CHILES

COSMOS HI LARGE EXTRAGALACTIC SURVEY

Attila Popping on behalf of the CHILES team

2015 PHISCC Workshop
HI Surveys Get Real
March 16-18 2015

International Centre for Radio Astronomy Research

CAASTRO
ARC CENTRE OF EXCELLENCE FOR ALL-SKY ASTROPHYSICS

THE UNIVERSITY OF WESTERN AUSTRALIA

CHILES team

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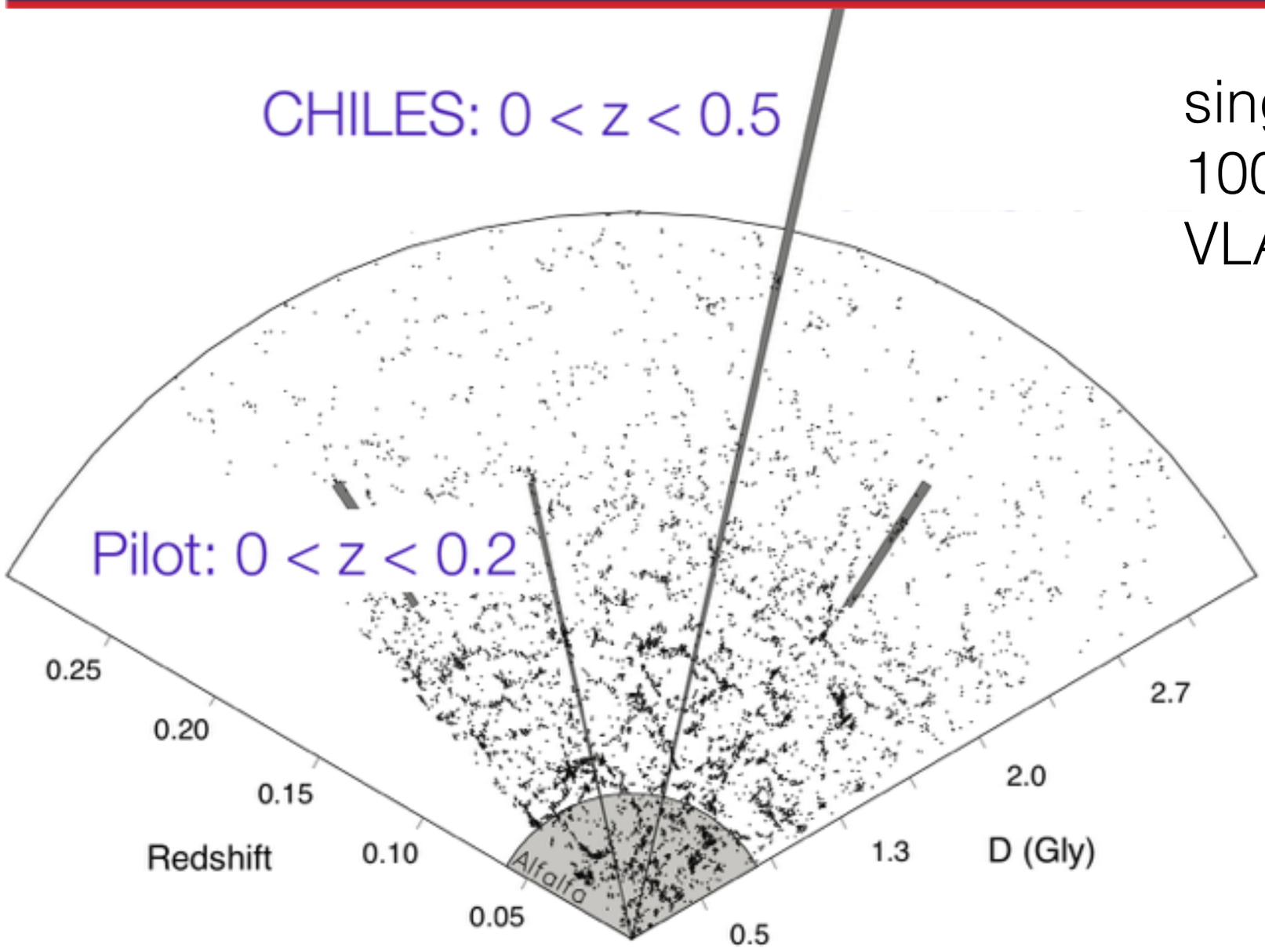
+ CHILES CON POL

(Survey led by Chris Hales)

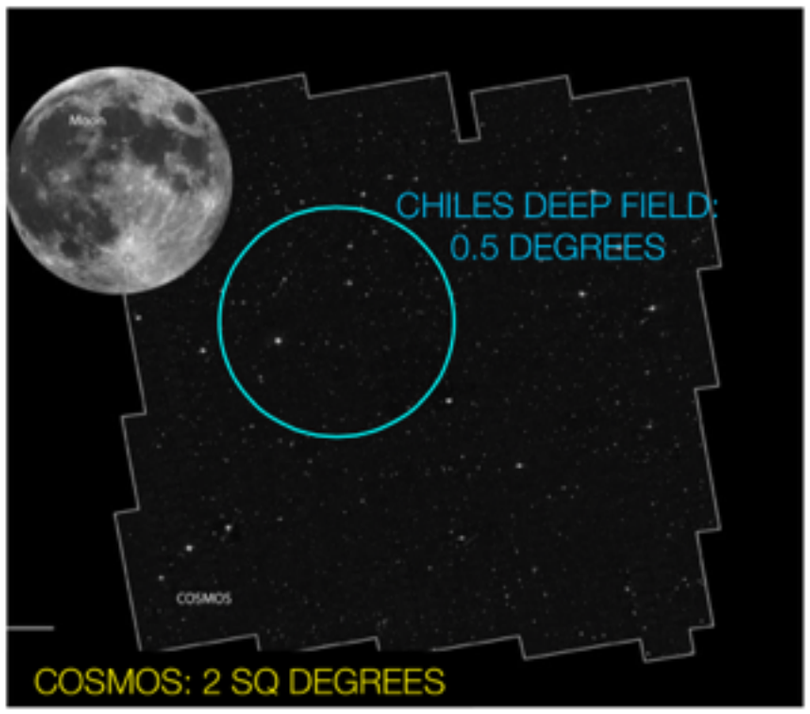
+ CHILES VERDES

(Survey led by Laura Chomiuk)

CHILES



single pointing in COSMOS
1000 hours integration
VLA B-configuration



Science Drivers

1. HI images in different environments across cosmic time
   - Study galaxy properties, scaling relations and SF
   - HI images will provide constraints to simulations to study gas accretion and removal processes

2. How does the HI mass function (HIMF) evolve with redshift and environment?
   - Probe the evolution of the high-mass end of the HIMF

3. How does the cosmic HI gas density evolve with time?
   - Constrain Ω_{HI} in the interval $0 < z < 0.5$

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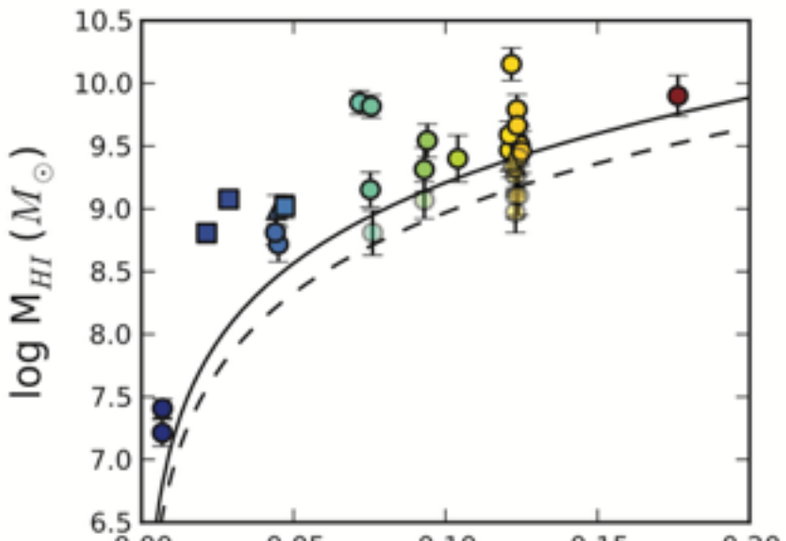
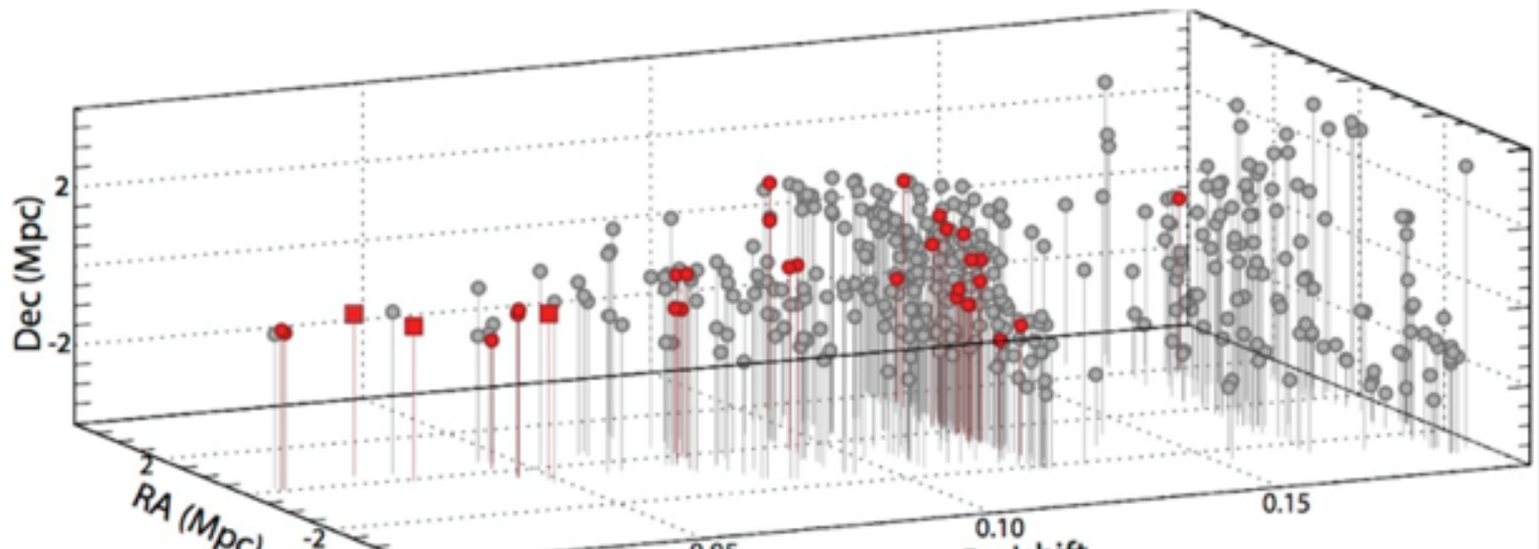
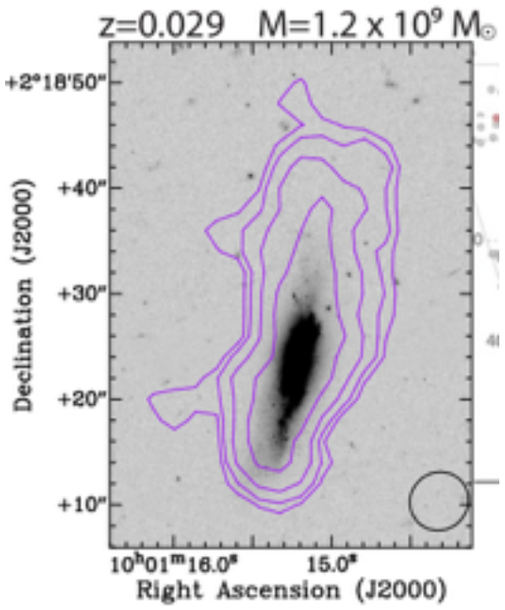
Pilot Survey

