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# First Technology Safety Systems

## Design Freeze Status

### FLEX-PLI-GTR Development Optional Instrumentation

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FTSS Europe

Comments addressed from Design Freeze meeting  
February 20<sup>th</sup> 2008, JARI, Tsukuba, Japan  
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# Content

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- Scope of the project
- Potential options and priorities for optional instrumentation
- On Board Data Acquisition packaging
- Computer Aided Engineering model

# Project Scope

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- Options should not make the standard version more expensive/complicated
- Standard instrumentation will meet all specifications
  - Purpose Regulatory Testing
- Versions with options may not meet all specifications
  - Purpose Research & Development Testing
- It may not be feasible to achieve all options simultaneously
- In the next phase we will concentrate on the standard design
  - Complete options design is outside the scope of this project
  - Optional Instrumentation design will be executed based on customer requests

Channel	Purpose	Standard	Option	DAS	Priority
Femur moment 1, 2 and 3	Calibration	3	0	Standard option On board DAS	
Tibia moment 1, 2, 3 and 4	Injury	4	0		
Tibia top acceln ax	Calibration	1	-1		
MCL elongation	Injury	1	0		
ACL elongation	Calibration	1	0		
PCL elongation	Calibration	1	0		
LCL elongation	Calibration	1	0		
Tibia top acceln ax, ay, az	Motion	0	3	optional on board if feasibl	1
Femur bottm acceln ax, ay, az	Motion	0	3		1
Tibia angular rate $\omega_x, \omega_y, \omega_z$	Motion	0	3		2
Femur angular rate $\omega_x, \omega_y, \omega_z$	Motion	0	3		2
Femur top acceln ax, ay, az	Motion	0	3	Lab	3
Tibia bottom acceln ax, ay, az	Motion	0	3	Lab	3
Segment acceln ax	Research	0	15	Lab	4
<b>Total</b>		<b>12</b>	<b>32</b>		

# Summary


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## On board pending feasibility

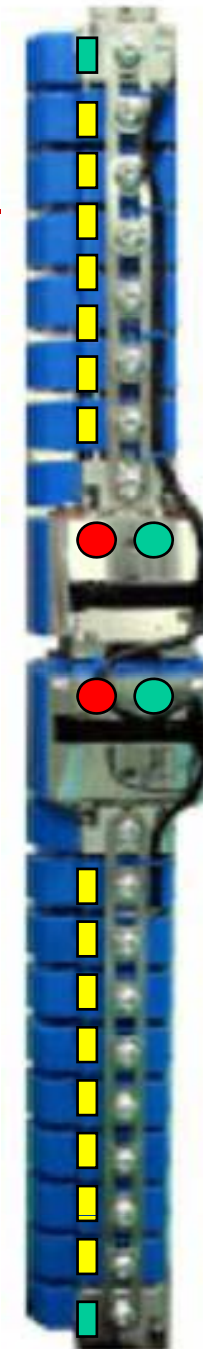
3 axis damped accelerometer 

3 axis angular velocity sensor 

## Off board

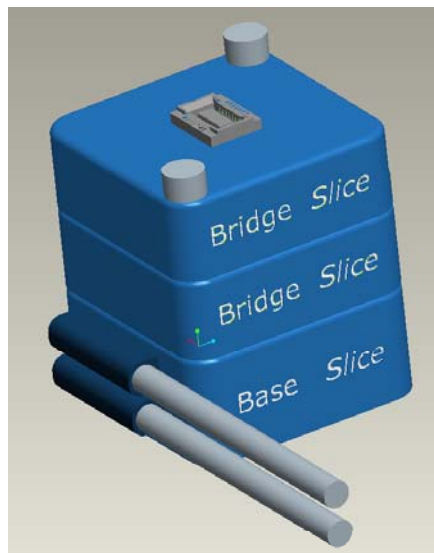
Attachment place for 3 axis damped accelerometer 

Attachment place for 1 axis damped accelerometer 

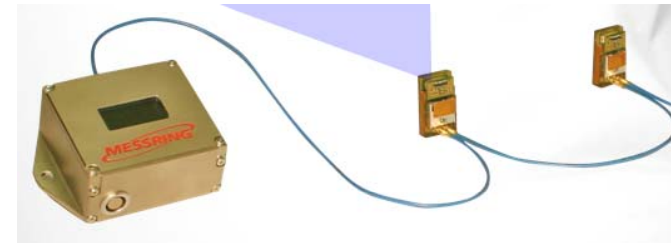


# On Board Data Acquisition Systems

- High priority
- 'Standard' option
- Improve free flight motion control
- Packaging space is optimized, though still limited
  - Potential solutions meet packaging space



