

# The challenges of new observing and operating modes at ground based optical observatories

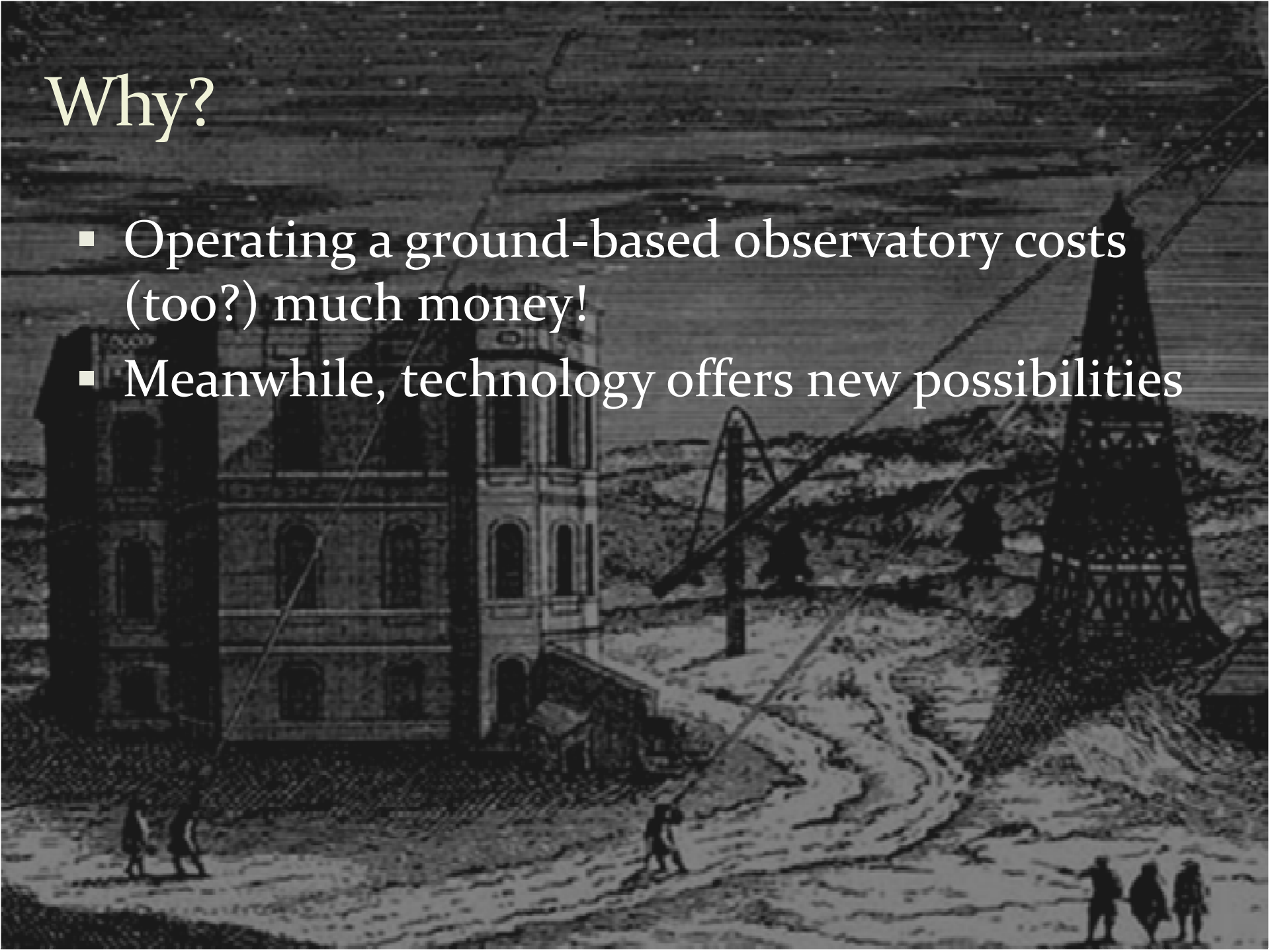


Christian Veillet – CFHT

Kanoa Withington & Billy Mahoney in the audience...

# Why?

- Operating a ground-based observatory costs (too?) much money!
- Meanwhile, technology offers new possibilities



# Why?

- Operating a ground-based observatory costs (too?) much money!
- Meanwhile, technology offers new possibilities
- Observatories and their users can (must?) move together toward new modes of observing

**FOR MORE SCIENCE WITH LESS MONEY**



# How?

- By always placing the users first!



# Early days

The telescope is in your  
backyard...

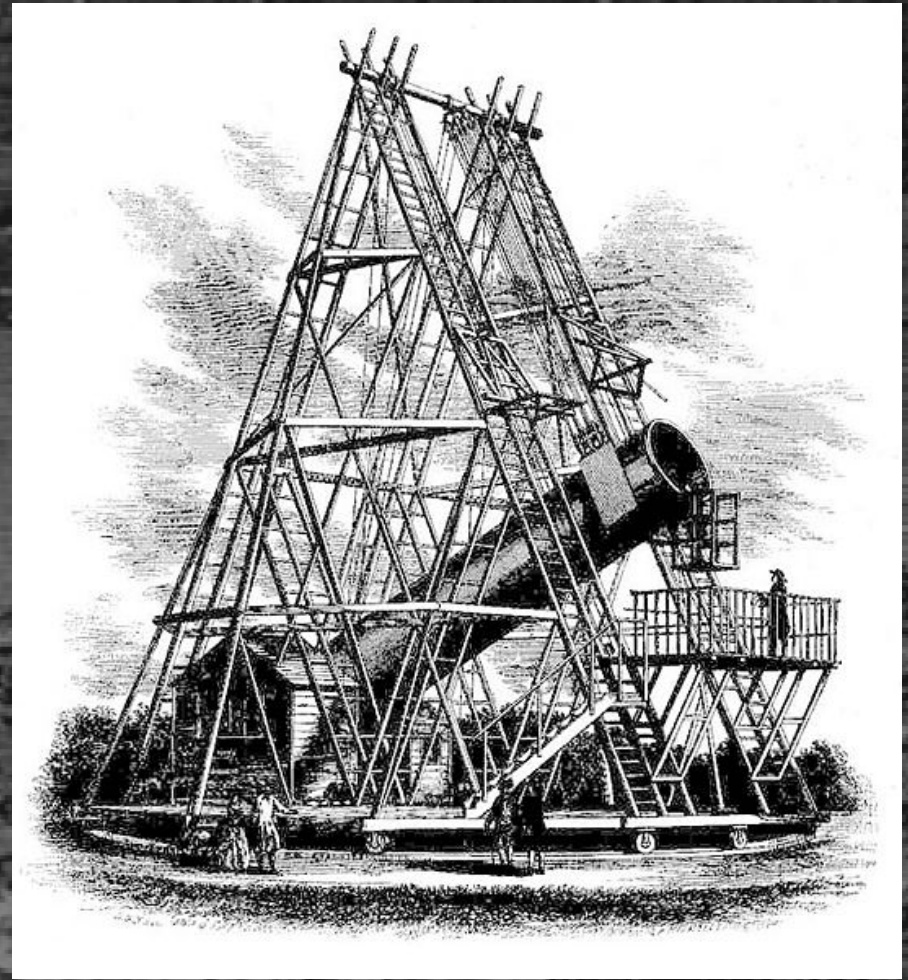
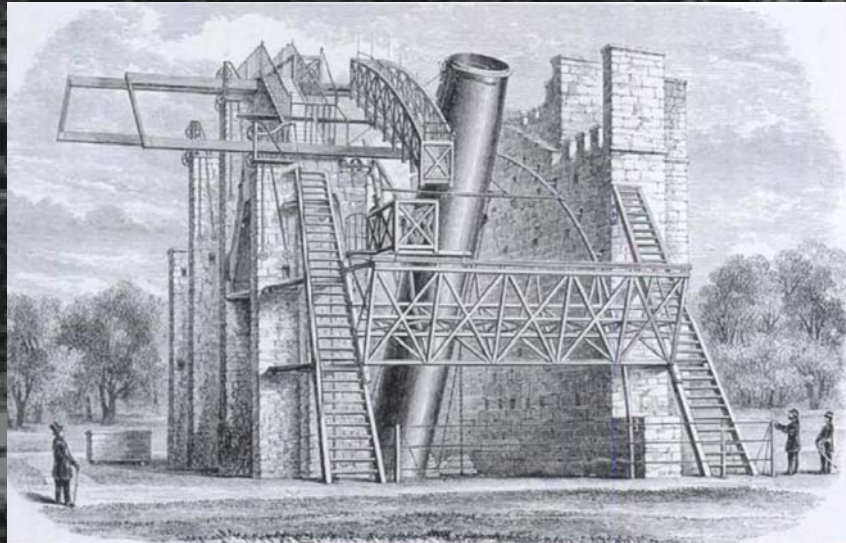
You work with some  
assistance