33 detections in different environments across cosmic time

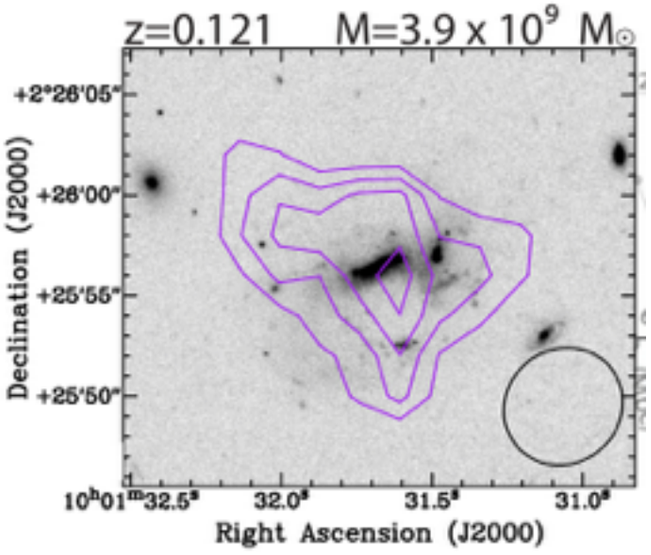




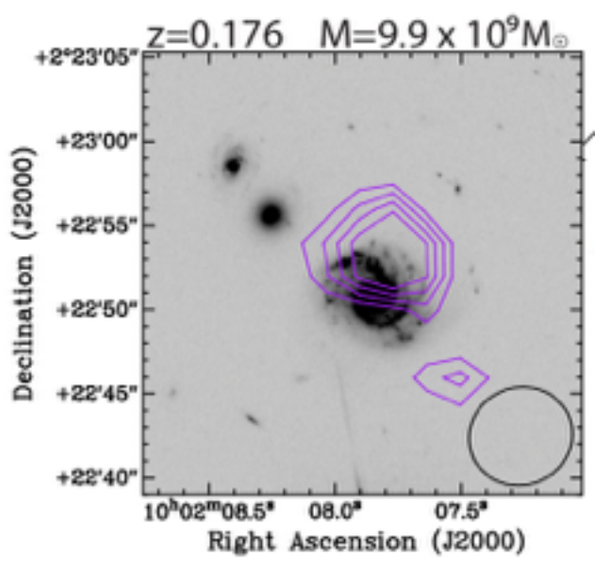
void



merger



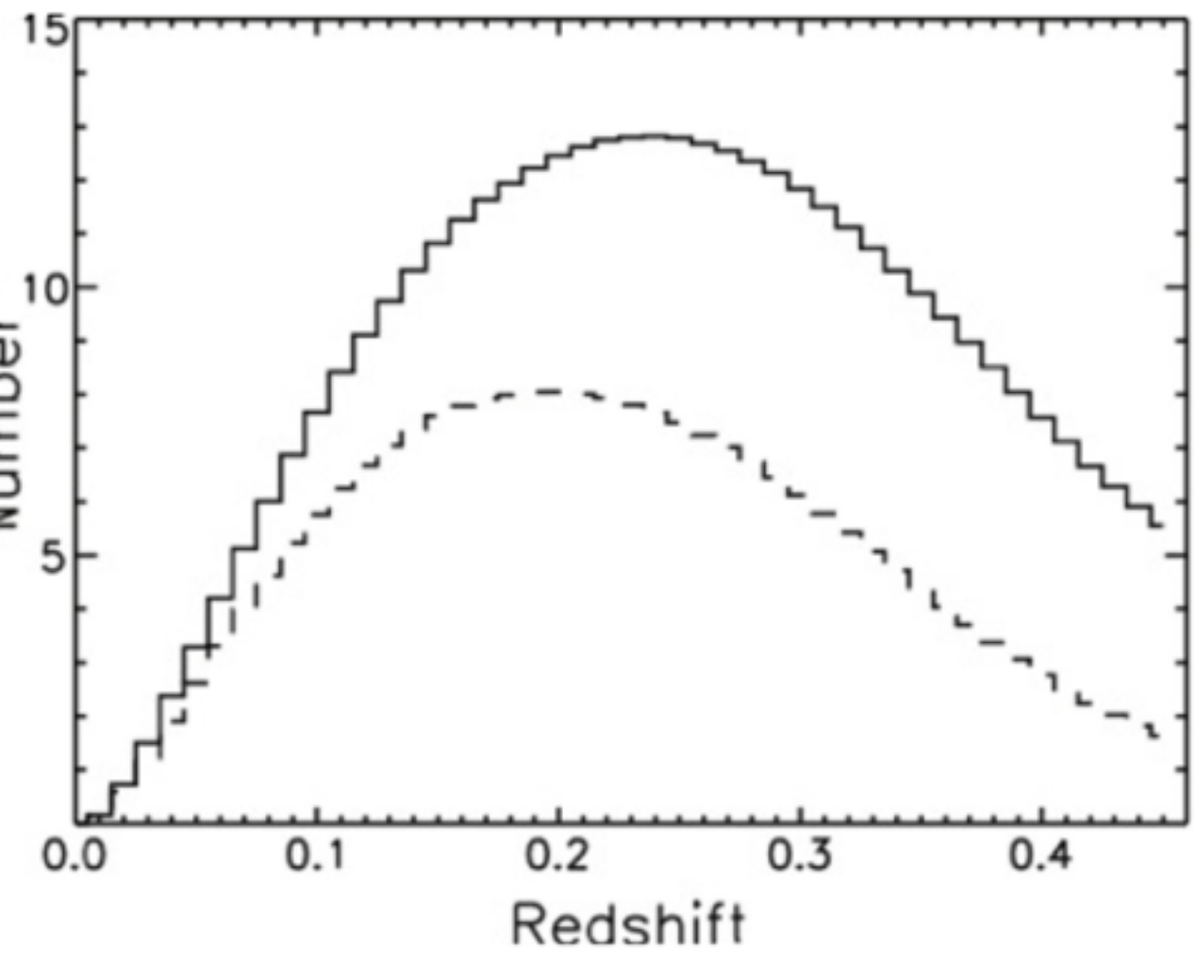
high z

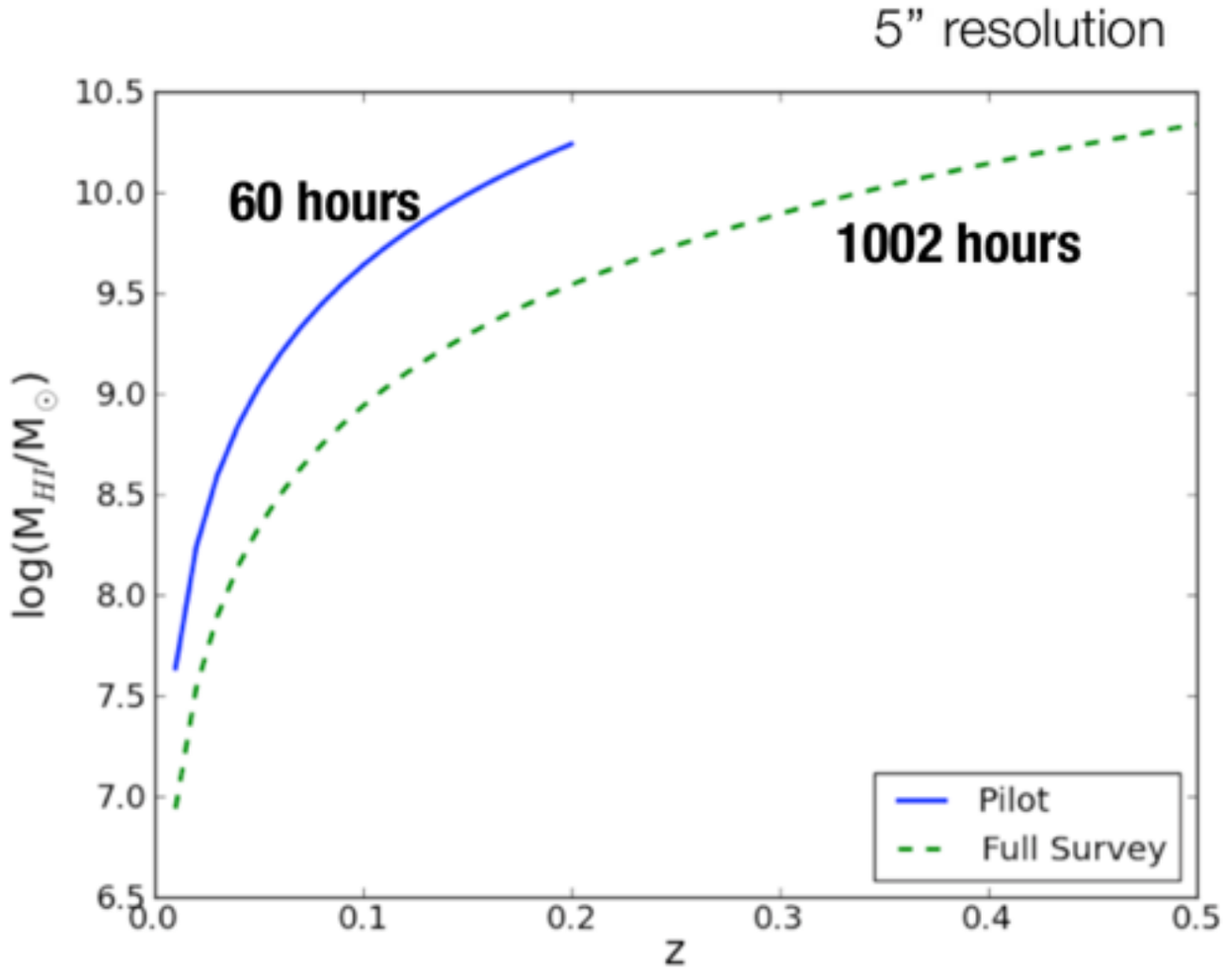


Fernández+ 13

Survey Design

1002 hours of observations will results in 300 detections





Goal: detect 3 x 10^{10} $M_\odot$ at highest z

Upgraded VLA

	OLD	PILOT	NEW
Bandwidth (MHz)	6.25	240	480
Channels	31	16384	30720
Velocity resolution (km/s)	40	3.5	3.5
Instantaneous z coverage	0<z<0.004	0<z<0.193	0<z<0.5

178 hours done in Fall 2013

270 hours allocated for Spring 2015


imaging
data combination
CHILES
RFI
continuum
CHILES
POLARSTERN
calibration
data
storage


