COROT Templates
How robust they are?

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LAM
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DE MARSEILLE

Plan

- The exoCOROT templates context.
- The build up process for robust templates
- Examples & results
- Conclusions & Perspectives

Robustness

- We say a template “robust” when the measured S/N shows low sensitivity to:
  - the PSF actual profile due to:
    - Modeling errors
    - Position shifts, bias in position and rotation
    - Color index errors, crowding
  - The crowding context & stray light:
    - Ex.gr. CENTER – ANTICENTER
- To be robust, templates must be tailored from a large collection of specific windows.

Windowing procedure

Candidates

- "Specific windows" : **Determine** the best photometric window for each of 2 x 6000 stars (2 CCDs).

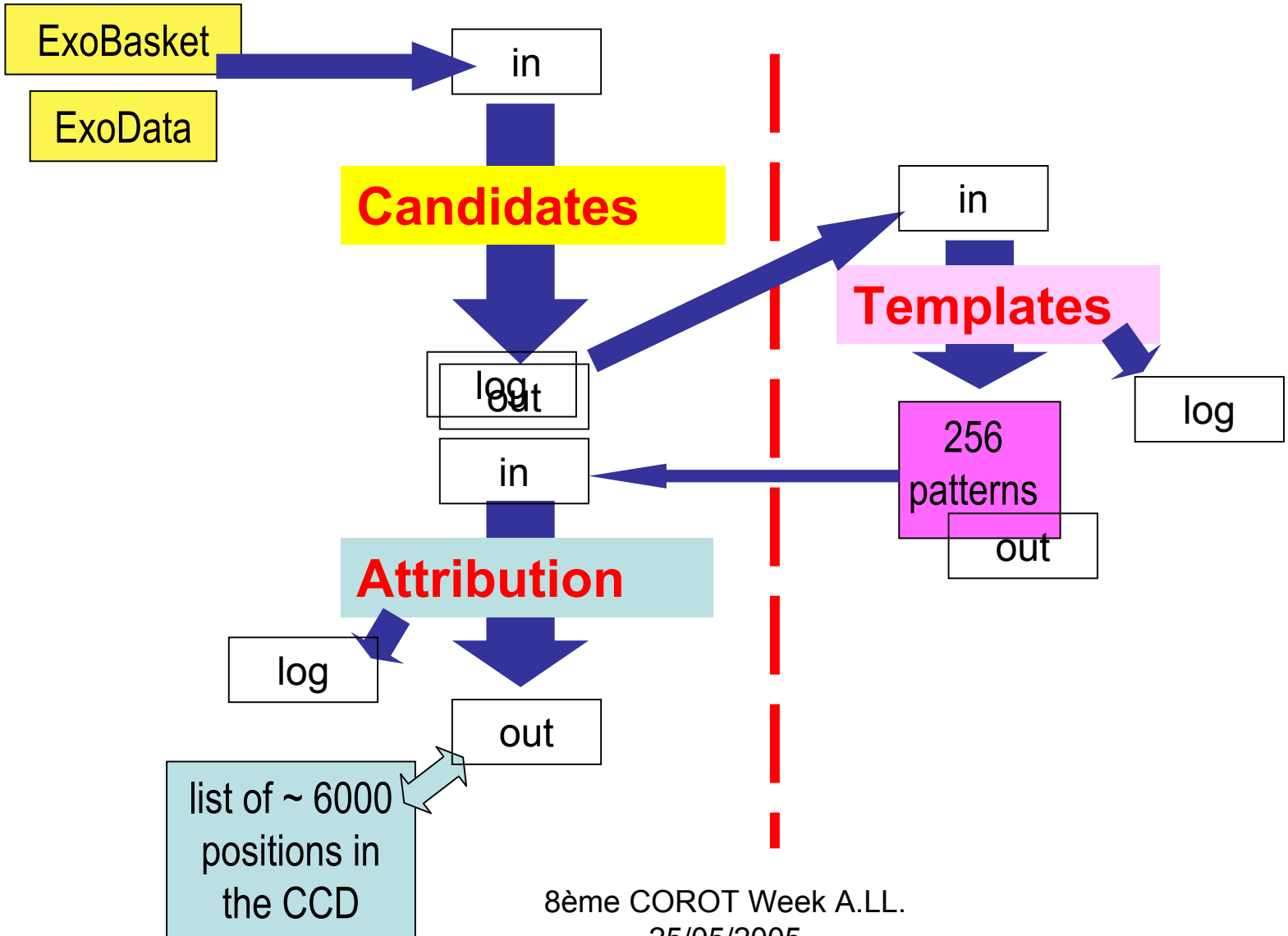
Templates

- "Generic windows" : **Cluster** this collection in a reduced set of 256 patterns.

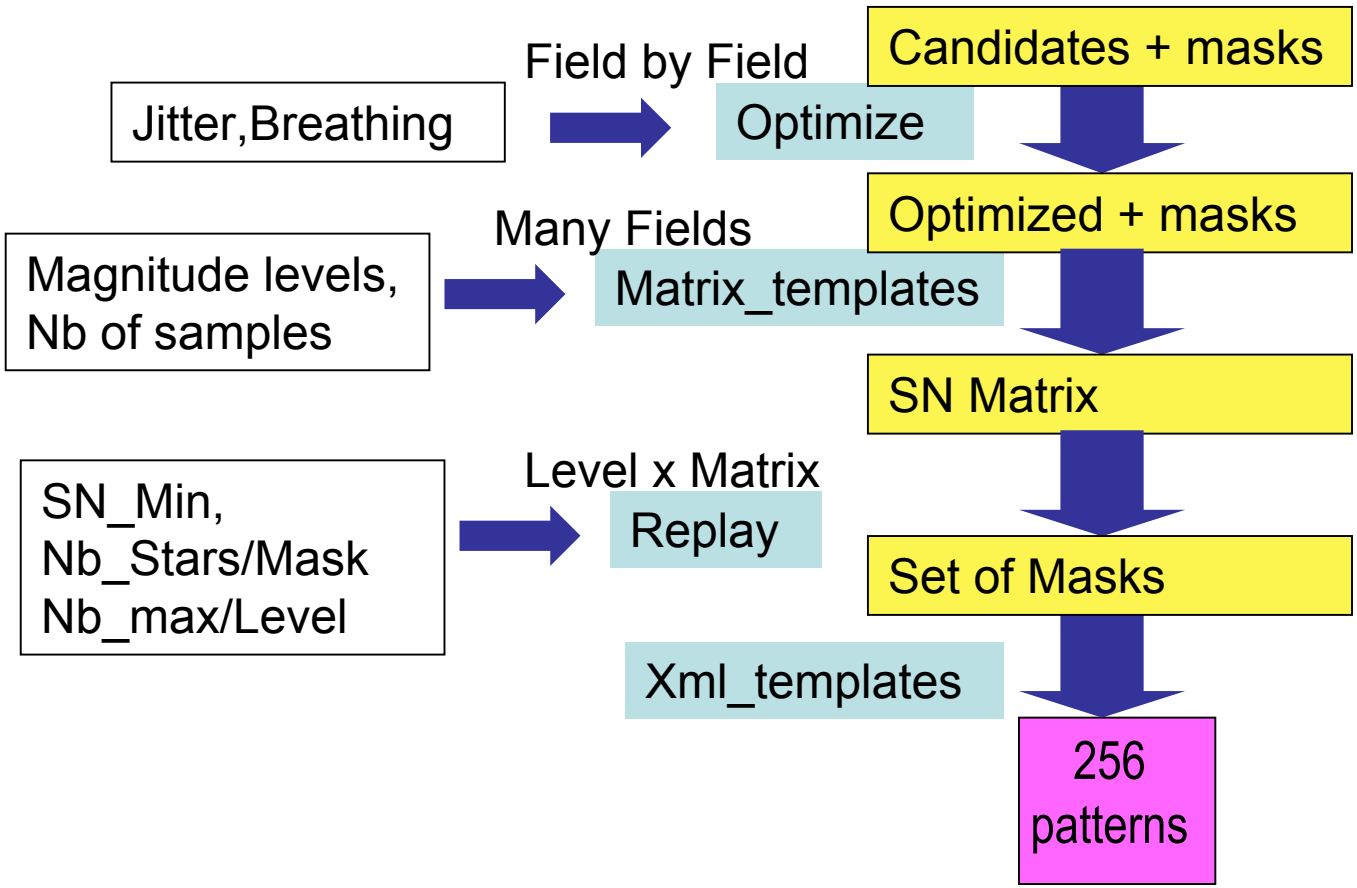
Attribution

- "Assignation" : **Associates** a generic window to each of 2 x 6000 stars.

Corot Windows in 3 procedures

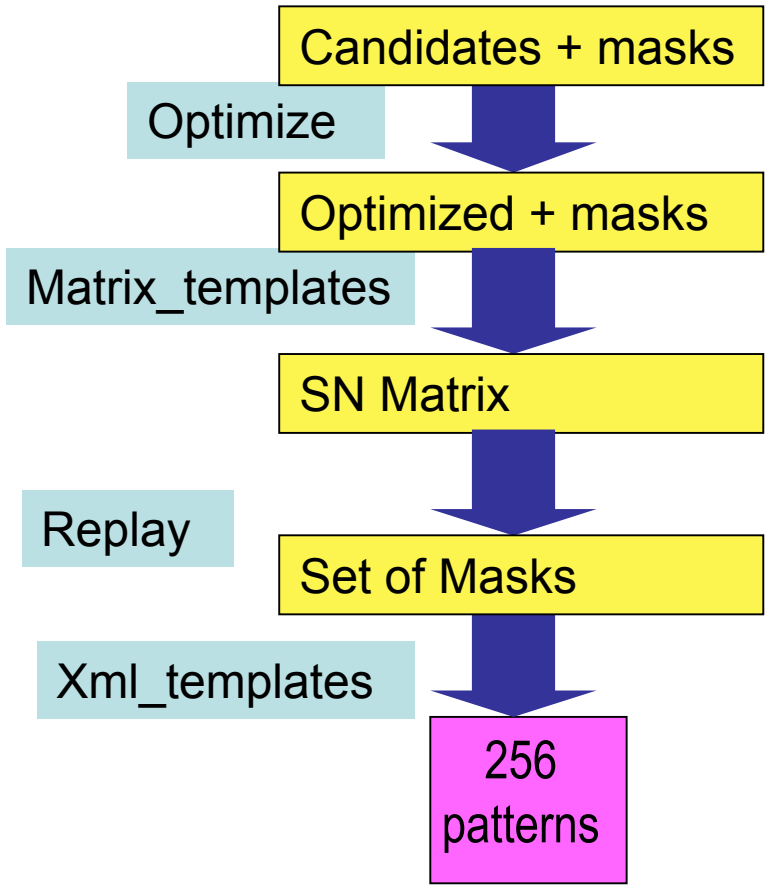


Procedure Templates



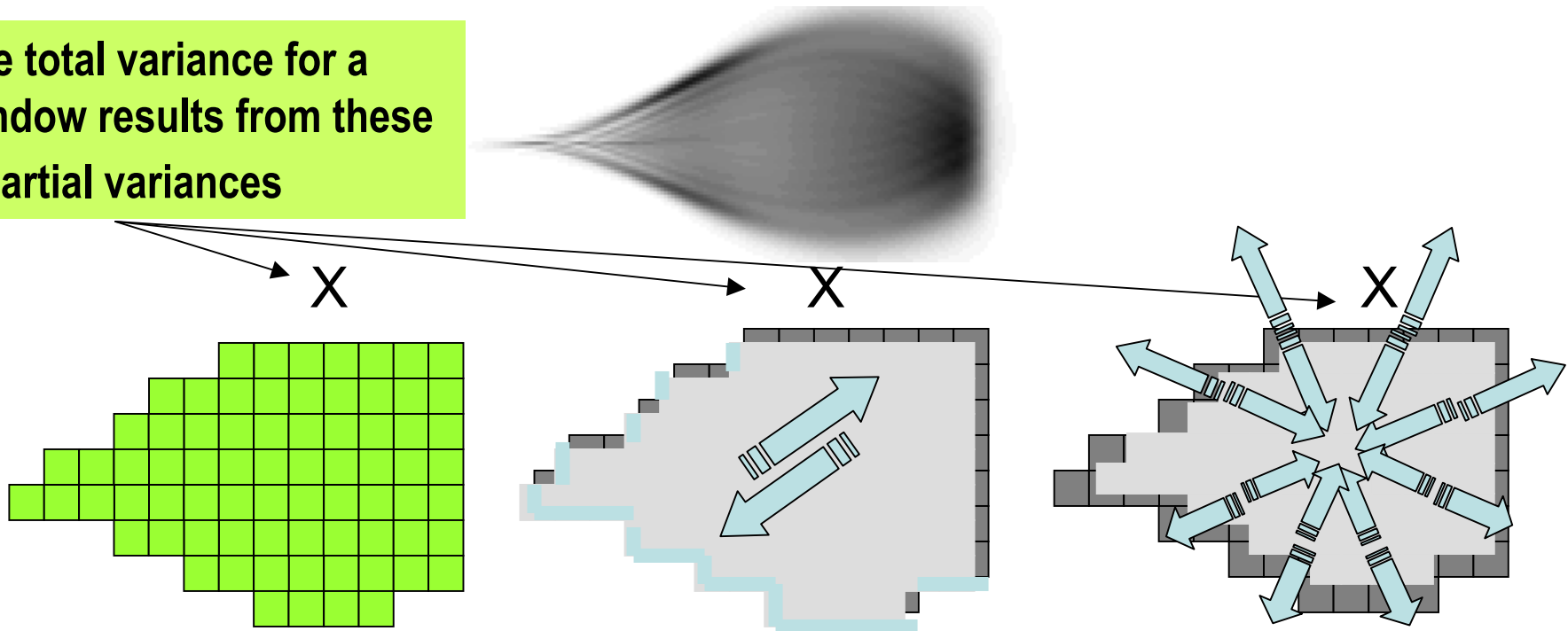
Build up strategy

- Optimization
  - Jitter & breathing levels
- Templates strategy
  - Set of input fields (set of windows)
  - Classes vs. parameters (magnitude, color, CCD, …)
- Attribution strategy
  - Optimize total number vs. optimize S/N



Adapt the window to jitter and breathing through exhaustive test

The total variance for a window results from these 3 partial variances



$N_{Poisson}$ N_{Jitter} $N_{Breathing}$

The best window (jitter & breathing)

