Rate handling in MICE

giles.barr@physics.ox.ac.uk

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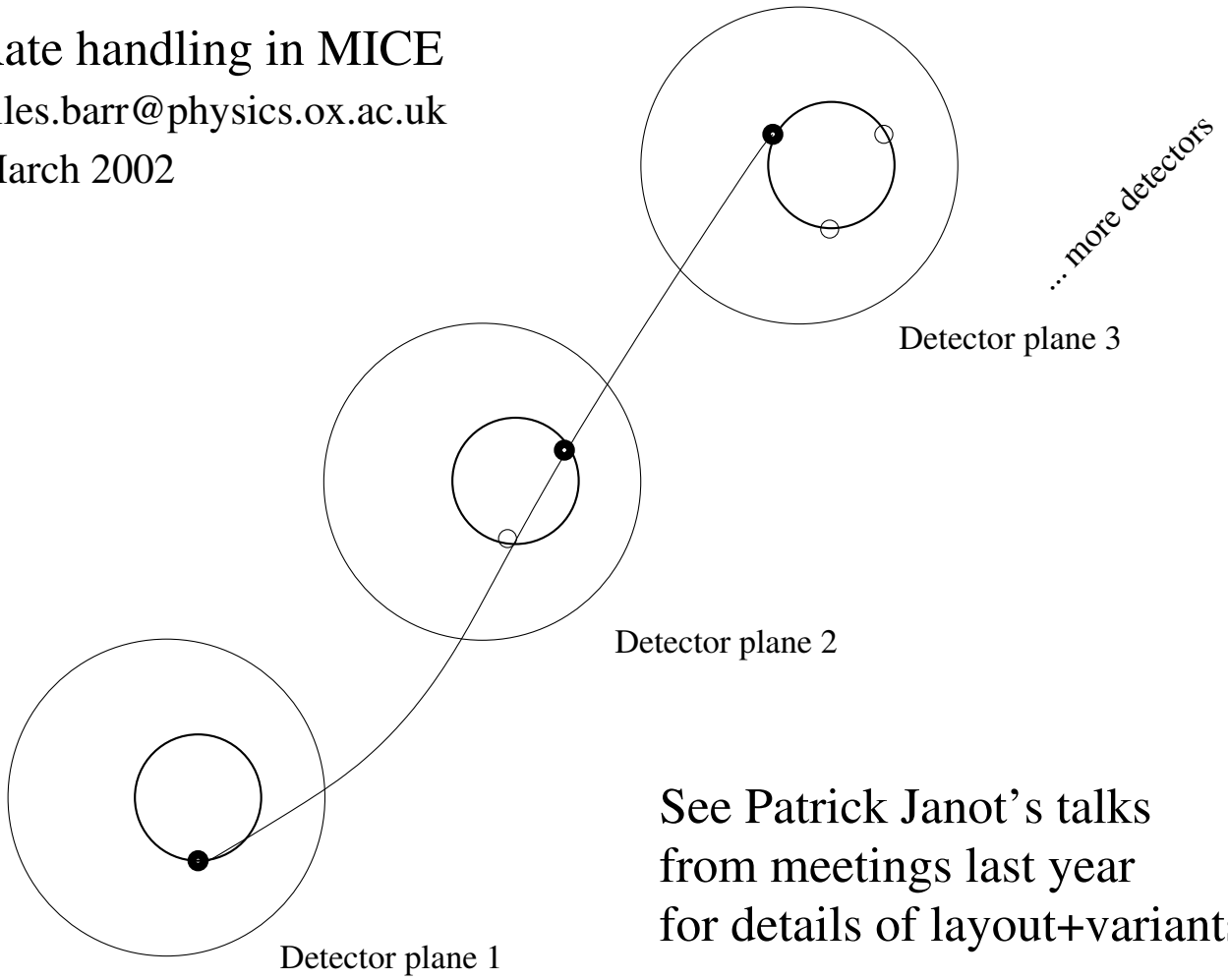


See Patrick Janot's talks
from meetings last year
for details of layout+variants.

