OMC and dark fringe characterisation

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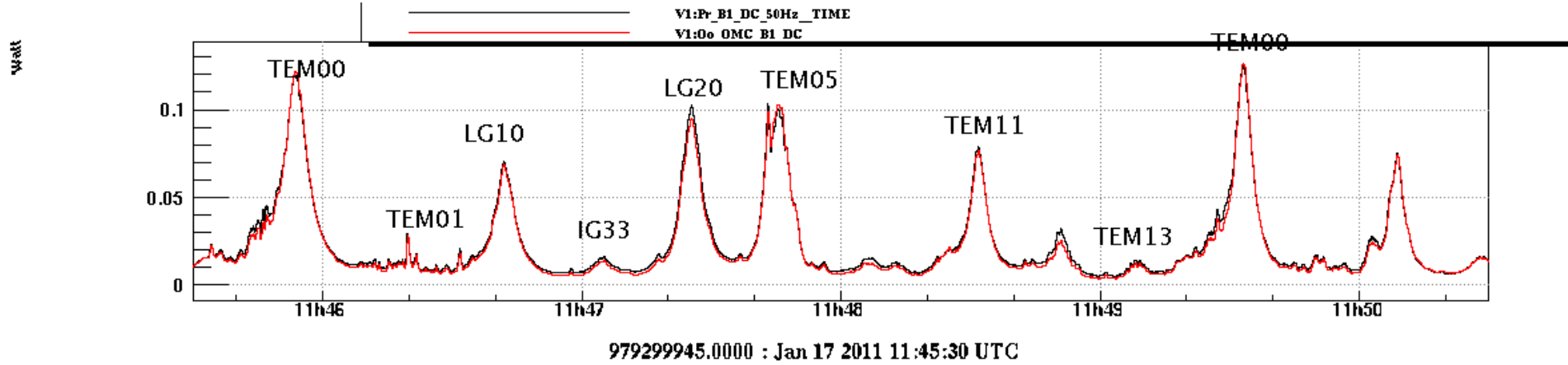
Virgo week - Commissioning meeting
Feb 7th ,2011

- OMC scans
- OMC matching and ITF alignment
- Dark fringe composition: higher order modes, carrier/sidebands
- OMC and Fabry-Perot higher order modes transmission
- Measurement of FP losses

OMC scans: what for?

- Example of OMC scan (with CHRoCC ~310 degrees, logbook entry 28635 by Julien)



These data are used to extract the dark fringe content in HO modes and to measure the OMC matching:

⇒ Which part of the observed HOMs is due to OMC mismatching / misalignment?

⇒ Which part is really the dark fringe content?

Look at the GW signal in each HO mode:

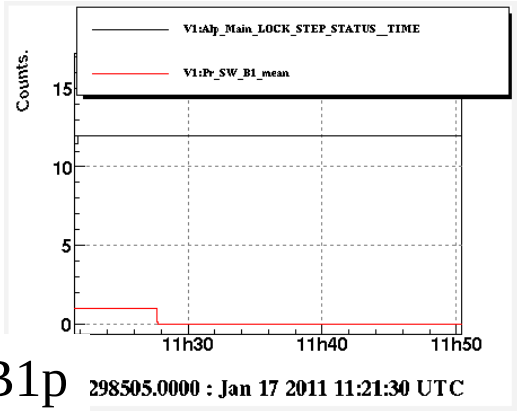
- modes due to OMC mismatching/ misalignment contain GW signal
- dark fringe HO modes do not contain GW signal

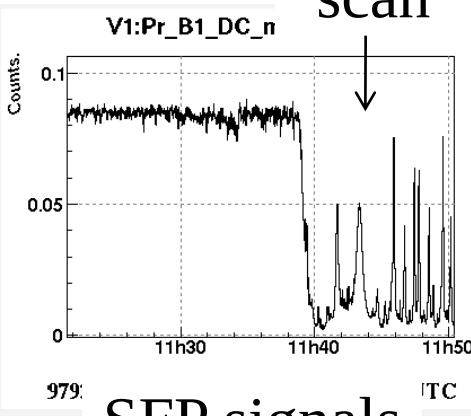
OMC scans in practice

- ITF in step 8 or 12
- Dark fringe controlled with B1p
  - Large offset on B1p_ACp due to the presence of HO mode
    - ⇒ The differential working point is not the good one
    - ⇒ B1_ACp often saturates when the ITF is controlled with B1p

