



Image credit: Alex Cherney

Ingest pipeline for ASKAP

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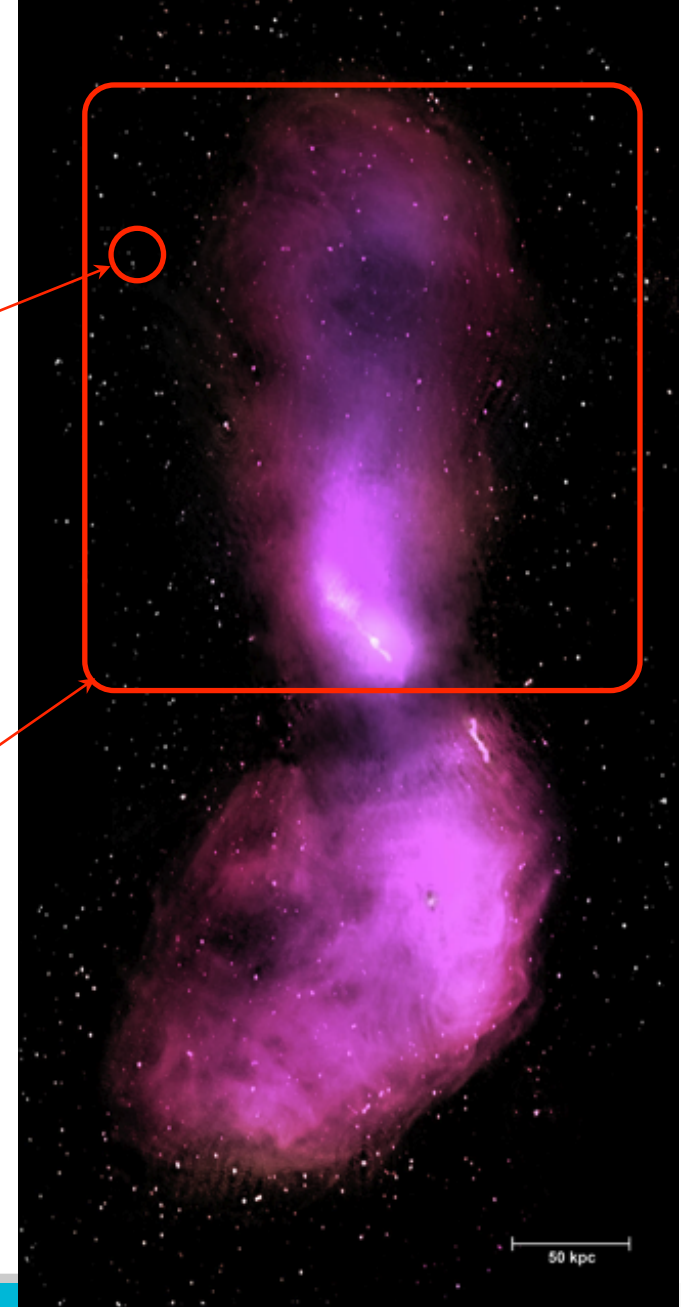


