

**Exercise 1.** Download raw gauge data in digital counts from strainmeter B073, process the gauge data to generate areal and shear strains.

1. Download data
2. Linearize
3. Combine into tensor strain

- Any data sets other than 10 minute interval data you need to retrieve from the IRIS Data Management Center (DMC).
- Web Services recommended
- Data are archived using the SEED channel name convention. You will need to know the SEED codes for the site

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

# SEED CODES

Data channels are uniquely identified by SEED code

**PB**.B073.RS1.T0

**PB** = **Network Code** (two character code)

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

**PB = Network Code** ( PB = PB0 )

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

**PB** = Network Code

**B073** = Site Code (four character code)

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

**GF** = Network Code

**B073** = Site Code

**RS1** = Channel Code

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

**Sample Rate** 

R < 1 sps

L = 1 sps

B = 20 sps

E = 200 sps



# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

**Measurement** 

**S = Strain**

**H = Seismic**

**K = Temperature**

**E = Voltage**

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

 **Orientation**

**N = North**

**E = East**

**1 = "not North"**

**2 = Perpendicular to 1**

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

**PB** = Network Code

**B073** = Site Code

**RS1** = Channel Code

**T0** = Location Code

# SEED CODES

Data channels are uniquely identified by SEED code

**PB.B073.RS1.T0**

## **Location Code**

T0, TS = BSM

IR, IM, II = LSM

“blank-blank” = Seismic & Pore pressure

# Archiving Information

<http://ds.iris.edu/mda>

IRIS DMC MetaData Aggregat... x +

ds.iris.edu/mda/PB Search

Most Visited Getting Started Latest Headlines JIRA Newest question... Seisr

IRIS MDA Usage **IRIS DMC MetaData Aggregat**

## Network summary (1 time span)

Legend: **R** **A** **R** **P**

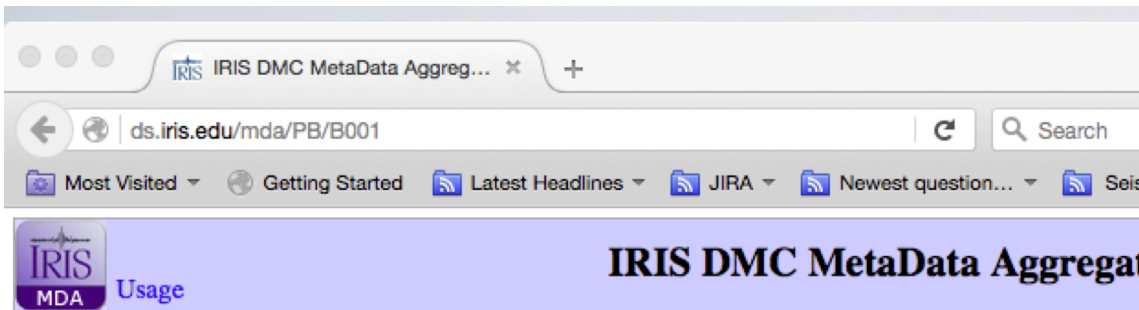
**Network** PB :: Plate Boundary Observatory Borehole Seismic Network :: [PB Network Map](#)  
**Start Year** 2004  
**End Year** 2500

