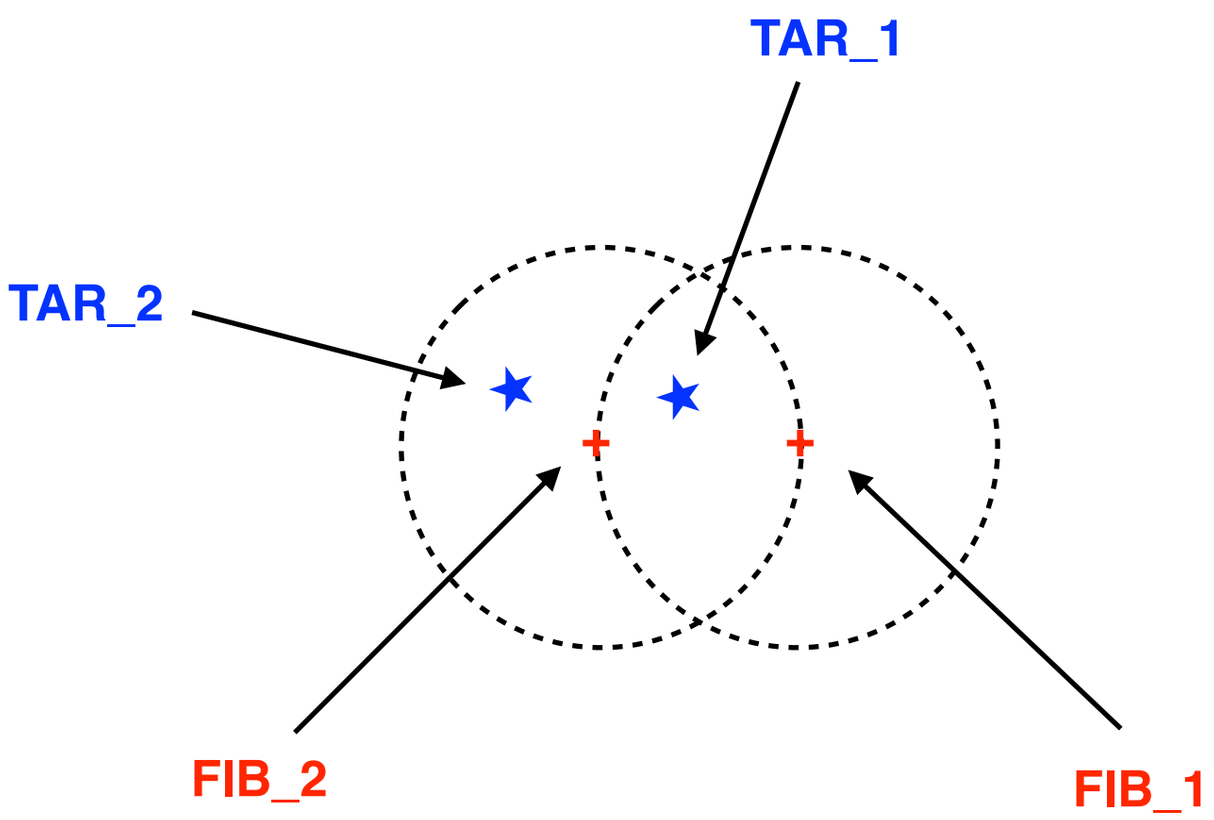
Optimized target allocation algorithm for multi-fibre fed spectrographs MOS@E-ELT

Stefano Rota

IASF - Milano

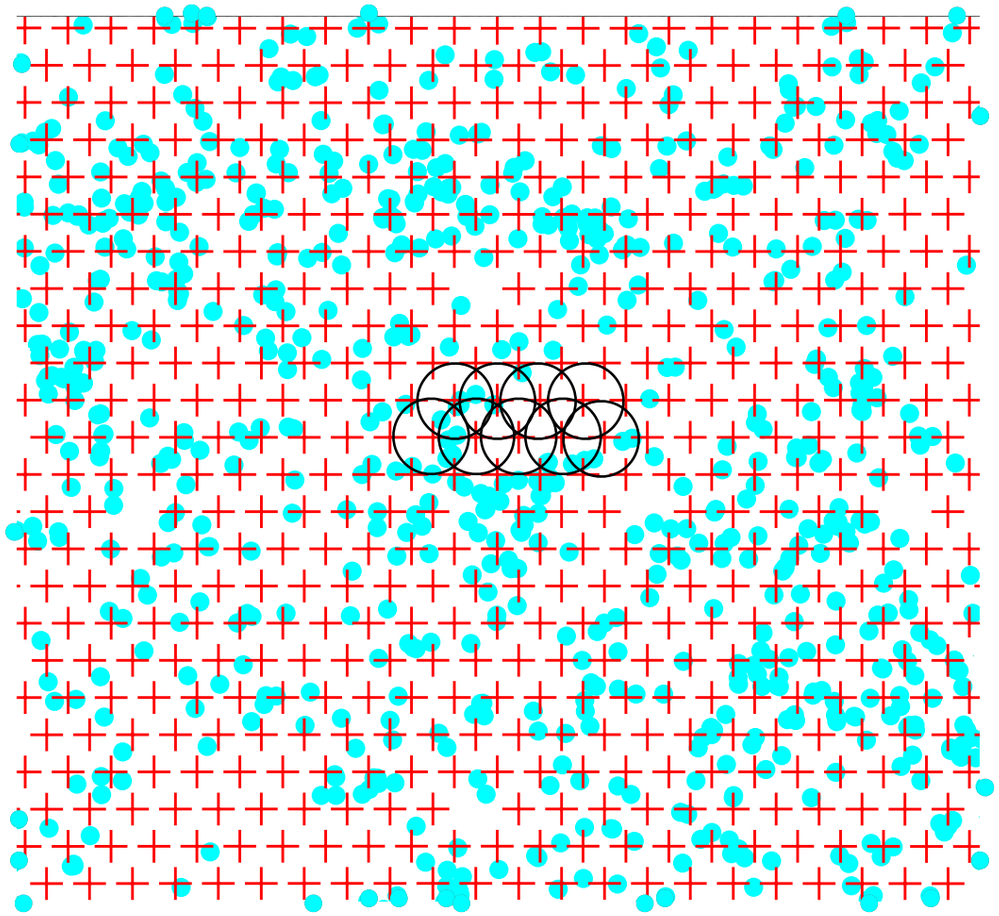
Sexten, July 2015

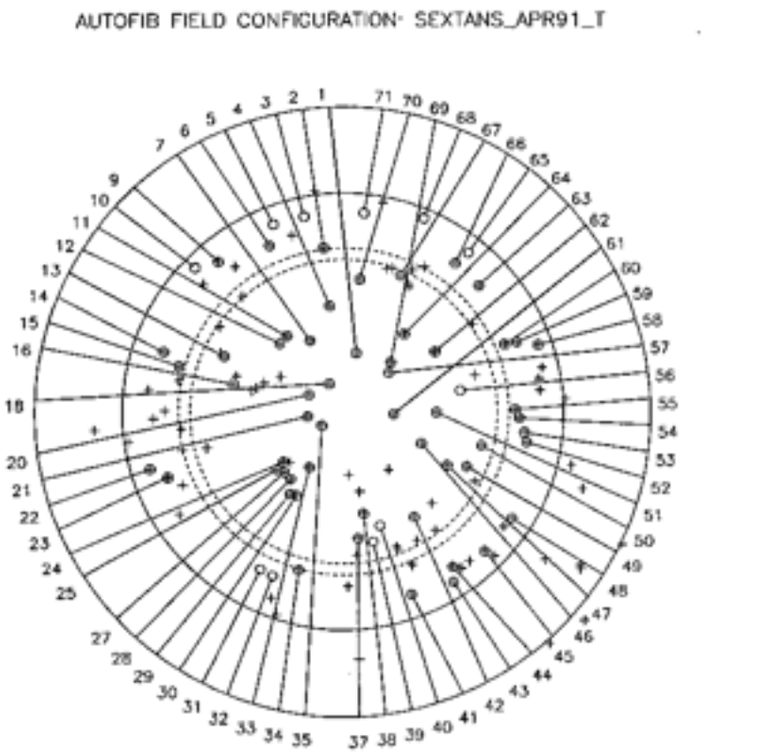
Why the optimization?



