PUMP/probe experiment

Alison E E. Malcolm[1]

[1]Memorial University of Newfoundland

Sep 29, 2022

dx.doi.org/10.17504/protocols.io.14egn71zyv5d/v1

Alison E E. Malcolm
Memorial University of Newfoundland

ABSTRACT

Run a PUMP/probe experiment as described by Gallot, T., et al. "Characterizing the nonlinear interaction of S-and P-waves in a rock sample." Journal of Applied Physics 117.3 (2015): 034902.

DOI

dx.doi.org/10.17504/protocols.io.14egn71zyv5d/v1

PROTOCOL CITATION

Alison E E. Malcolm 2022. PUMP/probe experiment. **protocols.io** https://dx.doi.org/10.17504/protocols.io.14egn71zyv5d/v1

CREATED

Jun 23, 2022

LAST MODIFIED

Sep 29, 2022

PROTOCOL INTEGER ID

65175

GUIDELINES

It is best to run the experiment once with a large spacing of delay times to make sure that the acquisition codes are working properly etc. The PUMP and probe should not be about around 5 Vpp if they are going through the amplifier.

MATERIALS TEXT

Rock sample
2 probe transducers (usually 1 MHz P-wave, but not necessarily)
2 PUMP transducers (usually 100 kHz S-wave, but not necessarily)
oscilloscope
function generator
filter
cables
computer with python installed and running

Pre-Experiment Steps

1 Gather equipment and attach transducers to samples. (Typically P traveling perpendicular to S with the polarization of the S-wave aligned with the polarization of the P-wave.)

2 Measure pump and probe velocities using the 'measuring velocities' protocol.

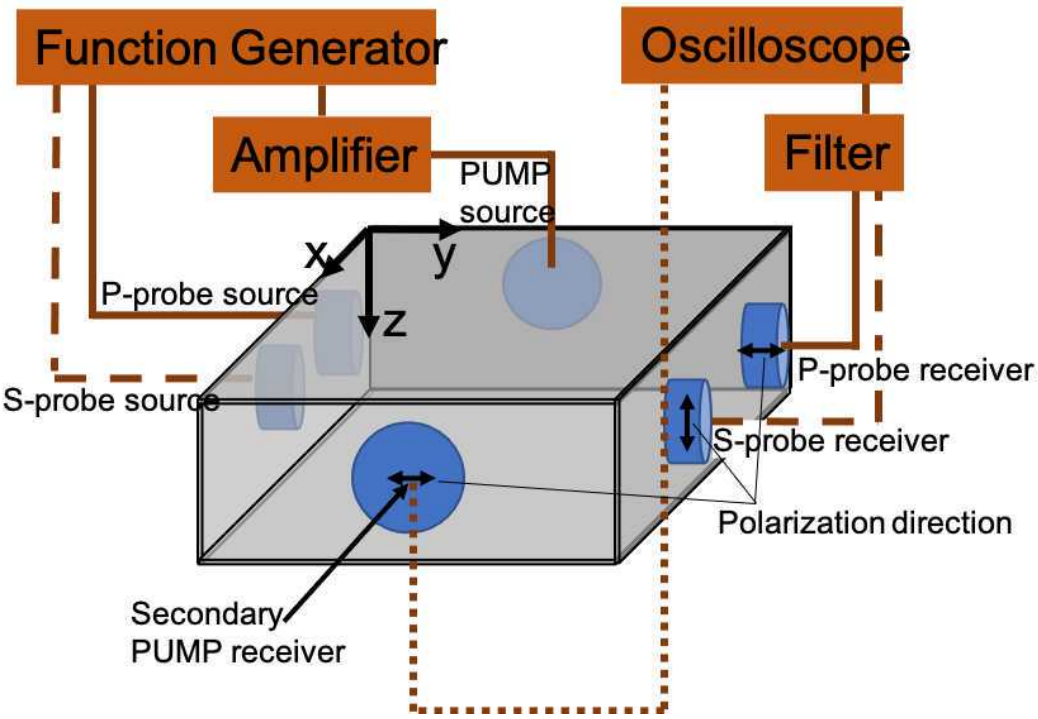
3 Calculate the travel time for the pump and probe to reach the centre of the sample.