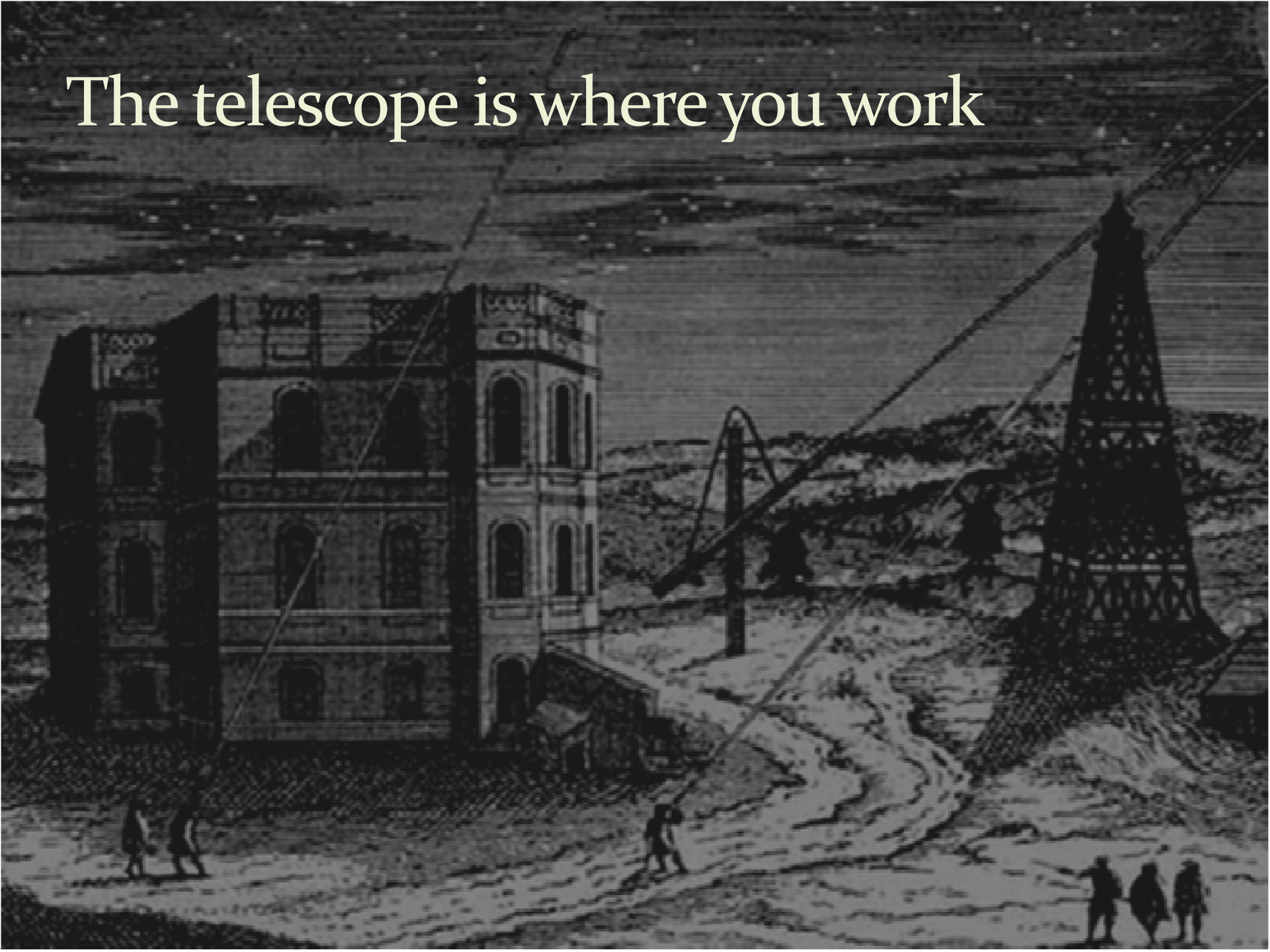


# Early days

...or need more assistance!

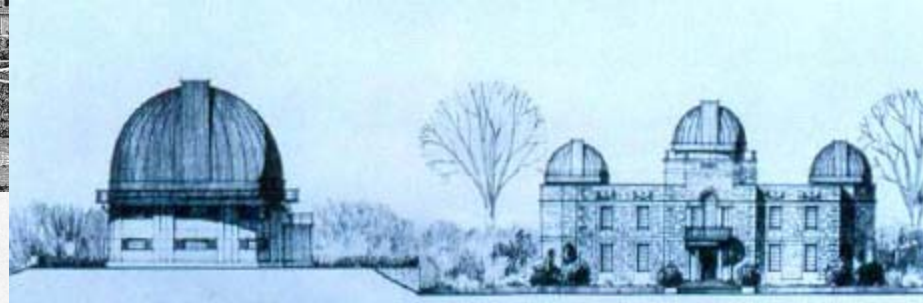
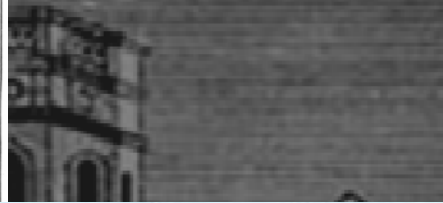


The telescope is where you work





# The telescope is where you work





...and then where you work is not good anymore!



# The telescopes move away from home





or (very) far away...



# But the astronomers still go to the telescope!

- Request for observing time
  - What for
  - How (instrument – conditions)
  - How much time
- Get (kind of) what you asked for





# But the astronomers still go to the telescope!

- Request for observing time
  - What for
  - How (instrument – conditions)
  - How much time
- Get (kind of) what you asked for
- Prepare for your run (or not...)
- Go to the observatory (it's far away...)
  - Learn (if needed)
  - Observe (if...)
- Come back home, tired... and hopefully with some data!



# The usual “visitor” mode

CANADA-FRANCE-HAWAII-TELESCOPE																																																																				
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Nights1	3.0				1.0			3.0			1.0			3.0			4.0		2.0		2.0		2.0		2.0			3.0		3.0										
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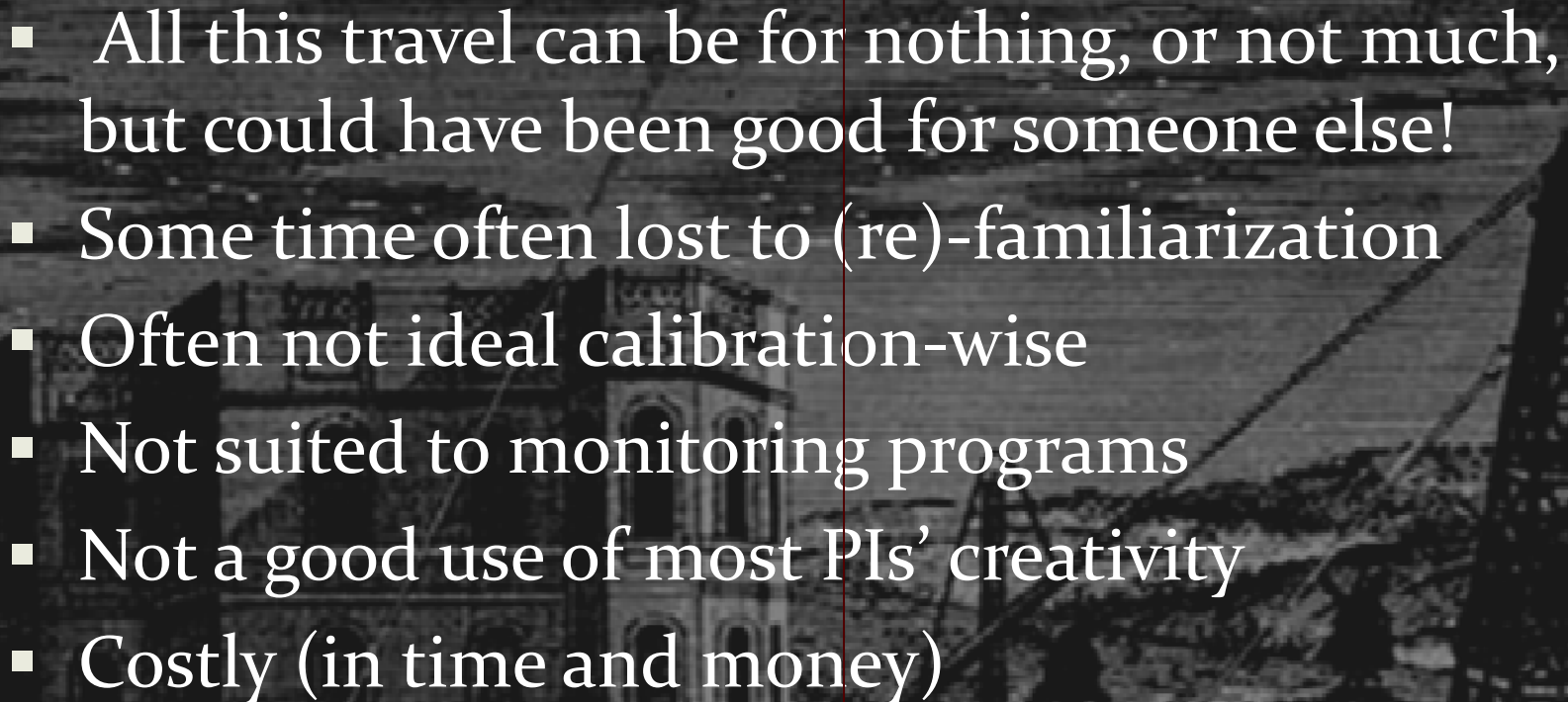


