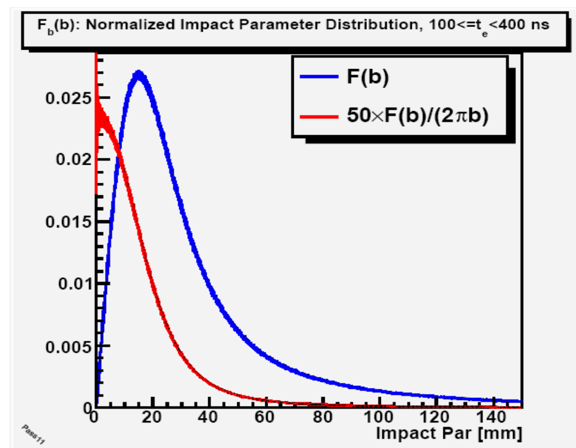


we can trust this (PK) simulation only qualitatively

• dμ effect from zero extrapolation,
assumption $F_{\mu d}(Rd)$ independent of cd<120 ppm

• pμ effect dominated by $F_{\mu p}(b)$ smaller $F_{\mu p}(R_d)$ dependence

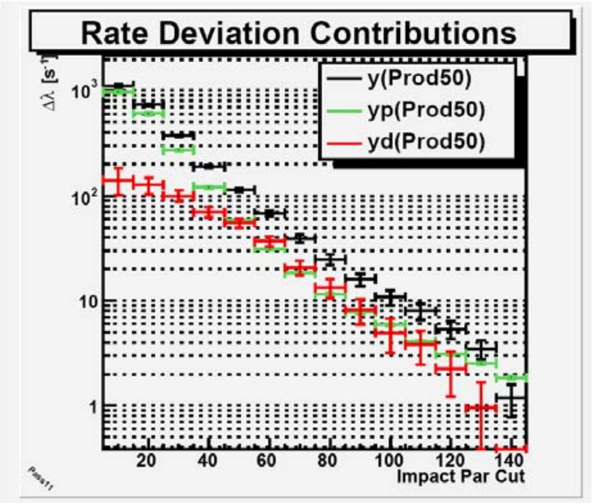
$F_b(b)$



averaged $F_{\mu p}(b)$ accurately from data
corrections to averaged distribution
diffusion model dependence

Correction procedure a'la Steve

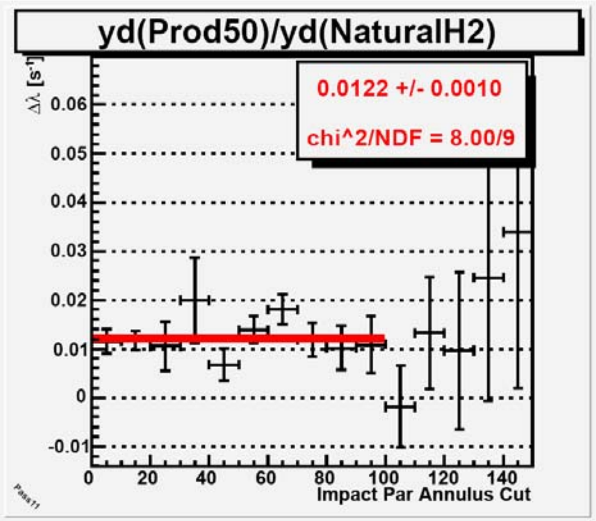
1. Adjust μp diffusion model (one parameter) to fix c_d independent $\lambda(b_{cut})$ part consistently for 3 c_d conc.



2. Determine remaining c_d proportional part of $\lambda(b_{cut})$

3. Extract $c = c_d(\text{Prod50}) / c_d(x)$ from ratio

$$\frac{\Delta\lambda(\text{Prod50}) - \Delta\lambda_{p\mu}}{\Delta\lambda(x) - \Delta\lambda_{p\mu}}$$

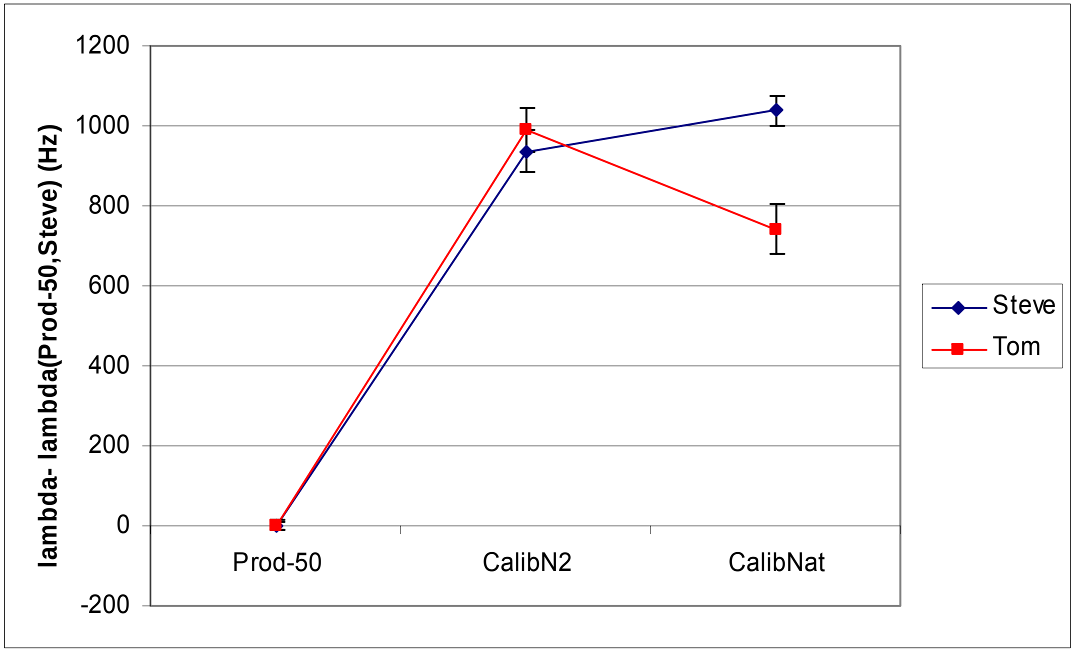


where x = NatH2 or CalibD2

Run8 fits

same cuts, statistics ?

