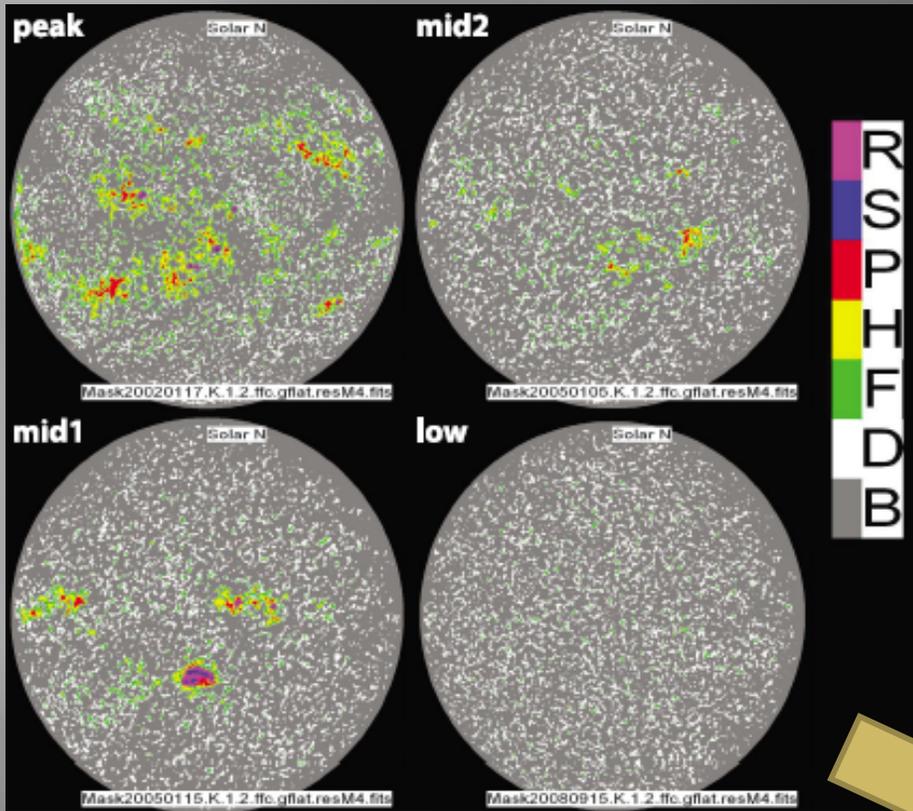


# PROPERTIES OF NETWORK AND FACULAE DERIVED FROM HMI DATA COMPENSATED FOR SCATTERED-LIGHT

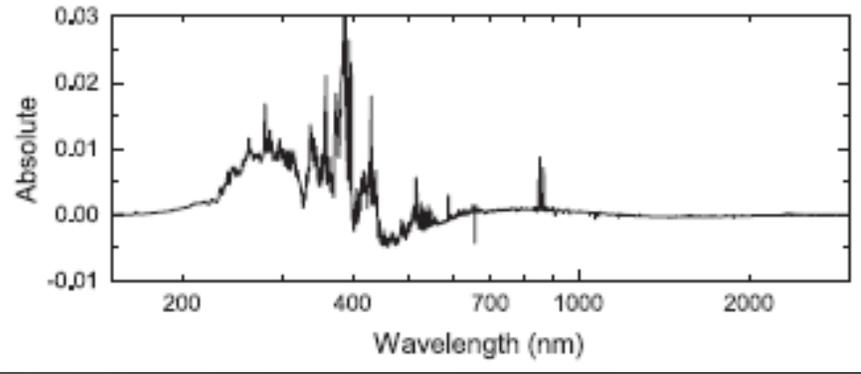
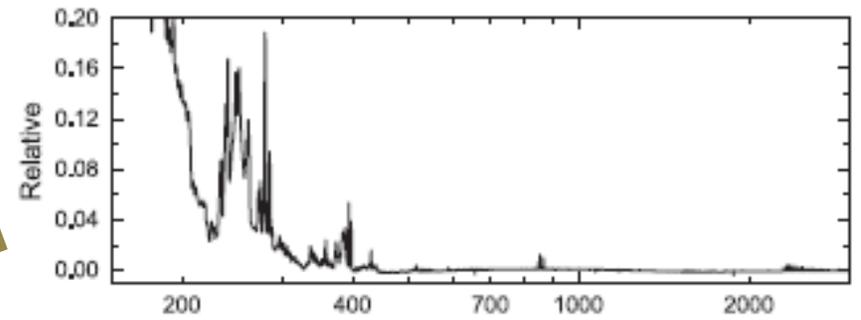
S. Criscuoli (NSO)

A. Norton (Stanford University)

T. Whitney (Nebraska University)



Irradiance variations



From Fontenla et al. 2011

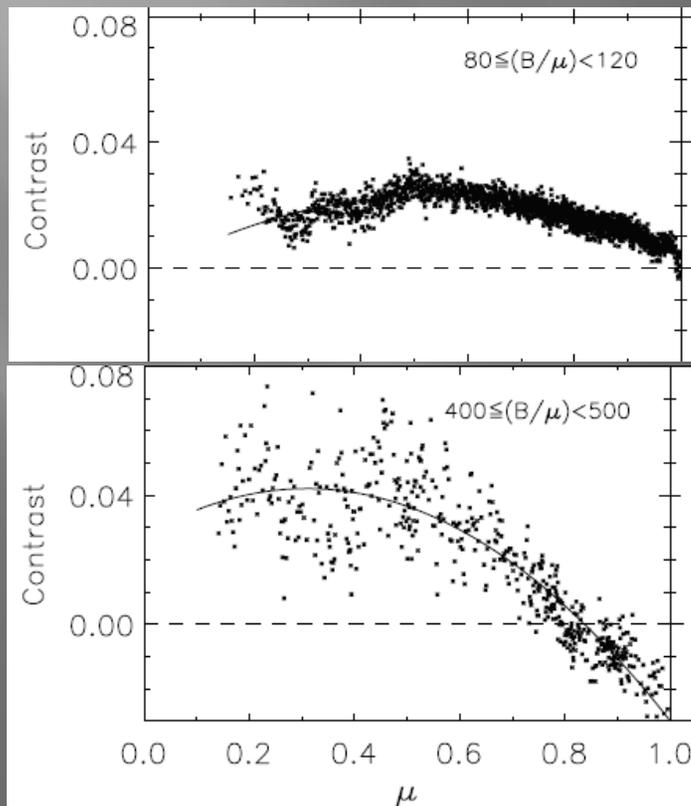
Solar Radiation Physical Modeling - SRPM