Why the optimization?

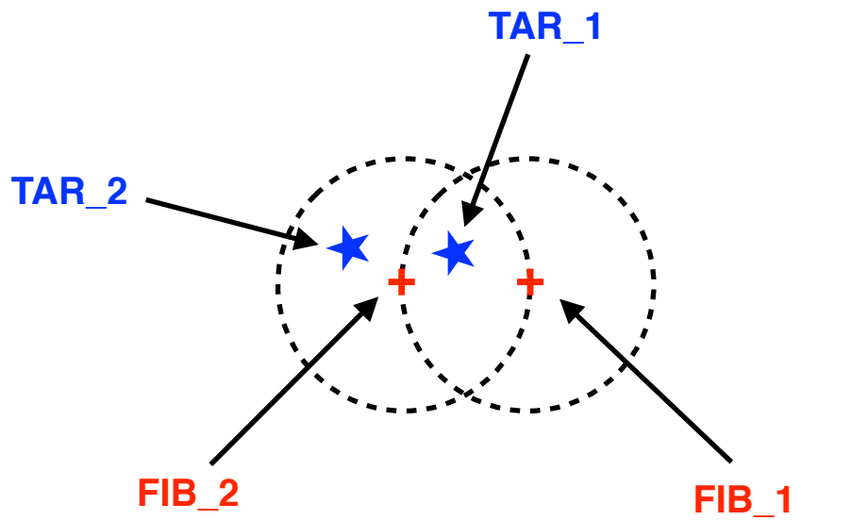
Increasing the number of fibres, ~hundreds:
maximizing the allocated targets is a complex problem

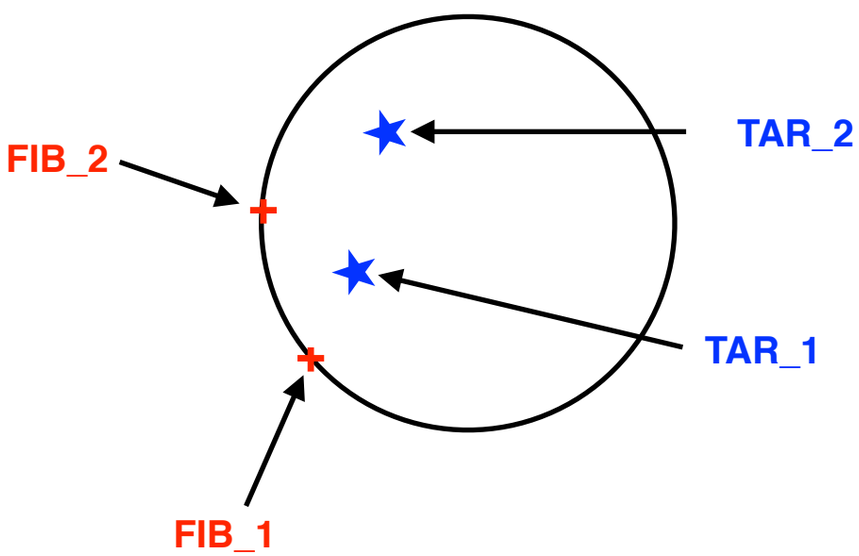




The optimization idea

STORING the INFORMATION:
for each fibre, generate a list of targets reachable by that fibre

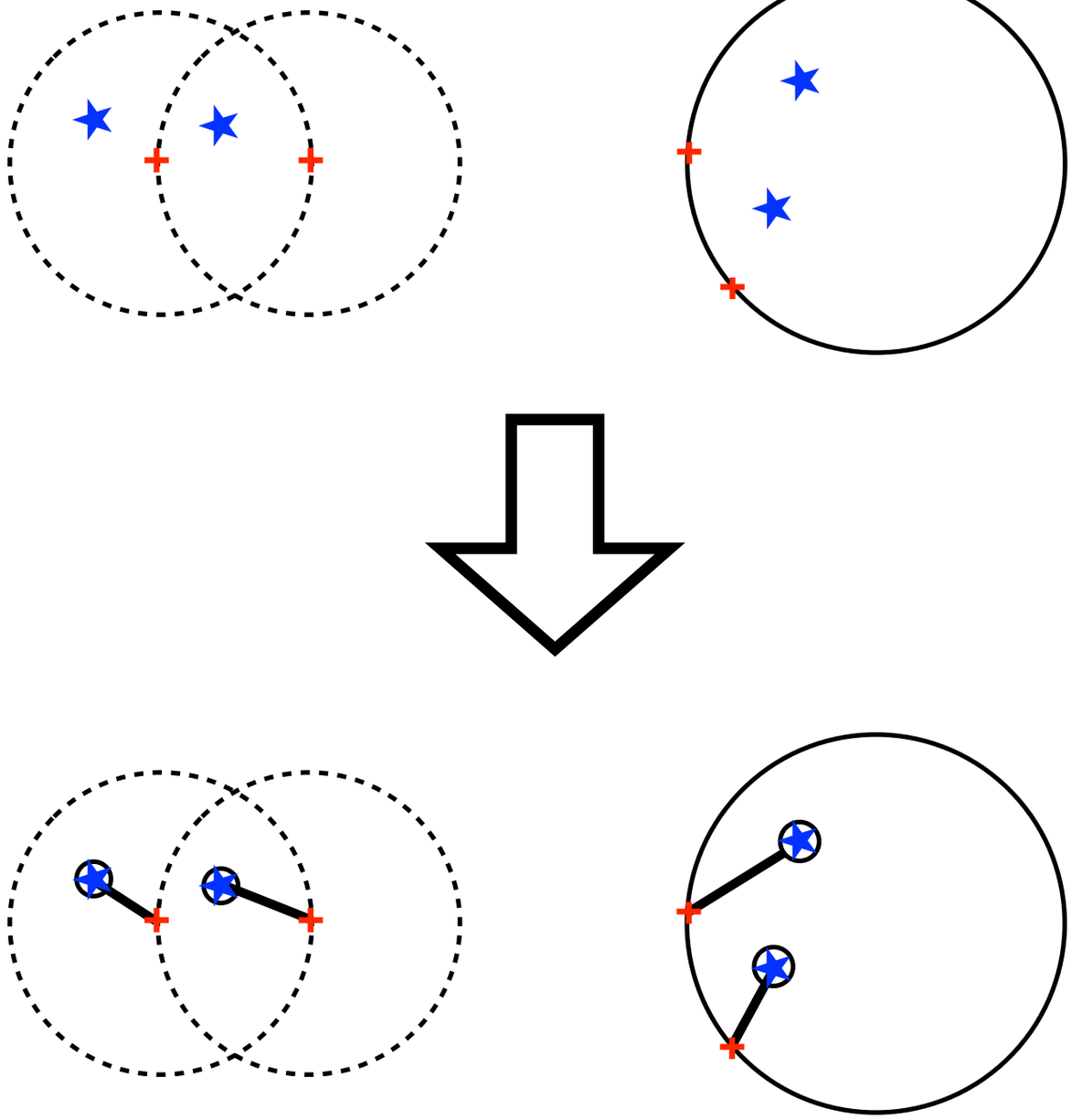




FIB_1	FIB_2
TAR_1	TAR_1
	TAR_2

The optimization idea

DISCARD targets from the most populated list



BEFORE OPT

FIB_1	FIB_2
TAR_1	TAR_1
	TAR_2

AFTER OPT

FIB_1	FIB_2
TAR_1	TAR_2

The optimization algorithm

1) choose the fibre that can reach more targets,
   fibre with more degrees of freedom (REF. Morales et al. 2012)