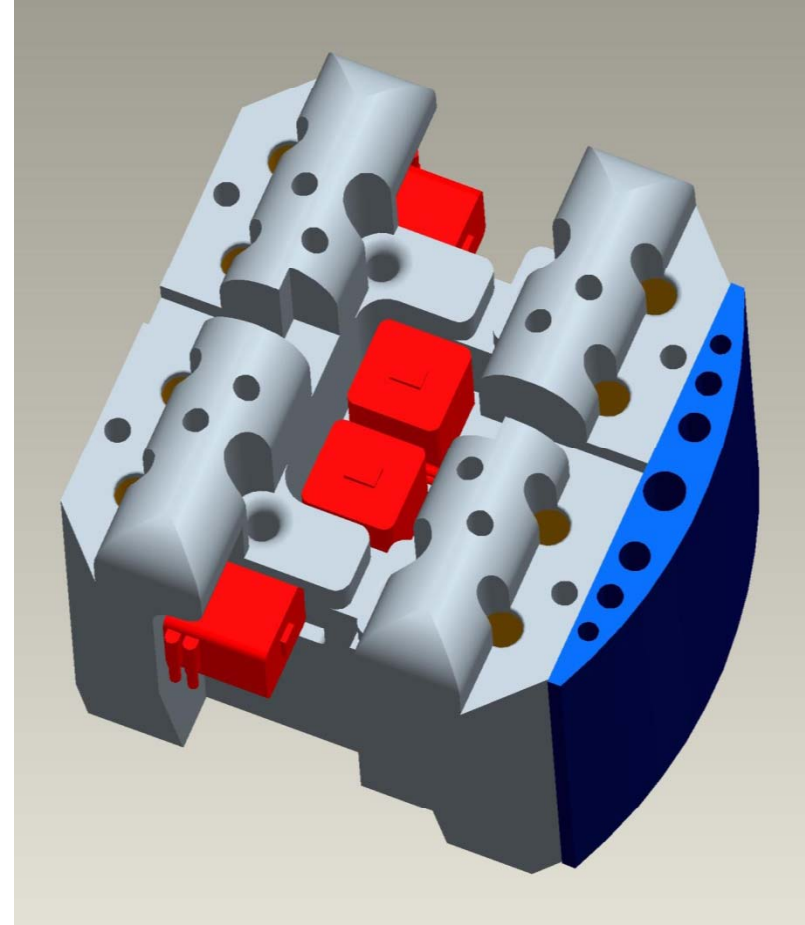
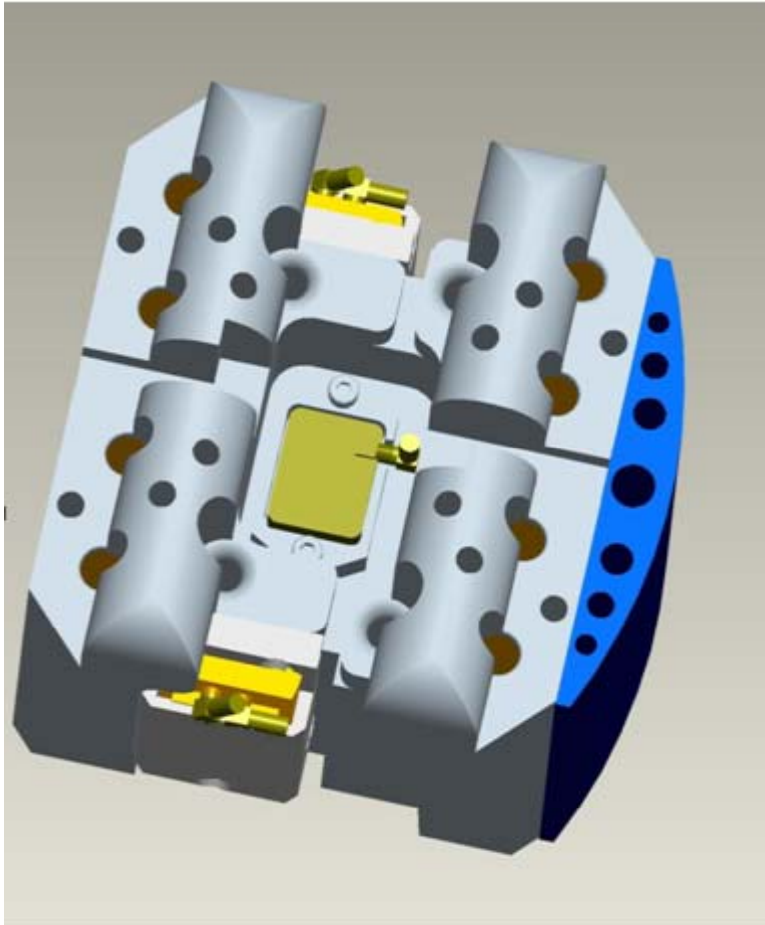
<http://www.e-sensing.com/>