# Faculae vs Network

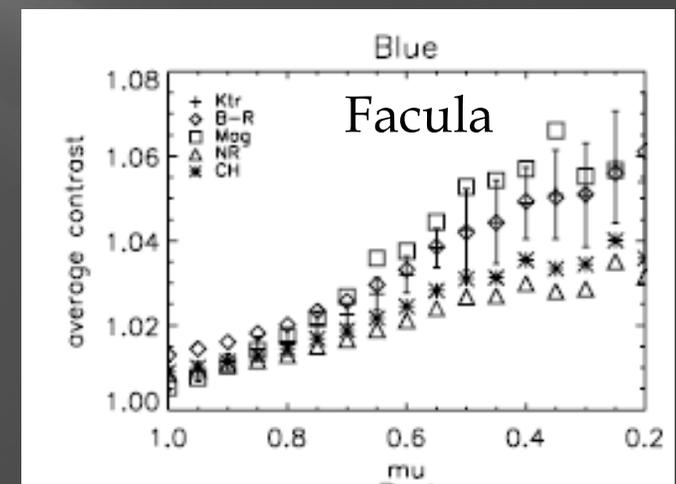
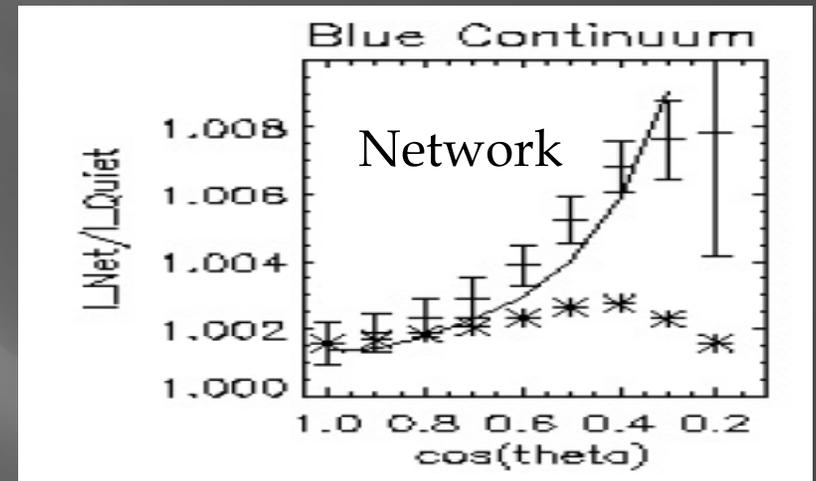
## Full-Disk Observations

- ❑ Network contrast is smaller than facular one
- ❑ Network contrast shows shallower CLV than faculae

Ermolli et al. 2003



Ortiz et a. 2002

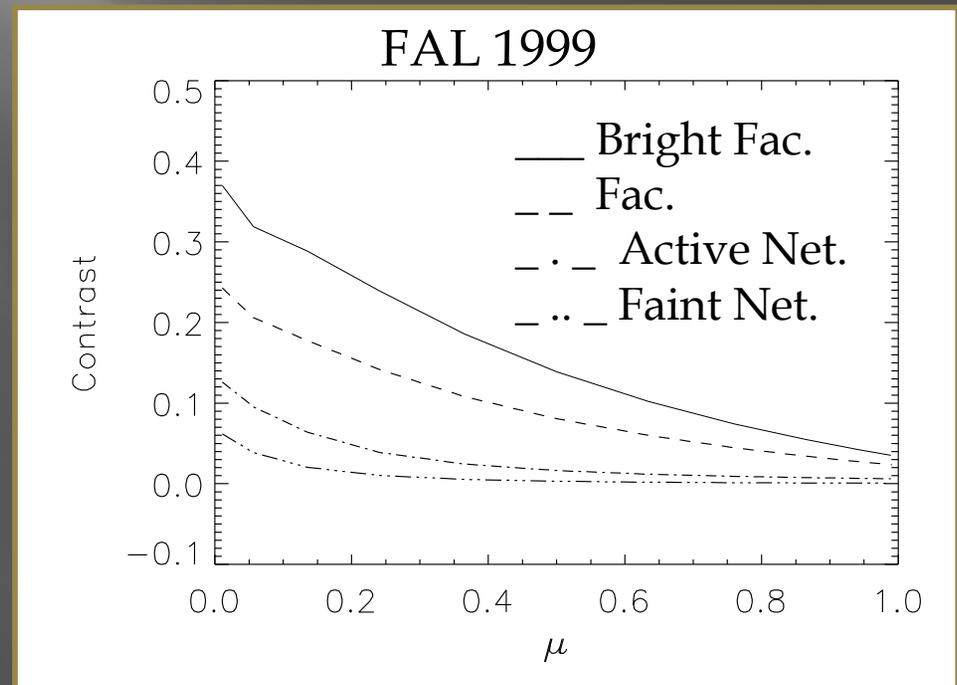
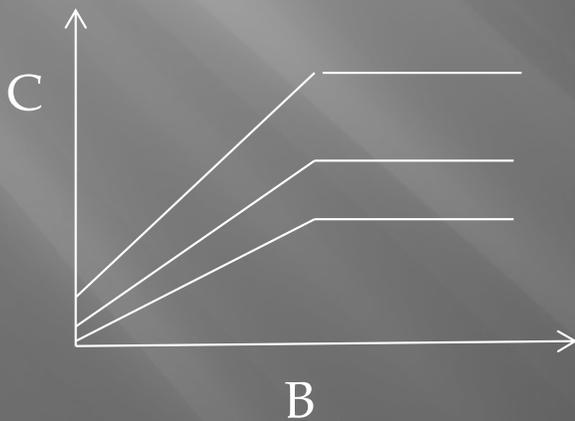