# The usual “visitor” mode: the good...

- Nice site – good experience □
- In touch with telescope and instrumentation
- Real time changes possible based on first data acquisitions

Day Date	Sat 1	Sun 2	Mon 3	Tue 4	Wed 5	Thu 6	Fri 7	Sat 8	Sun 9	Mon 10	Tue 11	Wed 12	Thu 13	Fri 14	Sat 15	Sun 16				
CF																				
Focus	PF																			
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Instrument	CFH12K																			
Detector																				
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RunID2																				
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RunID2																				
CFH																				
PI2																				
Nights2																				
Remarks																				
Support Astronomer																				
O.A.	Barton				Magnier				Woodworth				Fahlman				Wells			

# ...and the “not so good”

- 
- All this travel can be for nothing, or not much, but could have been good for someone else!
  - Some time often lost to (re)-familiarization
  - Often not ideal calibration-wise
  - Not suited to monitoring programs
  - Not a good use of most PIs' creativity
  - Costly (in time and money)

Day Date	Sat 1	Sun 2	Mon 3	Tue 4	Wed 5	Thu 6	Fri 7	Sat 8	Sun 9	Mon 10	Tue 11	Wed 12	Thu 13	Fri 14	Sat 15	Sun 16				
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Focus	PF																			
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Instrument	CFH12K																			
Detector																				
RunID1		H718			C124			C48			C202			D403						
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PI1		Chambers			Kavelaars			Gladders			Yee									
Nights1		3.0			1.5			4.0			3.0			2.0						
RunID2						C227														
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PI2						Hall														
Nights2						0.5														
Remarks																				
Support Astronomer																				
O.A.	Barton				Magnier				Woodworth				Fahlman				Wells			



# Remote observing?

- ~~All this travel~~ can be for nothing, or not much, but could have been good for someone else!
- Some time often lost to (re)-familiarization
- Often not ideal calibration-wise
- ~~Not suited to monitoring programs~~
- Not a good use of most PIs' creativity
- ~~Costly (in time and money)~~



*Local site (Waimea)*

*Remote site (Santa Cruz)*



# Move to Queue *and* Service Observing!

Semester 2011B	November																November															
LMST 0h HST	2 25	2 29	2 33	2 37	2 41	2 45	2 49	2 52	2 56	3 00	3 04	3 08	3 12	3 16	3 20	3 24	3 28	3 32	3 36	3 40	3 44	3 48	3 52	3 56	3 59	4 03	4 07	4 11	4 15	4 19		
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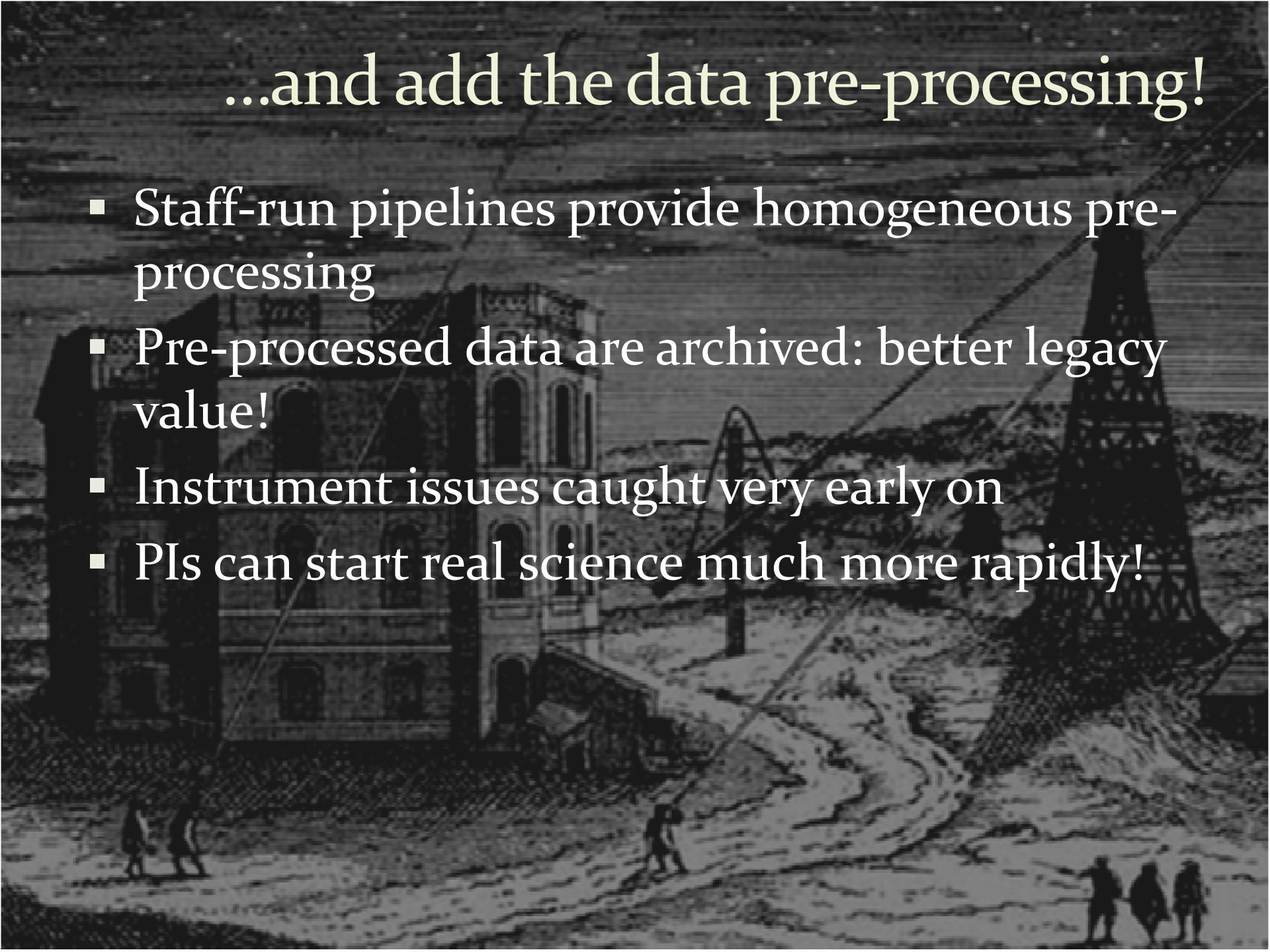


# Move to Queue *and* Service Observing!

- Well-trained staff, whose job is to observe, is better at observing than most (or all!) PIs.
- No need to have a PhD to observe!
- Observations always taken in the right conditions
- Prioritization of programs (using TAC rankings) insures best (?) scientific outcome
- Homogeneous set of calibrations available to all programs (better legacy value)
- No toll on PI's life

# ...and add the data pre-processing!

- Staff-run pipelines provide homogeneous pre-processing
- Pre-processed data are archived: better legacy value!
- Instrument issues caught very early on
- PIs can start real science much more rapidly!