POLARSTERN

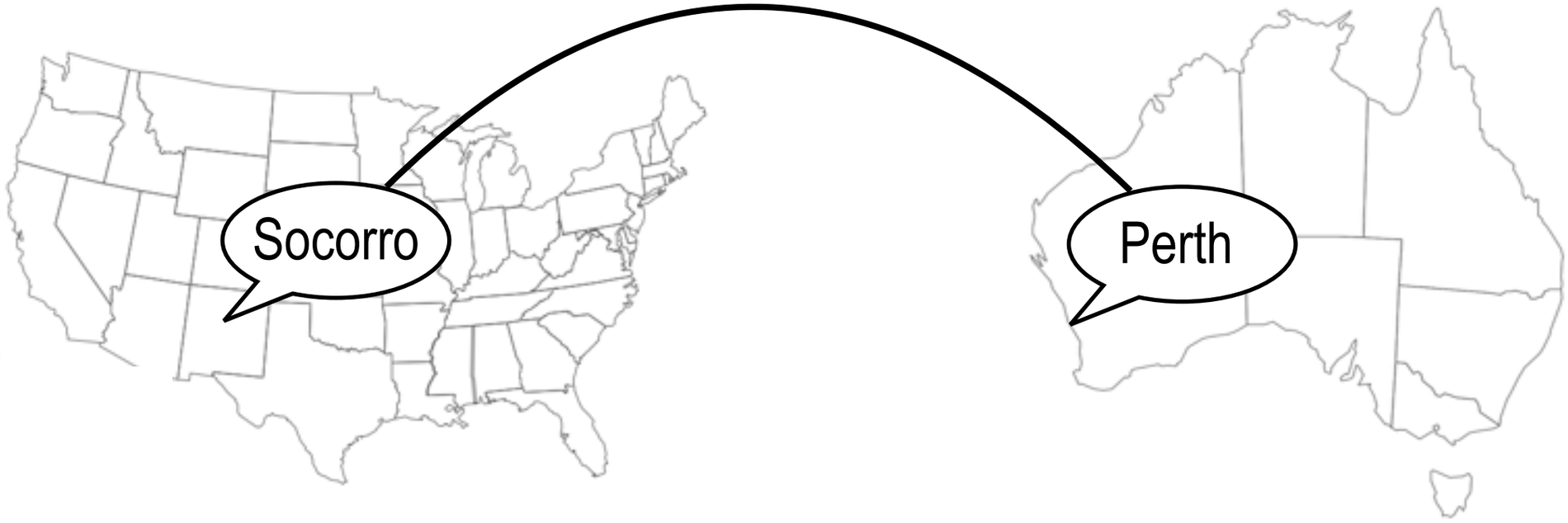

POLARSTERN

CHILES Workflow

Observing
Calibration
Flagging
Quality Control

CHILES Workflow

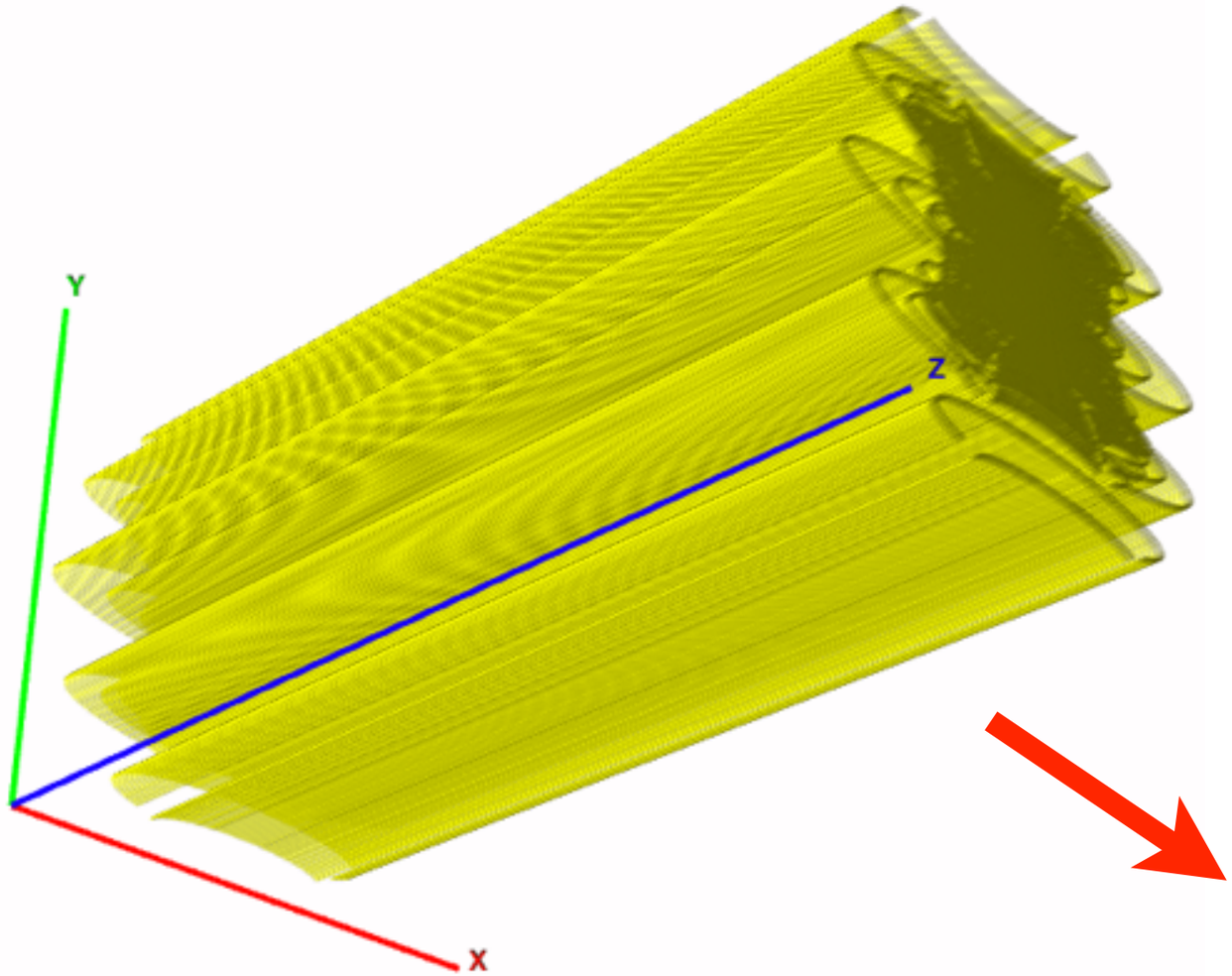
Raw data
Cal-tables
Flag-tables
Reduced Data

