

GEO++ Online Detector Characterization System.

LIGO-G020382-00-Z

GEO++ working group

Cardiff University:

Stas Babak

R. Balasubramanian

David Churches

B.S. Sathyaprakash

Birmingham University

Alberto Vecchio

Richard Ingley

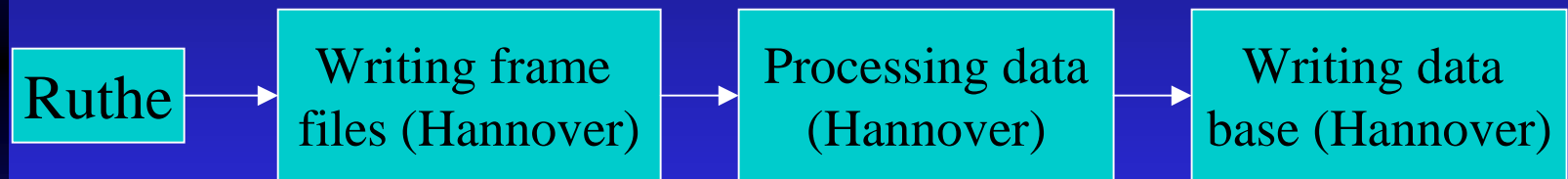
AEI:

Soumya Mohanty



GEO++: General Review

- Online software environment to monitor and characterize the various channels produced by the interferometer.
- The software is written in C++.
- “Online”:

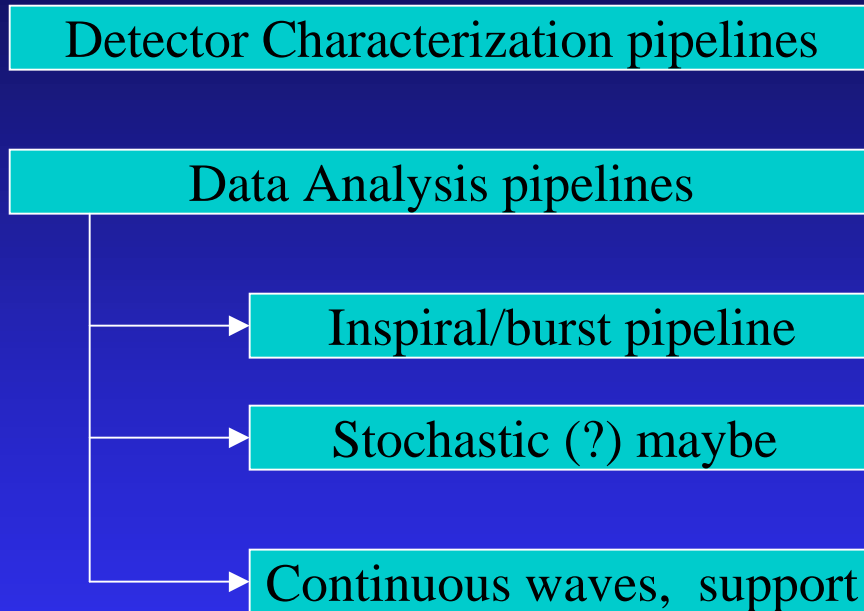


- GEO++ software:
 - ◆ Handles frame IO
 - ◆ C++ wrapper around mySQL C interface
 - ◆ Digital Signal Processing library: PSD, cross-correlation, filtering in time and frequency domain, filter design, resampling.
 - ◆ pipelines



GEO++: General Review

- GEO++ pipelines



- GEO++ is freely available from the web and is distributed as a standard GNU package.

