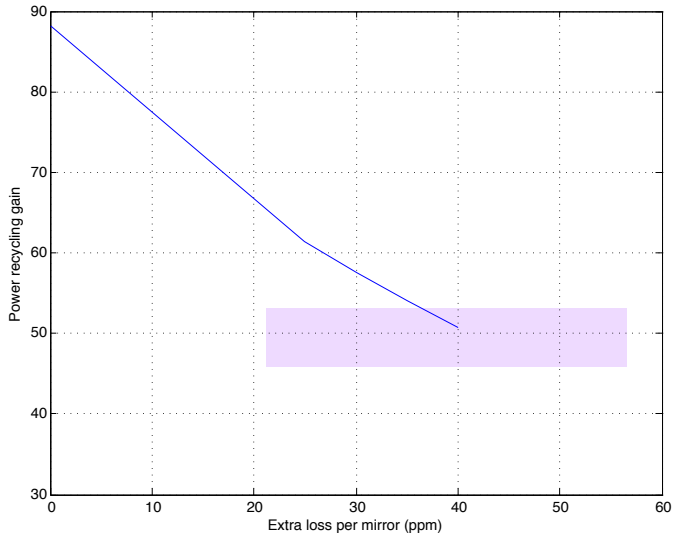
Extra loss ~ 40ppm / mirror microroughness = 4~5 ppm?

- Visibility, recycling gain, large angle scatterometer, etc are consistent with 150 ppm loss per arm
- known loss per arm
  - » surface figure ($\lambda > 0.6$cm) : 20-30 ppm / mirror x 2
  - » ETM transmission : 7 ppm
  - » absorption : 4ppm / mirror x 2
  - » diffractive loss : 2ppm
- 150 - known = 80 ppm / arm or 40 ppm / mirror

- FFT calculation with phasemaps($\lambda > 0.6$cm)
- extra loss as a free parameter



LIGO

Advanced LIGO

- total arm loss budget = 70ppm
- known loss : ~ 50 ppm / arm
  - » diffraction : 0.4 ppm
  - » absorption : 0.5 ppm x 2
  - » surface figure : 20ppm x 2
  - » ETM transmission : 7 ppm
- 11 ppm / mirror for microroughness and all other losses
- LIGO I mirror : 40 ppm

