

# $\tau \rightarrow \mu$ LS decay Search

Bruce Baller

6/16/04

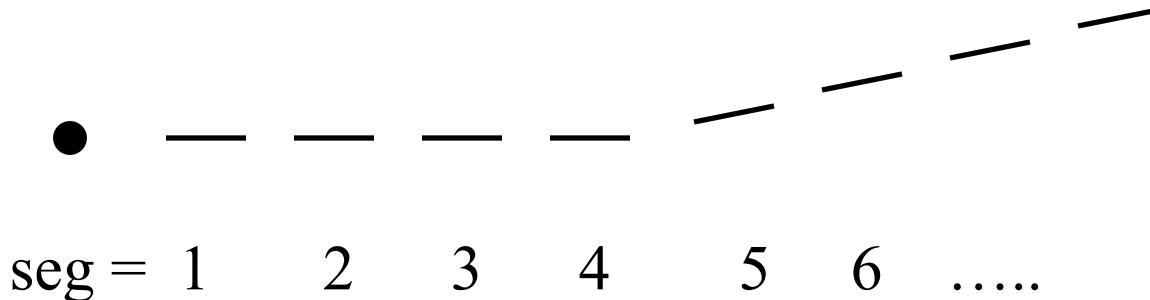
# LS Decay

- LS decay search has not been done in U.S. for Phase 2
- A Monte Carlo study has not been done
  - US MC doesn't simulate track breaking in ecvtxa
- Expectations
  - Higher momentum than LL, S for the same pt
  - Longer flight than LL, S
  - Yield unknown  $LS/(LS+LL+S) \sim 10\%?$
- LS decay search requires good quality emulsion tracks

# Event selection

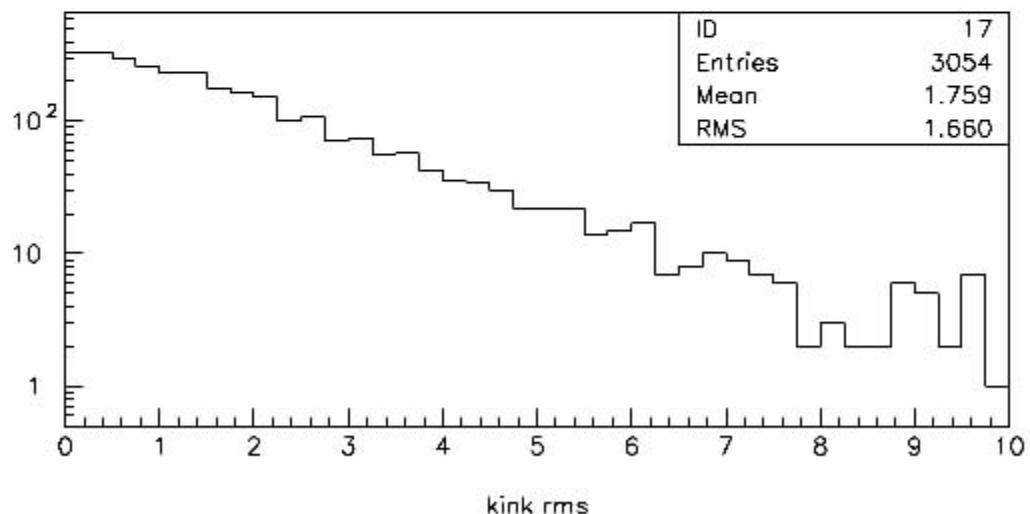
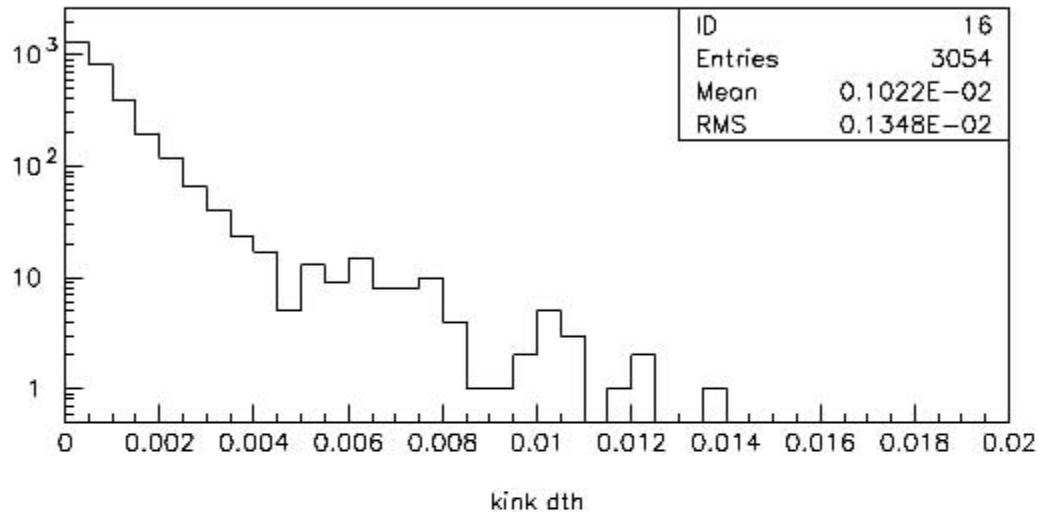
- Select CCmu events
  - 187 events classified by ANN (using MID prop + scint)
  - 159 events have  $>3$  prop tube MID hits
  - 154 events have muon tracks leaving the scan volume
    - Use follow-down scan volume if it exists
  - 5 events have “stopping” muon tracks
    - 3 muons stop at a “bad plate” (resolution  $> 1$  micron)
    - 1 muon stops at a ECC/bulk boundary
    - 1 spectrometer muon doesn’t match emulsion