Stations for PB network (121 stations) :: Click column title to sort

Station ▲▼	Site ▲▼	Latitude ▲▼	Longitude ▲▼	Elevation ▲▼	First start ▲▼	Last end ▲▼
<b>R</b> <b>A</b> <a href="#">B001</a>	golbeck01bwa2005, Sequim, WA, USA	48.043070	-123.131410	237	2005/06/21	2599/12/31
<b>R</b> <b>A</b> <a href="#">B003</a>	floequarybwa2005, FloeQuarry, WA, USA	48.062360	-124.140860	284.7	2005/06/21	2599/12/31
<b>R</b> <b>A</b> <a href="#">B004</a>	hokofallsbwa2005, Sekiu, WA, USA	48.201925	-124.427006	30	2005/06/15	2599/12/31
<b>R</b> <b>A</b> <a href="#">B005</a>	shoresnw1bwa2005, Port Angeles, WA, USA	48.059549	-123.503278	302.7	2005/07/19	2599/12/31
<b>R</b> <b>A</b> <a href="#">B006</a>	shoresne2bwa2005, Port Angeles, WA, USA	48.058800	-123.500800	302	2005/07/28	2599/12/31
<b>R</b> <b>A</b> <a href="#">B007</a>	shoresso3bwa2005, Shores, WA, USA	48.057577	-123.504113	293	2005/07/19	2599/12/31
<b>R</b> <b>A</b> <a href="#">B009</a>	pacgeosi1bbc2005, Sidney, BC, CA	48.648670	-123.451170	15	2005/09/14	2599/12/31
<b>R</b> <b>A</b> <a href="#">B010</a>	pacgeosi2bbc2005, Sidney, BC, CA	48.650170	-123.451330	5	2005/09/26	2599/12/31
<b>R</b> <b>A</b> <a href="#">B011</a>	pacgeosi3bbc2005, Sidney, BC, CA	48.649543	-123.448192	22	2005/09/13	2599/12/31
<b>R</b> <b>A</b> <a href="#">B012</a>	ucluelet1bbc2005, Ucluelet, BC, CA	48.924627	-125.541980	13	2005/09/21	2599/12/31
<b>R</b> <b>A</b> <a href="#">B013</a>	pnycrk013bwa2007, Quilcene, WA, USA	47.813000	-122.910800	75.3	2007/01/05	2599/12/31
<b>R</b> <b>A</b> <a href="#">B014</a>	quintl014bwa2008, Olympic NP, WA, USA	47.513300	-123.812500	64.7	2008/03/04	2599/12/31

# Archiving Information

<http://ds.iris.edu/mda>



## Station summary (1 time span)

Legend: **R** **A** **R** **P**

<b>Network</b>	<a href="#">PB</a> :: Plate Boundary Observatory Borehole Seismic Network :: <a href="#">PB Network Map</a>
<b>Station</b>	<a href="#">B001</a> :: golbeck01bwa2005, Sequim, WA, USA :: Plate Boundary Observatory Borehole Network :: <a href="#">B001 Station Map</a> :: <a href="#">RESP</a> :: <a href="#">SAC PZs</a> :: <a href="#">XML</a>
<b>Latitude</b>	48.043070
<b>Longitude</b>	-123.131410
<b>Elevation</b>	237
<b>Start</b>	2005/06/21 (172) 00:00:00
<b>End</b>	2599/12/31 (365) 23:59:59
<b>Epoch</b>	2006/07/13 (194) 00:00:00 - 2599/12/31 (365) 23:59:59
<b>Instrument</b>	PAROSCIENTIFIC DIGIQUARTZ DEPTH SENSOR 8WD0260-I
<b>Channels (Hz)</b>	Location --: <a href="#">RDD</a> (0.0033333) <b>A</b> , <a href="#">RKD</a> (0.0033333)
<b>Epoch</b>	2005/06/30 (181) 00:00:00 - 2599/12/31 (365) 23:59:59
<b>Instrument</b>	Quanterra 330 Linear Phase Composite
<b>Channels (Hz)</b>	Location --: <a href="#">LCC</a> (1) <b>R</b> <b>A</b> , <a href="#">LCE</a> (1) <b>R</b> <b>A</b> , <a href="#">LCL</a> (1) <b>R</b> <b>A</b> , <a href="#">LCQ</a> (1) <b>R</b> <b>A</b> , <a href="#">LPL</a> (1) <b>R</b> <b>A</b> , <a href="#">QBD</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QBP</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QDL</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QDR</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QGI</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QGD</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QLD</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QRD</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QRT</a> (0.05) <b>R</b> <b>A</b> , <a href="#">QWD</a> (0.05) <b>R</b> <b>A</b> , <a href="#">VCO</a> (0.1) <b>R</b> <b>A</b> , <a href="#">VEA</a> (0.1) <b>R</b> <b>A</b> , <a href="#">VEC</a> (0.1) <b>R</b> <b>A</b> , <a href="#">VEP</a> (0.1) <b>R</b> <b>A</b> , <a href="#">VKI</a> (0.1) <b>R</b> <b>A</b> , <a href="#">VPB</a> (0.1) <b>R</b> <b>A</b>
<b>Instrument</b>	HS-1-IT/Quanterra 330 Linear Phase Composite

Use web services to download data

<http://service.iris.edu/irisws/timeseries/docs/1/builder/>

Google “IRIS webservices url builder”

