Your Name | Your Meeting | Month DD–DD, YYY → Ian Sullivan | Science Pipelines group meeting | March 2, 2022

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Why refactor Image Differencing?

- The current ImageDifferenceTask is a monolithic block of code

  - This makes it hard to add tests of individual algorithmic components

- There are *many* different flavors of image differencing that are set by configs

  - Alard&Lupton vs ZOGY requires completely different code, but share the configs

  - Many different code branches required to support all combinations

  - Some configs must be set in multiple places (e.g. `coaddName` and `getTemplate.coaddName`)

-

New structure:

- The current ImageDifferenceTask is to be broken into three separate Tasks:

  - GetTemplateTask

  - AlardLuptonSubtractTask (and variants)

  - DetectAndMeasureDiaSourcesTask

GetTemplateTask

- In **getTemplate.py** in **ip_diffim**

- A modified version of **GetMultiTractCoaddTemplateTask** with a new name

- Assembles coadds and warps them to match the science image

- To subtract two calexps, you must first make a single visit coadd from one of them

- produces **{coaddName}Diff_templateExp**

- **GetDcrTemplateTask**

  - Uses most of the same code

  - Takes DcrCoadds and calexp.visitInfo as inputs

  -

AlardLuptonSubtractTask

- Written from scratch, and now lives in **imageDifference.py** in **ip_diffim**

- Steps

  - Constructs a matching kernel

  - PSF-matches the template and science image

  - Subtracts the science from the template

  - Produces **{coaddName}Diff_differenceExp** and **{coaddName}Diff_matchedExp**

- Can be configured to convolve either the template or science image based on PSF size, or only convolve the template (or science) image

- **AlardLuptonPreconvolveSubtractTask** is a separate Task, but uses much of the same code

  - Produces **{coaddName}Diff_scoreExp**

- **ZogySubtractTask** (not yet written) would also produce **{coaddName}Diff_scoreExp**
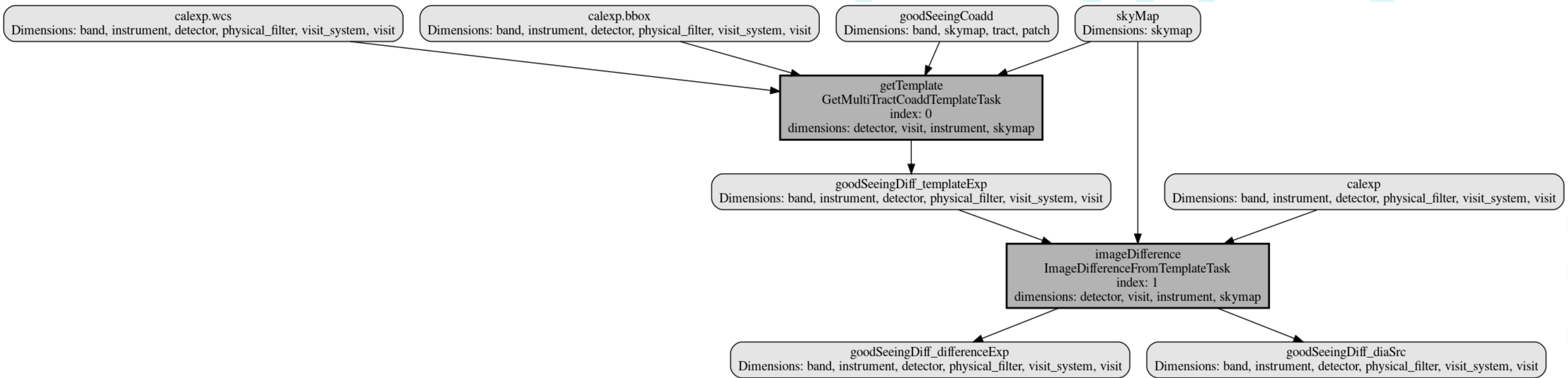
DetectAndMeasureDiaSourcesTask

- In **detectAndMeasureDiaSources.py** in **pipe_tasks**

- Preserves original functionality: forced sources, sky sources, etc..

- Produces **{coaddName}Diff_diaSrc**

- **DetectAndMeasureScoreDiaSourcesTask**

  - Separate Task that takes **{coaddName}Diff_scoreExp** as input

  - Produces **{coaddName}Diff_diaSrc**

Example PipelineTask: Before

```yaml
 1
 2    description: Test pipeline for running the old Diffim using DECam HiTS
 3
 4    instrument: lsst.obs.decam.DarkEnergyCamera
 5
 6    tasks:
 7      getTemplate:
 8        class: lsst.ip.diffim.getTemplate.GetMultiTractCoaddTemplateTask
 9        config:
10          connections.coaddExposures: goodSeeingCoadd
11      imageDifference:
12        class: lsst.pipe.tasks.imageDifference.ImageDifferenceFromTemplateTask
13        config:
14          coaddName: goodSeeing
15          getTemplate.coaddName: goodSeeing
16          getTemplate.warpType: direct
17          connections.coaddName: goodSeeing
18          # Setting template 'coaddName' is not sufficient to satisfy contract
19          connections.coaddExposures: goodSeeingCoadd
20          connections.subtractedExposure: goodSeeingDiff_differenceExp
21
```
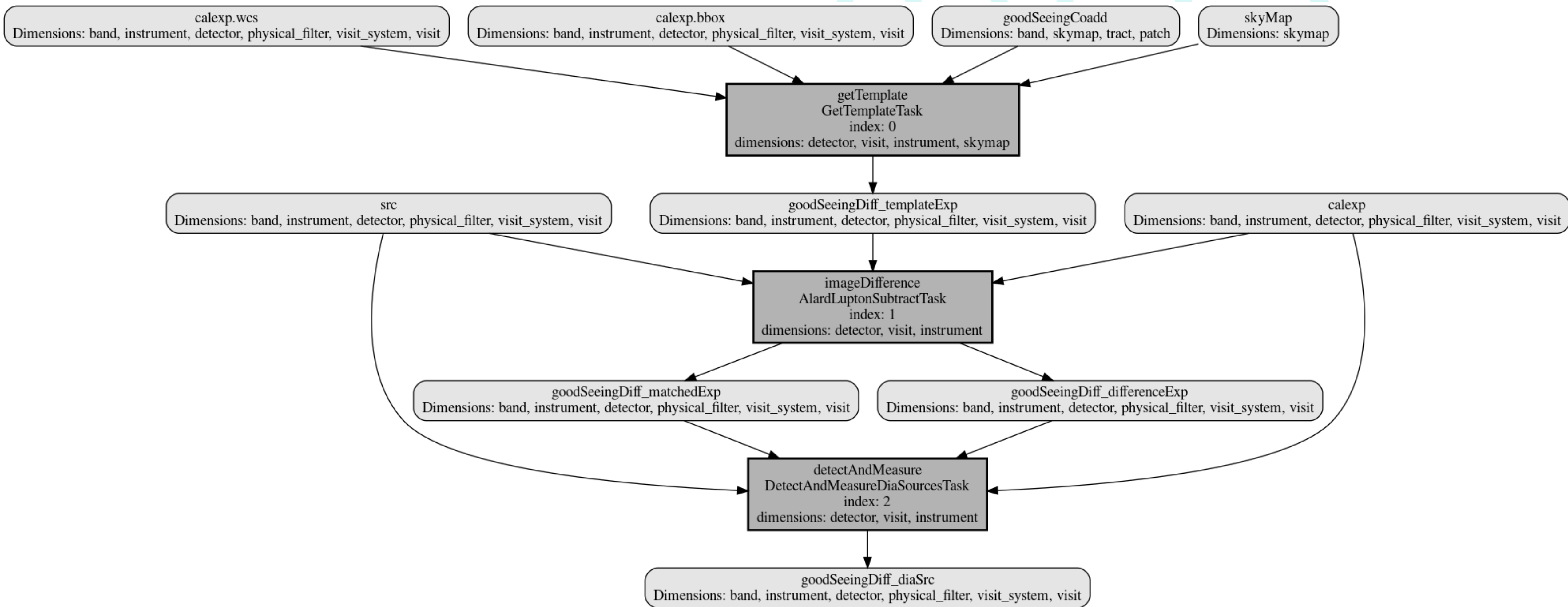
Example PipelineTask: Before

Example PipelineTask: Before

```yaml
1
2    description: Test pipeline for running the refactored Diffim using DECam HiTS
3
4    instrument: lsst.obs.decam.DarkEnergyCamera
5
6    tasks:
7      getTemplate:
8        class: lsst.ip.diffim.getTemplate.GetTemplateTask
9        config:
10         coaddName: goodSeeing
11         warpType: direct
12     imageDifference:
13       class: lsst.ip.diffim.imageDifference.AlardLuptonSubtractTask
14       config:
15         connections.coaddName: goodSeeing
16     detectAndMeasure:
17       class: lsst.pipe.tasks.detectAndMeasureDiaSources.DetectAndMeasureDiaSourcesTask
18       config:
19         connections.coaddName: goodSeeing
20
```
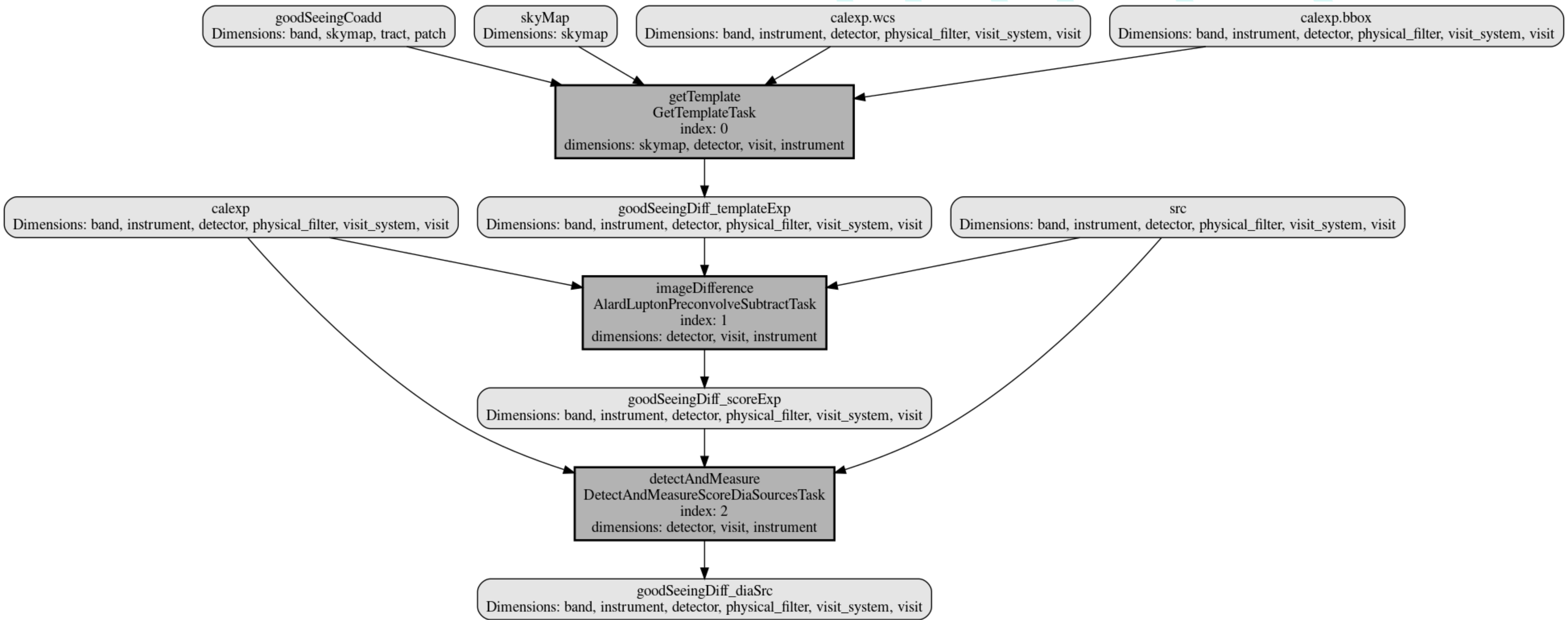
Example PipelineTask: Refactored

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```yaml
1
2    description: Test pipeline for running the refactored Diffim using DECam HiTS
3
4    instrument: lsst.obs.decam.DarkEnergyCamera
5
6    tasks:
7      getTemplate:
8        class: lsst.ip.diffim.getTemplate.GetTemplateTask
9        config:
10         coaddName: goodSeeing
11         warpType: direct
12     imageDifference:
13       class: lsst.ip.diffim.imageDifference.AlardLuptonPreconvolveSubtractTask
14       config:
15         connections.coaddName: goodSeeing
16     detectAndMeasure:
17       class: lsst.pipe.tasks.detectAndMeasureDiaSources.DetectAndMeasureScoreDiaSourcesTask
18       config:
19         connections.coaddName: goodSeeing
20
```

Example PipelineTask: Refactored

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```yaml
1
2    description: Test pipeline for running the refactored Diffim using DECam HiTS
3
4    instrument: lsst.obs.decam.DarkEnergyCamera
5
6    tasks:
7      getTemplate:
8        class: lsst.ip.diffim.getTemplate.GetDcrTemplateTask
9        config:
10         coaddName: dcr
11         warpType: direct
12         effectiveWavelength: 476.31
13         bandwidth: 147.
14     imageDifference:
15       class: lsst.ip.diffim.imageDifference.AlardLuptonSubtractTask
16       config:
17         connections.coaddName: dcr
18     detectAndMeasure:
19       class: lsst.pipe.tasks.detectAndMeasureDiaSources.DetectAndMeasureDiaSourcesTask
20       config:
21         connections.coaddName: dcr
```

Example PipelineTask: Refactored