The noise «expression» to be minimized is:

$$V = V_{Poisson} + c_J.V_{Jitter} + c_B.V_{Breathing}$$

$V_{Poisson}$ 1) depends on the window surface, 2) is a white noise

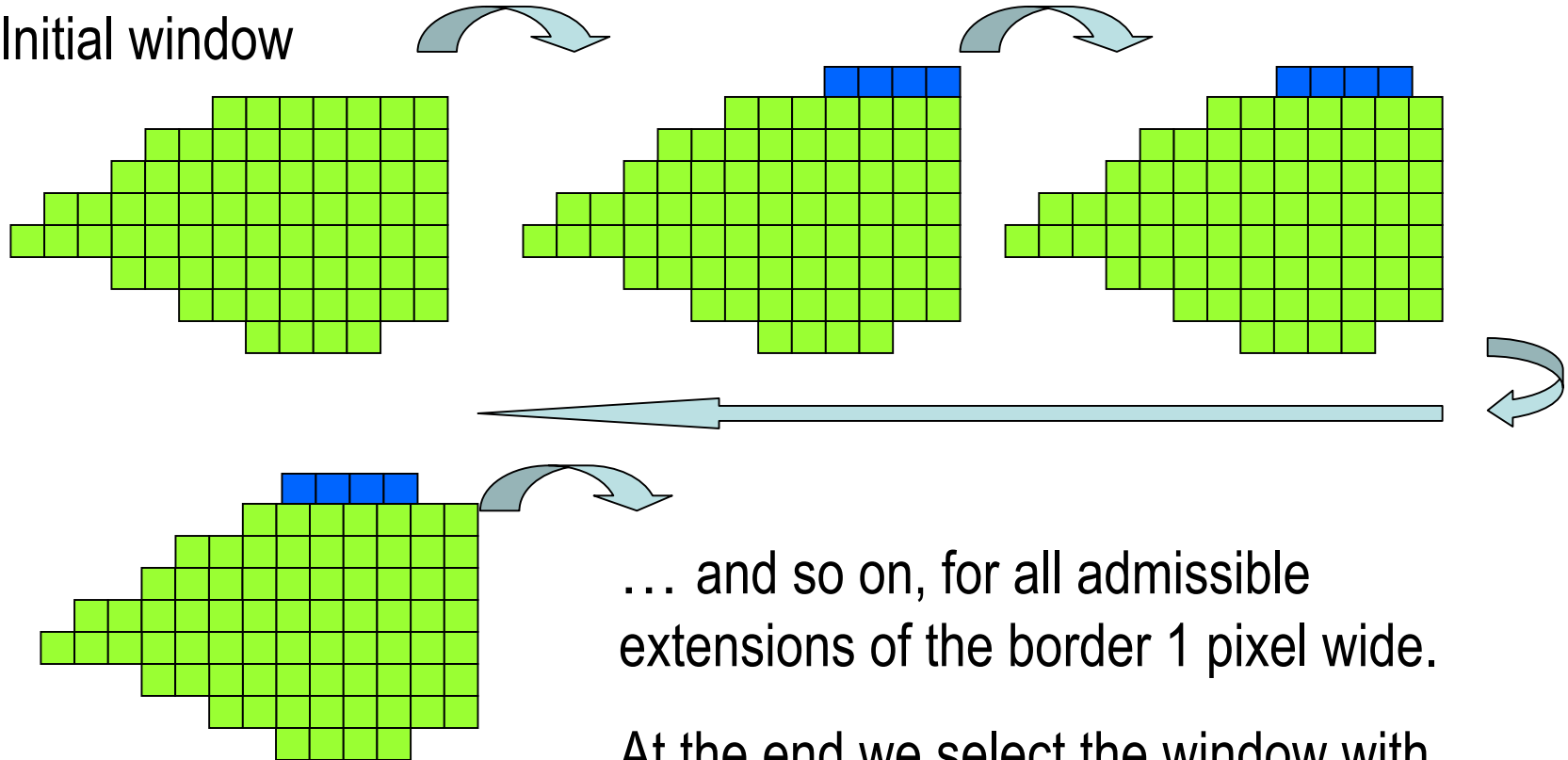
$c_J\ V_{Jitter}$ 1) depends on the window border, 2) is a white noise

$c_B V_{Breathing}$ 1) depends on the window border, 2) is mainly a residual «orbit» noise

Because $V_{Breathing}$ is different from $V_{Poisson}$ and V_{Jitter} c_B adds only residual white noise <u>after corrections</u>.

Optimization: Adapt the window to jitter and breathing by exhaustive test

Initial window



… and so on, for all admissible extensions of the border 1 pixel wide.

<u>At the end we select the window with best S/N</u>.

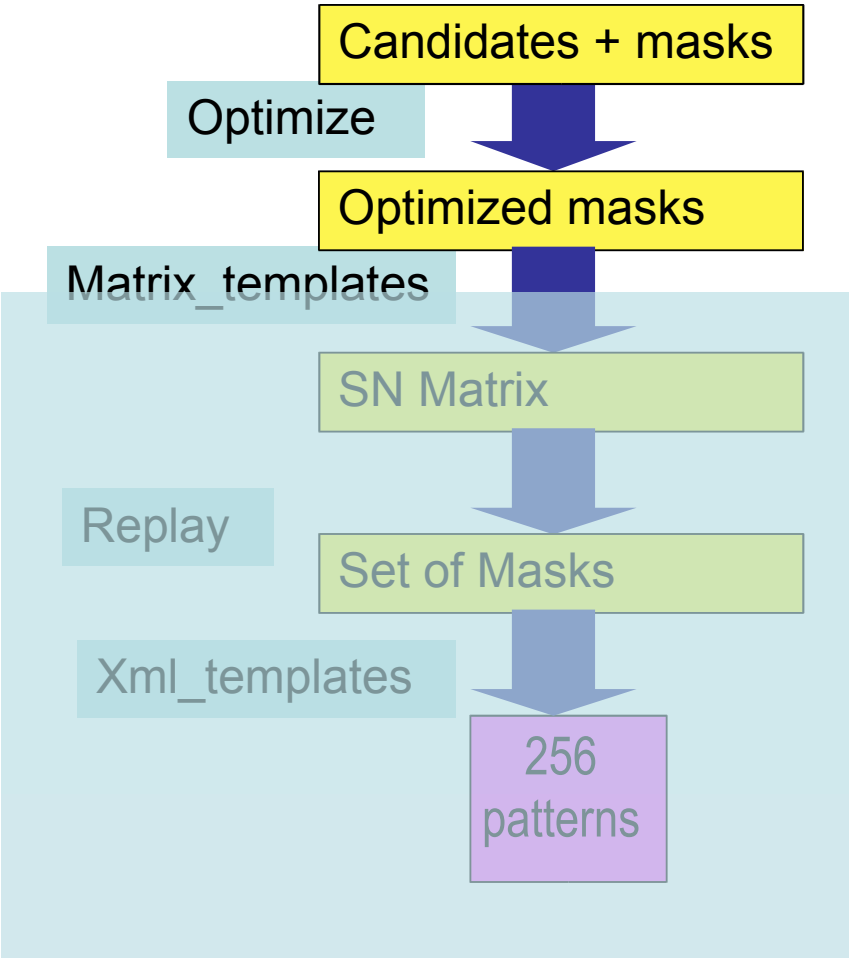
Key Parameters

VARIANCE (MAGNITUDE)