# WEB SERVICES

service.iris.edu/irisws/timeseries/docs/1/builder/ iris url builder

IRIS INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY

WebServices Home / IRISWS / Timeseries / Docs / v. 1 / Builder

### URL Builder: timeseries v.1

Service interface URL builder Help Revisions

Use this form to build a URL to the **timeseries** web service. Notice that as you edit the form, the link is automatically updated. Usage

Network:	<input type="text" value="PB"/>	Remove mean:	<input type="checkbox"/>
Station:	<input type="text" value="B004"/>	Low-Pass Filter:	<input type="checkbox"/> 1.0
Location:	<input type="text" value="T0"/>	High-Pass Filter:	<input type="checkbox"/> 1.0
Channel:	<input type="text" value="RS1"/>	Band-Pass Filter:	<input type="checkbox"/> 0.01-1.0
Start Time:	<input type="text" value="2016-03-01T00:00:00"/>	Differentiate:	<input type="checkbox"/>
End Time:	<input type="text" value="2016-03-15T00:00:00"/>	Integrate:	<input type="checkbox"/>
Correction:	<input type="text" value="None"/>	Envelope:	<input type="checkbox"/>
Frequency Limits:	<input type="checkbox"/> 0.0033-0.004-0.05-0.06	Taper:	<input type="checkbox"/> 0.5
Auto Limits:	<input type="checkbox"/> 3.0-3.0	Taper Window Type:	<input type="checkbox"/> HANNING
	<input type="checkbox"/> DEF	Decimate (samples per sec):	<input type="checkbox"/> 2.0
	<input type="checkbox"/> 2.0	Output:	<input type="text" value="plot"/>
	<input type="checkbox"/> 2.0	Dimensions (px):	<input type="checkbox"/> W 1000 H 700
		Anti Alias Plot:	<input type="checkbox"/>
		Audio Dynamic Range Compression:	<input type="checkbox"/>
		Audio Sample Rate (samples per sec):	<input type="checkbox"/> 16000

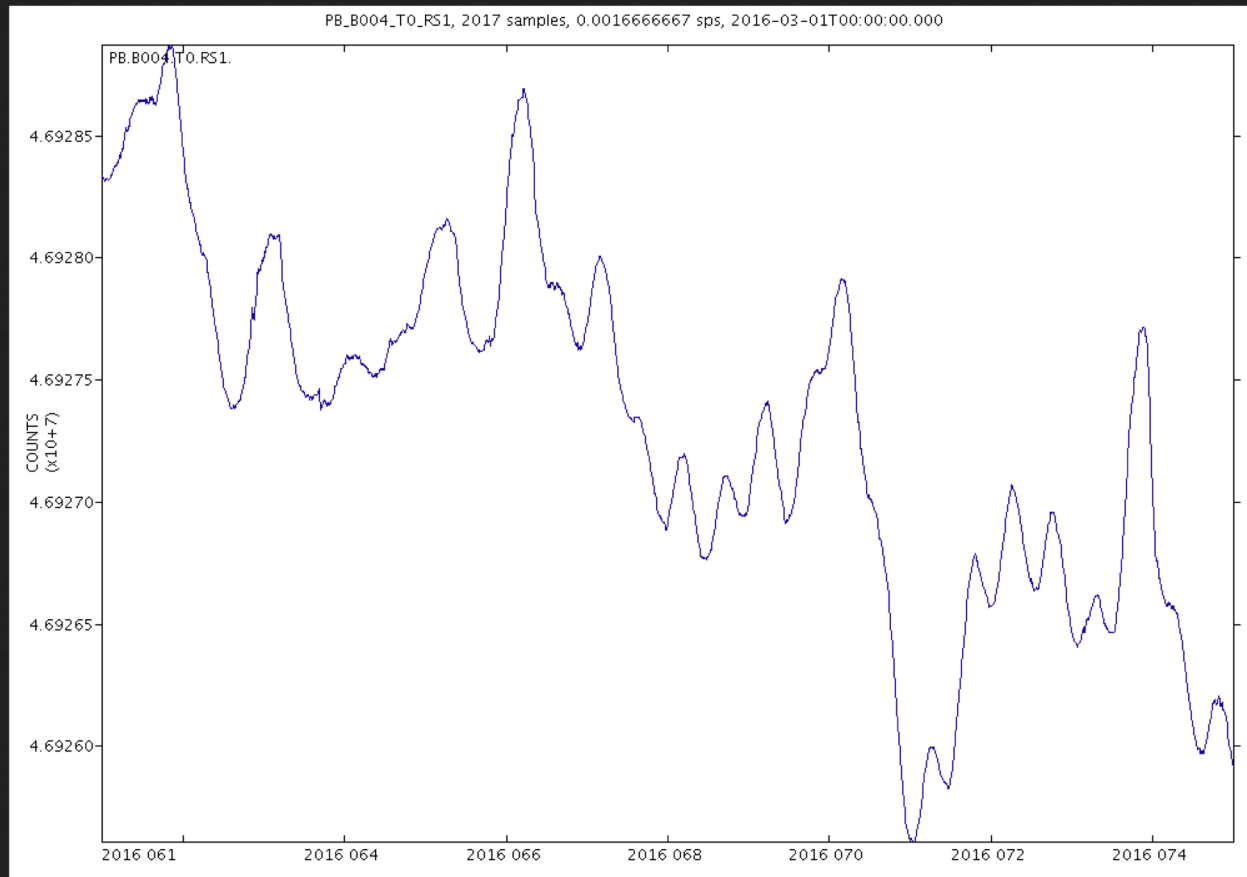
Click the link:  
<http://service.iris.edu/irisws/timeseries/1/query?net=PB&sta=B004&cha=RS1&start=2016-03-01T00:00:00&end=2016-03-15T00:00:00&output=plot&loc=T0>