2) select the target reachable by more fibres,
   target with more degrees of freedom

3) discard the chosen target from the fibre list

FIB_1	FIB_2	…	FIB_12	FIB_13	FIB_14	FIB_15	…
			TAR_1 (3)	TAR_1 (3)	TAR_1 (3)	TAR_2 (3)	
			TAR_2 (3)	TAR_2 (3)	TAR_4 (1)		
				TAR_3 (1)			

…	FIB_12	FIB_13	FIB_14	FIB_15	…
	TAR_1 (3)	TAR_1 (3)	TAR_1 (3)	TAR_2 (3)	
	TAR_2 (3)	TAR_2 (3)	TAR_4 (1)		
		TAR_3 (1)			

…	FIB_12	FIB_13	FIB_14	FIB_15	…
	TAR_1 (3)	TAR_1 (3)	TAR_1 (3)	TAR_2 (2)	
	TAR_2 (2)	TAR_3 (1)	TAR_4 (1)		

…	FIB_12	FIB_13	FIB_14	FIB_15	…
	TAR_1 (2)	TAR_1 (2)	TAR_4 (1)	TAR_2 (2)	
	TAR_2 (2)	TAR_3 (1)			

…	FIB_12	FIB_13	FIB_14	FIB_15	…
	TAR_1 (1)	TAR_3 (1)	TAR_4 (1)	TAR_2 (2)	
	TAR_2 (2)				

…	FIB_12	FIB_13	FIB_14	FIB_15	…
	TAR_1 (1)	TAR_3 (1)	TAR_4 (1)	TAR_2 (1)	

The optimization output

OPTIMIZATION OUTPUT

…	FIB_12	FIB_13	FIB_14	FIB_15	…	FIB_102	FIB_103	…
	TAR_1 (1)	TAR_3 (1)	TAR_4 (1)	TAR_2 (1)		TAR_5 (1)	TAR_7 (1)	
						TAR_6 (1)	TAR_8 (1)	
							TAR_9 (1)	

- After the optimisation each target is assigned to only one fibre
- Selecting targets depending on their priority

Checking for fibre collision

A PRIORI: avoid targets too close
because can collide due to the limited size of the fibre

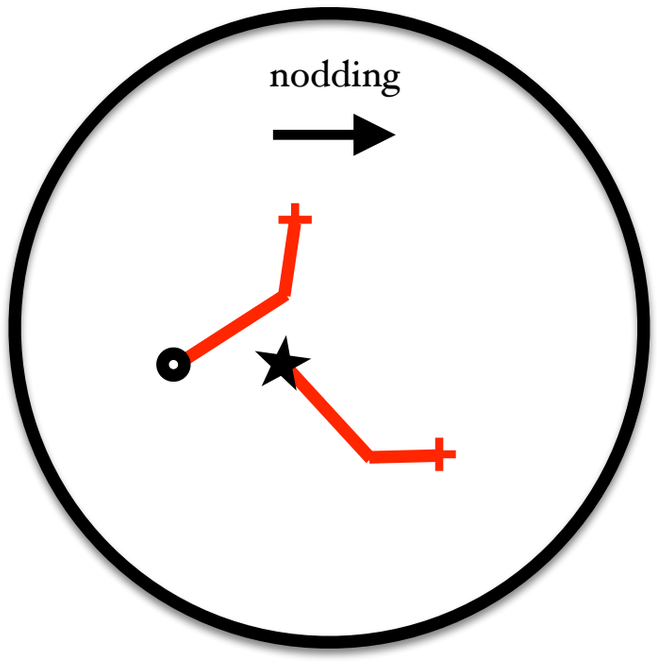
A POSTERIORI: check for fibre collision and,
when a conflict occurs, search for other targets

Best sky subtraction

- Infrared observations with high emission of the sky

- Half of the fibres allocated to targets (~ 50%).
  Half (~ 50%) is left to observe sky positions

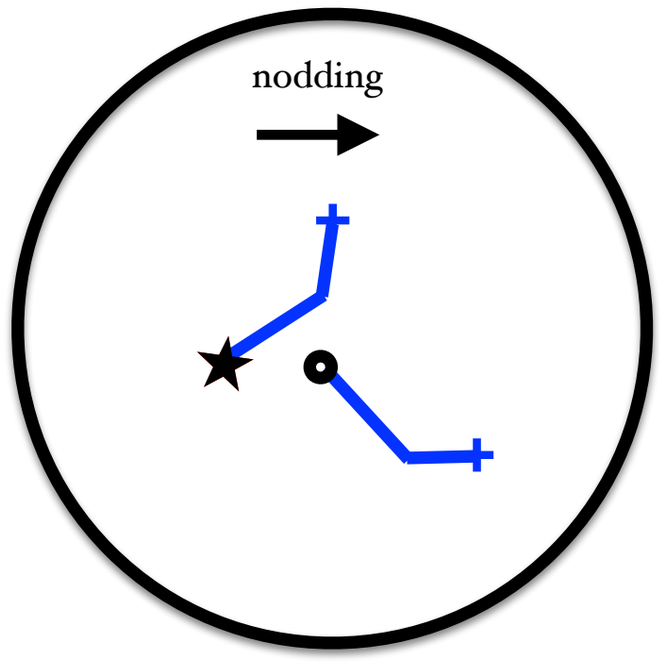
- ABBA nodding of the telescope:
  target observed during all the observation



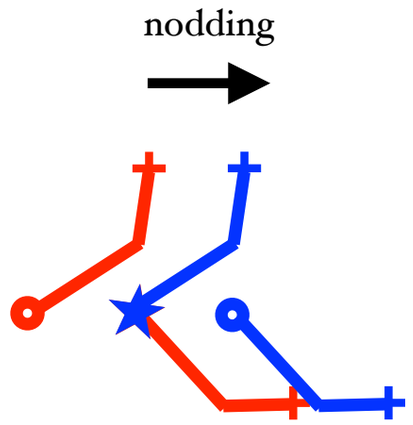
Best sky subtraction

Many objects are lost because:

- targets too close
- the sky position before/after the nodding ends up on a background source



