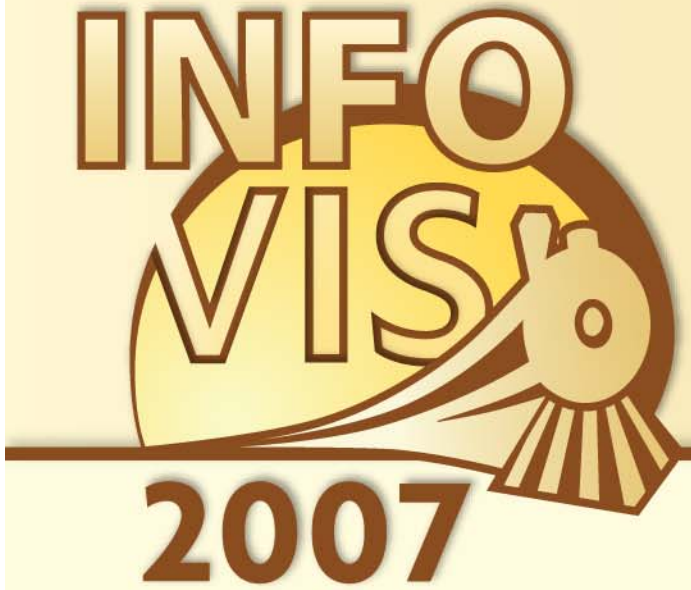

Overview Use in Multiple Visual Information Resolution Interfaces

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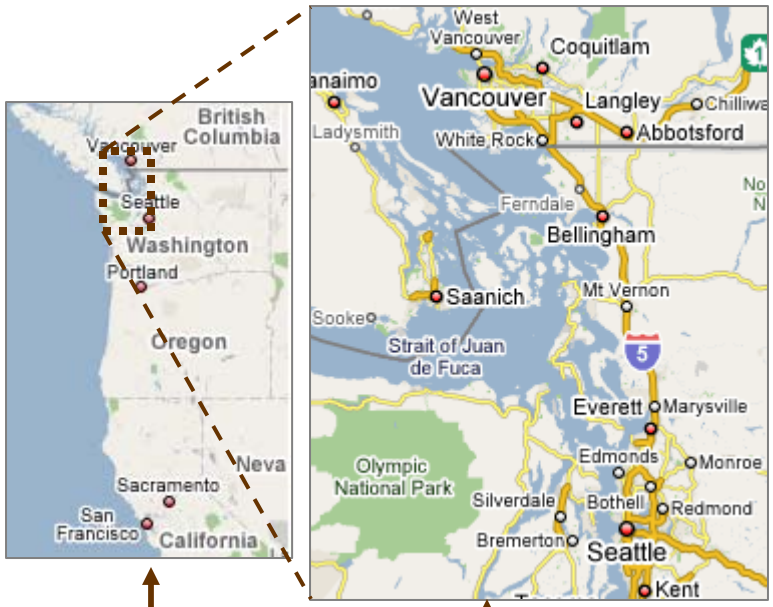
Agilent Technologies

Multiple Visual Information Resolution Interfaces

- Visual Information Resolution (VIR) =
  displayed information for each data point
- Multiple-VIR interfaces = interfaces that contain more than one VIR
- Examples include zooming, overview+detail, focus+context

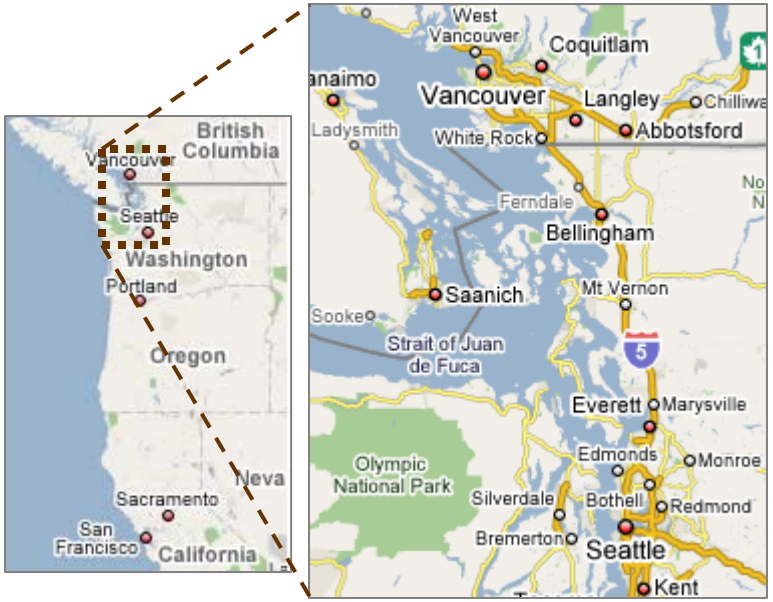


Low VIR High VIR

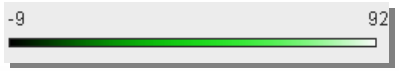
Low VIR	High VIR
Low zoom level	High zoom level
Overview	Detail
Context	Focus

Creating a Low VIR with Structured Data

- Creating a low VIR is the first step in creating an multiple-VIR interface
- Usually, the low VIR needs to accommodate the same amount of data in less space
- When the data has known structures, use categories higher up in the structure to create the low VIR
- E.g., Use provinces/states and cities, but no towns, no highways



Creating a Low VIR with Unstructured Data

- But what if there isn't a known data structure?
  e.g., unordered collection of line graphs
- Our approach for line graphs: reduce visual information to squeeze the data into a smaller space (Line Graph Explorer, Kincaid & Lam, 2006)
  - Low-VIR strip: 


  - High-VIR plot:

- Display the same data points, but the strip uses color only to encode the y-dimension
  - Details are less perceivable (Cleveland & McGill 1984)
- **Question: Can users still select areas of interest in the low-VIR display to examine the missing visual information in the high-VIR?**

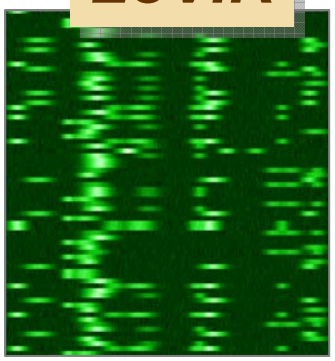
User Study Design

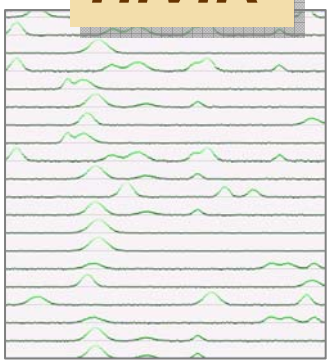
- **Design**: Within-subject, two-factor (4 interfaces, 4 tasks)
- **Data**
  - 114 line graphs x 800 points
  - Used unordered collection of line graphs to isolate effects of reduced visual information
    - Clustering and reordering of line graphs provide obvious benefits
- **Participants**: 24
- **Measurements**: Accuracy, time, subjective preference
- **Observations**: Interface mode used to locate final answer