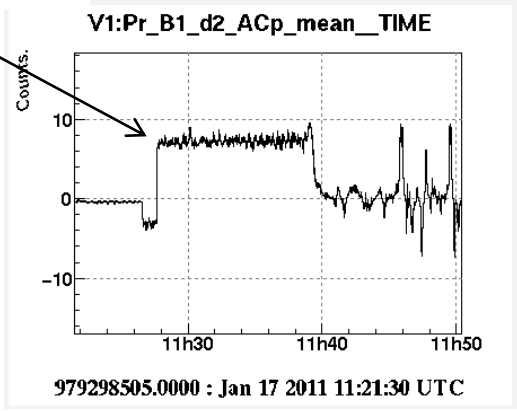
This offset should be subtracted
⇒ Easier interpretation of OMC scans
⇒ Easier switch B1p<->B1

OMC scan

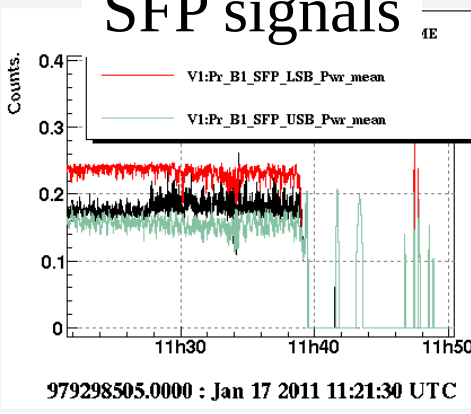




DARM control on B1p

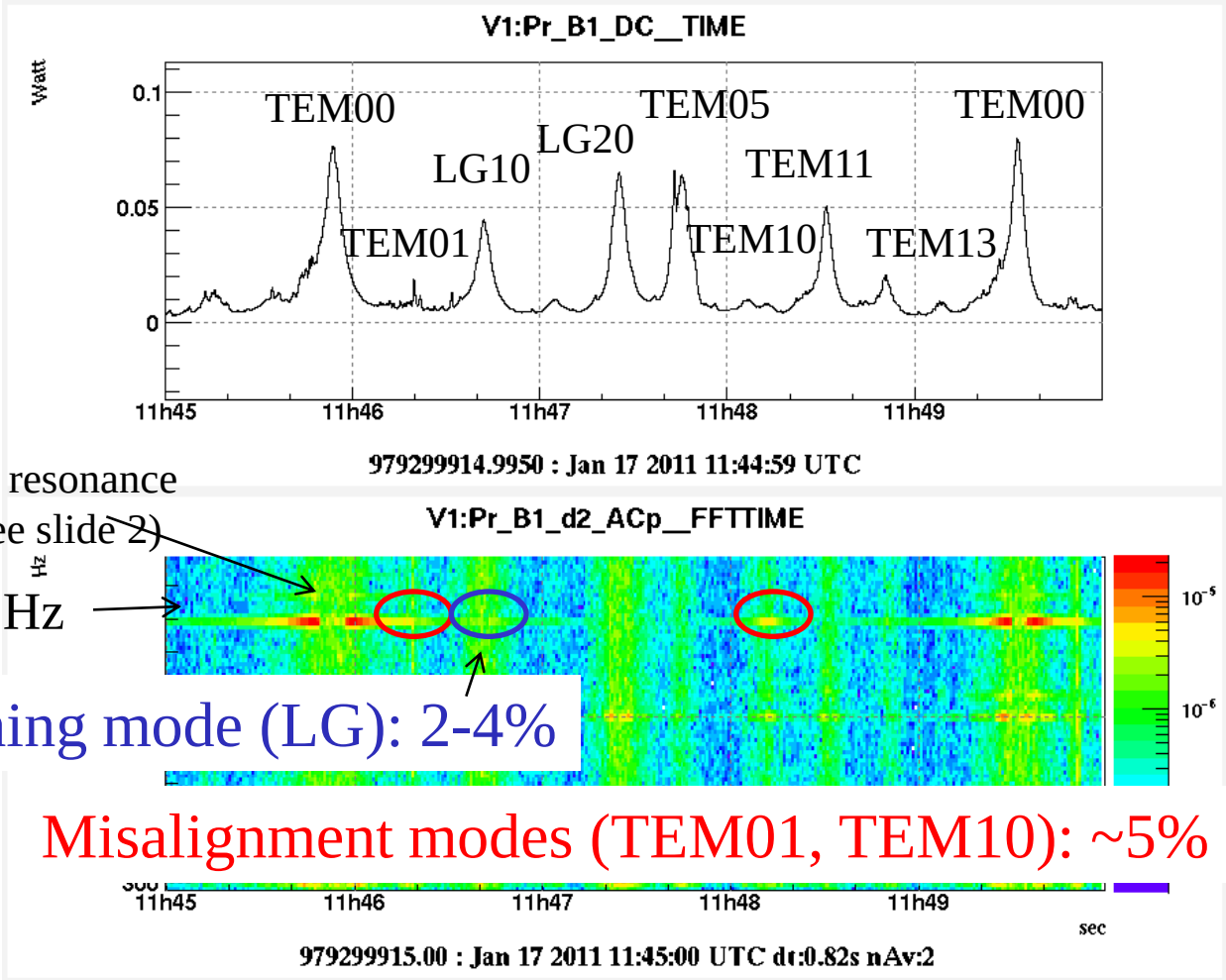


SFP signals



OMC matching / alignment

