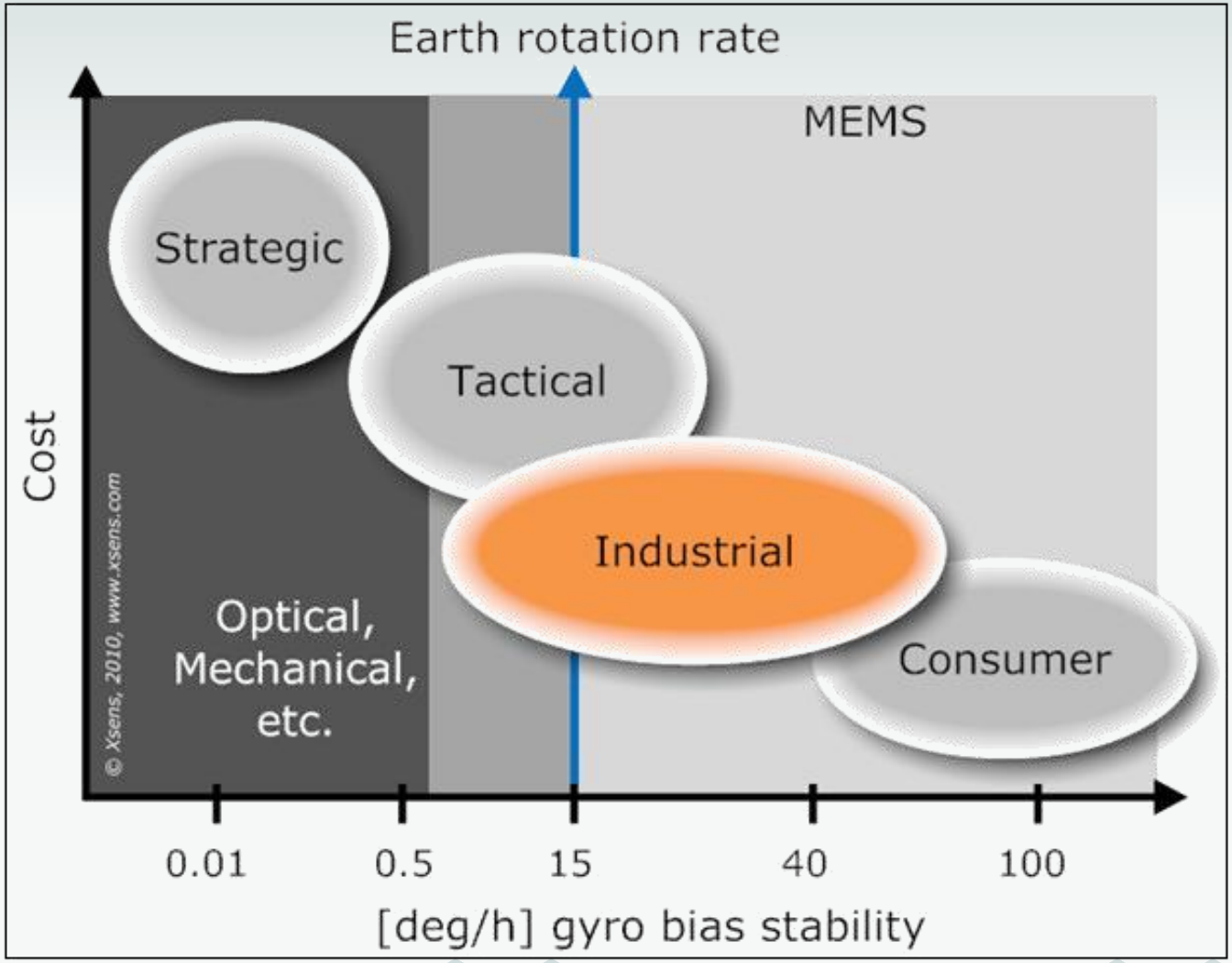
ACAMP Inertial Development

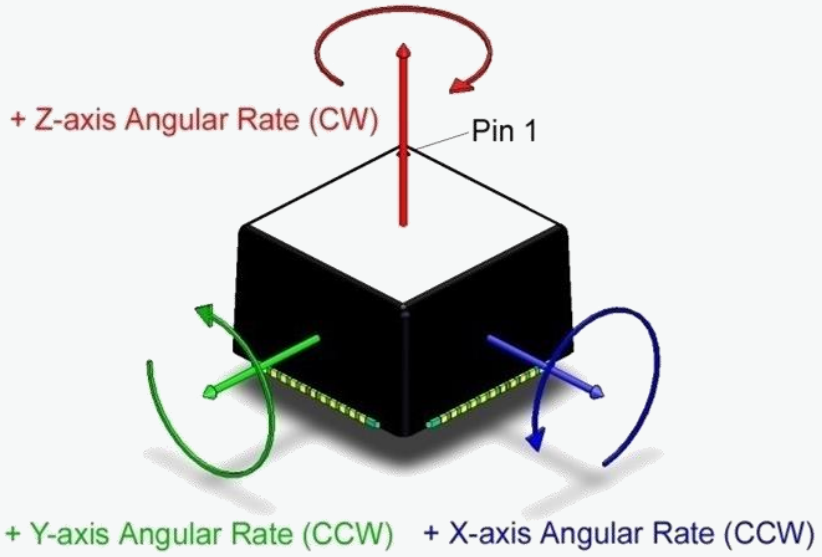
Sample Client Interactions

IMU Grades

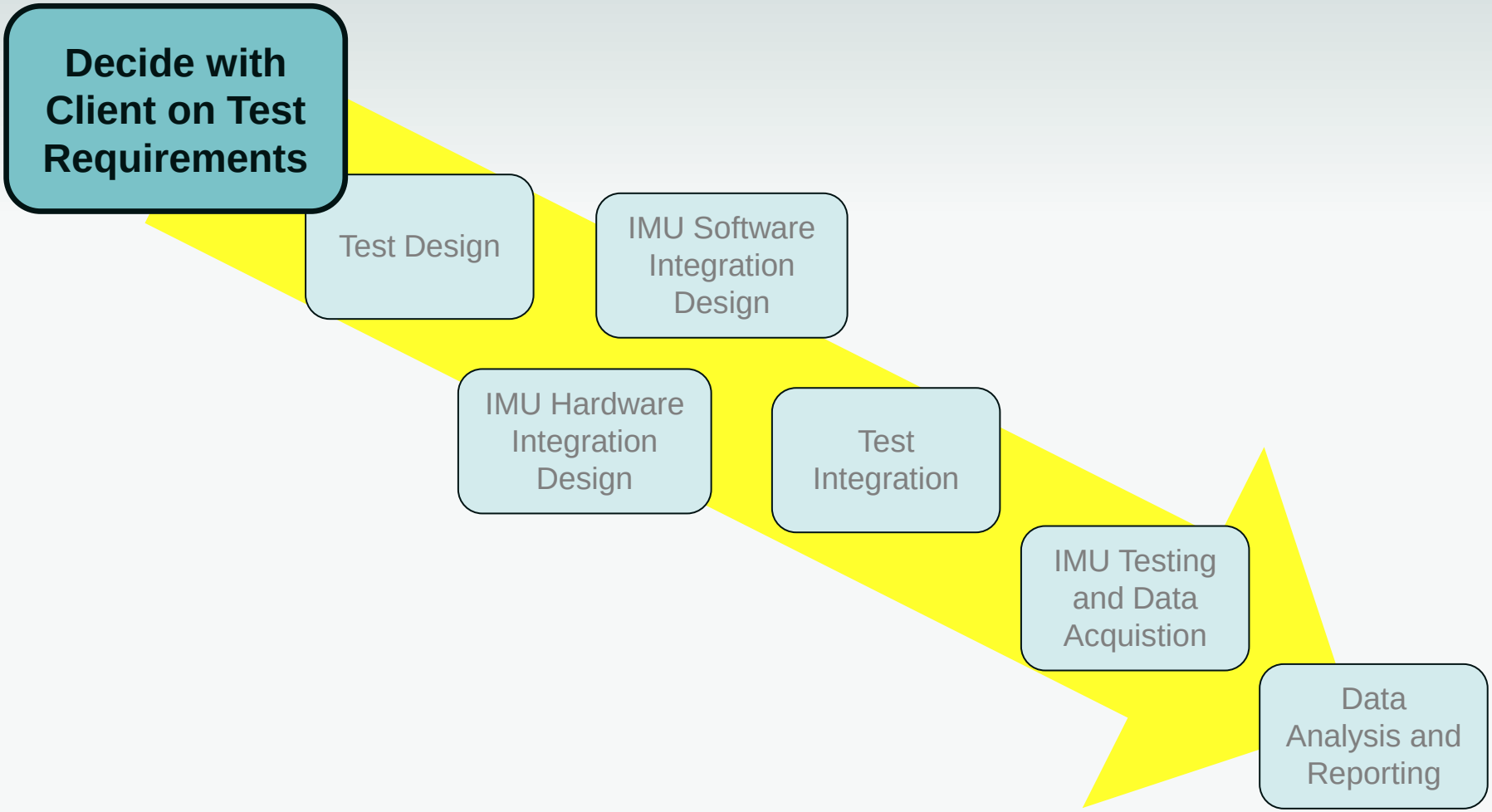

Earth rotation rate
MEMS
Strategic
Tactical
Industrial
Consumer
Optical,
Mechanical,
etc.
Cost
© Xsens, 2010, www.xsens.com
0.01
0.5
15
40
100
[deg/h] gyro bias stability

