



**LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY**  
**RECORD OF DECISION/AGREEMENT (RODA)**

Document	LIGO-M 040088-01 -Y	
Date:	16 March 2004	
Title:	RODA: OSEM counts and responsibilities for SUS Prototypes	
To the Attention of:	SUS: Norna Robertson, Dennis Coyne SUS/US: Janeen Romie, Mark Barton, Calum Torrie, Jay Heefner SUS/UK: Ken Strain, Caroline Cantley, Jim Hough, Justin Greenhalgh, Chris Castelli Systems: David Shoemaker, Carol Wilkinson, Peter Fritschel	
cc:	aligo_systems, aligo_sus	
From/signatories:	Name/Title:	Dennis Coyne (SUS Leader) Signature: _____
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	Name/Title:	Janeen Romie (SUS/US Leader) Signature: _____
	Name/Title:	Justin Greenhalgh Signature: _____
	Name/Title:	Caroline Cantley (SUS/UK/UG Project Manager) Signature: _____
	Name/Title:	Alberto Vecchio (SUS/UK/UB Project Manager) Signature: _____
System(s) affected:	<input type="checkbox"/> Initial LIGO <input checked="" type="checkbox"/> Advanced LIGO <input type="checkbox"/> Other: _____	
Nature/Scope:	<input type="checkbox"/> Design Decision <input type="checkbox"/> Requirements Decision <input type="checkbox"/> Work Scope Decision <input checked="" type="checkbox"/> Working Agreement between Groups <input type="checkbox"/> Other _____	
Subsystem(s) affected	<input checked="" type="checkbox"/> Relevant Subsystem(s)/Component(s): _____ Suspension (SUS) subsystem: US team _____ Suspension (SUS) subsystem: UK team	
Primary Contacts	Group or Affiliation and Contact    Caltech/Janeen Romie	
Reference Documents:	<u>1) D000069-A, Sensor/Actuator Assembly, Long, SMD</u> <u>2) D030105-01, Hybrid OSEM Assembly</u>	

## DECISION/AGREEMENT STATEMENT:

**Controls Prototype**

For the suspension "controls" prototypes, the University of Glasgow (UG) will provide the coil formers/heads and brackets and clamps for local control sensor/actuators (alias Optical Sensor and Electro-Magnetic actuator, or OSEM). ~~They will cycle the manufacture.~~ Caltech will wind the coils and finish fabrication and testing of these coils. ~~They-UG~~ will provide a quantity of 5036 local OSEMs (as indicated in the table below): The local control OSEMs for the Mode Cleaner (MC) prototypes are needed at CIT for final assembly in April. The local control OSEMs for the quad prototype suspension are needed at CIT in August. The OSEMs provided by UG are the so-called "hybrid OSEMs" (per drawing D030105-01, Hybrid OSEM Assembly)

$$\begin{aligned} \text{MC1} &= 6 + 4 \text{ spares} = 10, \\ \text{MC2} &= 6 + 4 \text{ spares} = 10, \\ \text{quad} &= 12 + 8 \text{ spares} = 20 \\ \text{shelf spares} &= 10. \\ \text{Total } &50 \text{ [D.C.1]} \end{aligned}$$

SUS Controls Prototypes

Destination	SUS		global with sensing and actuation				local				OSEM Total	Need Date for Assy. at CIT
	Type	number	req'd ea.	req'd total	spare	total	req'd ea.	req'd total	spare	total		
LASTI	MC	1	8	8	4	12	6	6	3	9	21	April, 04
	quad	1	8	8	4	12	12	12	6	18	30	Aug, 04
CIT	MC	1	8	8	4	12	6	6	3	9	21	April, 04
			24	12	36		24	12	36	72		

Since the assembly of the OSEMs for the controls prototypes are a collaborative effort between the UG and Caltech, the spares quantities shown in the table include in-process spares (i.e. units that may not complete the build and test and be delivered). The spares are based on 50% of the required quantity, quantized (rounded up) for each assembly and OSEM type. The expectation is that the delivered spares ("shelf spares") should be at least 20% of the required quantity (i.e. < 30% attrition).