URL is built as you type

Plot



# WEB SERVICES



# WEB SERVICES

URL Builder: timeseries v.1

Service interface | URL builder | Help | Revisions

Use this form to build a URL to the **timeseries** web service. Notice that as you edit the form, the link is automatically updated.

Network: PB  
Station: B004  
Location: T0  
Channel: RS1  
Start Time: 2016-03-01T00:00:00  
End Time: 2016-03-15T00:00:00  
Correction: None

Remove mean:   
Low-Pass Filter:  1.0  
High-Pass Filter:  1.0  
Band-Pass Filter:  0.01-1.0  
Differentiate:   
Integrate:   
Envelope:   
Taper:  0.5  
Taper Window Type:  HANNING  
Decimate (samples per sec):  2.0  
Output: ASCII: 2 column format  
Dimensions (px): W 1000 H 700  
Anti Alias Plot:   
Audio Dynamic Range Compression:   
Audio Sample Rate (samples per sec):  16000

Click the link:  
<http://service.iris.edu/irisws/timeseries/1/query?net=PB&sta=B004&cha=RS1&start=2016-03-01T00:00:00&end=2016-03-15T00:00:00&output=ascii2&loc=T0>

URL is updated

Change to ASCII

- plot
- miniseed
- ASCII: 1 column format
- ASCII: 2 column format
- audio
- ✓ plot
- SAC ASCII
- SAC binary big-endian
- SAC binary little-endian

← Time-stamped

# WEB SERVICES

service.iris.edu/irisws/timeseries/docs/1/builder/

IRIS INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY

WebServices Home / IRISWS / Timeseries / Docs / v. 1 / Builder

### URL Builder: timeseries v.1

Service interface | URL builder | Help | Revisions

Use this form to build a URL to the **timeseries** web service. Notice that as you edit the form, the link is automatically updated.

Network:	<input type="text" value="PB"/>	Remove mean:	<input type="checkbox"/>
Station:	<input type="text" value="B004"/>	Low-Pass Filter:	<input type="checkbox"/> 1.0
Location:	<input type="text" value="T0"/>	High-Pass Filter:	<input type="checkbox"/> 1.0
Channel:	<input type="text" value="RS1"/>	Band-Pass Filter:	<input type="checkbox"/> 0.01-1.0
Start Time:	<input type="text" value="2016-03-01T00:00:00"/>	Differentiate:	<input type="checkbox"/>
End Time:	<input type="text" value="2016-03-15T00:00:00"/>	Integrate:	<input type="checkbox"/>
Correction:	<input type="text" value="None"/>	Envelope:	<input type="checkbox"/>
Frequency Limits:	<input type="checkbox"/> 0.0033-0.004-0.05-0.06	Taper:	<input type="checkbox"/> 0.5
Auto Limits:	<input type="checkbox"/> 3.0-3.0	Taper Window Type:	<input type="checkbox"/> HANNING
Units:	<input type="checkbox"/> DEF	Decimate (samples per sec):	<input type="checkbox"/> 2.0
Scale:	<input type="checkbox"/> 2.0	Output:	<input type="text" value="ASCII: 2 column format"/>
Div-Scale:	<input type="checkbox"/> 2.0	Dimensions (px):	<input type="checkbox"/> W 1000 H 700
		Anti Alias Plot:	<input type="checkbox"/>
		Audio Dynamic Range Compression:	<input type="checkbox"/>
		Audio Sample Rate (samples per sec):	<input type="checkbox"/> 16000