Example 1

- Client has a standalone, automotive grade gyroscope
- “Compare our gyroscope to the manufacturer data sheet”

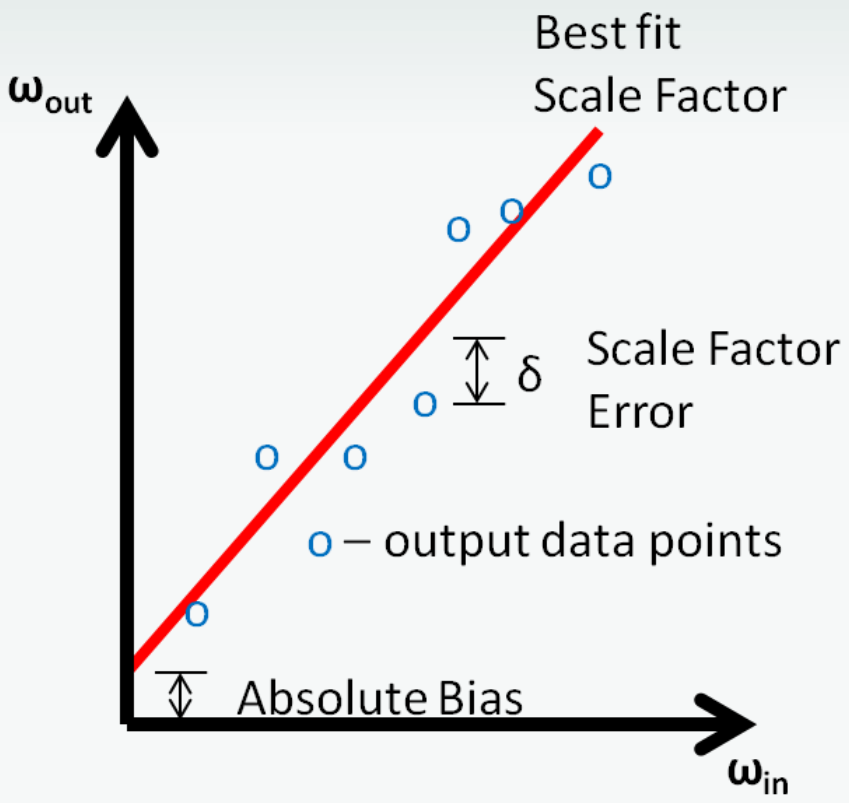


Rate Table Testing Process

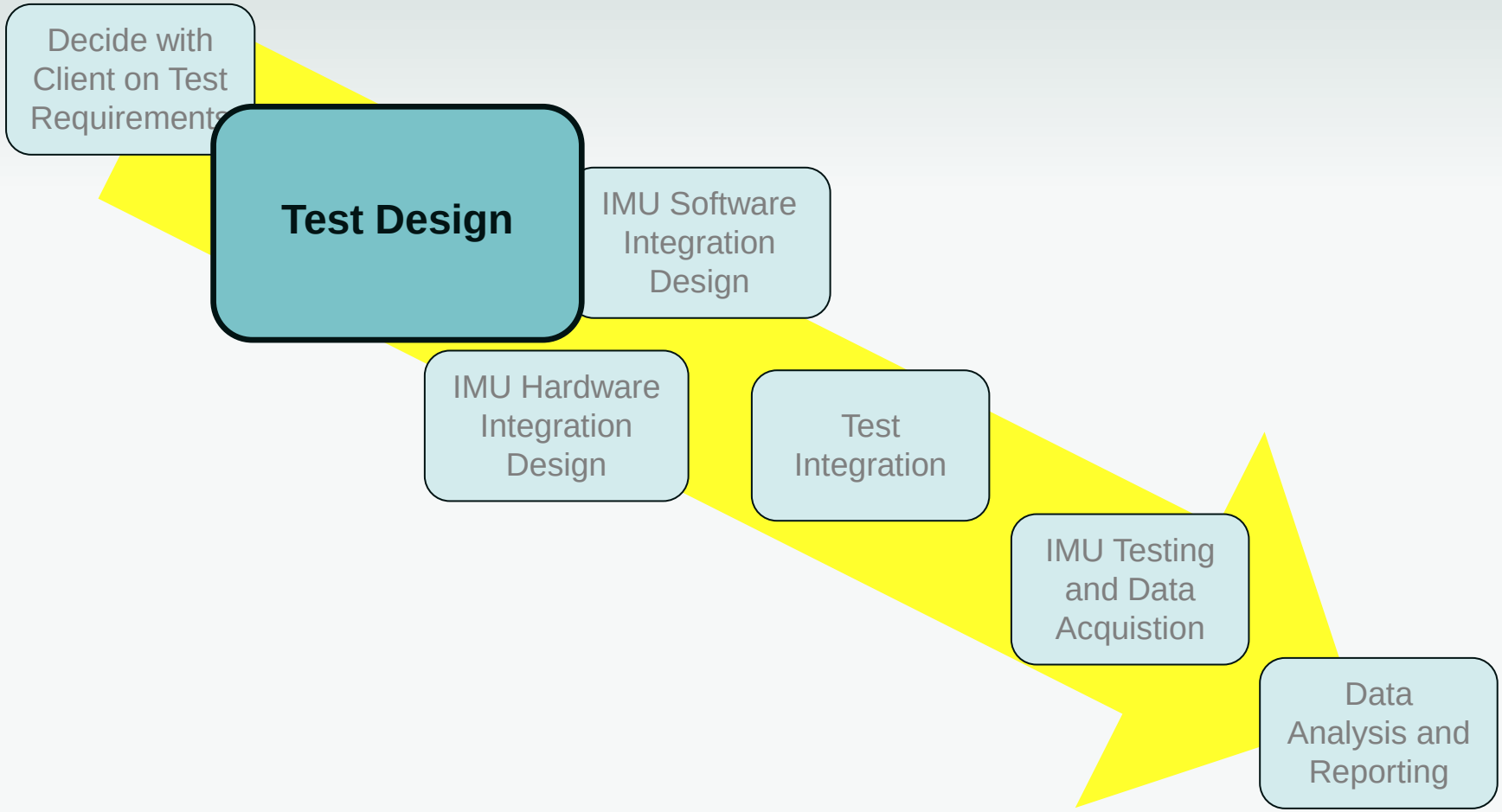


Example 1 Test Requirements

- Client wants to know
  - Scale factor
  - Scale factor error
  - Absolute bias



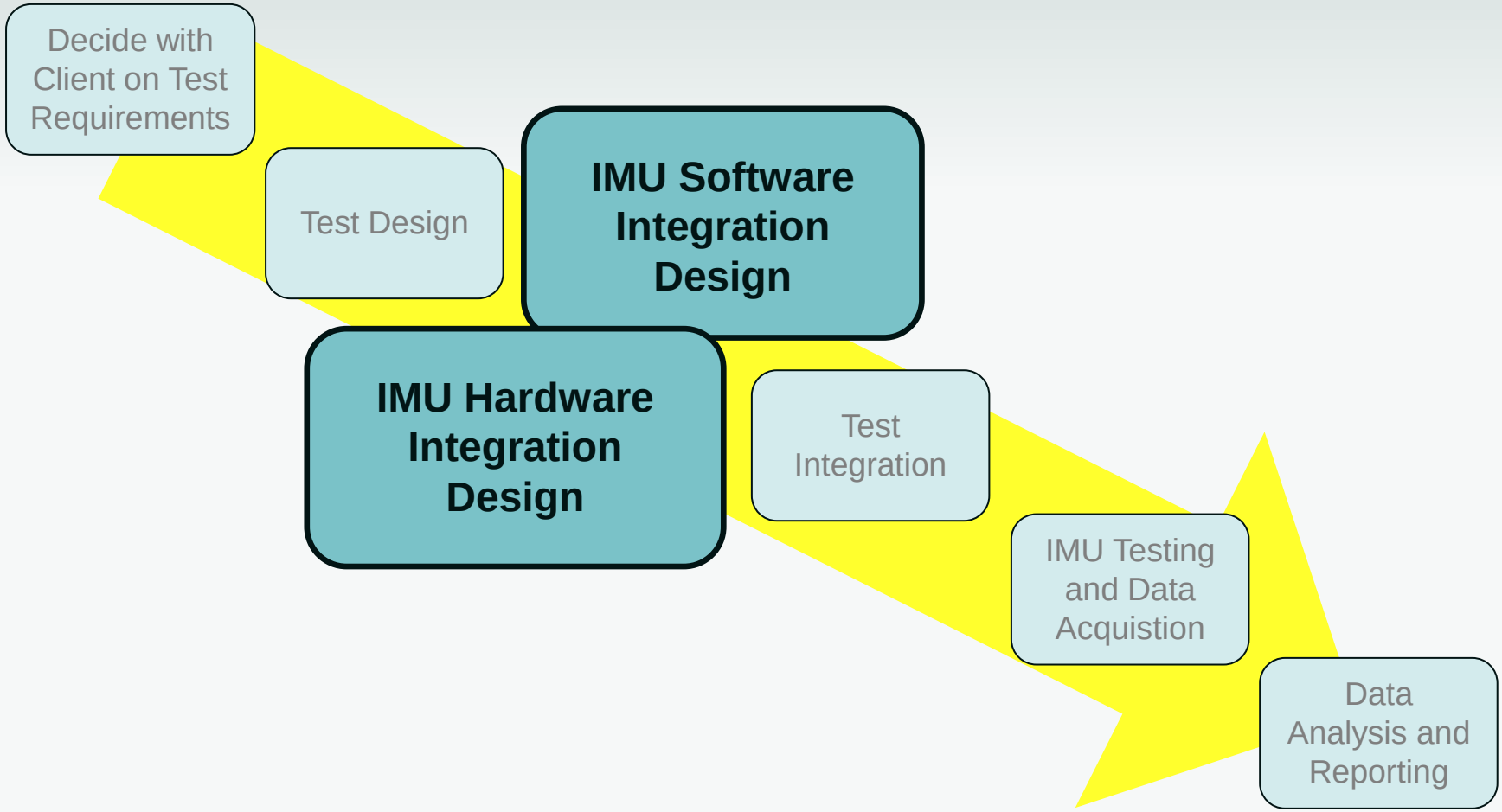
Rate Table Testing Process



Example 1 Test Design

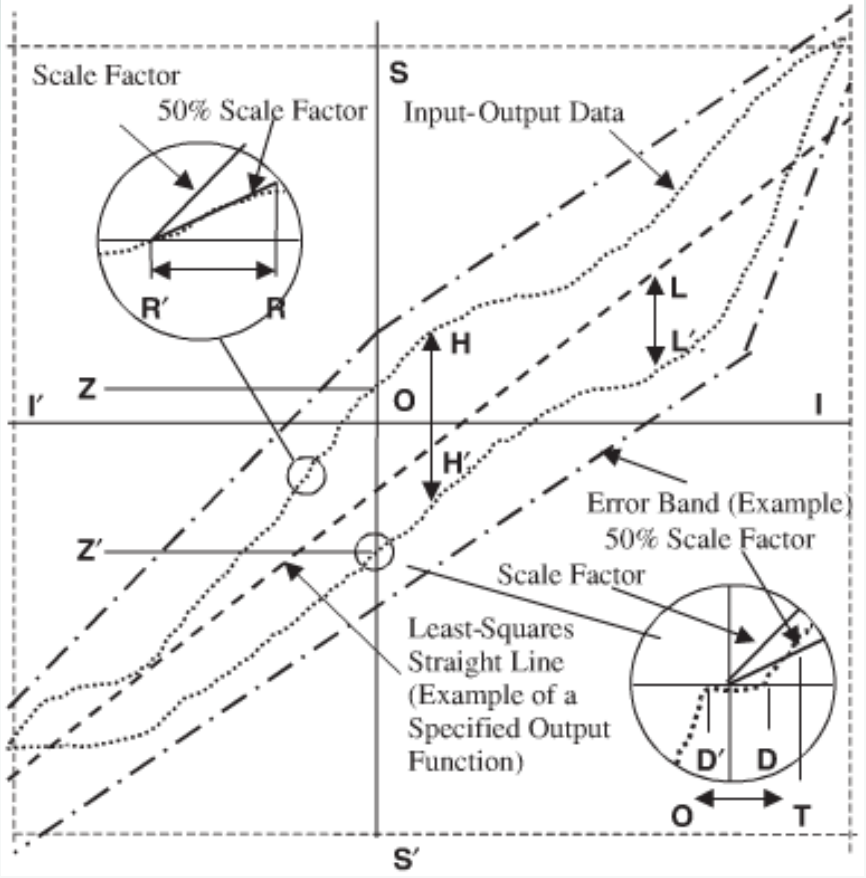