# Try not to lose the “good” of the visitor mode

- Maintain close contact with PIs
- Allow for near real time changes
- Accept visits of PIs or grad students (training)
- Accept to evolve!
  - Offer new modes on request from a PI
  - Make it available to all!

**PIs ARE NOT A PAIN! THERE ARE OUR RAISON D'ETRE**

**NGC 474**

**MegaCam**

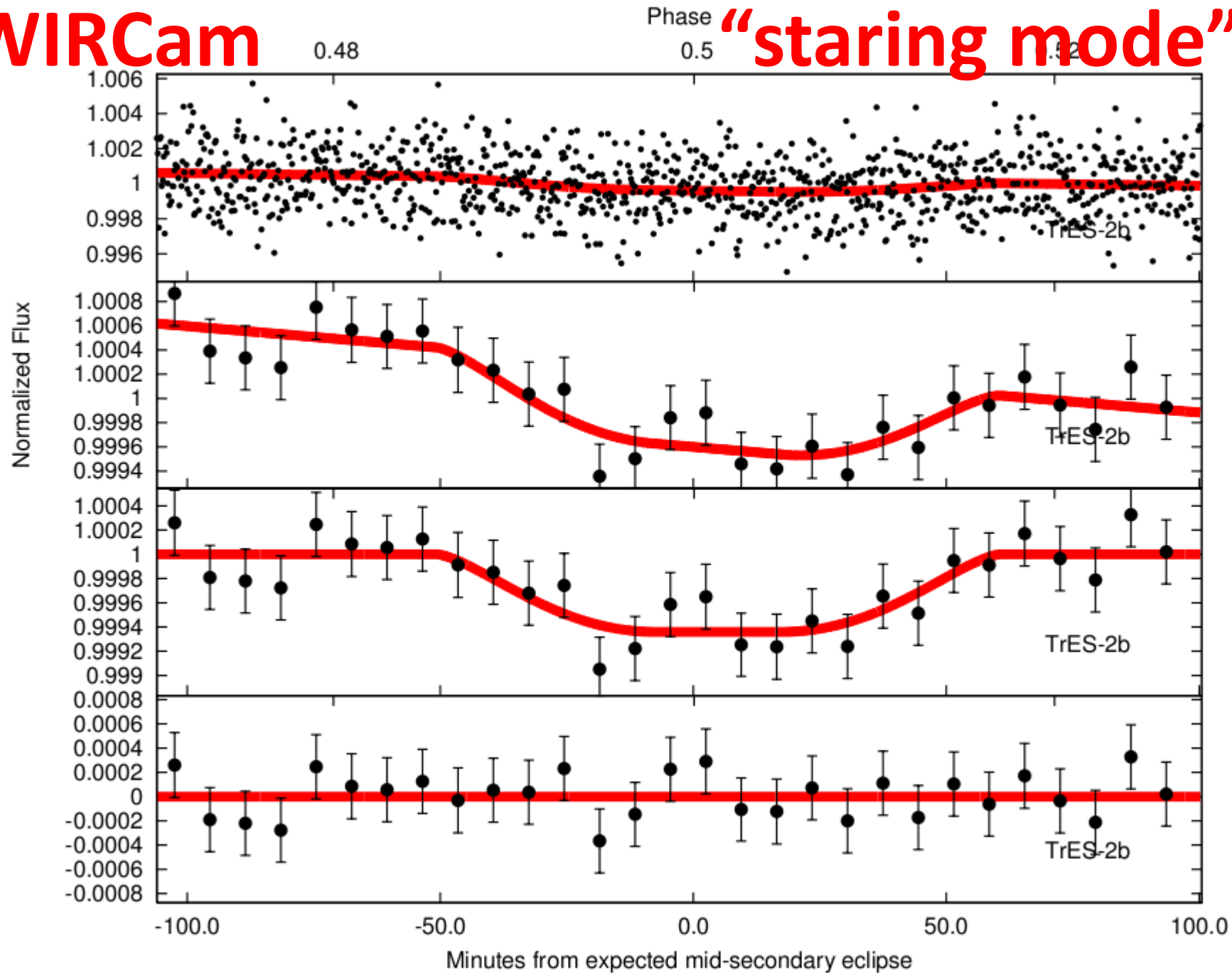
**LSB mode**





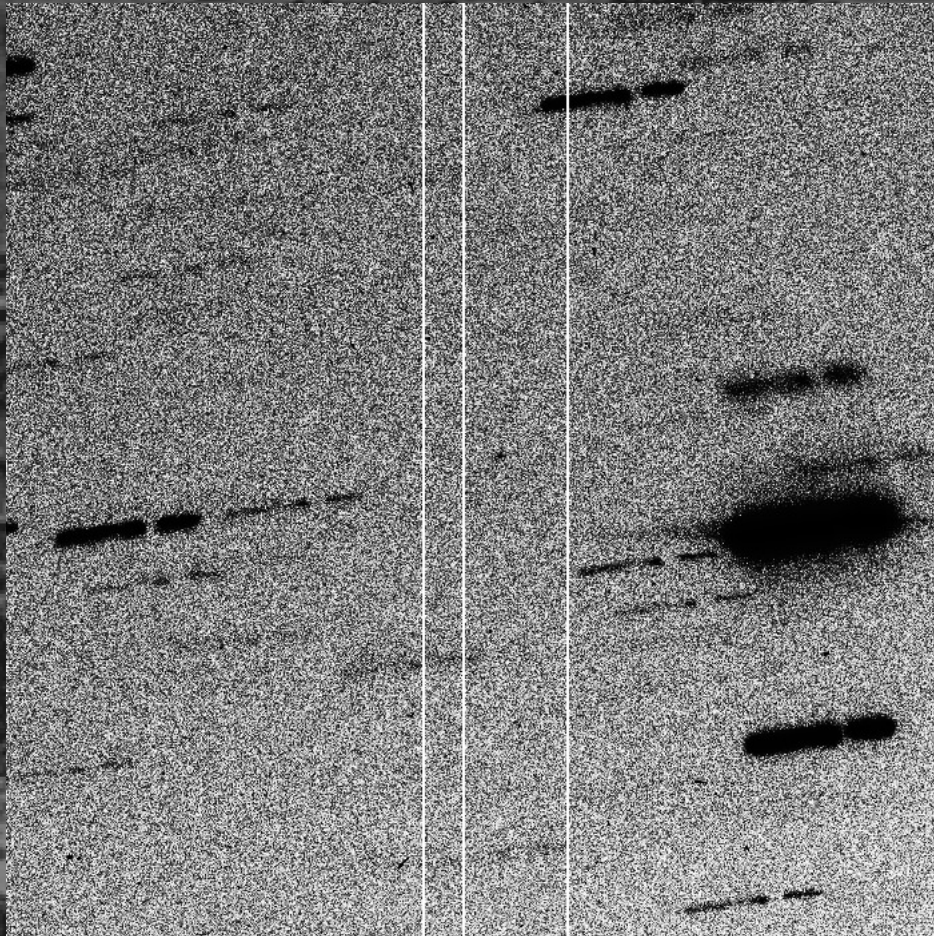
# WIRCcam

# “staring mode”





# First Earth's Trojan Asteroid



# nature

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE



## ALONG FOR THE RIDE

The Trojan asteroid  
that shares Earth's  
orbit **PAGE 401**

NATURE SURVEY

### LOOKING FOR INSPIRATION

*Graduate students' wish lists*

**PAGE 533**

EXTRATERRESTRIALS

### SCALING BACK THE SEARCH

*SETI retains allure despite telescope shut-down*

**PAGE 442**

AVIAN EVOLUTION

### PRE-FLIGHT CHECK

*Archaeopteryx knocked off its perch*

**PAGES 450 & 465**



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28 July 2011