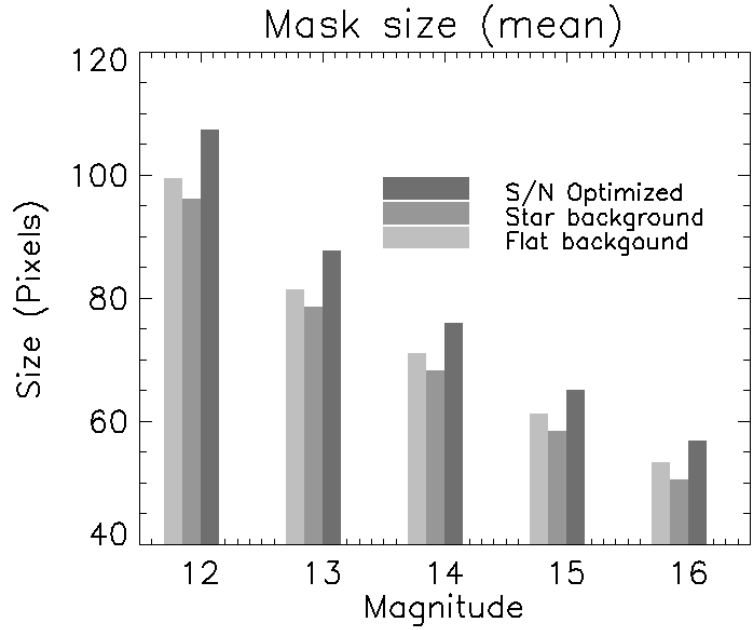
AREA (MAGNITUDE) → **?**

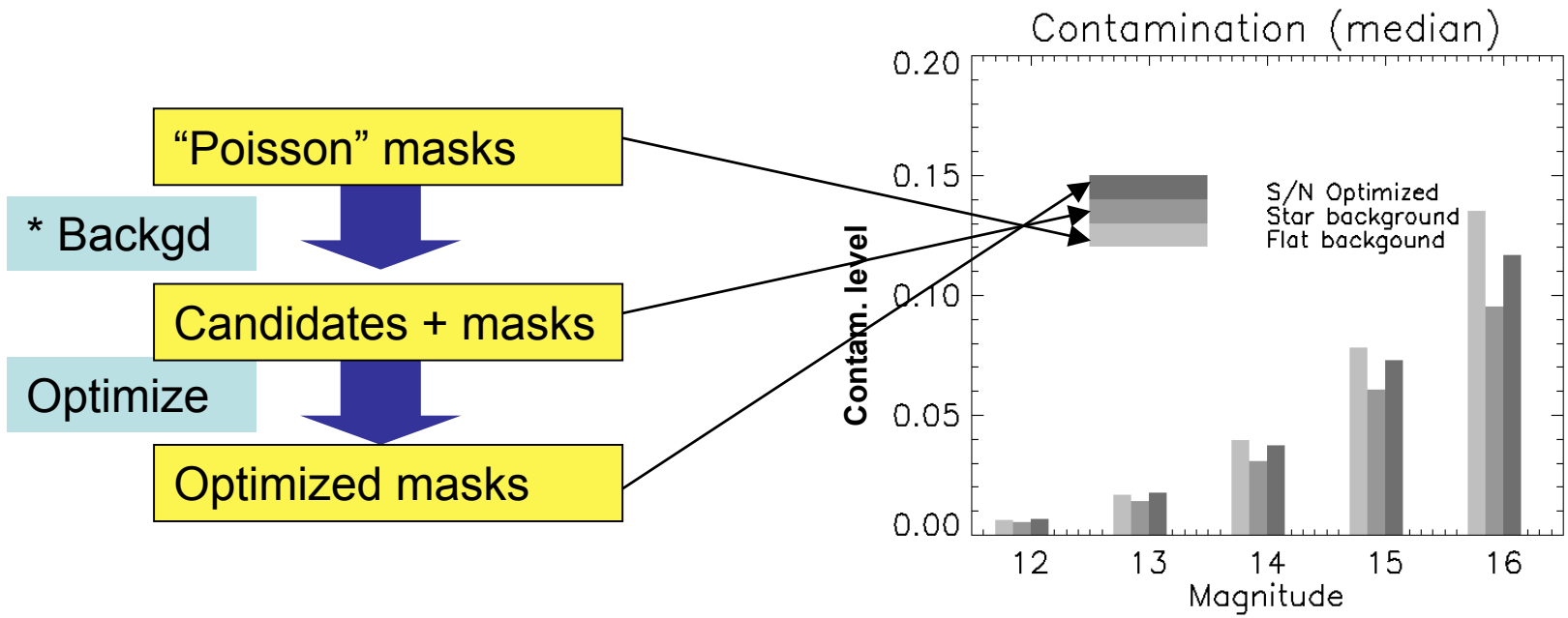
CONTAMINATION (MAGNITUDE) → **?**

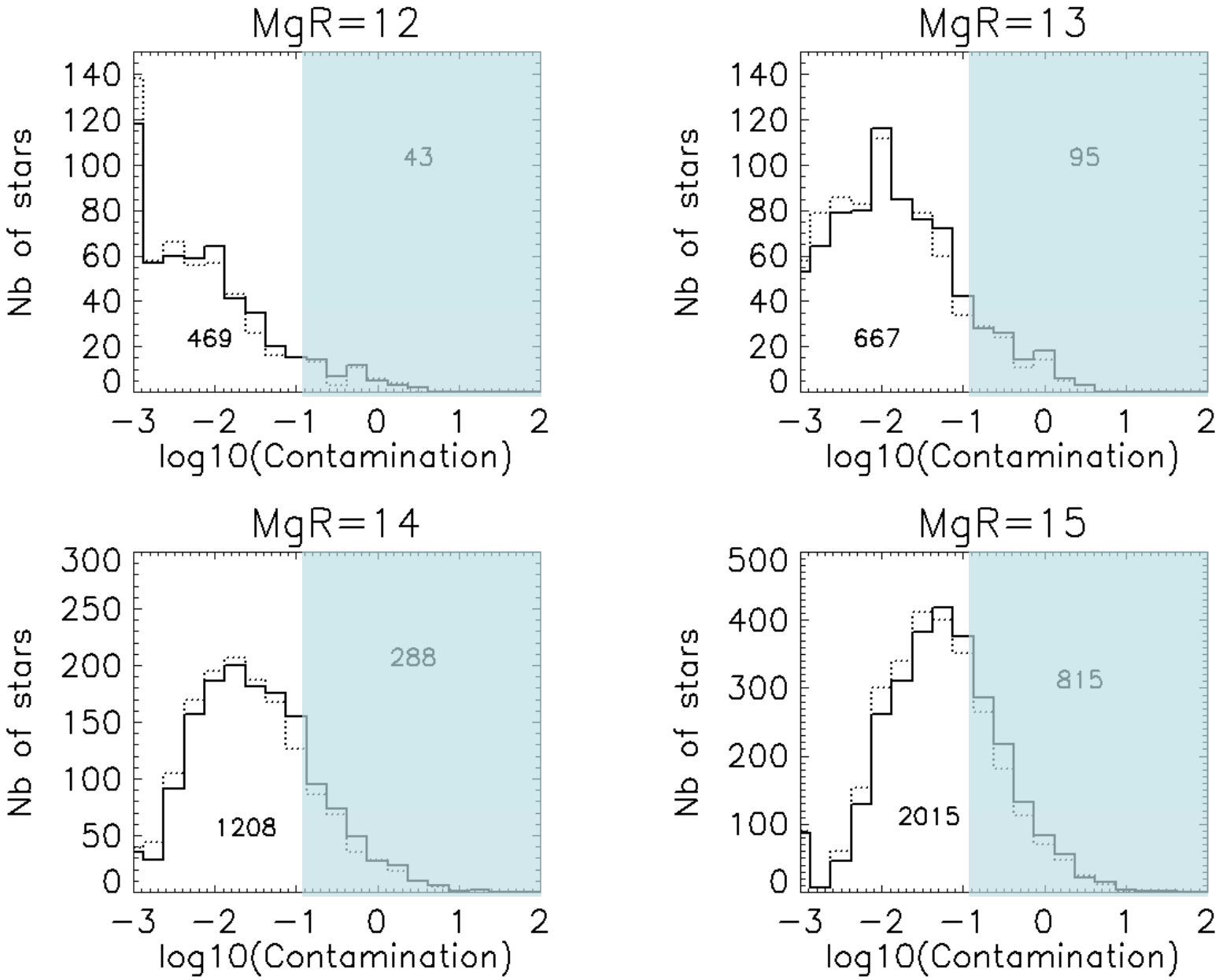
S/N RATIO (MAGNITUDE) → **?**

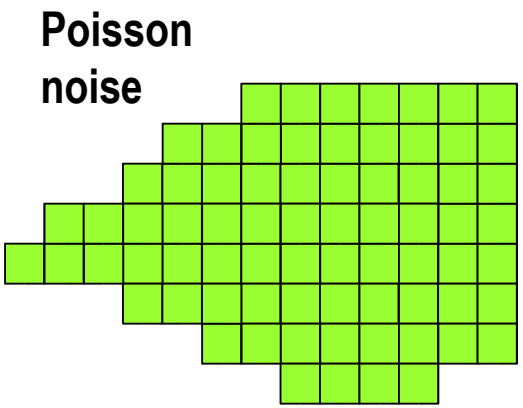


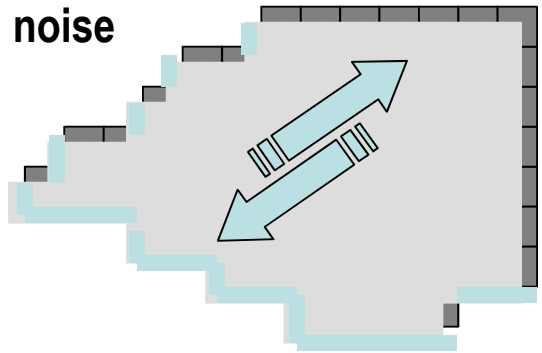
Contamination & mask size

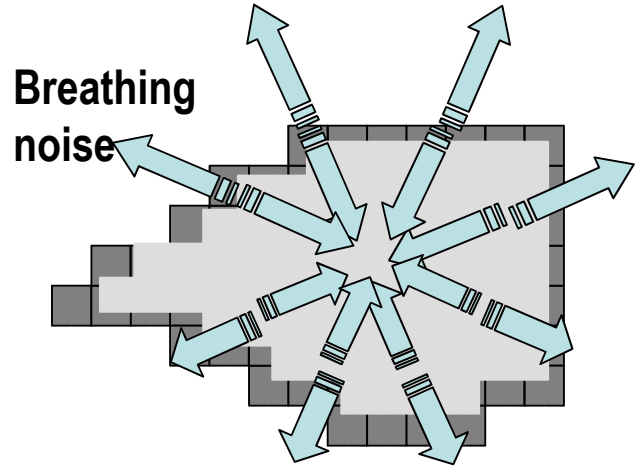





MgR=12
Nb of stars
log10(Contamination)
469
43
MgR=13
667
95
MgR=14
1208
288
MgR=15
2015
815

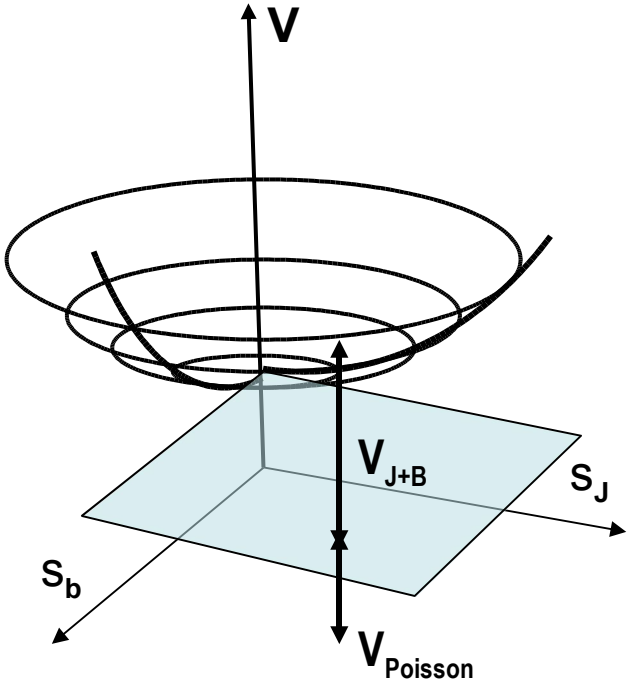


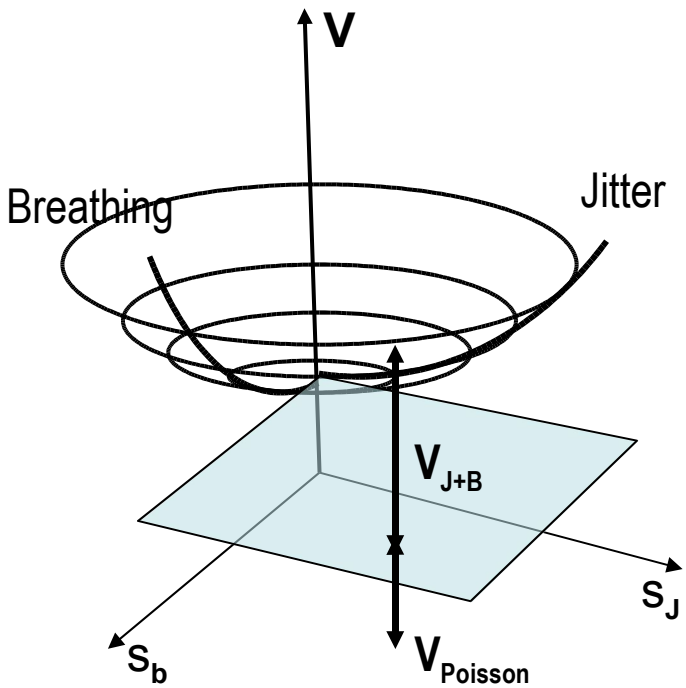




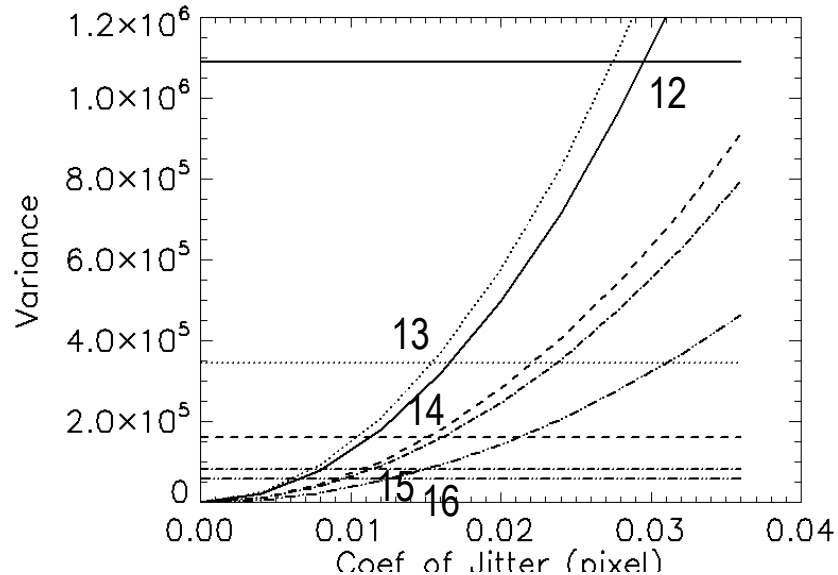
$$V = V_{Poisson} + s^2_J . V_{Jitter} + s^2_B . V_{Breathing}$$

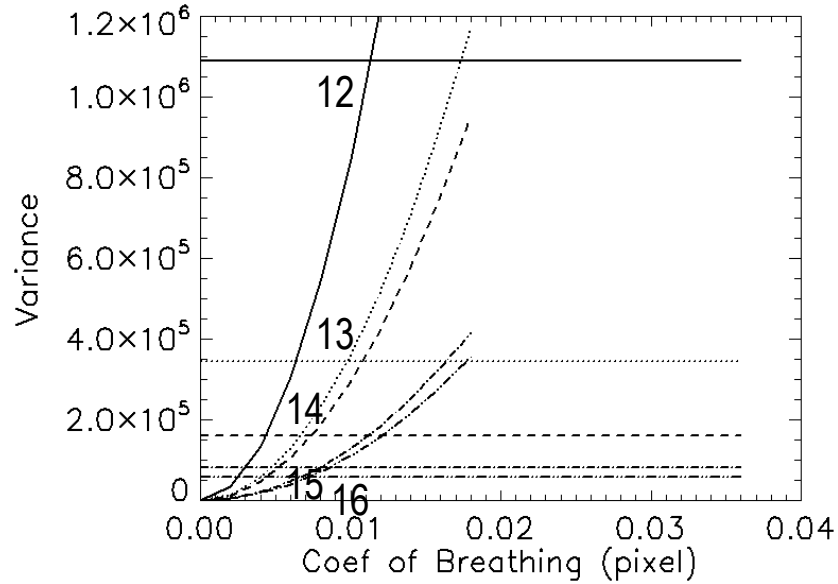
- $c_J = s_J^2$ (Jitter)
- $c_B = s_B^2$ (Breathing)
- Typical Values
  - Jitter : 0.2, 0.5, 0.2, 0.1 (pixel)
  - Breathing : 0.02, 0.03, 0.01, 0.005 (pixel)



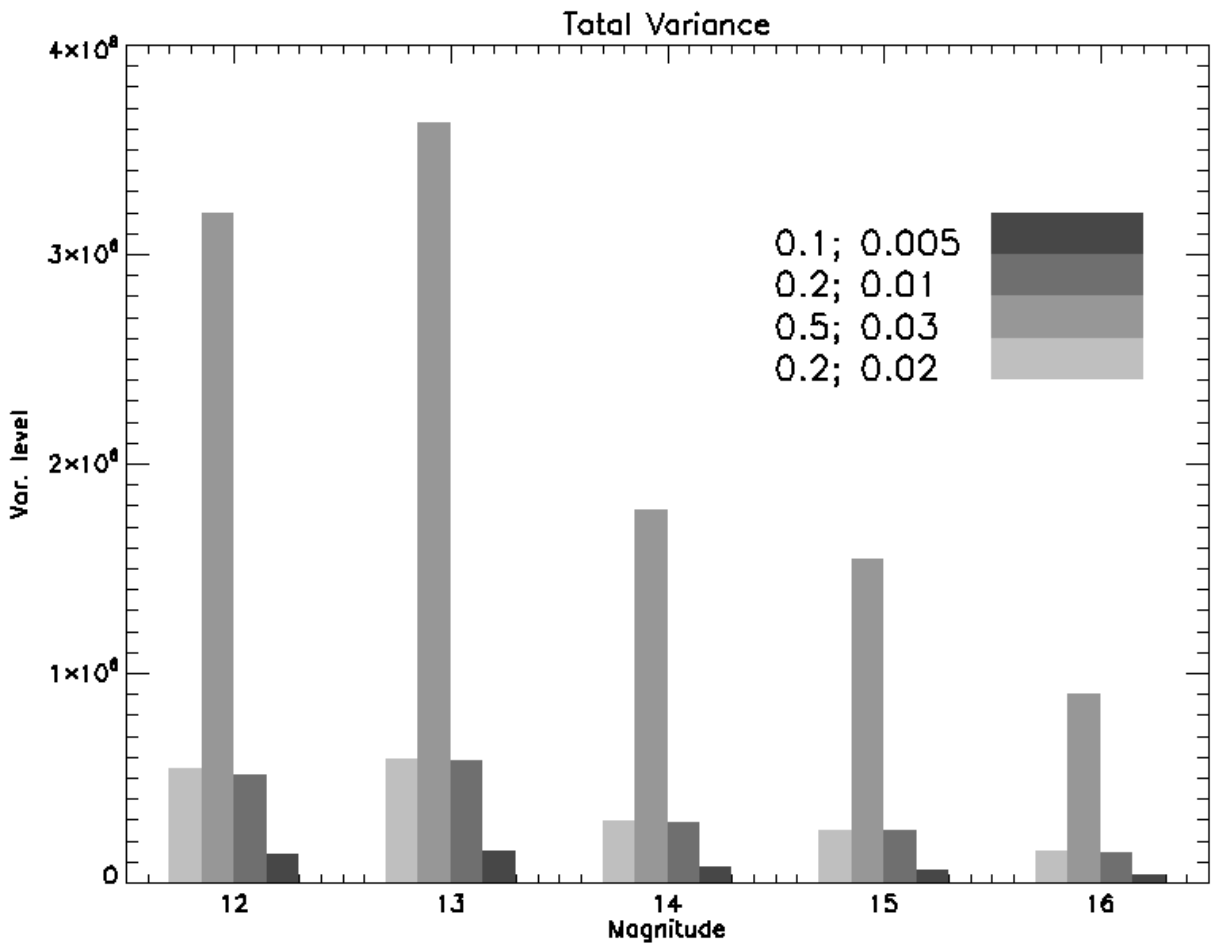


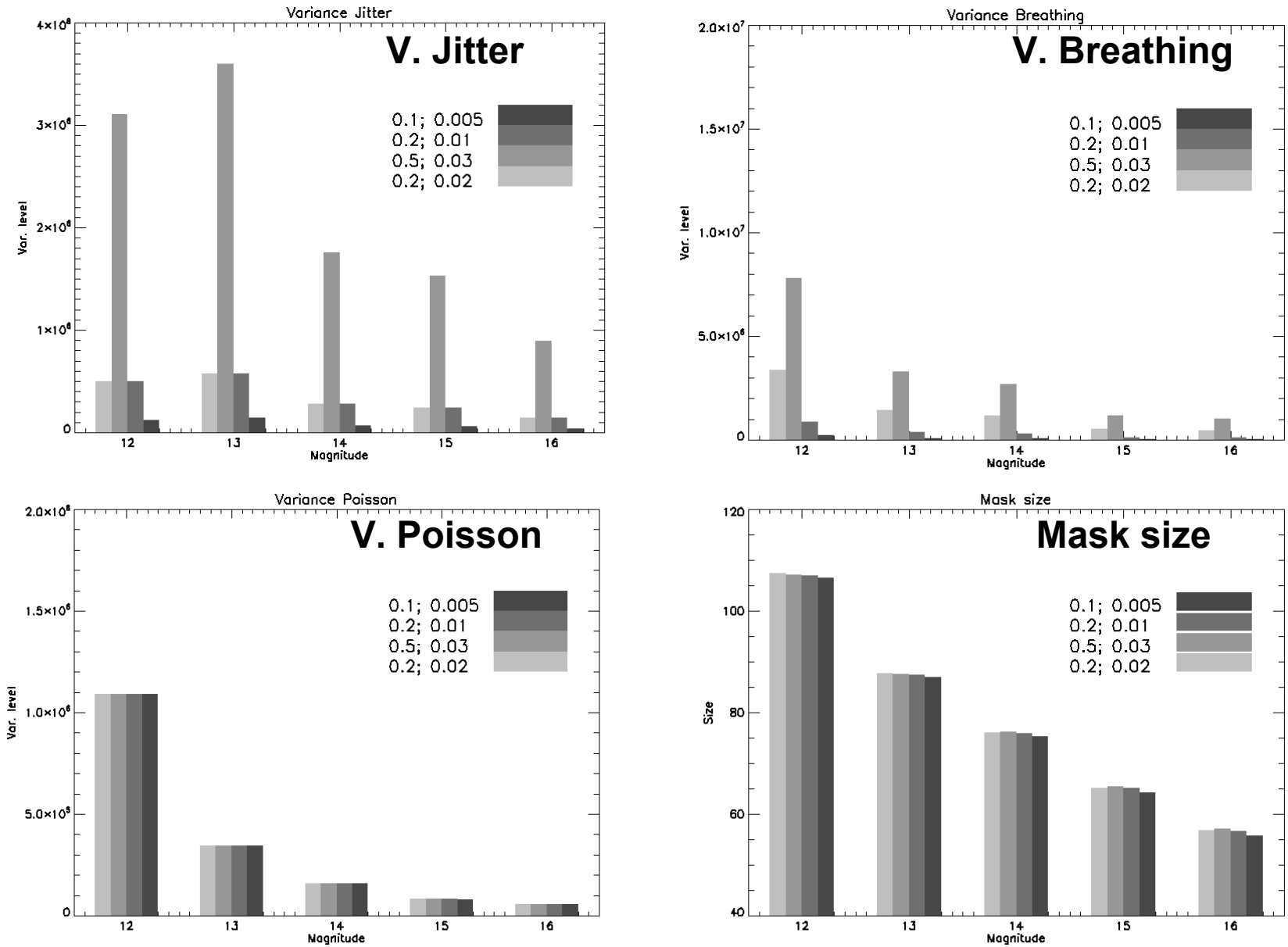
$$V = V_{Poisson} + s^2_J.V_{Jitter} + s^2_B.V_{Breathing}$$