<http://www.messring.de/>

# Options Packaging Space

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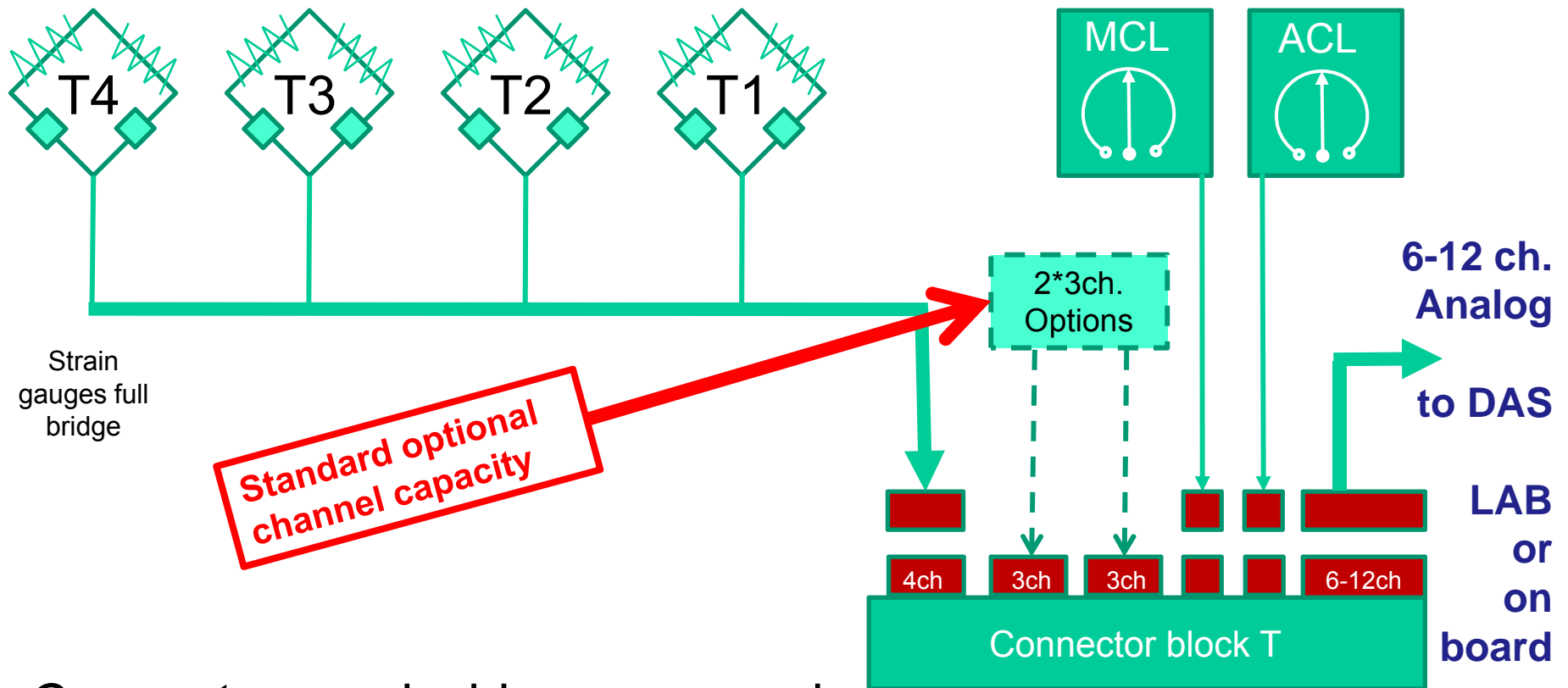


Packaging DAS, battery, wiring, connectors, auxiliaries, etc.