LIGO

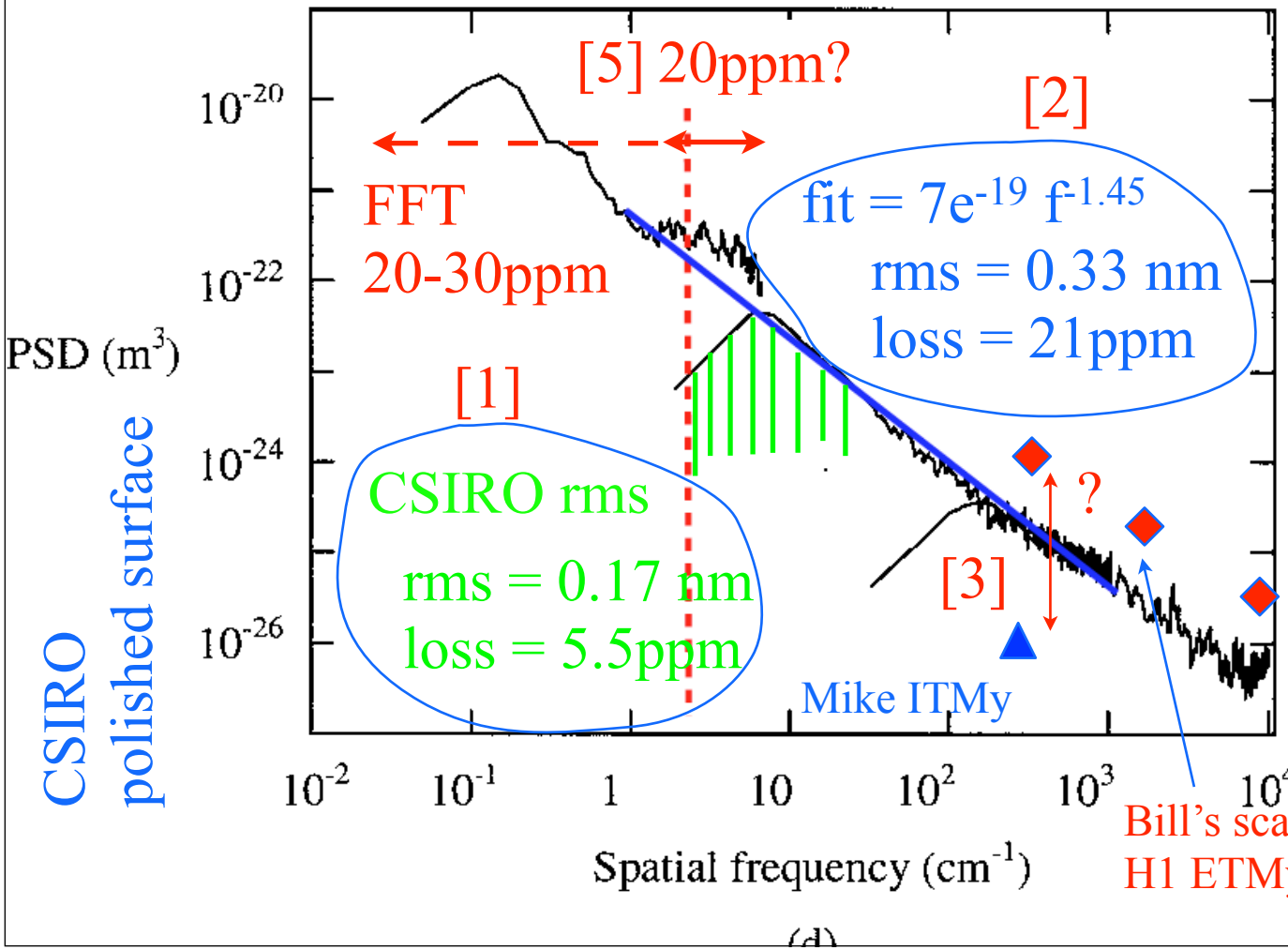
$$loss = C(\frac{4\pi\sigma_{1D}}{\lambda})^2$$

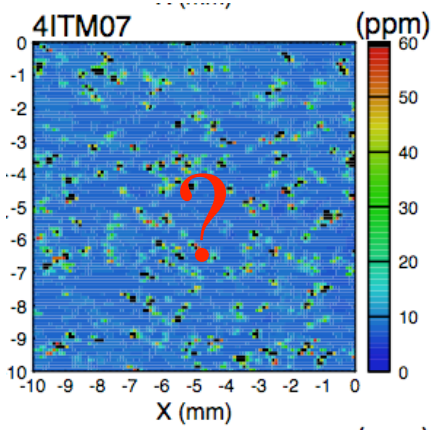
Summary

($C_{1D->2D}$=1.2)

3.8cm^{-1}

+ 10 ppm non smooth scattering [4]