Three detectors gives six measured quantities (x,y in each).

- Four of these give measurements we want:
  - (x,y) of centre of circle
  - radius of circle
  - starting point on circle (relative size of px and py)
- Two more can be used for constraints
  - To be conservative, I say that the radius of the circle in the third detector is used as a cross check and the position around the circle can be used to throw out wrong combinations.

Figure 1: slide 1

(This complication was motivated by somehow thinking that background from straight tracks is more nasty than curly ones).

Now, the probability that three random points satisfy this criterion is:

$P3 = md/c = 4 \times 0.5 / 500$
$= 0.4\%$

c = circumference of circle
m = 'roadwidth' for finding track
in units of pixels/fibres
d = size of each pixel

If we add another detector, we get two more constraints we can use to eliminate fake combinations of points. Generalising to N detectors,

$$PN = (md/c)^{N-2}(md\ 2\pi/c)^{N-3}$$

Now calculate some numbers. Let
a = #hits in *EACH* detector within time window

	N=3	N=4	N=5
PN	4 e –3	4 e –7	1 e –10
a= 2	0.032	6 e –6	1 e –9
a = 10	4	4 e –3	4 e –7
a = 100	4000	40	0.4

(This is with c = 500mm (r = 15cm), d = 0.5mm, m = 4)

Figure 2: slide 2

That was all where ‘hit’ meant spacepoints. OK for pixels, but for fibres (or other projective detector), we have to combine hits on each fibre to make spacepoints.

[*Discussion ommitted*]

f = fraction of detector area within ‘roadwidth’

3 planes, no inefficiencies	$p_3 = f\,a^3 + a\,(1-f)$
3 planes, one inefficiency	$q_3 = 3\,a^2 - 2\,a$
4 planes, no inefficiencies	$p_4 = f^2 a^4 + a\,(1-f^2)$
4 planes, one inefficient plane	$q_4 = 4\,f\,a^3 + a\,(1-4f)$

... Slightly more sophistication...

... Plots combining these probabilities to make spacepoints from hits with the probabilities to make tracks from spacepoints (as on previous slide).

Conclusions

* Calculations of combinations of spacepoints to tracks and (for fibres) hits to spacepoints.
* No matter what happens, we are dead very quickly as the rate goes up.
* We are discussing the difference of whether a=3 is the limit or a=5, but not a=10. Therefore, we cannot beat a high rate with the detectors – the rate must not be there in the first place.
* a depends on the time window and the road width – these should be made small if we fear a high rate.