Click the link:  
<http://service.iris.edu/irisws/timeseries/1/query?net=PB&sta=B004&cha=RS1&start=2016-03-01T00:00:00&end=2016-03-15T00:00:00&output=ascii2&loc=T0>

Q PB Highlight All Match Case 1 of 3 matches

Opening GF.TEPE.T0.RS1.2017.032.00.00.00.000-2017....

You have chosen to open:

...RS1.2017.032.00.00.00.000-2017.036.00.00.00.000.txt  
which is: TXT file (2.8 KB)  
from: <https://service.iris.edu>

What should Firefox do with this file?

Open with

Save File

Do this automatically for files like this from now on.

Cancel OK

Click on URL

# WEB SERVICES

service.iris.edu/irisws/timeseries/docs/1/builder/

IRIS INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY AND VOLCANOLOGY

WebServices Home / IRISWS / Timeseries / Docs / v. 1 / Builder

### URL Builder: timeseries v.1

Service interface | URL builder | Help | Revisions

Use this form to build a URL to the timeseries web service. Notice that as you enter values, the URL is updated in real time.

Network:  Remove metadata:

Station:  Low-Pass Filter:

Location:  High-Pass Filter:

Channel:  Band-Pass Filter:

Start Time:  Differentiate:

End Time:  Integrate:

Correction:  Envelope:

Frequency Limits:  0.0033-0.004-0.05-0.06 Taper:

Auto Limits:  3.0-3.0 Taper Window:

Units:  DEF Decimate (seconds):

Scale:  2.0 Output:

Div-Scale:  2.0 Dimensions:

Anti Alias Filter:  Audio Dynamic Range Compression:

Audio Sample Rate (samples per second):

Click the link:  
<http://service.iris.edu/irisws/timeseries/1/query?net=PB&sta=B004&cha=RS1&start=2016-03-01T00:00:00&end=2016-03-15T00:00:00>

Q PB Highlight All Match Case 1 of 3 matches

PB.B004.T0.RS1.2016.061.00.00.00.000-2016.075.00.00.00.000.txt

TIMESERIES PB\_B004\_T0\_RS1\_M, 2016 samples, 0.00166667 sps, 2016-03-01T00:00:00.000000 - 2016-03-15T00:00:00.000000 TSPAI INTERP COLITS

2016-03-01T00:00:00.000000	46928341
2016-03-01T00:10:00.000000	46928336
2016-03-01T00:20:00.000000	46928330
2016-03-01T00:30:00.000000	46928331
2016-03-01T00:40:00.000000	46928326
2016-03-01T00:50:00.000000	46928320
2016-03-01T01:00:00.000000	46928317
2016-03-01T01:10:00.000000	46928321
2016-03-01T01:20:00.000000	46928328
2016-03-01T01:30:00.000000	46928330
2016-03-01T01:40:00.000000	46928327
2016-03-01T01:50:00.000000	46928326
2016-03-01T02:00:00.000000	46928322
2016-03-01T02:10:00.000000	46928320
2016-03-01T02:20:00.000000	46928330
2016-03-01T02:30:00.000000	46928327
2016-03-01T02:40:00.000000	46928336
2016-03-01T02:50:00.000000	46928345
2016-03-01T03:00:00.000000	46928341
2016-03-01T03:10:00.000000	46928346
2016-03-01T03:20:00.000000	46928354
2016-03-01T03:30:00.000000	46928360
2016-03-01T03:40:00.000000	46928369
2016-03-01T03:50:00.000000	46928373
2016-03-01T04:00:00.000000	46928380
2016-03-01T04:10:00.000000	46928378
2016-03-01T04:20:00.000000	46928385
2016-03-01T04:30:00.000000	46928383
2016-03-01T04:40:00.000000	46928391
2016-03-01T04:50:00.000000	46928395
2016-03-01T05:00:00.000000	46928395
2016-03-01T05:10:00.000000	46928404
2016-03-01T05:20:00.000000	46928416
2016-03-01T05:30:00.000000	46928424
2016-03-01T05:40:00.000000	46928412
2016-03-01T05:50:00.000000	46928425
2016-03-01T06:00:00.000000	46928449
2016-03-01T06:10:00.000000	46928447
2016-03-01T06:20:00.000000	46928453
2016-03-01T06:30:00.000000	46928471
2016-03-01T06:40:00.000000	46928474
2016-03-01T06:50:00.000000	46928498
2016-03-01T07:00:00.000000	46928511
2016-03-01T07:10:00.000000	46928533
2016-03-01T07:20:00.000000	46928538
2016-03-01T07:30:00.000000	46928518
2016-03-01T07:40:00.000000	46928523
2016-03-01T07:50:00.000000	46928531
2016-03-01T08:00:00.000000	46928541
2016-03-01T08:10:00.000000	46928546
2016-03-01T08:20:00.000000	46928547