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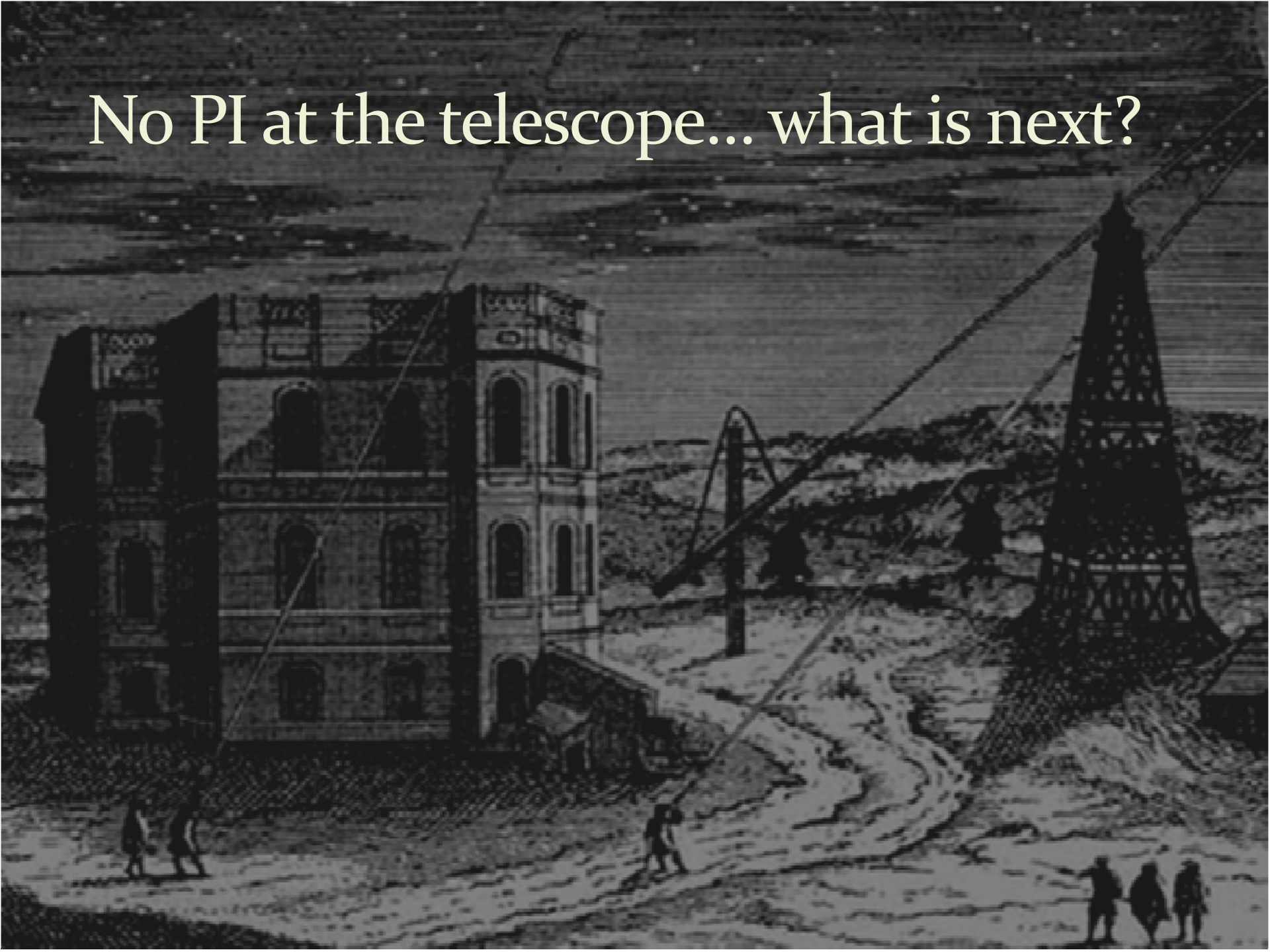


# QSO is working well

- CFHT (all QSO for the main instruments), UKIRT (single instrument – mostly surveys),...
- ESO, Gemini,... (though still in mixed mode)
- But others like Keck are still in the old mode (like a private telescope in your backyard...)

**QSO IS LIKELY TO BE THE MODEL USED FOR THE ELTs...**  
**(EFFICIENCY WILL BE PARAMOUNT!)**

No PI at the telescope... what is next?



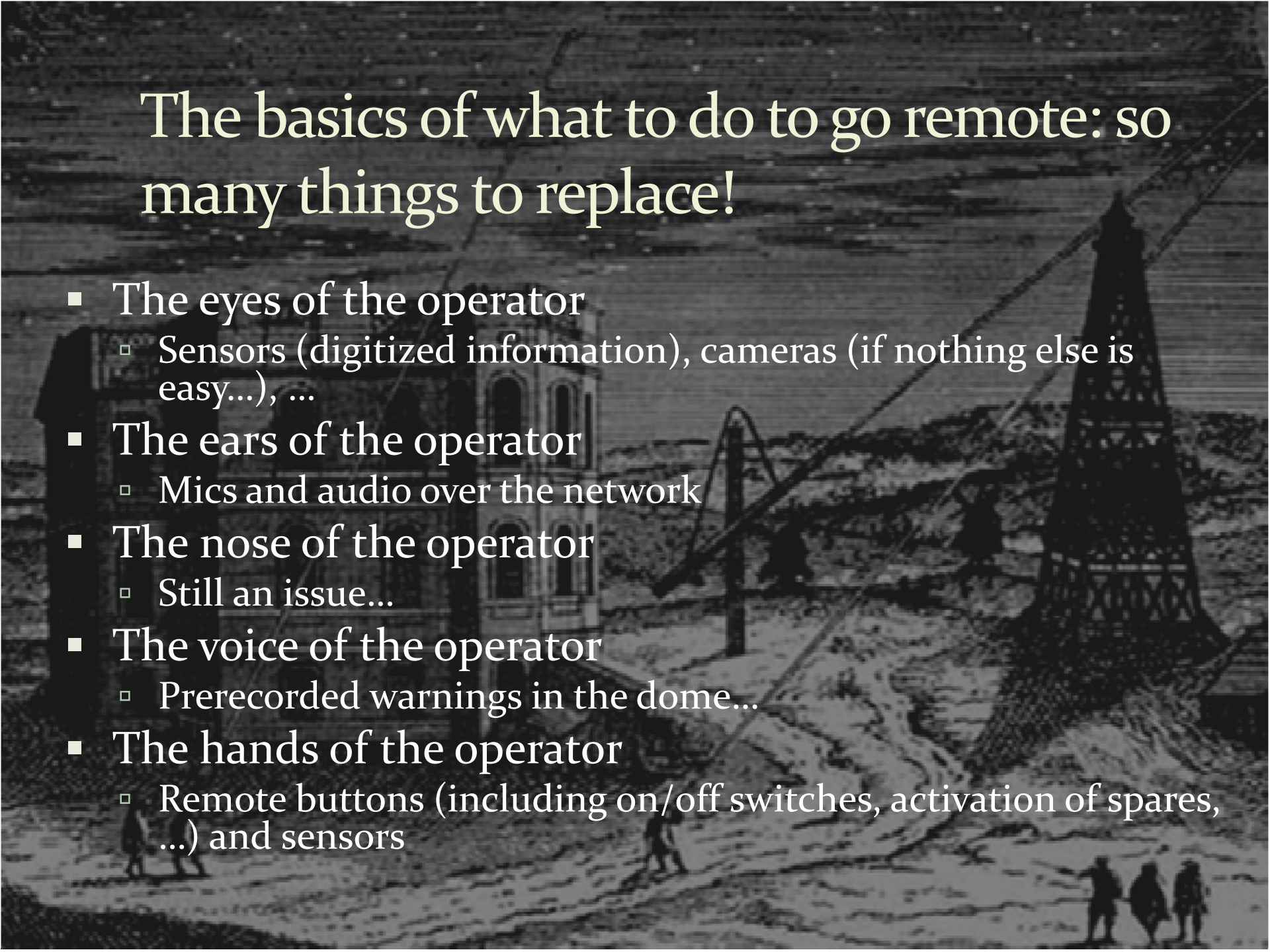


# Nobody at the telescope...

- If the telescope is far from the headquarters, stay at the headquarters!
- No commute to the telescope anymore!
  - Save time, energy and money
  - Minimize risks on the road!
- If telescope environment is hostile (Maunakea is a good example...)
  - Observations and operations are better done at the HQ (better judgment), leading to better science!
  - Safety 2-person rule? No longer an issue...