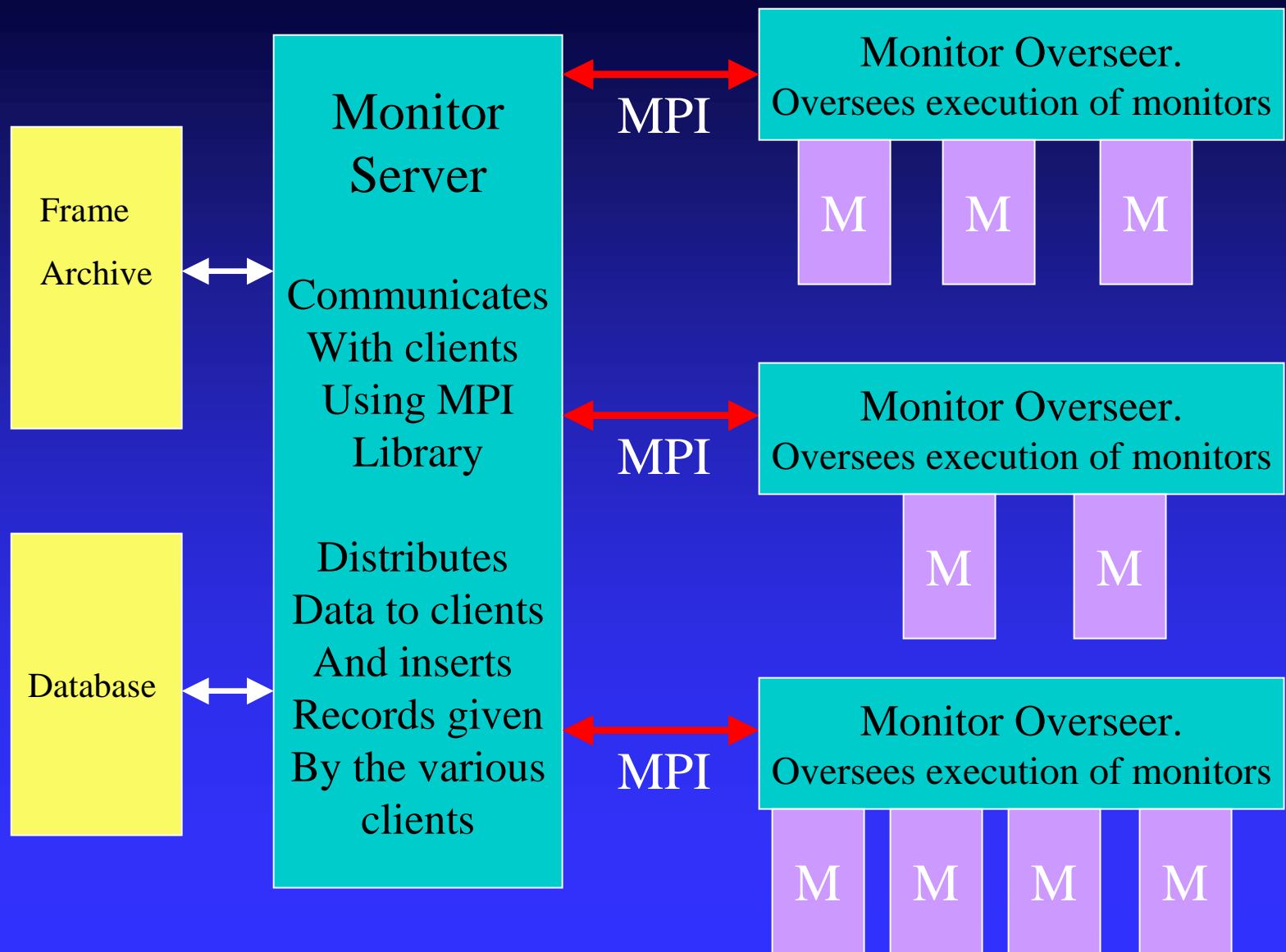


GEO++: Detector Characterization

- The system is designed to be highly extensible. All analysis is carried out by *Monitors* and users can determine which monitors they wish to execute.
- The system produces results primarily in the form of database records.
- Monitors are user defined algorithms which we will run continuously on the the various time series which are recorded at the interferometer.
 - ◆ Saturation Monitor.
 - ◆ Excess Power Monitor.
 - ◆ Line Tracking Monitor.
 - ◆ Power Tracking Monitor.
 - ◆ Inspiral Monitor.



GEO++ Online Detector Characterization System





GEO++ Monitors.

■ Saturation Monitor

- ◆ Checks if ADC is getting saturated
- ◆ $\text{Signal} > \text{maxVolt} - (100\% - \text{level\%})/100 * \text{maxVolt}$
- ◆ Level (in %) is specified by user

■ Excess Power Monitor

- ◆ Search for band limited burst.
- ◆ Calculates spectrograms of windowed overlapped subsegments. Calculates power in limited bands (bandwidth is specified by user). Compares power in each band with median over all subsegments.
- ◆ Trigger: $\text{power}/(\text{median power}) \geq \text{threshold}$ or $\leq 1/\text{threshold}$



GEO++ Monitors.

■ Power Tracking Monitor

- ◆ Tracks long time scale changes in power spectrum of a noise.
- ◆ Calculates PSD (or uses PSD calculated by other monitor) of a data segment. Computes power in limited (overlapped) bands (bandwidth specified by user). Compares with corresponding power of a previous segment.
- ◆ Trigger: $\text{power}/(\text{power prev.}) \geq \text{threshold}$ or $\leq 1/\text{threshold}$, or writes in database power within each limited band for every n -th data segment.
- ◆ Example of a table: Power Tacking Monitor database table

```
Channel_Name, GPStime, start_frequency, amplitude, process_id,  
pipeline_id, pipeline_name
```



GEO++ Monitors.

