The Australian Consortium for Interferometric Gravitational Astronomy

LSC Report July 1999

Advanced Configurations

Progress to date:

Finished design and basic modelling of the control system for a tunable RSE interferometer., using a carrier laser that is both AM and PM modulated. In addition, our design uses a tunable offset locked sub carrier laser. This sub carrier can be dynamically tuned with respect to the carrier by tuning the RF signal generator used to produced the offset frequency. The sub carrier has its own PM sidebands that are used for control of the combined power-signal cavity.

The required input field for control of the complete RSE system has been generated. In particular, the carrier laser has been locked to a rigid mode cleaner in order to both spatially filter and frequency stabilise the laser. We have assembled a Mach Zehnder interferometer in order to impose both the AM and PM sidebands in such a way to avoid inter modulation products that could otherwise distort the required error signals. In addition, the sub carrier laser has been offset phase locked to the carrier. By tuning the offset RF signal generator we can dynamically tune the sub carrier frequency from 10MHz offset to over 50MHz offset.

We have constructed the rigid arm cavities for the RSE interferometer. Both cavities have been tested to have a finesse of ~650 with an FSR of 530MHz. In addition, both cavities have been locked to the carrier laser using the PM sidebands generated from the input Mach Zehnder.

All required optic components have arrived and are being mounted on PZT actuators for use in the RSE interferometer.

Anticipated Progress next six months

Construction of all HV amplifiers (for driving the PZT mirror components within the RSE interferometer) is currently under way in the ANU electronics laboratory and should be completed in 2 months.

Construction of the servo electronics for the RSE interferometer is under way in the ANU electronics laboratory. The servo amplifiers should be completed in 3 months.

Concurrently with the completion of these HV amplifiers and servo amplifiers, the remaining RSE optics will be aligned to form the complete optical layout of the RSE interferometer.

With the above items successfully completed we will then have the ability to implement our RSE control system design. This will be attempted in a number of steps in order to individually verify the error signal generation and control of each optical degree of freedom before commencing simultaneous control of the total interferometer.

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Suspensions and Thermal Noise Working Group

Direct Measurement of Thermal noise

Progress to date

Development and testing of first generation frequency and intensity servo designs. This demonstrated that the intensity servo provided ample gain in order to achieve sub shot noise levels at low frequencies necessary to for the "squashed state" generation. The frequency servo results demonstrated barely sufficient gain at low frequencies with insufficient gain above ~30 Hz. It is planned to increase the broadband gain by ~20 dB with the addition of an EO element.

Identified instability causes within the "in-loop" topology: when both frequency and intensity servo's are operational, cross coupling within the laser and that to the mode cleaner cavity cause a parasitic loop to develop resulting in full oscillation of both servos. This places unacceptably stringent requirements on the RMS locking error of the laser frequency servo.

In order to avoid the instability caused by the "in-loop" topology , the intensity servo was re-designed to greatly reduce the required in-loop gain. This was achieved by using a nested intensity feedback servo. The reduced servo gain also reduced the gain of the parasitic loop to a level well below unity and should therefore prevent oscillation.

Anticipated progress next six months

Build up a new high gain broadband frequency servo in order to achieve sufficient frequency noise suppression across the total bandwidth.

Build up the nested intensity feedback servo in order to provide subshot noise stability.

Experimentally test out servo instability noise performance of this new servo configuration

Detailed design of the initial suspended test cavity experiment.

Procurement and assembly of the vacuum tanks and suspensions system necessary for implementing in vacuum, suspended test cavity experiments.