Measure the fraction of GW signal in each mode: use the diffential line at 379Hz



B1_ACp saturates on TEM00 resonance
(due to bad working point, see slide 2)

Mismatching mode (LG): 2-4%

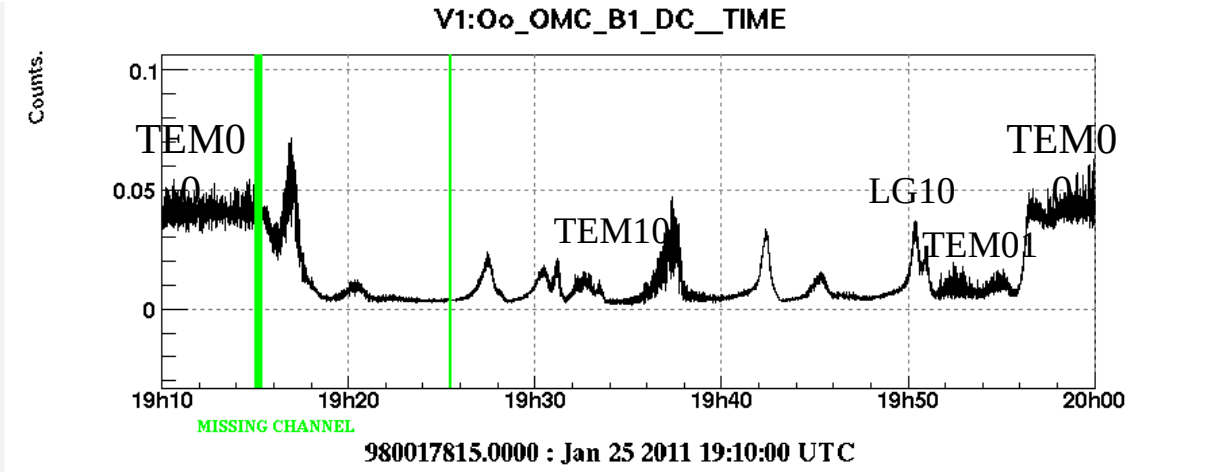
Misalignment modes (TEM01, TEM10): ~5%

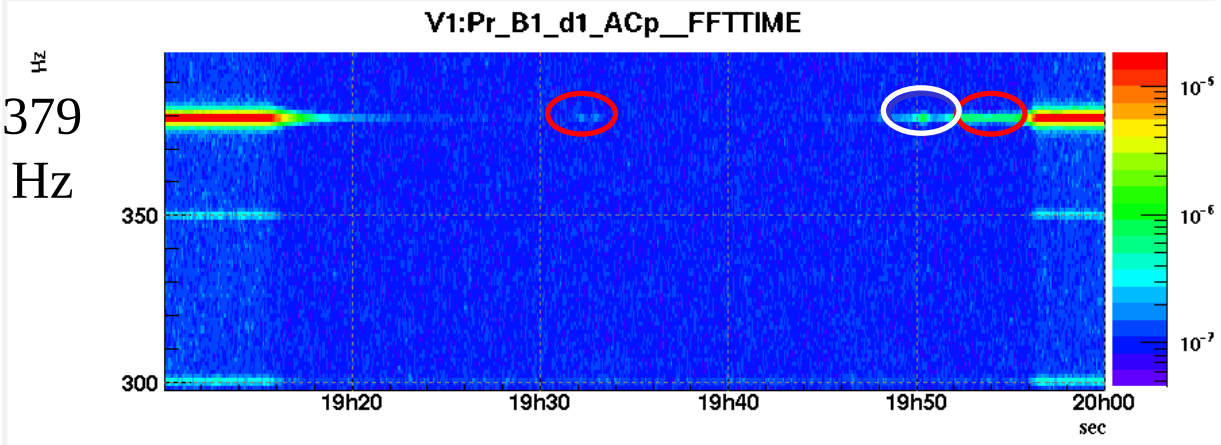
⇒ Signal loss due to OMC mismatching: ~10%

