

Advanced Virgo Suspension Control System

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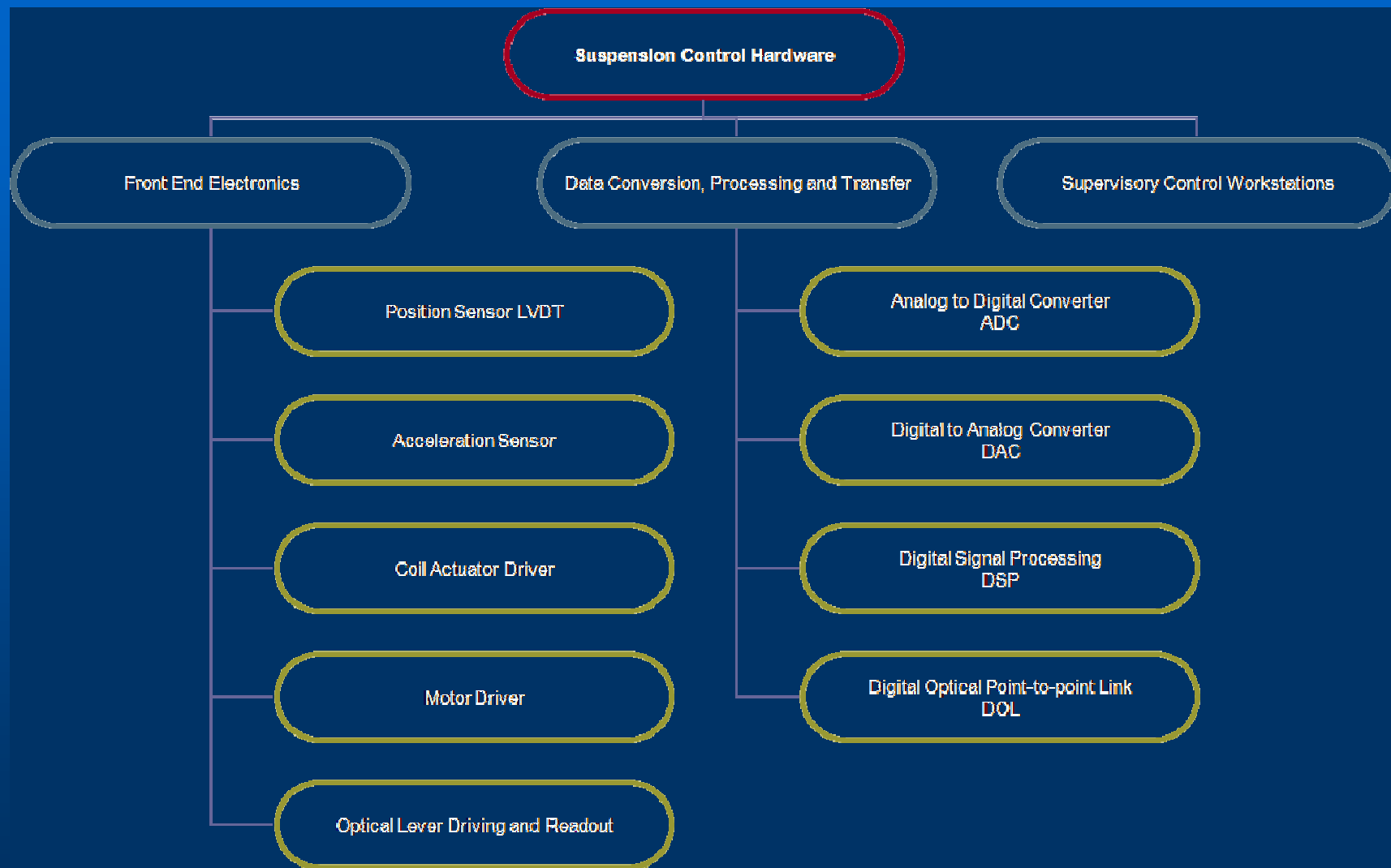
Introduction

- **The Suspension Control Systems (composed by about 500 devices and more than 50'000 lines of source code) is in use now since more than 10 years and would not guarantee Virgo operation beyond 2009 without upgrades**
- **Most upgrades are not requested from the performances point of view: the system fulfils Advanced Virgo requirements as it is**
- **Ref. Adv Virgo Suspension Control System, VIR-120A-08, November 2008**

Suspensions: what will change

- **One additional suspension: Signal Recycling**
- **Tilt Control**
 - Piezoelectric actuators below inverted pendulum legs
 - Position sensors detecting piezo actuators displacement
 - Angular acceleration sensors located on superattenuator base ring
- **Position monitoring of reaction masses**

Control Hardware (Virgo)



Front End Electronics: Upgrades

- **LVDT**
 - **Obsolete**
 - **NIM Standard → Eurocard**
 - **Add on-board ADC**
- **Accelerometers**
 - **NIM Standard → Eurocard**
 - **Add on-board ADC**
 - **Digital controller**
- **Coil Driver**
 - **Add on-board DAC**
- **Motor Control**