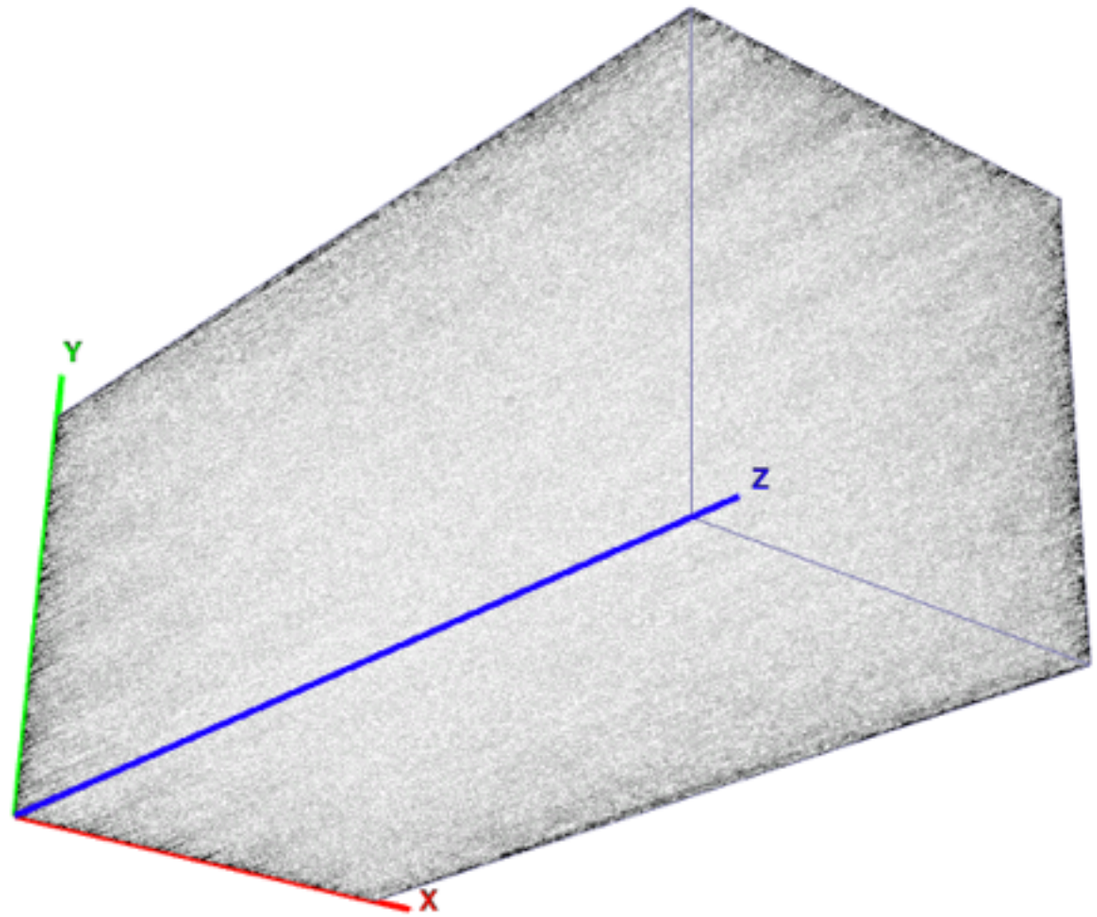


Observing
Calibration
Flagging
Quality Control

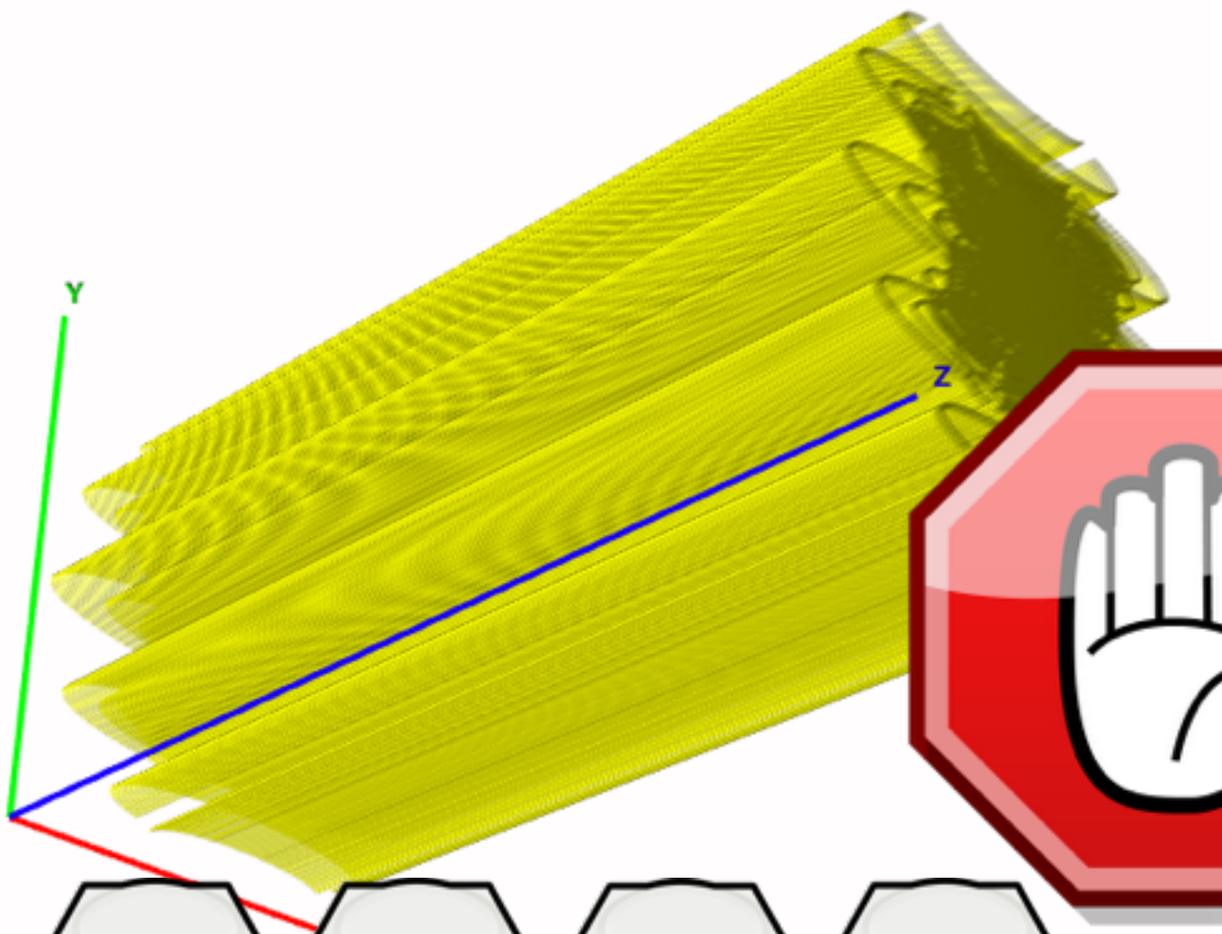
Backup
Combination
Imaging

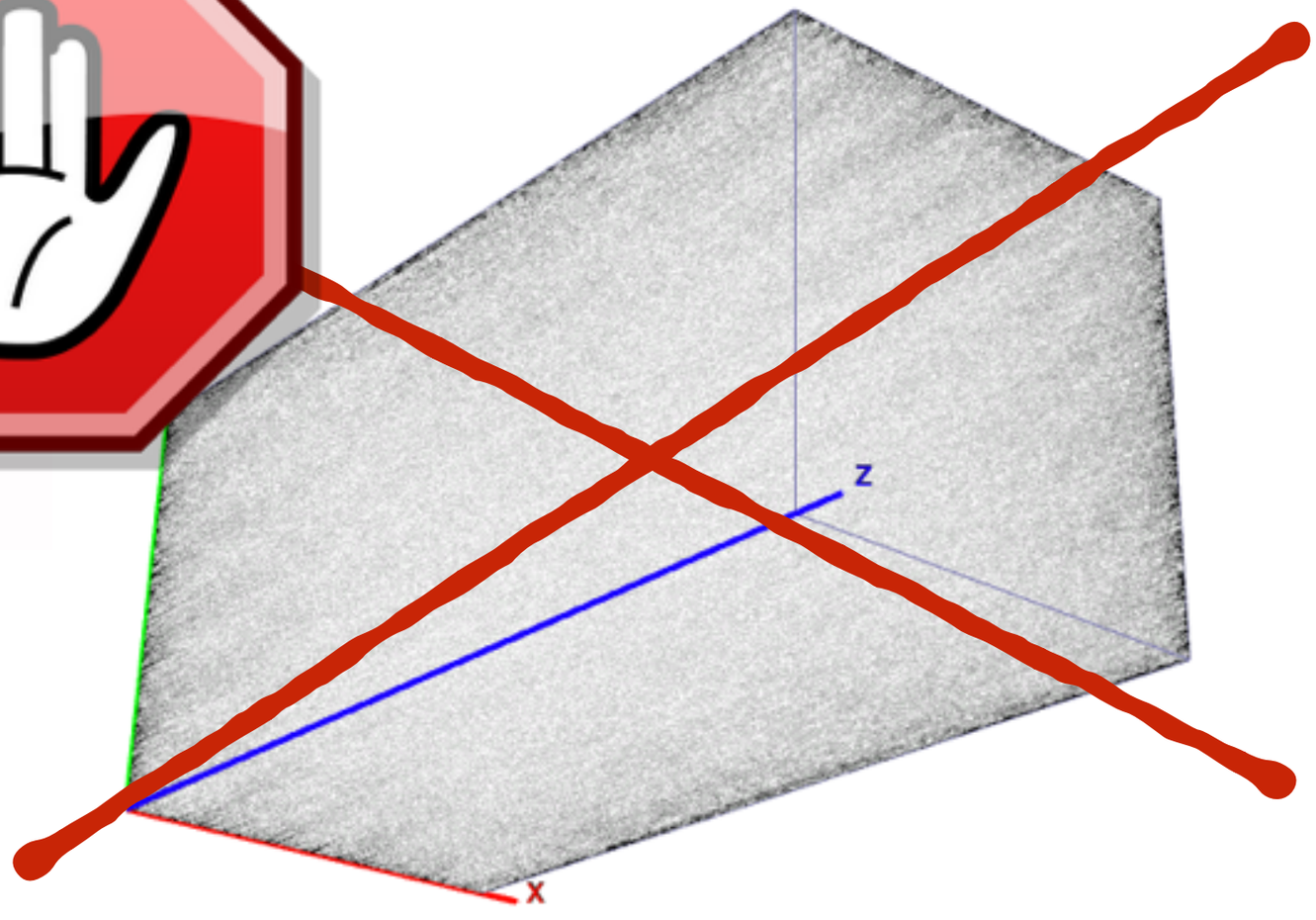
Imaging

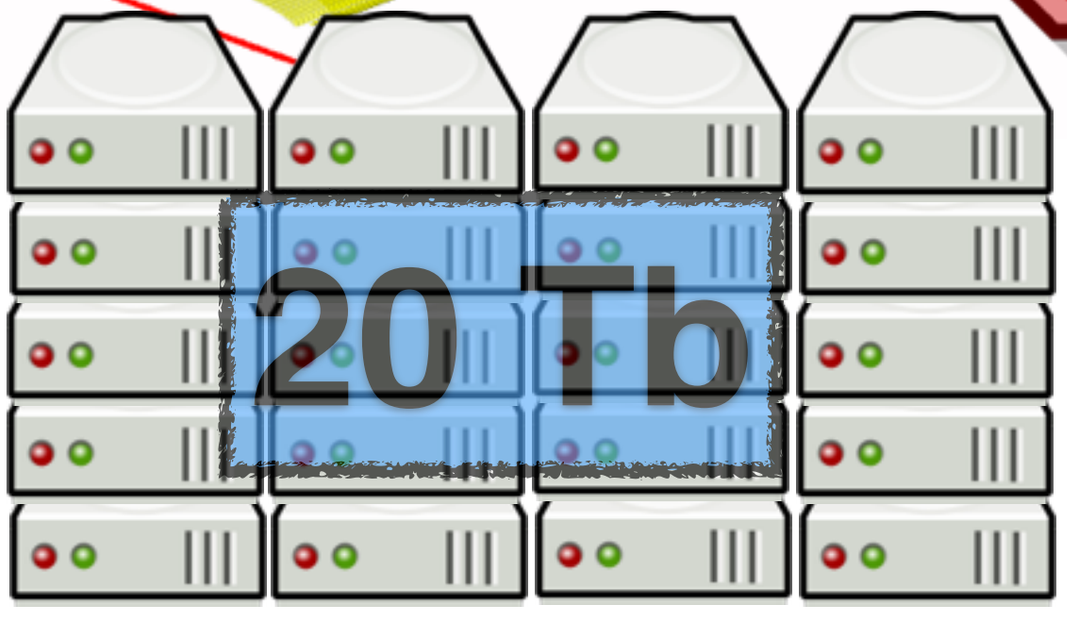




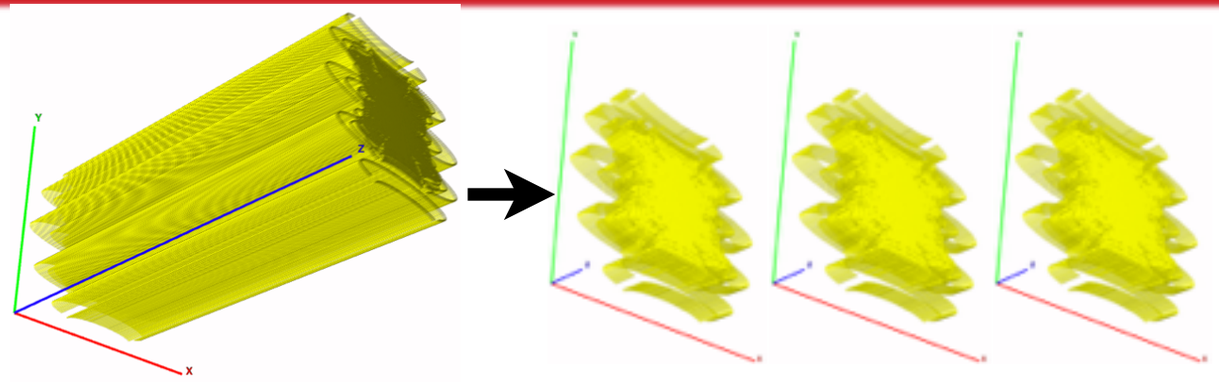
Imaging







Splitting visibilities



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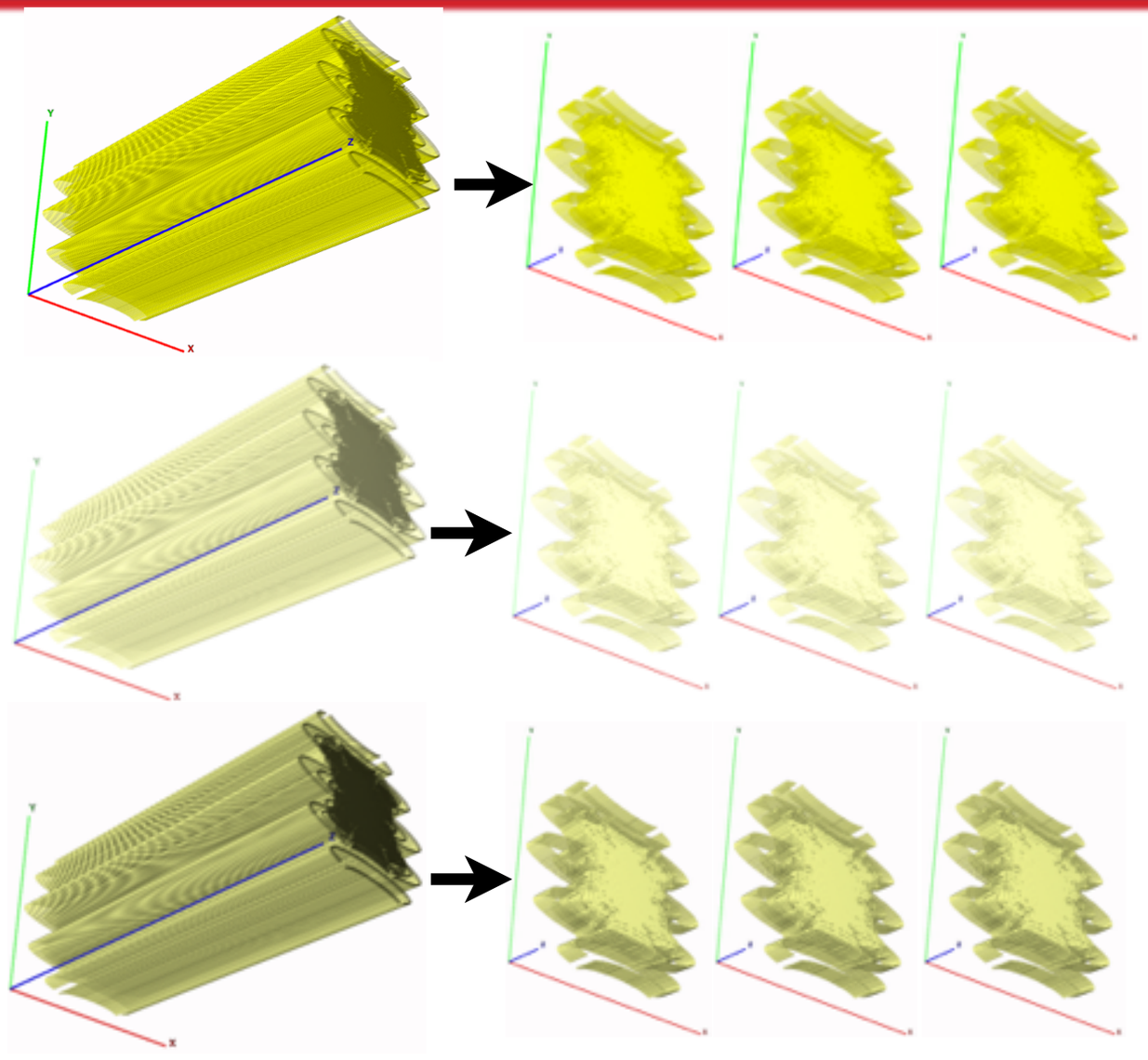
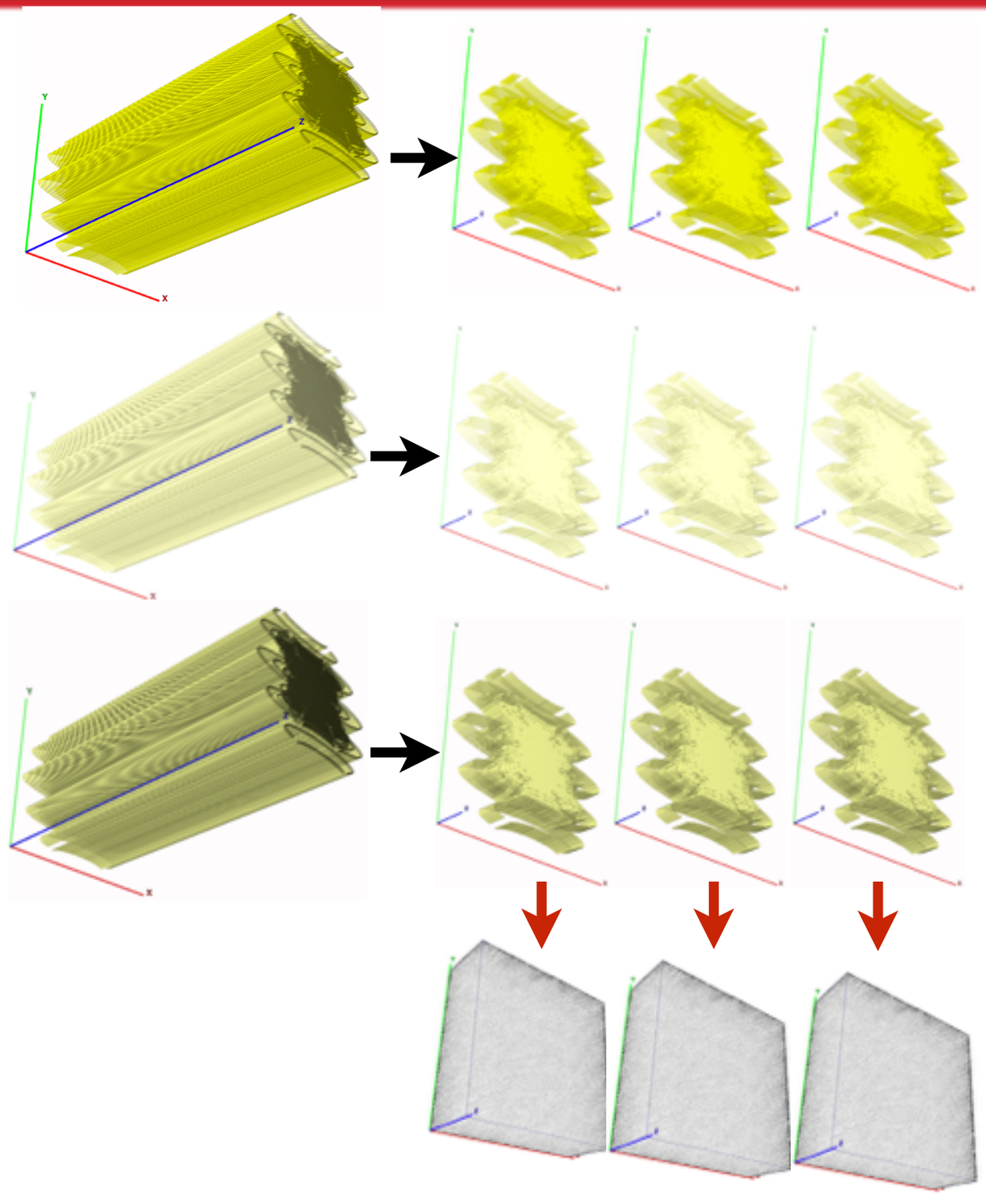
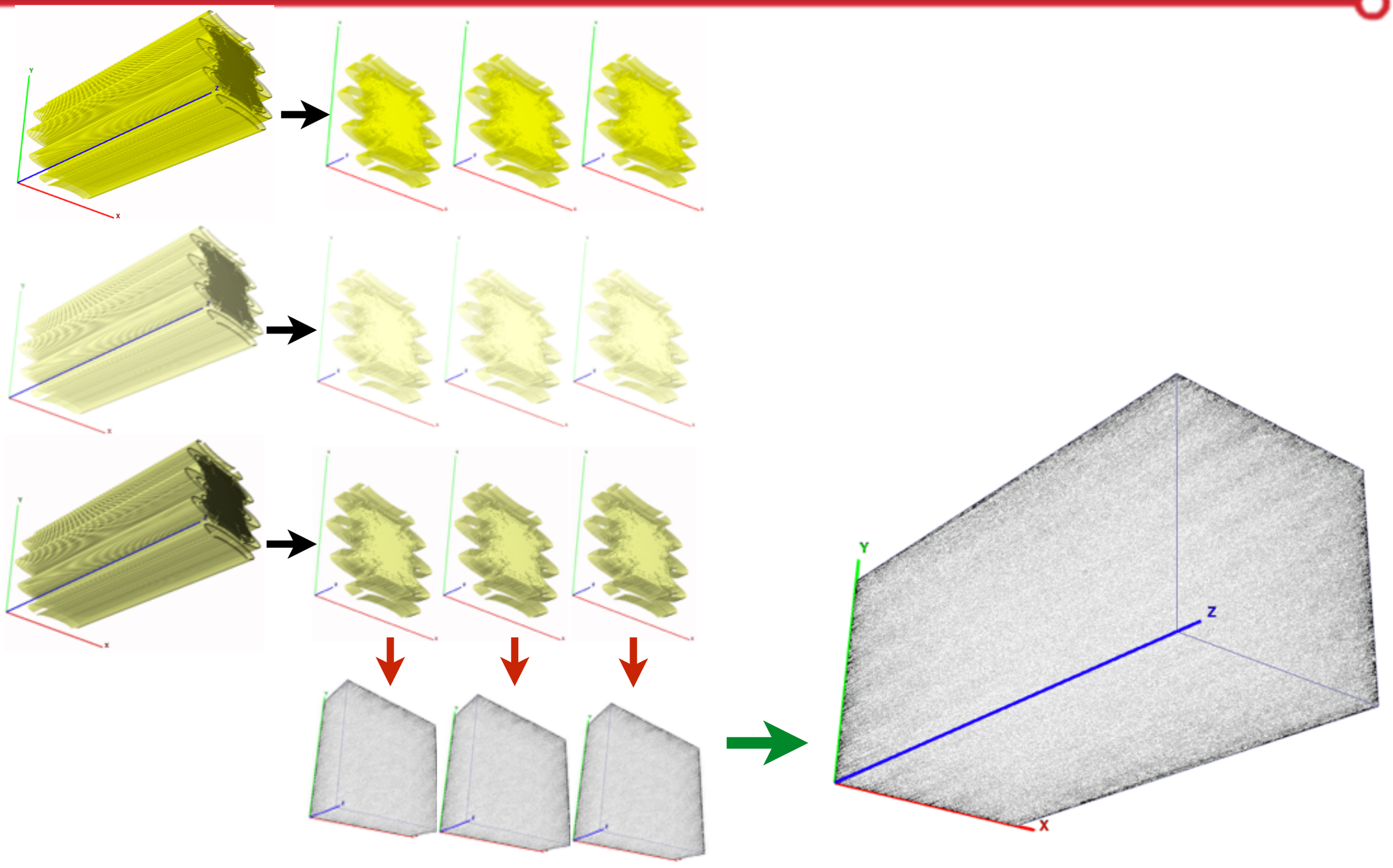
Splitting visibilities