OMC matching/alignment

- Same analysis at step8 (same CHRoCC working point):
  similar results for matching/alignment

⇒ TEM10 and TEM01 are partly due to OMC misalignment
⇒ other HO mostly reflect dark fringe content

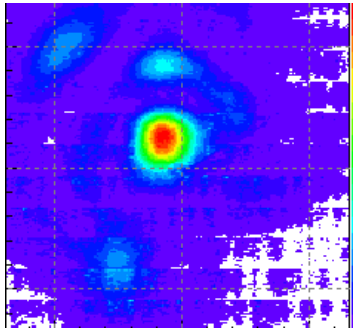


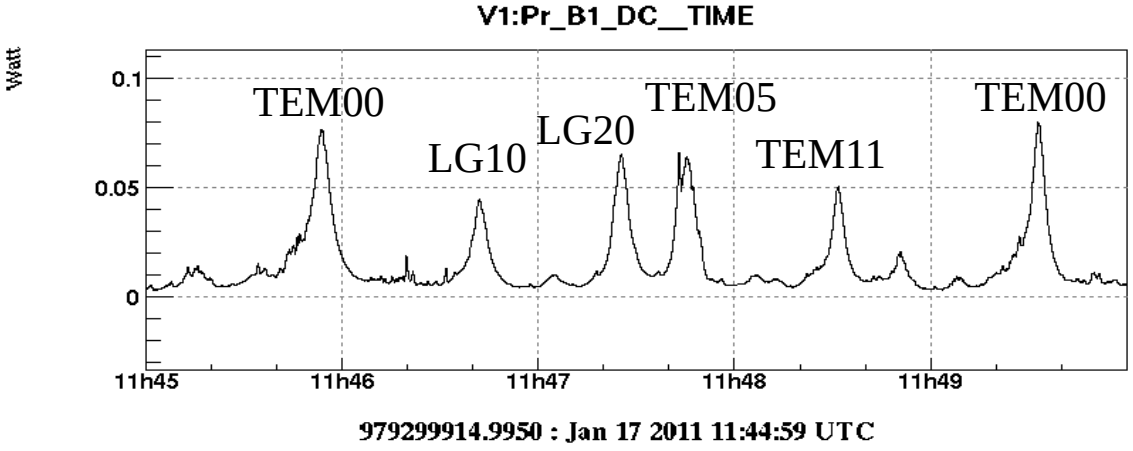


Dark fringe content: HOMs

- STEP 12: HO modes mostly due to ROCs and input beam mismatching and astigmatism

B1p at step 12

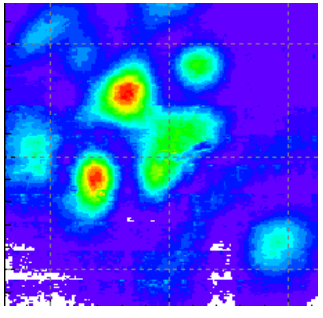


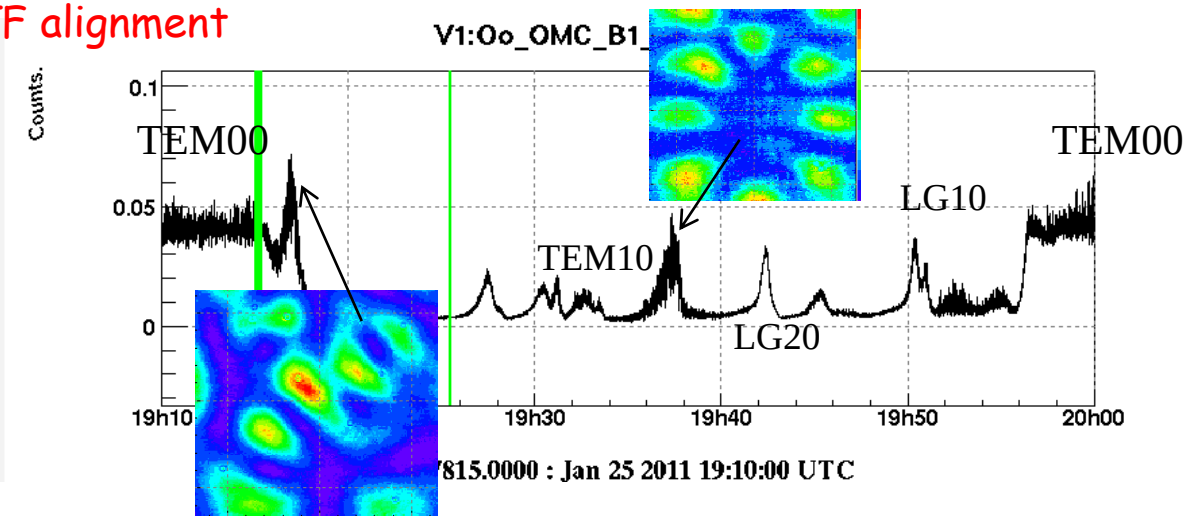


- STEP 8: HO modes due to poor ITF alignment
  - HO mode very close to TEM00 => OMC lock very difficult