The optimization algorithm



1) fix the nodding amount and direction

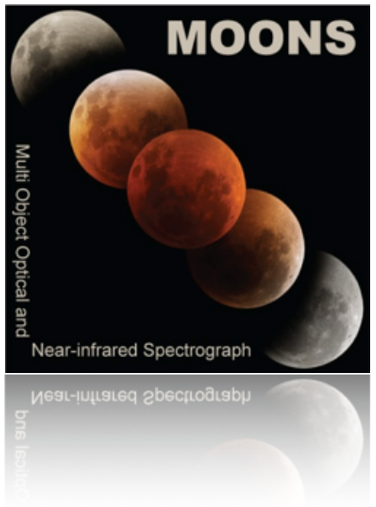
2) store the information

3) choose the fibre and randomly select a target

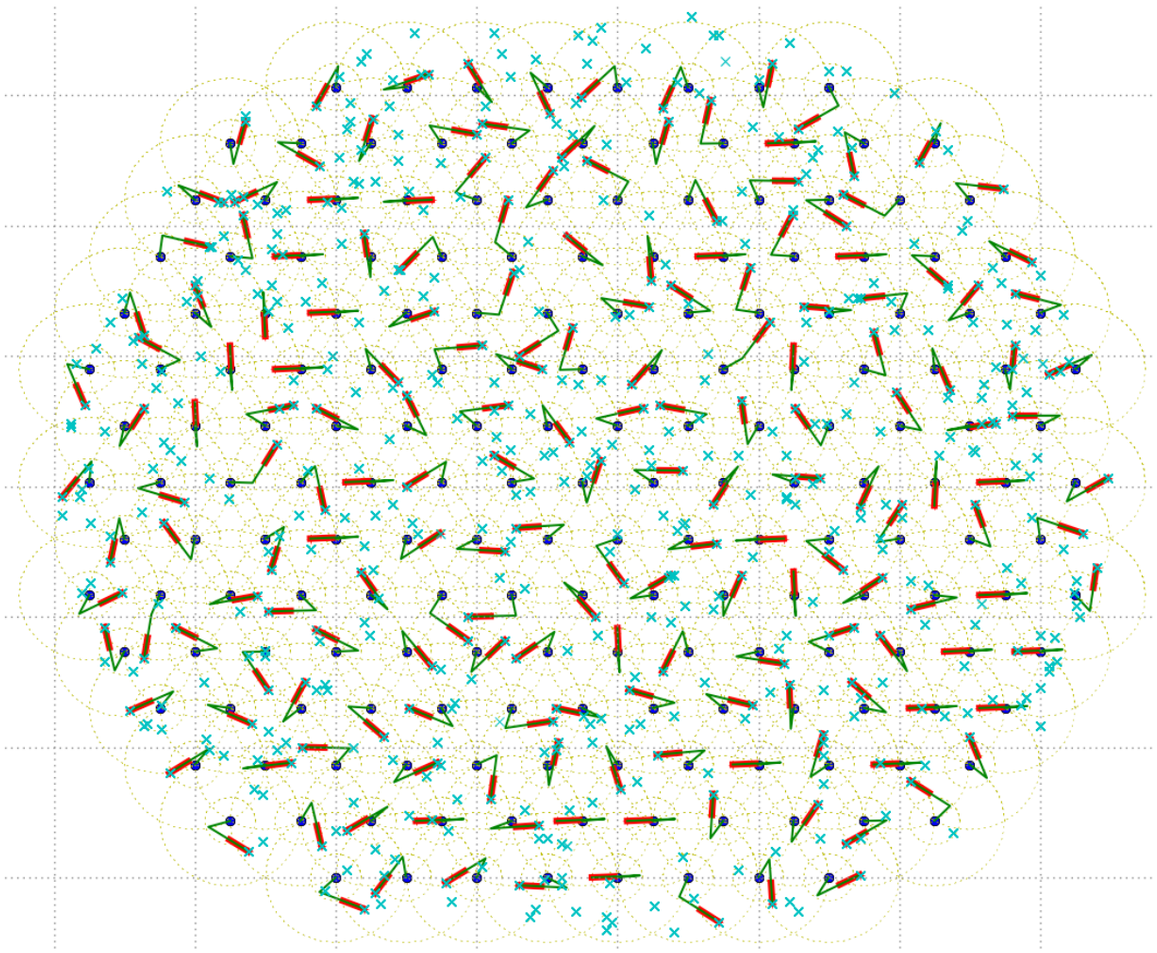
4) choose the sky position in the fibre list with the lowest number of targets

5) loop over different nodding to reach the best configuration

...	FIB_12	FIB_13	FIB_14	FIB_15	...
	TAR_1	TAR_1	TAR_1	TAR_2	
	TAR_2	TAR_2	TAR_4	SKY_4	
	SKY_1	TAR_3	SKY_4		
	SKY_2	SKY_1	TAR_3		
		SKY_2	SKY_2		
		SKY_3			



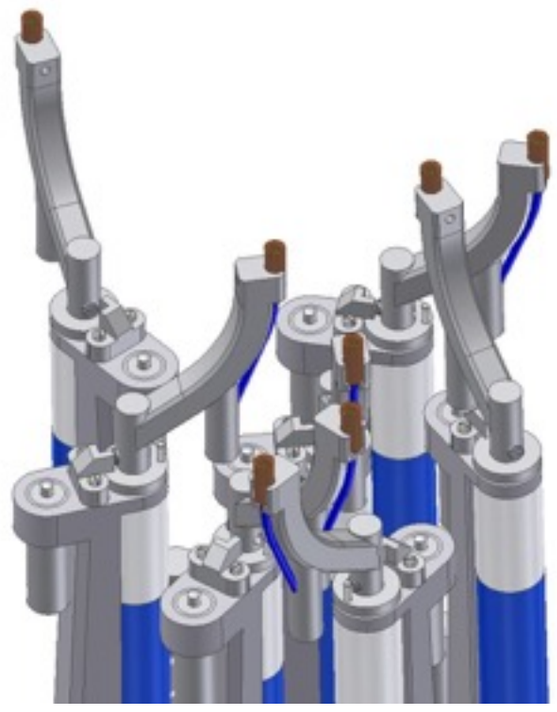
MOONS Spectrograph



more than 1000 fibres

3 observing modes:

- Stare mode
- XSwitch mode
- Stare+Nod mode

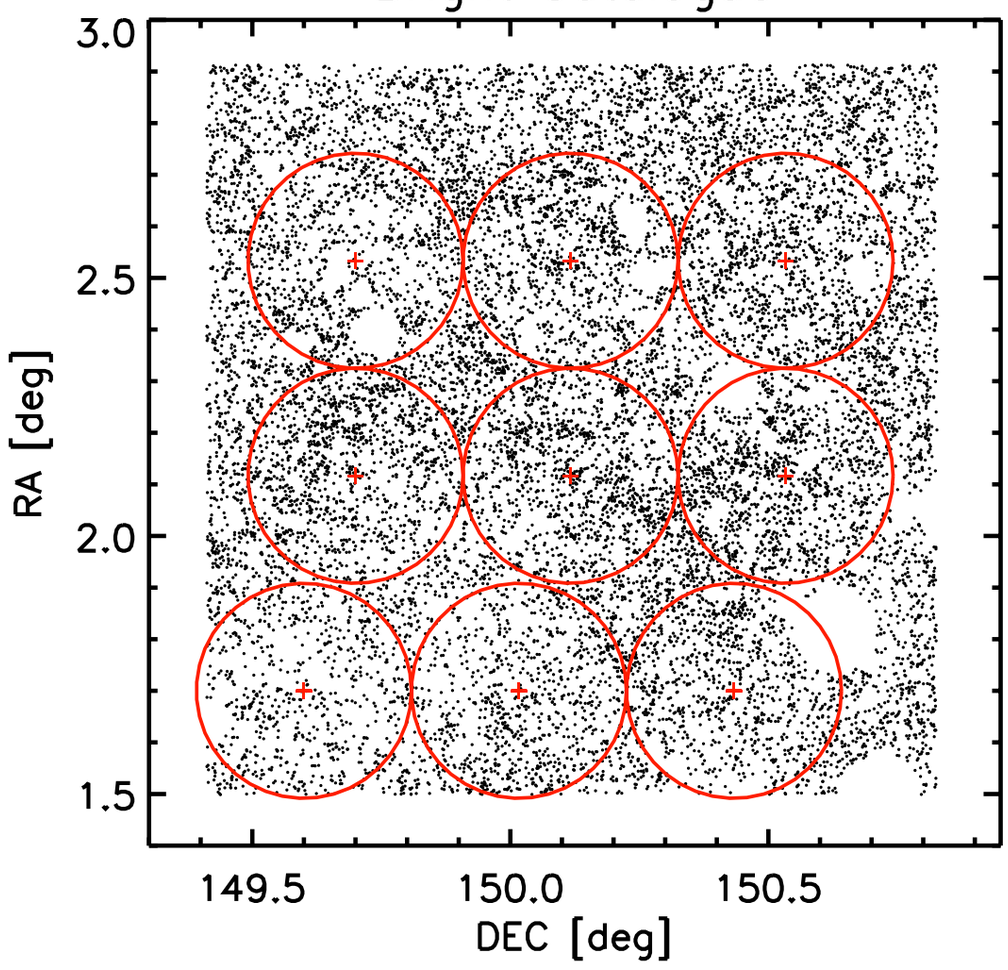


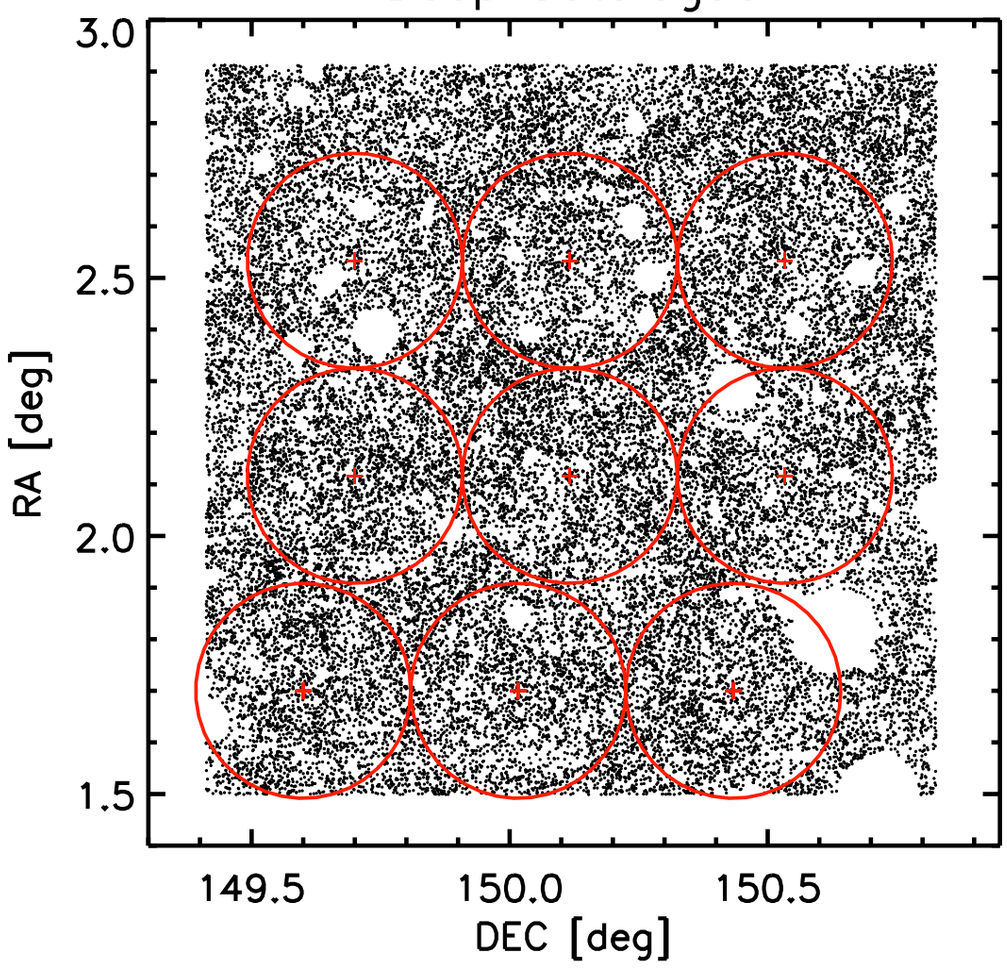
Some results …

INPUT CATALOGUE:
COSMOS photometric redshift catalogue v1.5 (Ilbert et al. 2008)