# WEB SERVICES

The URL forms a scriptable command we can run in the general directory,

```
% cd CLASS/general
```

copy paste the URL from your browser window to a terminal

```
wget -O MyData.txt
```

```
"http://service.iris.edu/irisws/timeseries/1/query?net=PB&sta=B004&cha=RS1&start=2016-03-01T00:00:00&end=2016-03-15T00:00:00&output=ascii2&loc=T0"
```

*(ftp and curl also work)*

# WEB SERVICES

You should now have a file named B004.RS1.txt

TIMESERIES PB\_B004\_T0\_RS1\_M, 2017 samples, 0.00166667 sps, 2016-03-01T00:00:00.000000,  
TSPAIR, INTEGER, **COUNTS**

```
2016-03-01T00:00:00.000000 46928341
2016-03-01T00:10:00.000000 46928336
2016-03-01T00:20:00.000000 46928330
2016-03-01T00:30:00.000000 46928331
2016-03-01T00:40:00.000000 46928326
2016-03-01T00:50:00.000000 46928320
2016-03-01T01:00:00.000000 46928317
```



Digital counts,  
contents of the  
bottle files

ASCII Translation of the  
native bottle file

# DOWNLOADING DATA

Download raw gauge data in digital counts from strainmeter B073, process the gauge data to generate areal and shear strains.

- 1. Download data**
2. Linearize
3. Combine into tensor strain

**B073, 8 May 2012 , all 4 strain channels, 1-sps**

# DOWNLOADING DATA

Download raw gauge data in digital counts from strainmeter B073, process the gauge data to generate areal and shear strains.

- 1. Download data**
2. Linearize
3. Combine into tensor strain

**B073, 8 May 2012 , all 4 strain channels, 1-sps**

Work in the CLASS/general directory, `get_data_ws.bash`



# DOWNLOADING DATA

Download raw gauge data in digital counts from strainmeter B073, process the gauge data to generate areal and shear strains.

1. **Download data**
2. Linearize
3. Combine into tensor strain

**B073, 8 May 2012 , all 4 strain channels, 1-sps**

Use the time-series URL Builder to build the URL

# DOWNLOADING DATA

## I.Download 8 May 2012 , all 4 channels from strainmeter B073

Use `get_data_ws.bash` in the general directory

```
#!/bin/bash
```

```
for g in 0 1 2 3
```

```
do
```

```
    c= $ (( g + 1 ))
```

```
    wget -O B073.CH$g.txt "http command"
```

```
    linearize.csh B073.CH$g.txt
```

```
done
```



*Put http command here*

# DOWNLOADING DATA

## I.Download 8 May 2012 , all 4 channels from strainmeter B073

Use `get_data_ws.bash` in the general directory

```
#!/bin/bash
```

```
for g in 0 1 2 3
```



*Looping over channels*

```
do
```

```
    c= $ (( g + 1 ))
```

```
    wget -o B073.CH$g.txt "http command"
```

```
    linearize.csh B073.CH$g.txt
```

```
done
```

# DOWNLOADING DATA

## I.Download 8 May 2012 , all 4 channels from strainmeter B073

Use `get_data_ws.bash` in the general directory

```
#!/bin/bash
```

```
for g in 0 1 2 3
```

```
do
```

```
  c= $ (( g + 1 ))
```

```
  wget -o B073.CH$g.txt "http command"
```

```
  linearize.csh B073.CH$g.txt
```

```
done
```