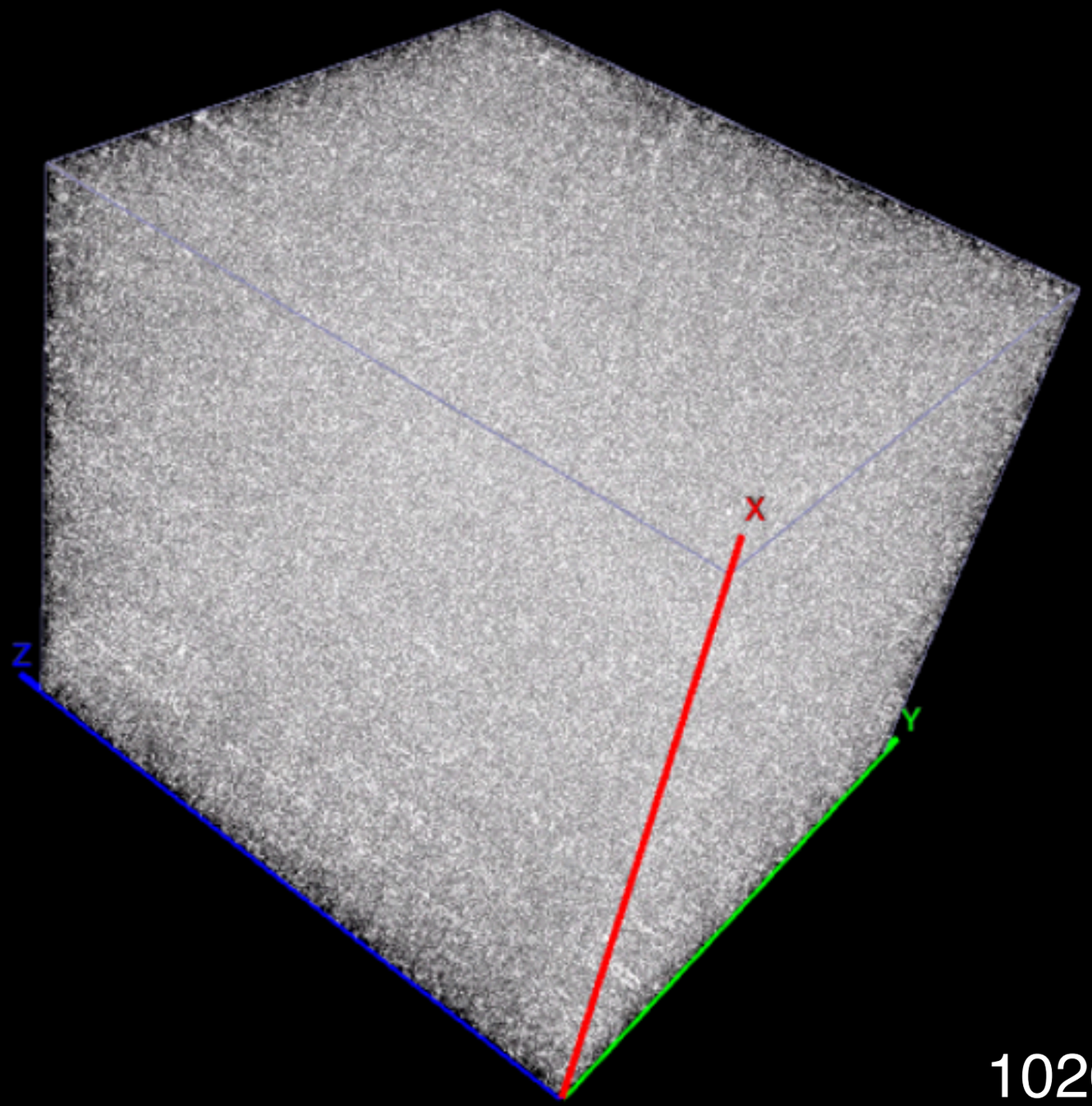
making sub-cubes



Imaging



We have now combined 42 observing runs (~20 Tb) and imaged 2048*2048*31.000 pixels (~500 Gb), covering the redshift range z=0~0.5



1020 - 1040 MHz

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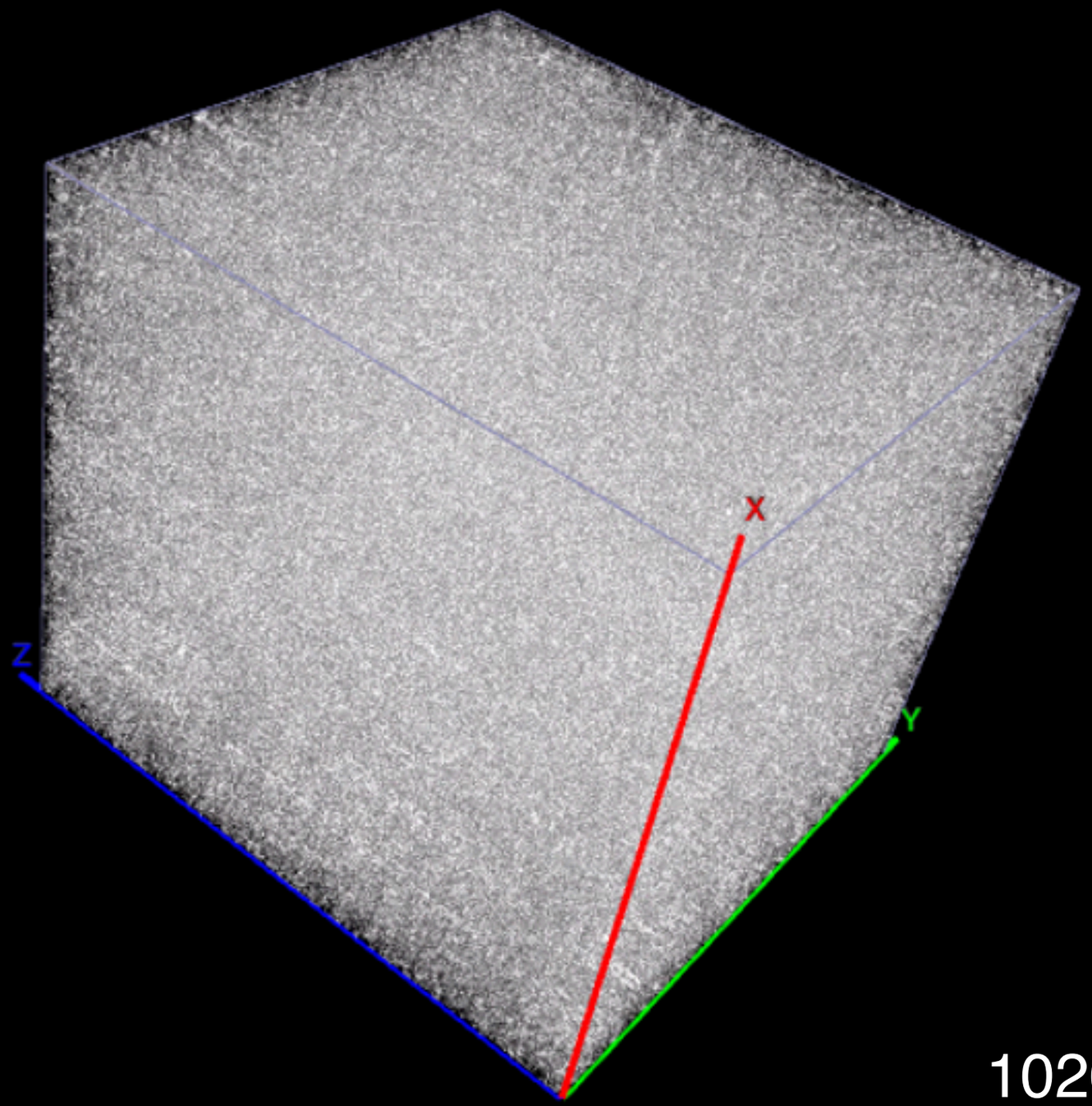