Front End Electronics: Additions

- **Piezo Actuators Drivers**
 - Eurocard
 - On-board DAC
- **Thermal Stabilization**
 - TBC

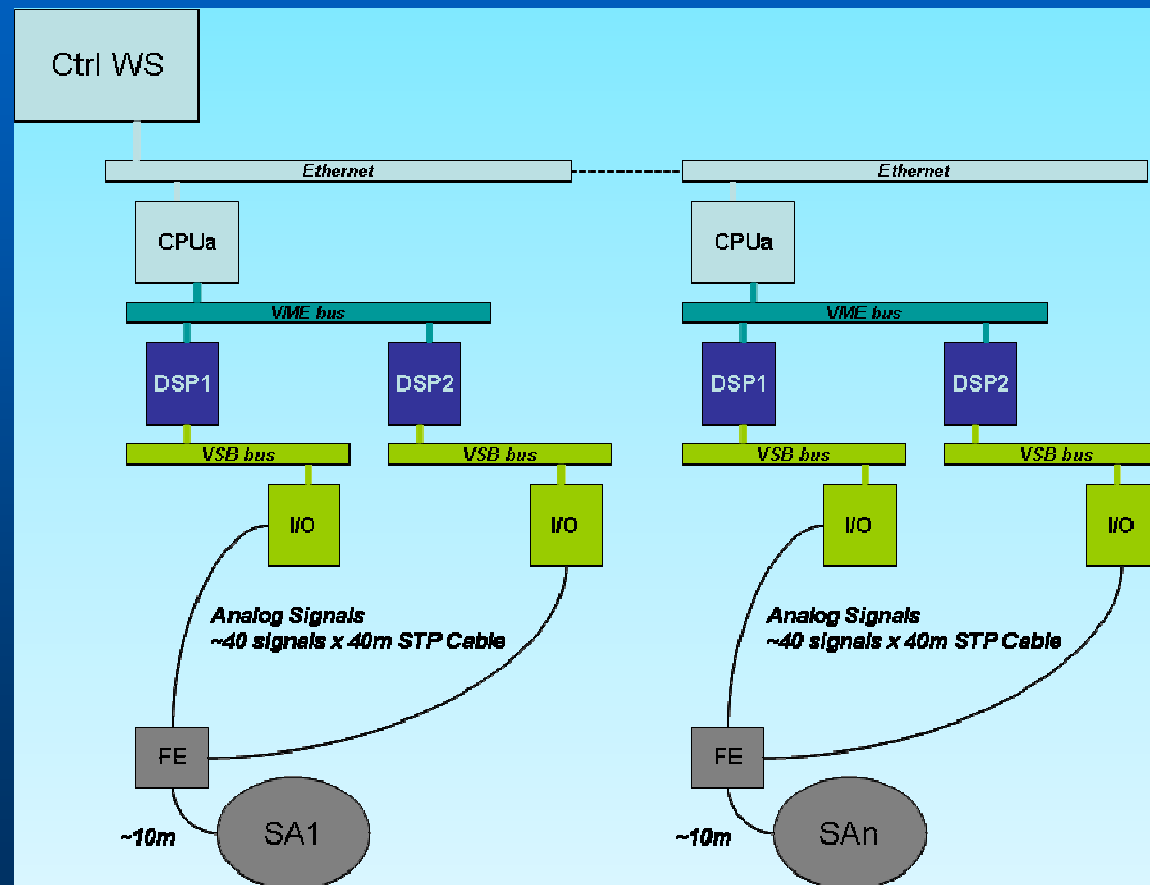
Data Conversion

- **DAC**

- **Performances of existing DAC meet Adv Virgo specifications**
- **Converter is obsolete and must be replaced**
 - **Not so simple finding something better**
 - **Converter in use: 20 bit, 120 dB SNR, -88 dB THD**
 - **DSD1792: 24 bit (Sigma-Delta), 125 dB SNR, -90 dB THD but higher 1/f corner (at 1Hz converters have the same noise, below 1Hz new one has more noise)**
 - **Other converters are being evaluated**