# The basics of what to do to go remote: so many things to replace!

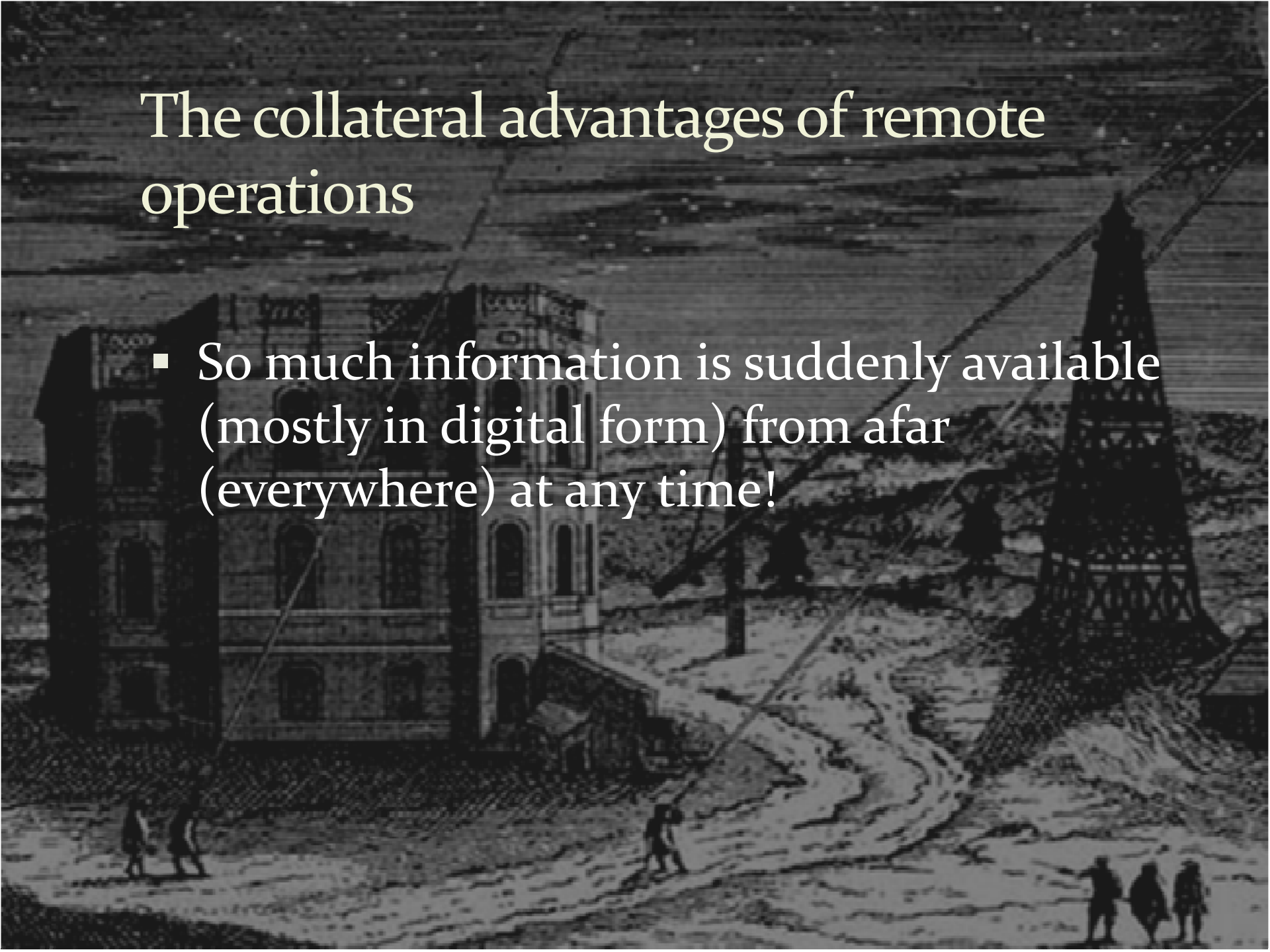
- The eyes of the operator
  - Sensors (digitized information), cameras (if nothing else is easy...), ...
- The ears of the operator
  - Mics and audio over the network
- The nose of the operator
  - Still an issue...
- The voice of the operator
  - Prerecorded warnings in the dome...
- The hands of the operator
  - Remote buttons (including on/off switches, activation of spares, ...) and sensors





# The collateral advantages of remote operations

- So much information is suddenly available (mostly in digital form) from afar (everywhere) at any time!



# Some examples...

- Automatic triggering of alerts (text messaging, email, phone call...) when parameters are off-limits:
  - catching issues before they become a real problem
  - inform all those concerned when it is a problem!
- Remote access to a wealth of information from everywhere (with internet access)
  - easy diagnostic for on-call staff, saving time and stress!
- Logging of everything (including audio and video)
  - an invaluable tool for understanding problems!
- Observatory control can be computer assisted
  - a single person can run the show!





# It makes everything more efficient!

- Improved reliability
- Preventive action instead of firefighting!
- Less down time
- Less stress on staff...

LEADING TO MORE AND BETTER DATA

ON THE NET

Many small remotely operated telescopes...  
...but big facilities can do it too!



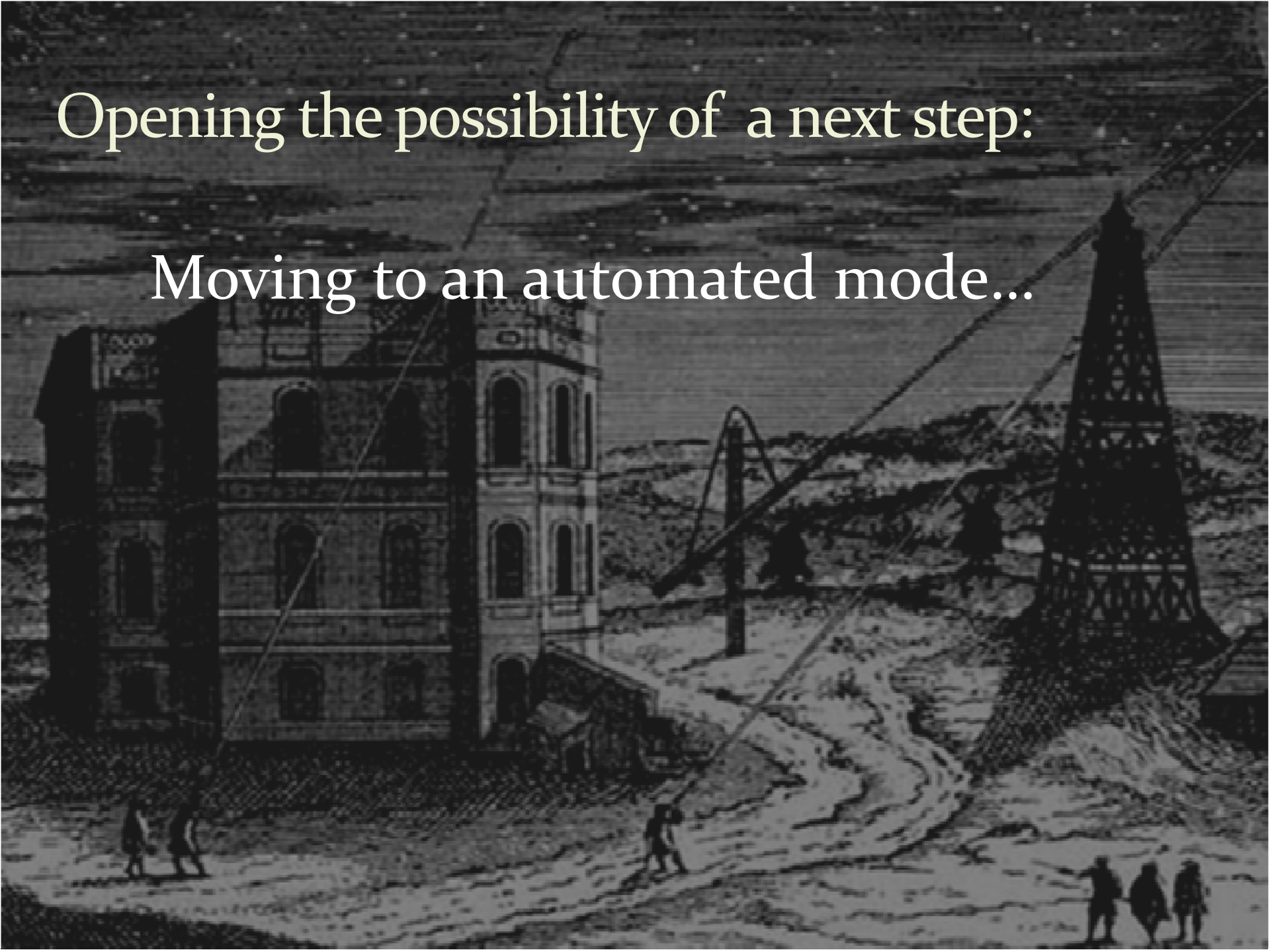
- Most telescope functions are linked to observing queues