# Search Algorithm



- For each segment  $n = 3$  to  $n_{\text{seg}} - 2$ 
  - Fit Upstream (US) section (1 to  $n-1$ ) :  $\theta_{\text{u,v}}$  and errors
  - Fit Downstream (DS) section ( $n$  to  $n+3$ ) :  $\theta_{\text{u,v}}$  and errors
  - Require  $\delta\theta_{\text{u}}/\sigma\theta_{\text{u}} > 3$  or  $\delta\theta_{\text{v}}/\sigma\theta_{\text{v}} > 3$  and  $p_{\text{t}} > 0.1 \text{ GeV}$
  - Require good track  $\chi^2 < 5$  (US and DS)
- Monitor  $\delta\theta_{\text{u}}$ ,  $\delta\theta_{\text{v}}$ , plate resolution,  $\chi^2$  for each fit
  - Refit US section with ( $n-2$  to  $n-1$ ) if  $\chi^2 > 5$

- Select good quality FD m-files
  - Resolution  $< 1 \mu\text{m}$
- Histogram  $\delta\theta_u, \delta\theta_v$ 
  - 1 mrad average
  - Didn't check for ECC/bulk boundaries...
- Histogram  $\delta\theta_u/\sigma\theta_u, \delta\theta_v/\sigma\theta_v$



# A Candidate

## (Using decay m-file)

2932\_15521

LSDECAY: Search trk 1 1911003763 mom= 42.2 Trk/Vtx chi= 16.4										
seg/plt	Usl	Vsl	dusl	dvsl	rmsu	rmsv	uschi	dschi	pt	flt
3 181	-30.7	-28.7	-1.6	-0.6	-1.4	-0.5	0.0	0.7	0.07	2.1
4 182	-30.5	-28.7	-0.2	0.5	-0.7	1.6	1.1	2.2	0.02	2.4
5 171	-29.9	-28.7	0.3	0.3	0.8	1.0	0.8	1.6	0.02	3.4
6 172	-30.4	-28.6	0.0	0.3	0.1	1.1	1.0	1.4	0.01	3.7
7 161	-30.7	-28.8	-0.4	0.0	-1.1	0.1	1.3	1.6	0.02	4.8
8 162	-30.1	-29.0	0.2	-0.2	0.5	-0.6	1.1	2.1	0.01	5.1
9 151	-31.0	-29.7	-0.7	-1.0	-1.7	-2.7	1.3	3.5	0.05	6.1
10 152	-31.6	-29.8	-1.2	-1.0	-2.8	-2.4	1.2	1.7	0.07	6.4
11 141	-32.6	-31.0	-2.3	-2.3	-6.5	-6.7	1.2	3.4	0.14	7.5
12 142	-33.2	-31.4	-2.9	-2.6	-7.2	-6.6	1.9	0.9	0.17	7.8
13 131	-33.3	-31.6	-2.9	-2.8	-10.7	-10.4	1.8	1.1	0.17	8.8
14 132	-33.6	-31.9	-1.0	-0.9	-2.2	-2.2	3.4	0.8	0.06	9.1 RF

Refit US track



E872 Run= 2932 Event= 15521 Wght= 1.0

	trk	nhtnseg	gnomvtx
1	-191100376335	20	-42.21
2	-19110039300	6	1
3	-19110039610	12	1
4	-191100396922	20	1