Figure 3: slide 3

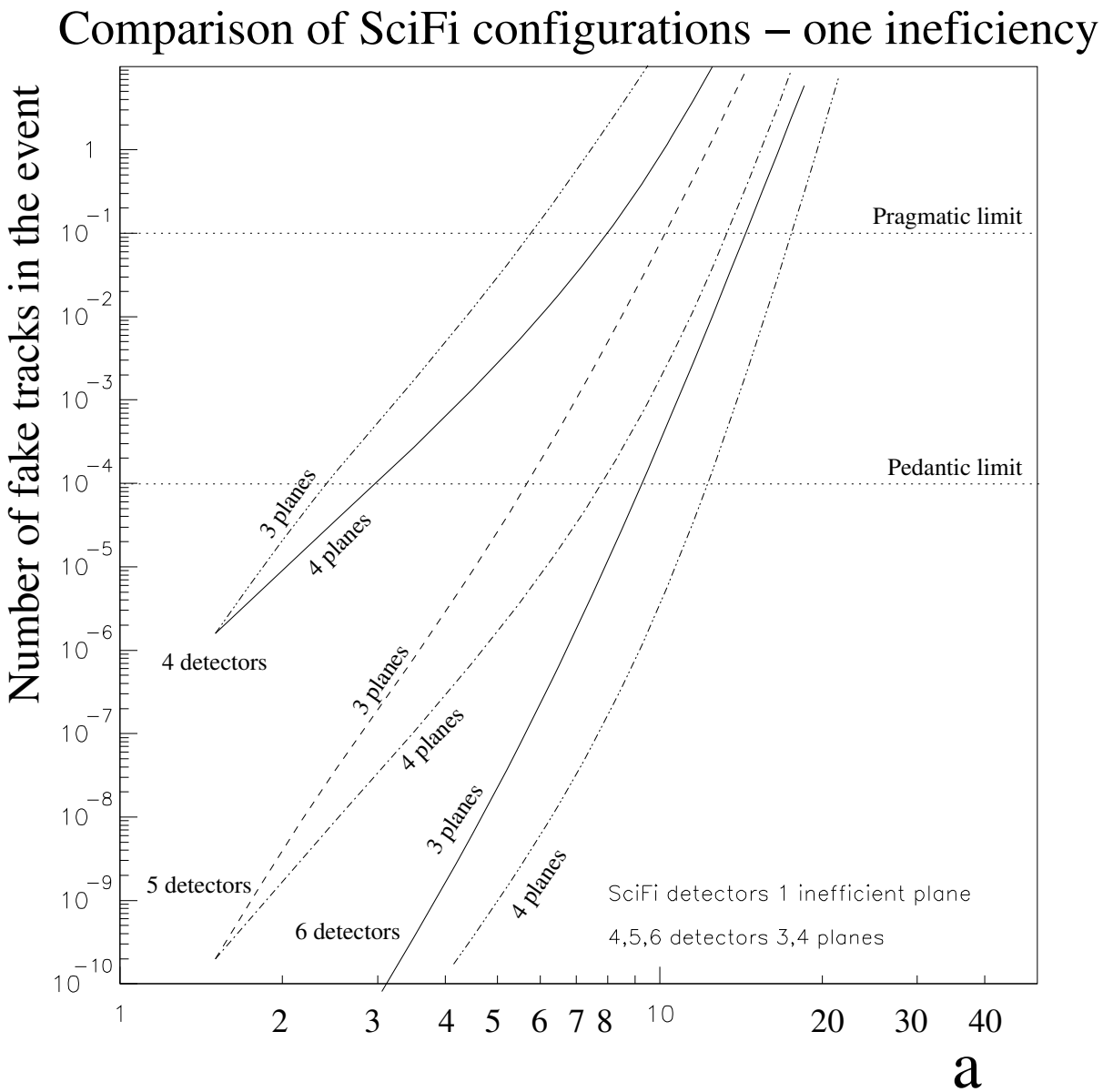

Comparison of SciFi configurations – one ineficiency
Number of fake tracks in the event
Pragmatic limit
Pedantic limit
3 planes
4 planes
4 detectors
3 planes
4 planes
5 detectors
3 planes
4 planes
6 detectors
SciFi detectors 1 inefficient plane
4,5,6 detectors 3,4 planes
a

Figure 4:

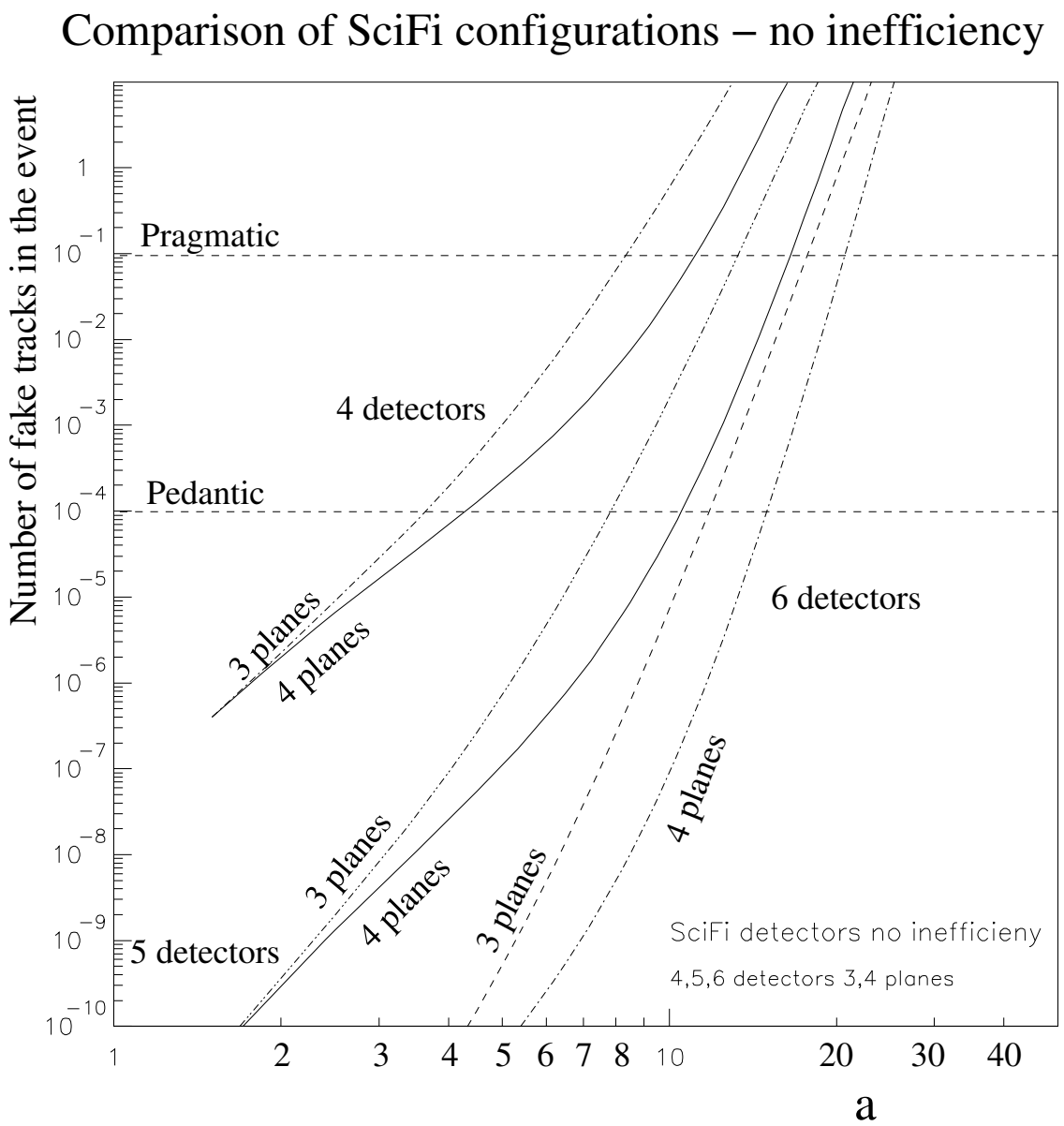