Form: 07-163  
Revision: A  
16 - May 07

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Innovative Solutions

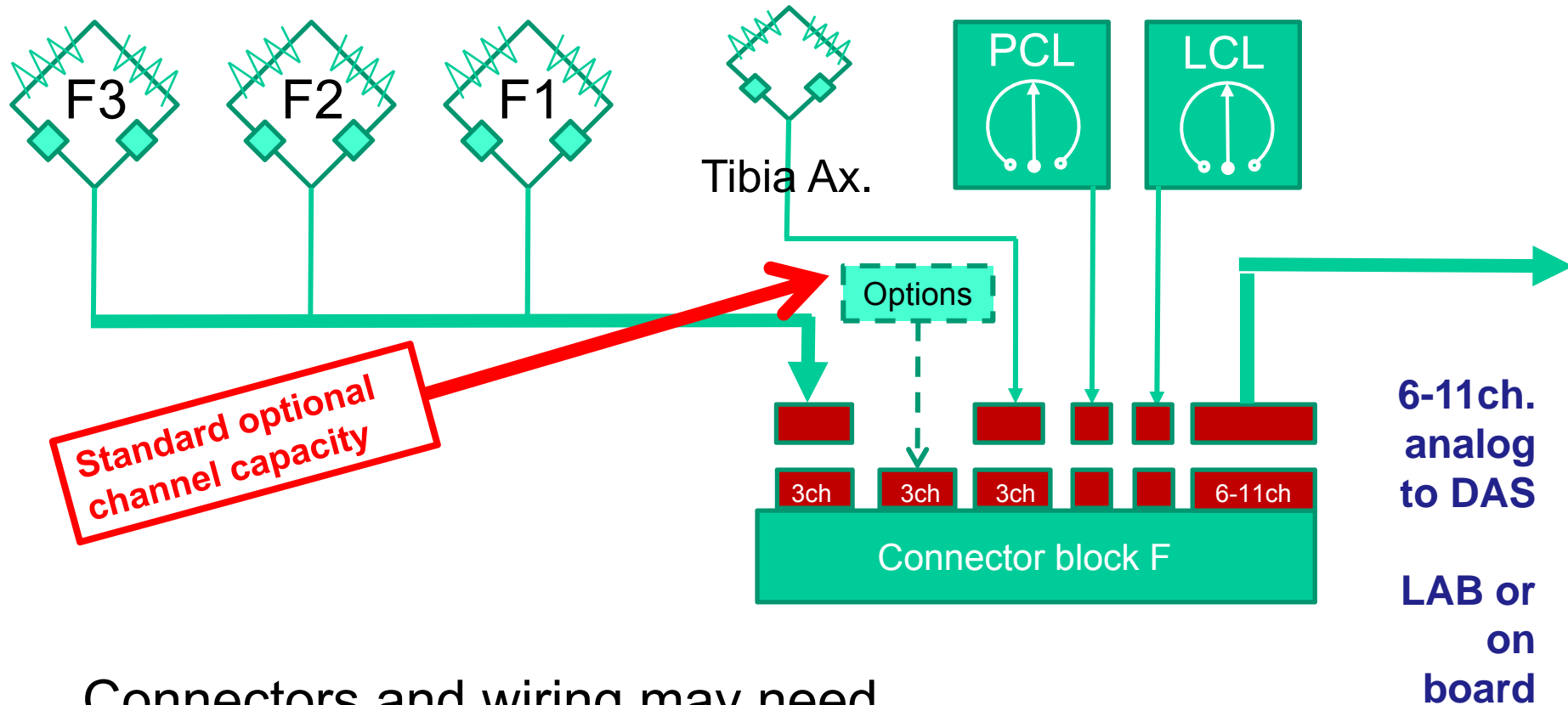
# Wiring Diagram Tibia Concept



Connectors and wiring may need to be tailored DAS specific



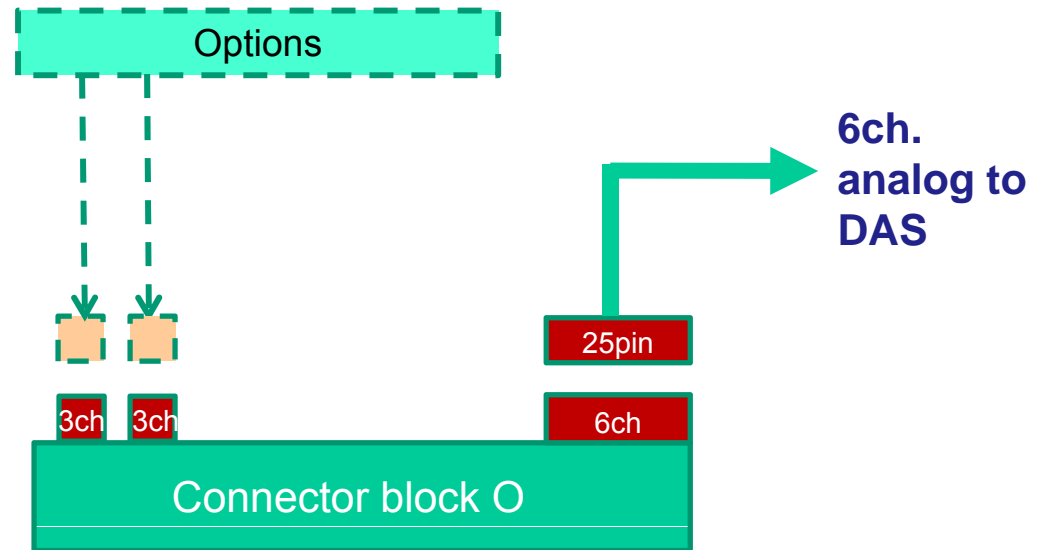
