GW Detector

Suspended cavities need to be kept on resonance with the laser by active control on the mirrors.
Pound-Drever-Hall Locking

- DARM = $L_x - L_y$
- CARM = $(L_x + L_y)/2$
- MICH = $I_x - I_y$
- PRCL = $I_p + (I_x - I_y)/2$
- SRCL = $I_s + (I_x - I_y)/2$
Sensors in the Interferometer

- Auxiliary sensors in optics and vibration-isolated system are used to investigate noise derived from control of the interferometer.
- Physical environmental monitors (PEM).
- Geophysics interferometer (GIF) in X-arm.
Calibration

- The strain:
  \[ h(t) = \frac{L_x(t) - L_y(t)}{L_0}, \quad L_0 = 3000\text{km in KAGRA}. \]
- 4 real-time digital feedback loops are used to control the lengths of the cavities.
- Photon calibrator (PCAL) and gravity field calibrator (GCAL) are used for precise calibration.
Reconstruction Pipelines

- **C10: Low-latency pipeline**
  - Receive DARM loop signals partially calibrated in the C00 pipeline.
  - Generate $h(t)$ with a latency less than 10 s using “gstlal”.
  - Calibration flags are provided.
Data Quality (DQ) State Vector

- The recorded data are classified in 2 categories:
  a. GW search,
  b. Evaluation of detector and the noise status.
- **Data-quality state vectors** are provided when some criteria of auxiliary channels are satisfied.
- Each GW search pipeline evaluates the false alarm probability from the background noise.
- Glitch pipelines detect bursts of excess power to identify transient noise.
**Data Quality (DQ) State Vector**

<table>
<thead>
<tr>
<th>Bit</th>
<th>Meaning of flags</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Odd parity</td>
</tr>
<tr>
<td>1</td>
<td>Lock check flag</td>
</tr>
<tr>
<td>2</td>
<td>Control setting check flag</td>
</tr>
<tr>
<td>3</td>
<td>Science mode flag</td>
</tr>
<tr>
<td>4</td>
<td>ADC overflow</td>
</tr>
<tr>
<td>5</td>
<td>DAC end test mass X(ETMX) overflow</td>
</tr>
<tr>
<td>6</td>
<td>DAC end test mass Y(ETMY) overflow</td>
</tr>
<tr>
<td>7</td>
<td>Injection flag for stochastic gravitational wave background</td>
</tr>
<tr>
<td>8</td>
<td>Injection flag for compact binary coalescence waveform</td>
</tr>
<tr>
<td>9</td>
<td>Injection flag for burst waveform (e.g. supernovae)</td>
</tr>
<tr>
<td>10</td>
<td>Injection flag for detector characterization</td>
</tr>
<tr>
<td>11</td>
<td>Injection flag for continuous wave waveform (e.g. pulsars)</td>
</tr>
</tbody>
</table>
Refs:

- [https://www.icrr.u-tokyo.ac.jp/~washimi/KAGRA/PEM/PEMmap/archives/O3GK/](https://www.icrr.u-tokyo.ac.jp/~washimi/KAGRA/PEM/PEMmap/archives/O3GK/)
- [http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/KAGRA/Subgroups/DET/DataQuality](http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/KAGRA/Subgroups/DET/DataQuality)
- [GWpy](https://gwpy.org)