*Requesting the data*

# DOWNLOADING DATA

## I.Download 8 May 2012 , all 4 channels from strainmeter B073

Use `get_data_ws.bash` in the general directory

```
#!/bin/bash
```

```
for g in 0 1 2 3
```

```
do
```

```
    c= $ (( g + 1 ))
```

```
    ftp -o B073.CH$g.txt "http command"
```

```
    linearize.csh B073.CH$g.txt
```

```
done
```



# LINEARIZING RAW DATA

- Linearizing equation supplied by GTSM Technologies.
- The linear gauge strain,  $u_t$ , at time  $t$ , is calculated with respect to a fixed raw data point ( $d_o$ ). **Units will be strain.**

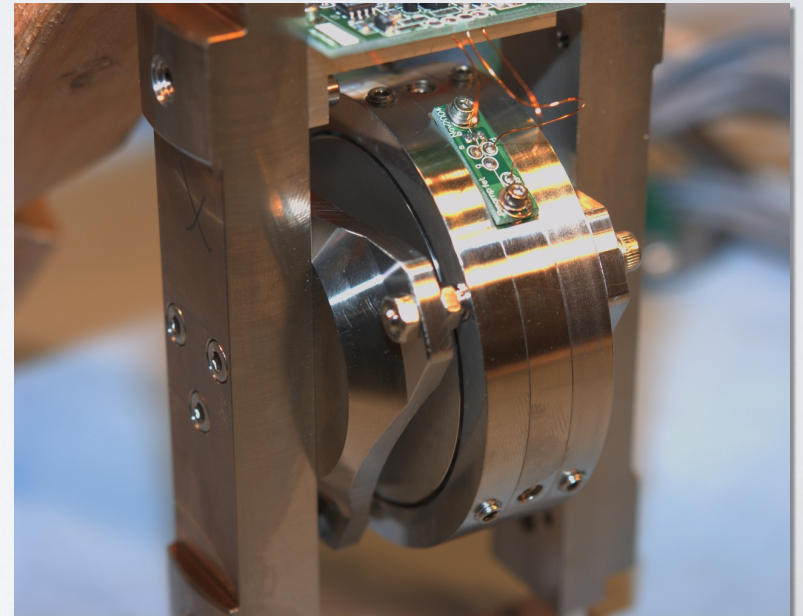
$$u_t = \left( \frac{10^{-8} d_t}{1 - 10^{-8} d_t} - \frac{10^{-8} d_o}{1 - 10^{-8} d_o} \right) * \frac{R}{M}$$

$d_t$  data value at time  $t$ ,

$d_o$  data value at fixed time  $t_o$

$R$  instrument reference gap ( $10^{-4}$  or  $2 \times 10^{-4}$  m)

$M$  instrument diameter (0.087 m)



# DOWNLOADING DATA

**To run,**

```
% ./get_data_ws.bash
```

Edit bash shell so scripts can run from anywhere, e.g.,

```
vi ~/.profile
```

```
export PATH="/opt/local/bin:/opt/local/sbin:.$PATH"
```

# DOWNLOADING DATA

**You should now have 4 raw files**

B073.CH0.txt

B073.CH1.txt

B073.CH2.txt

B073.CH3.txt

**and 4 files with linearized data**

LINEAR.B073.CH0.txt

LINEAR.B073.CH1.txt

LINEAR.B073.CH2.txt

LINEAR.B073.CH3.txt



# DOWNLOADING DATA

TIMESERIES PB\_B073\_T0\_LS1\_M, 86401 samples, 1 sps, 2012-05-08T00:00:00.000000, TSPAIR,  
INTEGER, COUNTS ,**linearStrain\_nanostrain, gap=0.0001**

2012-05-08T00:00:00.000000	47722919	0.00
2012-05-08T00:00:01.000000	47722915	-0.17
2012-05-08T00:00:02.000000	47722917	-0.08
2012-05-08T00:00:03.000000	47722923	0.17
2012-05-08T00:00:04.000000	47722921	0.08
2012-05-08T00:00:05.000000	47722918	-0.04
2012-05-08T00:00:06.000000	47722922	0.13
2012-05-08T00:00:07.000000	47722925	0.25
2012-05-08T00:00:08.000000	47722923	0.17
2012-05-08T00:00:09.000000	47722922	0.13

# TENSOR STRAIN

Before we can combine the data we need to know the gauge orientations, gauge weightings, scale factors i.e., the calibration matrix ( $S$ ).