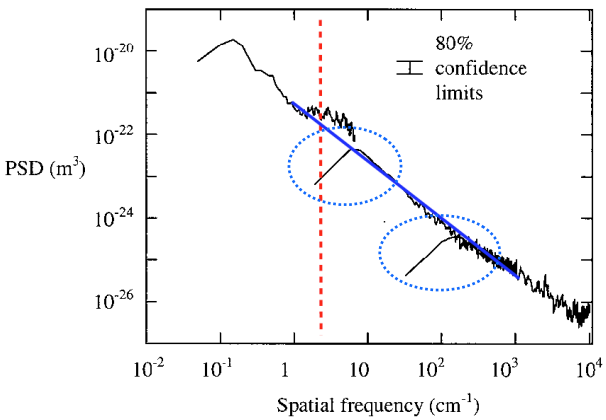


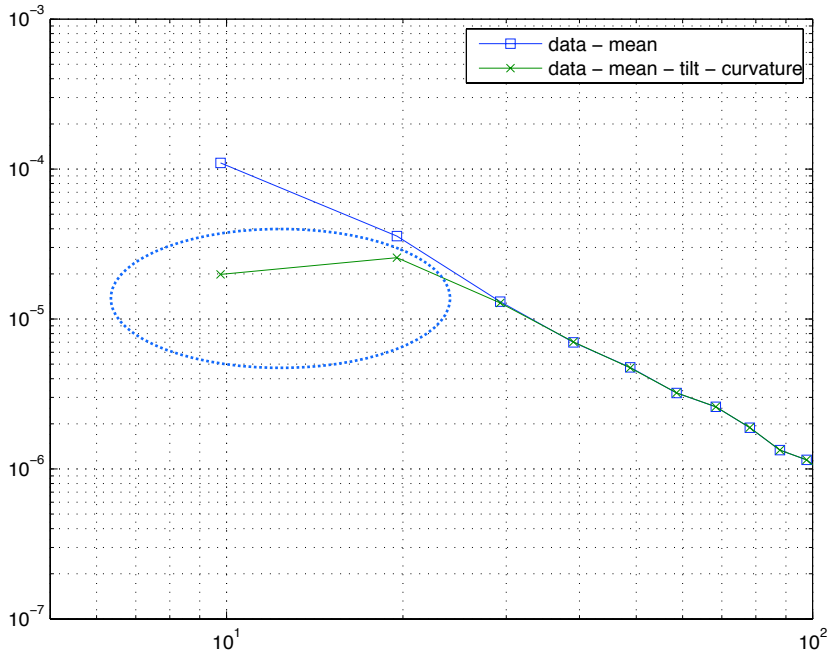
Liyuan's integrating sphere

Bill's scatterometer H1 ETMy

CSIRO RMS = 0.5 x true RMS

- 1d topo data - tilt - curvature using 1024 data points
  - » rms = 0.17nm
- generate data using spectrum f^{-2}
  - » rms = 0.12 using raw data
  - » rms = 0.064 using data with tilt and curvature subtracted
- loss ~ rms^2