Bright Sample
K = 22.5 & 0.8 < z < 1.4
Surface density ~1000 per FOV

Deep Sample
K = 23.5 & z > 1.4
Surface density ~2500 per FOV





Stare Mode OUTPUT

positioner
TAR not allocated
TAR allocated

1025 fibers
1329 targets
1159 selectable tar
851 fib allocated

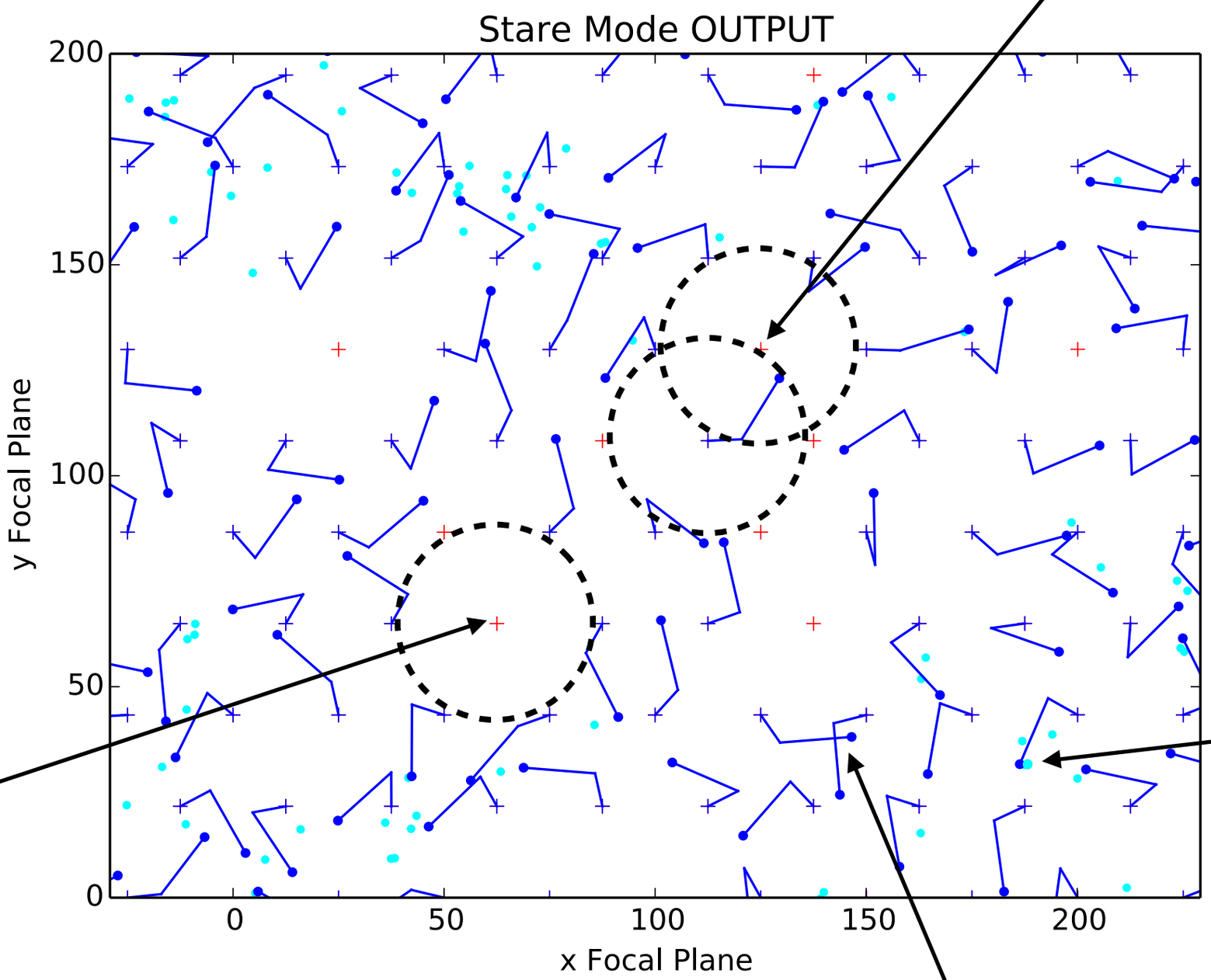
y Focal Plane

400
200
0
−200
−400

−400
−200
0
200
400

x Focal Plane

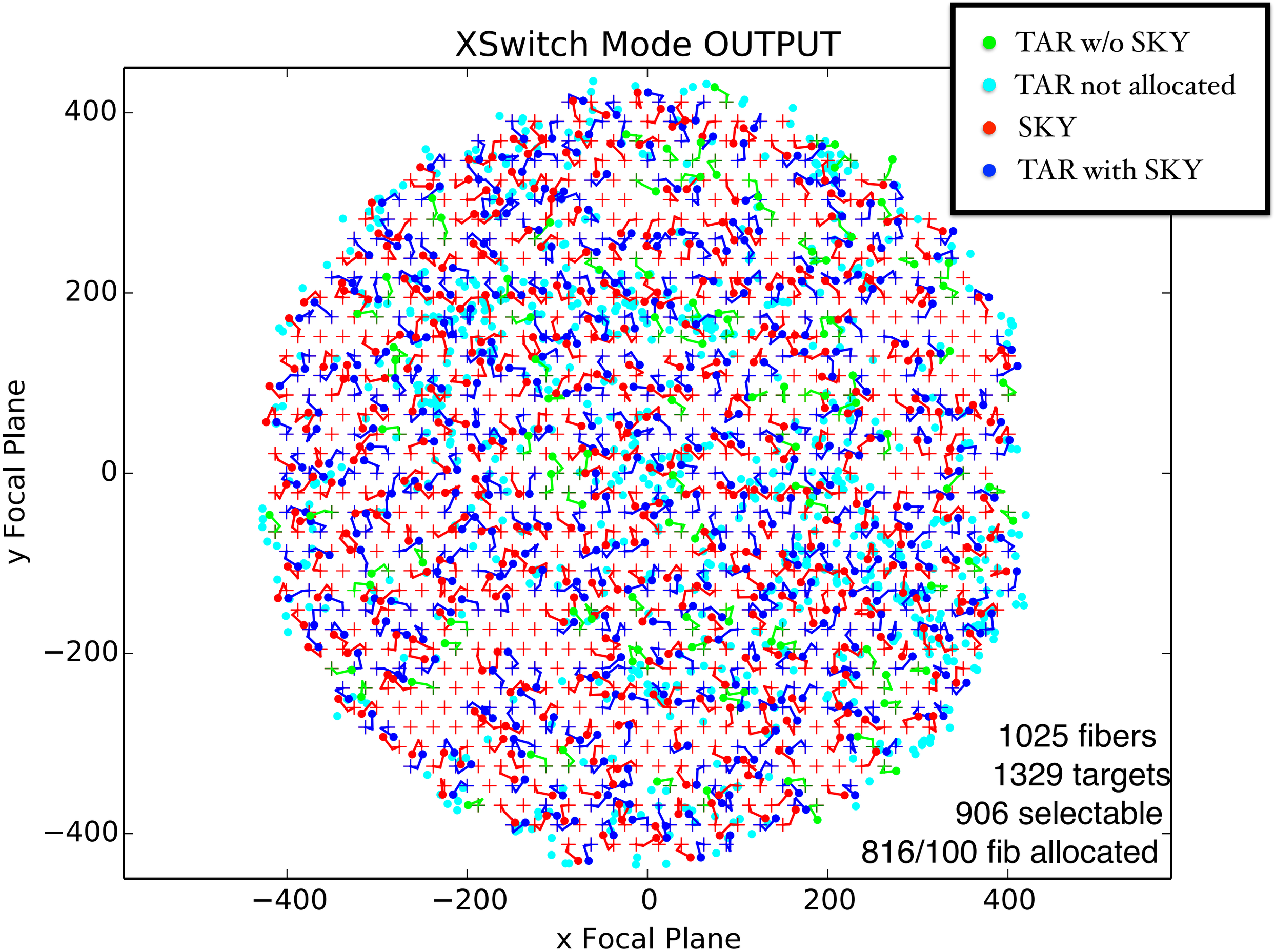
Inevitable Null
fibre After OPT



NULL fibre
before OPT

Objects
too close

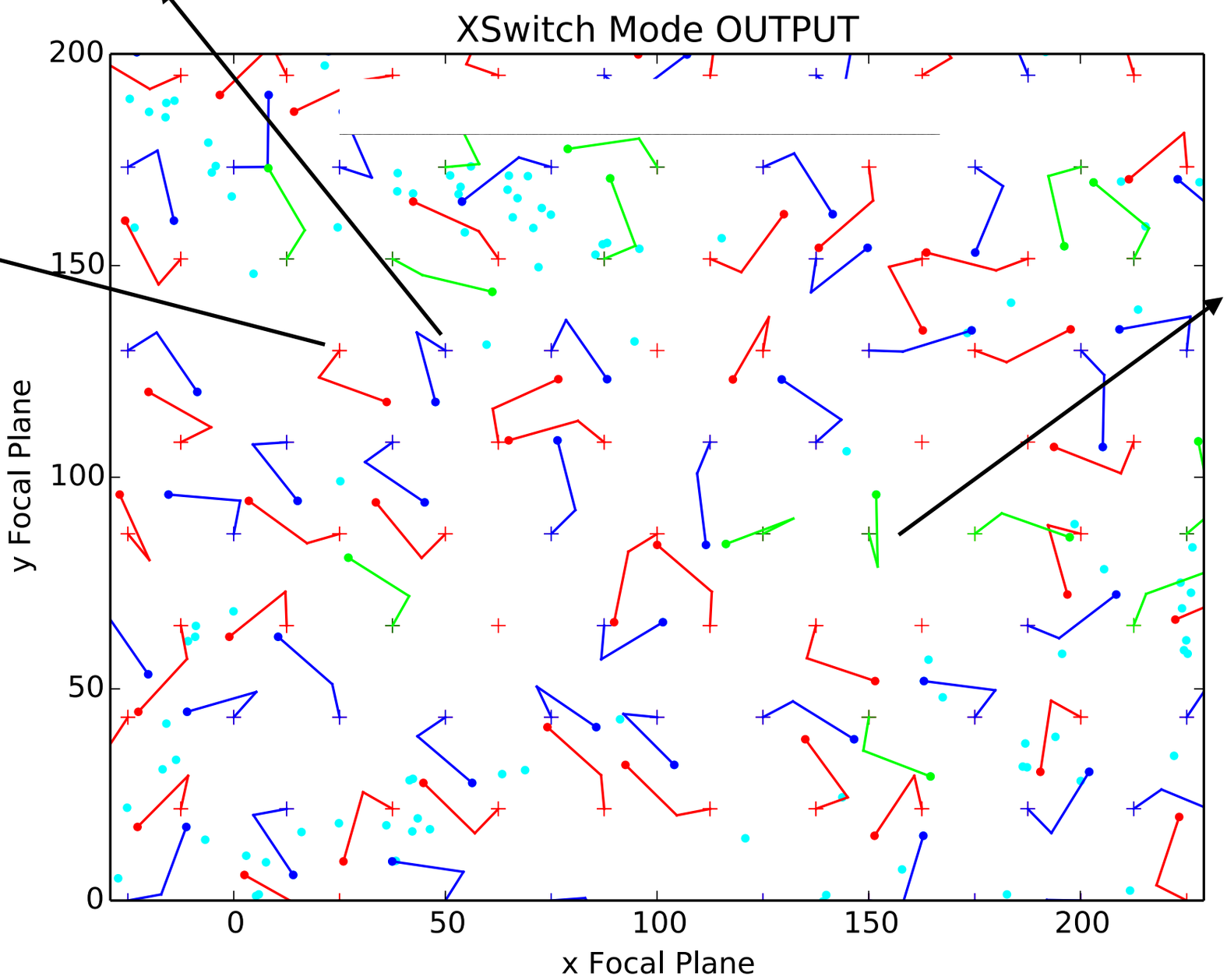
Collision


XSwitch Mode OUTPUT
TAR w/o SKY
TAR not allocated
SKY
TAR with SKY
1025 fibers
1329 targets
906 selectable
816/100 fib allocated
400
200
0
−200
−400
−400
−200
0
200
400
y Focal Plane
x Focal Plane