Interfaces

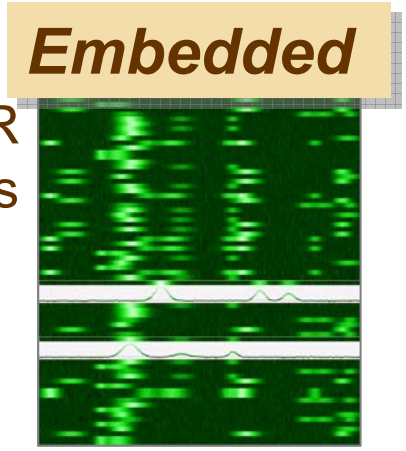
- Low-VIR strip
- High-VIR plot 

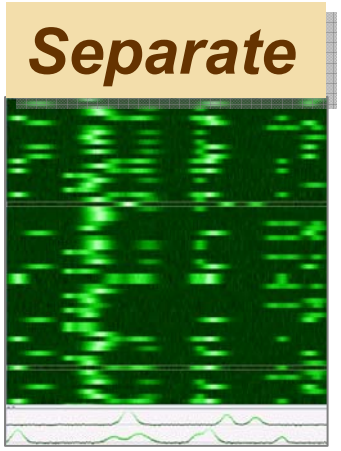
Single-VIR Interfaces





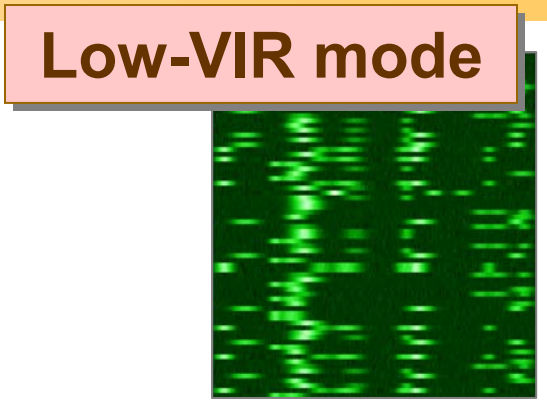
Multiple-VIR Interfaces

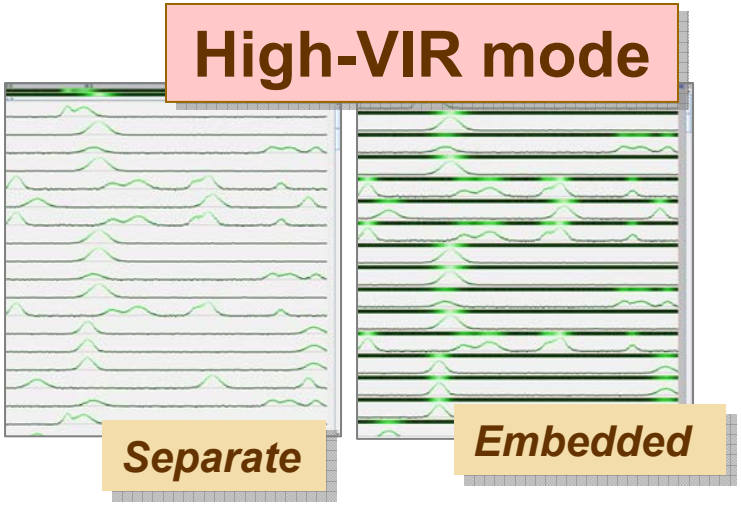


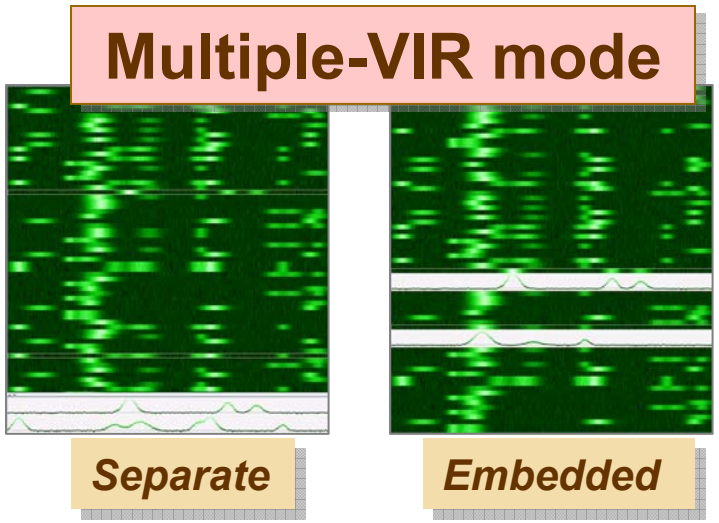


Multiple-VIR Interfaces: Modes

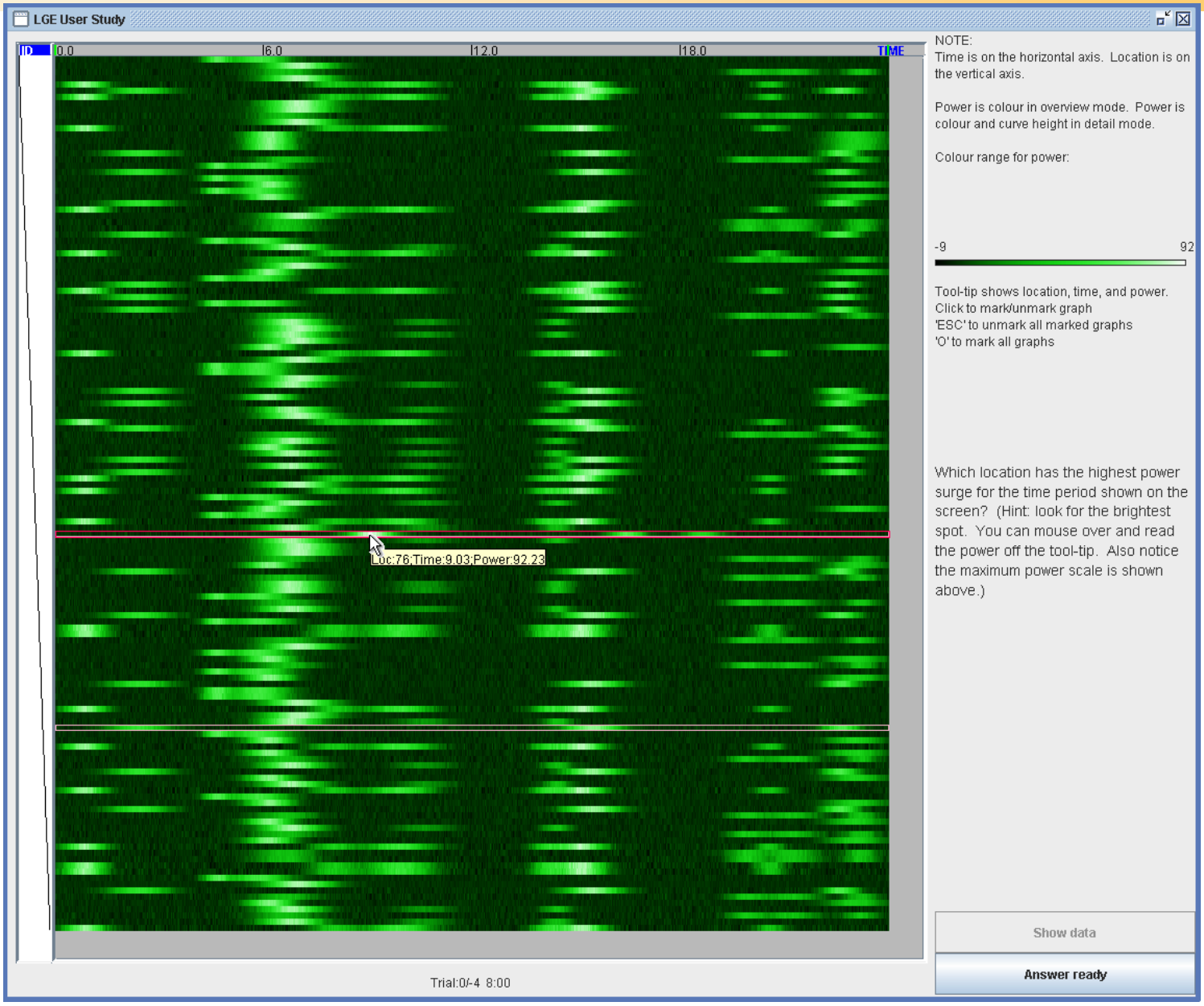
- Three modes
  - Low VIR: all graphs “closed”
  - High VIR: all graphs “opened”
  - Multiple VIR
- Open/close graph:
  - all graphs: key press
  - individual graph: mouse click







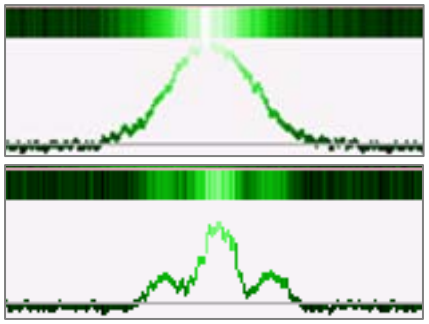
Interfaces


LGE User Study
ID
0.0
6.0
12.0
18.0
TIME
Loc:76;Time:9.03;Power:92.23
Trial:0/-4 8:00
NOTE:
Time is on the horizontal axis. Location is on the vertical axis.
Power is colour in overview mode. Power is colour and curve height in detail mode.
Colour range for power:
-9
92
Tool-tip shows location, time, and power.
Click to mark/unmark graph
'ESC' to unmark all marked graphs
'O' to mark all graphs
Which location has the highest power surge for the time period shown on the screen? (Hint: look for the brightest spot. You can mouse over and read the power off the tool-tip. Also notice the maximum power scale is shown above.)
Show data
Answer ready

Study Hypotheses

1. The low-VIR display alone is usable ONLY when the targets are single-peaked with limited horizontal span

   Used as "Grounding" for H2 and H3.

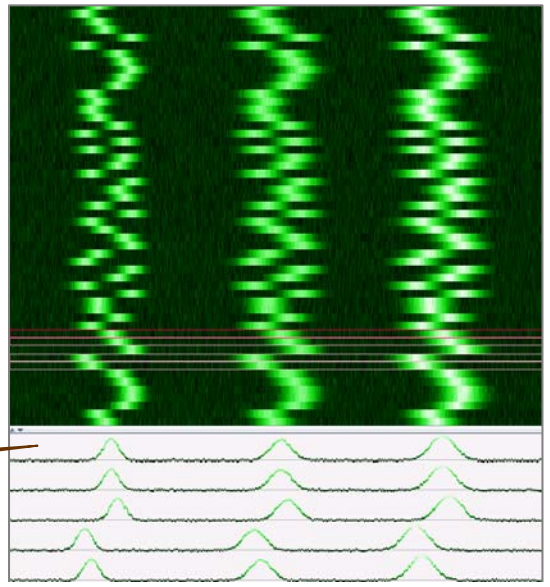


2. Multiple-peaked targets are easy to find in the low-VIR display, but harder to interpret.

   Embedding the Hi-VIR plots in place should help learning.

3. Similar targets are hard to find in the low-VIR display.

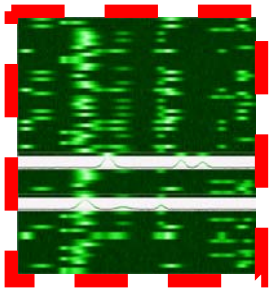
   Side-by-side comparison should help visual search.



Match this line graph

Study Results

- Statistical results based on time and accuracy measurements
  - Time (main effects):
    - Interface (p = .001): *LoVIR* > *Embedded*; *LoVIR* > *Separate*
    - Task (p < .0001): Compare > (Shape = Most) > Max
    - Interface-task interaction (p < .0001)
  - Accuracy (main effects):
    - Interface (p = .001): *Embedded* > *LoVIR; Separate* > *LoVIR*
    - Interface-task interaction (p = .001)
  - Interfaces that are found to be statistically significantly faster/more accurate are outlined in red boxes

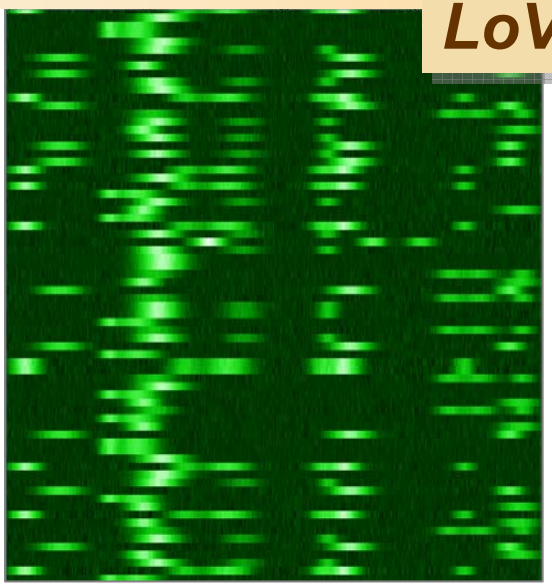


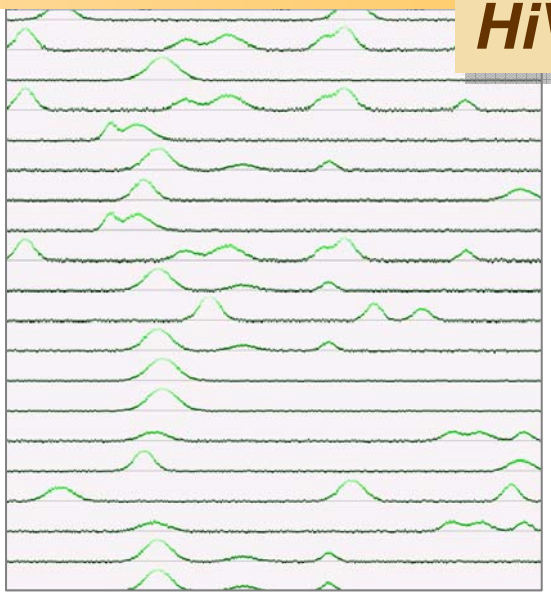
- Interface-use observations to help interpret statistical results
  - Percentage of single-VIR mode use shown as red call outs

58% in *Low-VIR mode*

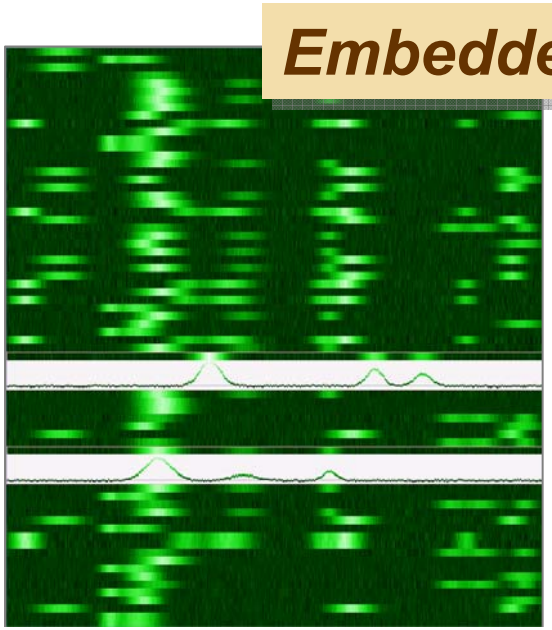
Task 1: *Max* (Look for the highest point)

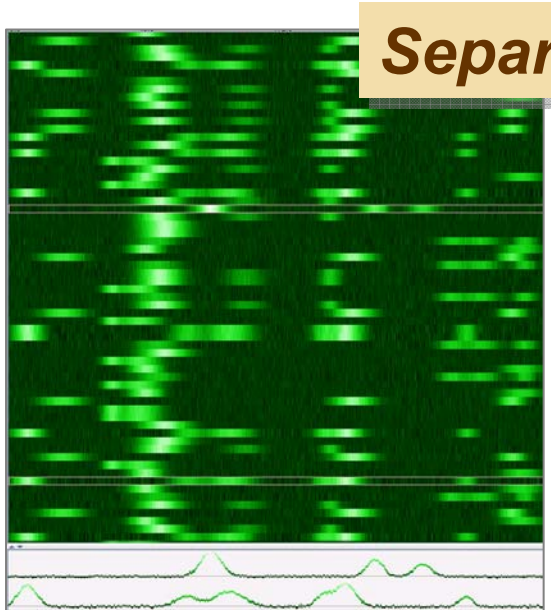
Single-VIR Interfaces

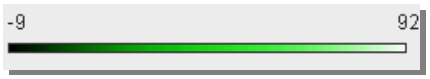




Multiple-VIR Interfaces

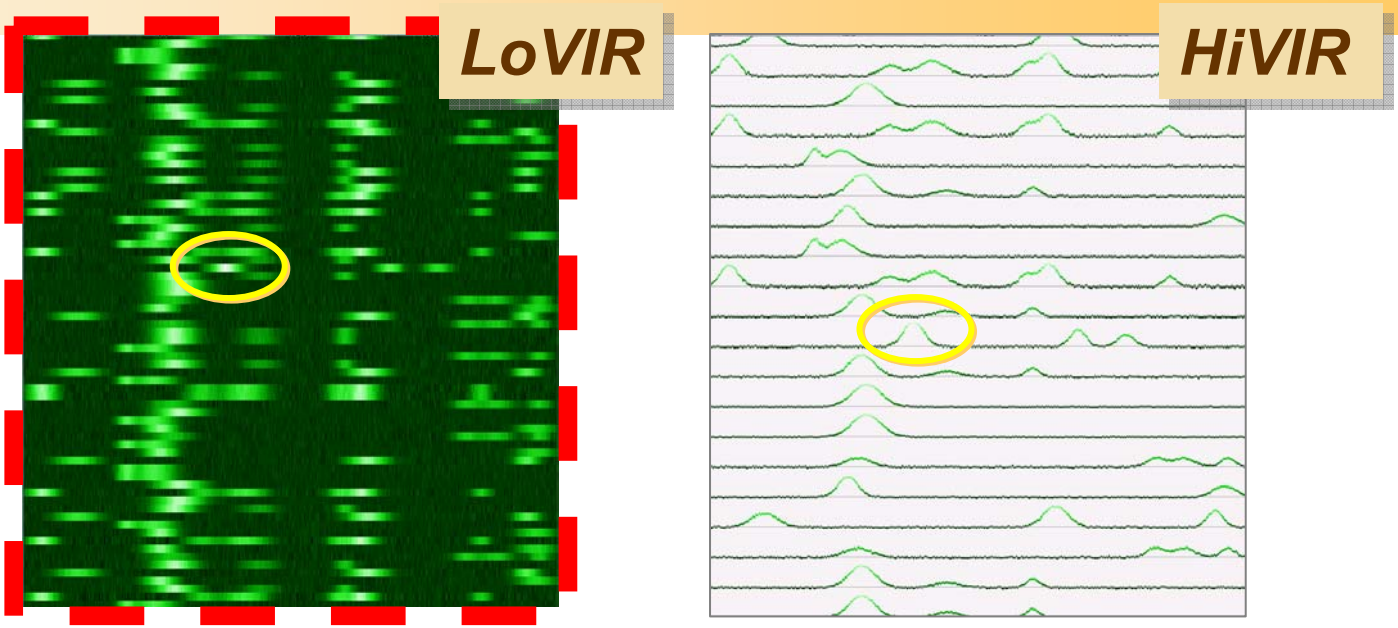




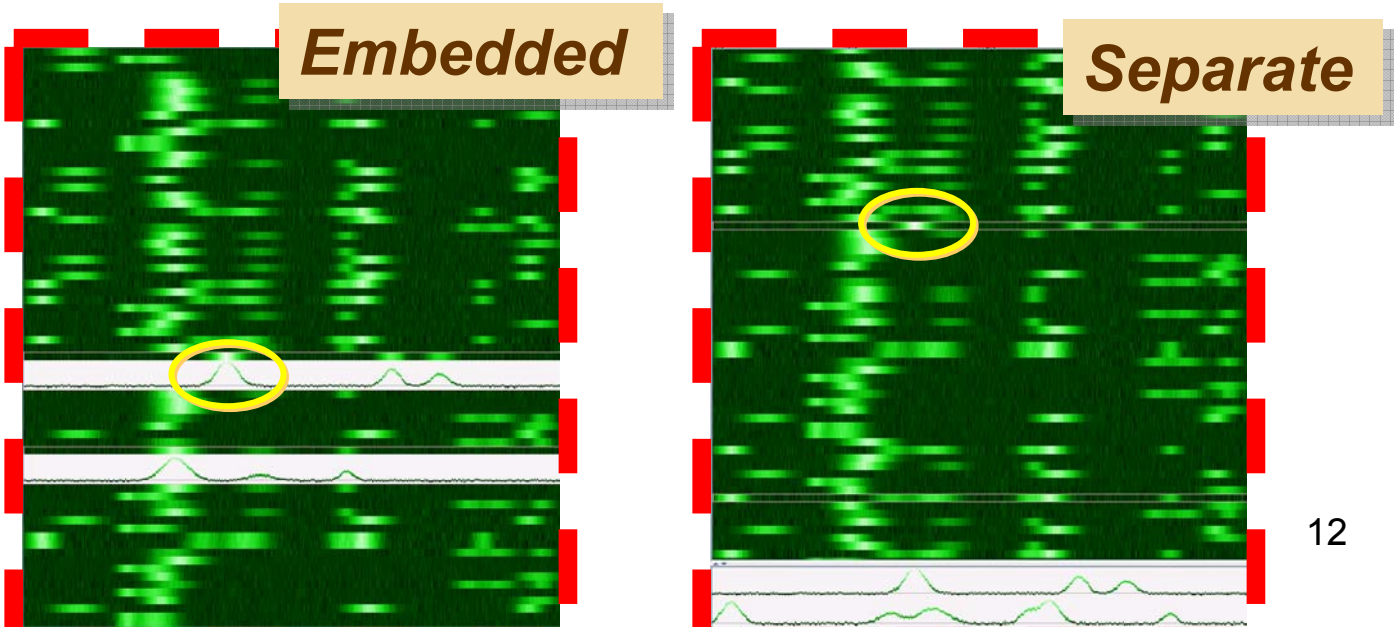


Task 1: *Max* (Look for the highest point)

Single-VIR Interfaces

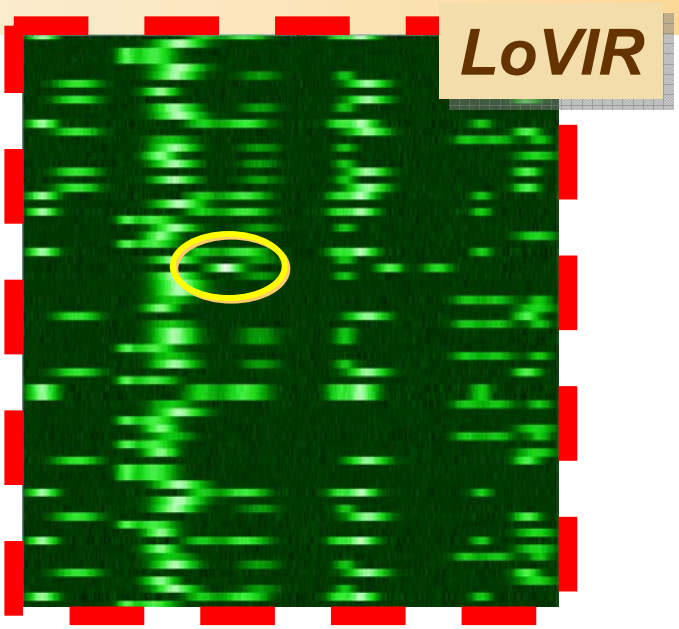


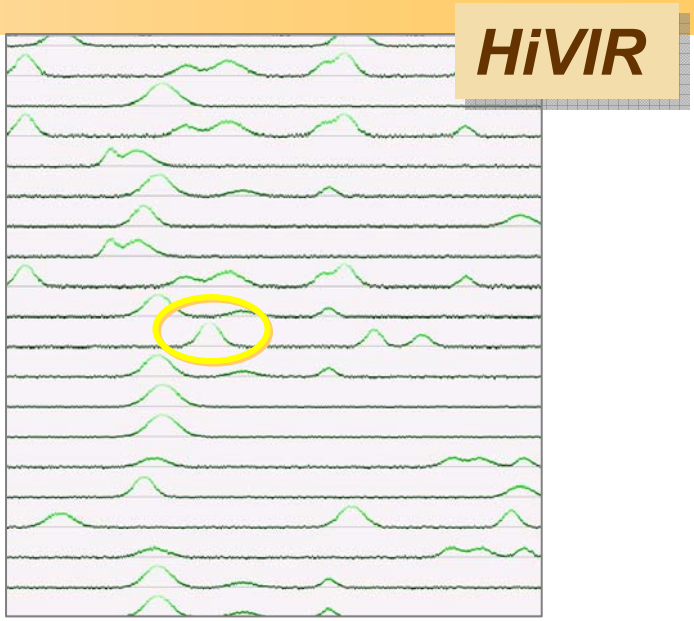
Multiple-VIR Interfaces



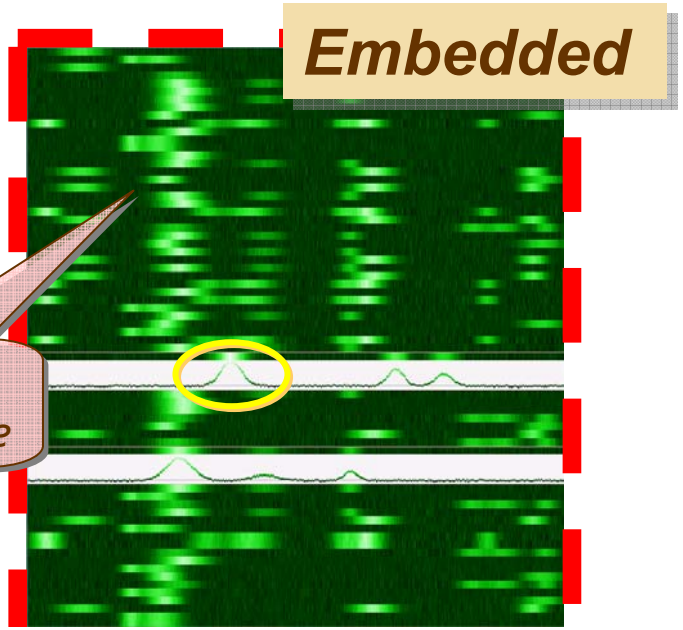
Task 1: *Max* (Look for the highest point)

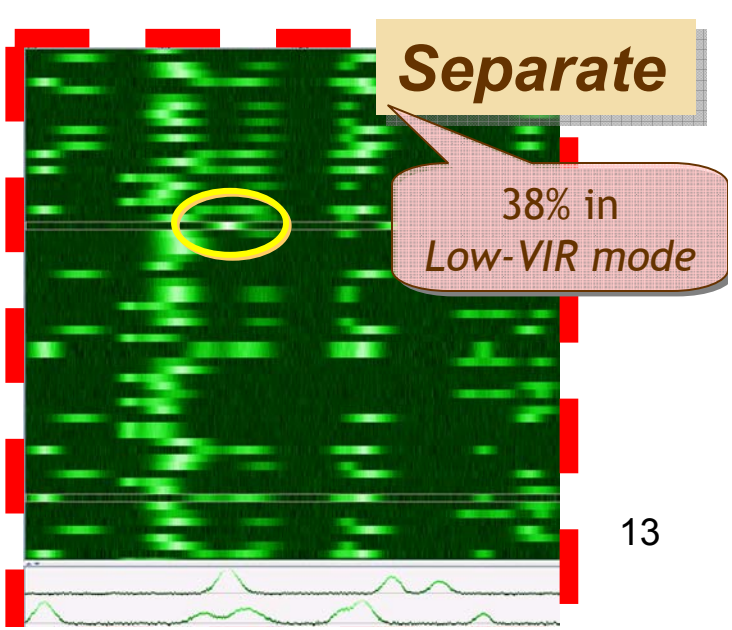
Single-VIR Interfaces





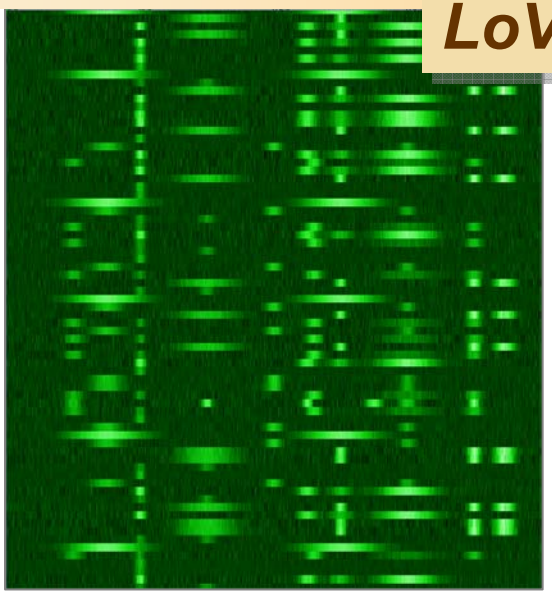
Multiple-VIR Interfaces

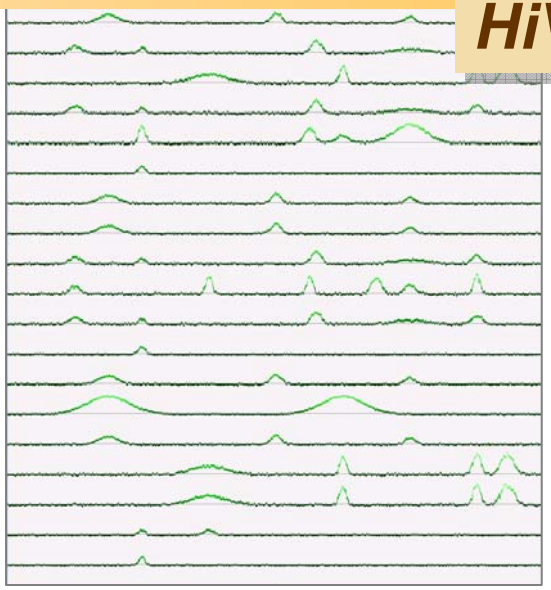




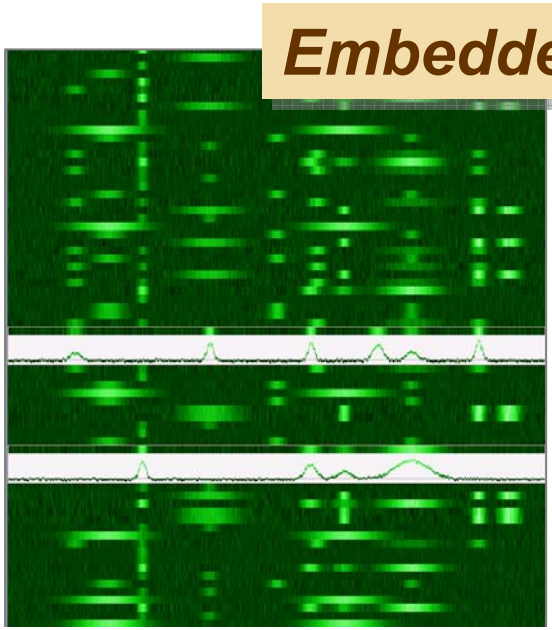
Task 2: *Most* (Look for the largest no. of peaks)

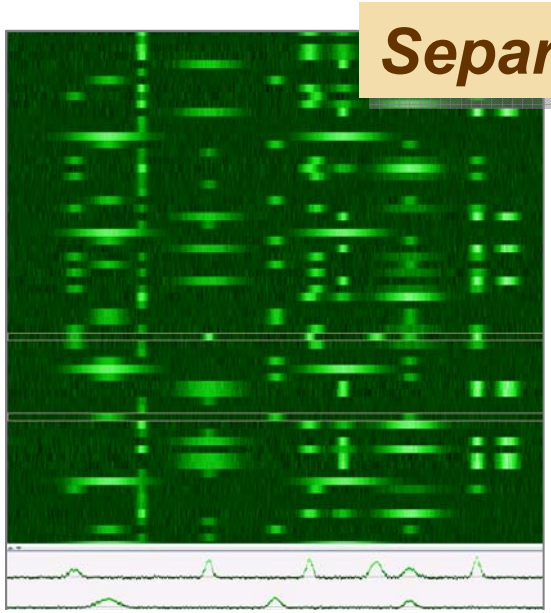
Single-VIR Interfaces





Multiple-VIR Interfaces





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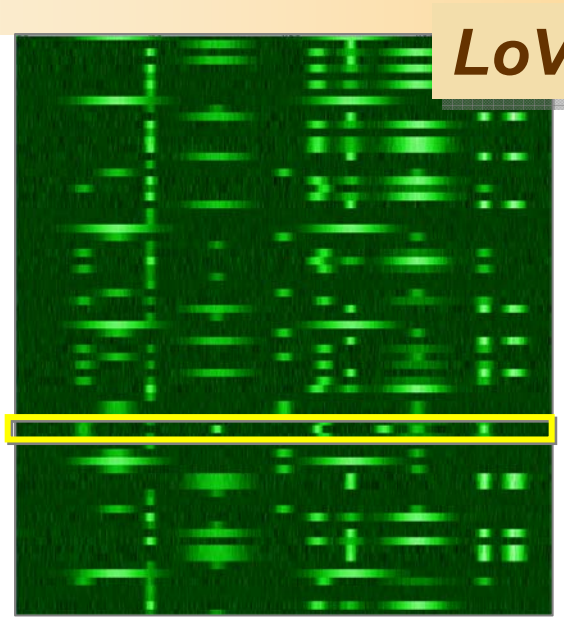
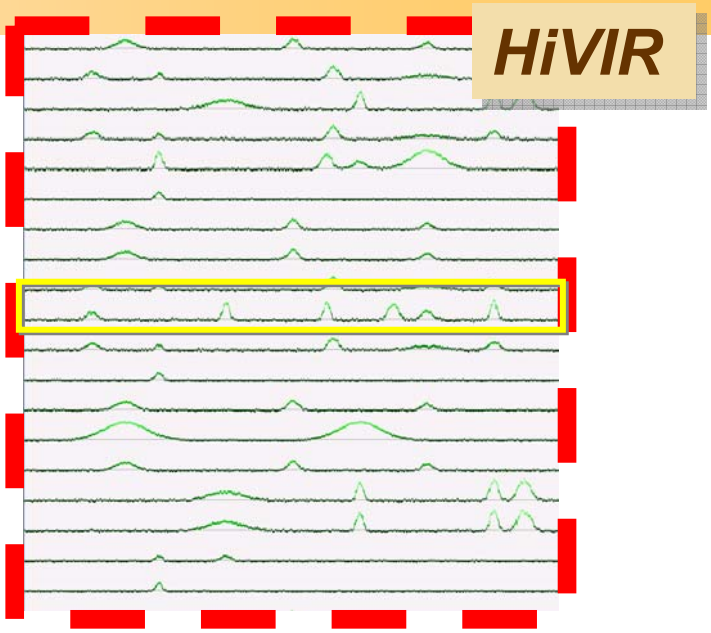
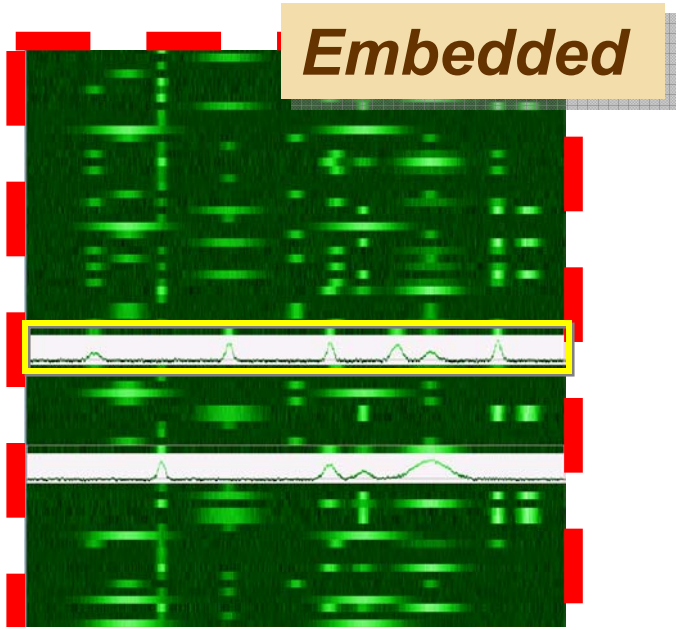
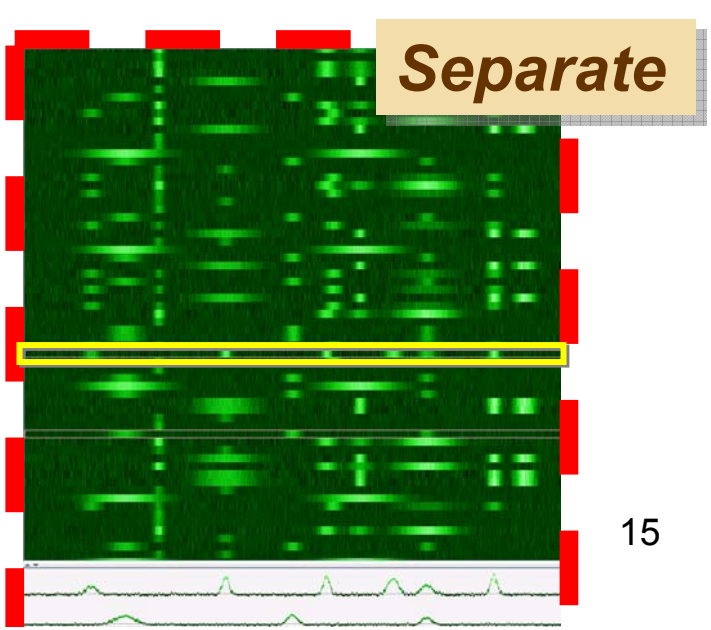
Single-VIR Interfaces





Multiple-VIR Interfaces

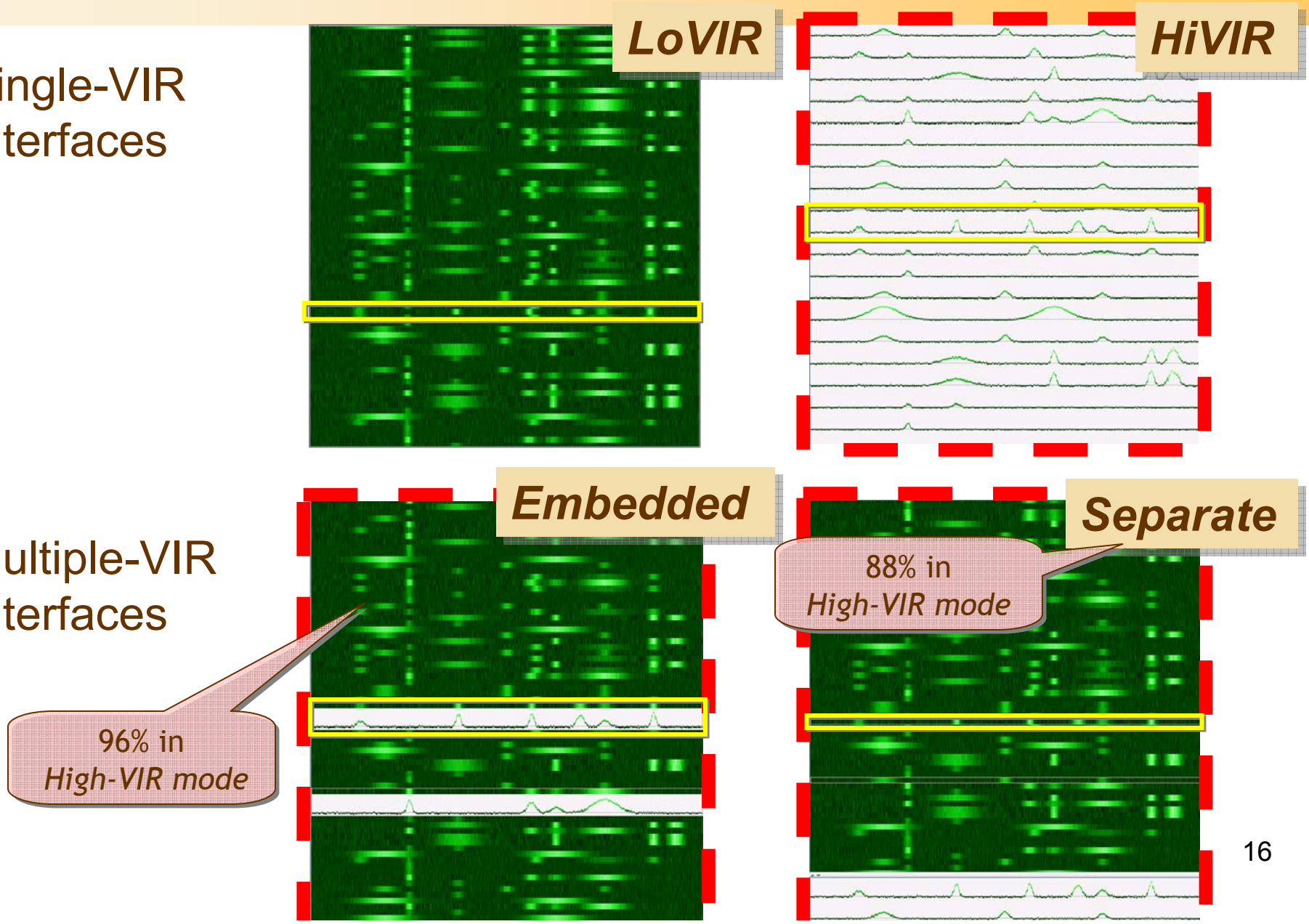


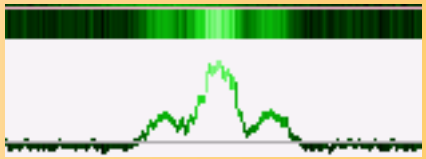


Task 2: *Most* (Look for the largest no. of peaks)

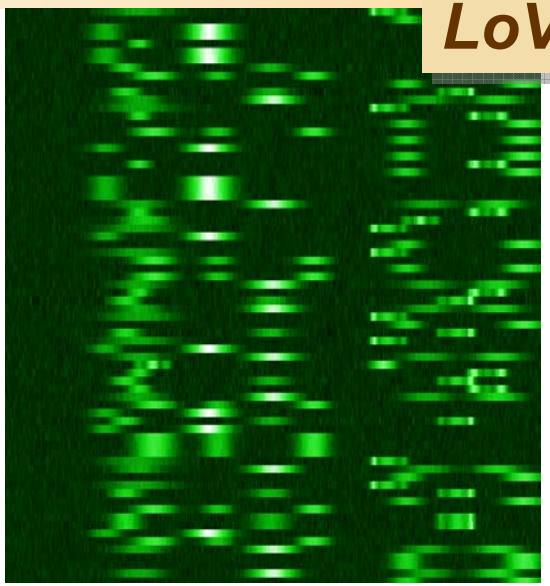
Single-VIR Interfaces

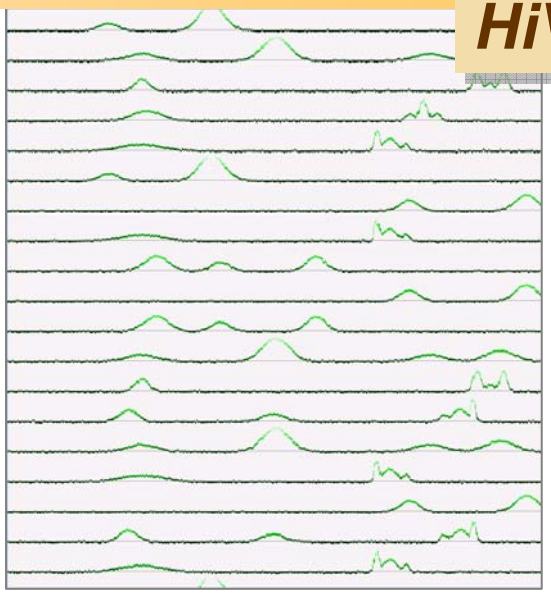
Multiple-VIR Interfaces



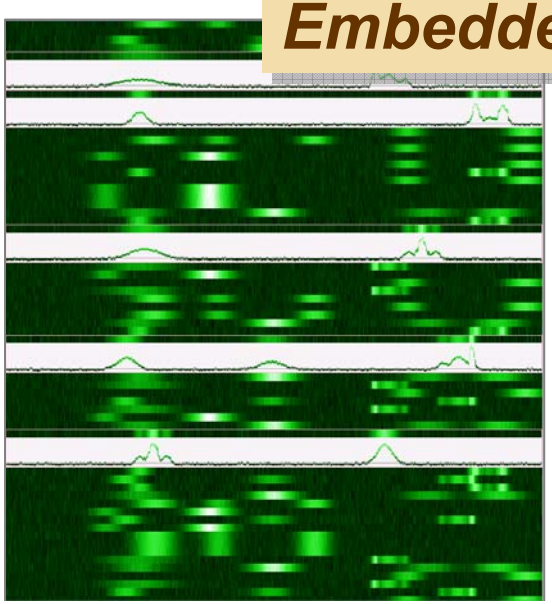
Task 3: *Shape* (Match shape: )

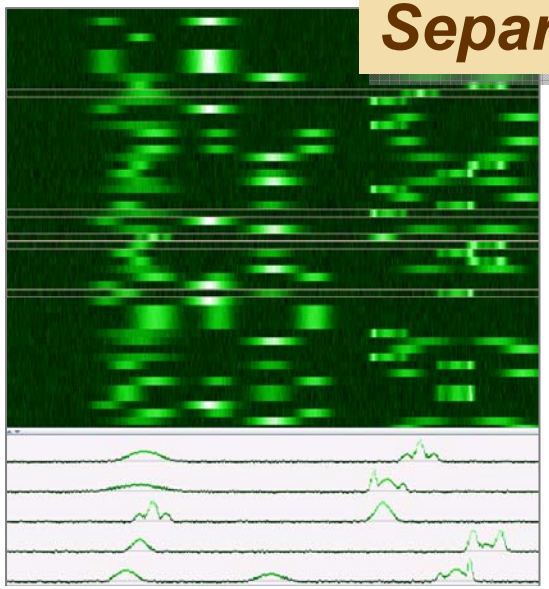
Single-VIR Interfaces

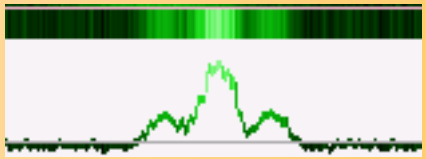




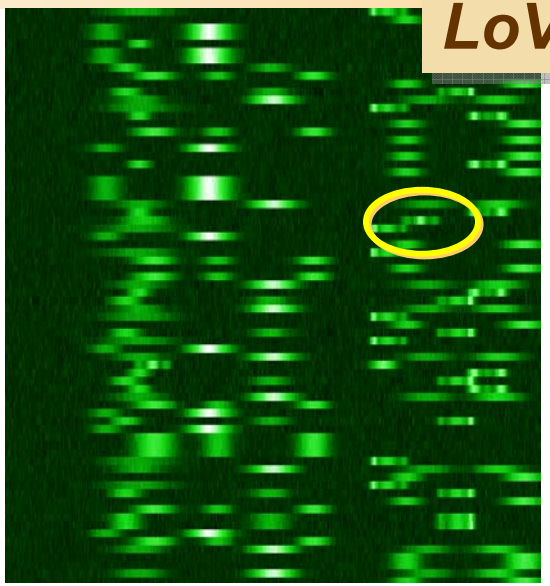
Multiple-VIR Interfaces

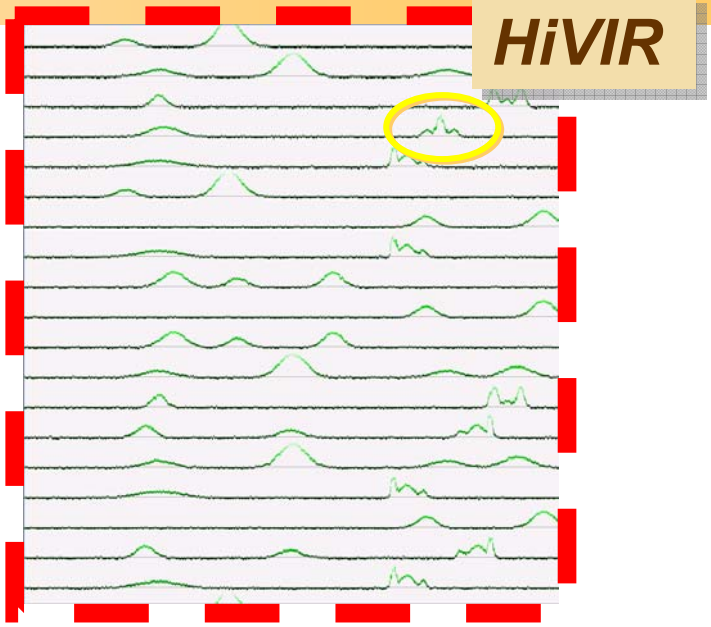




Task 3: *Shape* (Match shape: )

Single-VIR Interfaces





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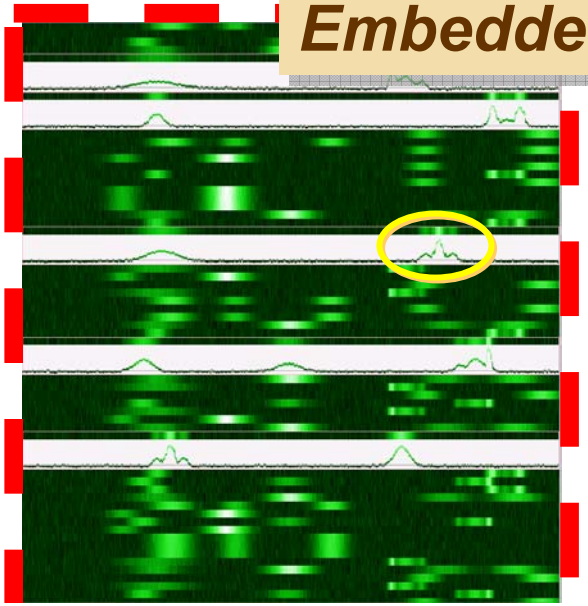
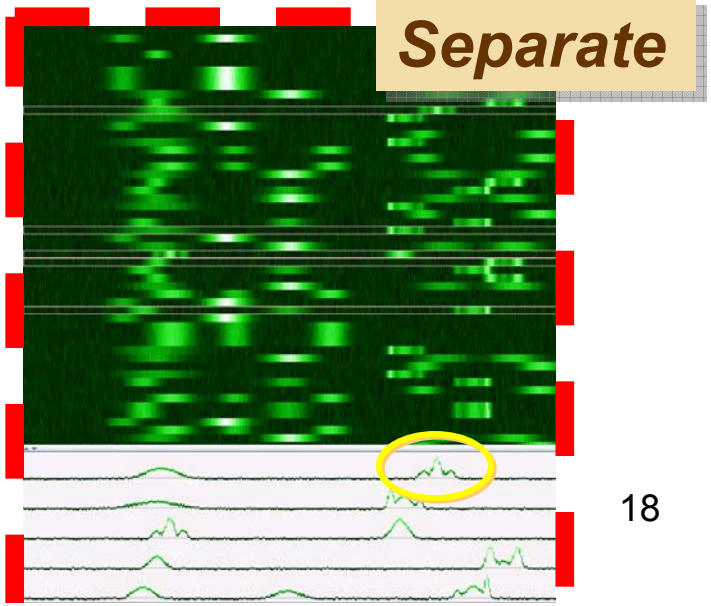
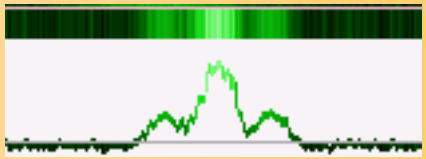
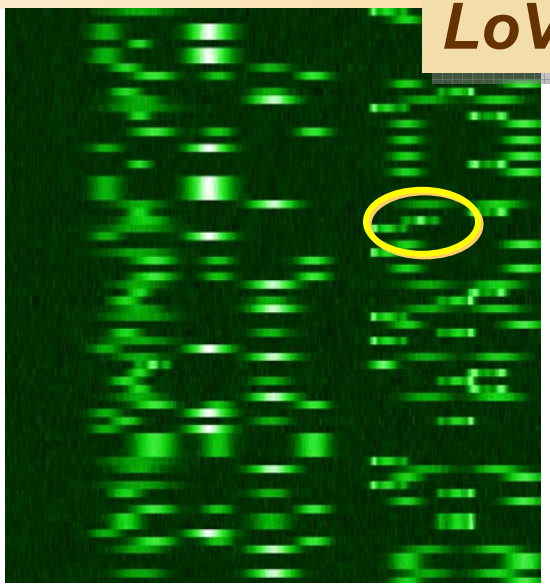
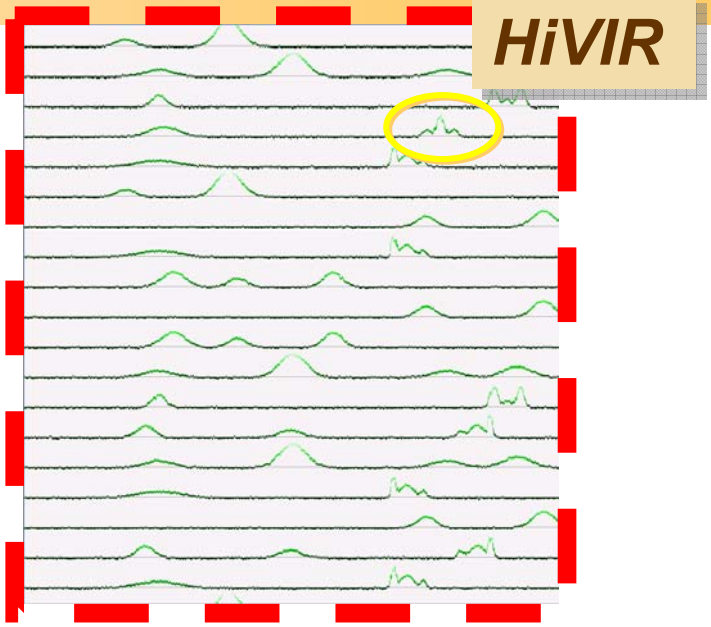




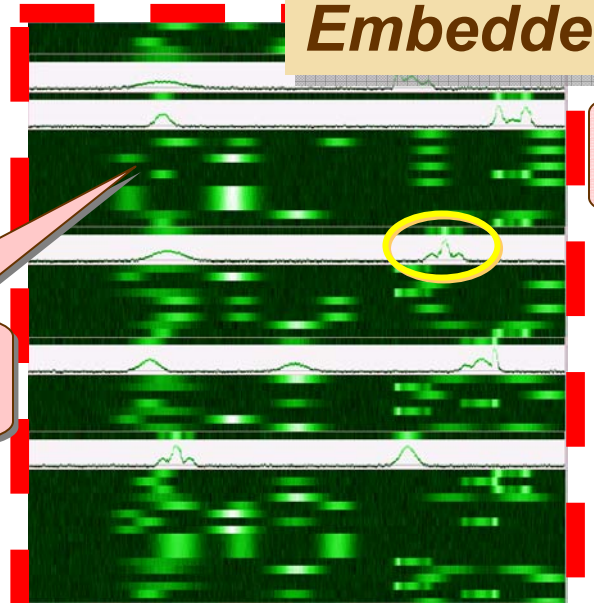
Task 3: *Shape* (Match shape: )

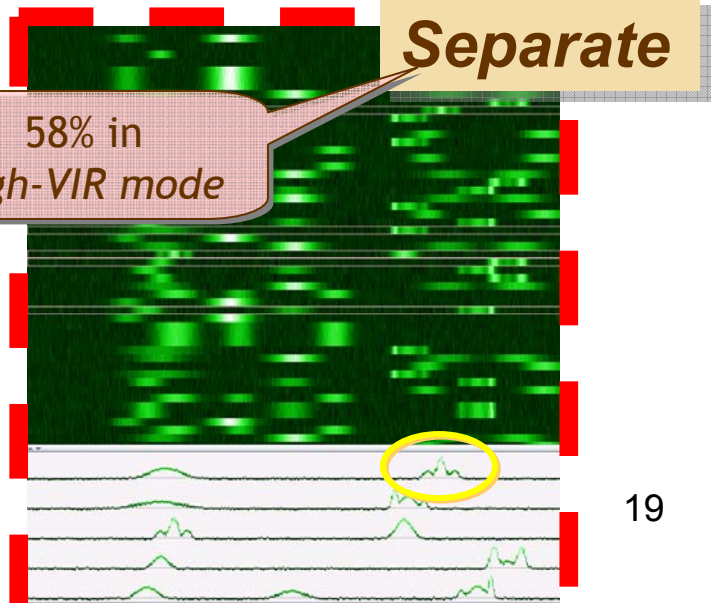
Single-VIR Interfaces





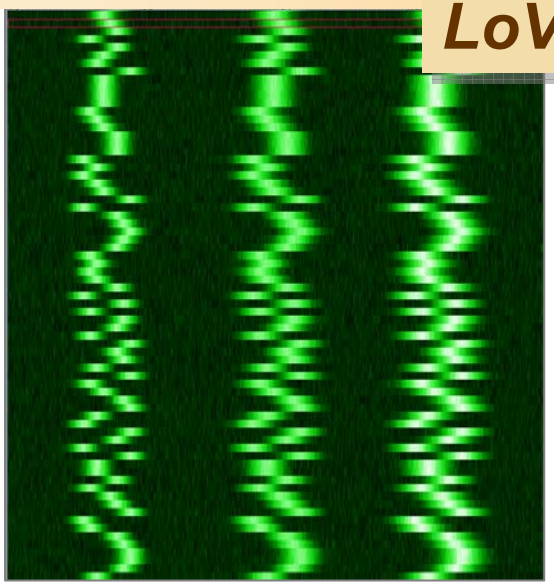
Multiple-VIR Interfaces

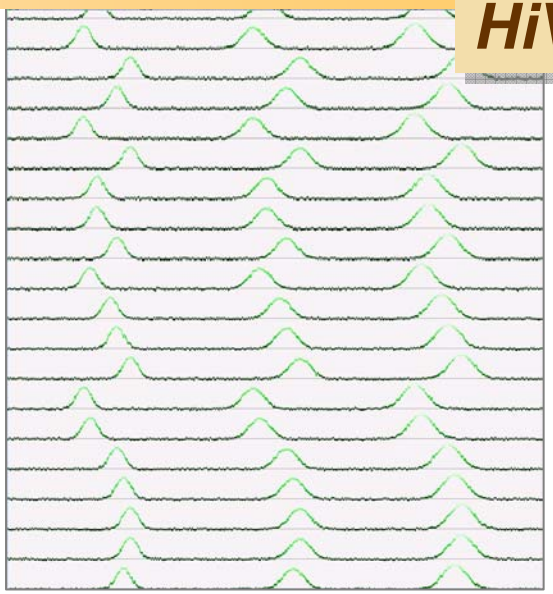




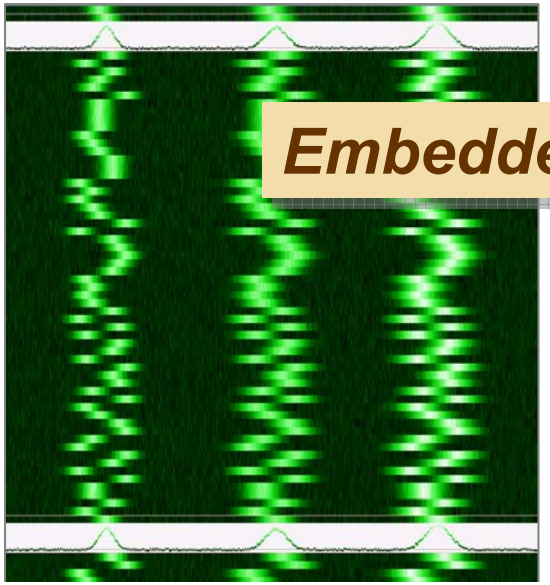
Task 4: *Compare* (Match a line graph:)

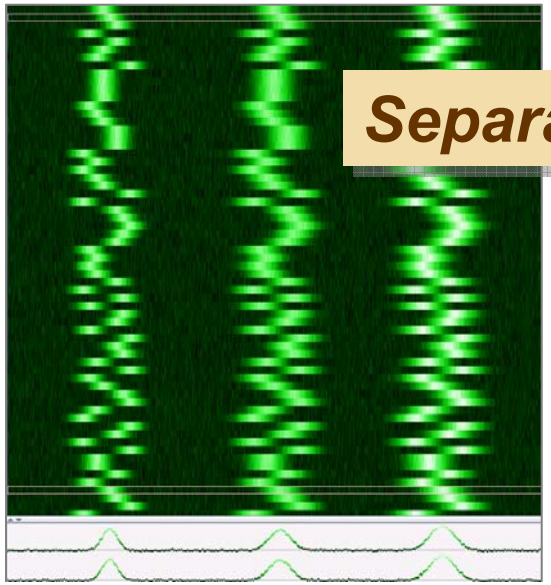
Single-VIR Interfaces



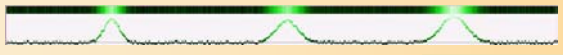


Multiple-VIR Interfaces

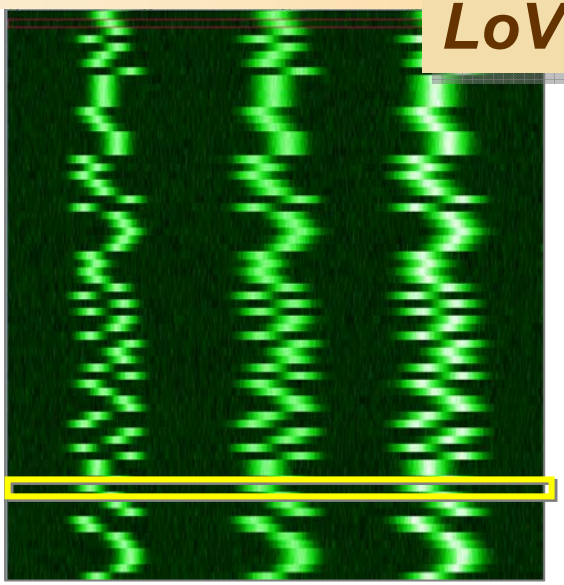


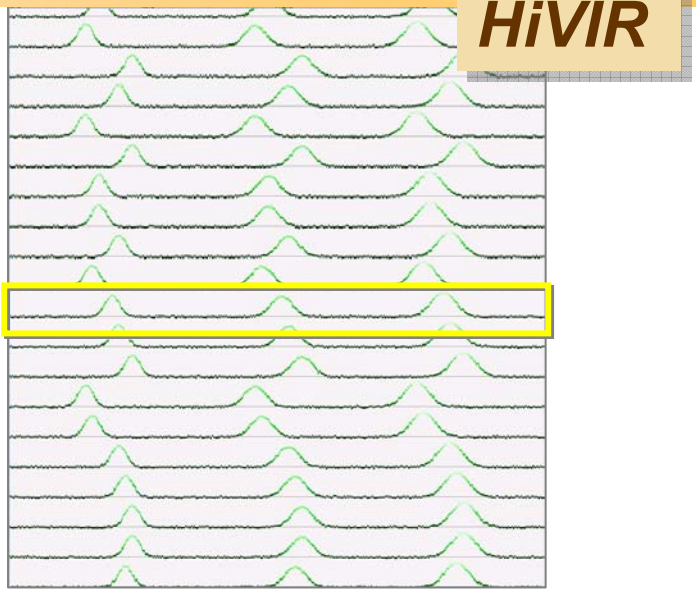


Task 4: *Compare* (Match a line graph:)

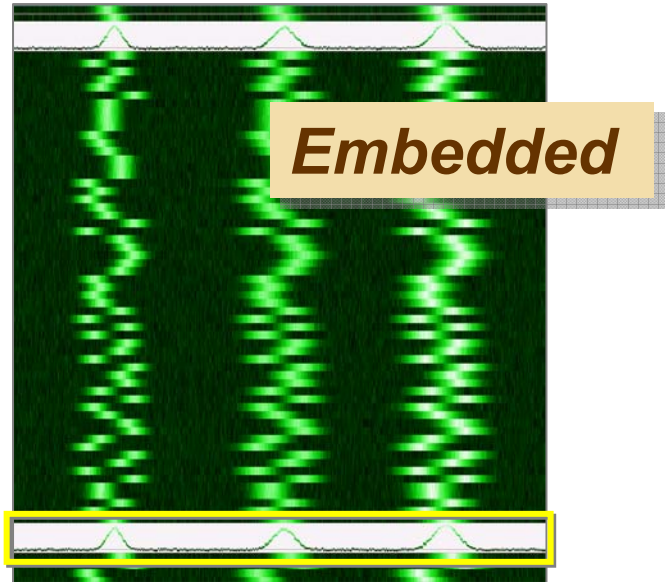


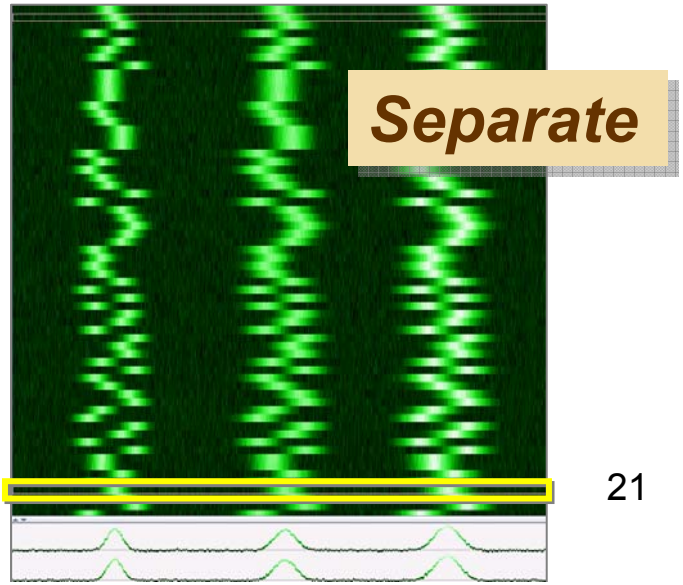
Single-VIR Interfaces





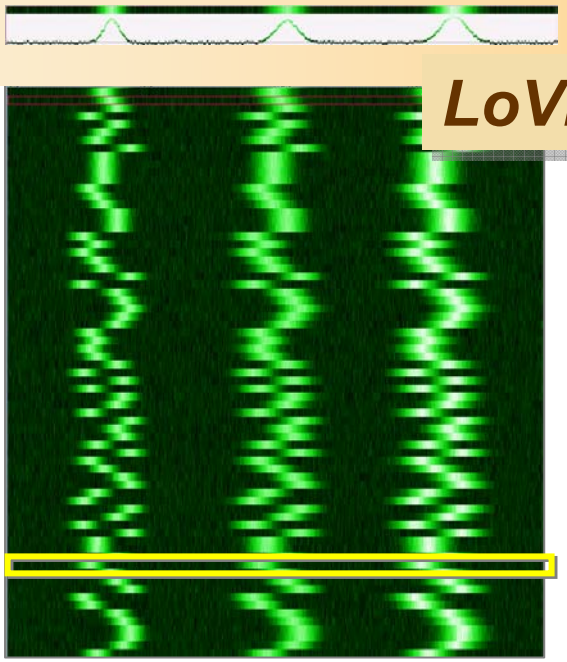
Multiple-VIR Interfaces

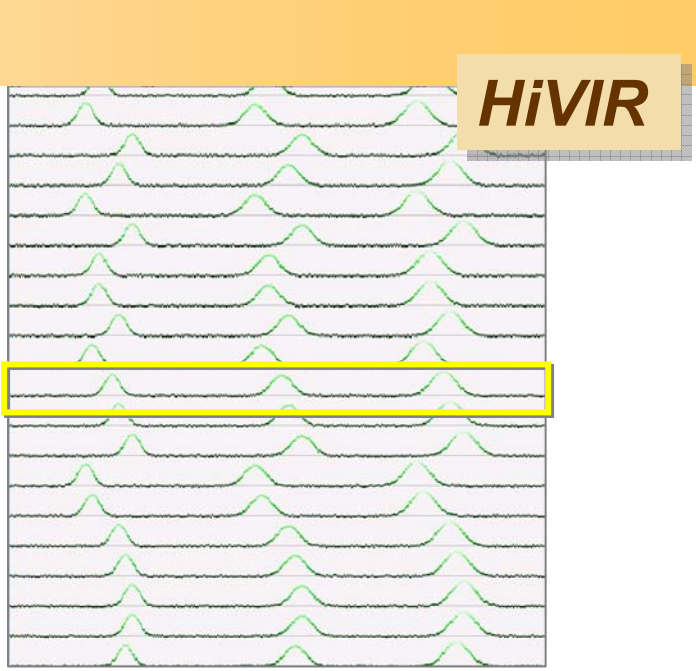




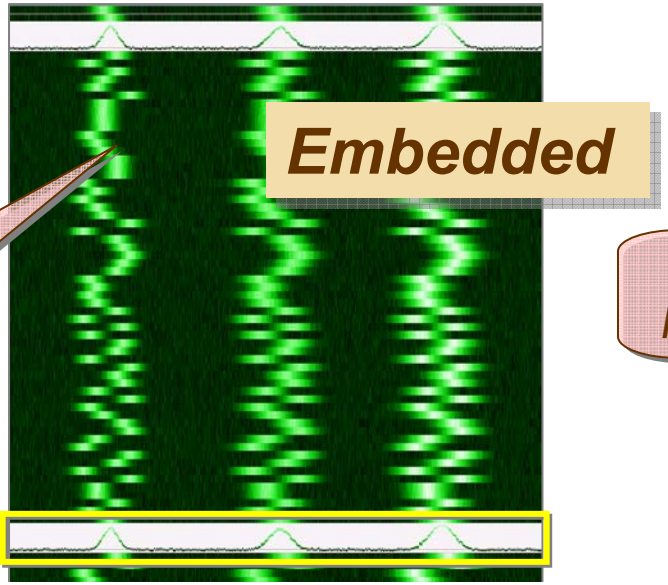
Task 4: *Compare* (Match a line graph:)