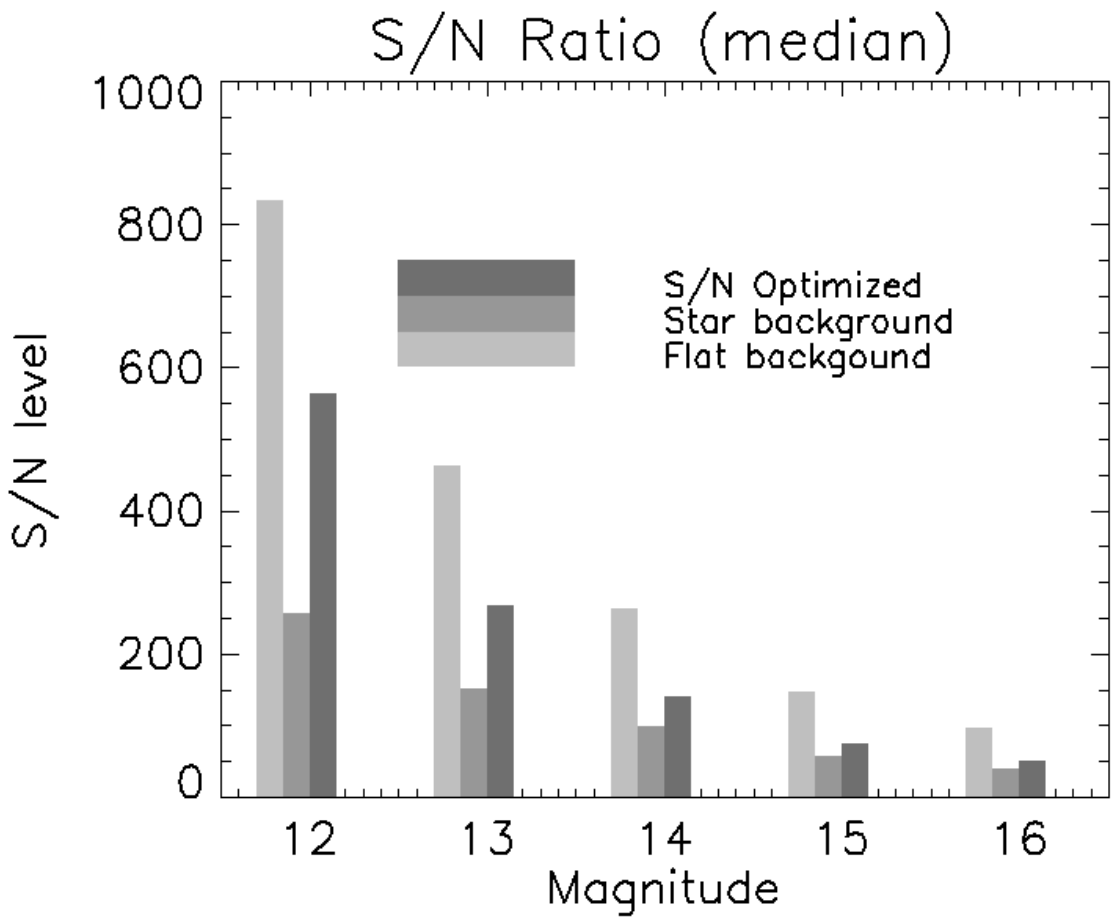


Variance depends on jitter & breathing

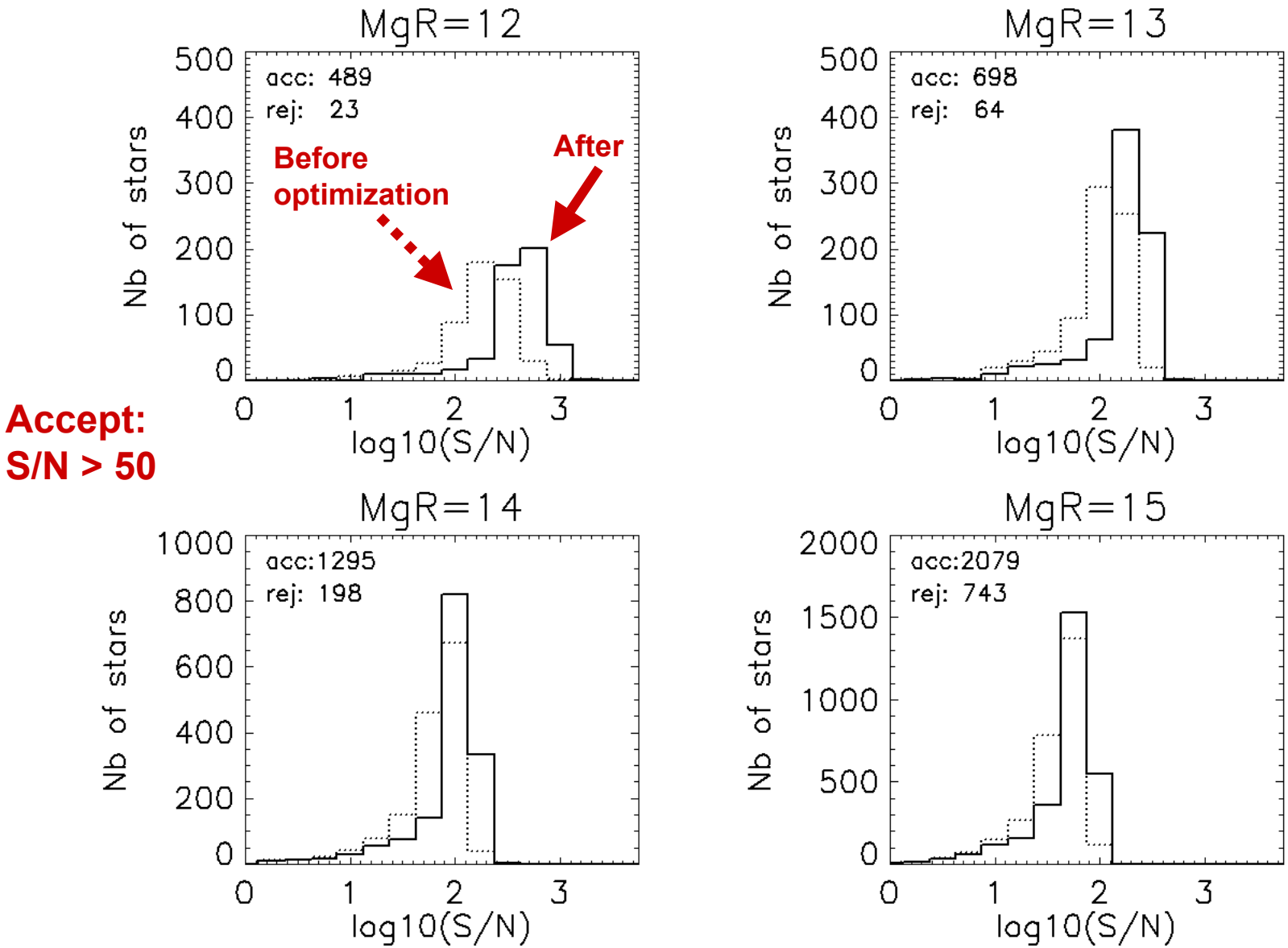



Variance Jitter
V. Jitter
0.1; 0.005
0.2; 0.01
0.5; 0.03
0.2; 0.02
Var. level
Magnitude
Variance Breathing
V. Breathing
Variance Poisson
V. Poisson
Mask size
Size