Ermolli et al 2007

# Faculae vs Network

## Models used for irradiance reconstructions

- 1) Models based on proxies : difference is not taken into account (e.g. NRLSSI).
- 2) SATIRE and SRPM: photometric contrast of Network lower than Facular. CLV flatter



# Faculae vs Network

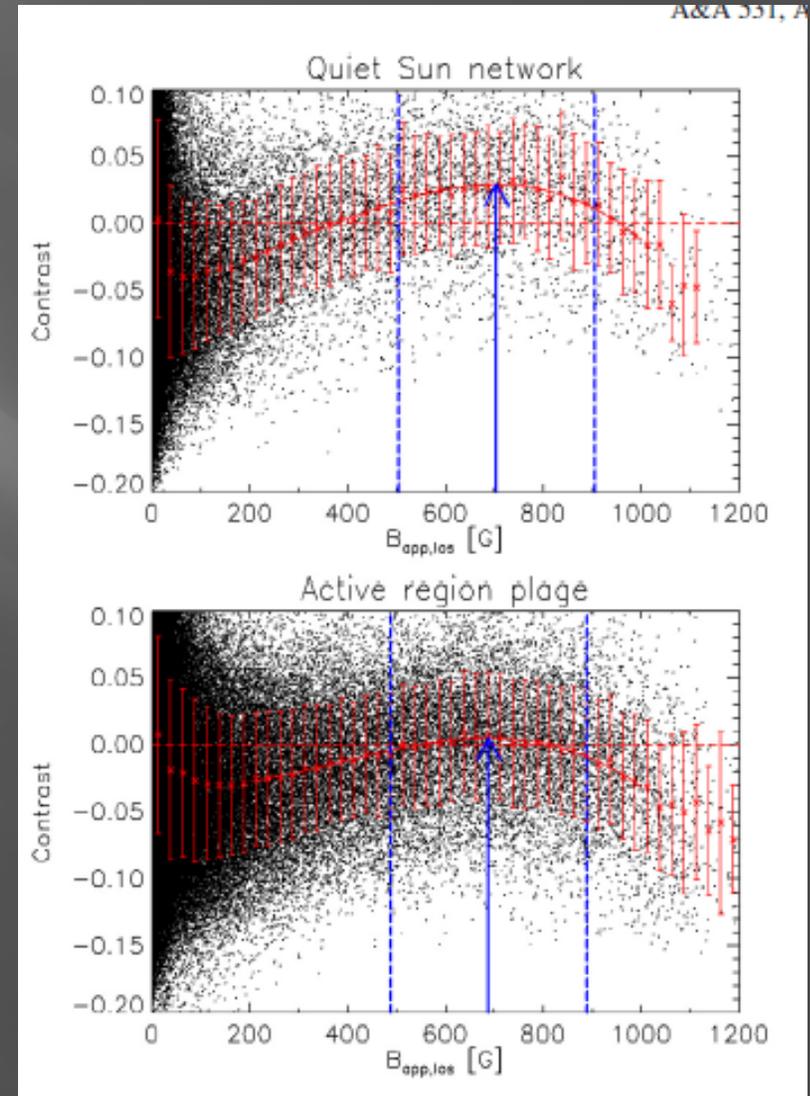
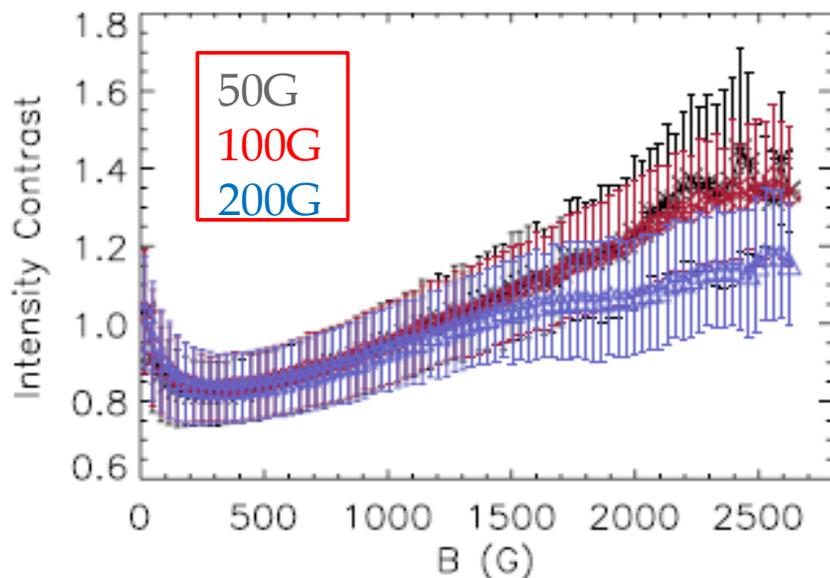
## 2) Sub-arcsec Observations and Simulations