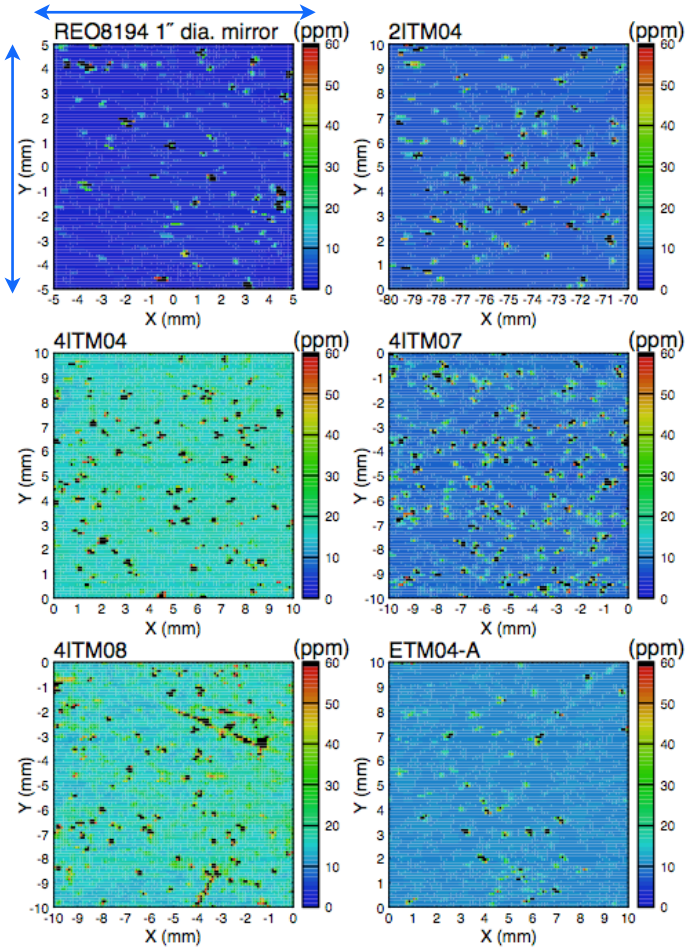


Integrating sphere data Liyuan

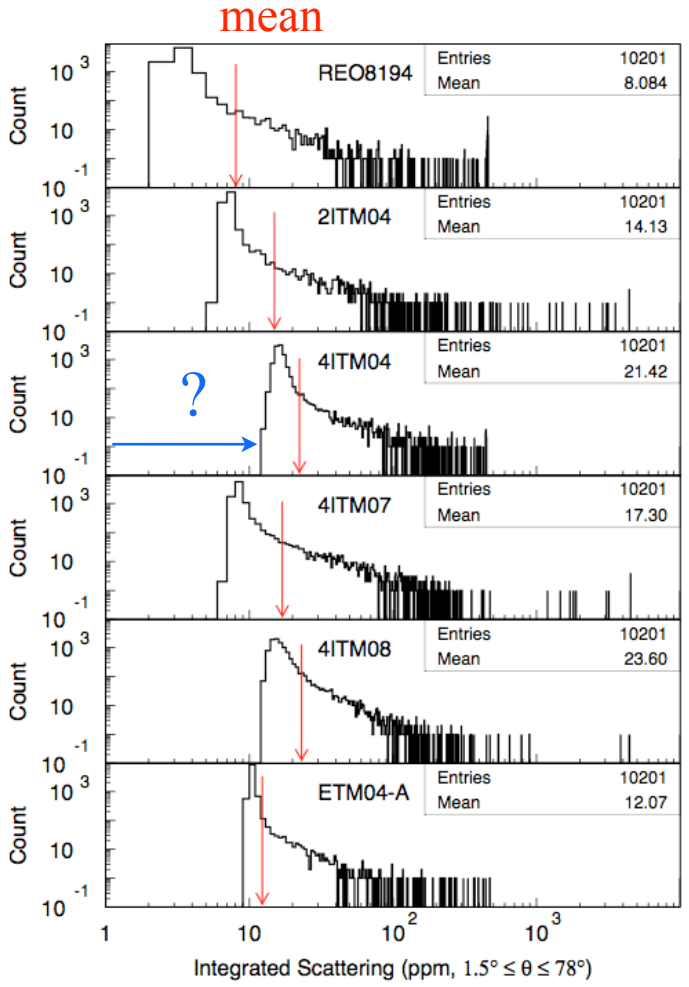
0.2mm beam size

1cm x 1cm

0.1mm step

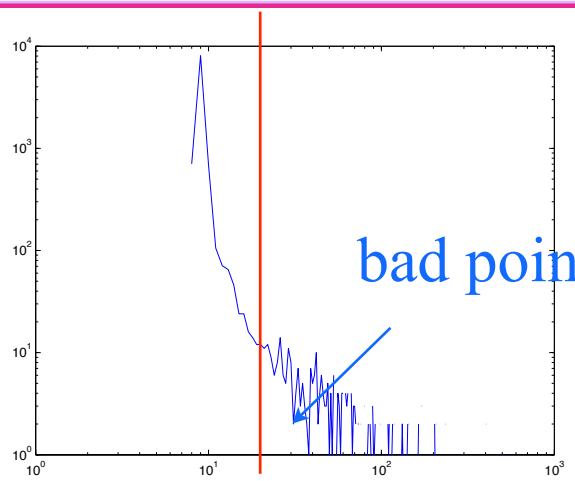


mean

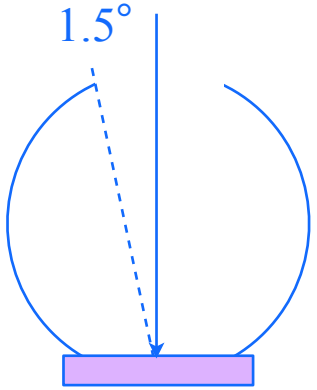


Point scattering loss ~ 10ppm

- 2ITM04
  - total of 10201 data
  - mean(all)=16, std(all)=109
  - bad points 362 with loss>20ppm
  - mean(bad)=193, std(bad)=556
  - mean(con)=193*362/10201=7 ppm