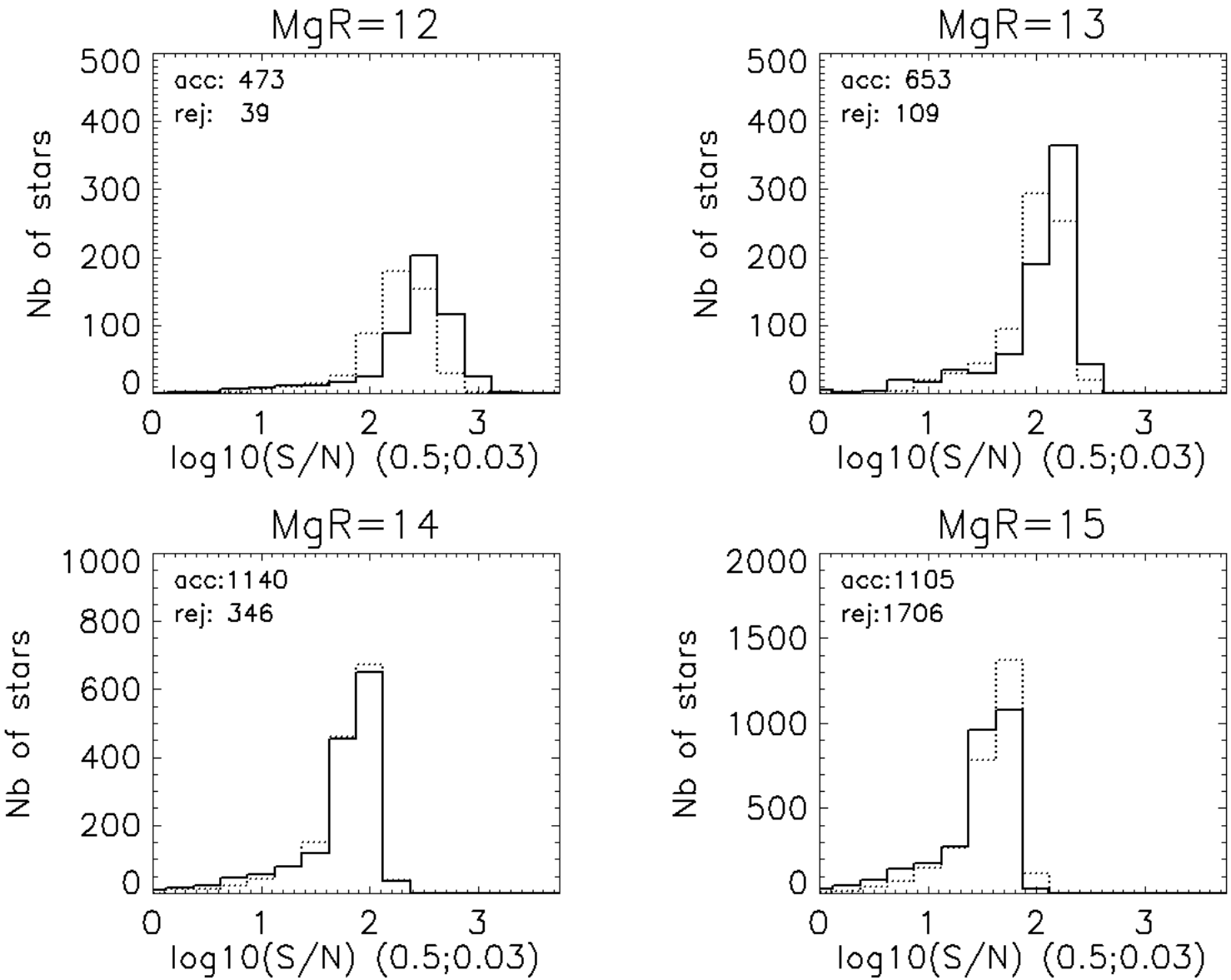
S/N ratio : optimization



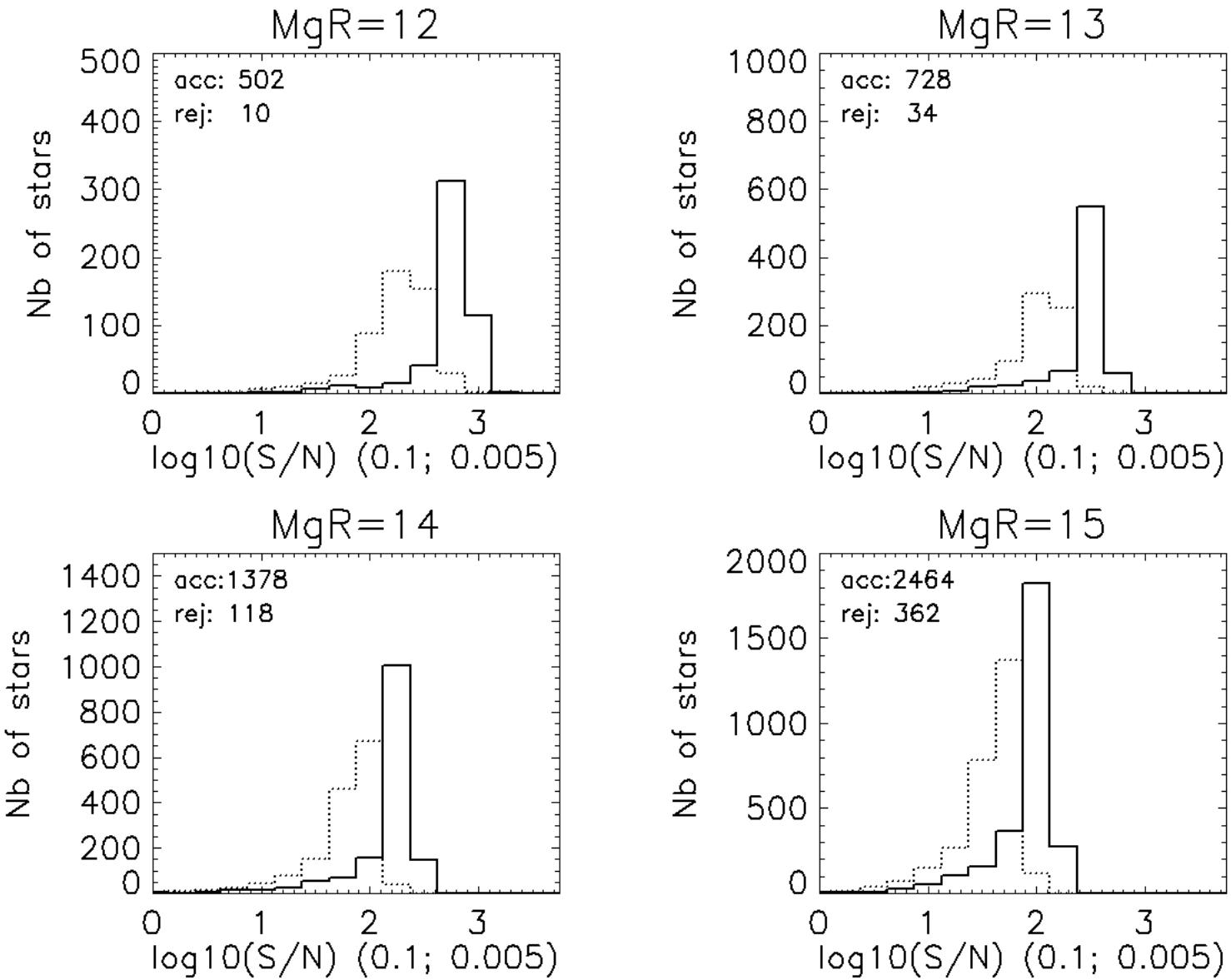
Jitter:0.2 ; Breathing:0.02



Jitter:0.5 ; Breathing:0.03



Jitter:0.1 ; Breathing:0.005

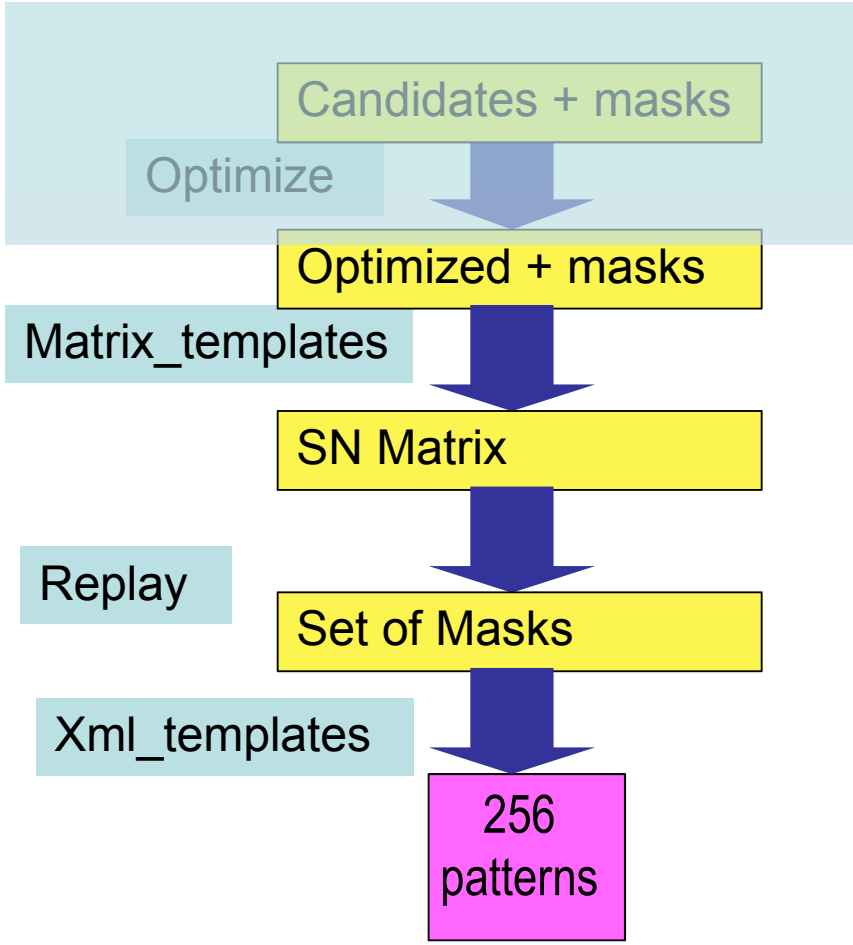


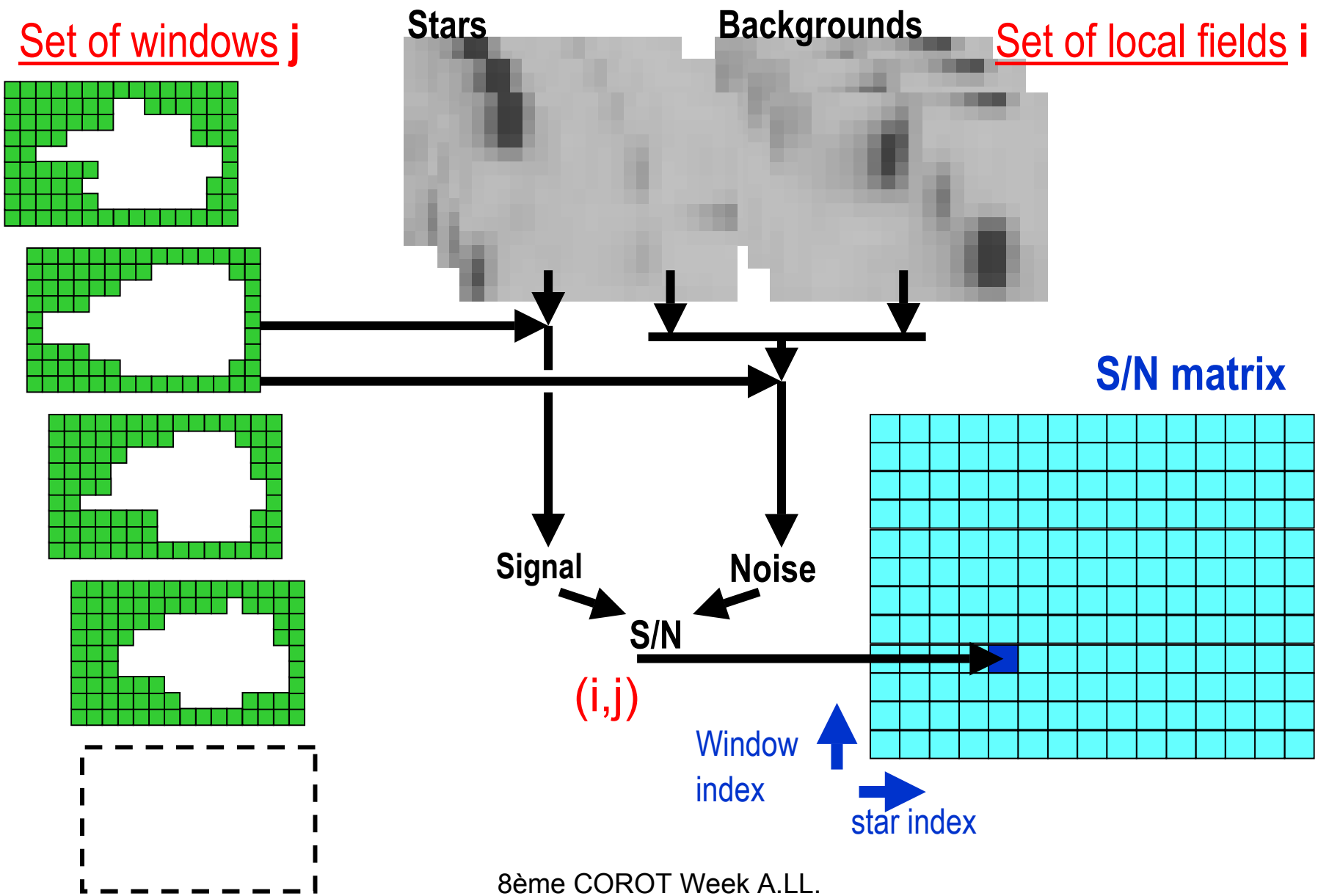
Conclusions

- Mask sizes depend mainly on magnitude
- S/N ratio is statistically insensitive to small changes on window patterns
- Jitter and breathing show a very strong influence in final S/N ratio

Build up strategy

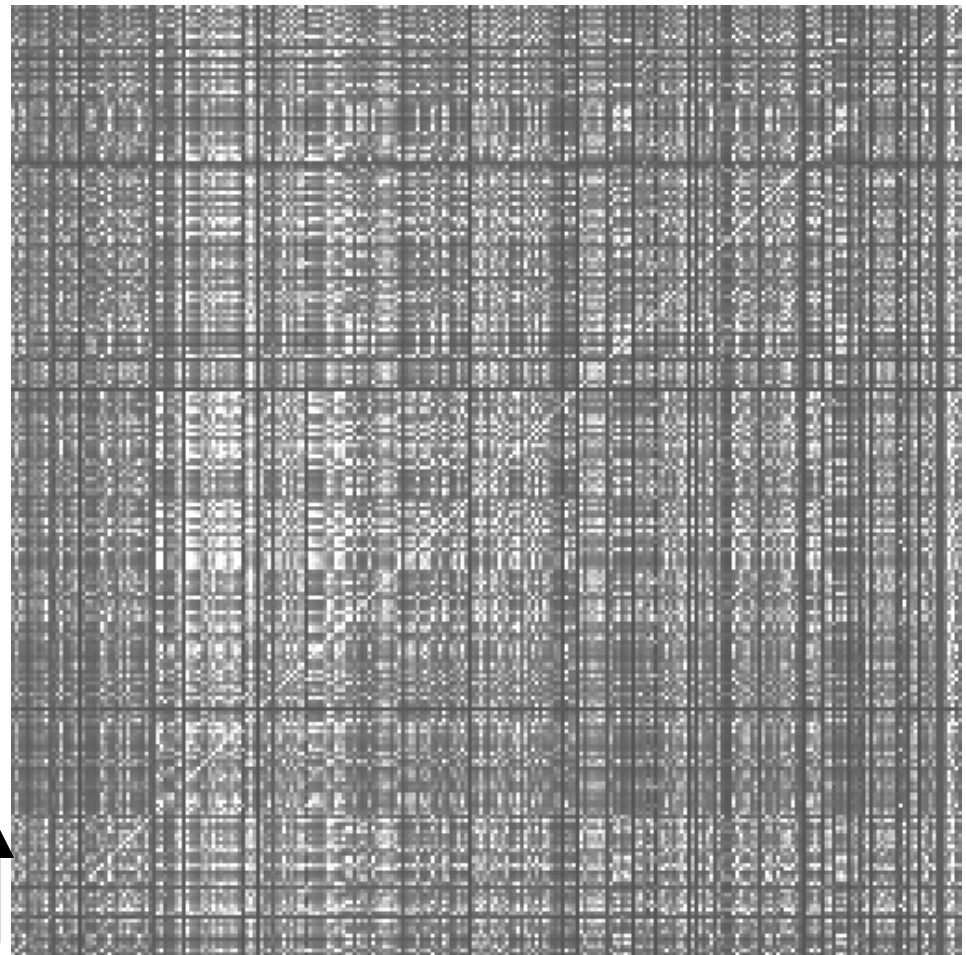
- Templates strategy
  - A large of input fields
  - Classes vs. magnitude




Set of windows j
Stars
Backgrounds
Set of local fields i
S/N matrix
Signal
Noise
S/N
(i,j)
Window
index
star index

Templates: S/N matrix

Extract of the S/N matrix



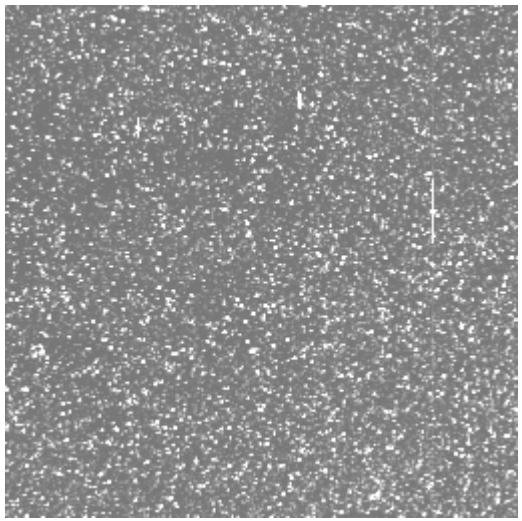
Window index

star index

Values are normalized between 0. (black) and 1 (white).

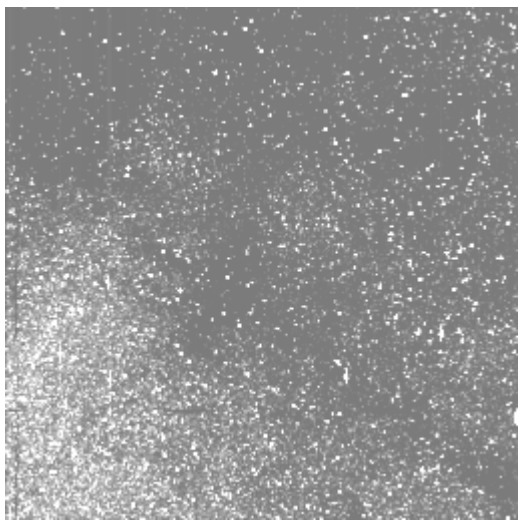
Remark the diagonal of optimal values.