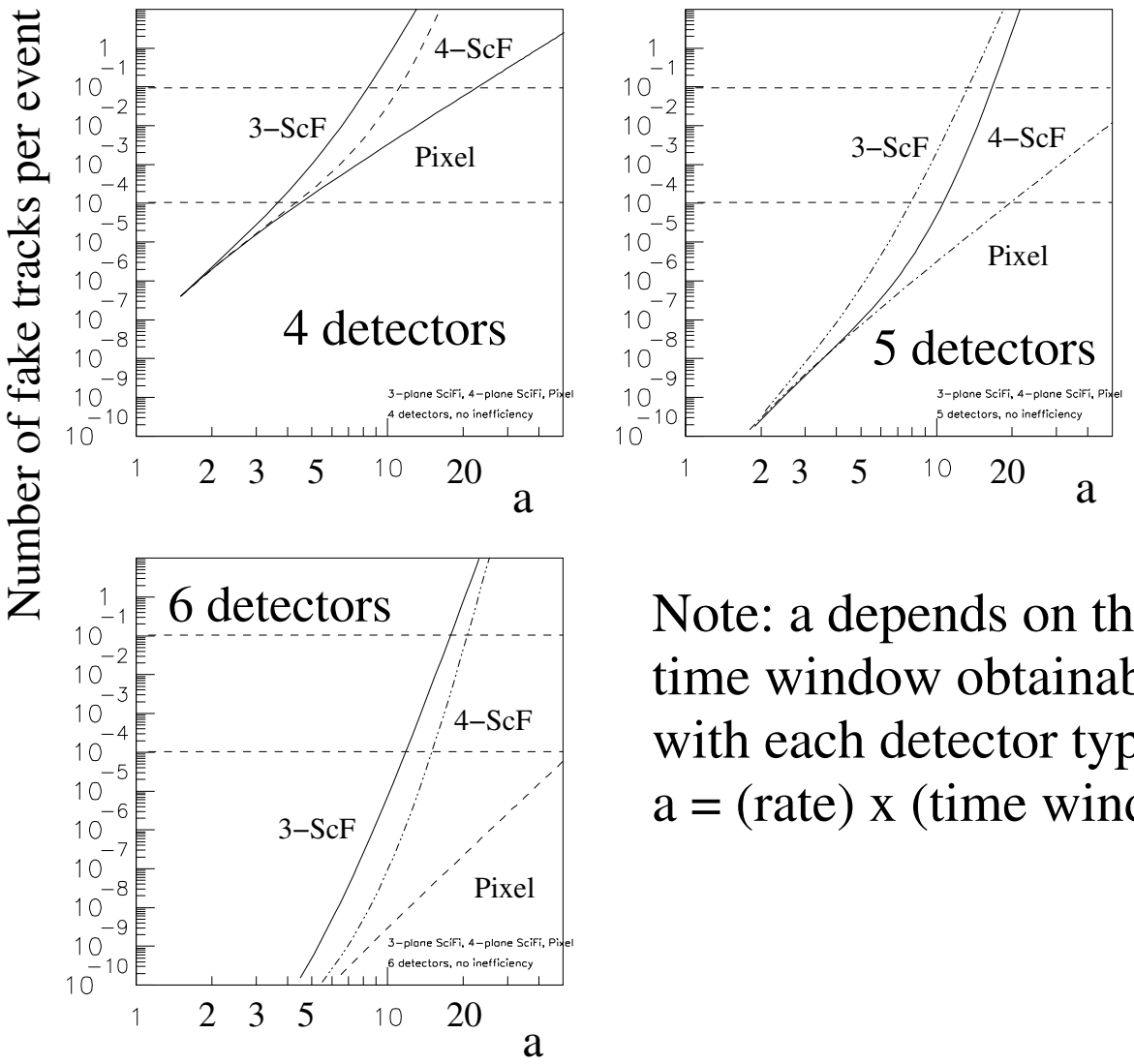