=> need to improve ITF alignment

B1p at step 8

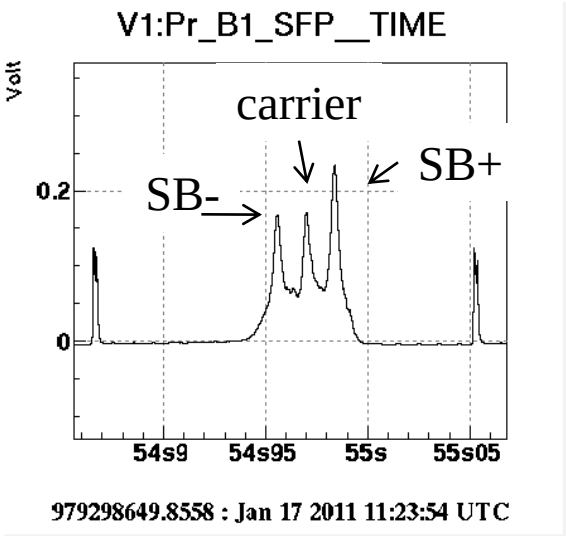




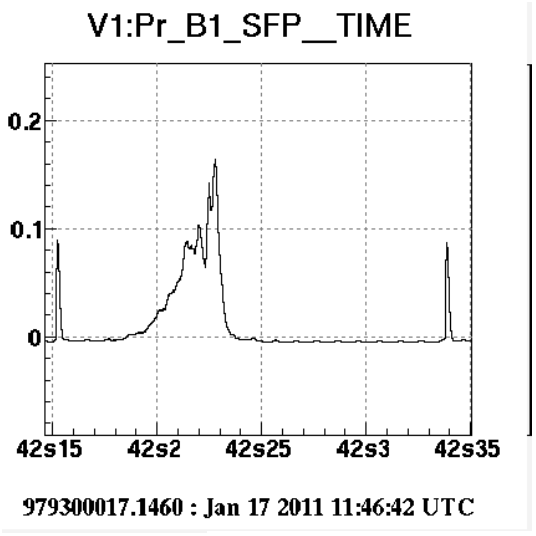
Dark fringe content: carrier/sidebands

- What are the HO modes made of: fraction of carrier and sidebands?
  - Use the scanning Fabry-Perot located after the OMC

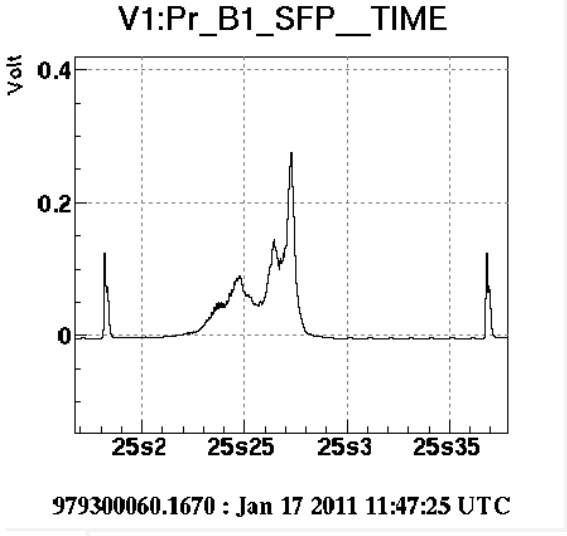
OMC on TEM00



OMC on LG10



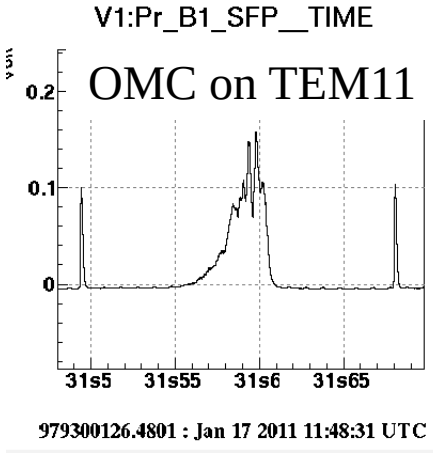
OMC on LG20



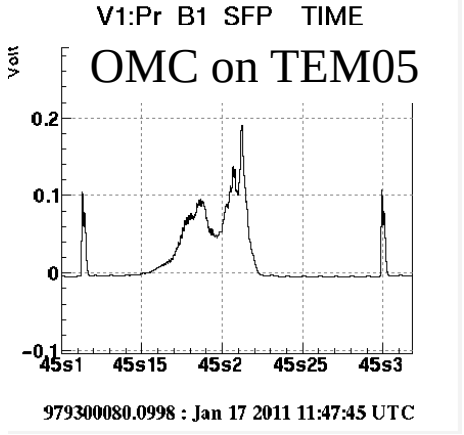
- Content is clear for TEM00:
  all 3 components roughly the same