Kobel et al. 2011

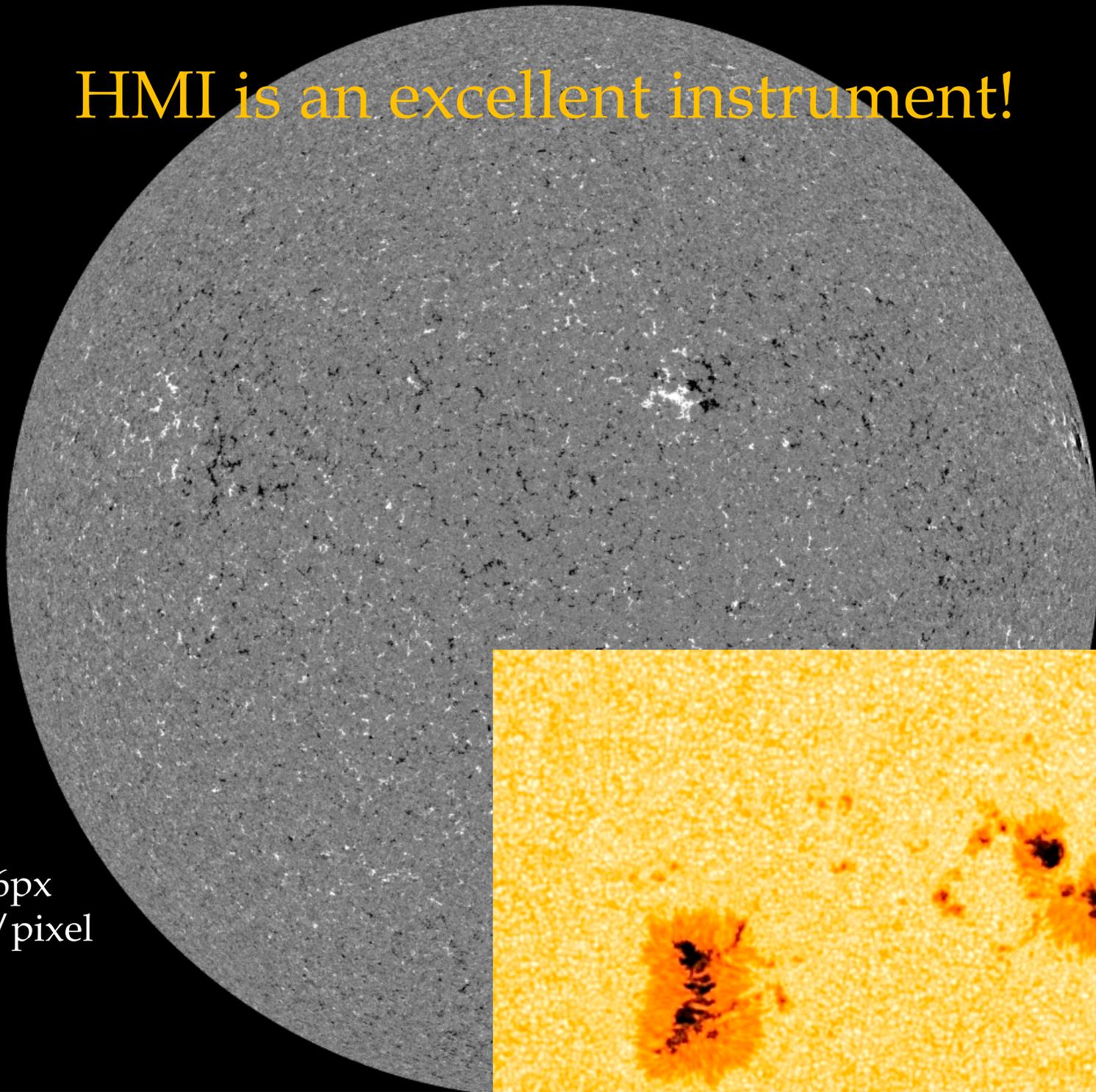
For a given magnetic field intensity,  
The contrast of magnetic elements is higher in  
Network than in AR regions

These observations are typically restricted  
to disk center, so no information is available  
about CLV.

Criscuoli 2013



HMI is an excellent instrument!