ASKAP: Wide Field of View

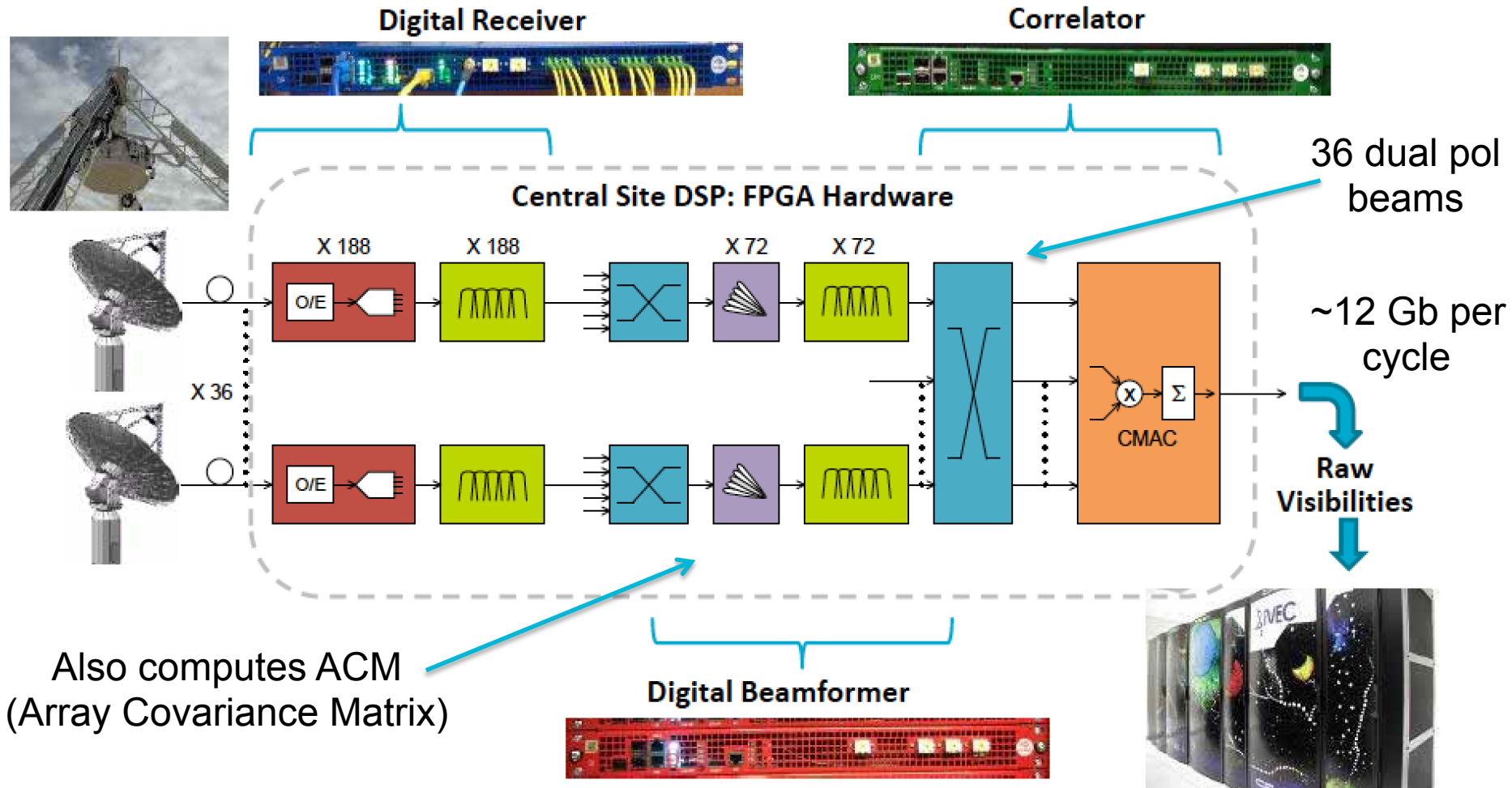
- Required 1200 hours observing with the Australia Telescope Compact Array



- ASKAP will take about 10 minutes



ASKAP – system architecture (I)