- Decomposition unclear for other modes.
  It seems that SB+ dominates (?)
  To be investigated

OMC on TEM11



OMC on TEM05

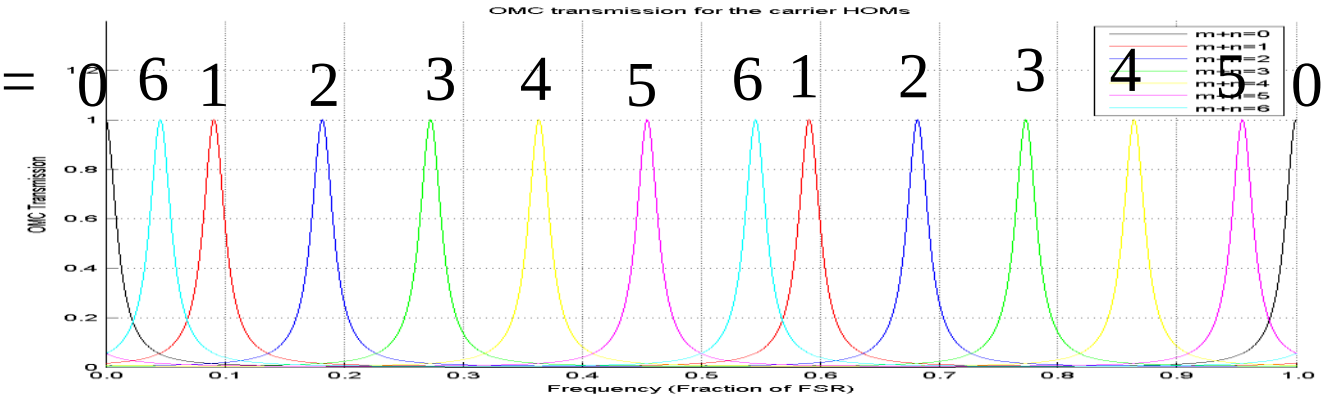


OMC and Fabry-Perot transmission for HOMs

OMC:

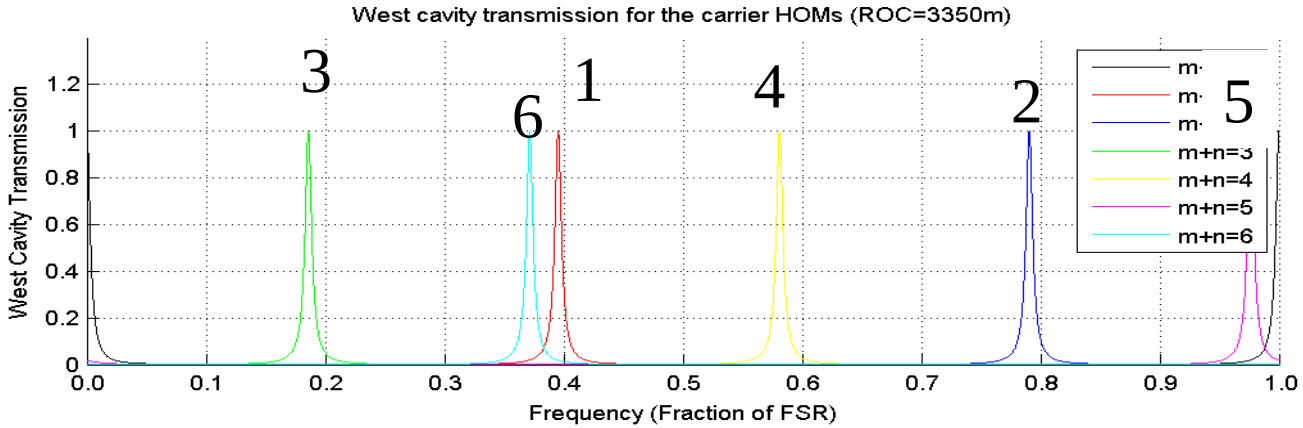
- TEMnm (m+n=5) close to TEM00 resonance only if n odd (T~7-8%)
- TEMnm (m+n=11) resonates with TEM00 (T~100%)