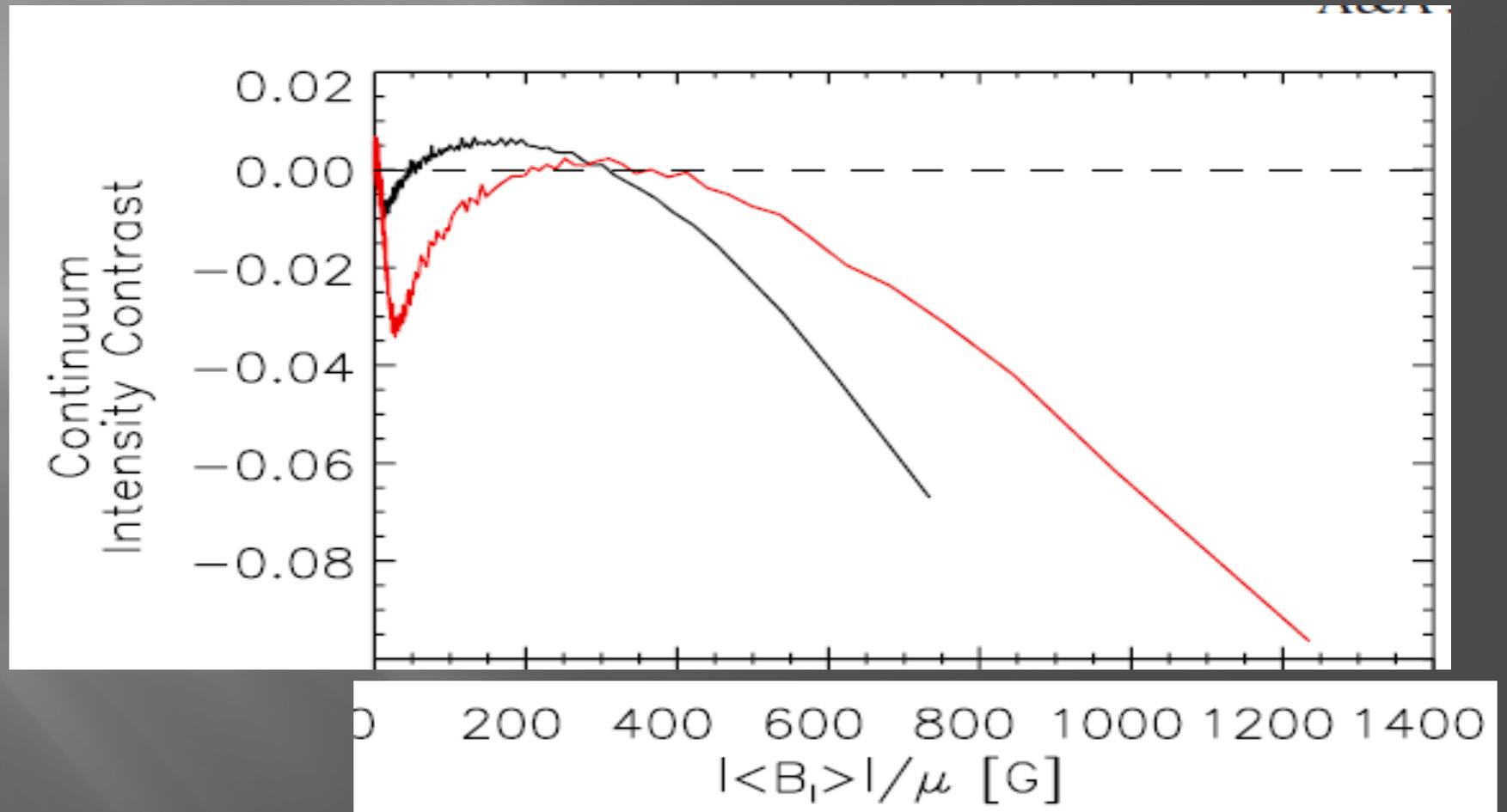


4096x4096px  
0.5arcsec/pixel  
1 arcsec  
617.3 nm

HMI Yeo et al. 2014

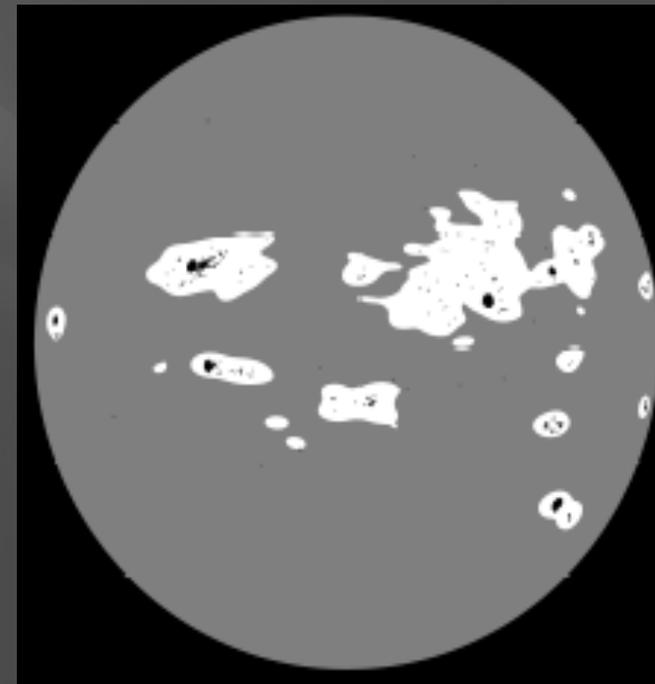
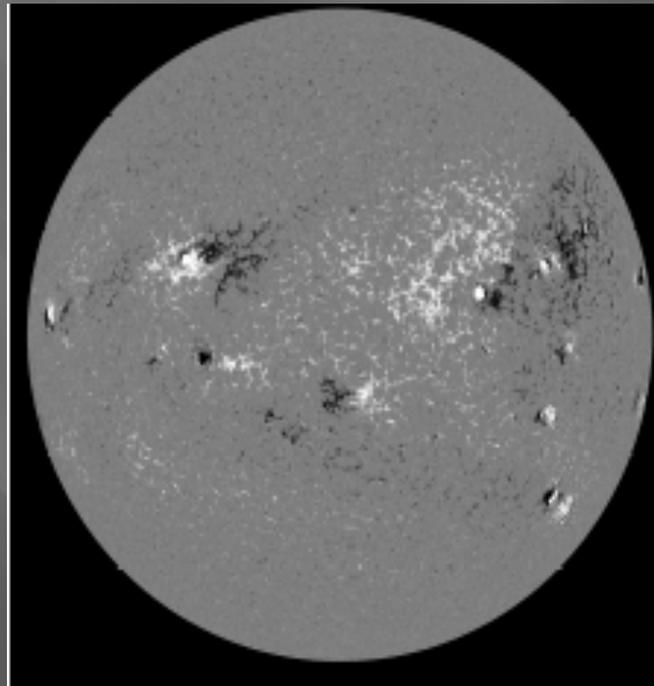
Black: original