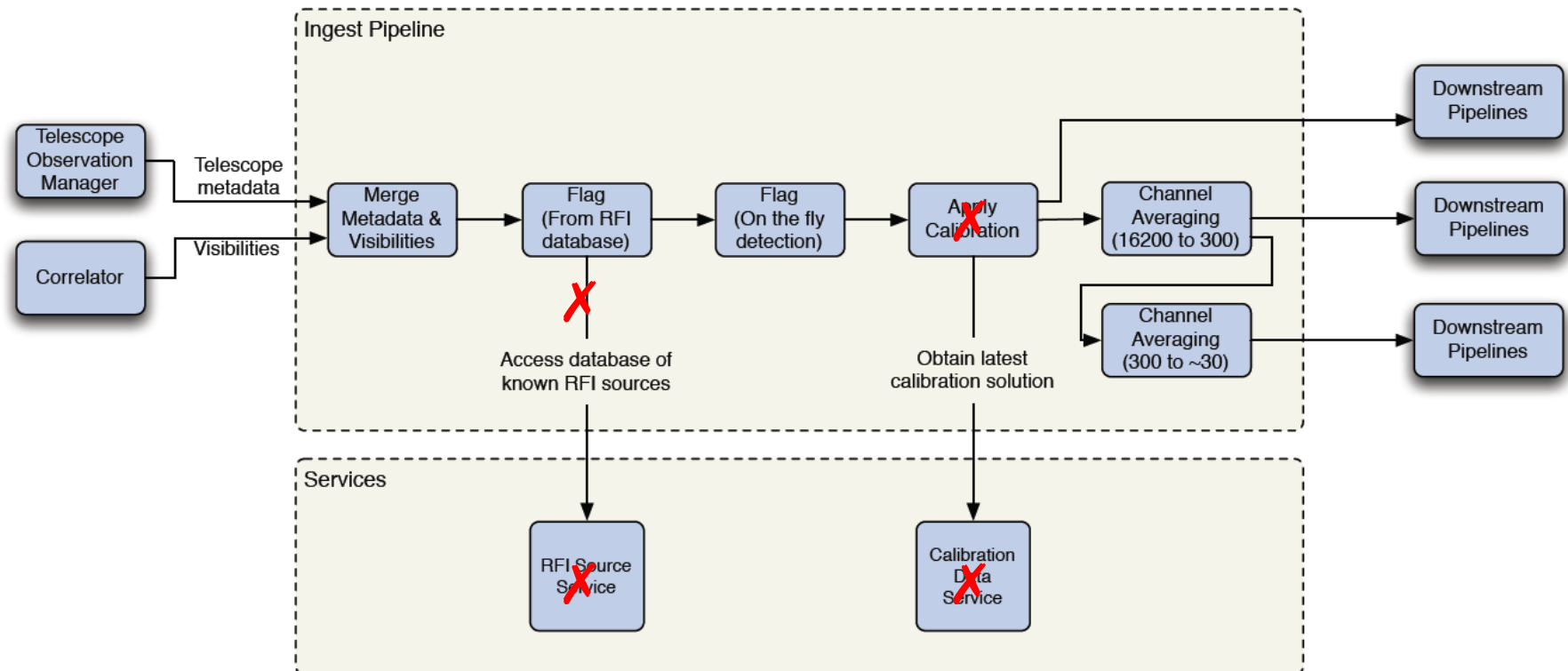
Plans vs. reality

- Initial design aimed at automatic processing of data
 - Largely due to inability to store data (run out of current storage in 1 week)
 - One size fits all approach with on-the-fly calibration – just 1 read of dataset
- Traditional processing model for now
 - User preference, more storage/better algorithms, lesser push for commensality
- Commissioning, staged deployment and support of BETA
 - Additional requirements never envisaged at the design stage
 - Lots of data inconsistencies in various ways, sometimes transient