Fibre allocated
to a target

Fibre allocated
to a sky position

Fibre allocated
to a target
(w/o sky)



nodding direction

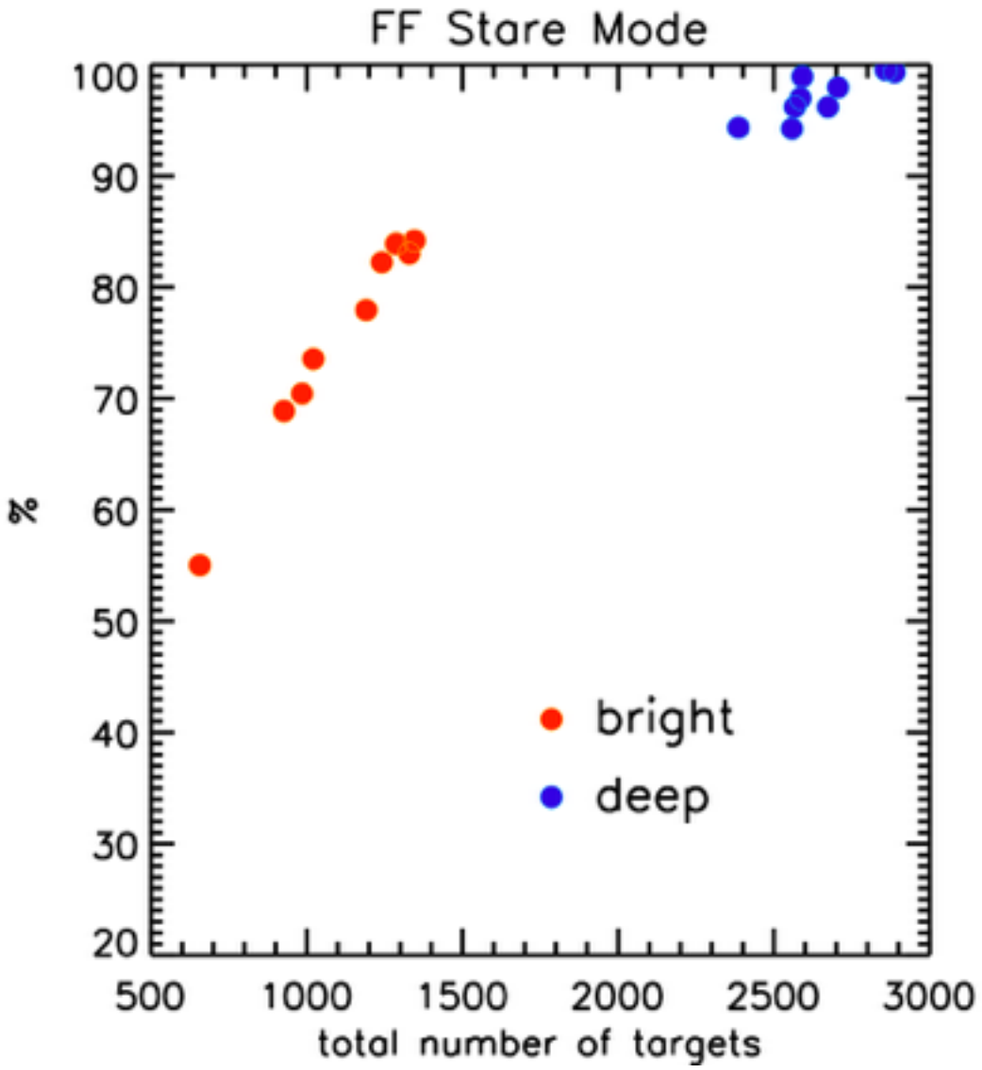
Statistics

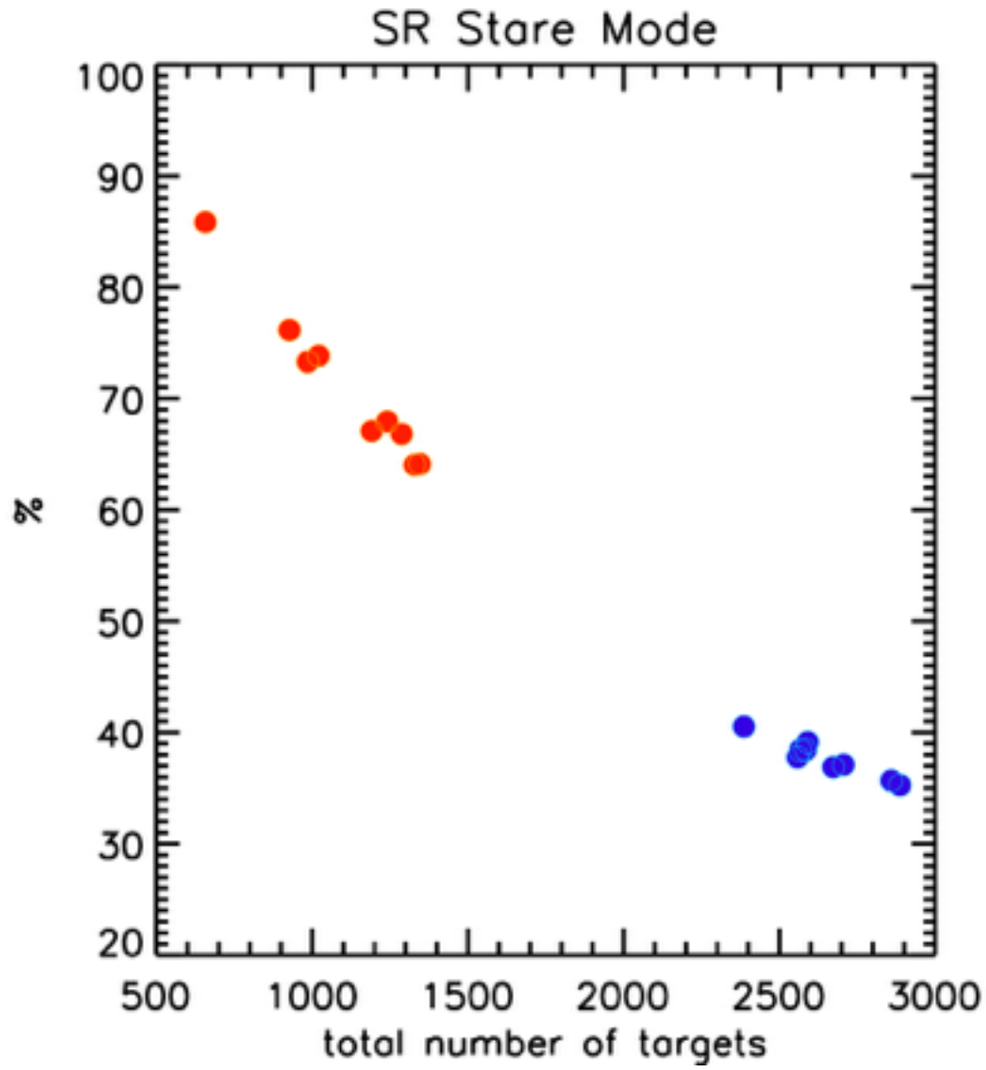
Filling Factor (FF) :