- Scale factor and scale factor error from rate test
- Test IMU at several rates between 0 and max RPM (positive and negative)
- Absolute bias >> *g*-sensitivity → can also be obtained by rate test

Rate Table Testing Process

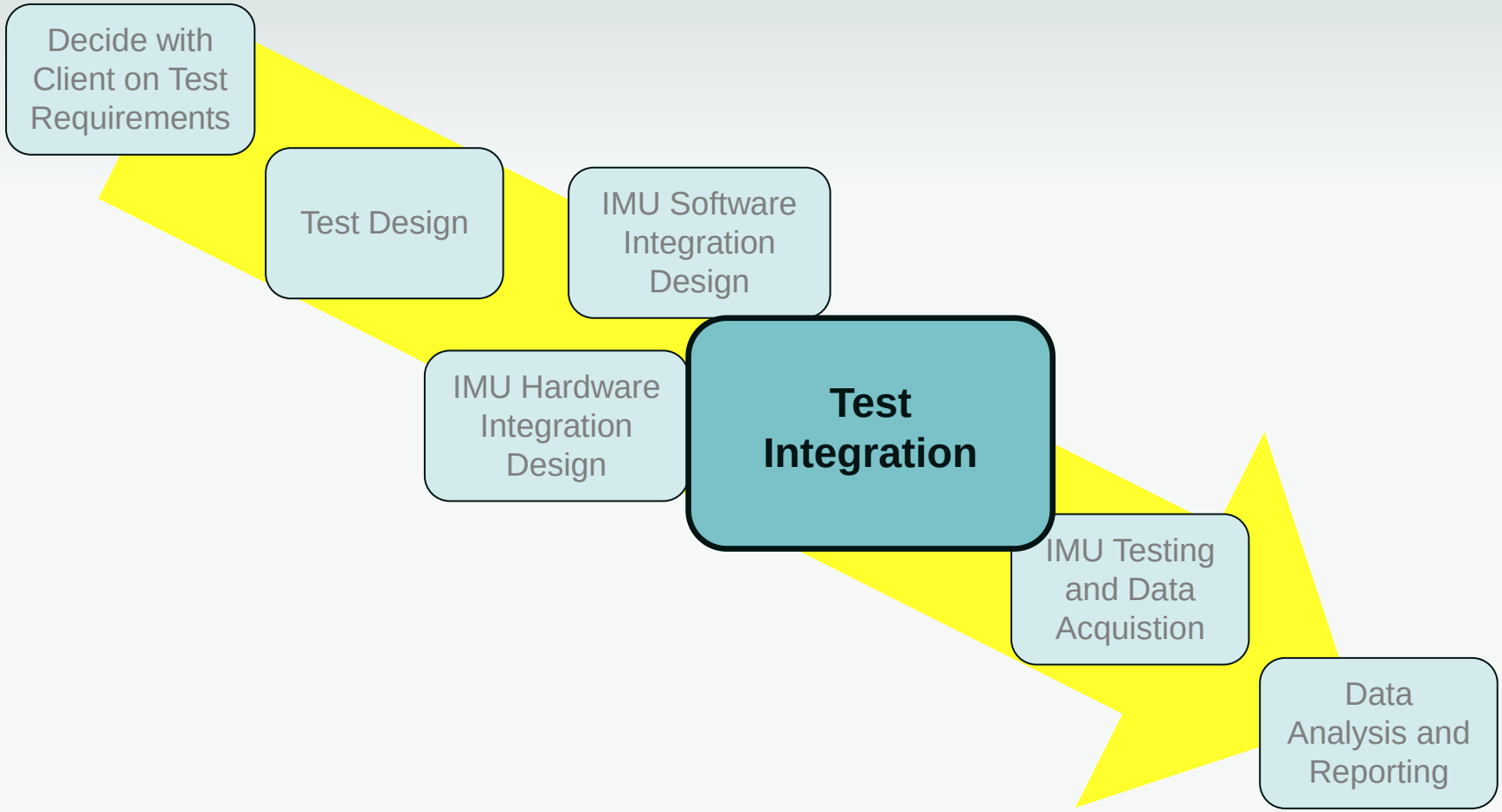


Example 1 IMU Integration

- Software
  - Tailor LabVIEW implemented SPI timing and settings
- Hardware
  - Build cabling for IMU power and I/O
  - Build mount for IMU stability