 - Intermediate s/w solutions allowed to get science faster



The role of ingest

- Prepare/re-format data for calibration & imaging pipelines
 - Synchronisation is the main part (especially if something doesn't work right)
 - Standard formats allow us to have more generic imaging & calibration tools
- Some processing which has to be done on-the-fly to reduce I/O
- Crucial part of the online calibration loop (when/if we do it)



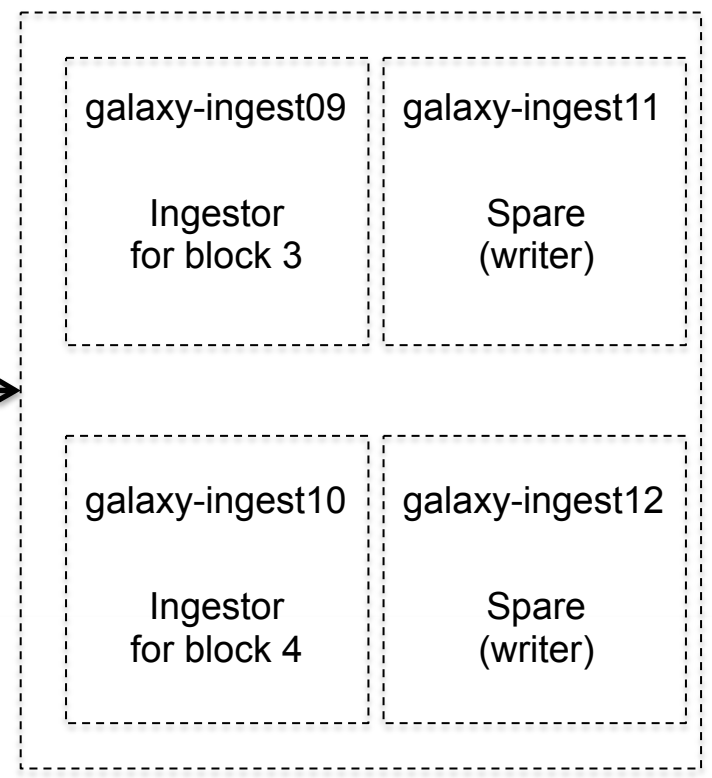
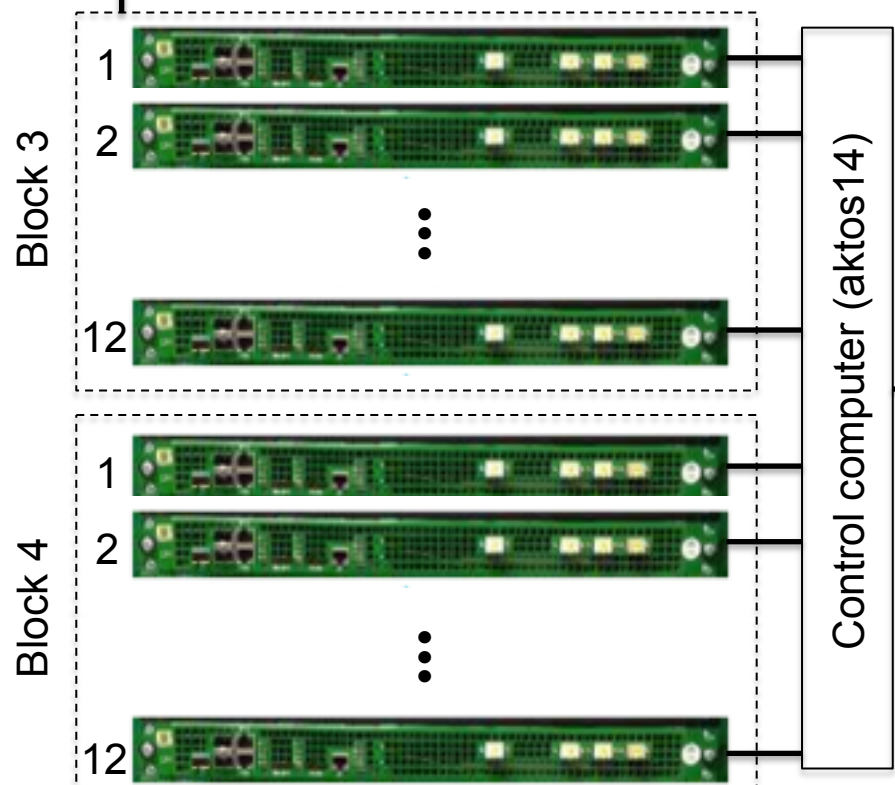
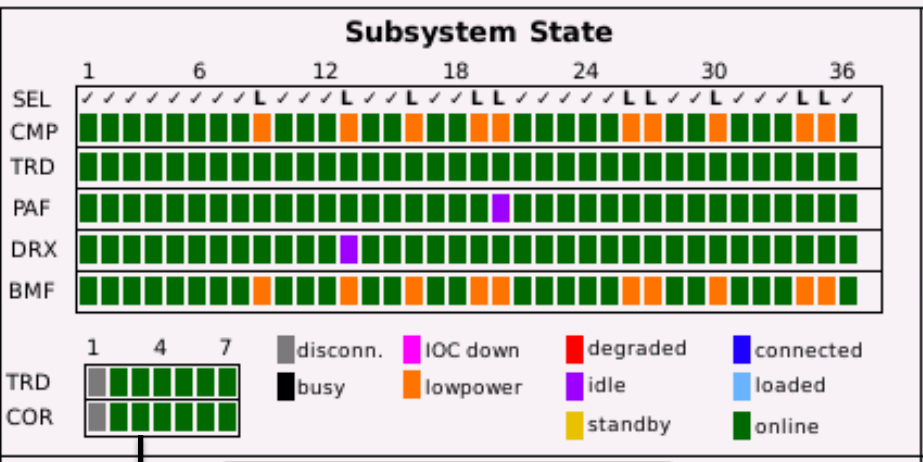
ASKAP - system architecture (II)