Mixing fields for templates



102.2° 2.1°S

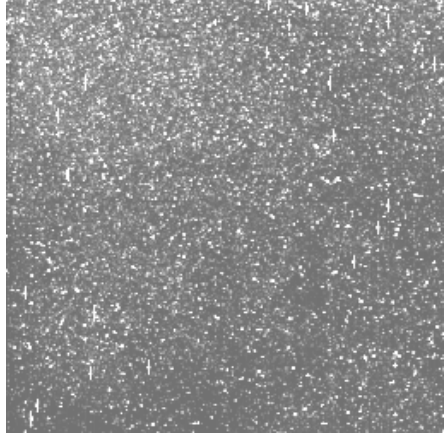
	12	13	14	15	16	Total
Conta.	0.0074	0.014	0.031	0.061	0.095	
Accept	182	642	1115	1763	883	4585
Reject	29	120	381	1067	845	2442



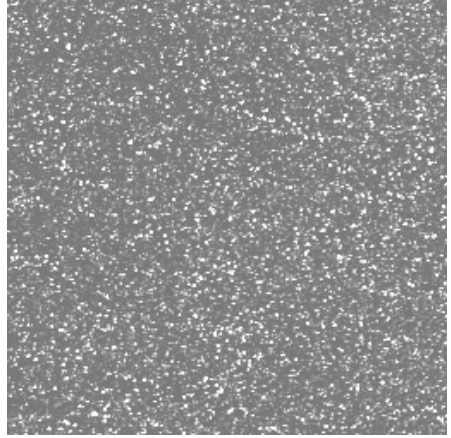
286.1° 4.5°N

	12	13	14	15	16	Total
Conta.	0.0054	0.020	0.061	0.111	0.170	
Accept	123	263	422	792	620	2220
Reject	6	40	247	893	971	2157

281.4 6.0 N



	12	13	14	15	16	Total
Conta	0.0115	0.025	0.044	0.077	0.121	
Accept	140	449	885	1430	1029	3933
Reject	5	53	268	1001	1318	2645

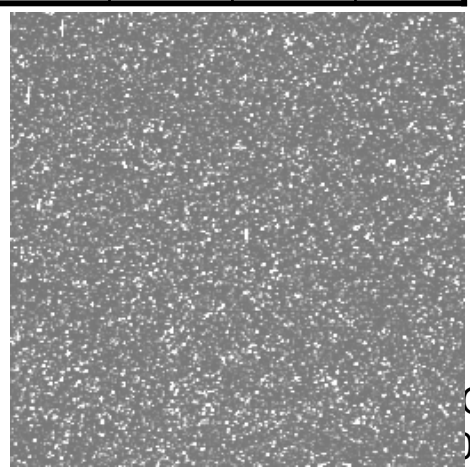


101.0 2.0 S

	12	13	14	15	16	Total
Conta.	0.0045	0.010	0.021	0.041	0.065	
Accept	367	560	1022	1795	1219	4963
Reject	18	94	264	762	795	1933

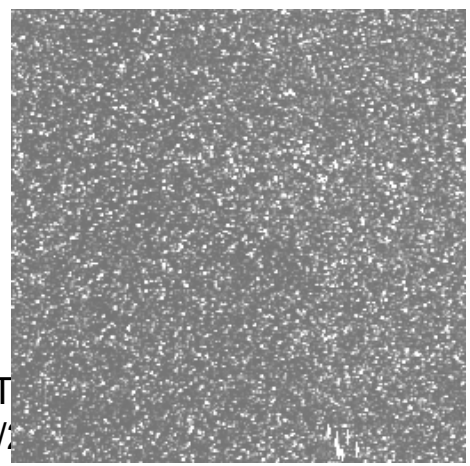
	12	13	14	15	16	Total
Conta.	0.0040	0.009	0.020	0.037	0.059	
Accept	346	462	964	1702	1084	4558
Reject	18	38	182	581	647	1466

920 5.2 N



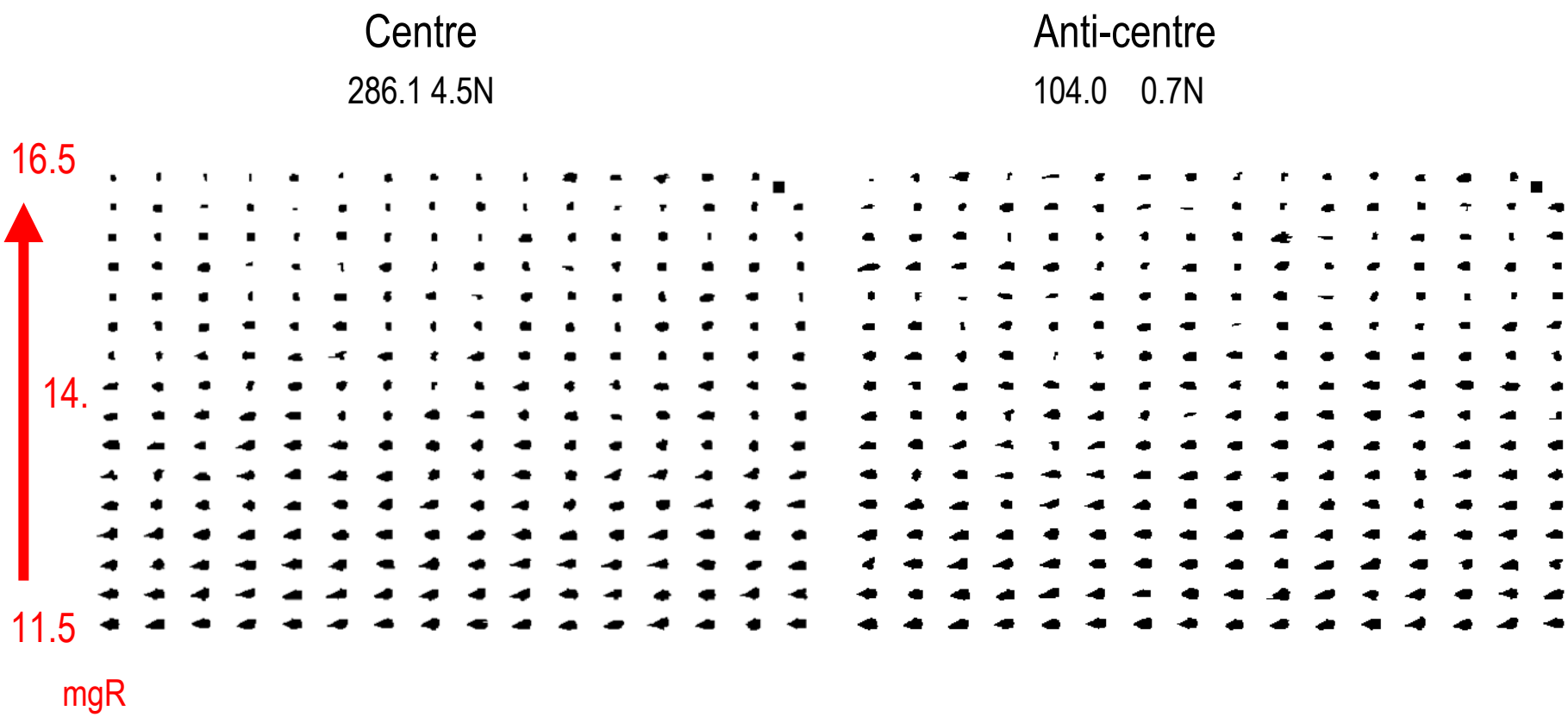
	12	13	14	15	16	Total
Conta.	0.0067	0.016	0.033	0.068	0.090	
Accept	501	698	1242	2050	508	4999
Reject	6	40	247	893	971	2314