m+n= 0 6 1 2 3 4 5 6 1 2 3 4 5 0



Fabry-Perot cavities: ROC=3350m

m+n= 3 6 1 4 2 5



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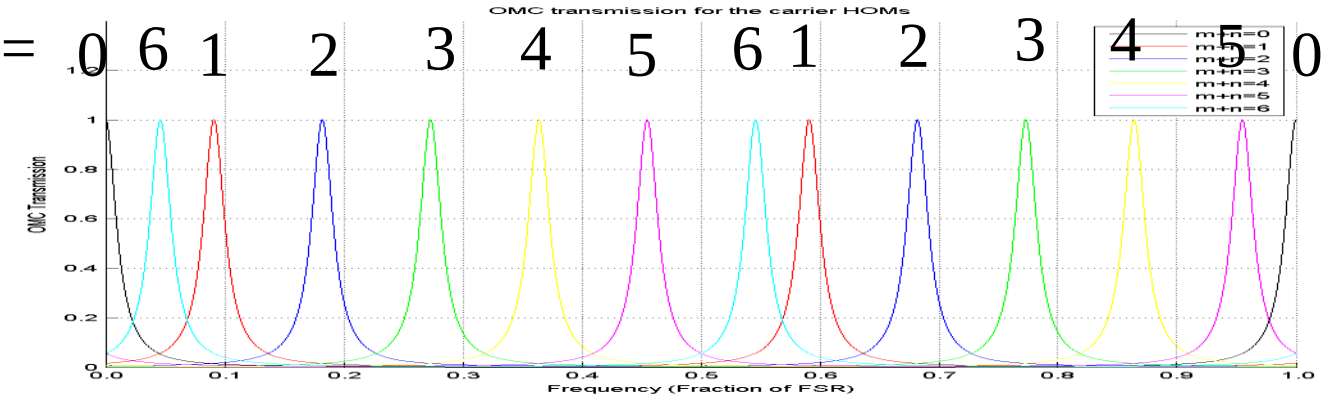
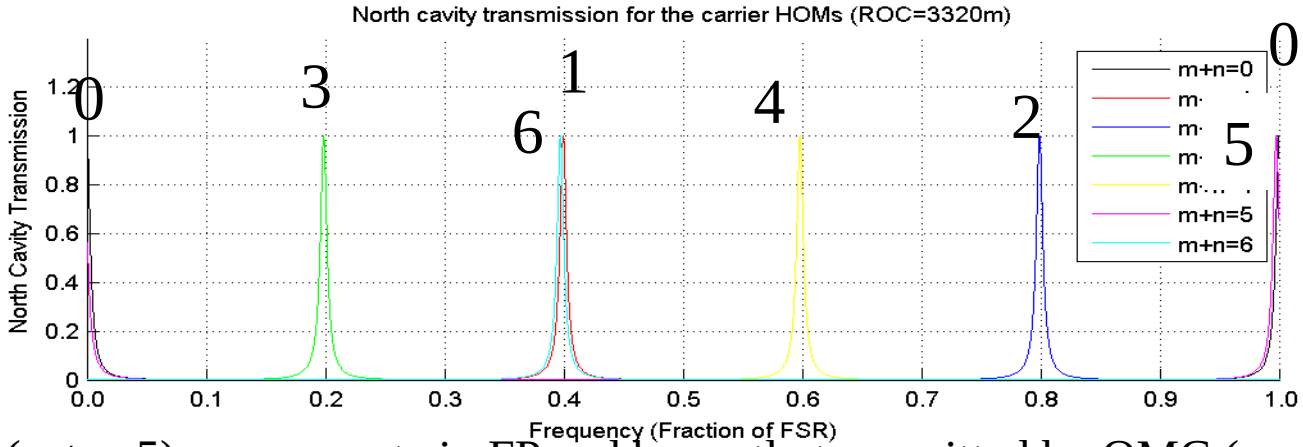


Fabry-Perot cavities: ROC=3320m

m+n= 0 3 6 1 4 2 5 0



⇒TEM (m+n=5) can resonate in FP and be partly transmitted by OMC (n odd only) if end mirror ROC = 3320 m

This has not yet been observed but bettter to avoid ROC=3320m

Measurement of FP losses on TEM00

The asymmetry of losses (on TEM00) inside the Fabry-Perot cavities drive:

- the contrast defect
- the coupling of frequency noise (and potentially other laser noises)

⇒ Impact on Virgo+ sensitivity

The Fabry-Perot losses can be measured by comparing the power reflected by the FP cavity when it is ON or OFF resonance:

- was done in November (logbook 28354, Vajente, Mantovani, Marque) using B1p
  => measure total FP losses (all modes): NA=130ppm, WA=580ppm

- what is important (contrast defect, coupling of frequency noise) is the losses for the TEM00
  ⇒ Need to use B1 with OMC locked on TEM00

We should redo this measurement using B1

Conclusions

- Large offset on DARM working point during OMC scans
  ⇒ Analysis of OMC scans more difficult / less precise
  ⇒ Need to substract this offset for future scans

- OMC lock difficult at step 8 due to HO modes from ITF misalignment
  ⇒ Need to improve the ITF alignment at step 8

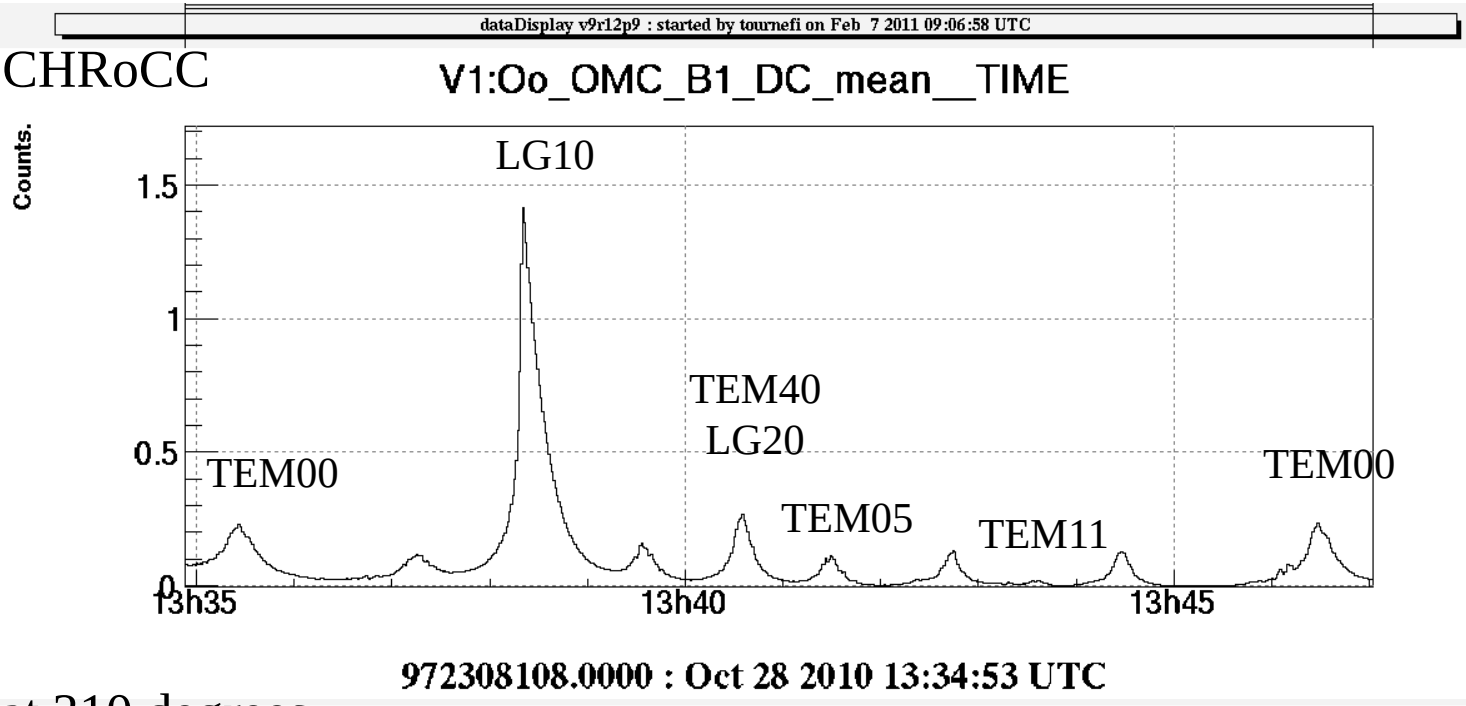
- Loss of GW signal due to OMC mismatching/misalignment: ~10%

- OMC scans can be used to extract the dark fringe content in HOMs
  - Fraction of carrier/ sidebands is unclear for HOMs (strange SFP signals)
    This information would be usefull to understand what is really due to ROCs and input beam mismatching

- Other measurement to be done with the OMC: FP losses on TEM00

OMC scans without/with CHRoCC at 300 degrees

No CHRoCC



CHRoCC at 310 degrees