1020 - 1040 MHz

Computing efforts

Single Machine
Big desktop: 48 Gb RAM

Good for testing
Would take ~year to finish

Conventional Cluster (pleiades)
5 nodes each node has 2x Intel Xeon X5650 2.66GHz CPUs (6 cores / 12 HTs) with 64-192 GB of RAM

Enough computing power, however disk access limitations

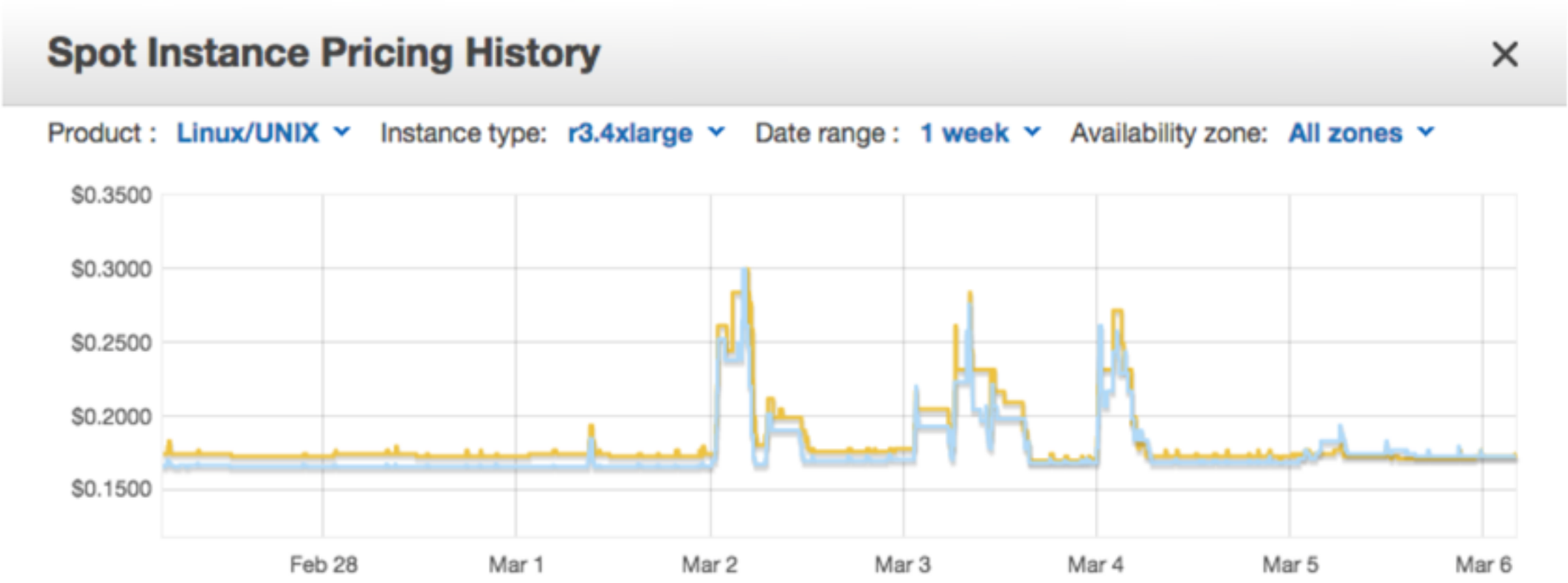
Super computer (MAGNUS)
Cray XC40 - 24 cores per node

Alternative (AWS)

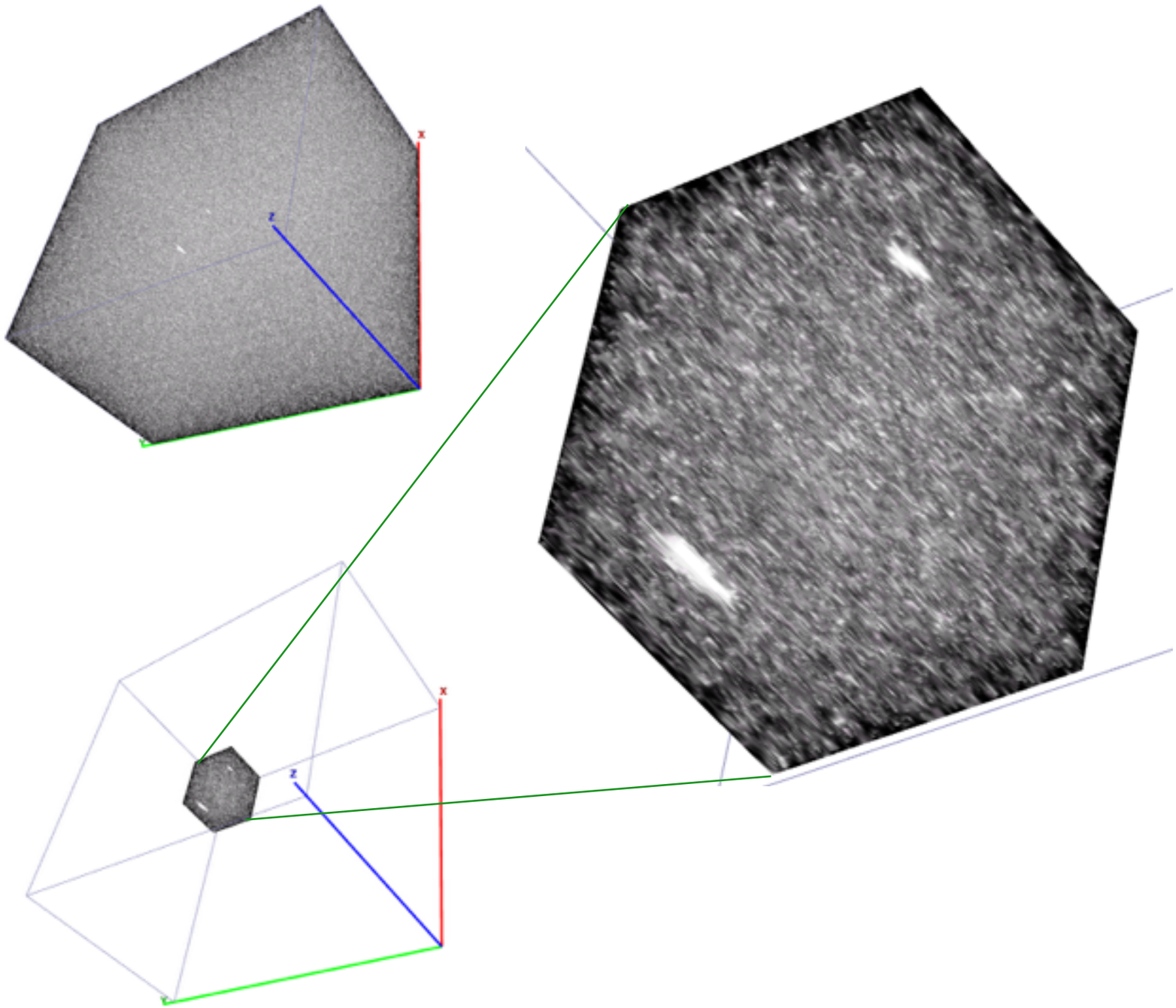
amazon web services™

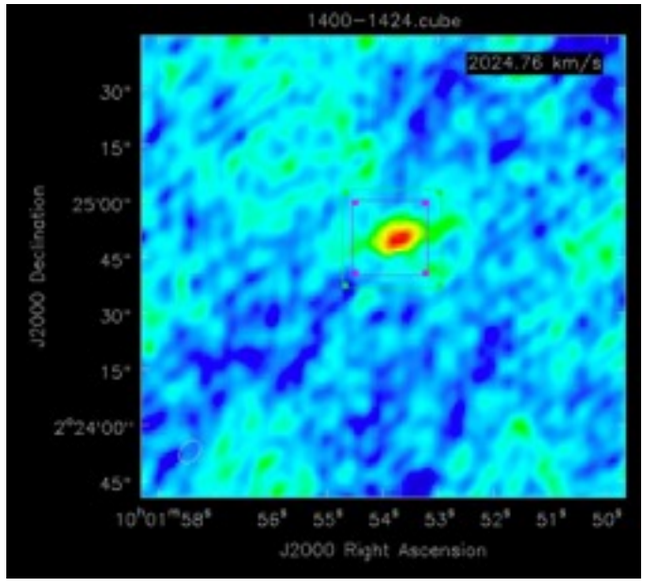
	On demand	Spot Price
r3.4xlarge	$1.68	$0.20
r3.2xlarge	$0.840	$0.09
m3.xlarge	$0.392	$0.04
m3.medium	$0.098	$0.01