Opening the possibility of a next step:

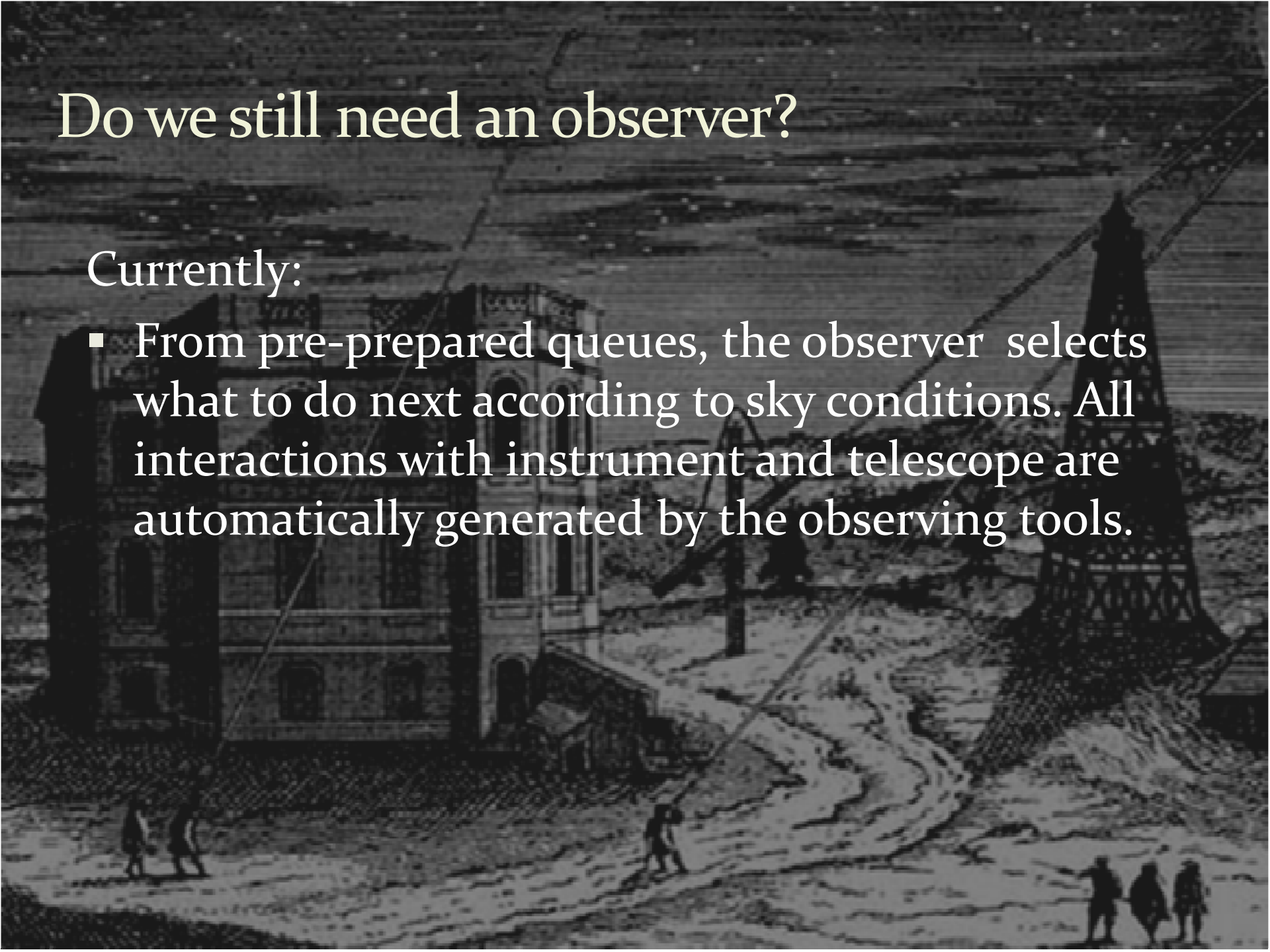
Moving to an automated mode...



# Do we still need an observer?

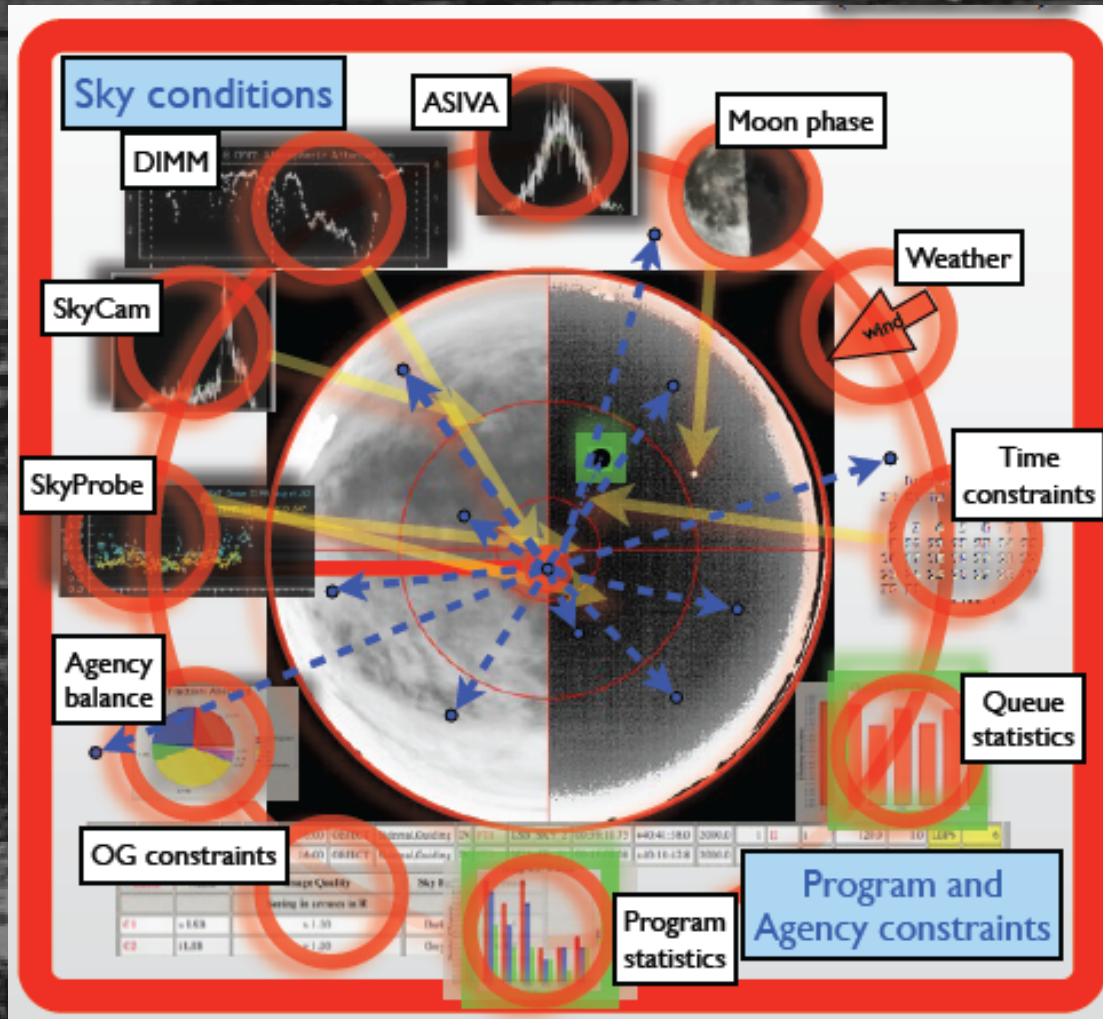
Currently:

- From pre-prepared queues, the observer selects what to do next according to sky conditions. All interactions with instrument and telescope are automatically generated by the observing tools.