Comparison of SciFi configurations – no inefficiency
Number of fake tracks in the event
Pragmatic
Pedantic
4 detectors
6 detectors
5 detectors
3 planes
4 planes
3 planes
4 planes
3 planes
4 planes
SciFi detectors no inefficieny
4,5,6 detectors 3,4 planes
a

Figure 5:

Compare detector types with same number of detectors of each type.



Note: a depends on the time window obtainable with each detector type.
a = (rate) x (time window)

Figure 6:

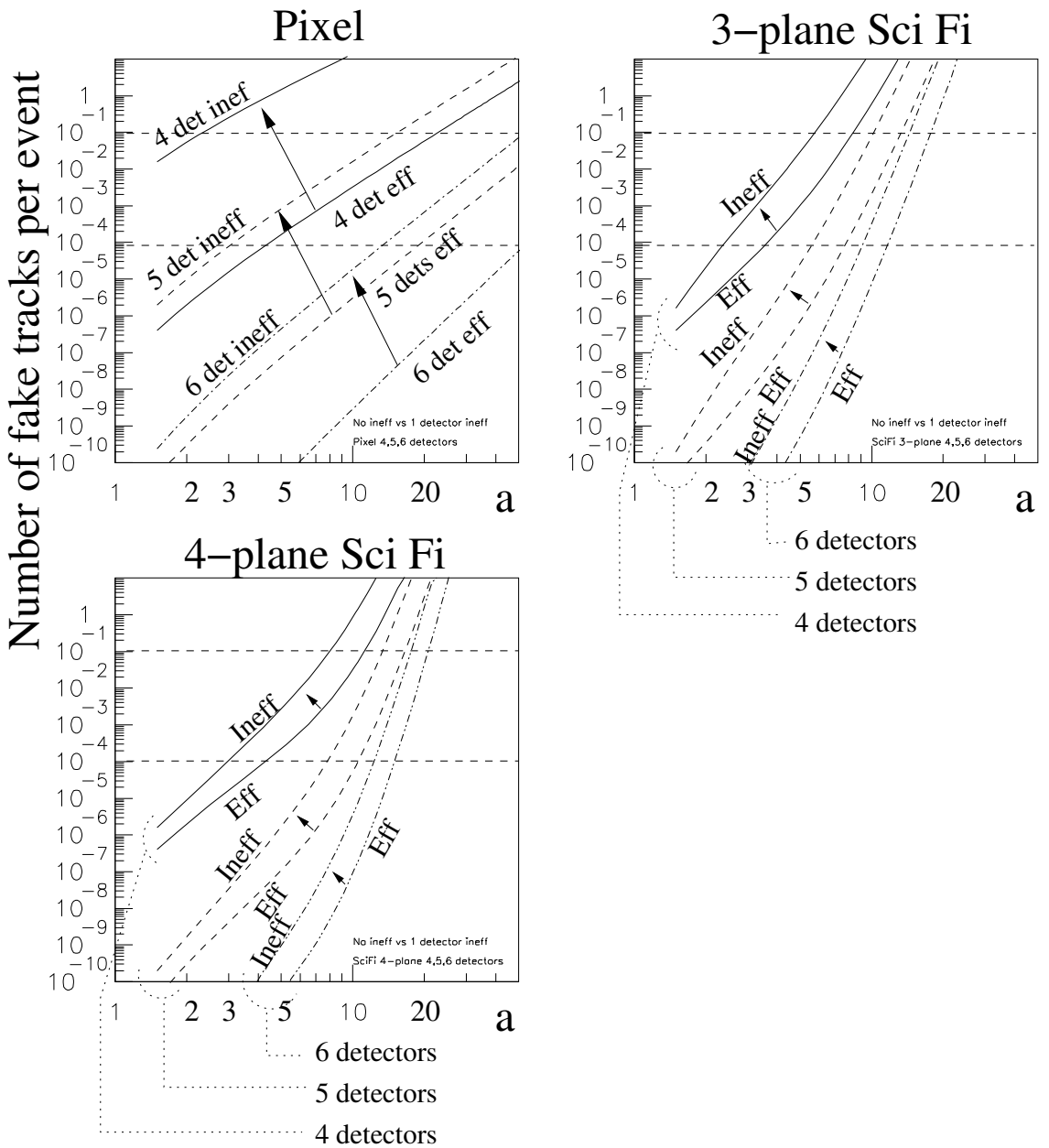

Compare effect of allowing an inefficient Sci−Fi plane
or an inefficient Pixel detector
Pixel
3−plane Sci Fi
4−plane Sci Fi
Number of fake tracks per event
4 det inef
4 det eff
5 det ineff
5 dets eff
6 det ineff
6 det eff
Ineff
Eff
No ineff vs 1 detector ineff
Pixel 4,5,6 detectors
SciFi 3−plane 4,5,6 detectors
SciFi 4−plane 4,5,6 detectors
a
6 detectors
5 detectors
4 detectors

Figure 7: