Karlsruher Institut für Technologie

CEL

The GNU Radio Companion Changelog

Communications Engineering Lab
Prof. i.R. Dr.rer.nat. Friedrich K. Jondral

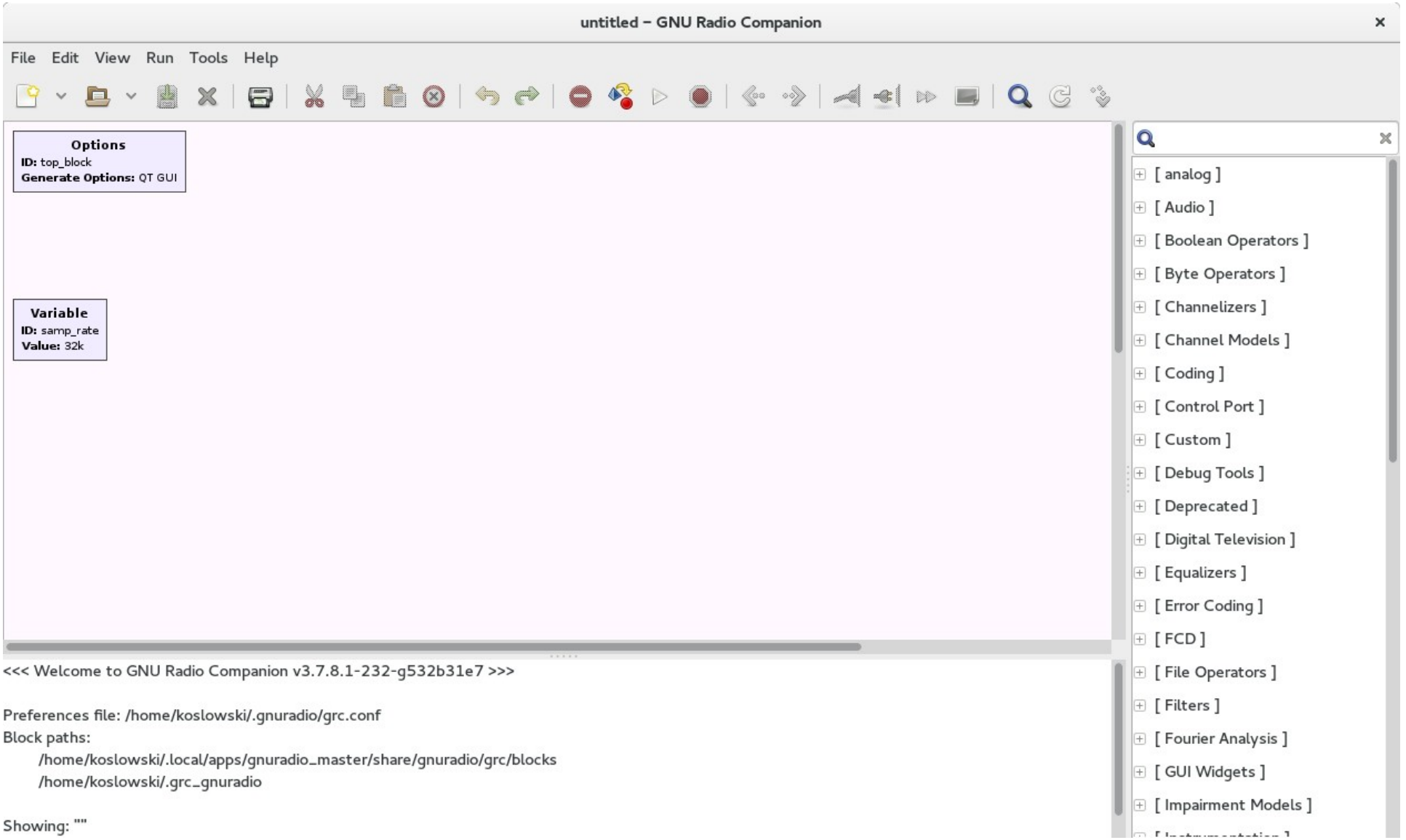
Overview

- GNU Radio Companion Intro
  - Graphical Flow Graph Design
  - How to add your own blocks
- Recently added features
  - Bypassed Blocks
  - Embedded Python Blocks / Modules
  - Custom Run Commands
  - Bootstrap depending hier_blocks
- Current development and plans for future versions

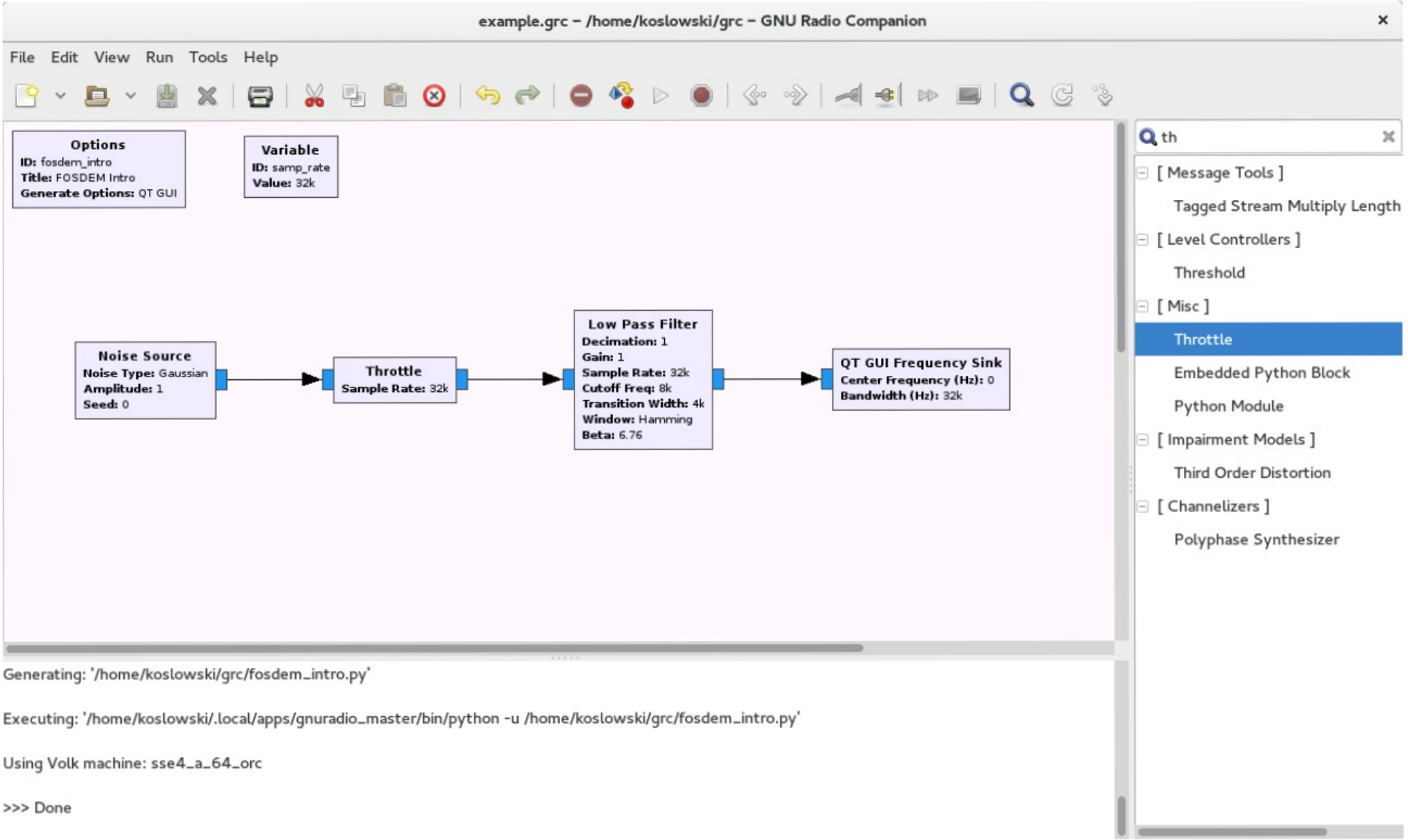
The GNU Radio Companion

- Written by Josh Blum around 2007
  - Extended, patched and tinkered with by many since
  - 45 contributors (~90% of commits by 4 people)
- Maintained by me since 2013
- Written in (legacy) Python
  - PyGTK as GUI
  - Cheetah for templating Python code
  - Code base: ~12k lines, almost no tests =(

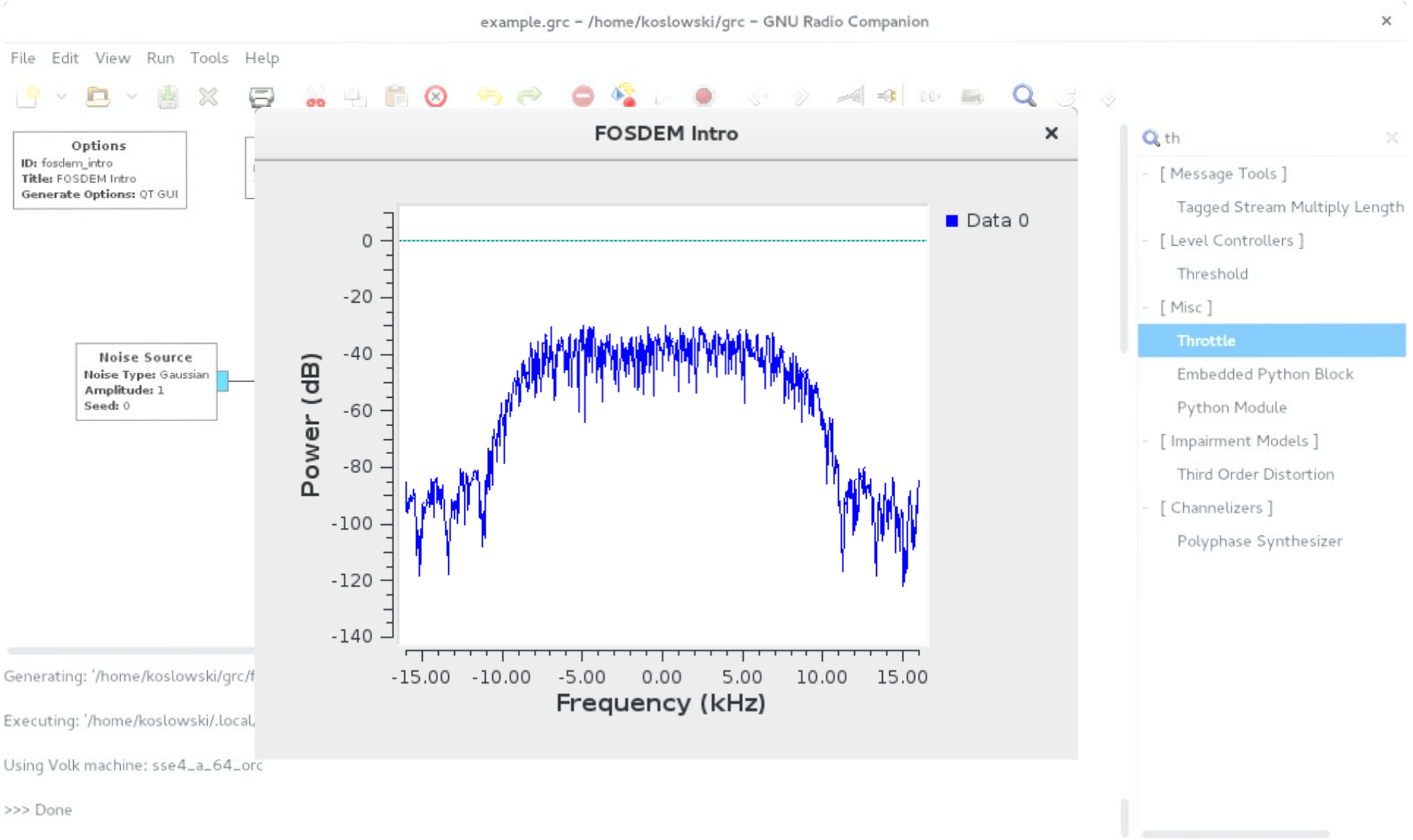
The GUI


untitled – GNU Radio Companion
File Edit View Run Tools Help
Options
ID: top_block
Generate Options: QT GUI
Variable
ID: samp_rate
Value: 32k
[analog]
[Audio]
[Boolean Operators]
[Byte Operators]
[Channelizers]
[Channel Models]
[Coding]
[Control Port]
[Custom]
[Debug Tools]
[Deprecated]
[Digital Television]
[Equalizers]
[Error Coding]
[FCD]
[File Operators]
[Filters]
[Fourier Analysis]
[GUI Widgets]
[Impairment Models]
<<< Welcome to GNU Radio Companion v3.7.8.1-232-g532b31e7 >>>
Preferences file: /home/koslowski/.gnuradio/grc.conf
Block paths:
/home/koslowski/.local/apps/gnuradio_master/share/gnuradio/grc/blocks
/home/koslowski/.grc_gnuradio
Showing: ""

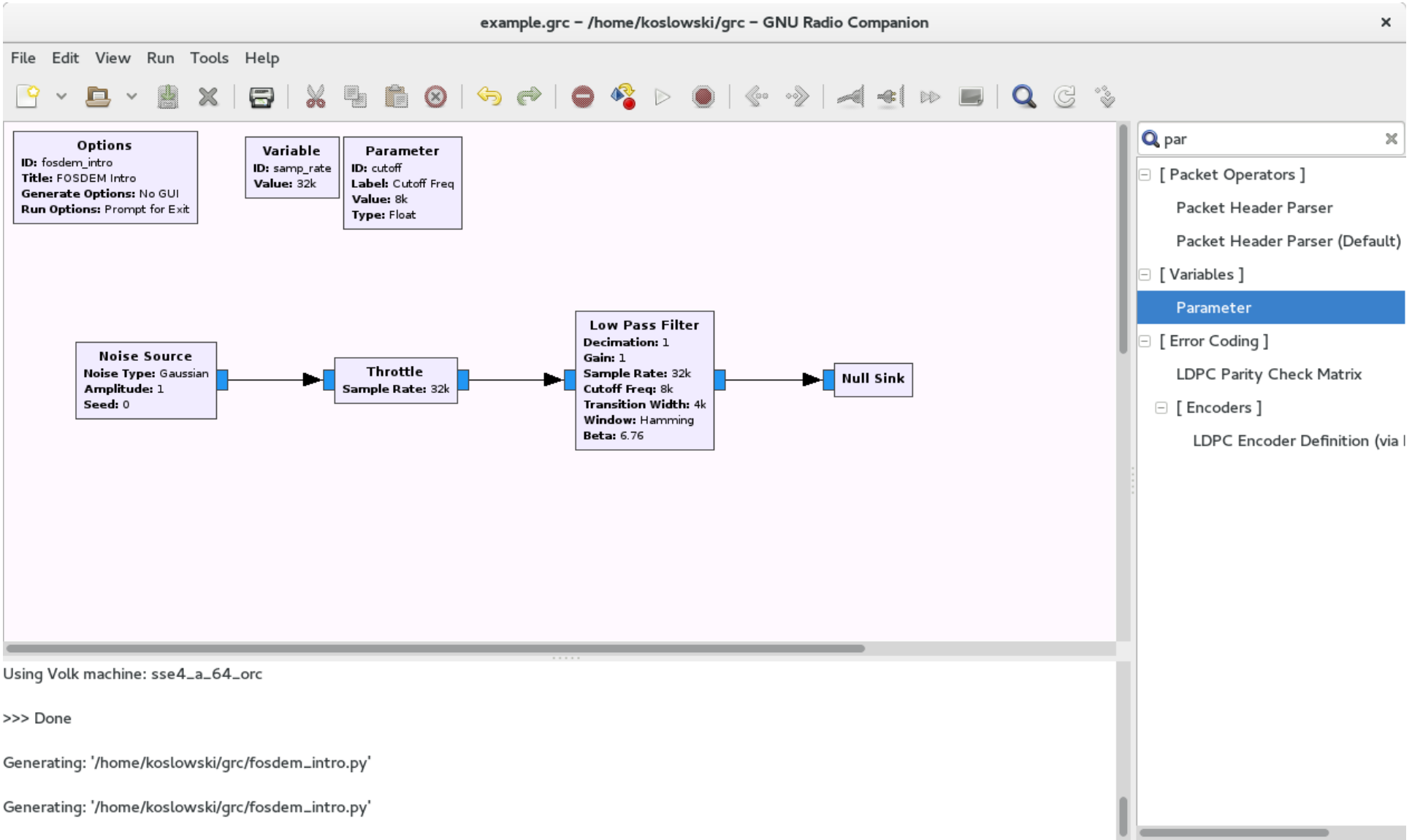
Example Flow Graph



Example Flow Graph in Action



Behind the Scenes Example



Generated Python

```
#!/usr/bin/env python2
# -*- coding: utf-8 -*-
##################################################
# GNU Radio Python Flow Graph
# Title: FOSDEM Intro
# Generated: Thu Jan 28 16:35:35 2016
##################################################

from gnuradio import analog
from gnuradio import blocks
from gnuradio import eng_notation
from gnuradio import filter
from gnuradio import gr
from gnuradio.eng_option import eng_option
from gnuradio.filter import firdes
from optparse import OptionParser

class fosdem_intro(gr.top_block):

    def __init__(self, cutoff=8e3):
        gr.top_block.__init__(self, "FOSDEM Intro")
```

Generated Python

```
class fosdem_intro(gr.top_block):

    def __init__(self, cutoff=8e3):
        gr.top_block.__init__(self, "FOSDEM Intro")

        ##################################################
        # Parameters
        ##################################################
        self.cutoff = cutoff

        ##################################################
        # Variables
        ##################################################
        self.samp_rate = samp_rate = 32000

        ##################################################
        # Blocks
        ##################################################
        self.low_pass_filter_0 = filter.fir_filter_ccf(1, firdes.low_pass(
            1, samp_rate, cutoff, 4e3, firdes.WIN_HAMMING, 6.76))
        self.blocks_throttle_0 = blocks.throttle(gr.sizeof_gr_complex*1, samp_rate,T
        self.blocks_null_sink_0 = blocks.null_sink(gr.sizeof_gr_complex*1)
        self.analog_noise_source_x_0 = analog.noise_source_c(analog.GR_GAUS
```

Generated Python

```
def __init__(self, cutoff=8e3):
    …
    ##################################################
    # Connections
    ##################################################
    self.connect((self.analog_noise_source_x_0, 0), (self.blocks_throttle_0, 0))
    self.connect((self.blocks_throttle_0, 0), (self.low_pass_filter_0, 0))
    self.connect((self.low_pass_filter_0, 0), (self.blocks_null_sink_0, 0))

def get_cutoff(self):
    return self.cutoff

def set_cutoff(self, cutoff):
    self.cutoff = cutoff
    self.low_pass_filter_0.set_taps(firdes.low_pass(1, self.samp_rate, self.cuto

def get_samp_rate(self):
    return self.samp_rate

def set_samp_rate(self, samp_rate):
    self.samp_rate = samp_rate
    self.blocks_throttle_0.set_sample_rate(self.samp_rate)
    self.low_pass_filter_0.set_taps(firdes.low_pass(1, self.samp_rate, self.cuto
```

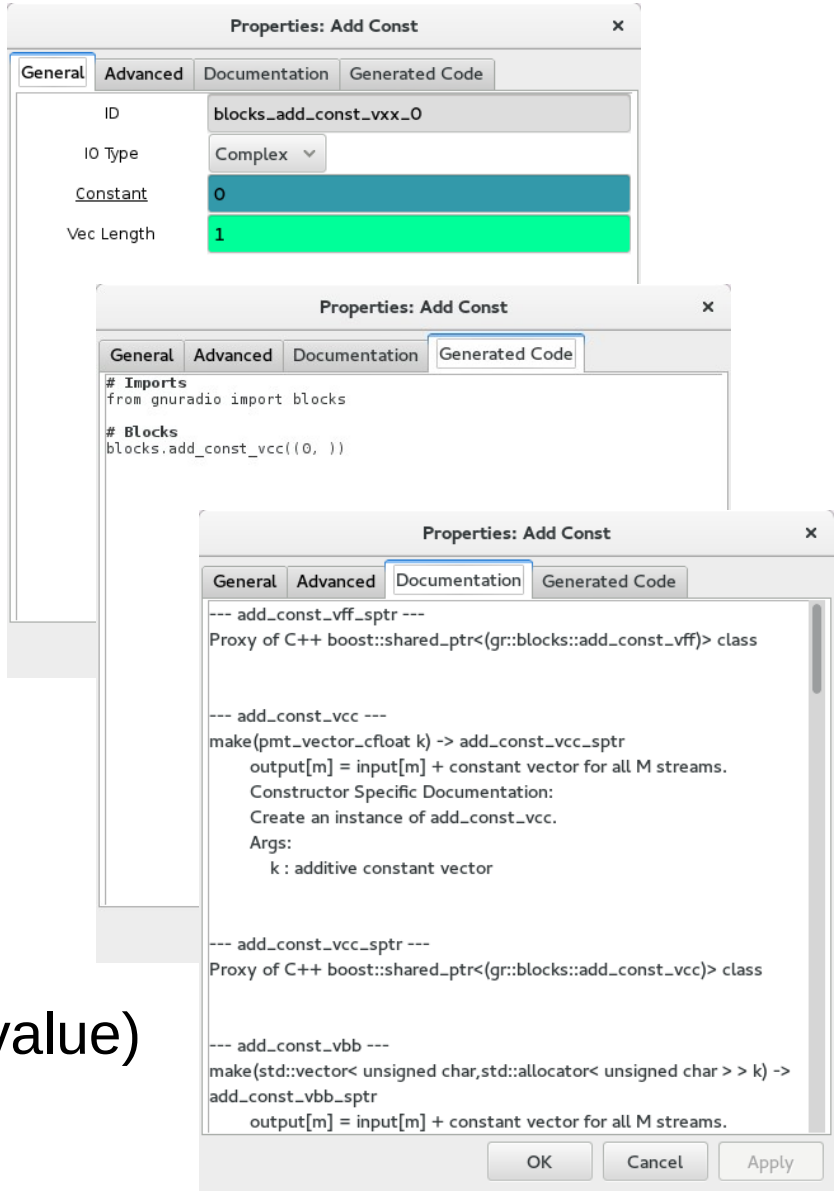
Generated Python

```
def argument_parser():
    parser = OptionParser(option_class=eng_option, usage="%prog: [options]")
    parser.add_option(
        "", "--cutoff", dest="cutoff", type="eng_float", default=eng_notation.num_to_
        help="Set Cutoff Freq [default=%default]")
    return parser


def main(top_block_cls=fosdem_intro, options=None):
    if options is None:
        options, _ = argument_parser().parse_args()

    tb = top_block_cls(cutoff=options.cutoff)
    tb.start()
    try:
        raw_input('Press Enter to quit: ')
    except EOFError:
        pass
    tb.stop()
    tb.wait()


if __name__ == '__main__':
    main()
```

How to add your own block

- *Block Wrapper/ XML*

- Metadata:
  - name, category, docs, flags
- Parameters:
  - key, name, type, default value, GUI
- Ports:
  - key, name, type (vlen), domain, GUI
- Templates:
  - imports, make, callbacks, (variable value)



How to add your own block

```
<block>
  <name>Add Const</name>
  <key>blocks_add_const_vxx</key>
  <import>from gnuradio import blocks</import>
  <make>blocks.add_const_v$(type.fcn)($const)</make>
  <callback>set_k($const)</callback>
  <param>
    <name>IO Type</name>
    <key>type</key>
    <type>enum</type>
    <option>
      <name>Complex</name>
      <key>complex</key>
      <opt>const_type:complex_vector</opt>
      <opt>fcn:cc</opt>
    </option>
    <option>
      <name>Float</name>
      <key>float</key>
      <opt>const_type:real_vector</opt>
      <opt>fcn:ff</opt>
    </option>
  </param>
  ....
  <param>
    <name>Constant</name>
    <key>const</key>
    <value>0</value>
    <type>$type.const_type</type>
  </param>
  <param>
    <name>Vec Length</name>
    <key>vlen</key>
    <value>1</value>
    <type>int</type>
  </param>
  <check>len($const) == $vlen</check>
  <check>$vlen &gt; 0</check>
  <sink>
    <name>in</name>
    <type>$type</type>
    <vlen>$vlen</vlen>
  </sink>
  <source>
    <name>out</name>
    <type>$type</type>
    <vlen>$vlen</vlen>
  </source>
</block>
```

Overview

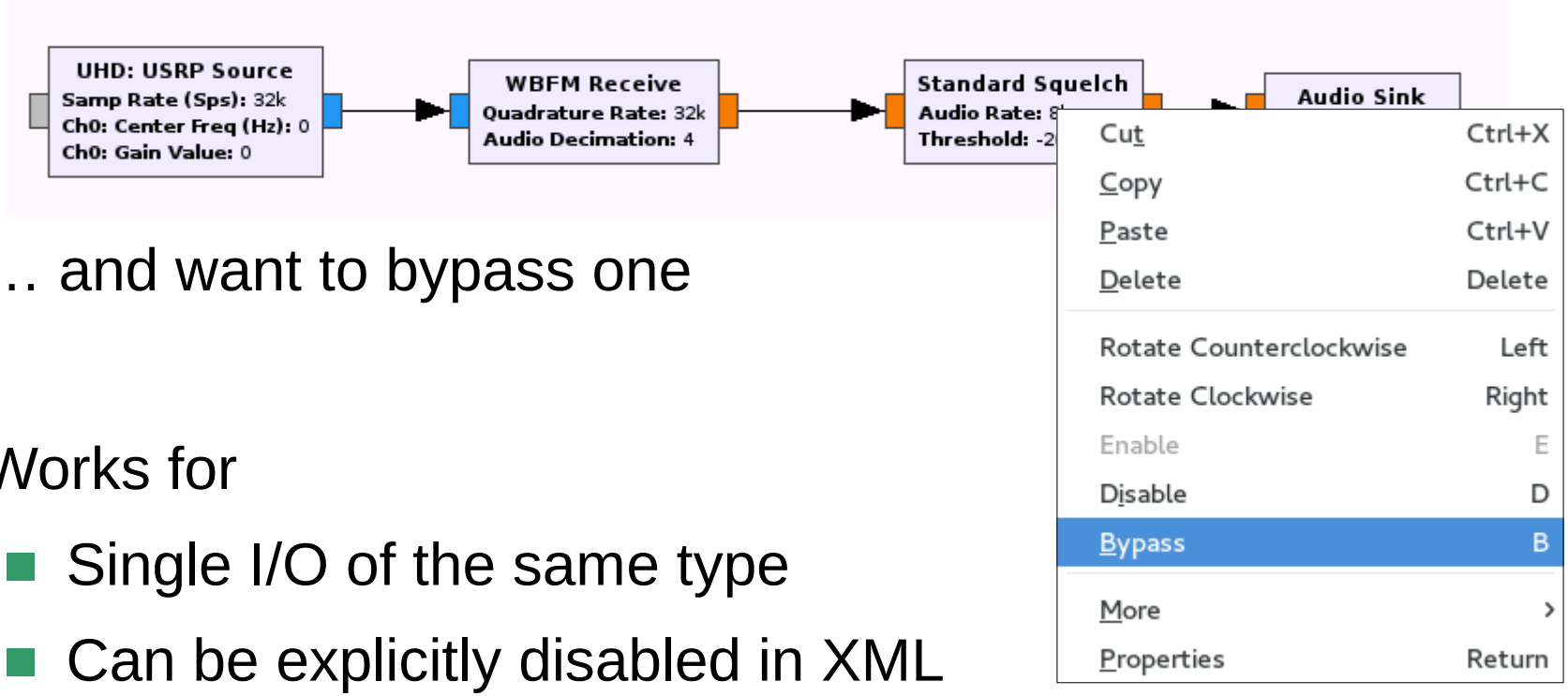
- GNU Radio Companion Intro
  - Graphical Flow Graph Design
  - How to add your own blocks

- Recently added features
  - Bypassed Blocks
  - Embedded Python Blocks / Modules
  - Custom Run Commands
  - Bootstrap depending hier_blocks

- Current development and plans for future versions

Bypassed Blocks

- Say you're streaming data through some blocks...



… and want to bypass one

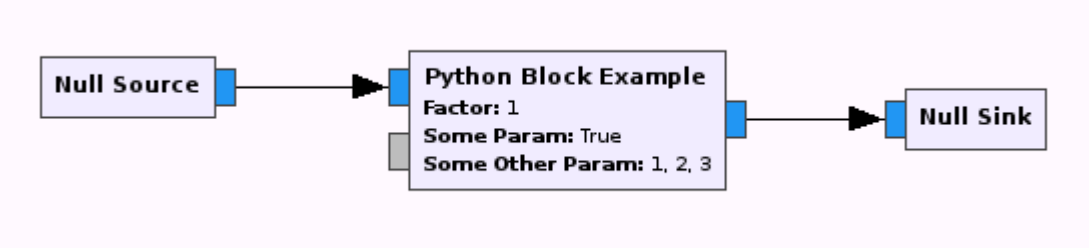
- Works for
  - Single I/O of the same type
  - Can be explicitly disabled in XML

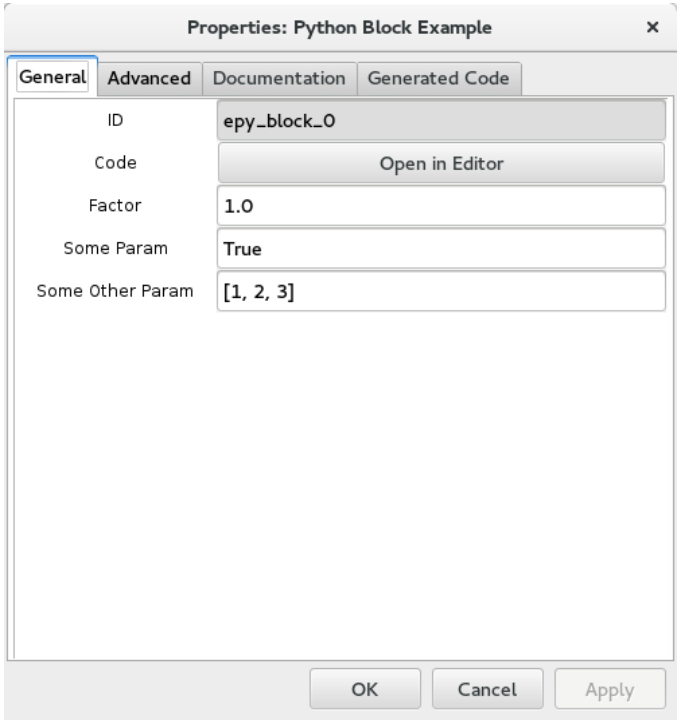
- Thanks to Seth Hitefield

Embedded Python Blocks

- Say you want ...
  - to quickly try something
  - a self-contained (tutorial) Flowgraph with custom DSP

- Python Blocks
  - Stored in the Flowgraph
  - Edited directly from GRC
  - Live, on-the-fly Block Wrappers



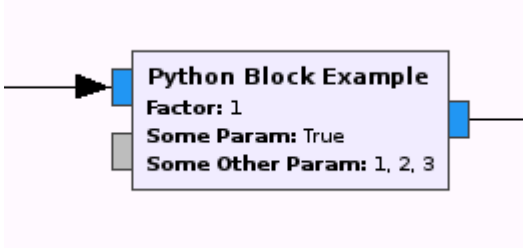


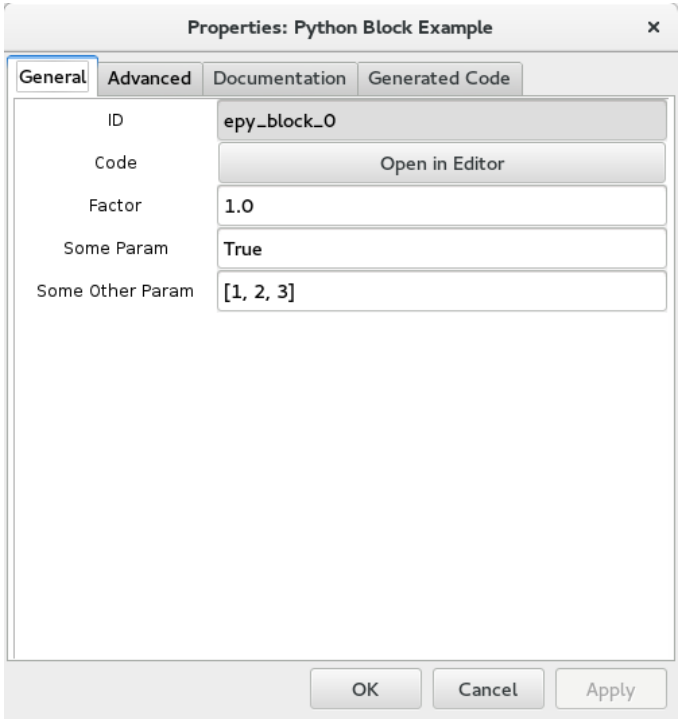
Embedded Python Blocks

Open | epy_block_0_JvUKuA.py /tmp | Save

```
import numpy as np
from gnuradio import gr
import pmt

class blk(gr.sync_block):
    def __init__(self, factor=1.0, some_param=True,
                 some_other_param=[1,2,3]):
        gr.sync_block.__init__(
            self,
            name='Python Block Example',
            in_sig=[np.complex64],
            out_sig=[np.complex64]
        )
        self.factor = factor
        port_key = pmt.intern('control')
        self.message_port_register_in(port_key)
        self.set_msg_handler(port_key, self.handle_msg)

    def handle_msg(self, msg):
        pass

    def work(self, input_items, output_items):
        output_items[0][:] = input_items[0] * self.factor
        return len(output_items[0])
```

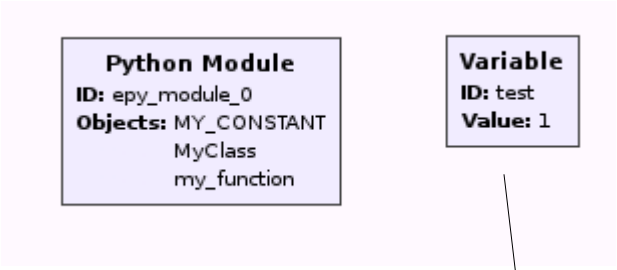
Python | Tab Width: 8 | Ln 16, Col 10 | INS

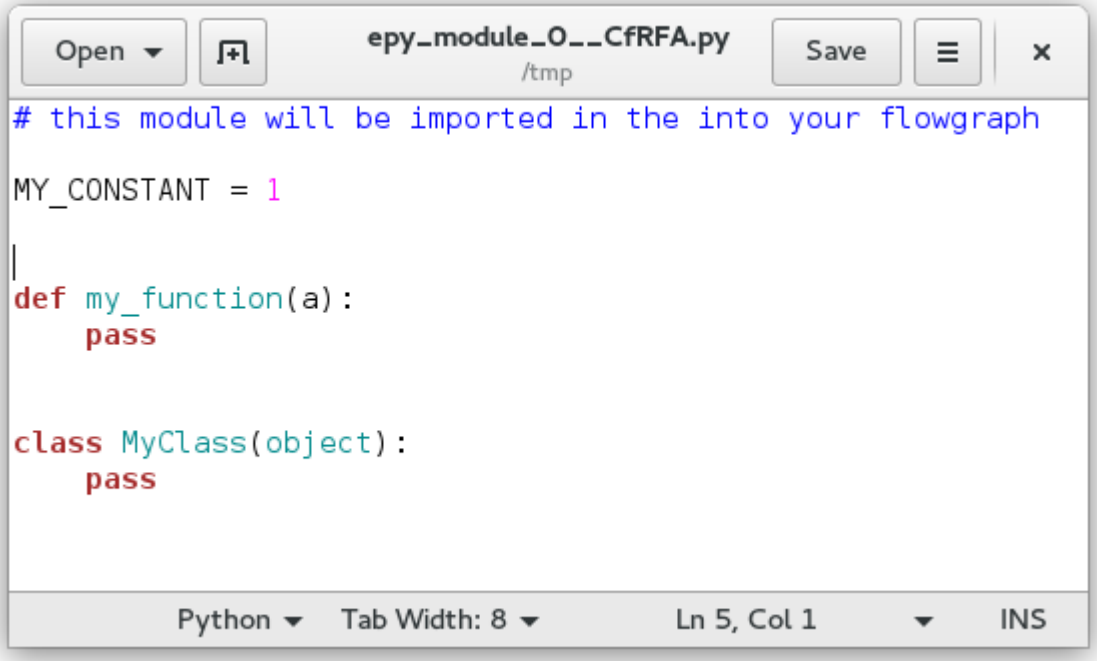


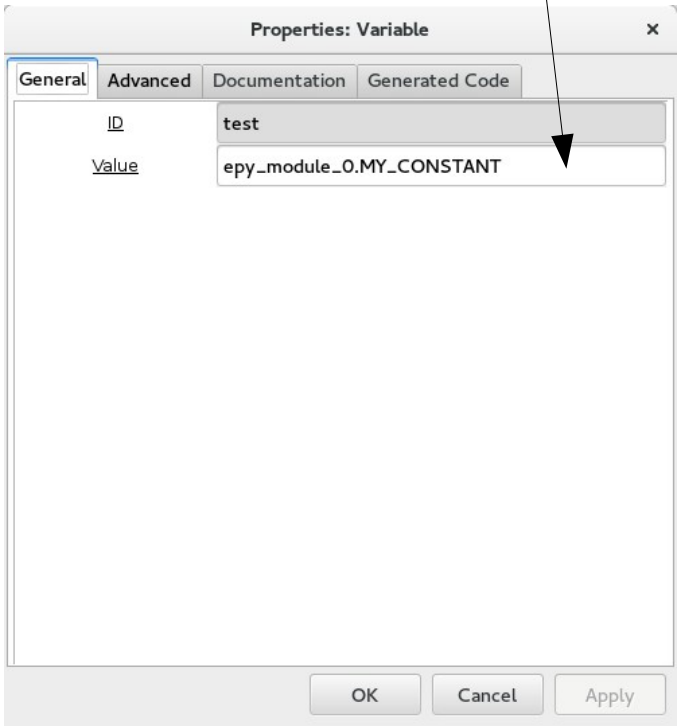


Embedded Python Modules

- Say you quickly want ...
  - to include longer python code
  - keep it in the GRC file

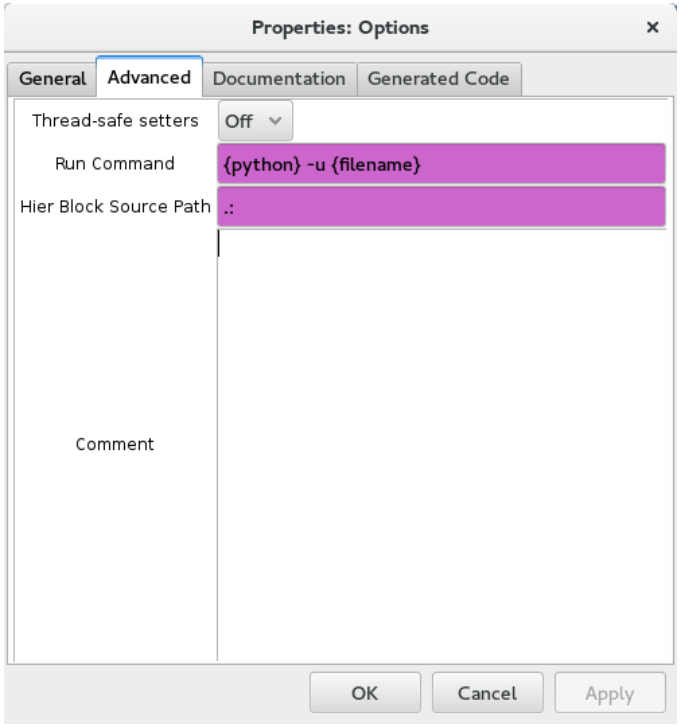






Custom Run Commands

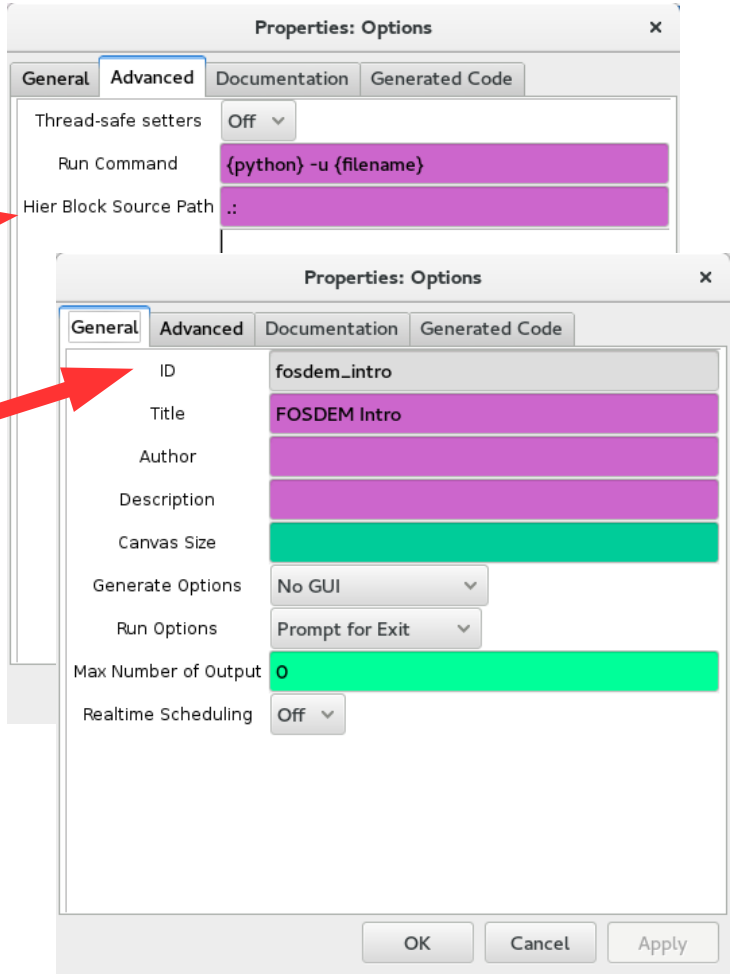
- Say you want ...
  - to modify/extend/embedded your Flowgraph and still run in from GRC
  - deploy and execute it remotely



- You can have GRC run any command
  - Oh oh…
  - import the generated code in new model and reuse/extend the
    - top_block, main, arg_parser
  - Have some script run SCP and SSH for remote execution

Bootstrap depending hier_blocks

- Say you distribute a OOT module including a Flowgraph which depends on other GRC generated hier_blocks
- GRC will auto-generate these now if
  - it knows where to look
    - "." is default, multiple allowed
  - the Flowgraph ID and filename match
- Of course, embedded hierarchical blocks would be nicer…



Overview

- GNU Radio Companion Intro
  - Graphical Flow Graph Design
  - How to add your own blocks
- Recently added features
  - Bypassed Blocks
  - Embedded Python Blocks / Modules
  - Custom Run Commands
  - Bootstrap depending hier_blocks
- Current development and plans for future versions

Current development and future versions

- Long term goals
  - Switch to a QT-based GUI
  - Rewrite/clean/modularize the core
    - get rid of quick fixes, endless special cases and side-effects
    - ease entry for new contributors
  - Switch to Python3
  - Replace XML-based Block Wrappers

- Want to help? Join the GRC Working Group!

Karlsruher Institut für Technologie

The end