103.7 2.1 S

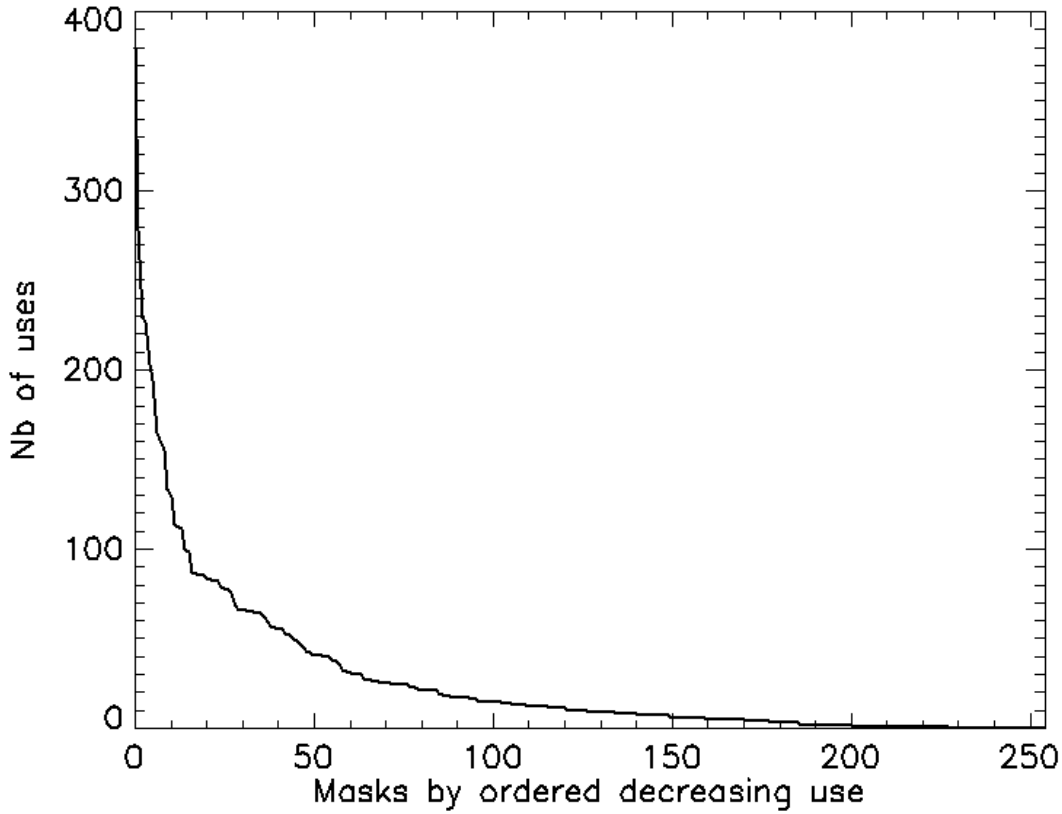


OT
05/

Templates for center & anticenter

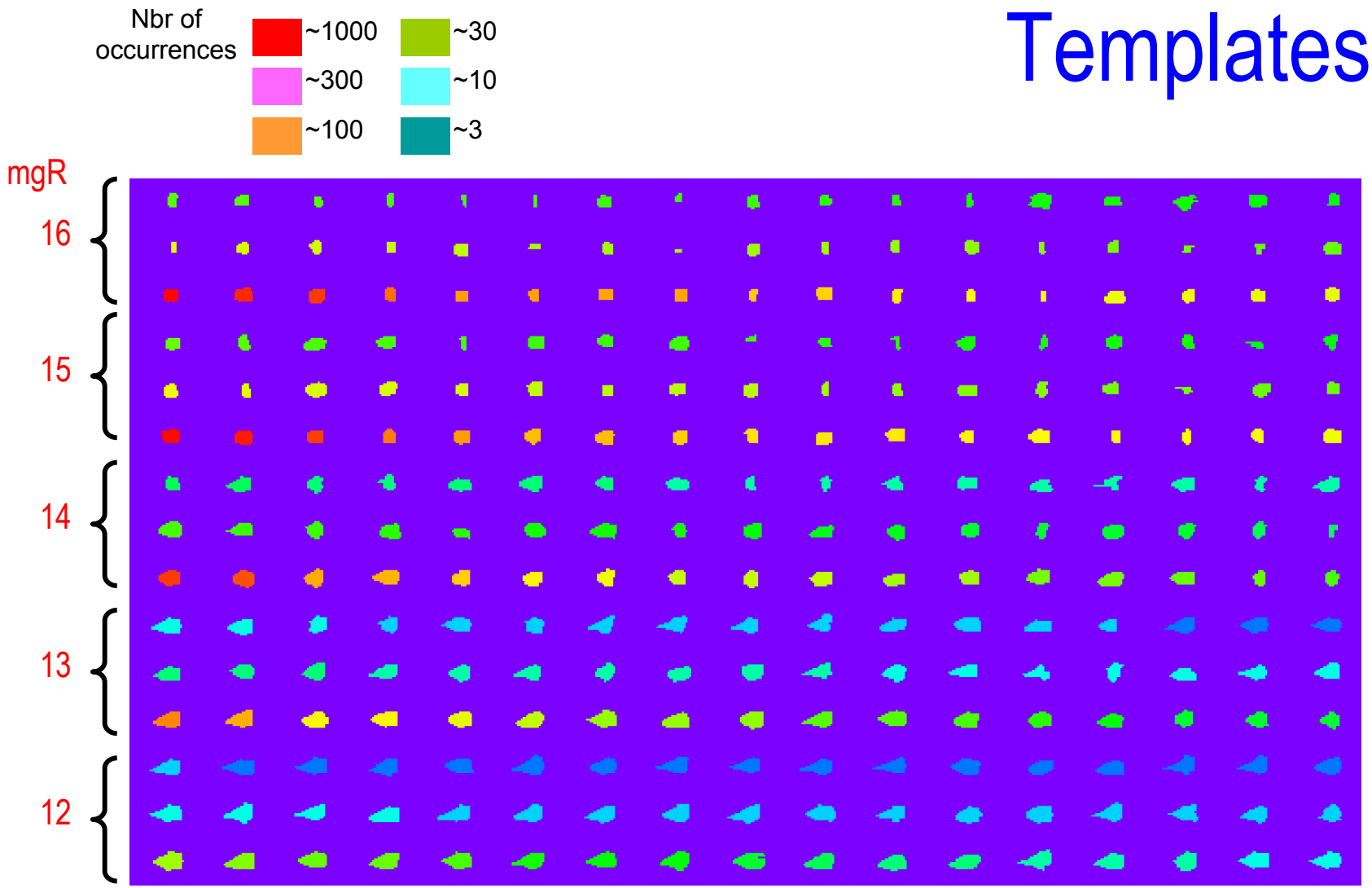


From *specific* to *generic* windows

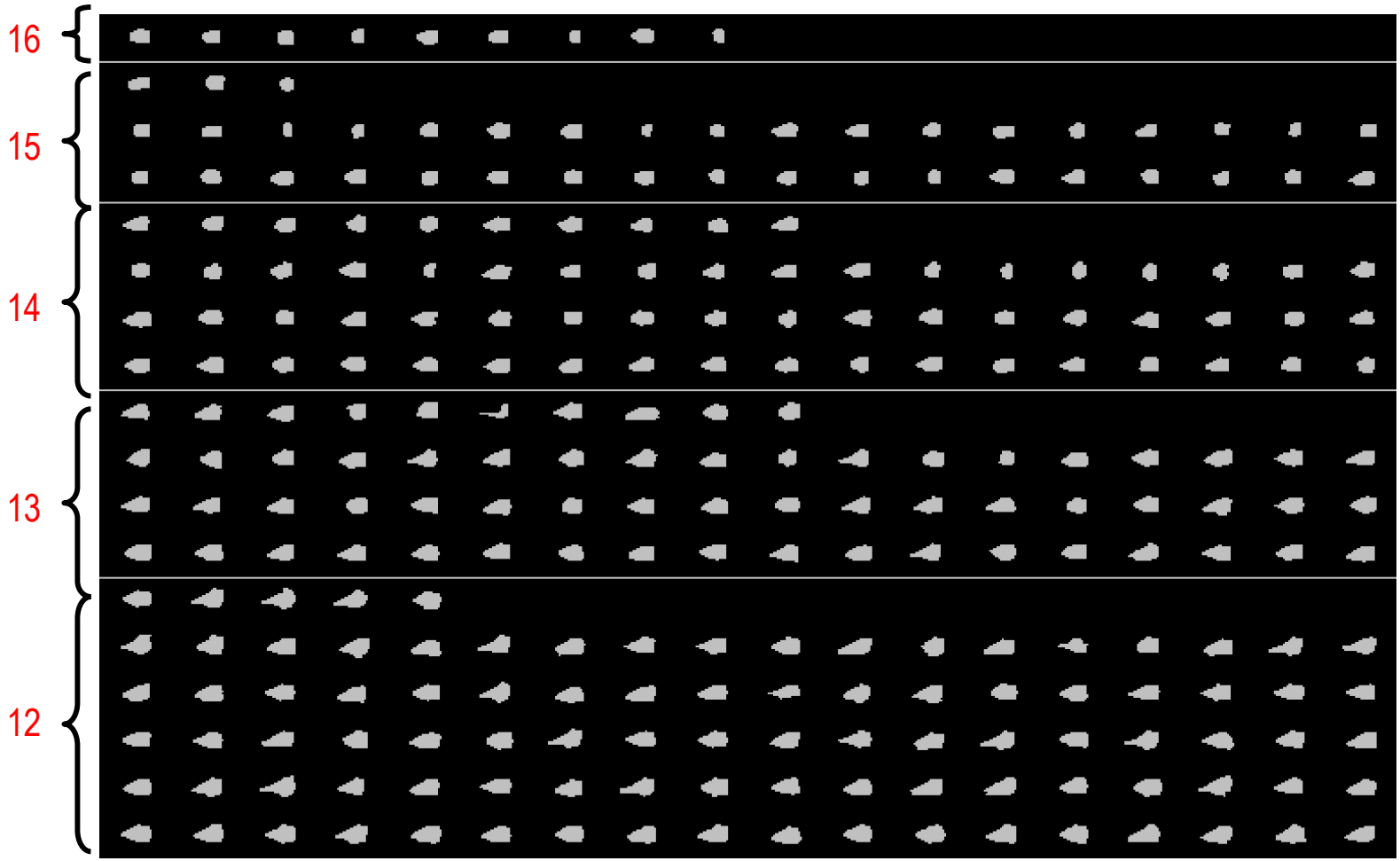


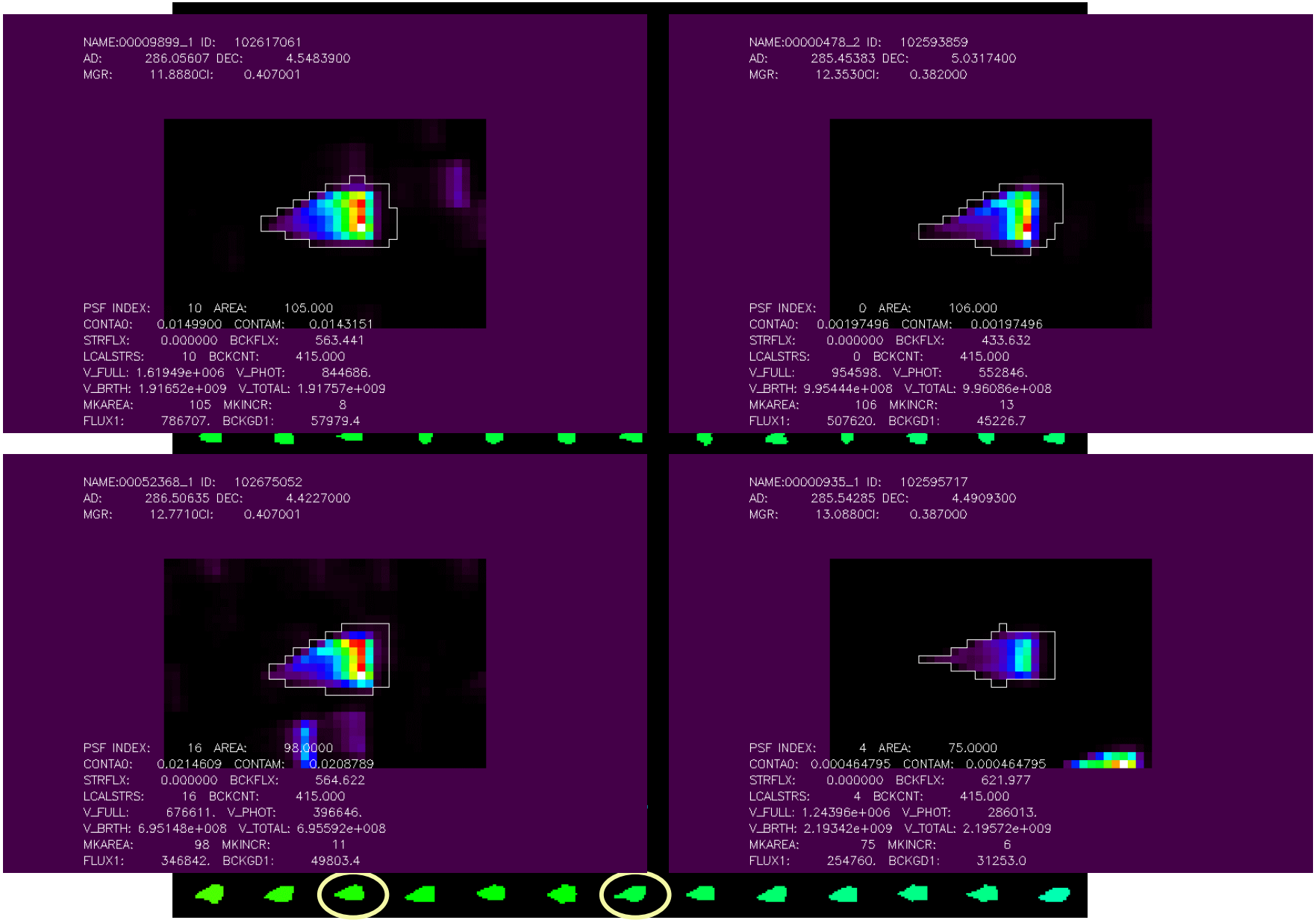
A limited set of shapes cover a great number of measures

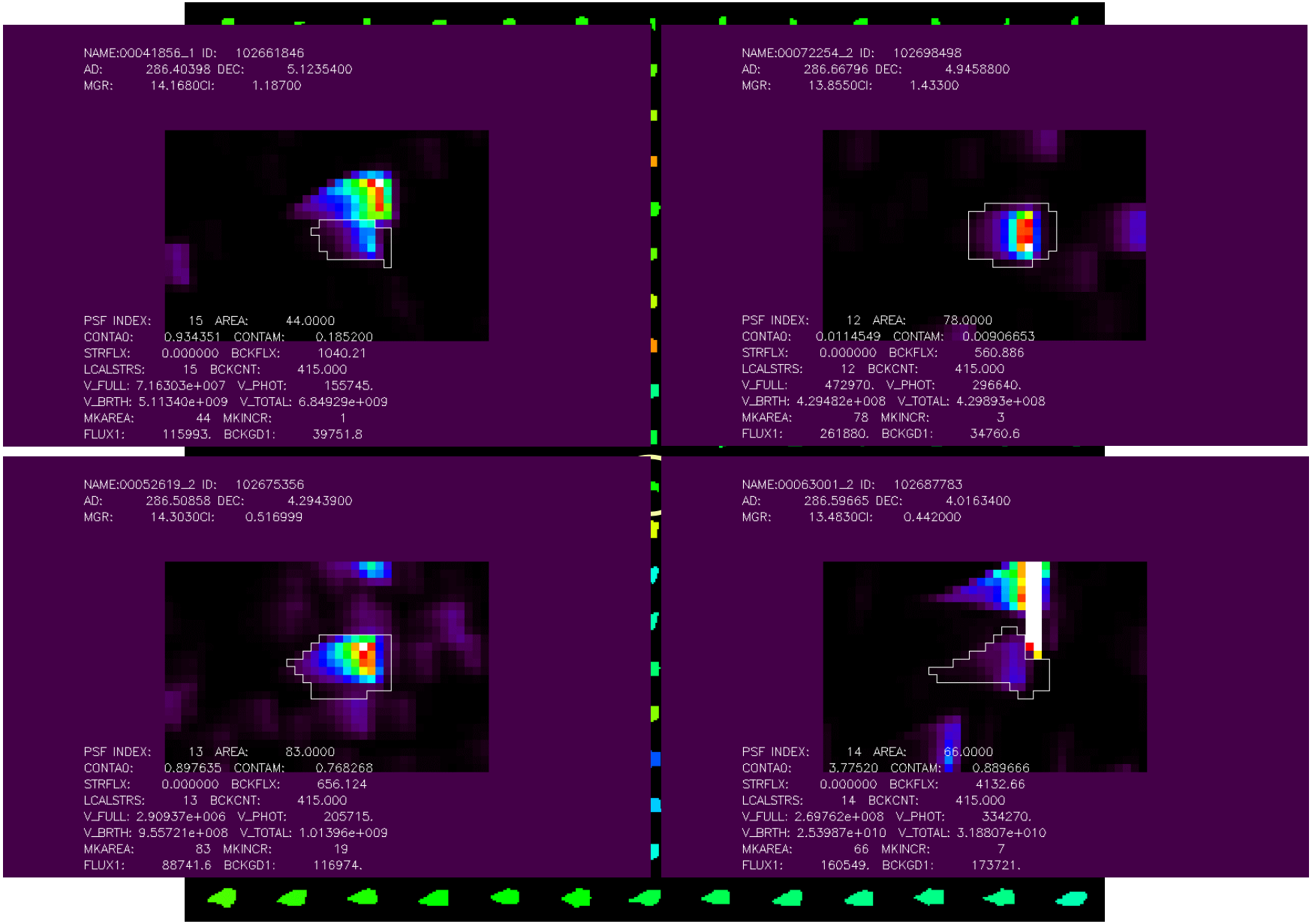
Templates

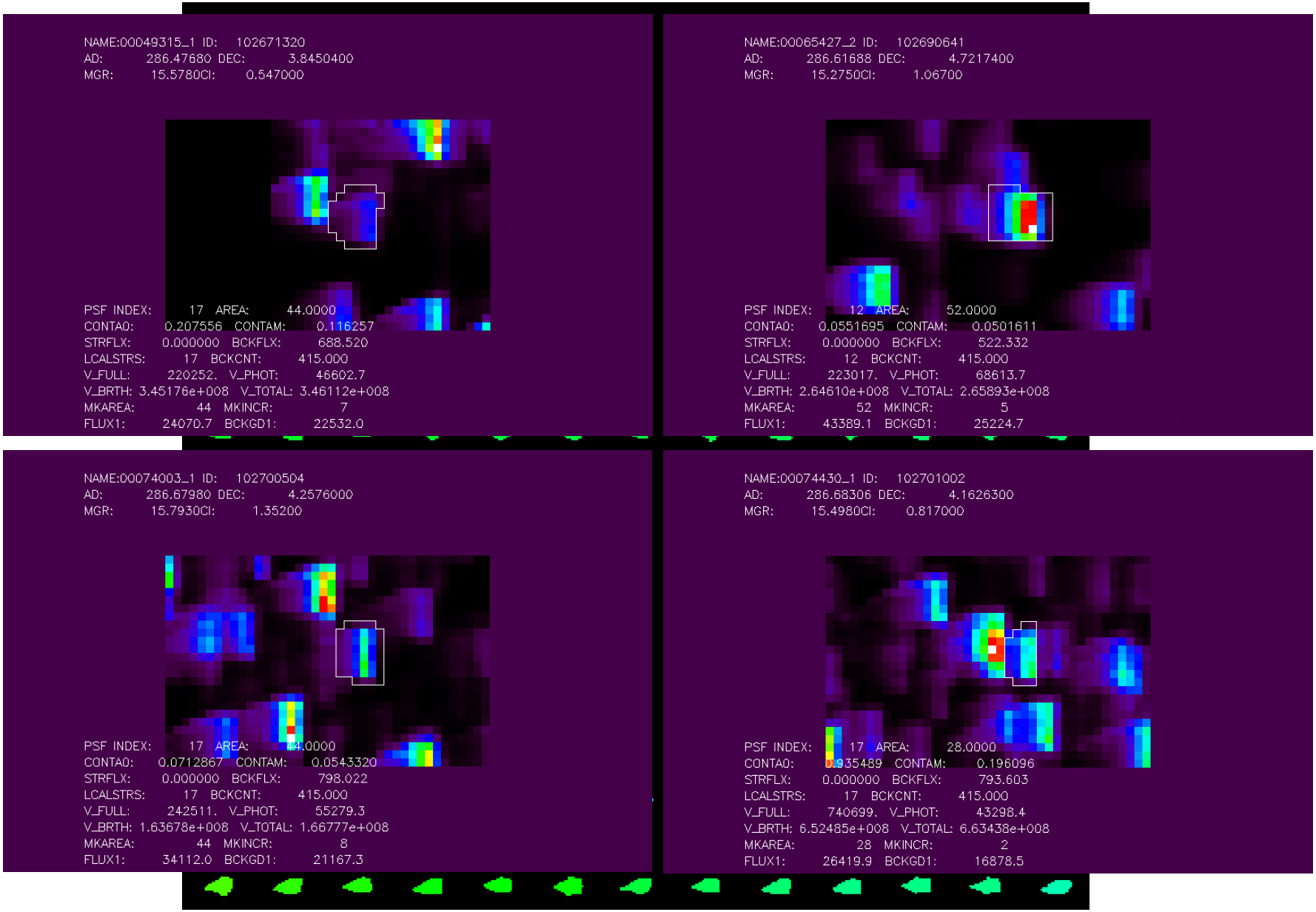


Masks: L9998 series




NAME:00009899_1 ID: 102617061
AD: 286.05607 DEC: 4.5483900
MGR: 11.8880CI: 0.407001
PSF INDEX: 10 AREA: 105.000
CONTA0: 0.0149900 CONTAM: 0.0143151
STRFLX: 0.000000 BCKFLX: 563.441
LCALSTRS: 10 BCKCNT: 415.000
V_FULL: 1.61949e+006 V_PHOT: 844686.
V_BRTH: 1.91652e+009 V_TOTAL: 1.91757e+009
MKAREA: 105 MKINCR: 8
FLUX1: 786707. BCKGD1: 57979.4
NAME:00000478_2 ID: 102593859
AD: 285.45383 DEC: 5.0317400
MGR: 12.3530CI: 0.382000
PSF INDEX: 0 AREA: 106.000
CONTA0: 0.00197496 CONTAM: 0.00197496
STRFLX: 0.000000 BCKFLX: 433.632
LCALSTRS: 0 BCKCNT: 415.000
V_FULL: 954598. V_PHOT: 552846.
V_BRTH: 9.95444e+008 V_TOTAL: 9.96086e+008
MKAREA: 106 MKINCR: 13
FLUX1: 507620. BCKGD1: 45226.7
NAME:00052368_1 ID: 102675052
AD: 286.50635 DEC: 4.4227000
MGR: 12.7710CI: 0.407001
PSF INDEX: 16 AREA: 98.0000
CONTA0: 0.0214609 CONTAM: 0.0208789
STRFLX: 0.000000 BCKFLX: 564.622
LCALSTRS: 16 BCKCNT: 415.000
V_FULL: 676611. V_PHOT: 396646.
V_BRTH: 6.95148e+008 V_TOTAL: 6.95592e+008
MKAREA: 98 MKINCR: 11
FLUX1: 346842. BCKGD1: 49803.4
NAME:00000935_1 ID: 102595717
AD: 285.54285 DEC: 4.4909300
MGR: 13.0880CI: 0.387000
PSF INDEX: 4 AREA: 75.0000
CONTA0: 0.000464795 CONTAM: 0.000464795
STRFLX: 0.000000 BCKFLX: 621.977
LCALSTRS: 4 BCKCNT: 415.000
V_FULL: 1.24396e+006 V_PHOT: 286013.
V_BRTH: 2.19342e+009 V_TOTAL: 2.19572e+009
MKAREA: 75 MKINCR: 6
FLUX1: 254760. BCKGD1: 31253.0