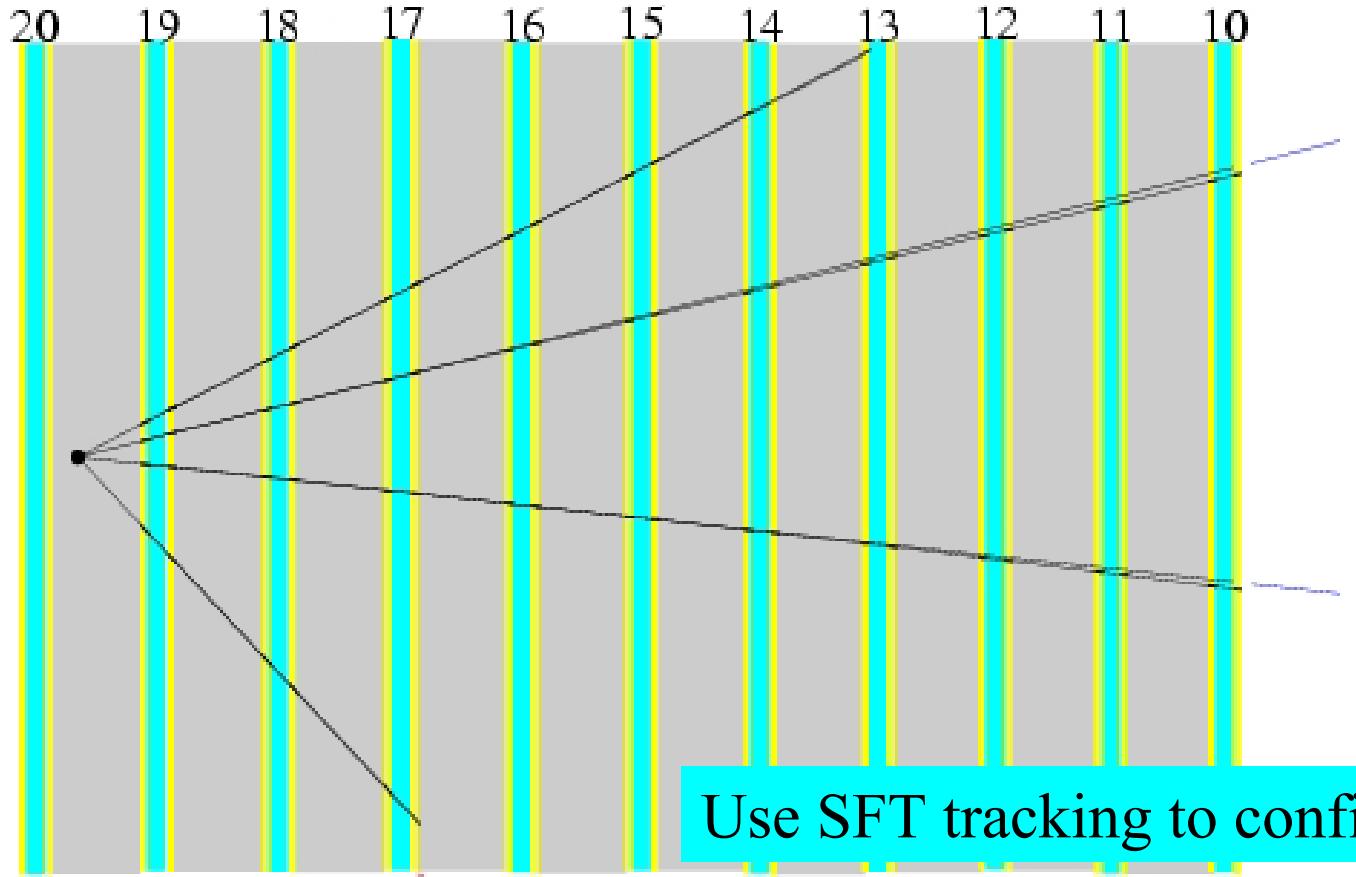
8

US fit (1<sup>st</sup> 3 segs)

5

# U View

trk	nhtnseg	nomvtx
1-191100376335	20	-42.21
2-19110039300	6	1
3-19110039610	12	1
4-191100396922	20	1



Use SFT tracking to confirm?