# Wiring Diagram Femur



Connectors and wiring may need to be tailored DAS specific

# Wiring Diagram Options

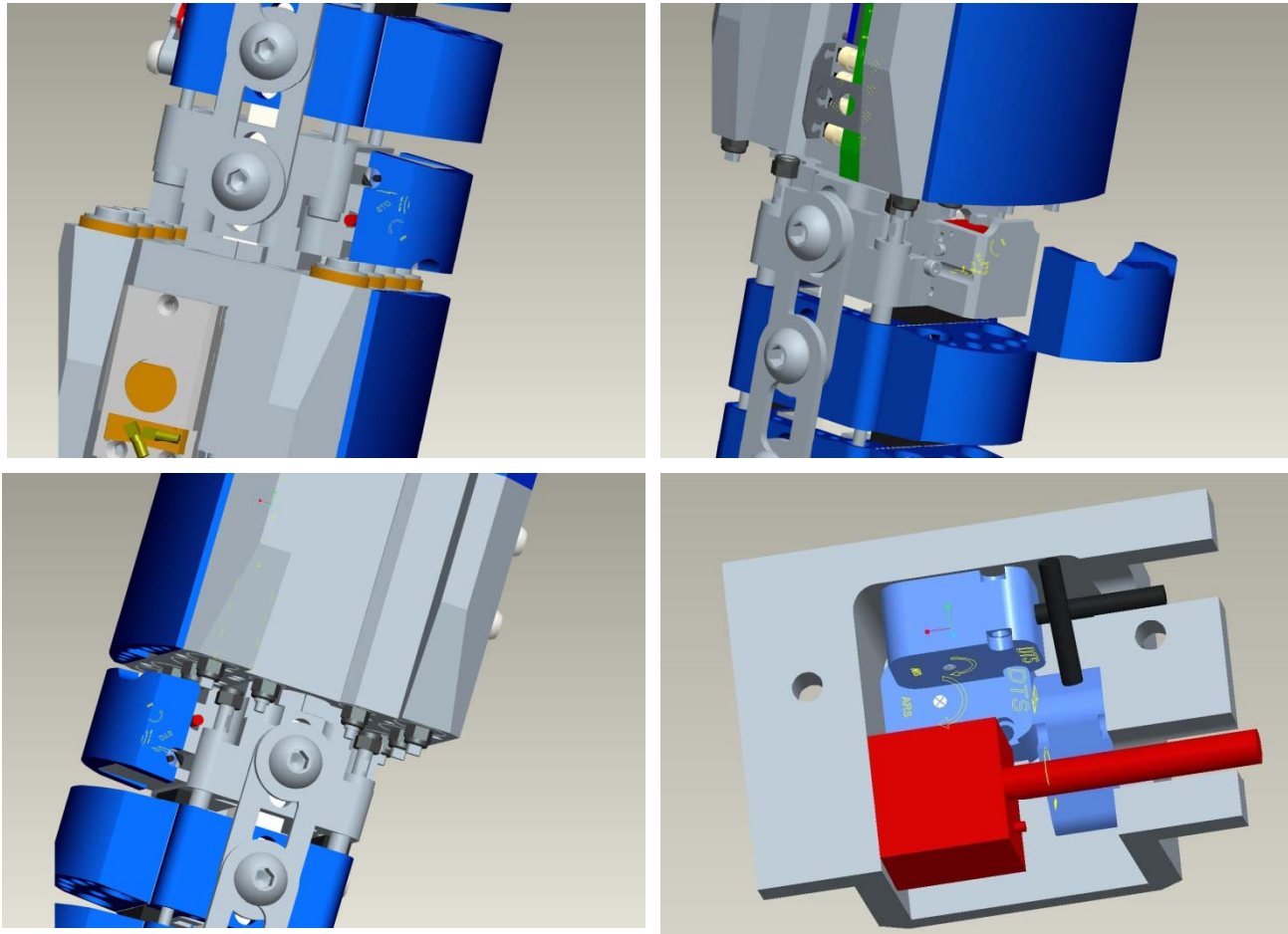
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Connectors and wiring for options may need to be tailored DAS and customer specific