Ingest cluster @ Pawsey

- 16 nodes, 2 sockets per node
- 8 cores CPUs, 64 Gb of RAM per node
- Shared Lustre storage with 30 Gb/s peak I/O performance

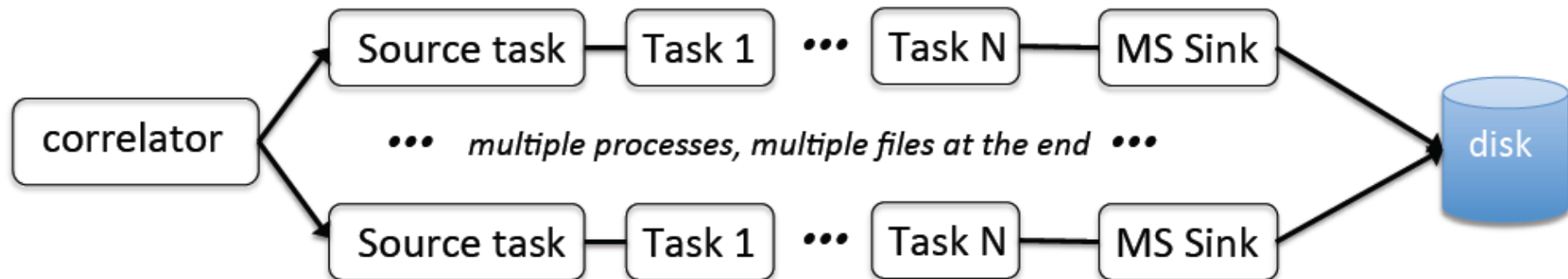
VLAN covering this fibre & 4 nodes

x4



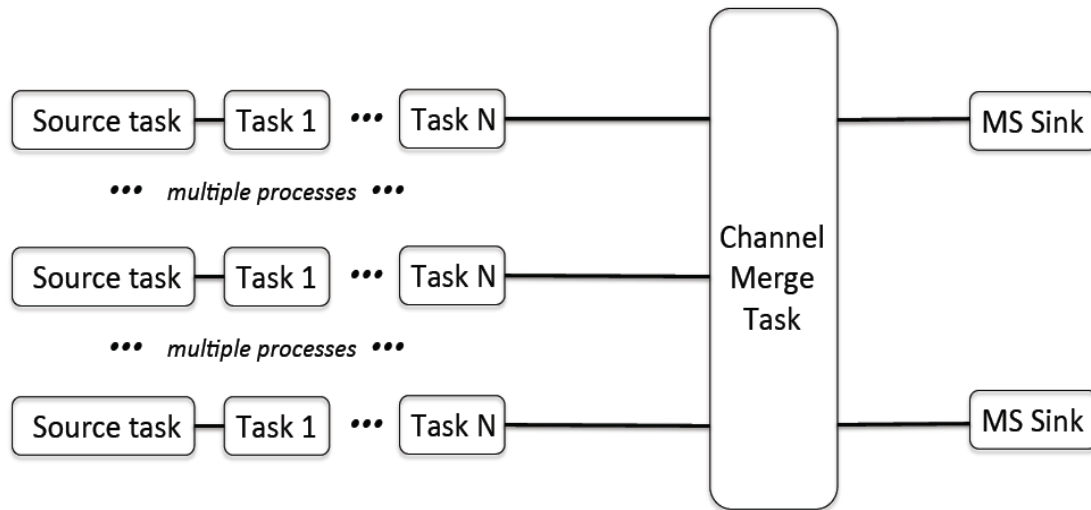
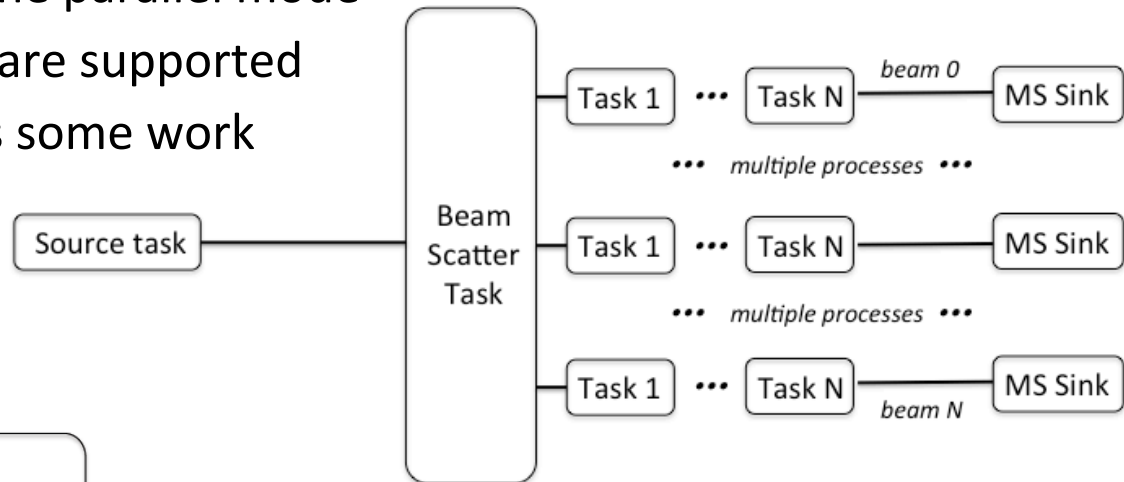
Tasks and data streams

- Ingest can be viewed as a chain of “processing” tasks
 - Configurable (via **tasklist** Facility Control Manager parameter)
 - Processing chain should always start with a source task (two options available)
 - Any task except source can occur in the chain any number of times (with the same or different parameters)
 - Sink task doesn't have to be the last (or even doesn't have to be present)
- Both parallel and serial modes are supported
 - Source tasks are rank-aware and would listen different UDP ports
 - Some tasks (merging, splitting) are specific to the distributed mode
 - Service ranks (i.e. those which do not run source task) are now also supported