number of fibres allocated / total number of fibres

Sampling Rate (SR) :

number of objects observed / total number of objects in the FoV





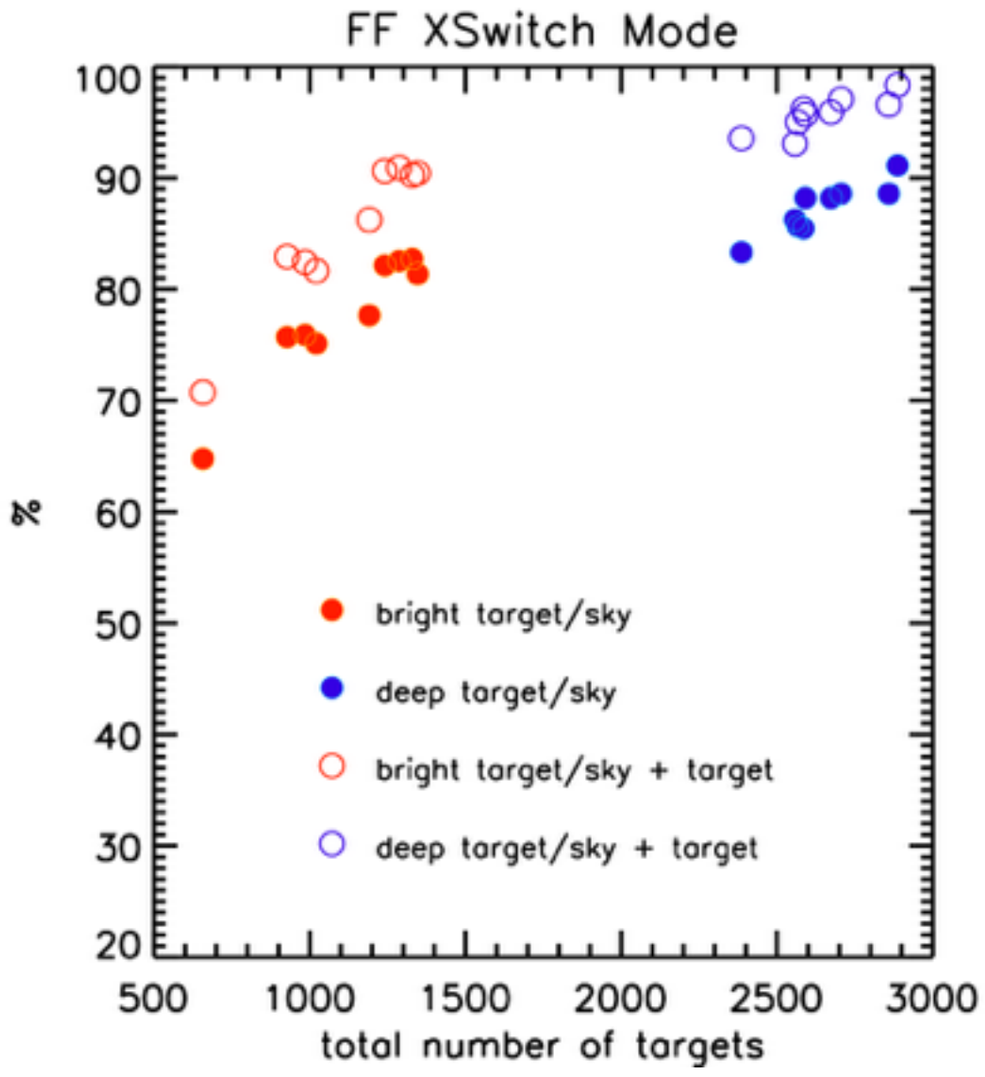
Statistics

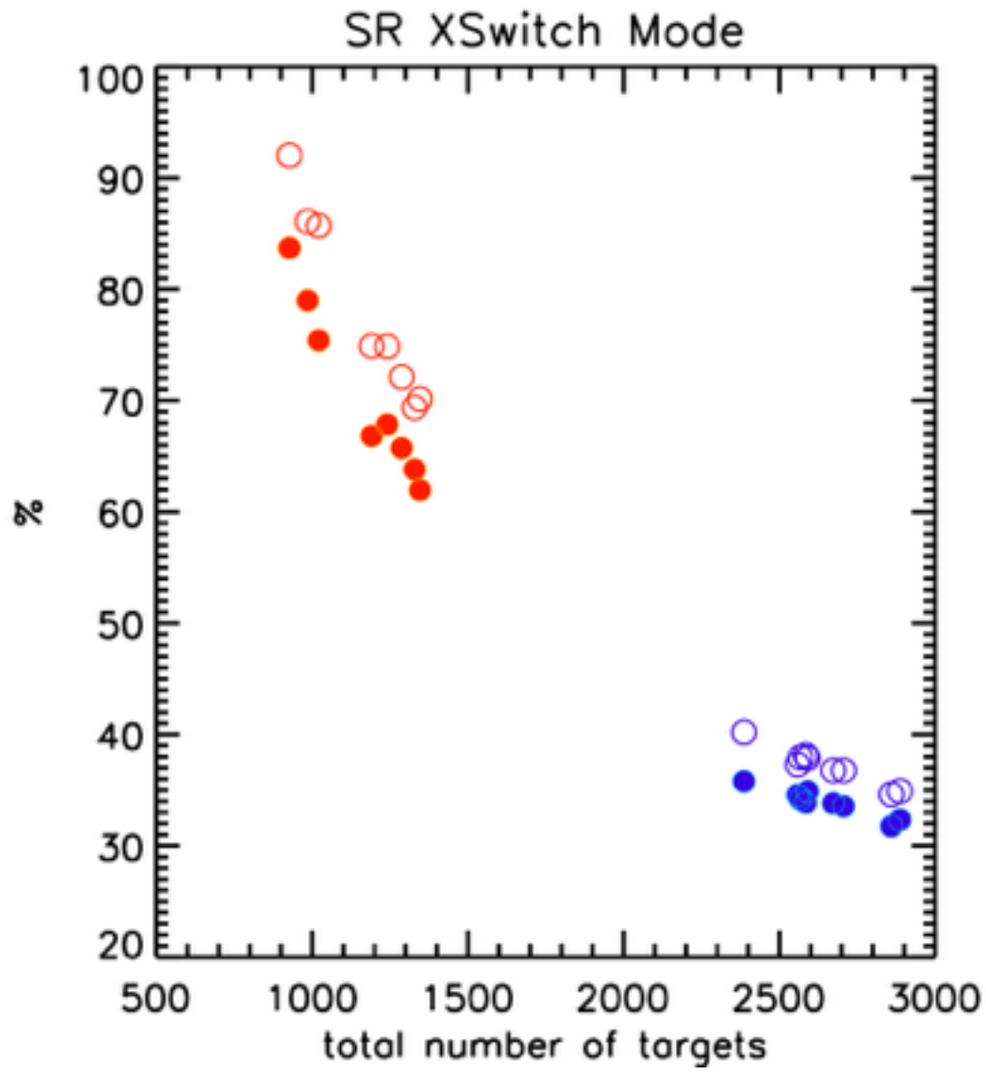
Filling Factor (FF) :

number of fibres allocated / total number of fibres

Sampling Rate (SR) :

number of objects observed / total number of objects in the FoV





end