# Tibia and Femur Knee Part

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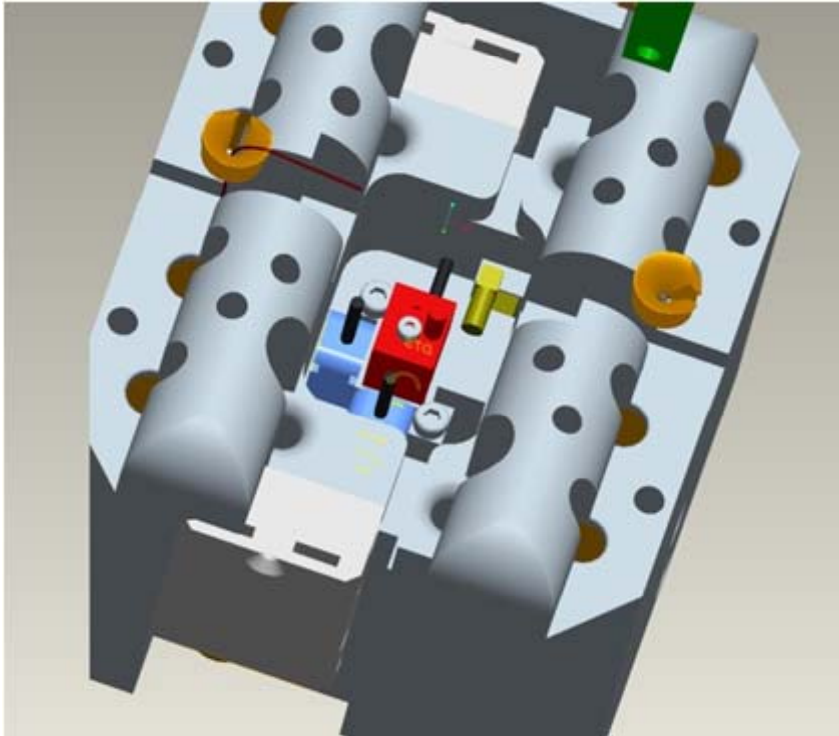


Measurement Specialties M68C Endevco 7268C  
DTS Angular Rate Sensors

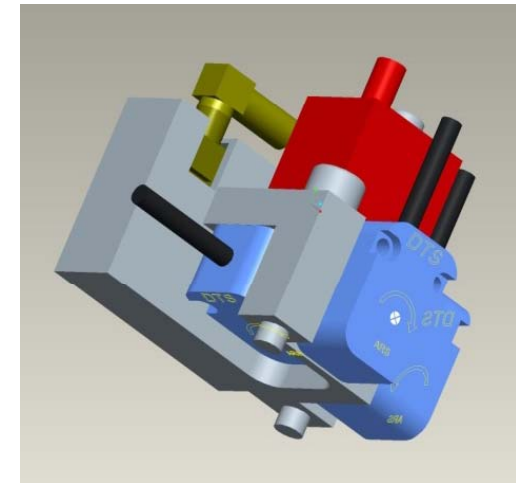
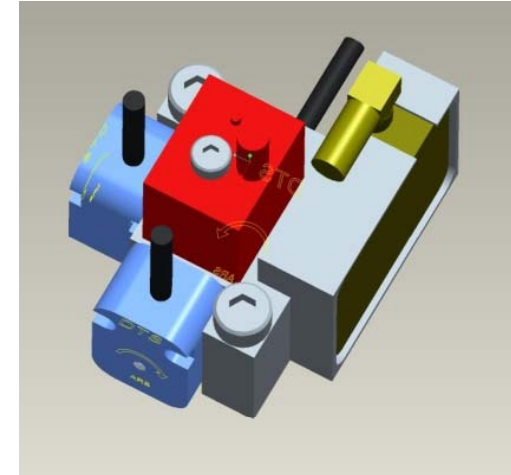
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Revision: A  
16 - May 07

