	Y1	Y2	Y3	Y4
X1	-2	0	2	0
X2	-2	-2	-2	0
X3	2	-2	2	0
X4	0	0	0	0

Looking at the S_box biases we observe that the following equations hold with a bias +-⅛

1. $x1 \oplus y1 = 0$
2. $x1 \oplus x3 = 0$
3. $x2 \oplus y1 = 0$
4. $x2 \oplus y2 = 0$
5. $x2 \oplus y3 = 0$
6. $x3 \oplus y1 = 0$
7. $x3 \oplus y2 = 0$
8. $x3 \oplus y3 = 0$

We can use these to construct the following linear trail->

Round 1

$X_{11} \oplus Y_{11}=0$

$X_{21} \oplus Y_{21}=0$

$X_{31} \oplus Y_{31}=0$

Where $X_{21}=K_{21}\oplus Y_{11}$, $X_{31}=K_{31}\oplus Y_{21}$, $X_{41} = K_{41}\oplus Y_{31}$

Combining all these and using the pumping lemma

$X_{11}\oplus Y_{11}\oplus K_{21}\oplus Y_{11}\oplus Y_{21}\oplus K_{31}\oplus Y_{21}\oplus Y_{31}=0$

I.e. $P_1\oplus X_{41}=0$

with a probability

$= ½ + 2^2(⅛)^3$

I.e. a bias = 1/128

Thus for the first 6 S_boxes we have the following trails

1. Box 1
   P1->X1,1->Y1,1->X2,1->Y2,1->X3,1->Y3,1->X4,1
   I.e. $P_1\oplus X_{4,1}=0$
2. Box 2
   P9->X1,9->Y1,9->X2,3->Y2,3->X3,17->Y3,17->X4,5
   I.e. $P_9\oplus X_{4,5}=0$
3. Box 3
   P17->X1,17->Y1,17->X2,5->Y2,5->X3,2->Y3,2->X4,9
   $P_{17}\oplus X_{4,9}=0$
4. Box 4
   P25->X1,25->Y1,25->X2,7->Y2,7->X3,18->Y3,18->X4,13
5. Box 5
   P2->X1,2->Y1,2->X2,9->Y2,9->X3,3->Y3,3->X4,17
   $P_2\oplus X_{4,17}=0$
6. Box 6
   P10->X1,10->Y1,10->X2,11->Y2,11->X3,19->Y3,19->X4,21

$P_{10} \oplus X_{4,21} = 0$

No linear trails could be obtained for boxes 7 and 8.

As the bias for each trail is 1/128, we need to have at least 128^2 pairs