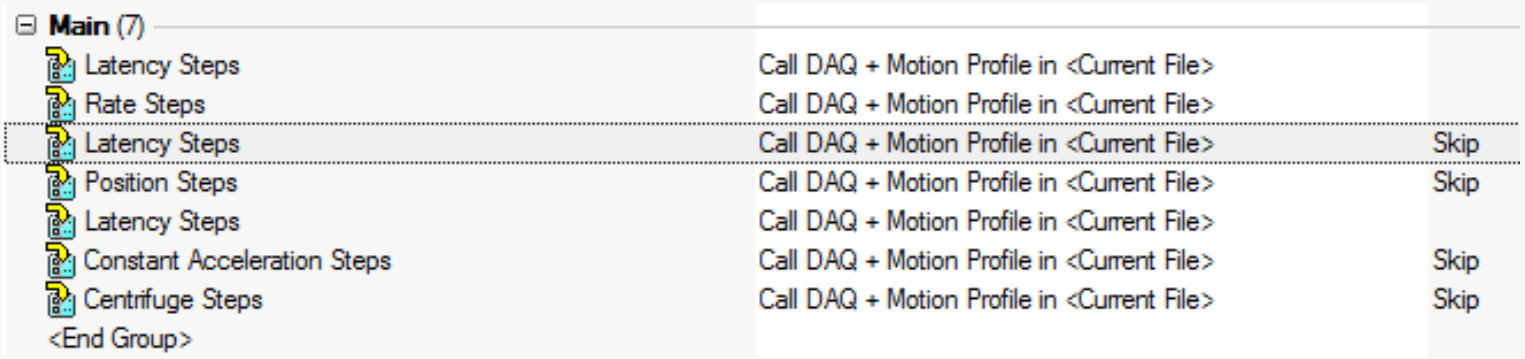


Rate Table Testing Process

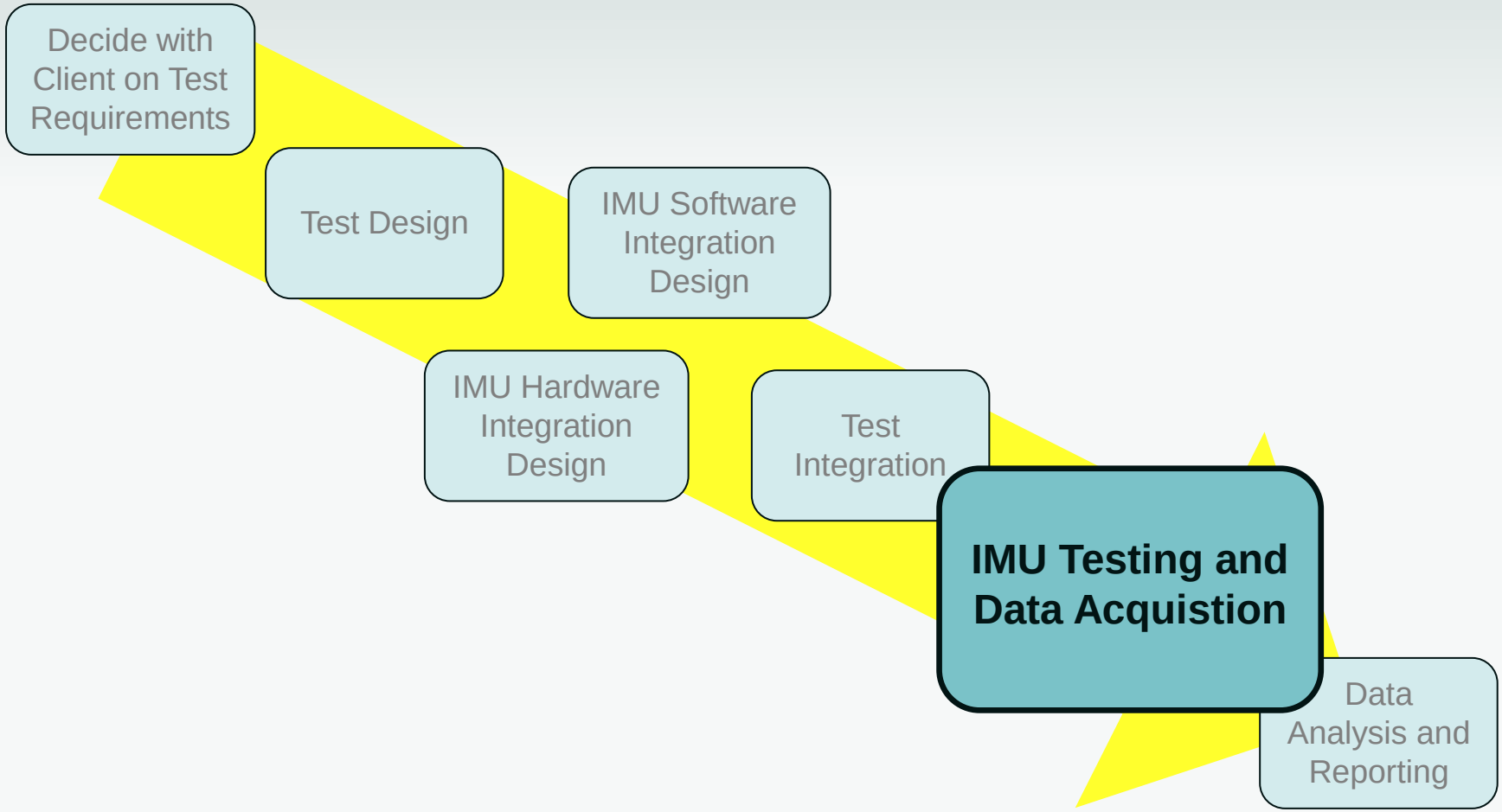


Example 1 Test Integration

- Set testing steps to run on TestStand
  - Rate test – Timing chosen to minimize error based on in-run bias stability time
- Set TestStand variables
  - Thermal soak sufficient for gyro to stabilize
  - IMU capture rate – 200 Hz