Data Path Optimization

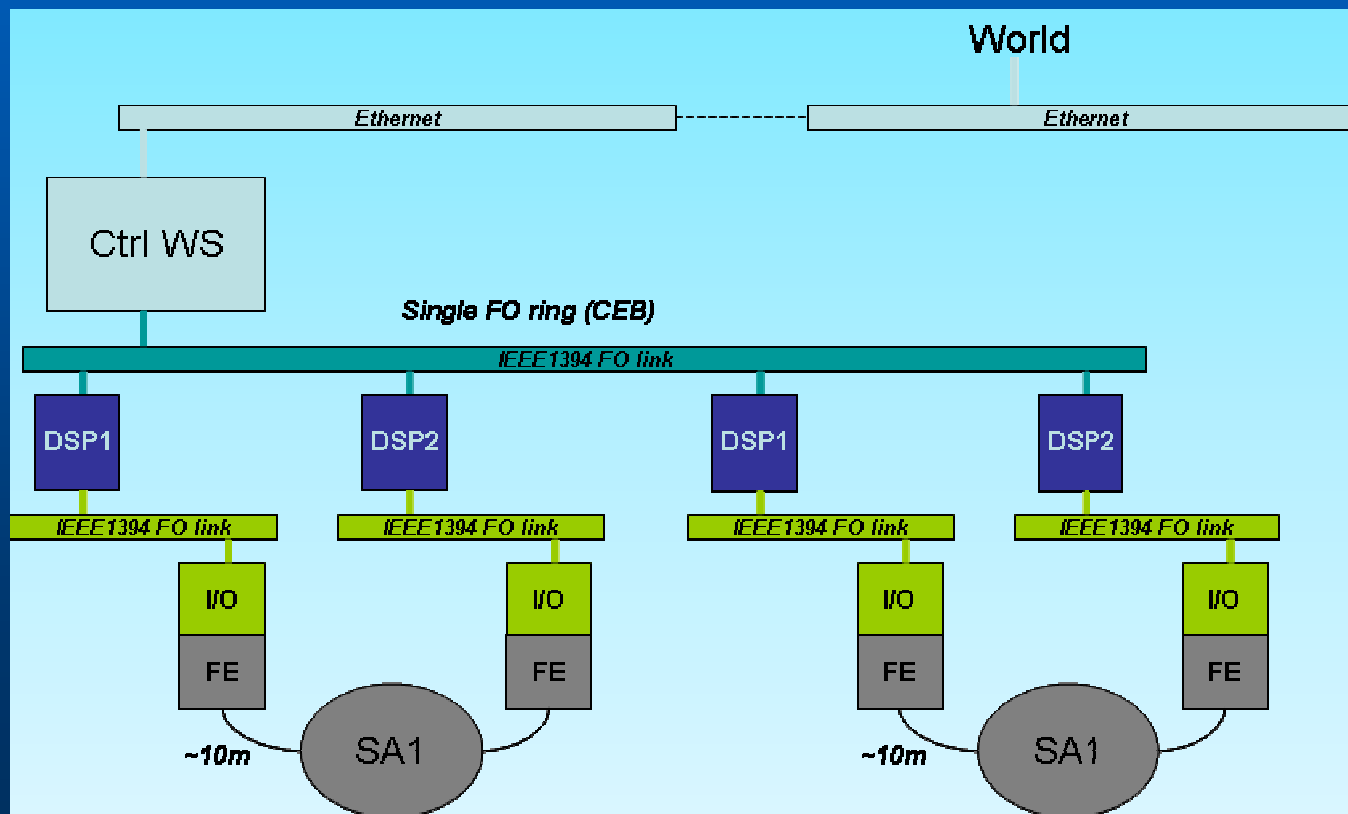
- Virgo/Virgo+



Adv Virgo

- Remove

- about 1600 m of STP cable per tower
- 1 RIO/CPU + VME Crate per tower



Other Activities

- **Angular Accelerometer Electronics**
 - Same as Accelerometers?
- **Conduction Cooling**
 - Removal of fan from the experimental area will require adoption of conduction cooling standards.
- **DC Supplies Distribution**

Suspension Control Software

- **Software upgrade is focused mainly on cleaning up existing software**
 - **Provide in-system test capabilities for hardware devices**
 - **Minimize changes on interfaces with external packages**
 - **Simplify operation**
 - **Improve software fault tolerance and maintainability**

Suspension Control

- All control loops are Single Input Single Output (SISO)
- Virgo approach for Multiple Input Multiple Output (MIMO) systems
 - Achieve some diagonal dominance (i.e. make cross couplings as small as possible)
 - Design controllers for main diagonal terms
 - Correct result adding some off-diagonal controllers
- Drawbacks
 - Non optimal controllers
 - Poor adaptation to changing disturbances
- Adv Virgo
 - Move towards MIMO implementation and adaptive control

Manpower

- **Additional Positions**

- System/Control Engineer. Overall coordination support
- Software Engineer. Firmware
- Hardware Engineer. Design
- Electronic Technician. Assembly and test.

- **External Firms whenever possible**

- **EGO Support**

	Design	PCB Design	Test	Firmware
<i>FE Crates Replacement</i>			1	
<i>LVDT Conditioning Electronics</i>	4	3	1	2
<i>Accelerometer Electronics</i>	4	3	2	2
<i>Coil Drivers</i>	4	3	2	2
<i>Motors Control</i>	3	2	1	3
<i>Motors Power</i>	3		1	
<i>Piezo Drivers</i>	4	3	1	2
<i>Thermal Stab.</i>				
<i>Data Converters</i>	4	3	2	4
<i>DSP</i>	4	3	2	4
<i>DSP Carrier</i>	3	3	1	3
<i>Scientific & Technical Supervision</i>	36			
<i>Technical Management</i>	36			
<i>Contracts & Procurement</i>	12			
<i>Software D&D</i>	54			
<i>Installation</i>				
<i>Commissioning</i>				
<i>Maintenance</i>				
Total	230			(month-man)