$$S \begin{bmatrix} e_0 \\ e_1 \\ e_2 \\ e_3 \end{bmatrix} = \begin{bmatrix} e_{EE} + e_{NN} \\ e_{EE} - e_{NN} \\ 2e_{EN} \end{bmatrix}$$

This can be found in the XML file or README file available from UNAVCO.  
<ftp://bsm.unavco.org/pub/bsm/level2/B073/B073.README.txt>

# TENSOR STRAIN

```
Plate Boundary Observatory x ftp://bsm.unavc...073.README.txt x +
ftp://bsm.unavco.org/pub/bsm/level2/varian073bcs2006/B073.README.t ☆ ▾ ↻ Google Q [★] [↓] [🏠]
CH2 -8.1
CH3 -7.7

Tidal Constituents
Gauge Tide Phase Amp(ns)
CH0 M2 -171.986 10.818
CH0 O1 -165.843 2.888
CH0 P1 -173.719 1.430
CH0 K1 -164.050 2.335
CH0 N2 179.035 1.973
CH0 S2 -176.131 6.371
CH1 M2 -148.785 8.070
CH1 O1 144.980 4.311
CH1 P1 146.725 2.295
CH1 K1 136.745 5.148
CH1 N2 -144.430 1.872
CH1 S2 -167.897 3.175
CH2 M2 106.685 1.108
CH2 O1 -161.045 2.946
CH2 P1 -171.018 1.176
CH2 K1 -163.181 2.279
CH2 N2 12.114 0.360
CH2 S2 103.644 1.878
CH3 M2 152.710 2.999
CH3 O1 -135.187 2.465
CH3 P1 -140.896 0.885
CH3 K1 -113.995 2.099
CH3 N2 106.861 0.471
CH3 S2 151.864 2.373

Strain Matrices To Compute Areal and Shear Strain from Gauge Strain

Manufacturer's Isotropic Strain Matrix, C=1.5, D=3.0, Gauge Weights=1, Orientation = 270.1
ISOTROPIC 0.29629699 0.51851820 0.29629592 0.22222222
ISOTROPIC 0.37081499 -0.18406666 -0.29718805 0.11043972
ISOTROPIC 0.12700876 0.32139321 -0.25556544 -0.19283653

Roeloffs 2010 Tidal Calibration
Calculated CH0 orientation = 273.3 degrees east of north

ER2010 -0.88182914 -0.81225113 -0.57421371 -0.60171802
ER2010 0.47546729 -0.31102462 -0.63122543 -0.04953135
ER2010 0.16962093 0.42674938 -0.62218982 -0.47306098
Reference: Roeloffs, E. (2010), Tidal calibration of Plate Boundary Observatory borehole strainmeters: Roles
```

The script pulls metadata file

# TENSOR STRAIN

Use `make_tensor.pl` in the general directory

```
% make_tensor.pl B073
```

# TENSOR STRAIN

make\_tensor.pl does the following

- downloads the B073.README.txt file
- extracts the calibration matrix from the readme.txt files
- combines the gauges using the matrix
- prints out gauge measurements, areal and shear strain
- outputs a file, B073.tensor.txt

# TENSOR STRAIN

## B073.tensor.txt

DateTTime	CH0L	CH1L	CH2L	CH3L	Eee+Enn	Eee-Enn	2Ene
2012-05-08T00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012-05-08T00:00:01.00	-0.17	0.00	0.03	-0.03	-0.05	-0.08	-0.02
2012-05-08T00:00:02.00	-0.08	0.06	-0.06	-0.07	-0.03	-0.03	0.04
2012-05-08T00:00:03.00	0.17	0.06	-0.16	-0.07	0.02	0.09	0.10
2012-05-08T00:00:04.00	0.08	0.12	-0.03	-0.10	0.05	0.01	0.08
2012-05-08T00:00:05.00	-0.04	0.06	0.03	-0.10	0.01	-0.05	0.03
2012-05-08T00:00:06.00	0.13	-0.12	0.00	0.03	-0.02	0.07	-0.03
2012-05-08T00:00:07.00	0.25	-0.25	0.00	0.10	-0.03	0.15	-0.07
2012-05-08T00:00:08.00	0.17	0.00	-0.13	0.00	0.01	0.10	0.05

# TENSOR STRAIN

- Use GMT script `plot_tensor.bash` to plot the data
- Creates postscript file `B073.tensor.ps`
- To view,

`gs B073.tensor.ps`