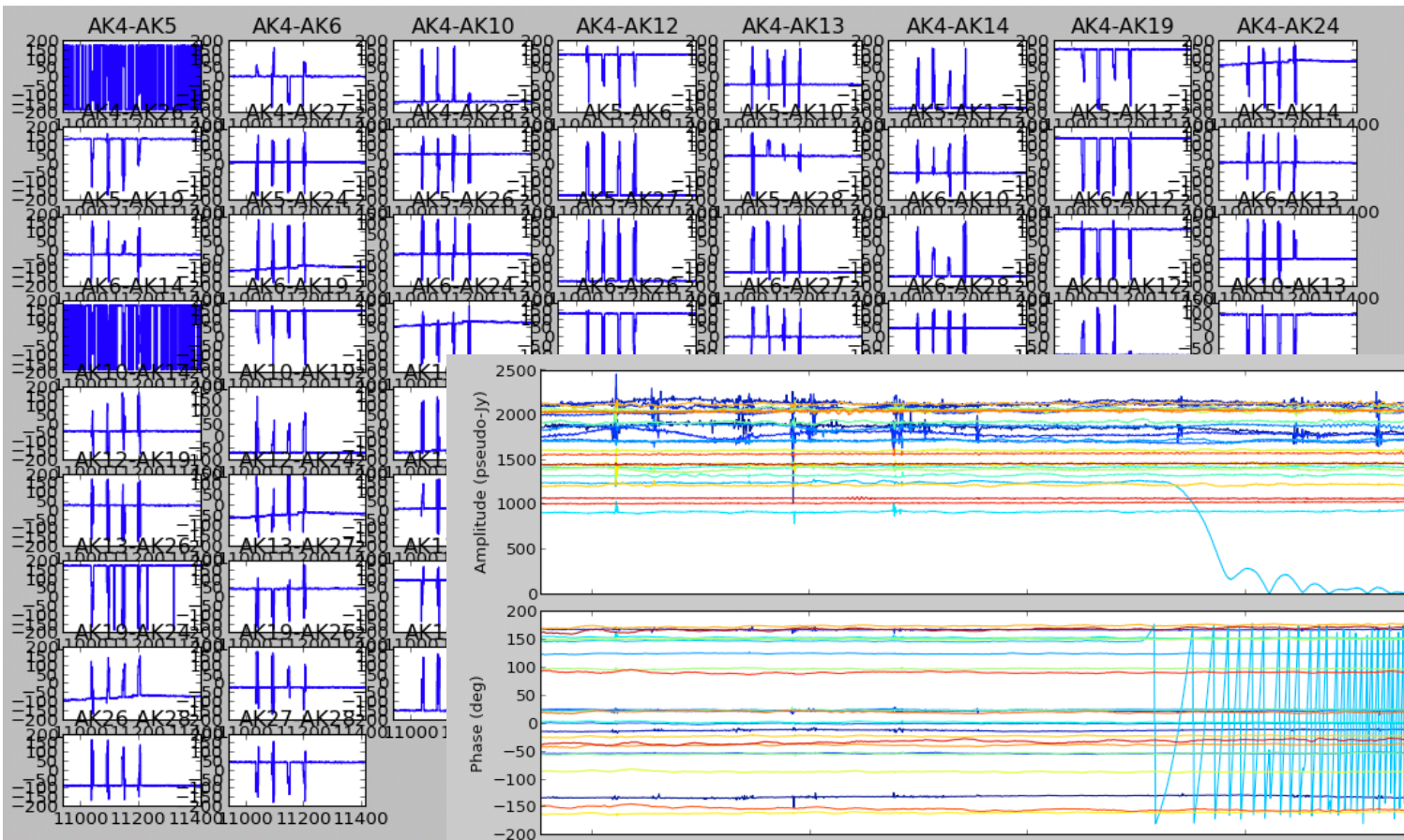


Splitting and merging data streams

- Each stream can be active or deactivated (behind the scene)
 - Splitting/merging tasks can change the state + can use service ranks
 - These tasks are specific to the parallel mode
 - Not all setup combinations are supported
 - Support of 5s cycle requires some work