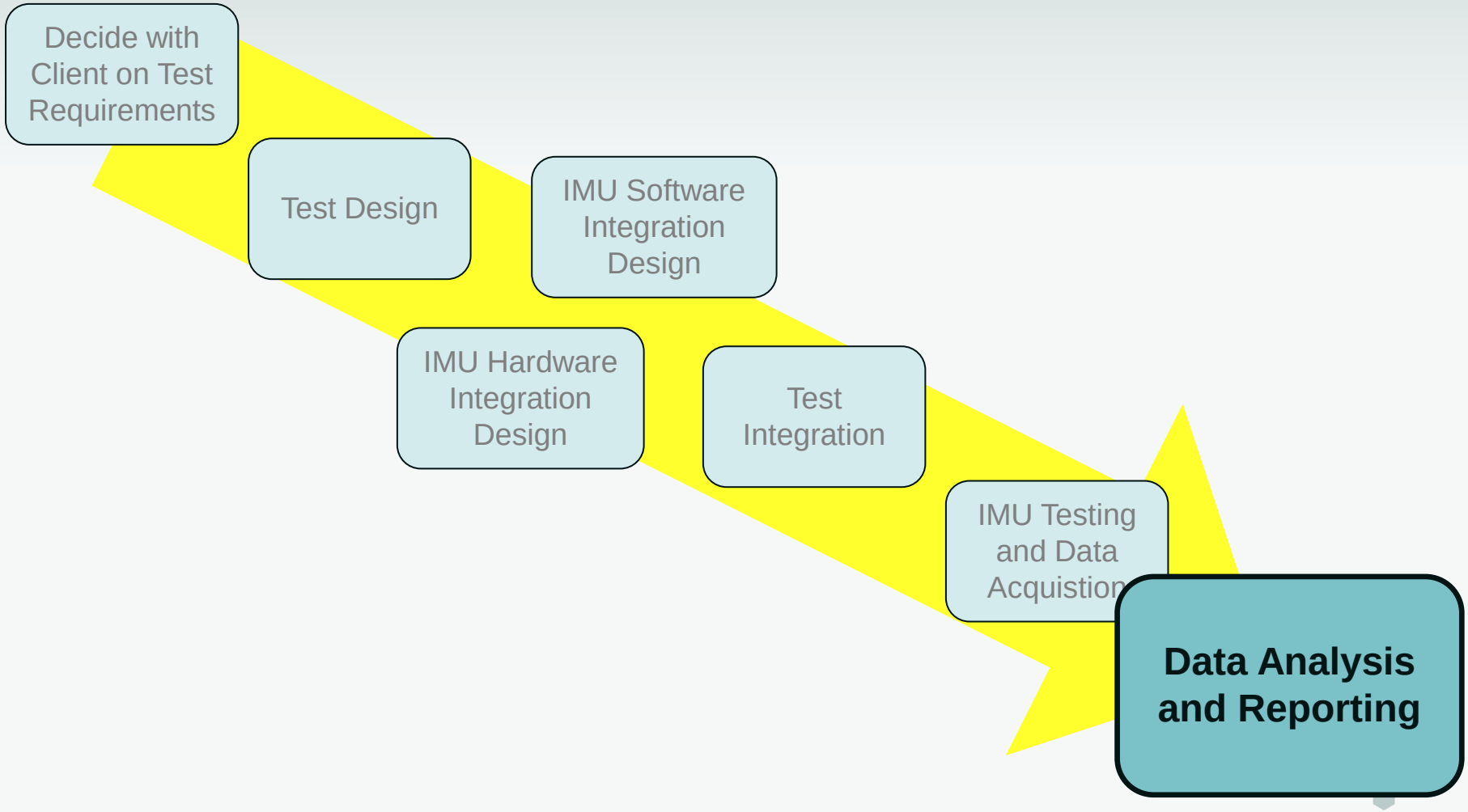
Rate Table Testing Process



Example 1 IMU Testing and DAQ

- Spin table at several rates
- Range : -160 RPM → +160 RPM
  - Integral number of table revolutions at each rate for increased accuracy
  - Can alternate between positive and negative rates to mitigate any transient errors
  - Choose times at each rate to minimize noise error in measurement

Rate Table Testing Process



Example 1 Data Analysis

- Scale Factor - Extract linear least-squares line for ‘Input Rate’ vs. ‘IMU Output’
- Scale Factor Error – Standard deviation of measured data from fit line
- Bias – y-intercept of fit line

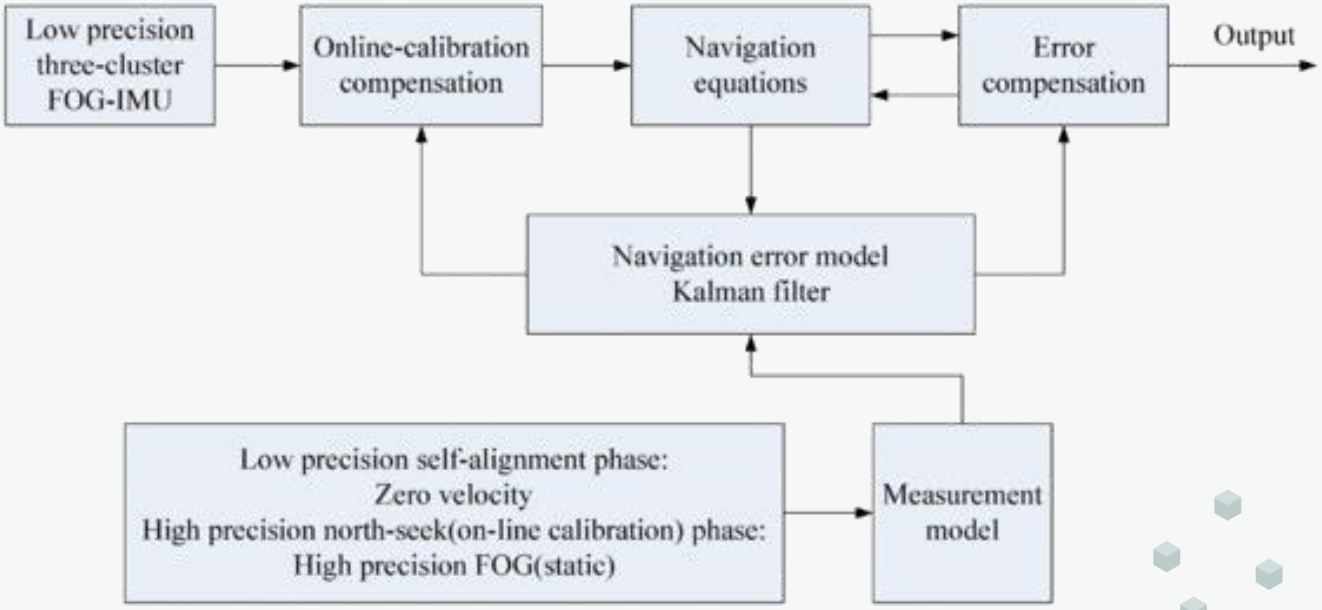
Example 1 Data Analysis

ADIS 16375

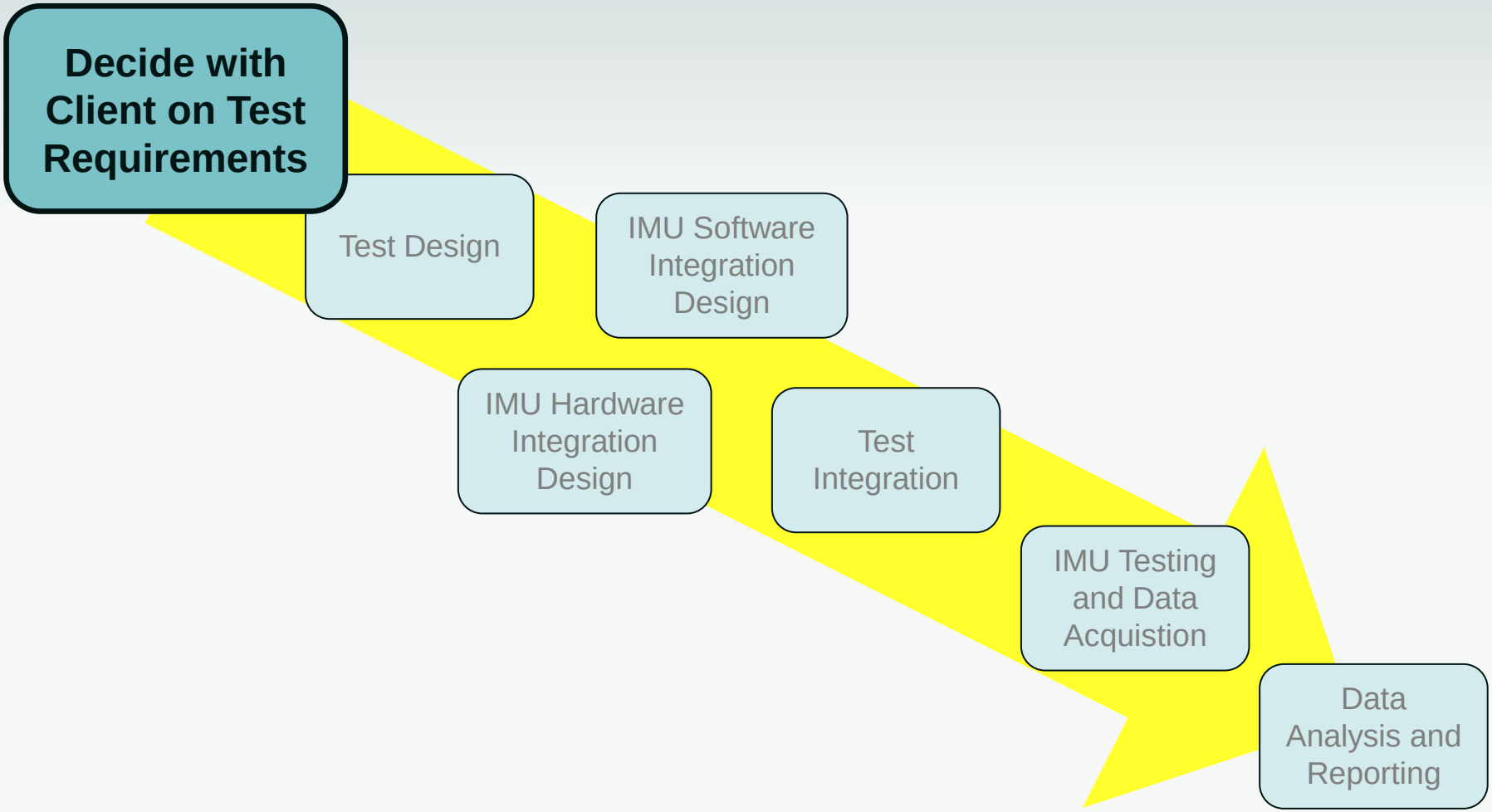
Characteristic	ACAMP Measurement	Manufacturer Data Sheet
Scale Factor (Gyro)	0.013105 °/s/LSB	0.01311 °/s/LSB
Scale Factor Error (Gyro)	330 ppm	< 250 ppm
Absolute Bias (Gyro)	0.2 °/s	1 °/s (1σ)