# Alternative Sensors in Knee Triax and Angular rate sensors

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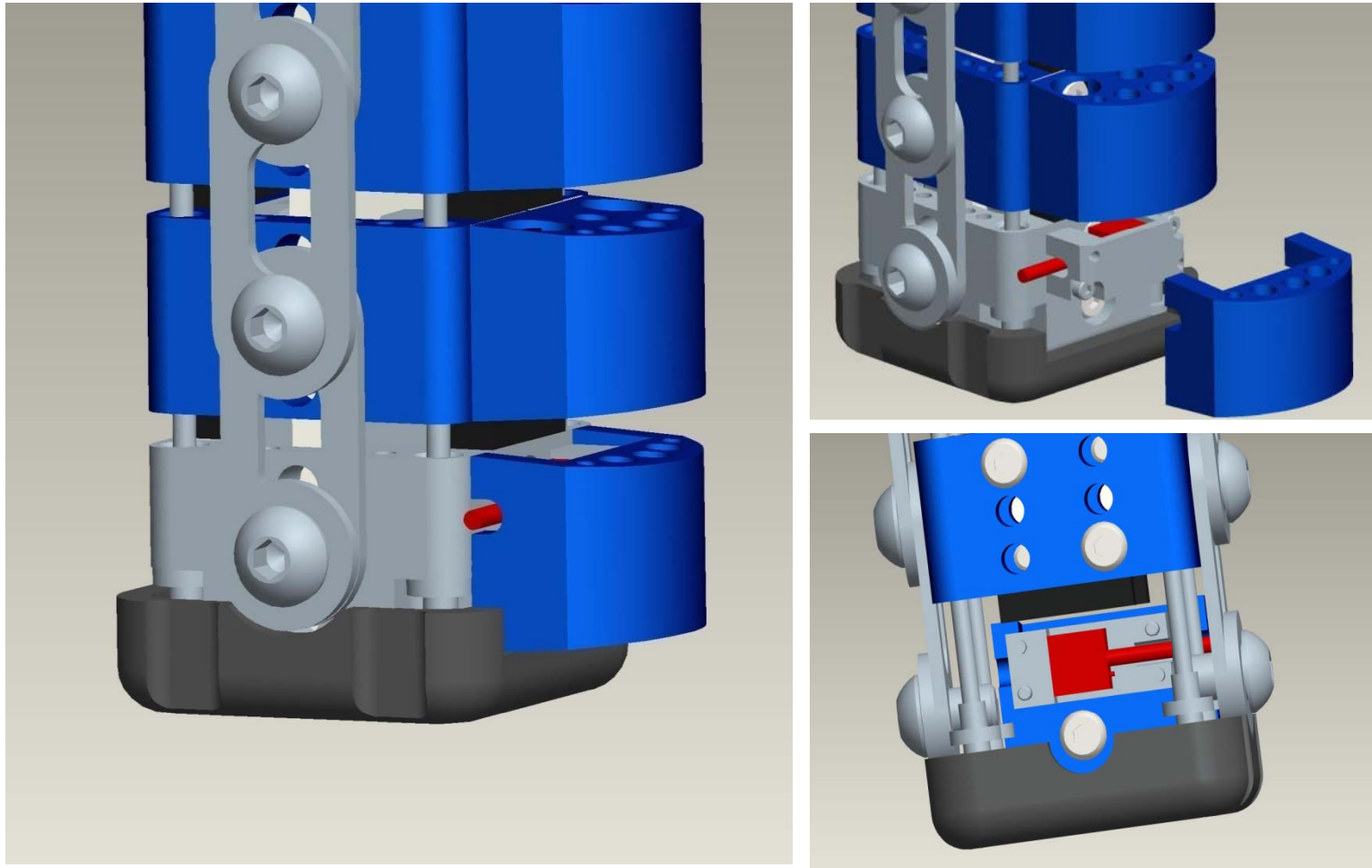


- This idea is limited to the femur
- Calculate tibia motion from MCL, ACL PCL



# Triax accelerometer Distal Tibia (shown) and Proximal Femur

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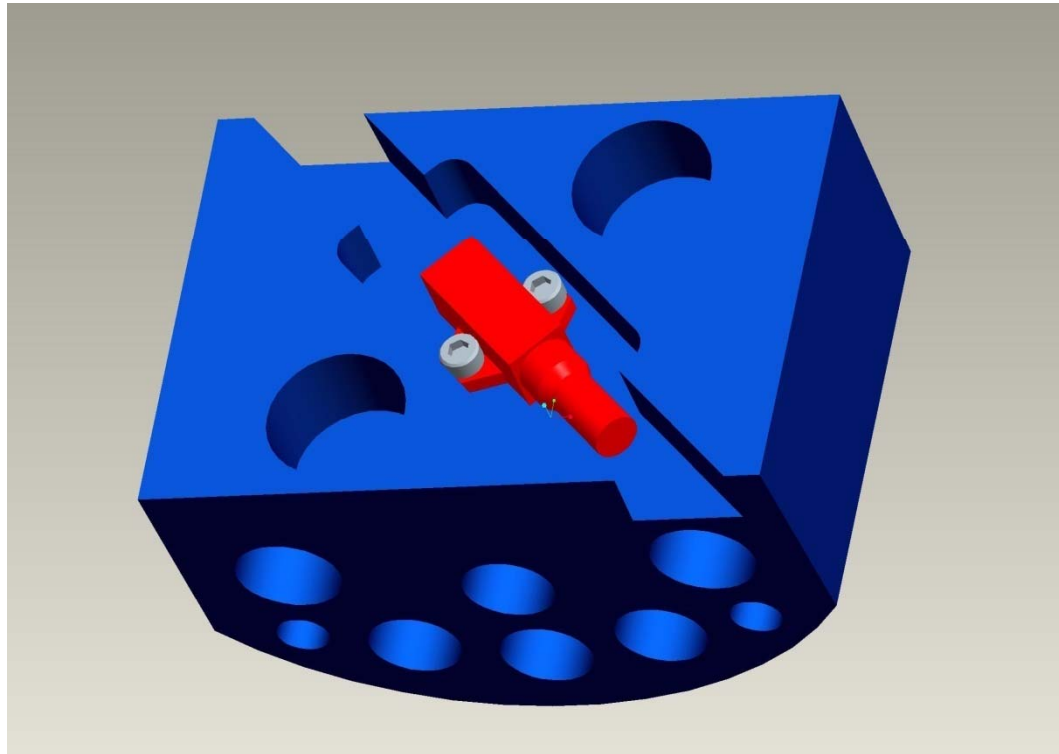


Measurement Specialties M68C or Endevco 7268

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# Single axis accelerometer x-direction each segment