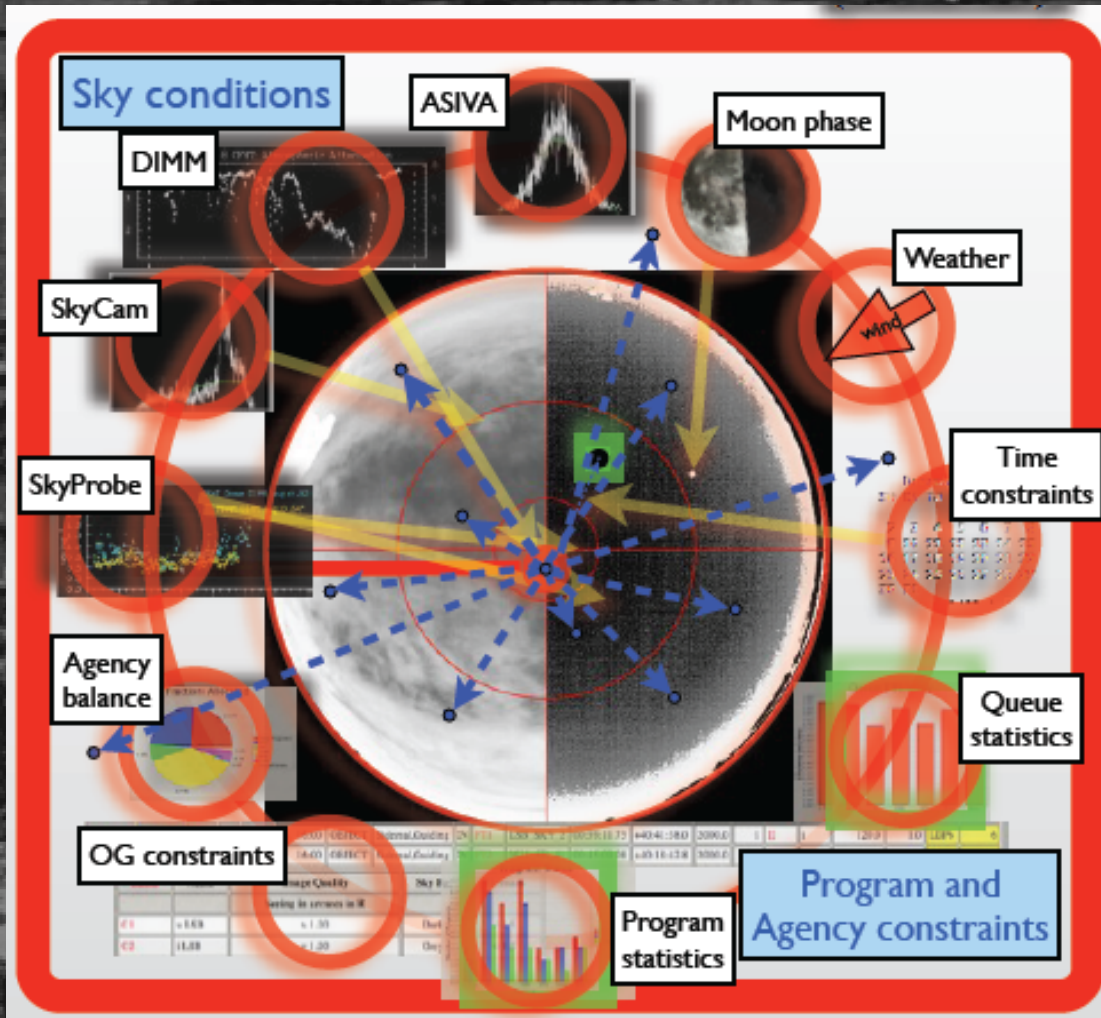


# Do we still need an observer?



Too many things to take into account for an observer at night without all the possibilities narrowed down before hand!

# With an Autonomous System



## **Realtime OG selection**

**NO Queue construction!**

(by Autonomous System)

Based on:

1. Observing + Program constraints

**Define suitability and fitness functions (Selection)**

*current sky conditions (IQ, attenuation), weather (wind, cloud cover), target position (airmass, moon phase and proximity), time constraints, other PI specified constraints*

2. Metrics

**Quantify metrics (Selection)**

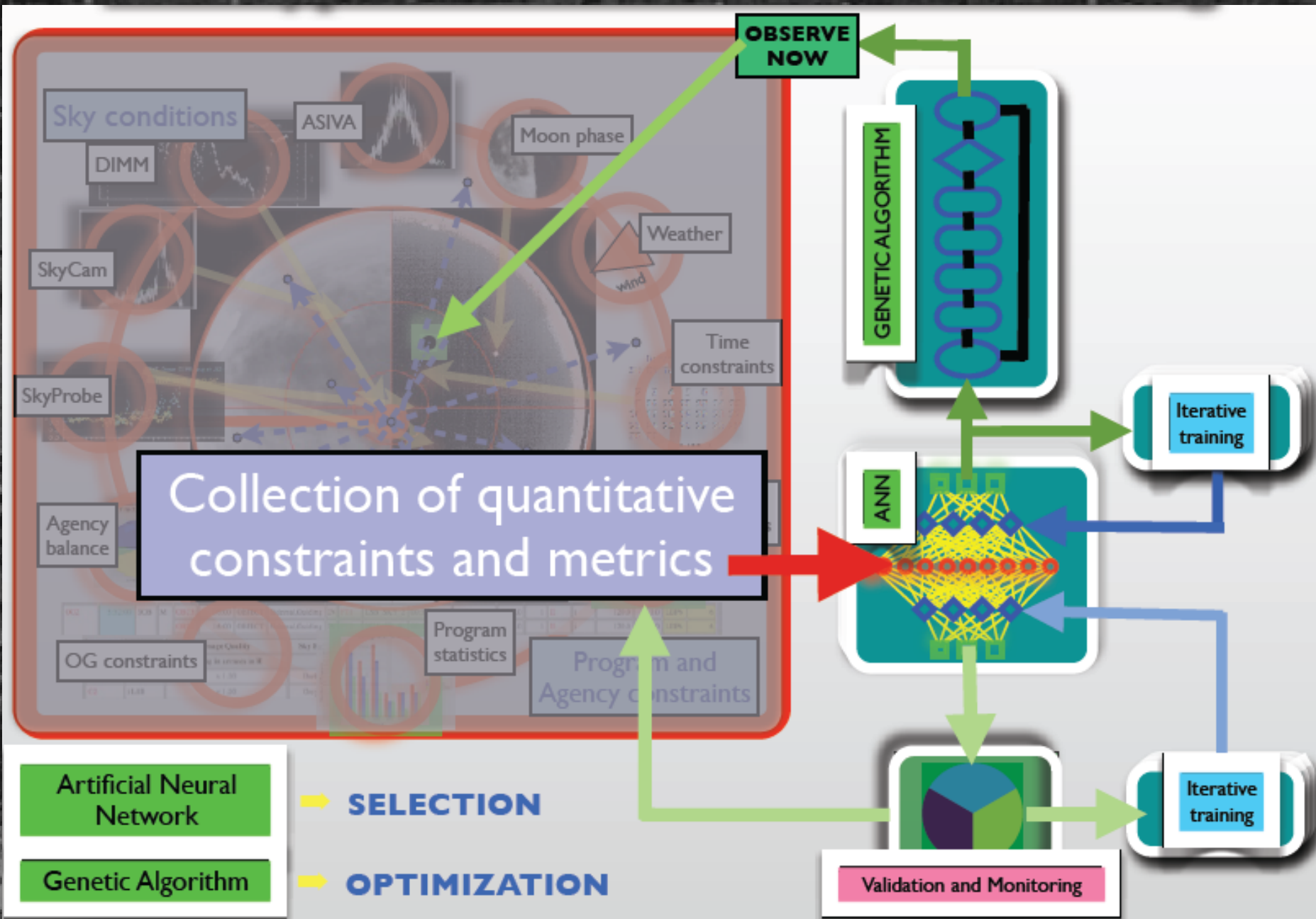
*target pressure, agency balance, program completion, validation statistics, and queue efficiency*

3. Return on risk

**Most "fit" OG (Optimization)**

*short and long term planning, instrument availability.*





# Moving toward autonomous observations

- Relieve staff of repetitive work, make the maximum use of the observing time available under a variety of conditions, and possibly operate autonomously.
- At present, AI based prototype scheduler, a tool for data validation, and sky monitoring software are being tested.
- Benchmarking other AI tools and integration of these systems are planned for the next stage of development.

END OF 2013?



# A new paradigm for ground-based telescope!

- New instruments
  - have to be fully operable remotely at night, and
  - shall not require manual interventions for a few days
- Next generation of telescopes
  - Shall move to queue and service observations to be as efficient as possible (a night is not cheap!)
- No staff scientist needed at night...
- Automation possible, with, or without, a human watching...

...but not a new paradigm for astronomy!