Example 2 Test Requirements

- Client has a tactical grade IMU integrated into their product, with additional software
- “Create a data sheet for our integrated IMU product”



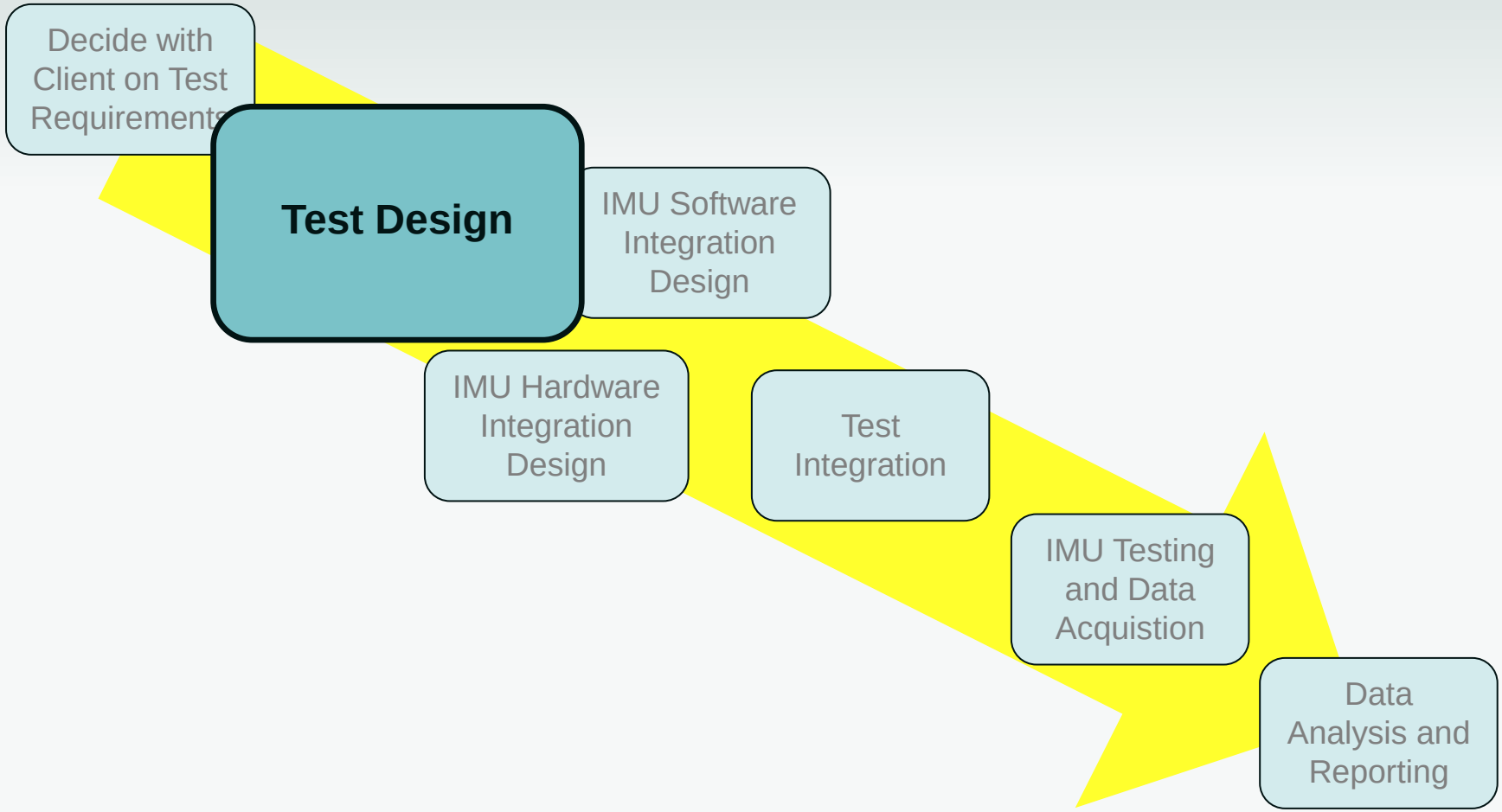
Rate Table Testing Process



Example 2 Test Requirements

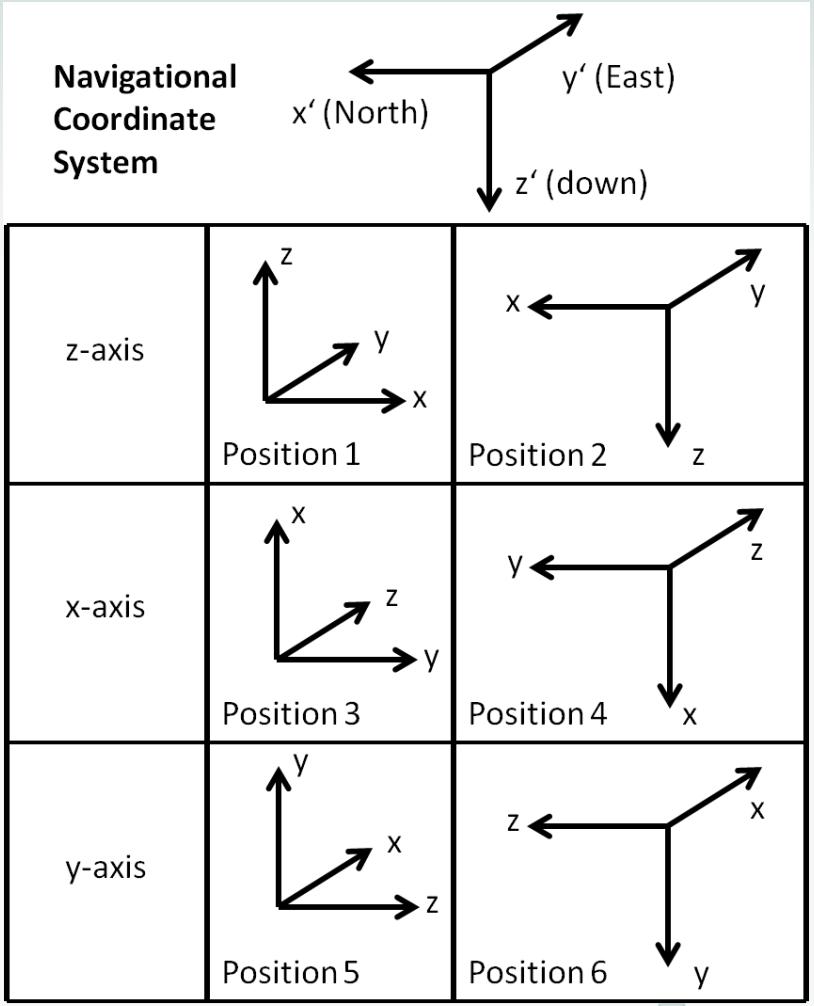
- Client wants to know
  - Gyro scale factor and scale factor error
  - Accl scale factor and scale factor error
  - Gyro and Accl bias
  - Gyro and Accl cross-axis misalignment
  - Noise – ARW and in-run bias stability, as function of temperature