■ Power Line Tracker / Line tracker.

- ◆ Tracks power lines (harmonics) / lines with known frequencies taken from line database (Uta Weiland).
- ◆ Calculates PSD (or uses PSD calculated by other monitor) . Adjust frequency of lines. Determines amplitude of lines. Compares with result obtained from previous data set. Records to database if frequency drift exceeds (freq.)threshold and if

$\text{Amplitude} / (\text{Amplitude prev.}) \geq (\text{line})\text{threshold} \leq 1 / (\text{line})\text{threshold}$
or writes to data base amplitude and frequency of lines estimated from every n -th data segment.



GEO++ Monitors.

■ Inspiral Monitor.

- ◆ Checks the sensitivity of $h(t)$ channel to the inspiral signal from BH-BH (10-10) M_{\odot} , BH-NS (10-1.4) M_{\odot} , NS-NS (1.4-1.4) M_{\odot} systems.
- ◆ Uses stationary phase approximation. Incorporates upper frequency cut-off at LSO. SNR specified by user. Estimates an effective distance to those systems.

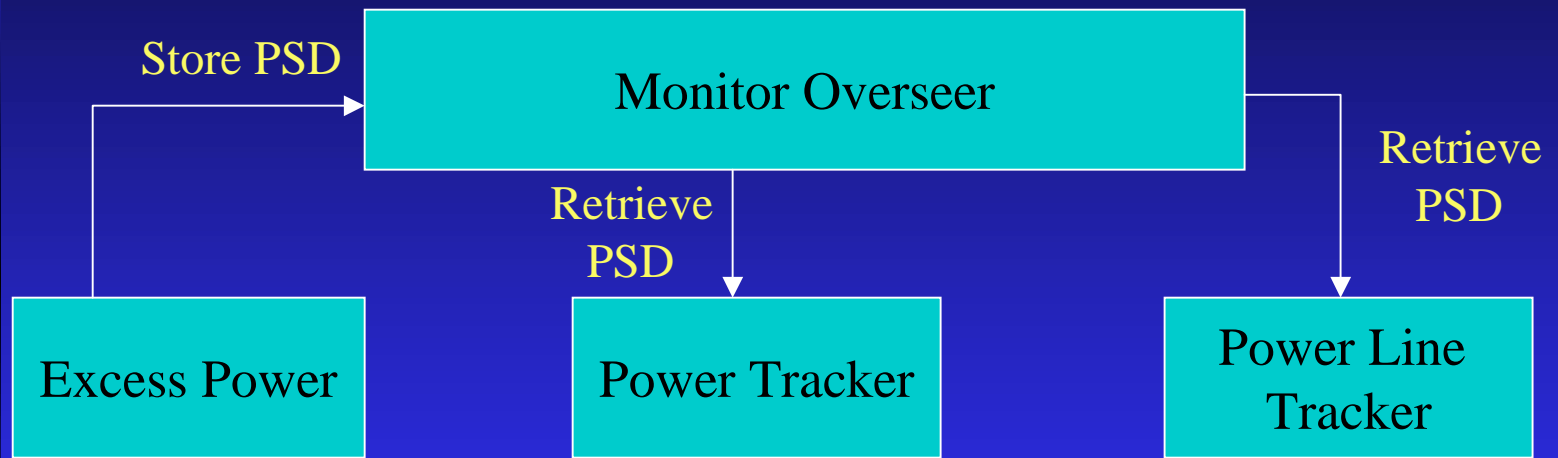
■ Line Auto Detection Monitor

- ◆ Not ready yet as a GEO++ monitor (matlab code).
- ◆ Automated detection of lines and recording (frequency, amplitude, width) to line database.



GEO++ Monitors.

Example of pipeline



Monitor can change data and pass it to the next monitor via Store-Retrieve commands.



GEO++ Monitors.

jobFile

```
singleDCPipeline
```

```
database(geopp)
```

```
hostname(local)
```

```
user(geopp)
```

```
password(geopp)
```

```
comment(this is a test)
```

```
basedir(/frames/frames)
```

```
interval(694321200 694321380)
```

```
job(16 0)
```

```
monitor(test) SaturationMon(5) channels(SEI_NBC_SEIS-Y)
```

```
monitor(test) ExcessPowerMon(4 128 10) channels(LSC_MID_EP-P) store()
```



GEO++ : future plans.

- Minimum of man-power in development, more effort in creating new monitors.
- Time-frequency analysis
- Improve algorithms of existing monitors
- Other monitors as a request/interaction from/with experimentalists.