E872 Run= 2932 Event= 15521 Wght= 1.0

U View

-1200.0

-1200

-1200.0

-1200

-1200.0

-1200

3.5

3

4

1

US fit (1<sup>st</sup> 3 segs)  
in black

DS fit (last 3 segs)  
in red

*Good match to DS fit*

E872 Run= 2932 Event= 15521 Wght= 1.0

V View

-1200.0

-1200

-1200.0

-1200

3.5

T3-T1

T3-T2

T2-T1

4

3

2

1

*Better match to US fit*

# Check for kink in Follow-Down m-file

seg/plt	Usl	Vsl	dusl	dvsl	rmsu	rmsv	uschi	dschi	pt	flt	
3 181	-30.6	-29.1	-1.7	-0.5	-0.8	-0.2	0.0	0.3	0.07	2.1	
4 182	-30.3	-29.0	-0.4	0.5	-0.8	0.9	0.3	1.1	0.03	2.4	
5 171	-30.0	-29.0	-0.1	0.3	-0.2	0.7	0.2	0.9	0.01	3.4	
6 172	-30.5	-28.8	-0.4	0.4	-1.1	1.0	0.5	0.8	0.02	3.7	
7 161	-30.1	-28.7	-0.1	0.5	-0.2	1.0	0.6	0.8	0.02	4.8	
8 162	-29.9	-29.0	0.2	0.1	0.4	0.3	0.5	0.0	0.01	5.1	
9 151	-30.1	-28.9	0.0	0.1	0.1	0.2	0.7	0.0	0.00	6.2	
10 152	-30.4	-28.8	-0.2	0.1	-0.4	0.5	0.7	0.1	0.01	6.5	
11 141	-30.4	-29.0	-0.3	-0.1	-0.8	-0.2	0.6	0.2	0.01	7.5	
12 142	-30.4	-28.8	-0.2	0.1	-0.5	0.5	0.6	0.6	0.01	7.8	
13 131	-30.2	-29.0	0.0	-0.1	-0.1	-0.3	0.6	0.8	0.01	8.9	
14 132	-30.5	-29.3	-0.3	-0.4	-0.8	-1.2	0.5	0.4	0.02	9.2	
15 121	-31.2	-28.7	-1.0	0.2	-2.8	0.5	0.6	0.1	0.04	10.3	
16 122	-31.1	-28.7	-0.9	0.2	-2.6	0.4	0.6	0.0	0.04	10.6	
17 111	-30.8	-29.0	-0.6	-0.1	-1.9	-0.4	0.6	0.0	0.03	11.6	
18 112	-31.1	-29.7	-0.8	-0.8	-2.3	-2.7	1.0	2.7	0.05	11.9	
19 101	-32.7	-30.7	-2.4	-1.8	-6.6	-4.7	1.3	1.1	0.13	13.0	UV-Kink
20 102	-32.7	-30.1	-2.4	-1.2	-6.2	-3.5	1.7	0.1	0.11	13.3	UV-Kink
21 91	-31.8	-30.6	-1.4	-1.7	-3.7	-4.4	2.6	0.4	0.09	14.3	
22 92	-31.8	-30.7	0.9	-0.1	1.6	-0.1	1.1	0.2	0.04	14.6	RF