Red: restored

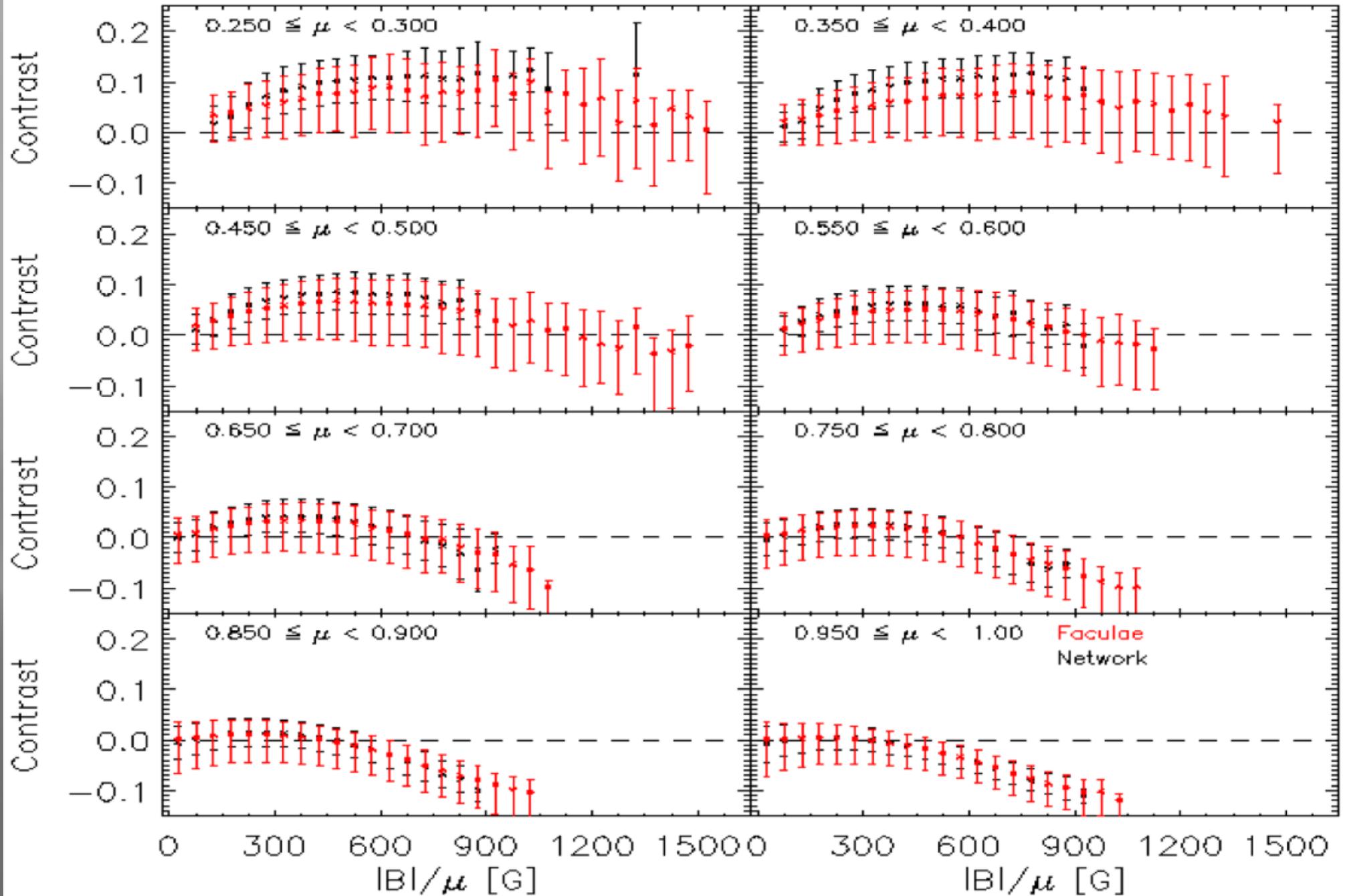


# HMI data

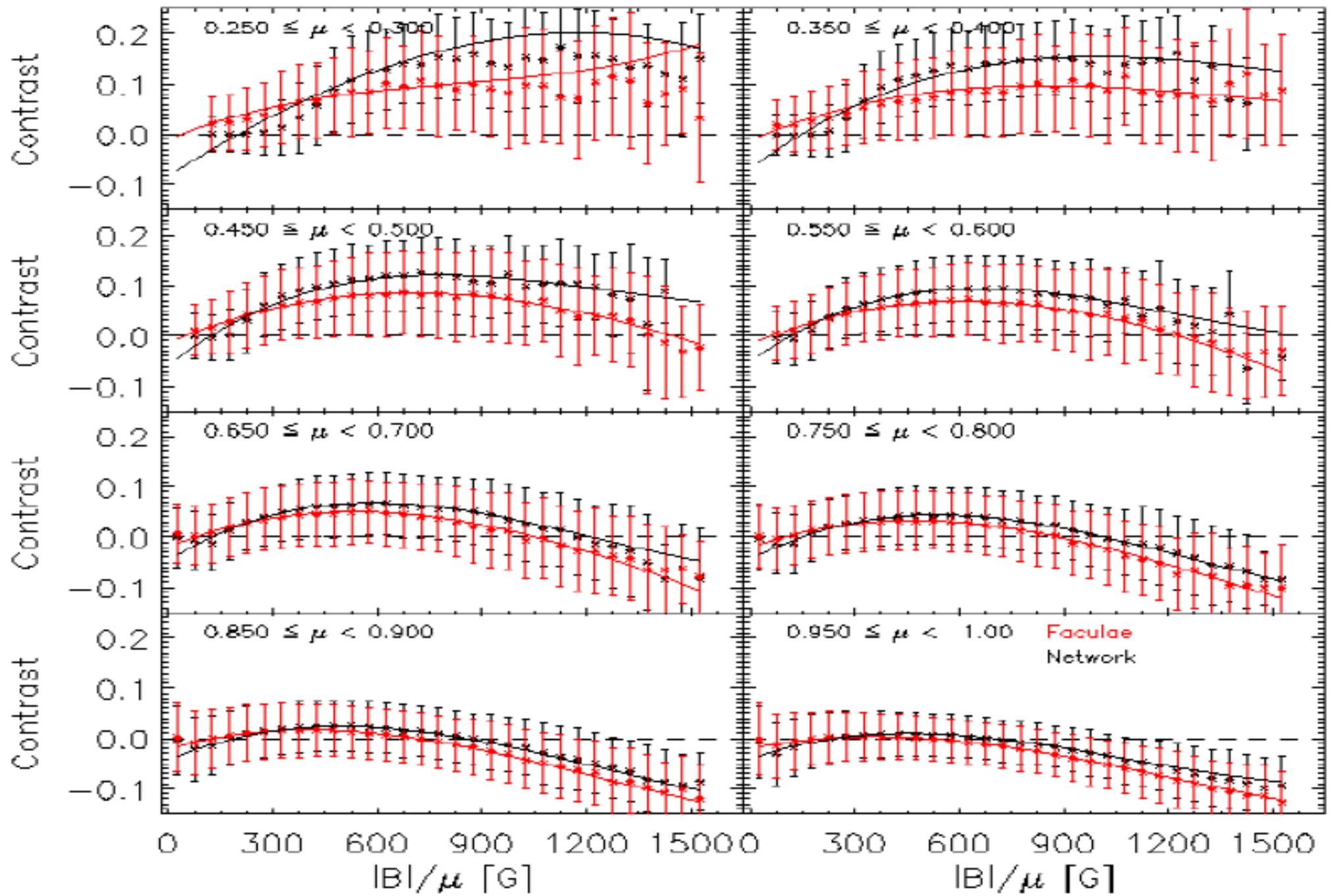
- ❑ 45-s Data acquired in 10 days, from 2011 to 2015
- ❑ Intensitygrams, Magnetograms and HARP masks
- ❑ Intensitygrams and Magnetograms were also compensated for instrumental scattered light (Richardson-Lucy algorithm, is standard in HMI pipeline)



Original data...



# Restored data



## What is the error in the estimate of Total irradiance variations if Network and Faculae are not considered separately?

Facular excess (Lean et al. 1998; Foukal et al. 1991)

$$\frac{\Delta F}{F} = \sum_k \sum_j \frac{5\mu_j N(\mu_j, B_k) C(\mu_j, B_k) \Psi(\mu)}{2}$$