4 Determine the pump/probe delays that you want to measure. Typically you want the first delays to be from before the PUMP crosses the probe path, and the last ones to be after the last cycle of the PUMP cross the probe path.

For example, if the probe arrives at the centre after 30 us and the S-wave arrives after 40 us, and the PUMP signal is 20 us in length, then you could start with a 0 delay (P-wave arrives 10 us before S-wave) and then measure until a delay of 40 us. This will give you 10 us before the PUMP arrives, 20 us while the two waves interact and 10 us after the PUMP has passed the interaction region.

Wiring and Setting up the experiment

5 Attach the following cables (see diagram below)



5.1 Function generator 'trig out' to oscilloscope 'ext in'

5.2 Function generator channel 2 (usually) to amplifier to PUMP source

5.3 Function generator channel 1 (usually) to probe source

5.4 probe receiver to filter to oscilloscope channel 1 (usually)

5.5 PUMP receiver to oscilloscope channel 2 (usually) if monitoring the PUMP before/after experiment

Check waveforms

6 PUMP check

Citation: Alison E E. Malcolm PUMP/probe experiment https://dx.doi.org/10.17504/protocols.io.14egn71zyv5d/v1

6.1 Set the parameters for the PUMP, typical values are:
f=70-100 kHz
amplitude=3-8 Vpp through the amp (150-400 Vpp)
4 cycles, sine wave

6.2 Look at the PUMP signal, and change the frequency until you have a signal in which you clearly see 4 cycles of your sinusoid recorded on the opposite face of the sample.

6.3 Record this waveform for later.

7 probe check

7.1 Set the parameters for the probe, typical values are:
f=800 kHz- 1MHz
amp=1-10 Vpp without amplification
1 cycle, sinusoid

7.2 Setup the filter, typical parameters are:
butterworth, high-pass cut-off frequency 600 kHz

7.3 Compare the signal with and without the filter, to make sure that the probe waveform is still clear and has not been changed too much by the filter. Adjust the frequency of the probe, its amplitude, and the cut-off frequency of the filter until you have a clean pulse. Example is below.

7.4 Centre the oscilloscope on the probe waveform and zoom in until the waveform fills the screen. This involves moving the signal left/right (small knob on top of the oscilloscope) as well as changing the horizontal scale (large knob on the oscilloscope). Record the 'shift' value on the top of the oscilloscope. Also find the minimum vertical scale that does not clip your data.

7.5 Record this waveform for later

Citation: Alison E E. Malcolm PUMP/probe experiment https://dx.doi.org/10.17504/protocols.io.14egn71zyv5d/v1

Record Data

8 Typically we collect the data automatically with a python code, an example of which is here: https://github.com/alisonmalcolm/GAELCodes/tree/master/PUMPprobe . This set of steps details what is done in that code, without the details (like communicating between the oscilloscope and computer).

8.1 Setup your time shifts, using the calculations from step 4. Generally it's best to use a large step (e.g. 5 us) at first, then do a longer run once you have QCd the results.

8.2 Add in your time delay (found in step 7.4) so that you will record the entire probe waveform.

8.3 Record the probe by itself (turn off the output of the PUMP on the function generator)

8.4 Record the PUMP by itself, on the probe receiving transducer (channel 1) (turn off the output for the probe on the function generator)

8.5 Record the PUMP and probe together (both channels of the function generator on), using the probe receiving transducer.

8.6 Change the delay so the probe is sent dt later.

8.7 Shift the oscilloscope recording window

8.8 Repeat steps 8.3-8.7 until you have collected all of your delays.

9 Measure the travel time delay between the signal recorded in 8.3 and the difference between 8.5 and 8.4 (explained below)

Citation: Alison E E. Malcolm PUMP/probe experiment https://dx.doi.org/10.17504/protocols.io.14egn71zyv5d/v1

Data Processing

10 Measure travel time delays, using the ComputeDelays code from here: https://github.com/alisonmalcolm/GAELCodes/tree/master/PUMPprobe

Citation: Alison E E. Malcolm PUMP/probe experiment https://dx.doi.org/10.17504/protocols.io.14egn71zyv5d/v1