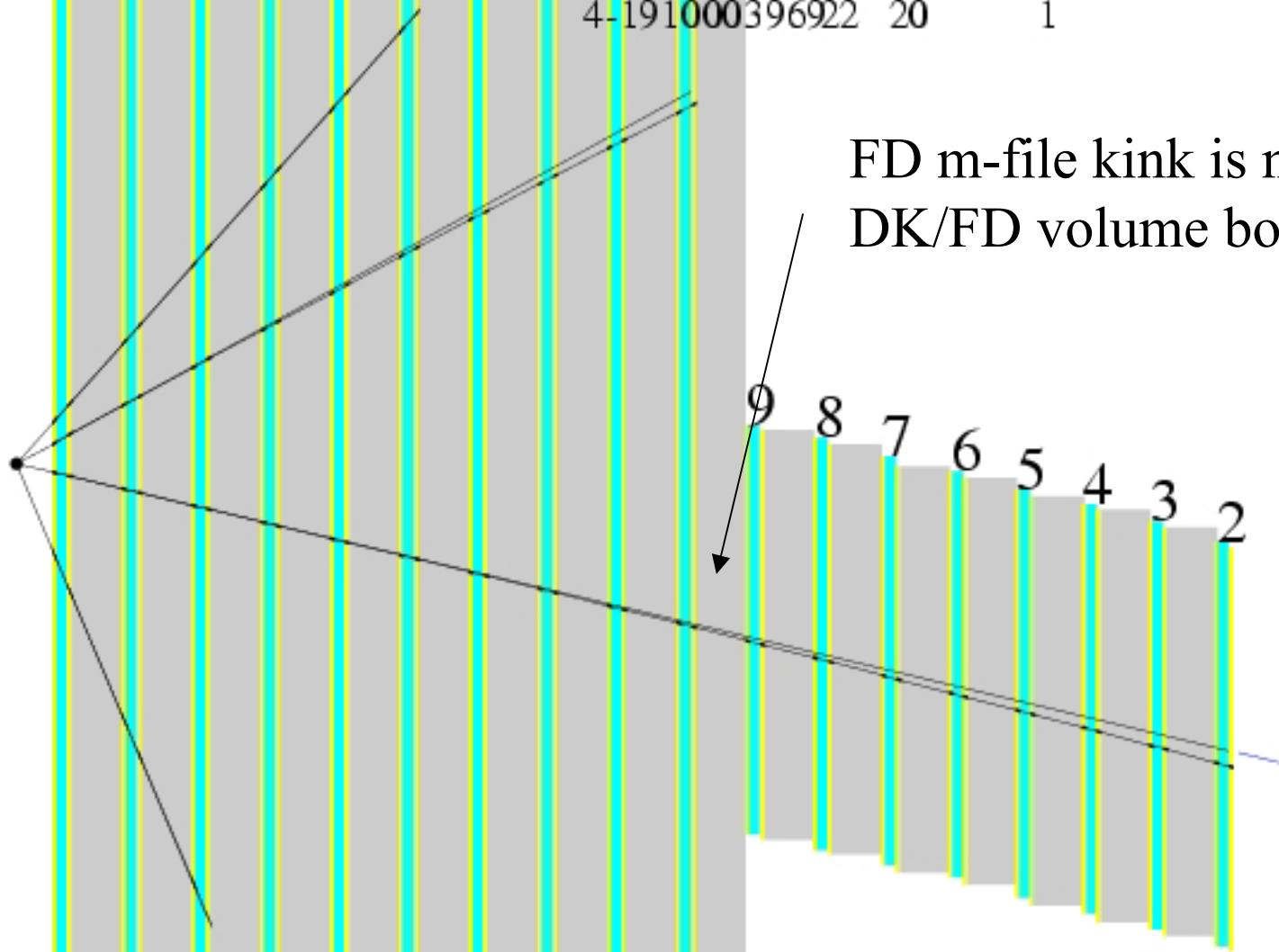
DK m-file kink gone

FD m-file kink

E872 Run= 2932 Event= 15521 Wght= 1.0

**U View**

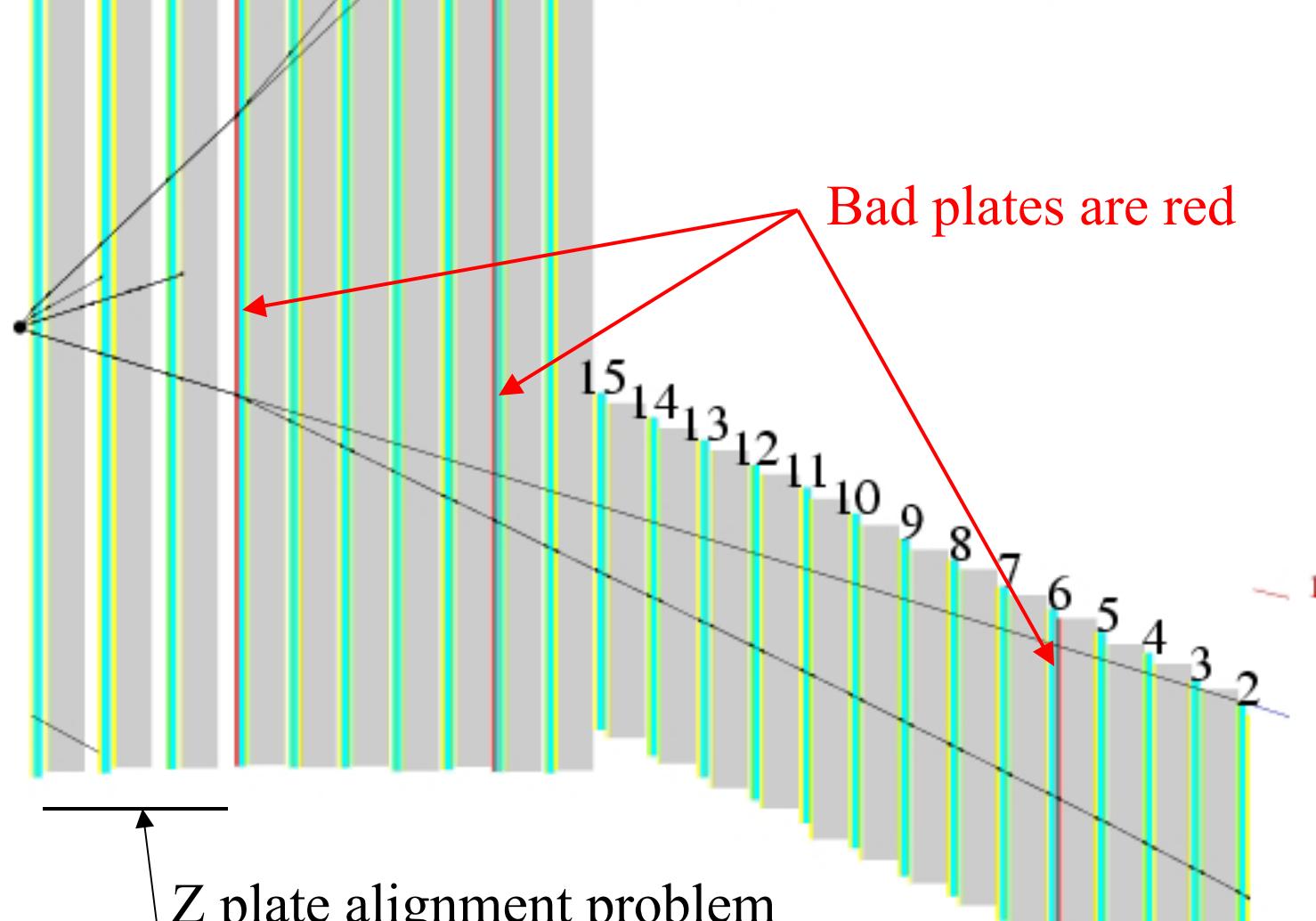
trk	nhtnseg	gnomvtx
1-191000376335	36	-42.21
2-19100039300	6	1
3-19100039610	12	1
4-191000396922	20	1