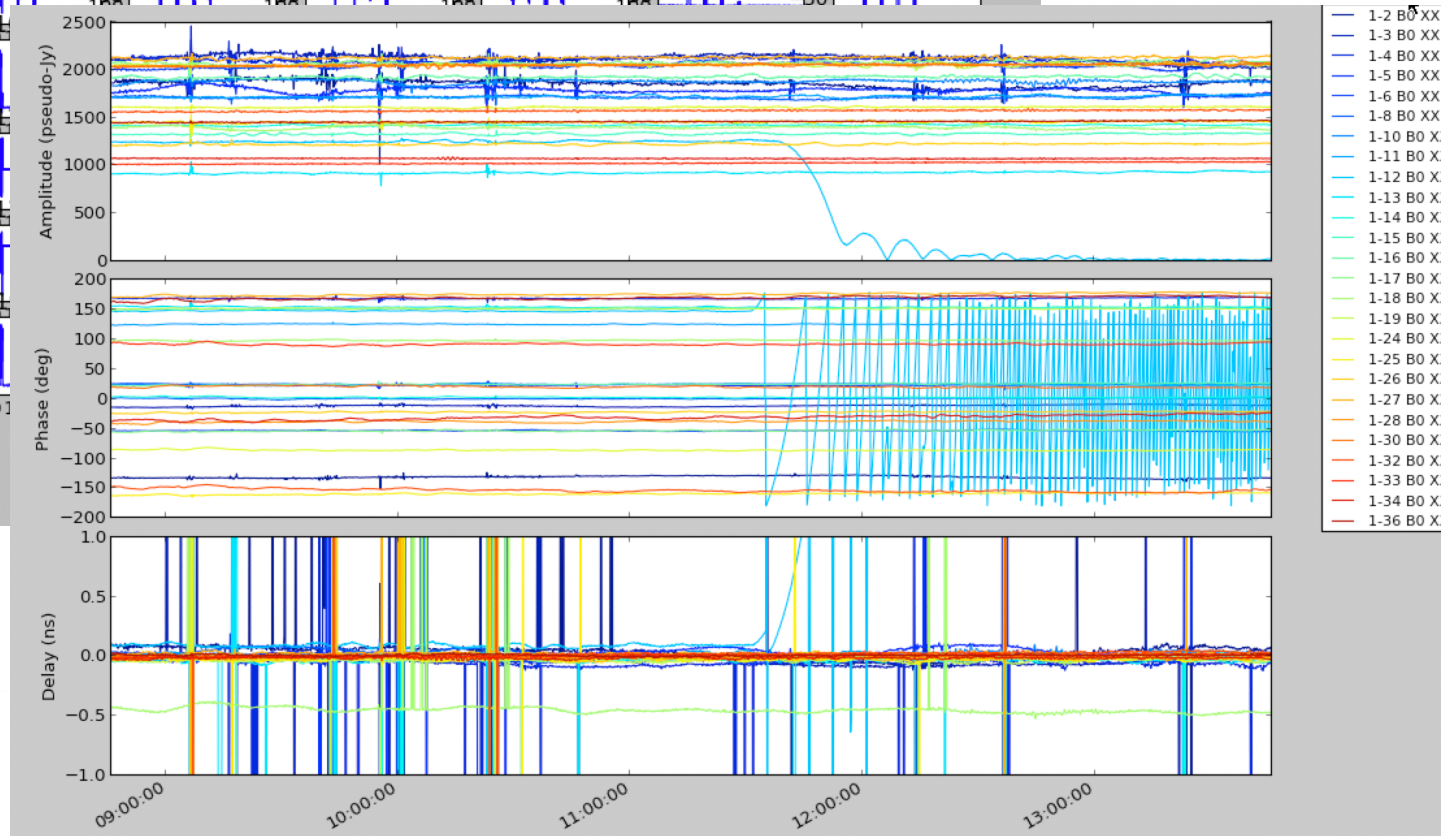


Data monitoring via TCPSink/vispublisher



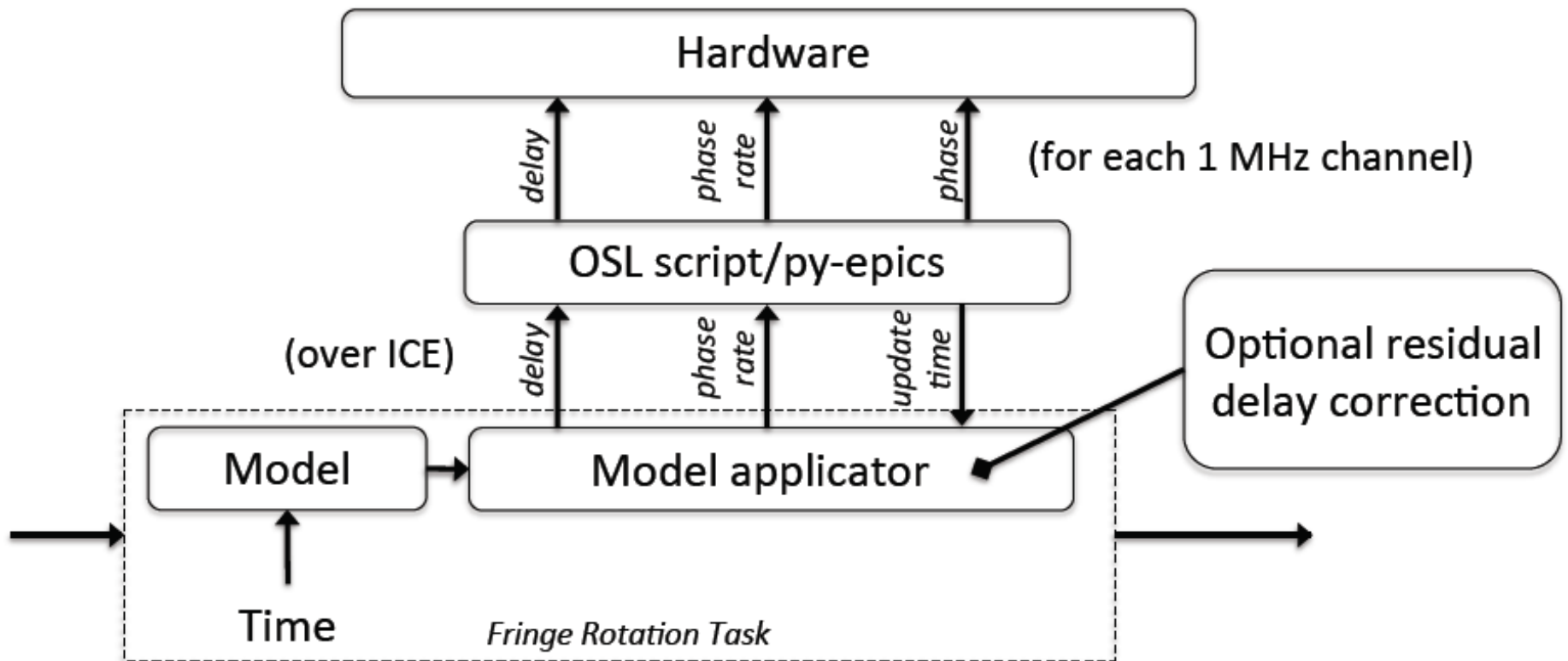
← Spectra
(spd)

Frequency
average →
(vis)