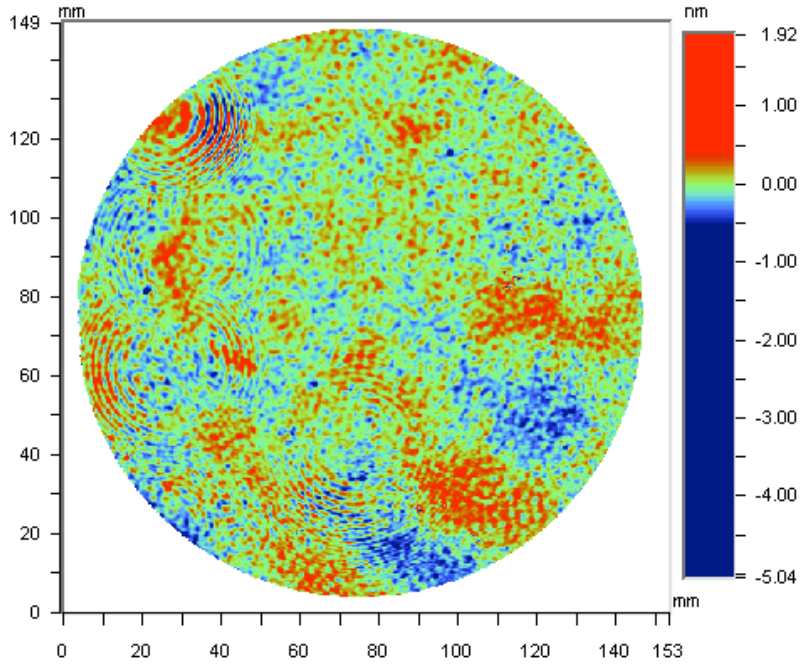
	cut ppm	bad points	mean(all)	mean(bad)	mean(con)
2ITM04	20	362	16	193	7
4ITM04	30	613	23	95	5.7
4ITM07	20	882	18	105	9.1
4ITM08	30	936	25	91	8.3
ETM04A	15	356	12	53	2

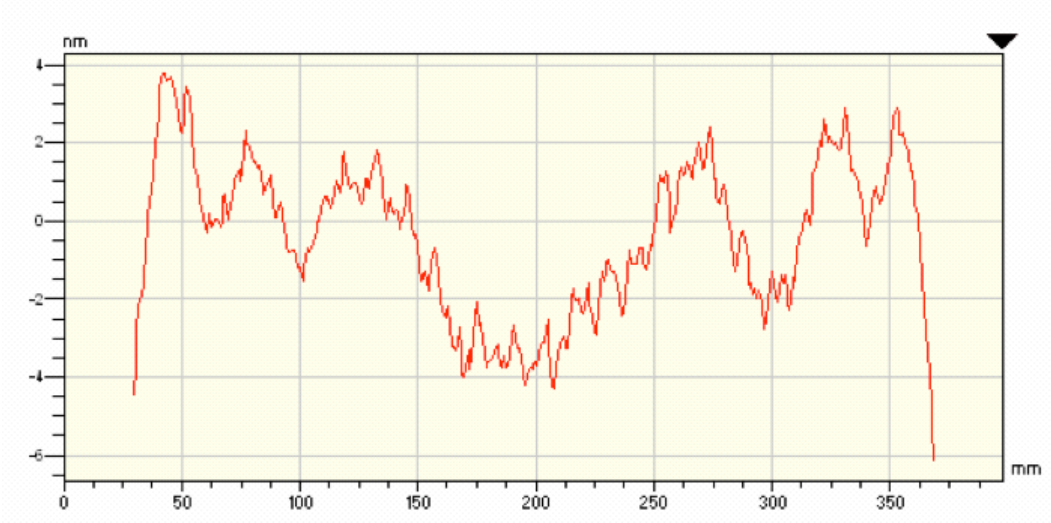


point scattering : uniform
~10 ppm

smooth roughness :
BRDF(θ)~$\theta^{-2.45}$
loss(>3.8cm^{-1}) =
$(1.5°/380\lambda)^{0.45}$ x 15ppm
= 100 ppm

Fine structure in mm region





loss pe size or

Loss calculated using a bin size : assume no loss with spatial frequency longer than 1/bin size

loss(1/bin2) - loss(1/bin1)
= loss coming spatial freq between 1/bin2 - 1/bin1