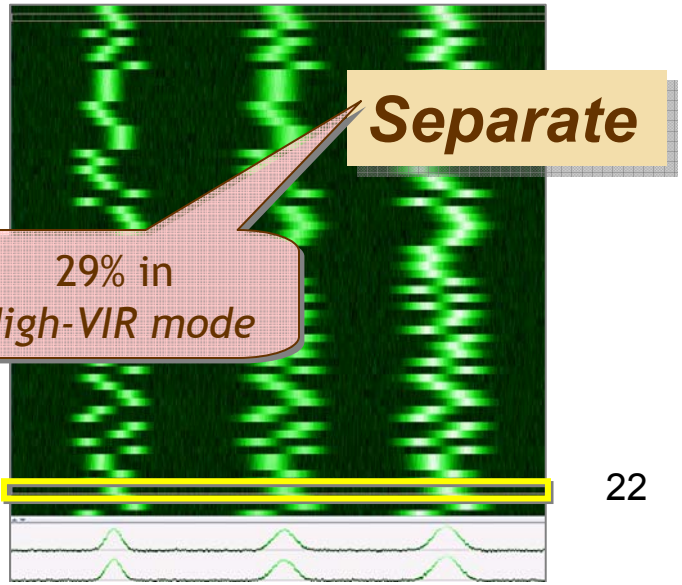
Single-VIR Interfaces



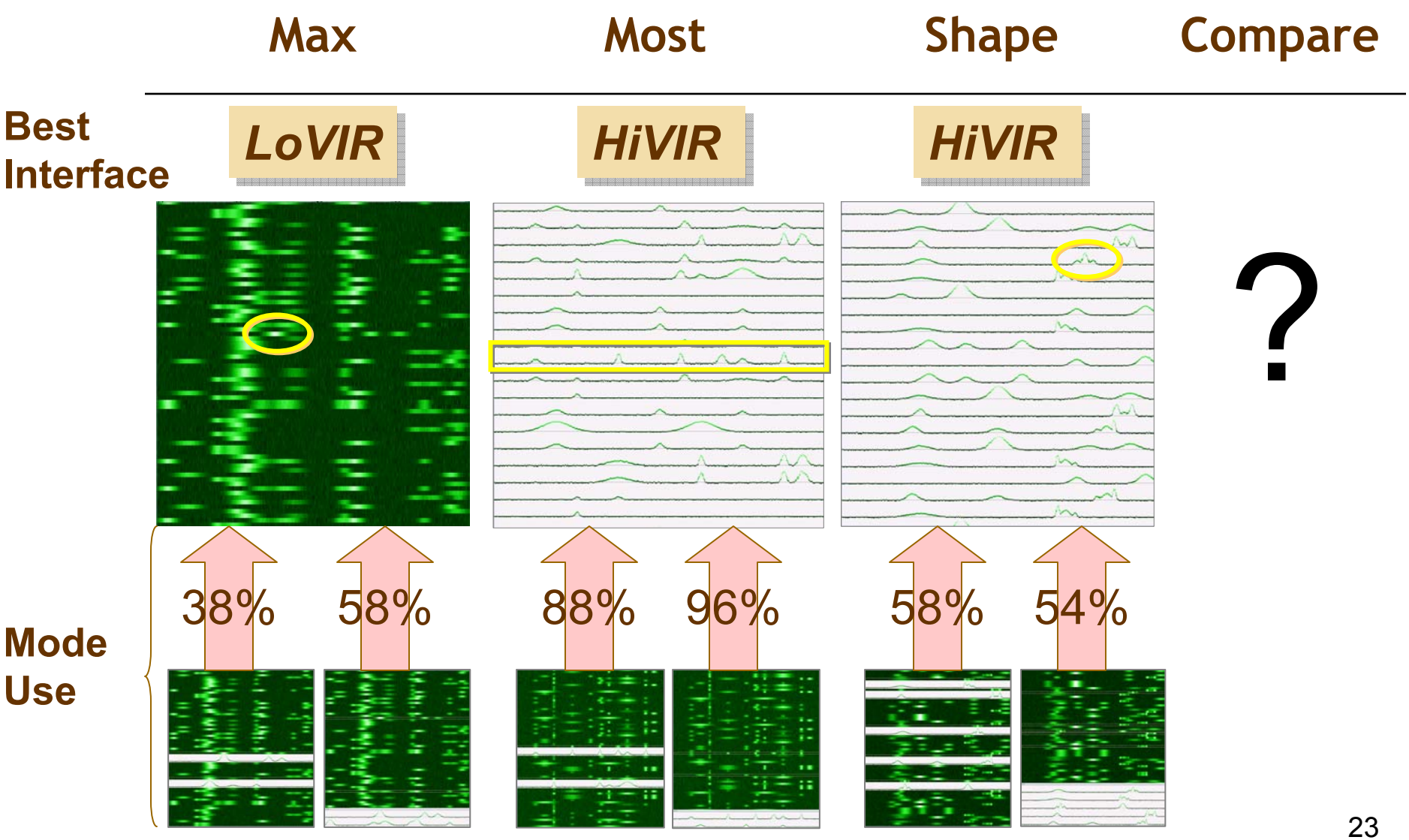


Multiple-VIR Interfaces



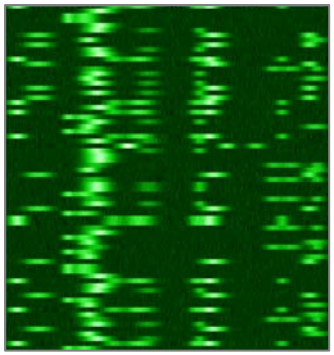


Result Summary



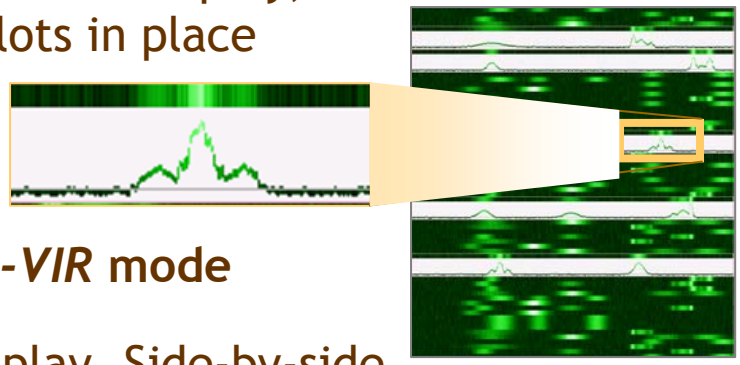
Study Hypotheses Revisited

1. ✓ Our low-VIR display alone is usable ONLY when the targets are single-peaked with limited horizontal span



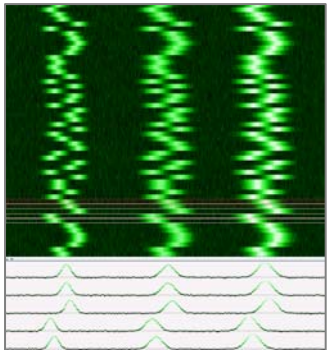
***LoVIR* is the best interface *only* for the Max Task**

2. ✗ Multiple-peaked targets are easy to find in the low-VIR display, but harder to interpret. Embedding the Hi-VIR plots in place should help learning.



***Embedded* is not any better than *HiVIR*.**
54% of the Shape Task trials were done in *High-VIR* mode

3. ✗ Similar targets are hard to find in the low-VIR display. Side-by-side comparison should help.



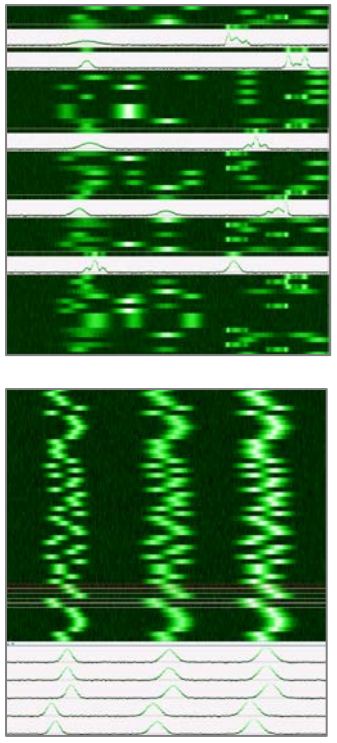
***Separate* is not better than either *HiVIR / LoVIR* interface**
29% of the Compare Task trials were done in the *High-VIR* mode

Why *HiVIR*?

- Overall, our participants used the multiple-VIR interfaces **as intended** in only half the trials
- ***HiVIR*** is tedious
  - Participants needed to scroll 6 screens to see all the data and memorized the targets
  - We saw ~10% missed the targets in the first scan, and had to rescan all 6 screens
  - Participants derived strategy to use *HiVIR* in the Compare task
- **Conjecture: *interaction complexity*** in the multiple-VIR interfaces may be the intrinsic problem

Multiple-VIR Interfaces: Interaction Complexity

- Multiple-VIR interfaces require active selection of areas of interest
  - seems especially hard when identifying such areas is difficult (e.g., multiple-peak targets)
- Our multiple-VIR interfaces had “classic” problems:
  - *Embedded* plots disrupt overview scan
  - *Separate* needs view coordination
- In contrast, using high-VIR plots has low cognitive load
  - Only available navigation is scrolling
  - Answer is apparent sooner or later
- Did participants pick what *seemed easier* ?



Summary

- **Motivation**: Overview tradeoffs in sacrificing visual details for display capacity for single-leveled data
- **Study Question**: Does the less-detailed overview allow selection of areas of interest?
- **Grounding**: Low-VIR overview alone is insufficient for visual signals that are complex (multiple-peaked) or span a wide horizontal space
- **Finding**: many participants used either single-VIR display alone in multiple-VIR interface trials
  - ~40% for Max; ~100% for Most; ~50% for Shape; ~20% for Compare
- **Conjecture**: Participant choice reflects interaction complexity of multiple-VIR interfaces

Acknowledgment

- We appreciate many discussions with **Ron Rensink** on study design and perceptual literature
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