Fill	Steve			Tom		
	Y^{EVH} (ppm)	λ (s^{-1})	σ_λ (s^{-1})	Y^{EVH} (ppm)	λ (s^{-1})	σ_λ (s^{-1})
Prod-50	10.7 ± 0.1	455,434.0	12.1	12.9 ± 0.1	455,436.3	12.3
CalibN2	728.9 ± 2.8	456,370.4	53.0	774.9 ± 2.4	456,425.2	55.4
CalibNat	67.5 ± 0.6	456,471.7	35.5	48.6 ± 0.7	456,175.9	61.8



?

Run8 fits

Steve

Data Set	N	λ [s^{-1}]	B	B/N	χ^2/DOF
Prod50	1.632×10^9	455434.0 ± 12.1	2191.4 ± 5.7	1.343×10^{-6}	0.97 ± 0.06
CalibN2	8.548×10^7	456370.4 ± 53.0	116.9 ± 1.3	1.367×10^{-6}	0.95 ± 0.06
NaturalH2	1.905×10^8	456471.7 ± 35.5	279.7 ± 2.0	1.468×10^{-6}	1.41 ± 0.06
CalibD2	2.155×10^8	455717.0 ± 33.4	309.2 ± 2.1	1.435×10^{-6}	1.03 ± 0.06

Tom

Fill	ePC table	λ (s^{-1})	σ_λ (s^{-1})	χ^2/d
Prod-50	cathode-AND	455,428.06	12.86	0.964
	cathode-OR	455,436.29	12.33	0.998
CalibNat	cathode-AND	456,193.79	64.47	1.099
	cathode-OR	456,180.37	61.80	1.111

CalibD2 results?

same statistics and cuts
start time scan
not simple exp. effects

AMS results from ETH

Claude

Fill	c_d (ppm)	Method of determination
Prod-50	1.44 ± 0.13	External measurements
CalibD2	17.75 ± 0.25	Claude calculation
CalibNat	126.9 ± 1.9	External measurements

ETH different bottle than run8
121 ± 6

Results

my evaluation of S&T results

Prod-50	Steve		Tom		CalibNat	Steve		Tom	
	λ	err	λ	err		λ	err	λ	err
	455434.0	12.1	**455436.3**	12.3		456471.7	35.3	456175.0	61.8
Z>1	**-13.9**		**-18.7**	1.6		-88.0		-72.7	6.2
corr Z	**455420.1**		**455417.6**			456383.7		456102.3	
λ(nat)–λ(prod)	963.6		684.7						
C Steve	82.0	**?**							
δλ μd	**-11.9**	**?**	**-8.5**						
C AMS	83.3	0.9							
δλ μd	-11.7	1.2	-8.3						
δλ μp	**-2.7**	0.08?							
corr D/P	**455405.5**		**455406.4**						

C: model errors
other errors?

$$\delta\lambda = \frac{-\tilde{c}^{-1}}{1-\tilde{c}^{-1}}(\lambda_{calib} - \lambda_{Prod}),$$

Tom: stat. consistency ?

	λ	λ	λ		Δ
	prod50	**NatH2**	**NatH2-prod50**		**prod50**
120	455434	456472	1038	→	12.6
no	455420	456159	739	→	9.0
diff	14	313		→	3.8

Condition	Steve			Tom		
	$\Delta\lambda$ (s^{-1})	λ (s^{-1})	σ_λ (s^{-1})	$\Delta\lambda$ (s^{-1})	λ (s^{-1})	σ_λ (s^{-1})
eSC-only		455,425.1	12.6		455,433.9	12.9
cathode-OR	−5.3	455,419.8	12.2	−8.2	455,425.7	12.4
cathode-AND	−4.2	455,415.6	12.6	−8.6	455,417.1	13.0
cathode-OR		455,419.8	12.2		455,425.7	12.4
cathode-OR, 120 mm impact cut	+14.2	455,434.0	12.1	+10.6	455,436.3	12.3
... remove scatters	−1.1	455,432.9	12.1	−4.5	455,431.8	12.3
... high-Z correction	−13.9	455,419.0	12.1	−18.7	455,413.1	12.4
... deuterium correction	−12.1	455,406.9	12.2	−8.6	455,404.5	12.5
... μp diffusion correction	−2.7	455,404.2	12.2	−2.8	455,401.7	12.5

S&T results

Todo

- Solve CalibNat λ disagreement. Tom full statistics of CalibD2 and CalibNat. T&S differences.
- Reconsider effect of non exponential contributions. PK&B
- pμ model studies to check sensitivity and consistency of Steve's pμ diffusion results. PK, Adamzcak?
- MC challenge to Steve, to check his sophisticated formalism
  - Probably only fast MC realistic (needs discussion) PW
- consistency no/120mm impact cut, D&F
- Diffusion geometry MC (later?) who?