FD m-file kink is near the  
DK/FD volume boundary

**U View**

trk	nhtnseg	nomvtx	
1-25	100023450	10	1
2-25	100023469	3	1
3-25	110025168	7	1
4-25	100025225	44	-28.41

31

# Summary of LS “kinks”

- Find 27 events in DK m-file with
  - $>3\sigma$  muon track kink &  $\text{pt} > 0.1 \text{ GeV}$
  - Good US/DS track  $\chi^2$
- Categories
  - 16 kinks aren’t seen in the FD file
  - 5 kinks near bad plates
  - 4 kinks due to plate Z alignment problem
  - 1 kink at ECC/bulk boundary
  - 1 kink with no obvious maladies
    - Next slides

3290\_03529

LSDECAY: Search trk 2 5911007105 mom= 47.6 Trk/Vtx chi= 0.3										
seg/plt	Usl	Vsl	dusl	dvsl	rmsu	rmsv	uschi	dschi	pt	flt
3 571	-25.6	41.0	2.0	-0.2	2.8	-0.2	0.0	0.3	0.10	2.0
4 561	-25.8	41.3	1.1	0.8	2.8	2.1	1.7	0.9	0.06	2.8
5 541	-25.8	41.7	0.5	1.1	1.4	2.9	2.3	0.2	0.06	4.4
6 531	-26.1	41.7	-0.1	0.9	-0.4	2.6	2.2	0.3	0.04	5.2
7 521	-26.1	41.9	-0.2	0.9	-0.7	2.8	2.4	0.1	0.04	6.0
8 511	-26.7	42.6	-0.9	1.5	-2.8	4.6	2.3	2.6	0.08	6.8
9 501	-26.9	42.9	-1.1	1.7	-3.0	5.0	2.6	1.5	0.10	7.5
10 491	-27.0	43.3	-1.1	2.0	-3.3	6.0	2.8	2.4	0.11	8.3 UV-Kink
11 481	-27.7	44.0	-1.0	1.4	-2.2	3.1	2.6	0.2	0.08	9.1 RF

DK

LSDECAY: Search trk 2 5910007105 mom= 47.6 Trk/Vtx chi= 0.3										
seg/plt	Usl	Vsl	dusl	dvsl	rmsu	rmsv	uschi	dschi	pt	flt
3 571	-26.4	39.9	2.2	-0.4	2.7	-0.5	0.0	0.2	0.10	2.0
4 561	-26.5	40.1	1.3	0.6	2.7	1.3	1.0	0.2	0.07	2.8
5 541	-26.4	40.5	0.8	0.9	1.4	1.8	1.5	0.0	0.06	4.4
6 531	-26.8	40.6	0.2	0.9	0.5	1.7	1.4	0.2	0.04	5.2
7 521	-26.8	40.7	-0.1	0.9	-0.2	1.8	1.5	0.1	0.04	6.0
8 511	-27.4	41.8	-0.7	1.9	-1.8	3.9	1.5	1.5	0.09	6.8
9 501	-27.0	41.8	-0.3	1.8	-0.7	4.0	1.5	2.0	0.09	7.6
10 491	-27.1	41.7	-0.4	1.6	-1.1	4.0	1.6	1.8	0.08	8.4
11 481	-27.8	42.4	-1.0	2.1	-2.6	4.3	3.3	0.2	0.11	9.1 V-Kink
12 471	-27.3	43.0	-0.5	2.6	-1.0	5.6	3.7	0.2	0.13	9.9 V-Kink
13 461	-27.1	43.7	0.1	2.1	0.1	3.3	1.8	0.1	0.10	10.7 RF
14 451	-26.9	43.3	0.2	1.6	0.4	2.7	1.8	0.2	0.08	11.4
15 441	-27.9	43.7	-0.8	2.0	-1.4	3.6	1.8	1.2	0.10	12.2 V-Kink
16 431	-27.7	43.7	-0.6	2.1	-1.1	3.5	1.8	1.4	0.10	12.9 V-Kink
17 421	-27.4	43.7	-0.3	2.1	-0.6	3.6	1.8	0.8	0.10	13.7
18 411	-27.7	44.2	-0.6	2.5	-1.1	4.0	1.8	0.2	0.12	14.5 V-Kink

FD

SFT match US fit 1.02587235 -6.27094889  
 SFT match DS fit 0.746009886 -1.69087195