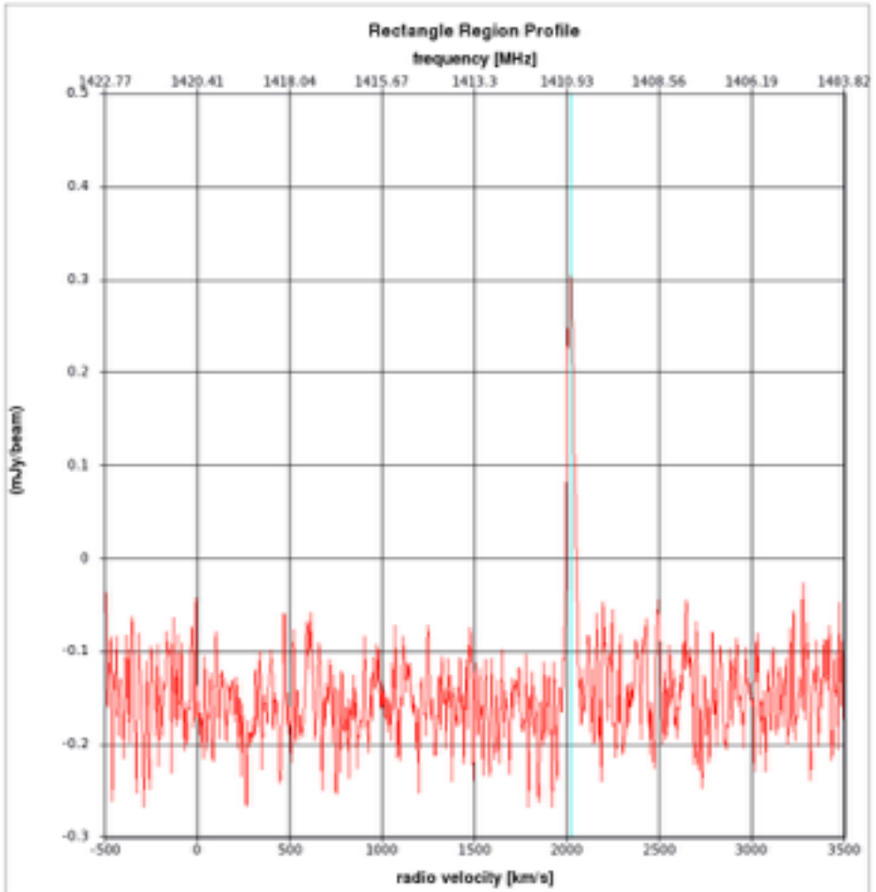
Works!
costs so far : ~$2000



Detections


x
z
y
x
z
y

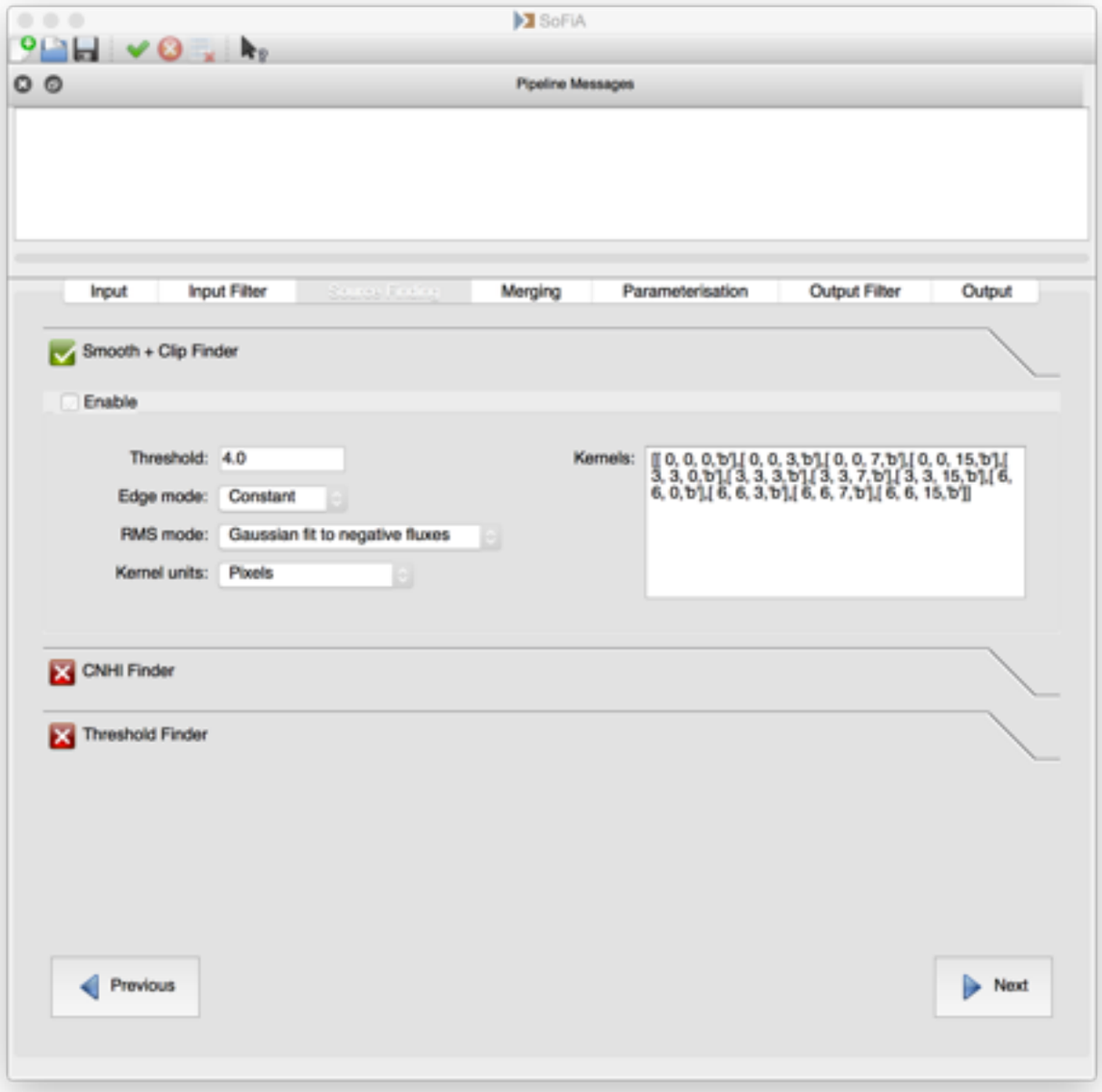

1400−1424.cube
2024.76 km/s
30°
15°
25'00"
45°
30°
15°
2°24'00"
45°
10h01m58s
56s
55s
54s
53s
52s
51s
50s
J2000 Declination
J2000 Right Ascension


Rectangle Region Profile
frequency [MHz]
1422.77
1420.41
1418.04
1415.67
1413.3
1410.93
1408.56
1406.19
1403.82
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
(mJy/beam)
-500
0
500
1000
1500
2000
2500
3000
3500
radio velocity [km/s]

Source Finding

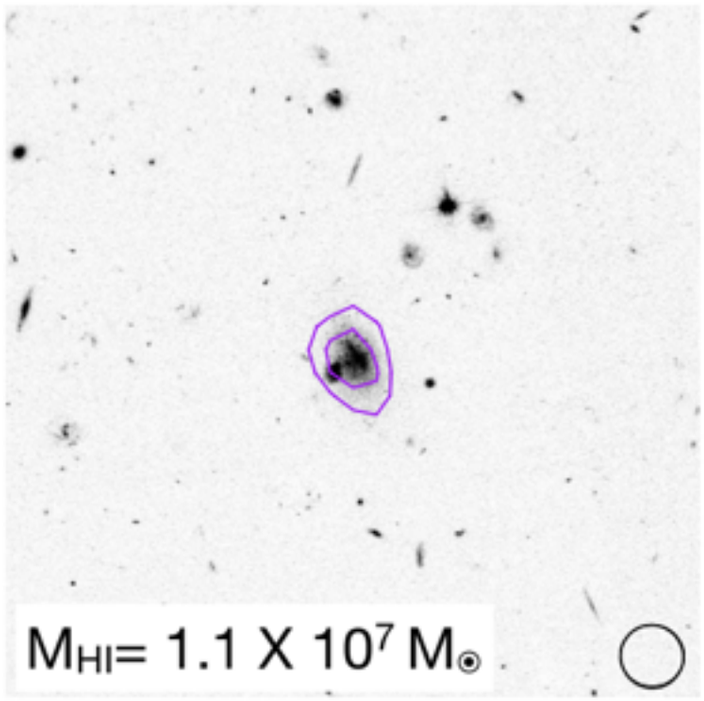
SoFiA: Source Finding Application

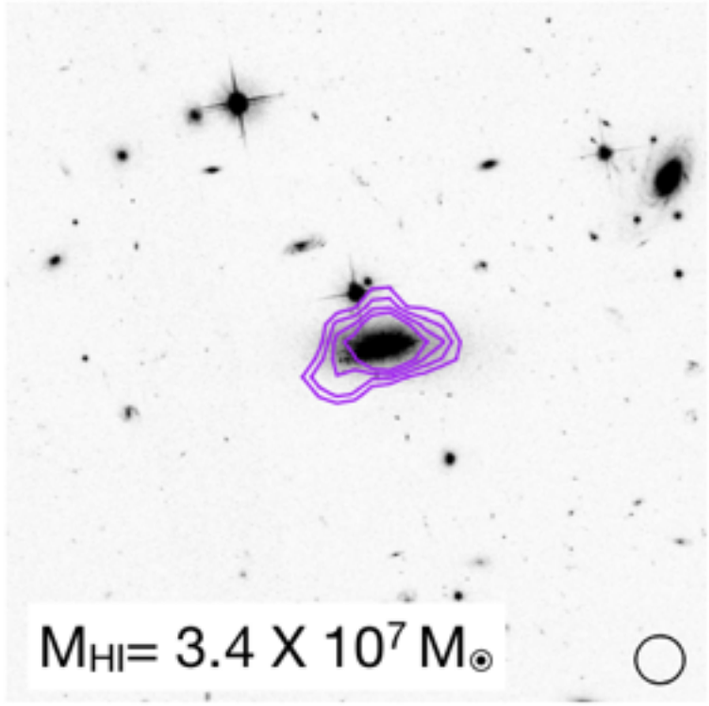
https://github.com/SoFiA-Admin/SoFiA/



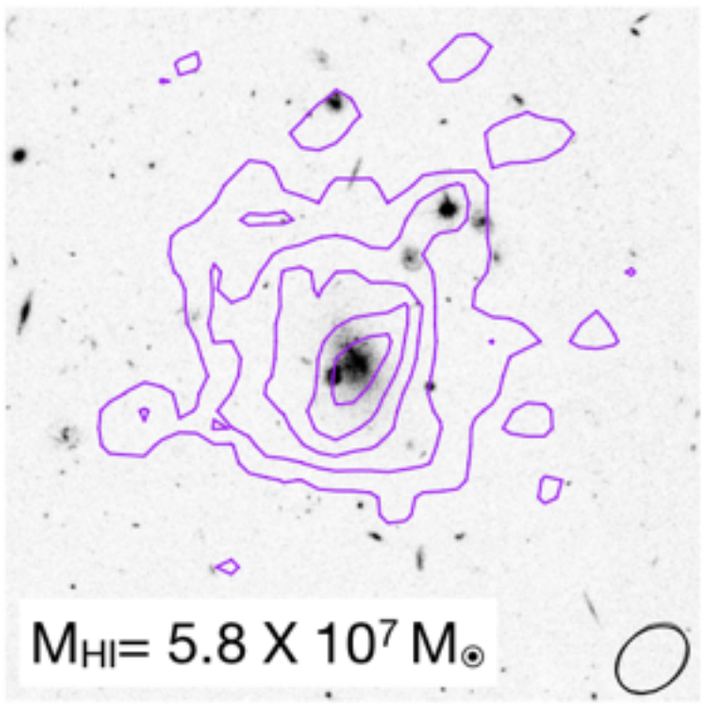
See demonstration this afternoon !!