For the global control OSEMs, on the suspension controls prototypes, the baseline is initial LIGO style OSEMs (drawing D000069-A, Sensor/Actuator Assembly, Long, SMD), which Caltech will provide. The quantities are as follows indicated in the table, and total 36:

$$\begin{aligned} \text{MC1} &= 8 + 4 \text{ spares} = 12 \\ \text{MC2} &= 8 + 4 \text{ spares} = 12 \\ \text{quad} &= 8 + 4 \text{ spares} = 12 \\ \text{shelf spares} &= 10 \\ \text{Total } &46 \end{aligned}$$

Systems Engineering will provide direction on the force requirements for the global control osems for the quadruple suspension ("quad") by DATE (TBD). After SUS receives this information, a decision will be made about whether the magnetic field strength of the initial LIGO size magnets (2mm dia., NdBFe) will be sufficient, or if the hybrid's magnet (10mm dia) is the better choice.

If a hybrid/local control style OSEM is appropriate, Glasgow will ~~consider~~ providing the formers/heads, brackets and clamps, up to a maximum of 80. As indicated in the table, a total quantity of 72, local plus global, OSEMs is anticipated (i.e. < the maximum quantity that UG can provide)-If hybrid osems are deemed the better choice for the global controls for the quad controls prototype they would be needed at Caltech in the October 2004 time frame. Since Caltech

coordinates coil winding, head assembly, and UHV preparation, the formers/heads, brackets and clamps would be needed from Glasgow in the late August time frame, at the latest.

The global OSEMs for LASTI are intended to have embedded sensing as well. This option is intended to provide more observability of the suspension modes and dynamics during LASTI testing and characterization. In the noise prototypes and the final design, the global OSEMs will only provide actuation.

### **Noise Prototypes**

Concerning the noise prototypes, the sensor/actuator W.B.S 4.03.3.3.3, which was the basis for the PPARC award, covered sensor/actuator prototypes for all final design prototype suspensions. This includes prototypes that are delivered to LASTI and prototypes which stay at the research facilities (RAL, CIT, Glasgow) as bench prototypes. According to [RODA M040007-03](#) (and the re-plan that David Shoemaker reviewed in the AdL Systems meeting in January), the prototype count changes from a total of 3 BSCs, 3 MCs, 3 RMs and 1 HAM Aux., to the count shown in the following table:

#### **LASTI Prototypes**

ETM/ITM = 20

4 MCs = 4(14) = 56

1 RM = 14

Total for LASTI = 90

#### **Bench Prototypes:**

1 BSC = 20

1 HAM = 14

1 HAM Aux. = 5

Total bench = 39

SUS Noise Prototypes

Destination	SUS		global without sensing, just actuation				local				OSEM Total
	Type	number	req'd ea.	req'd total	spare	total	req'd ea.	req'd total	spare	total	
LASTI	ETM/ITM	1	8	8	2	10	12	12	3	15	25
	MC	4	8	32	7	39	6	24	5	29	68
	RM	1	8	8	2	10	6	6	2	8	18
UK	BSC	1	8	8	2	10	12	12	3	15	25
CIT	HAM	1	8	8	2	10	6	6	2	8	18
	HAM Aux.	1	0	0	0	0	5	5	1	6	6
				64	15	79		65	16	81	160

Total 129 + spares

Note that the spare OSEM quantities shown in the above table are based on 20% delivered spares (no in-process spares are indicated in the above), quantized (rounded-up) for each assembly and OSEM type.

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[D.C.1] This list has far too many spares indicated. I think that "spares" here means "in process spares" and "shelf spares" means delivered spares. Even though UG delivers parts and there may well be attrition in the assembly and test at CIT, I think we have indicated too many spares. The numbers above are based on 50% sparing for each suspension assembly and type (local or global).