Commissioning experiments

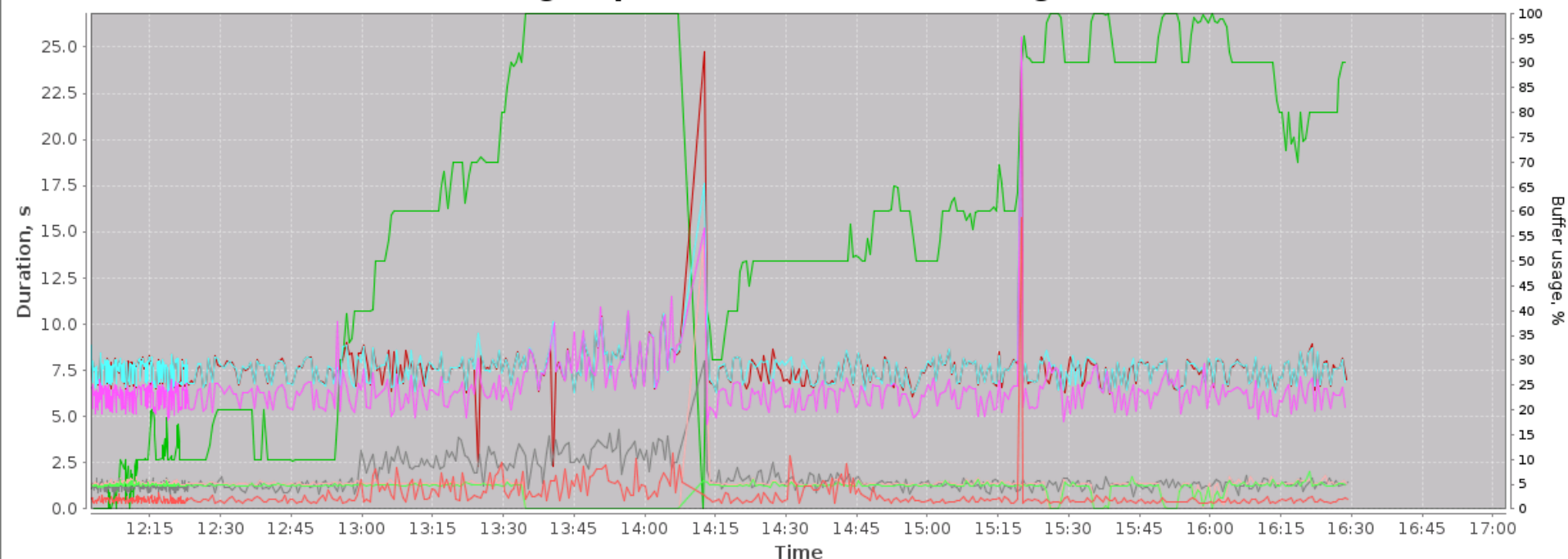
- Intermediate mode to control fringe rotator from ingest
 - Grew up from the need to support early BETA array, extended to early ASKAP
 - Investigate relative timing + well-controlled baseline system
 - Early science done a few years earlier



Performance monitoring

- Many performance metrics are published every cycle via Ice
 - Figures for representative ranks can be monitored (monica or Grafana)
 - As many tasks have implicit synchronisation barriers, interpretation requires knowledge of the system architecture and configuration of ingest pipeline
 - Buffer usage and writing times are the most straightforward metrics

Ingest performance and buffer usage



— ingest36 MSWritingDuration — ingest0 MSWritingDuration — ingest0 VisCornerTurnDuration — ingest36 VisCornerTurnDuration — ingest0 ProcessingDuration
— ingest36 ProcessingDuration — ingest0 SourceTaskDuration — ingest45 MSWritingDuration — ingest45 ProcessingDuration — ingest45 VisCornerTurnDuration
— ingest0 BufferUsagePercent — ingest36 BufferUsagePercent

Various performance lessons

- Logical vs. physical isolation of ingest
 - Writing data to shared lustre filesystem (with dedicated OST/metadata nodes)
 - It took surprisingly long time to get to an acceptable level
 - May be not over yet – we are not pushing the system the same way now
 - Our own processes/processing can also affect performance
 - If it locks up, it happens inside 3rd party libraries, so can't really time out
- Real-world astronomy data formats vs. idealistic I/O benchmarks
- Implicit barriers
 - Data sent in staggered fashion (if you need more than one chunk, you wait)
 - Metadata are not available until the end of the cycle
 - Logging at scale may be non-trivial, especially for a synchronous system
 - Consistency cross-checks may require additional communication
- Not in the regime how HPC is typically used – watch out for bugs
 - It matters where each rank goes

What wasn't in design, but in use now

- On-the-fly averaging as a separate mode
 - Instead of full-resolution mode, not in addition to
 - This is largely to save disk space / for projects which don't need full resolution
 - Prior flagging is essential
- Per-beam partitioning of the data (one beam in one MS)
 - Single beam mode is a particular case
- Flexible partitioning in frequency (merge/split)
- Real-time monitoring of data after ingest (i.e. vis/spd)
- Various data consistency cross-checks
- Flexible configuration options
 - Zoom modes (user-controlled)
 - Adding correlator hardware (FCM controlled, but requires expert knowledge)
 - Changing antennas included in the array
 - We used to have the main and commissioning array

Summary

- **Ingest is a flexible adapter s/w between correlator and processing**
 - Allows us to debug/test synthesis jobs from a standard MS
 - Synchronise parallel data and metadata streams
 - Aggregate/split data as required
 - On-the-fly flagging, if necessary
 - On-the-fly calibration application in the future
 - Optional on-the-fly averaging in frequency
 - Interface to on-the-fly data monitoring (vispublisher -> vis and spd)
- **Invaluable tool for commissioning**
 - Detect oddities in data stream
 - Non-standard experiments
 - Intermediate solutions (e.g. fringe rotation) to get science results faster

We acknowledge the Wajarri Yamatji people as the traditional owners of the Observatory site

Thank you

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