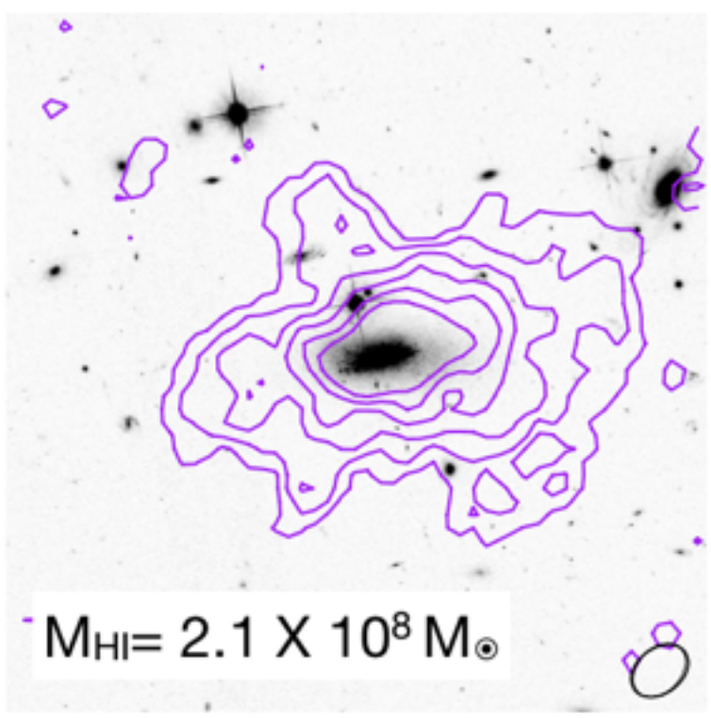
Detections





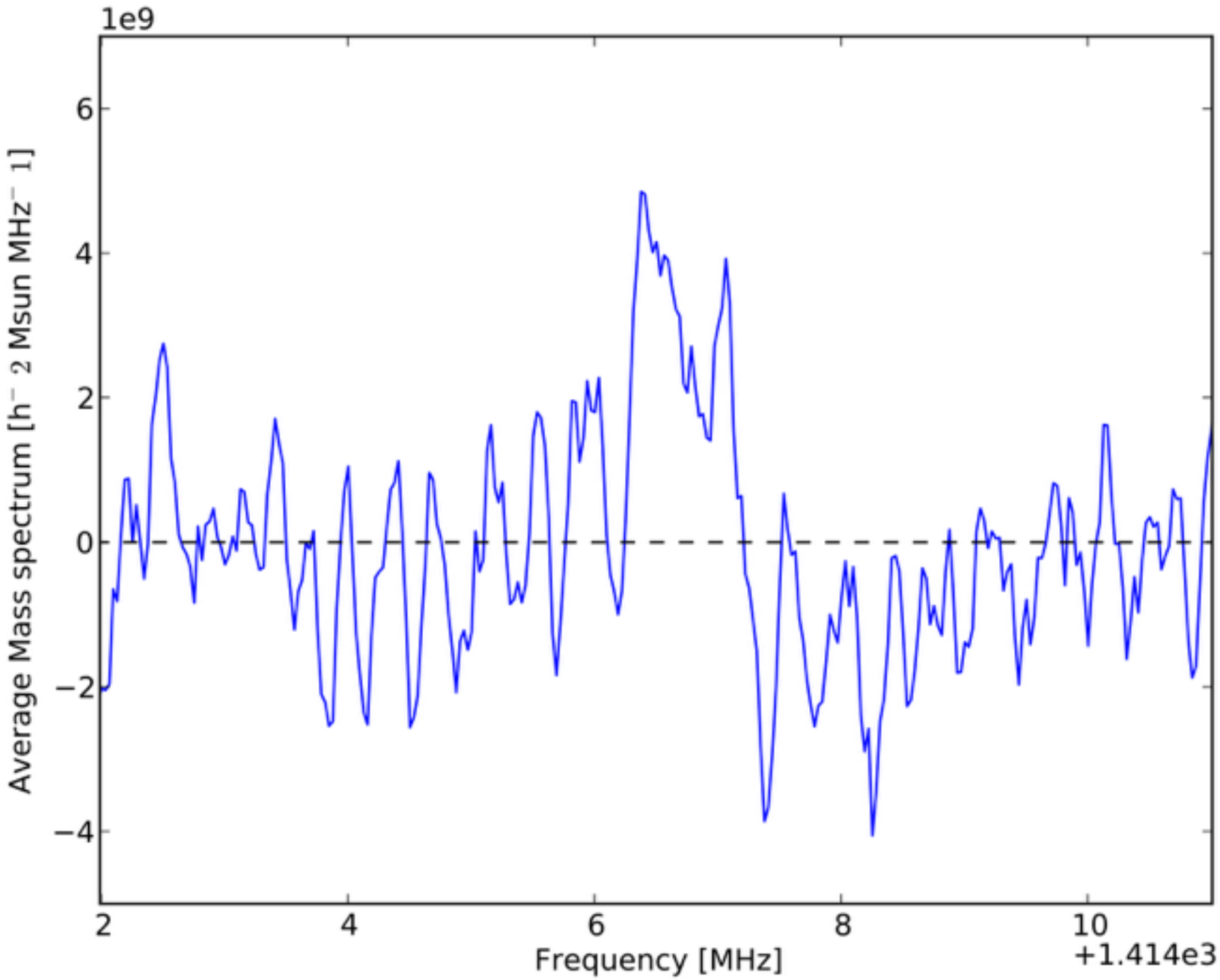
60 hours





170 hours

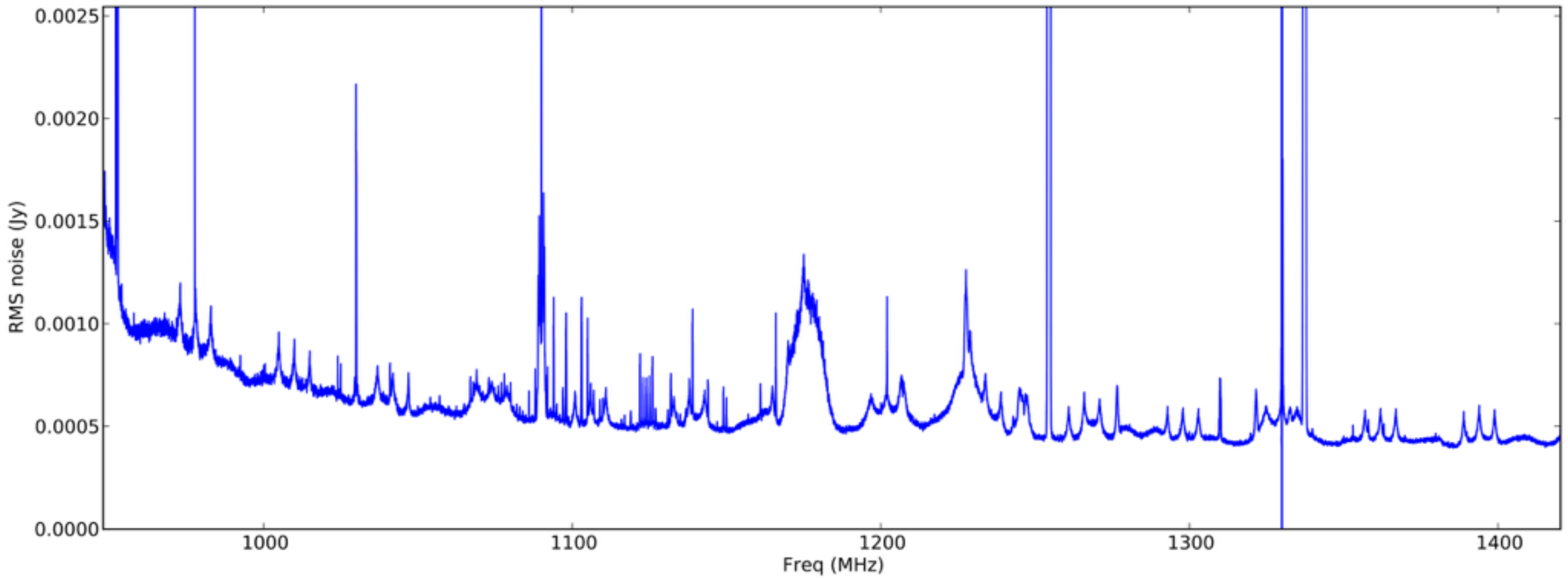
Stacking the Wall (z~0.12)



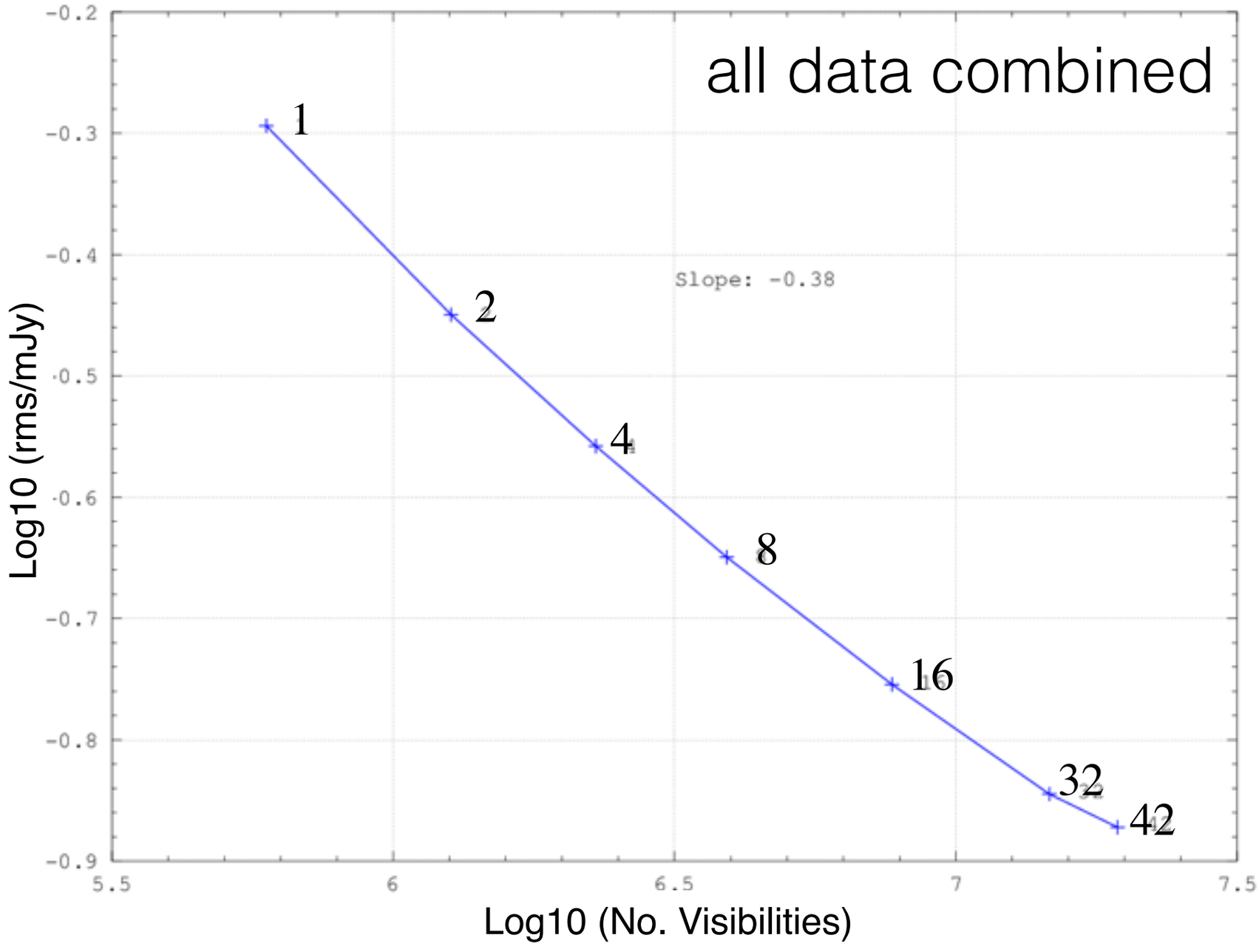
redshifts in COSMOS field from Davies et al. 2015

Noise

3 sessions combined

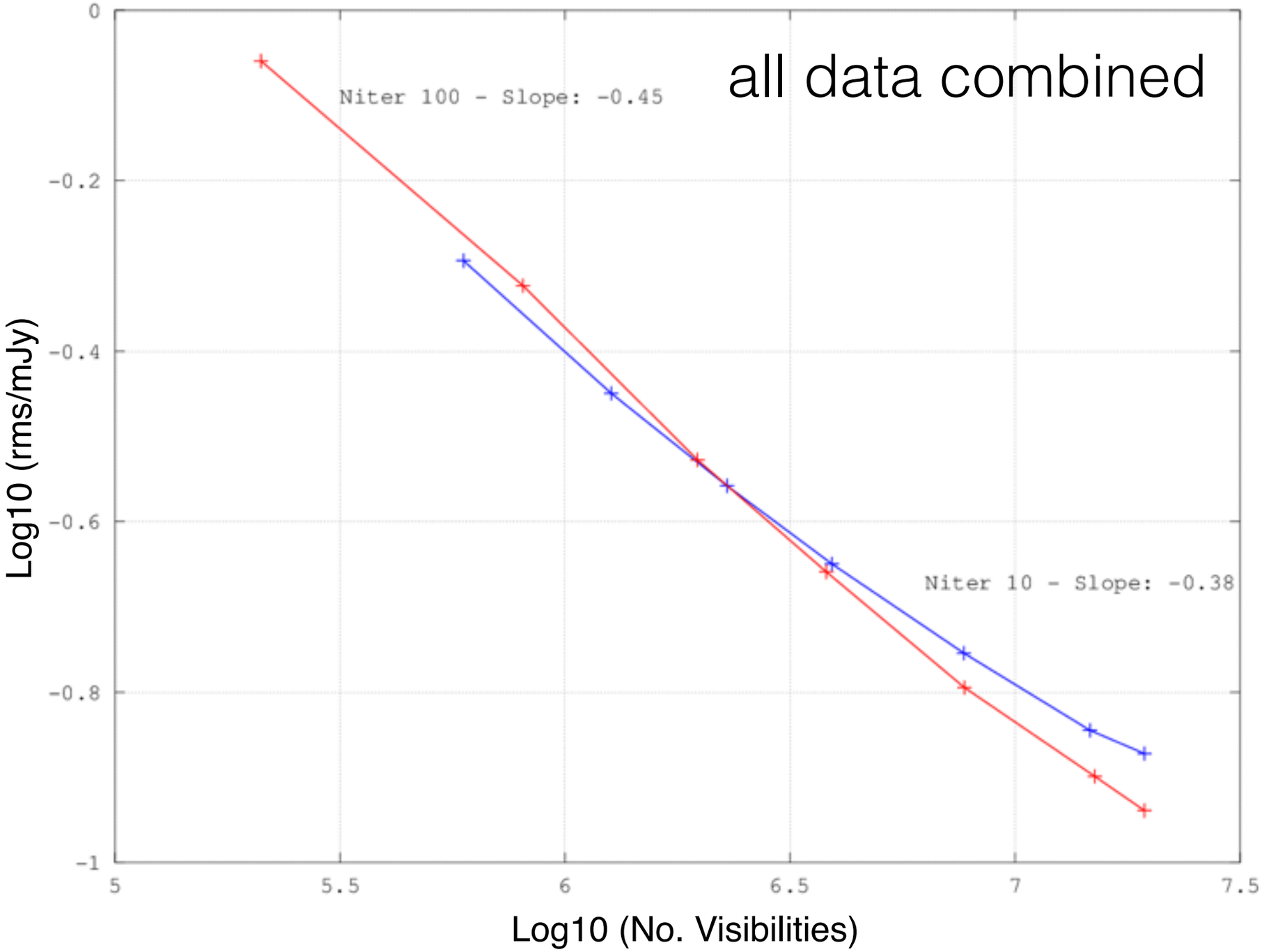


Noise



10 “clean” iterations, slope ~ -0.38

Noise



all data combined

100 “clean” iterations, slope ~ -0.45

Conclusions

- CHILES will observe HI out to z~0.5
- We have observed and reduced 178 hours of data
- ~270 hours will be observed in current semester
- We have successfully developed an implemented imaging algorithms
- First results look very promising (detections, noise)

- You need a good data plan
- You need a computing person in your team from the beginning