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- Dedicated nylon segment for optional accelerometer
- Threaded metal insert

# Option CAE model development

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- FTSS proposes to develop a Flex-PLI-GTR CAE model through a consortium project parallel to the hardware development
- FTSS offers to take the responsibility to develop the models and co-ordinate the project
- The model(s) will become part of the FTSS model database and will be maintained and further enhanced accordingly
- The consortium members will fund the consortium project and will receive a free license allowing to use the model in the next 3 years



## DTS-ARS SPECIFICATIONS

### DTS-ARS – The Next Generation in Angular Rate Sensors

The DTS-ARS is the latest in intelligent design from DTS. With ranges as high as 12,000 deg/sec, these incredibly small and lightweight sensors have a remarkable DC to 2,000 Hz bandwidth. Suitable for many automotive, aerospace and industrial testing applications, the DTS-ARS can also be used inside crash test dummies for precise measurements of head rotation, thorax rotation and other biodynamic measurements. Re-calibration services are available.

#### Applications

- FMVSS 202a and rollover crash testing
- Side curtain deployment development
- Component testing
- Biodynamic research testing

Single axis DTS-ARS



DTS-ARS triax package with DTS mounting block



Part Number	Specifications	Additional Information
ARS-300	±300 deg/sec range SAE Class 60 response	Ships standard with pigtail termination. Options*: -C: add connector -CID: add connector and Dallas ID
ARS-1500	±1500 deg/sec range SAE Class 600 response	
ARS-12K	±12000 deg/sec range SAE Class 1000 response	Optional ranges*: 300 to 50,000 deg/sec Optional bandwidth*: 40 to 10,000 Hz * additional lead time required



A six-axis package is easily obtained by taking the DTS-ARS triax package shown above and mounting three standard Endevco 7264 or MSI 64 accelerometers.

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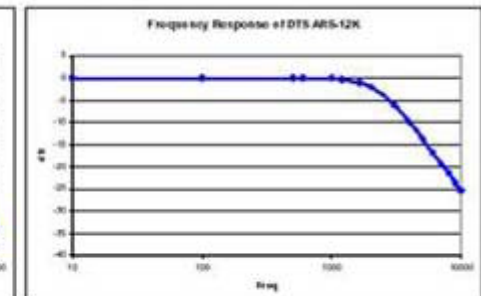
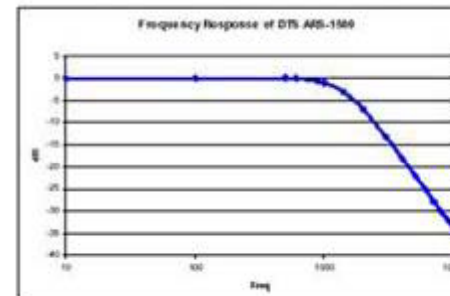


RANGE and FREQUENCY RESPONSE		
Range deg/sec (rad/sec)	Bandwidth* (Hz)	Noise (rms full scale)
300 (5.2)	DC to 100	<math><0.15\%</math>
1500 (26.2)	DC to 1000	<math><0.15\%</math>
12000 (209.4)	DC to 1650	<math><0.25\%</math>
ELECTRICAL		
Excitation	4.95 to 14.00 VDC; output not proportional to excitation	
Current	6 mA nominal	
Zero Output	±200 mV	
Full Scale Output	±2 V nominal	
PERFORMANCE		
Cross axis sensitivity	<math><1.0\%</math>	
Linearity	<math><0.5\%</math> full scale	
Influence of linear acceleration	0.2 deg/sec/g	
Drift	0.1 deg/sec/sec	

PHYSICAL	
Enclosure	Anodized aluminum
Size	0.3 x 0.4 x 0.58 inches 7.6 x 10.2 x 14.7 mm
Mass	<math><3</math> grams
Shock	2000 G, any direction
Cable	<ul style="list-style-type: none"> <li>• four conductor, 28 AWG</li> <li>• Overall shield isolated from enclosure</li> <li>• Standard 25 ft (8.3 m)</li> <li>• Color code                             <ul style="list-style-type: none"> <li>○ Black: -Excitation</li> <li>○ Red: +Excitation</li> <li>○ Green: +Signal</li> <li>○ White: -Signal</li> </ul> </li> </ul>
Temperature Range	-40 to +85°C
Humidity	99%, non-condensing
Connector	LEMO or other installed per request
Dallas ID	Installed in connector

Specifications may be revised without notice.

\* Indicates flat response in this frequency range. The 1500 deg/sec ARS meets SAE Class 600 performance requirements. The 12000 deg/sec ARS meets SAE Class 1000. All DTS-ARS sensors have DC response. Nominal frequency response for 1500 and 12000 deg/sec units are show below.



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Revised Nov 2006



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# Design frozen!