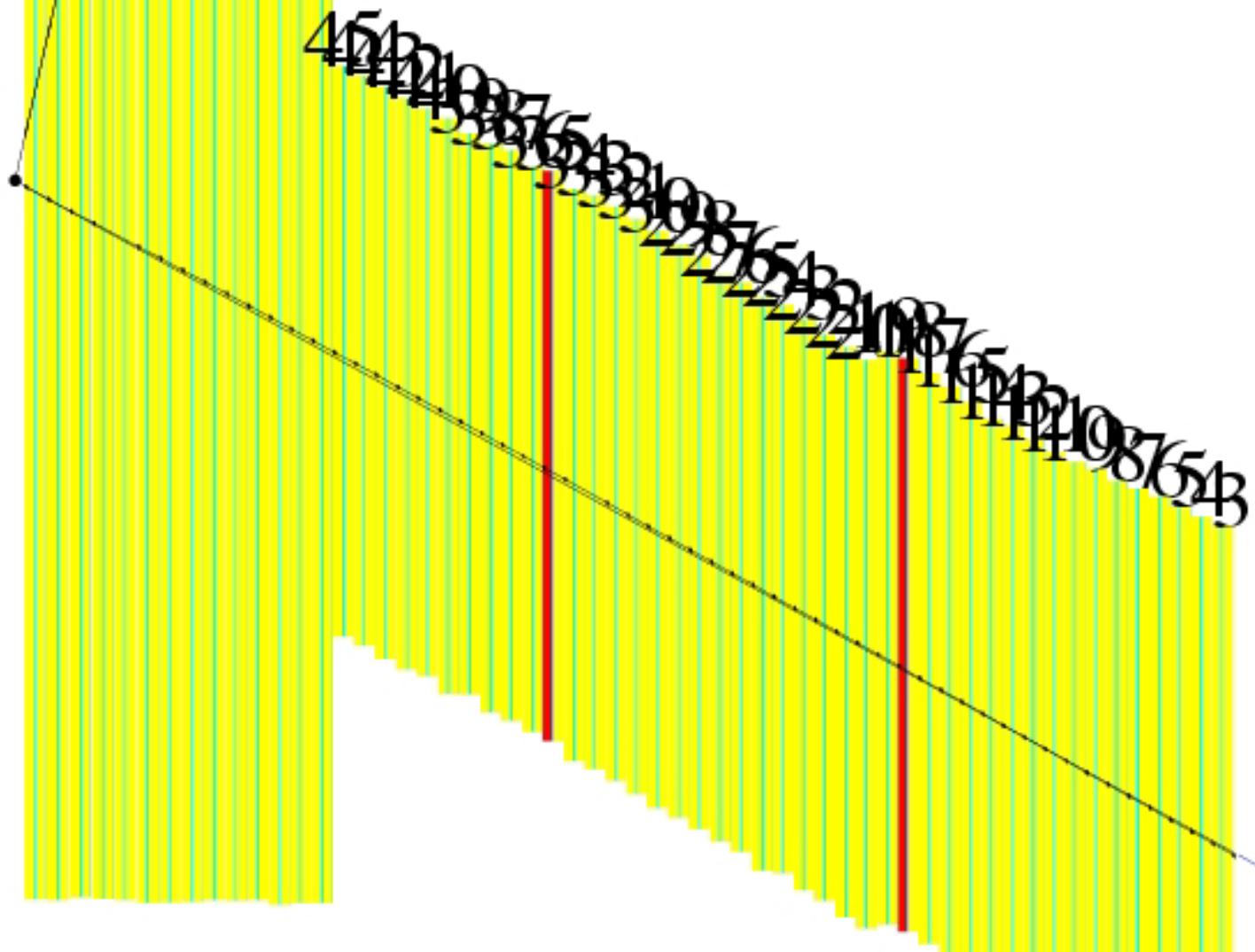
6σ slope deviation US fit



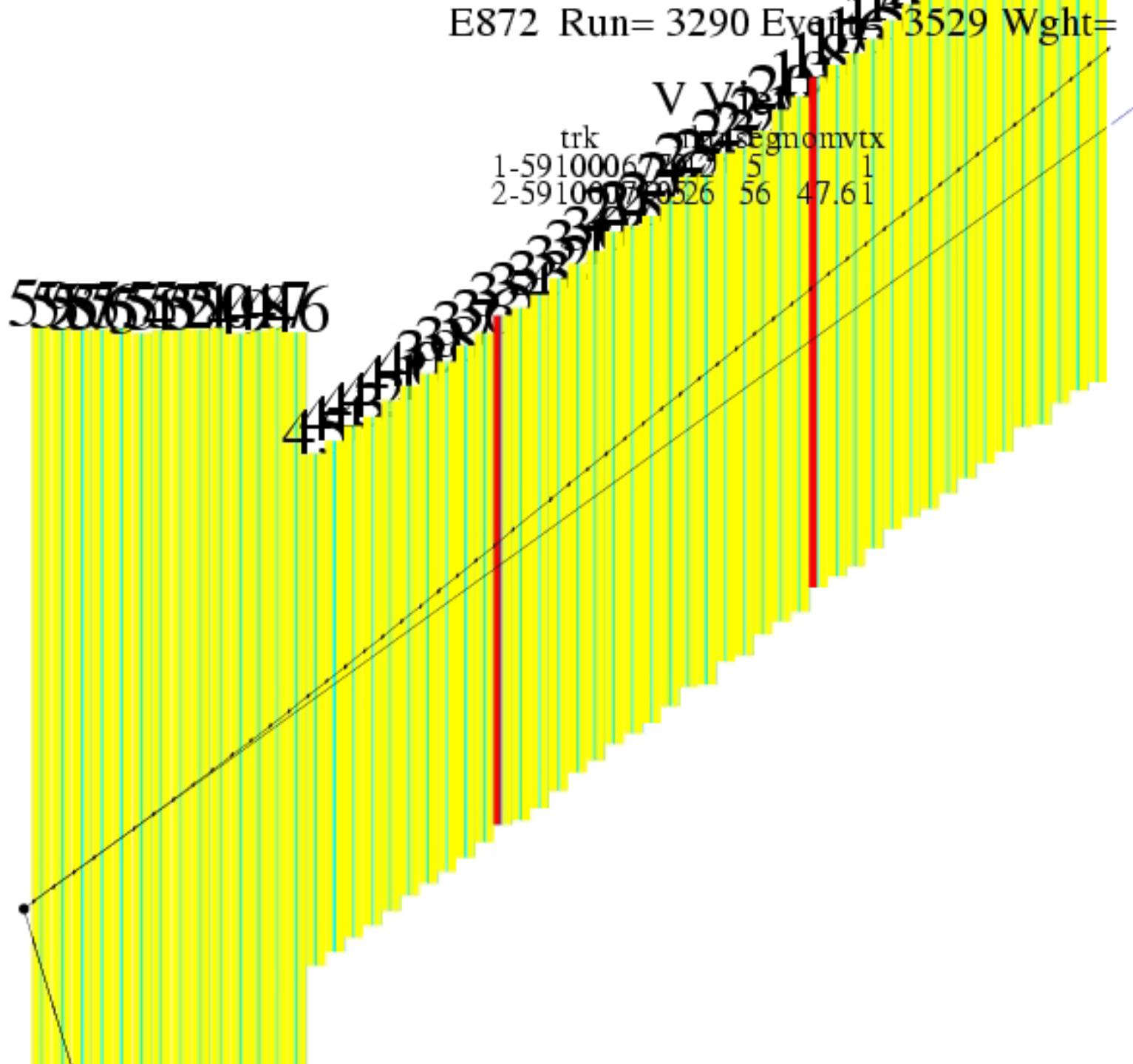
E8/2 Run= 3290 Event= 3529 Wght= 1.0

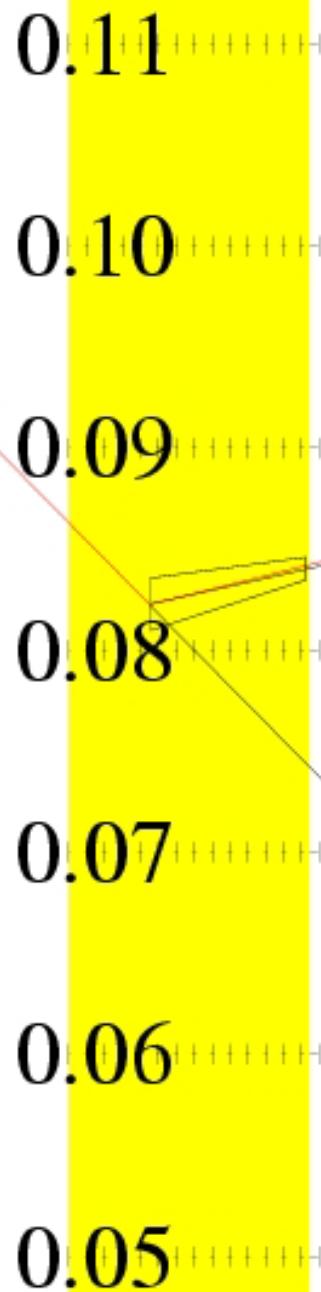
UView

trk nhtnsegmnmvtx  
1-591000677012 5 1  
2-59100071026 56 47.61



E872 Run= 3290 Event= 3529 Wght= 1.0





E872 Run= 3290 Event= 3529 Wght= 1.0

V View

DS fit in red

US fit in black

$\delta\theta_{US/DS} = 4.6$  mrad

Kink  $\delta\theta = 2$  mrad

MCS  $\theta_o = 0.14$  mrad

Probable alignment problem

# Summary

- First look for LS decays finds no striking candidates
- Possible next steps
  - Evaluate alignment using background tracks
  - Determine expected decay rate into LS