$300 \text{ G} < B_k < 1500 \text{ G}; 0.2 < \mu_j < 1$

N: Area of features at position  $\mu_j$  and magnetic field  $B_k$ , normalized to solar disk

$\Psi(\mu)$ :  $(3\mu+2)/5$  quiet Sun limb-darkening function

$C(\mu, B)$ : contrast derived from surface fit to HMI data

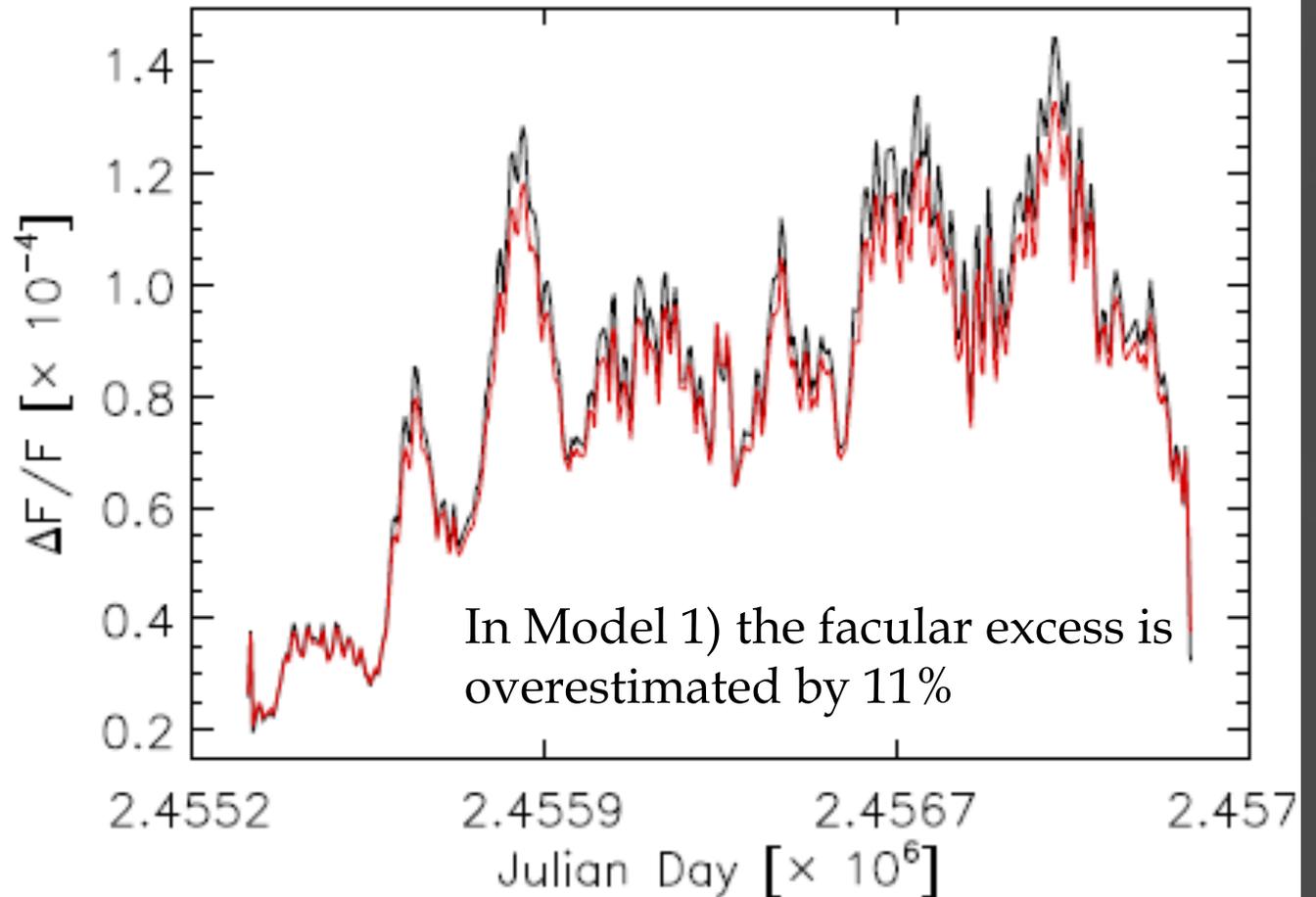
$$C\left(\mu, \frac{B}{\mu}\right) = \begin{bmatrix} 10^{-2} \left(\frac{B}{\mu}\right)^0 \\ 10^{-3} \left(\frac{B}{\mu}\right)^1 \\ 10^{-6} \left(\frac{B}{\mu}\right)^2 \\ 10^{-9} \left(\frac{B}{\mu}\right)^3 \end{bmatrix}^T [\mathcal{M}] \begin{bmatrix} \mu^0 \\ \mu^1 \\ \mu^2 \\ \mu^3 \end{bmatrix}$$