NAME:00041856_1 ID: 102661846
AD: 286.40398 DEC: 5.1235400
MGR: 14.1680CI: 1.18700
PSF INDEX: 15 AREA: 44.0000
CONTA0: 0.934351 CONTAM: 0.185200
STRFLX: 0.000000 BCKFLX: 1040.21
LCALSTRS: 15 BCKCNT: 415.000
V_FULL: 7.16303e+007 V_PHOT: 155745.
V_BRTH: 5.11340e+009 V_TOTAL: 6.84929e+009
MKAREA: 44 MKINCR: 1
FLUX1: 115993. BCKGD1: 39751.8
NAME:00072254_2 ID: 102698498
AD: 286.66796 DEC: 4.9458800
MGR: 13.8550CI: 1.43300
PSF INDEX: 12 AREA: 78.0000
CONTA0: 0.0114549 CONTAM: 0.00906653
STRFLX: 0.000000 BCKFLX: 560.886
LCALSTRS: 12 BCKCNT: 415.000
V_FULL: 472970. V_PHOT: 296640.
V_BRTH: 4.29482e+008 V_TOTAL: 4.29893e+008
MKAREA: 78 MKINCR: 3
FLUX1: 261880. BCKGD1: 34760.6
NAME:00052619_2 ID: 102675356
AD: 286.50858 DEC: 4.2943900
MGR: 14.3030CI: 0.516999
PSF INDEX: 13 AREA: 83.0000
CONTA0: 0.897635 CONTAM: 0.768268
STRFLX: 0.000000 BCKFLX: 656.124
LCALSTRS: 13 BCKCNT: 415.000
V_FULL: 2.90937e+006 V_PHOT: 205715.
V_BRTH: 9.55721e+008 V_TOTAL: 1.01396e+009
MKAREA: 83 MKINCR: 19
FLUX1: 88741.6 BCKGD1: 116974.
NAME:00063001_2 ID: 102687783
AD: 286.59665 DEC: 4.0163400
MGR: 13.4830CI: 0.442000
PSF INDEX: 14 AREA: 66.0000
CONTA0: 3.77520 CONTAM: 0.889666
STRFLX: 0.000000 BCKFLX: 4132.66
LCALSTRS: 14 BCKCNT: 415.000
V_FULL: 2.69762e+008 V_PHOT: 334270.
V_BRTH: 2.53987e+010 V_TOTAL: 3.18807e+010
MKAREA: 66 MKINCR: 7
FLUX1: 160549. BCKGD1: 173721.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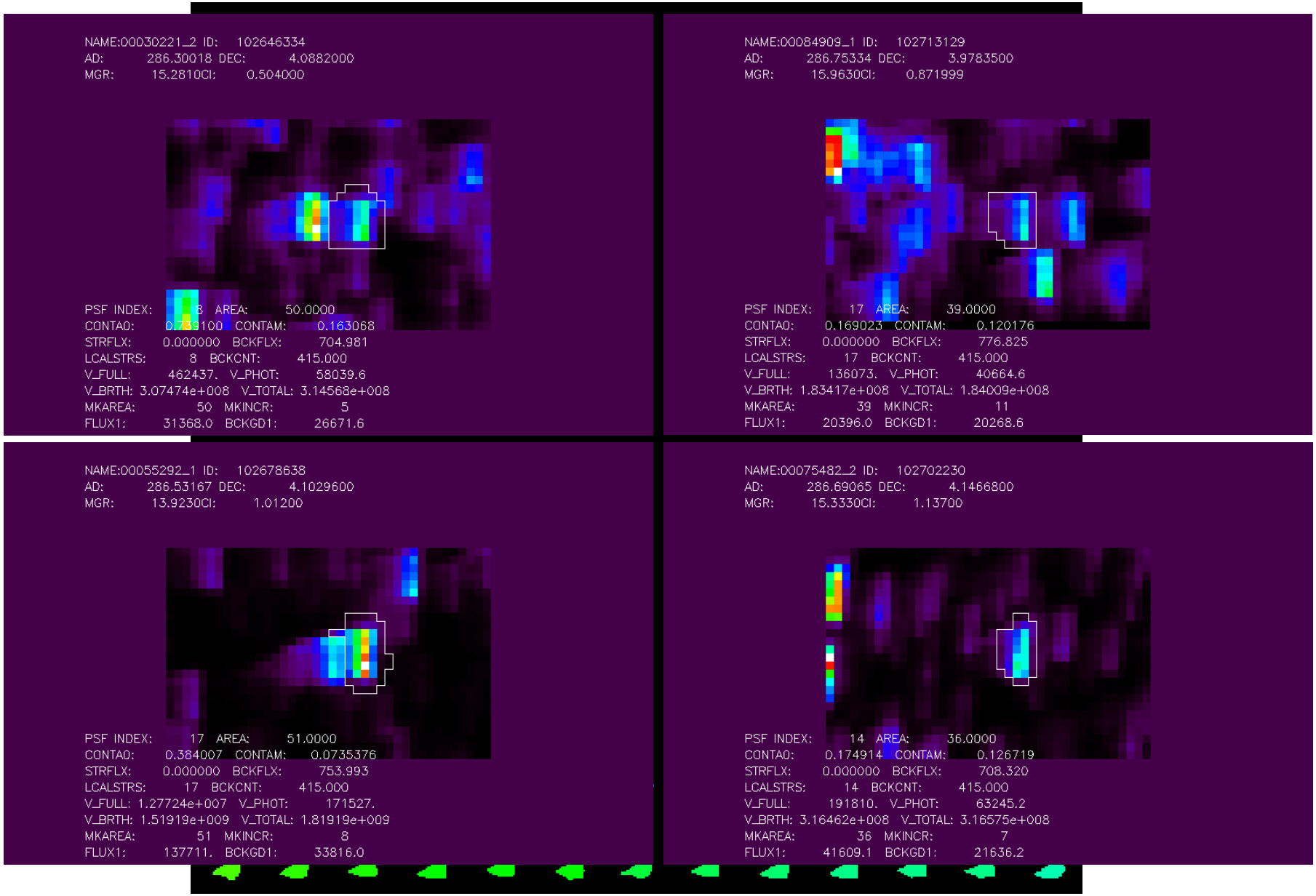
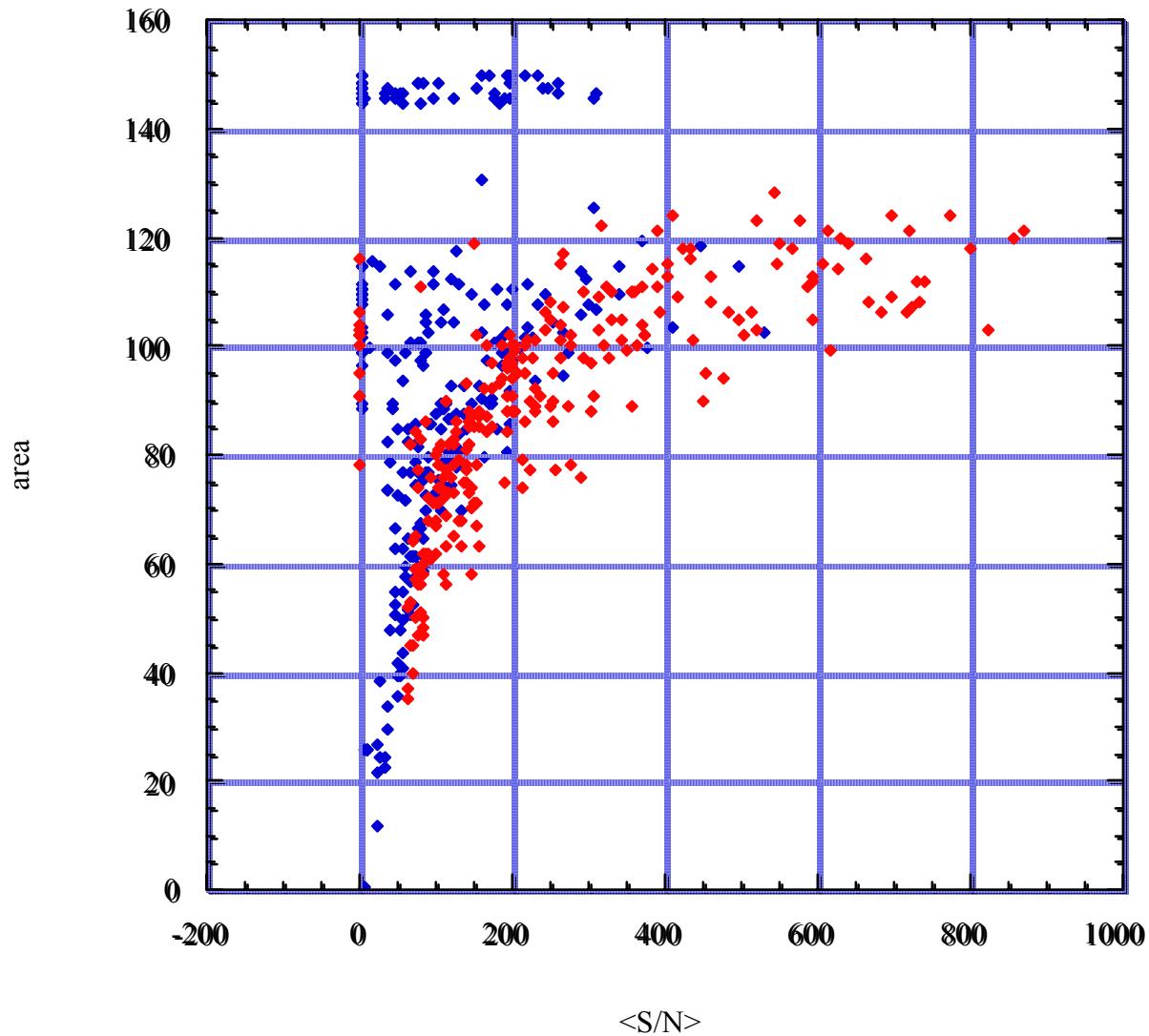
AD: 286.47680 DEC: 3.8450400
MGR: 15.5780CI: 0.547000
PSF INDEX: 17 AREA: 44.0000
CONTA0: 0.207556 CONTAM: 0.116257
STRFLX: 0.000000 BCKFLX: 688.520
LCALSTRS: 17 BCKCNT: 415.000
V_FULL: 220252. V_PHOT: 46602.7
V_BRTH: 3.45176e+008 V_TOTAL: 3.46112e+008
MKAREA: 44 MKINCR: 7
FLUX1: 24070.7 BCKGD1: 22532.0
NAME:00065427_2 ID: 102690641
AD: 286.61688 DEC: 4.7217400
MGR: 15.2750CI: 1.06700
PSF INDEX: 12 AREA: 52.0000
CONTA0: 0.0551695 CONTAM: 0.0501611
STRFLX: 0.000000 BCKFLX: 522.332
LCALSTRS: 12 BCKCNT: 415.000
V_FULL: 223017. V_PHOT: 68613.7
V_BRTH: 2.64610e+008 V_TOTAL: 2.65893e+008
MKAREA: 52 MKINCR: 5
FLUX1: 43389.1 BCKGD1: 25224.7
NAME:00074003_1 ID: 102700504
AD: 286.67980 DEC: 4.2576000
MGR: 15.7930CI: 1.35200
PSF INDEX: 17 AREA: 44.0000
CONTA0: 0.0712867 CONTAM: 0.0543320
STRFLX: 0.000000 BCKFLX: 798.022
LCALSTRS: 17 BCKCNT: 415.000
V_FULL: 242511. V_PHOT: 55279.3
V_BRTH: 1.63678e+008 V_TOTAL: 1.66777e+008
MKAREA: 44 MKINCR: 8
FLUX1: 34112.0 BCKGD1: 21167.3
NAME:00074430_1 ID: 102701002
AD: 286.68306 DEC: 4.1626300
MGR: 15.4980CI: 0.817000
PSF INDEX: 17 AREA: 28.0000
CONTA0: 0.935489 CONTAM: 0.196096
STRFLX: 0.000000 BCKFLX: 793.603
LCALSTRS: 17 BCKCNT: 415.000
V_FULL: 740699. V_PHOT: 43298.4
V_BRTH: 6.52485e+008 V_TOTAL: 6.63438e+008
MKAREA: 28 MKINCR: 2
FLUX1: 26419.9 BCKGD1: 16878.5


NAME:00030221_2 ID: 102646334
AD: 286.30018 DEC: 4.0882000
MGR: 15.2810CI: 0.504000
PSF INDEX: 8 AREA: 50.0000
CONTA0: 0.739100 CONTAM: 0.163068
STRFLX: 0.000000 BCKFLX: 704.981
LCALSTRS: 8 BCKCNT: 415.000
V_FULL: 462437. V_PHOT: 58039.6
V_BRTH: 3.07474e+008 V_TOTAL: 3.14568e+008
MKAREA: 50 MKINCR: 5
FLUX1: 31368.0 BCKGD1: 26671.6
NAME:00084909_1 ID: 102713129
AD: 286.75334 DEC: 3.9783500
MGR: 15.9630CI: 0.871999
PSF INDEX: 17 AREA: 39.0000
CONTA0: 0.169023 CONTAM: 0.120176
STRFLX: 0.000000 BCKFLX: 776.825
LCALSTRS: 17 BCKCNT: 415.000
V_FULL: 136073. V_PHOT: 40664.6
V_BRTH: 1.83417e+008 V_TOTAL: 1.84009e+008
MKAREA: 39 MKINCR: 11
FLUX1: 20396.0 BCKGD1: 20268.6
NAME:00055292_1 ID: 102678638
AD: 286.53167 DEC: 4.1029600
MGR: 13.9230CI: 1.01200
PSF INDEX: 17 AREA: 51.0000
CONTA0: 0.384007 CONTAM: 0.0735376
STRFLX: 0.000000 BCKFLX: 753.993
LCALSTRS: 17 BCKCNT: 415.000
V_FULL: 1.27724e+007 V_PHOT: 171527.
V_BRTH: 1.51919e+009 V_TOTAL: 1.81919e+009
MKAREA: 51 MKINCR: 8
FLUX1: 137711. BCKGD1: 33816.0
NAME:00075482_2 ID: 102702230
AD: 286.69065 DEC: 4.1466800
MGR: 15.3330CI: 1.13700
PSF INDEX: 14 AREA: 36.0000
CONTA0: 0.174914 CONTAM: 0.126719
STRFLX: 0.000000 BCKFLX: 708.320
LCALSTRS: 14 BCKCNT: 415.000
V_FULL: 191810. V_PHOT: 63245.2
V_BRTH: 3.16462e+008 V_TOTAL: 3.16575e+008
MKAREA: 36 MKINCR: 7
FLUX1: 41609.1 BCKGD1: 21636.2

Mask area vs. S/N ratio

Début mars

Fin avril



From
A.Baglin

Conclusions

- In order to build robust patterns a large collection of star fields has been used as start point (center and anticenter).
- In the pattern process, pattern for bright stars are favored. It results on a better S/N for this class.

In progress

- Verifying:
  - The performances when the same collection of templates is used with different fields.
  - The reduction of S/N when the predetermined collection of templates is used with unexpected PSFs.
- Build up & analysis with PSFs deduced from “in flight” images.