Status of KGWG-KAGRA DetChar Activities

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On behalf of KGWG-Detchar Working Group

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Project Milestones

- **EtaGen**: An Event Trigger Generator based on Hilbert-Huang Transform
  To find almost all the injections or transient signals in the time series data

- **CAGMon**: A Detchar Tool via Correlation Scores
  To clarify the correlation between auxiliary channels and GW channels in order to find any nonlinear couplings that may be harmful to detect a signal

- **Safe Channel Study**
  To figure out uncorrelated or weakly correlated auxiliary channels to hardware injections in $h(t)$ in order to use for investigation on detector characterization

- **Machine Learning for Glitch Classification**
  To classify glitches by using morphology in $h(t)$ and auxiliary channels and to figure out which auxiliary channels are responsible for glitch appearance
Status Report I – EtaGen (η-Gen)

• EtaGen is an event trigger generator based on Hilbert-Huang Transform.

• The efficiency of EtaGen finding simulated sine-Gaussian and white noise burst signals are over 90%.

• Triggers generated near the injection times will be used in the further analyses, e.g., finding safe/unsafe auxiliary channels.
Status Report I – EtaGen (η-Gen) (contd.)

• EtaGen is currently a test version and not released to the public.

• The user interface is almost fixed and a hands-on tutorial will be given at the Boot Camp on Dec. 9.

• After some tedious works on bug-fixing, it will be released with a paper.

• One more thing. In addition to ETG functions, EtaGen can now reconstruct waveforms.
Status Report II - CAGMon

CAGMon Project: Analysis Results
- Correlation analysis based Detchar Tool using MIC, Pearson’s, and Kendall’s tau coefficients -

Developers & Coauthors
Shinji H., KAGRA Dev. Team
Kagawa, Y., Ueno, H., Ioka, S., & Hattori, A.

Project Goal
CAGMon is a tool for analyzing correlation between gravitational wave channel and auxiliary channel data. It computes Pearson’s correlation coefficient, Kendall’s tau, and MIC. It also checks the significance of correlation tests. The Correlation Matrix is also plotted.

Theoretical: CAGMon Analysis Results
- Correlation analysis using MIC, Pearson, and Kendall’s tau coefficients

User Guide
- Installing: Python
- Dependencies: Numpy, Pandas, Matplotlib
- Usage: Analyze data from KAGRA

Workflow
1. Find data at GPS Time
2. Segment iKAGRA Data
3. Extract all auxiliary channels & GW channel data
4. Compute MIC, Pearson, and Kendall’s tau

Scattered Plot
Correlation Matrix

iKAGRA Data

CAGMon2.0 Summary Page
http://seikai.icrr.u-tokyo.ac.jp/~johnoh/

CAGMon2.0 Code Release
@GitHub.KAGRA-Detchar
Parallel Computing Process
- Systematic Auxiliary Channel List (.ini file)
- Subsystem Module Computation
- Band pass filter module
- Other nonlinear measures
- Listing High-correlated Channel List
# Timeline - CAGMon

<table>
<thead>
<tr>
<th>Year</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Interface</td>
<td>Summary Page Interface Modify</td>
<td>Interact. Page for tCAG</td>
</tr>
<tr>
<td>Build/Documentation</td>
<td>Package Build</td>
<td>Documenation</td>
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<tr>
<td>Test Run</td>
<td>Test In LLO/LHO</td>
<td>Test In LLO/LHO</td>
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Current summary page and example runs: [http://seikai.icrr.u-tokyo.ac.jp/~johnoh/](http://seikai.icrr.u-tokyo.ac.jp/~johnoh/)
# Timeline - EtaGen

<table>
<thead>
<tr>
<th>Oct</th>
<th>Nov</th>
<th>Dec and after [2017]</th>
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<tbody>
<tr>
<td>Current version of EtaGen (Python core) is already installed in <code>/home/eddy</code></td>
<td>New EtaGen module (C++ core) will be installed in <code>/home/eddy</code> (It can be installed in `/home/detchar if requested)</td>
<td>Fine-tuning and upgrades</td>
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- Preliminary results in `http://seikai.icrr.u-tokyo.ac.jp/~eddy/etagen_list.html`
# Timeline - Safe Channel Study

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<tbody>
<tr>
<td><strong>Trigger based</strong></td>
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<td></td>
<td>hVeto onto Omicron Triggers: Code Development for KAGRA and its Test Runs</td>
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<td></td>
<td>Categorizing Safe/Unsafe Channels: Comparison between hVeto and CAGMon</td>
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<tr>
<td><strong>Correlation based</strong></td>
<td>Application of CAGMon: Categorizing Safe/Unsafe Channels</td>
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# Timeline - Machine Learning for Glitch Classification

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<tbody>
<tr>
<td><strong>Trigger Classification (Tensorflow)</strong></td>
<td>Development of ANN using Tensorflow</td>
<td>Data Preparation using LIGO data Test/Run</td>
<td>Defining ROCs and FOMs Documentation &amp; Code Build</td>
</tr>
<tr>
<td><strong>Channel Analysis</strong></td>
<td>Code development for Analyzing Significant Channels</td>
<td>Test Runs of the Code onto aLIGO / KAGRA</td>
<td>Development of iDQ/ANN interface for KAGRA and its Test Runs</td>
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