$N(\mu, B)$  was estimated using daily HMI 45-s data acquired between April 2010 and October 2015

Faculae and Network area discriminated using HARP regions

Model 1) : Facular excess computed without discrimination (BLACK)

Model 2) Facular excess computed discriminating between faculae and Network (RED)



# Conclusions

- For  $B > 300$  G the Network is brighter than facula. At the limb it is up to twice the facular one.
- For  $B < 300$  G the network is Darker than Faculae
- These results are in agreement with high-res obs. and simulations, but extend the results to the whole disk.



The magnetic flux alone is not a good discriminant for irradiance modeling purposes

The facular excess is overestimated by about 11% if faculae and network are not considered separately. This is in agreement with uncertainties estimated in NRL and EMPIRE .



Models, at least those that distinguish between faculae and network, should take these new results into account.

Thank you!

In kind memory  
of  
Juan Fontenla

# Implications for irradiance studies

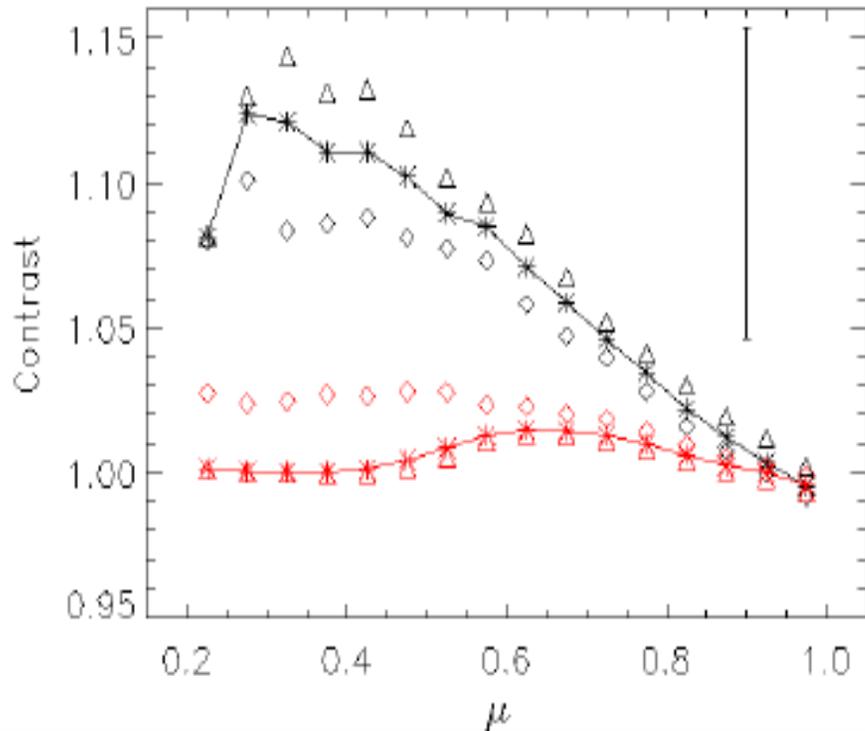
- 1) Use of magnetograms to distinguish between Faculae and Network
- 2) What is the error in the estimate of Total irradiance variations if Network and Faculae are not considered separately?

# 1) Use of magnetograms to distinguish between Faculae and Network

SATIRE, MDI (Ortiz et al. 2007, Foukal et al. 2011); HMI (Yeo et al. 2013)

B < 180 G network

B > 180 G Facula



Triangle: Network  
Diamond: Faculae  
Star: no discrimination

Red: B=200G  
Black: B=600G

- For B = 400 G photometric properties of Network are well defined
- For B > 400 G properties of Faculae are statistically affected by Network, and Facular contrast is overestimated!