Rate Table Testing Process

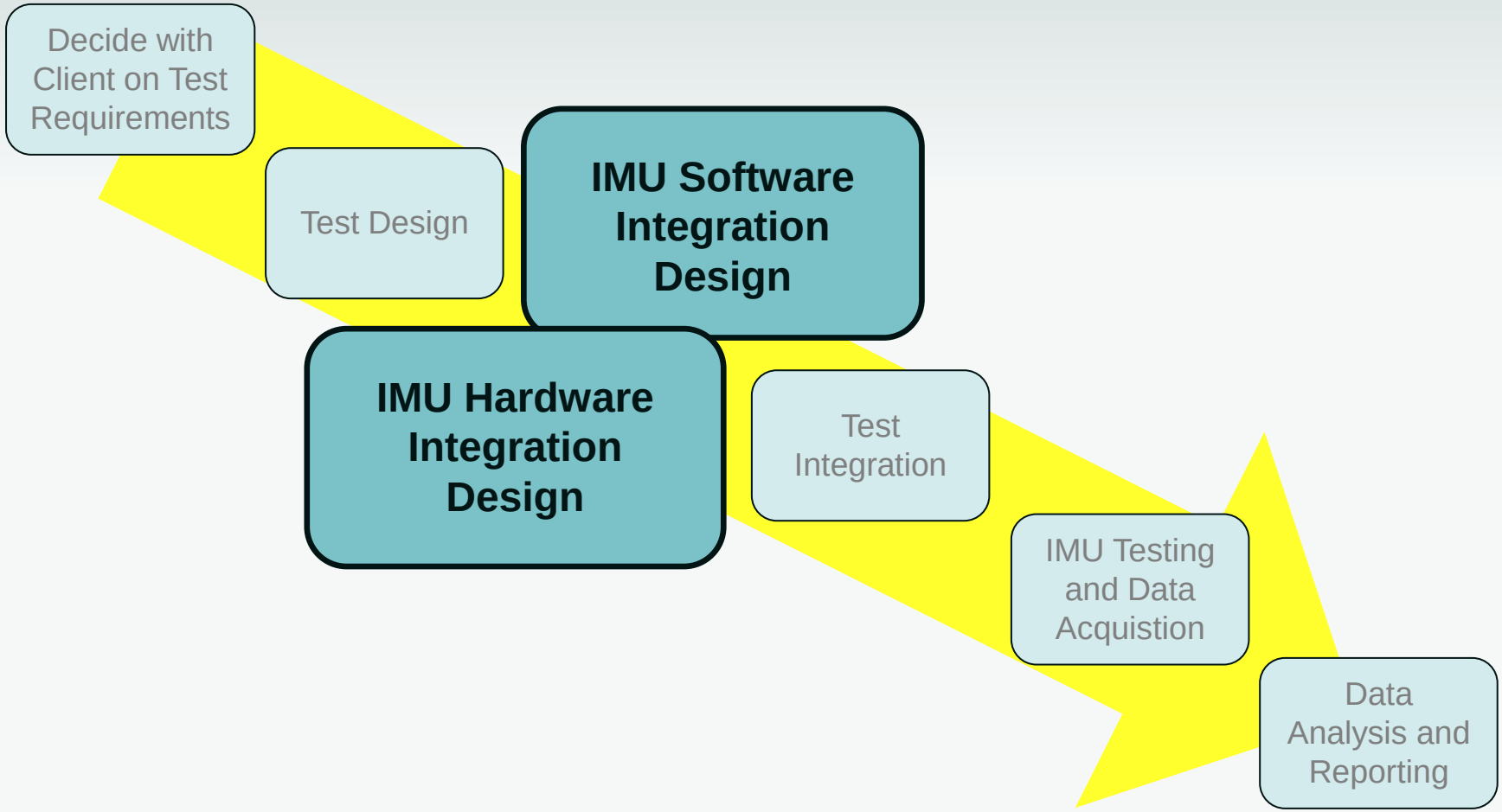


Example 2 Test Design

- Rate test
  - Test across range of rates product is designed for
- 6-position test
  - Positions should be held long enough to achieve accurate results
- Allan Variance test
  - Should be characterized long enough to achieve accurate results



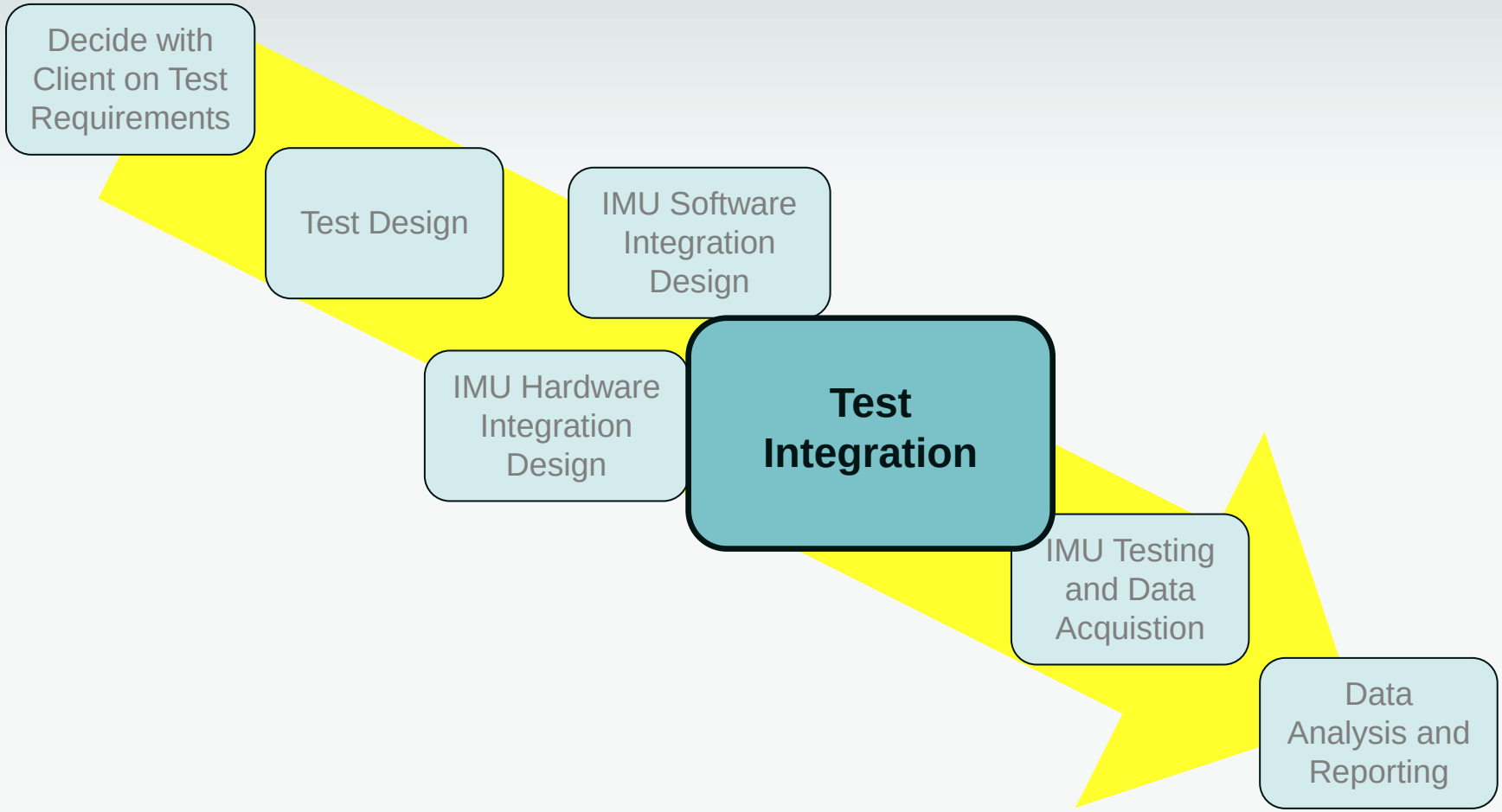
Rate Table Testing Process



Example 2 IMU Integration

- Software
  - Client product has own data acquisition system
  - Sync IMU product data to rate table data
- Hardware
  - Integrate cabling for device power and I/O
  - Build mount for product stability

Rate Table Testing Process

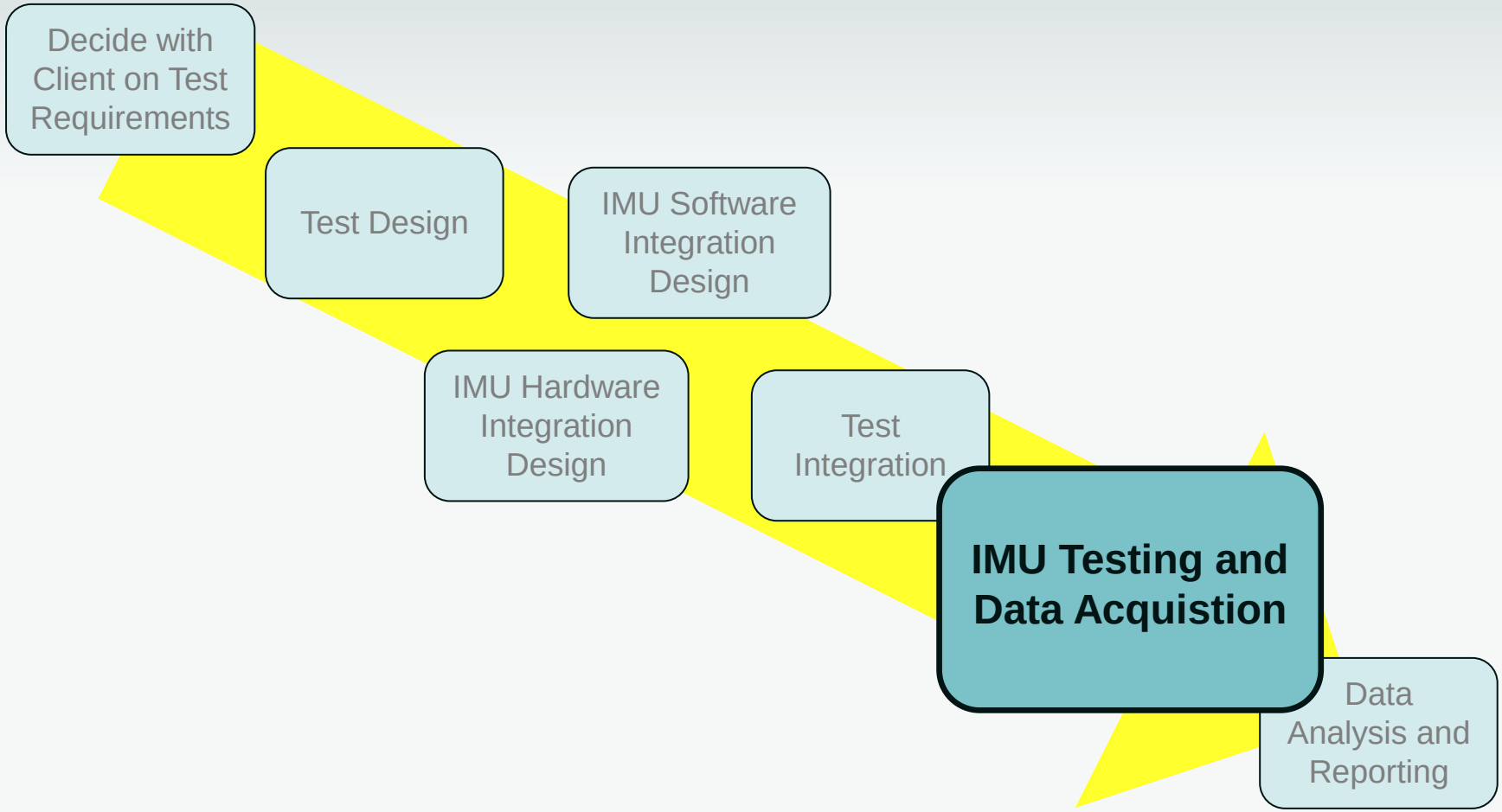


Example 2 Test Integration

- Set testing steps to run on TestStand
  - Rate Test, 6-position test, Allan Variance test
  - Can be done in single or separate steps
- Set DAQ to collect rate table data only, add timing synchronization steps

Setup (7)			
Initialize Sequence Control Variables	FileGlobals.SkipSoak = FileGlobals.CancelledByUser = FileGlobals.AbortVI...		Done
Get Sequence Name	Locals.Tokens = Split(RunState.SequenceFile.Path, "\\"), FileGlobals.Se...		Done
Set DAQ command to Connect	FileGlobals.DAQ_Command = 0		Done
Initialize Instruments	Call Initialize Instruments in <Current File>	Post Action	Passed
IdentifyUUT	Action, DisplayUUTInformationDialog (modelsupport2.dll)	Precondition, Post Expression, Post Action	Done
Turn Torquers on	Action, ACAMP - Host PC.lvproj, Aero4000 - Enable Torquers.vi		Done
Run cRIO Host Interface	Call 'My Computer\ADIS - Host Main.vi' Asynchronously on Host '<localhos...	New Thread	Done
<End Group>			
Main (7)			
For	{0} Locals.Index=StationGlobals.RunState.TestStep; Locals.Index< GetNu...		Done
Update Thermal Controller Variables	Locals.ThermalChamberParameters.Temp_Set_Point = FileGlobals.TempSt...		Done
Save Test Step	StationGlobals.RunState.TestStep = Locals.Index, RunState.Engine.Com...		Done
Start Thermal Ramp and Soak	Call 'My Computer\Thermal Chamber - Main.vi' Asynchronously on Host '<l...	Post Action, New Thread	Done
Status Monitor	Action, ACAMP - Host PC.lvproj, Status Monitor.vi	Post Expression, Post Action	
Test Profile	Call Test Profile in <Current File>		
End			
<End Group>			

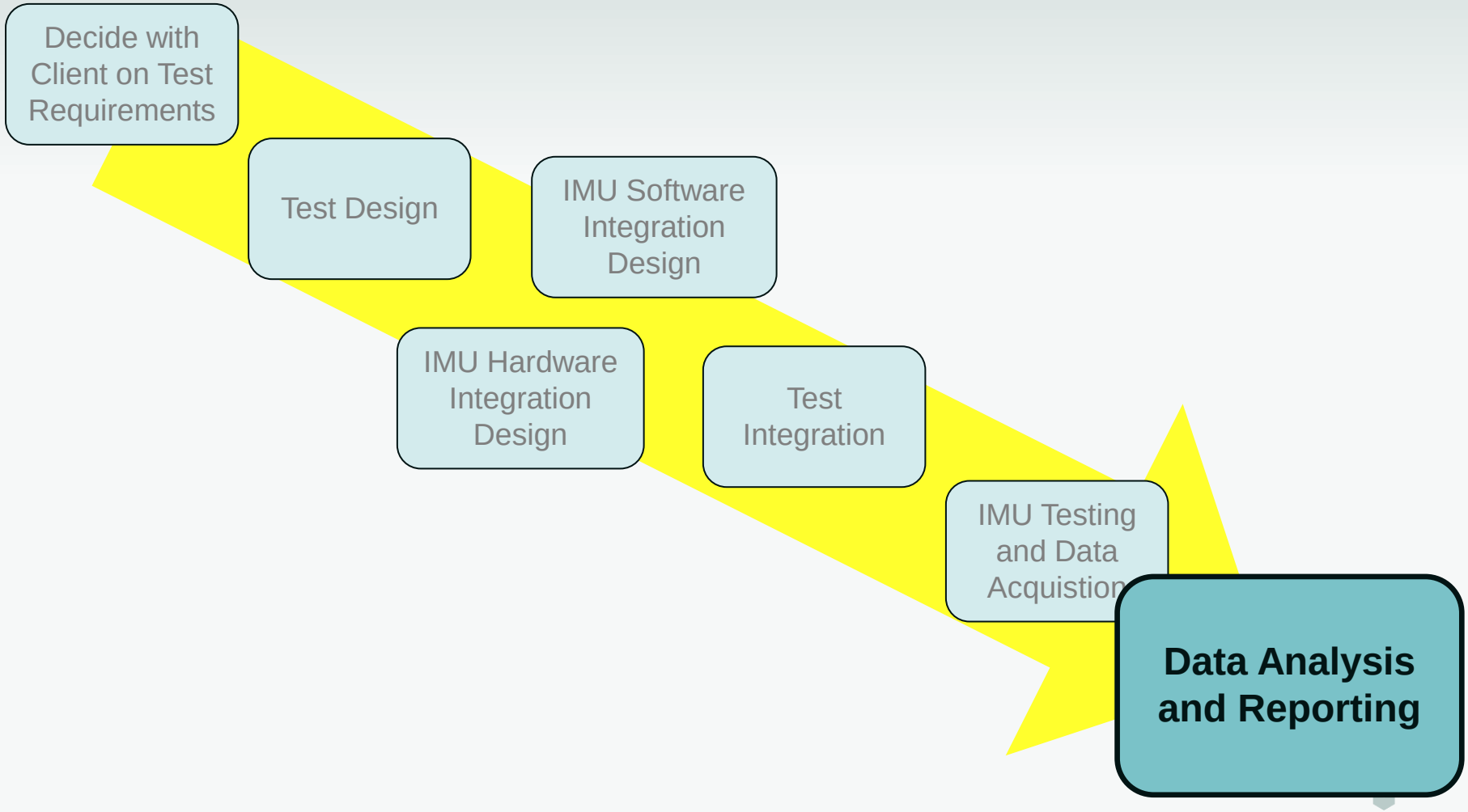
Rate Table Testing Process



Example 2 IMU Testing and DAQ

- Rate test - Spin table through range of rates, along all 3 gyro axes
- 6-Position test – Orient table in 6 orthogonal positions
- Allan Variance Test – Collect static data, temperature controlled

Rate Table Testing Process



Example 2 Data Analysis

- Gyro scale factor – same as example 1
- Accl scale factor – 2 *g* difference between vertically up and down orientation
- Bias – average output of 6 orthogonal positions has 0 net external bias
- Noise – Allan Variance plot can be derived as difference of average between successive time intervals

acamp
ALBERTA CENTRE FOR ADVANCED MNT PRODUCTS

RATE TABLE DEMO