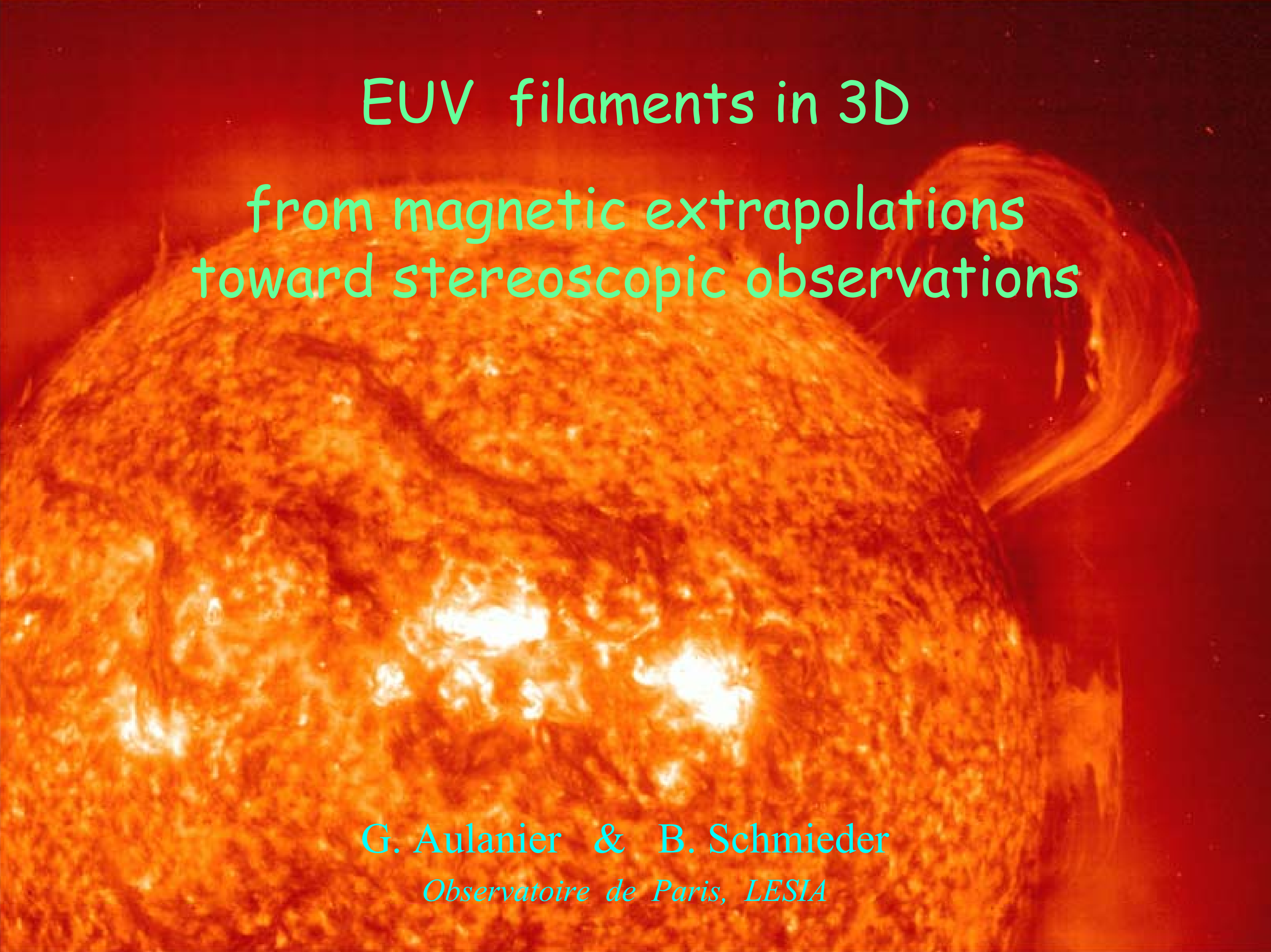


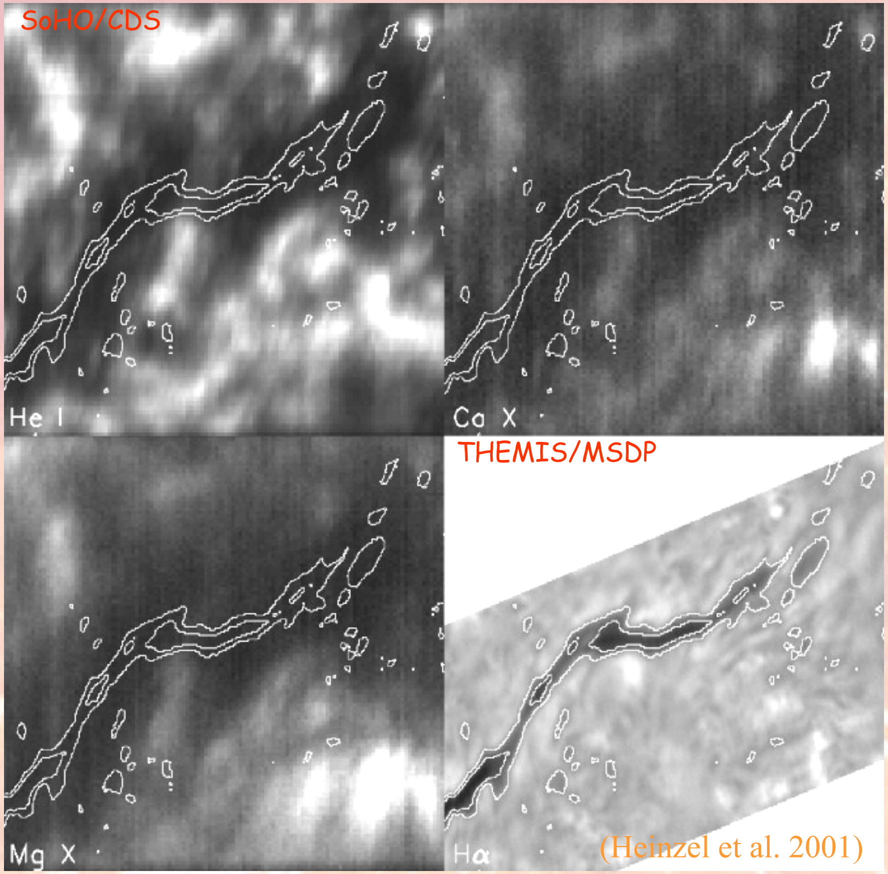
EUV filaments in 3D

from magnetic extrapolations toward stereoscopic observations

G. Aulanier & B. Schmieder

Observatoire de Paris, LESIA

Disc observations of EUV filaments



- Observed only for $\lambda < 912$ Å

  (Chiuderi Drago et al. 2001)

  ⇨ *EUV lines absorbed in the Lyman continuum of Hydrogen*

- $\tau_{912} = 60 - 100\ \tau_{H\alpha}$

  (Heinzel et al. 2001, Schmieder et al., 2002)

  ⇨ *fewer material can absorb the background EUV radiation*

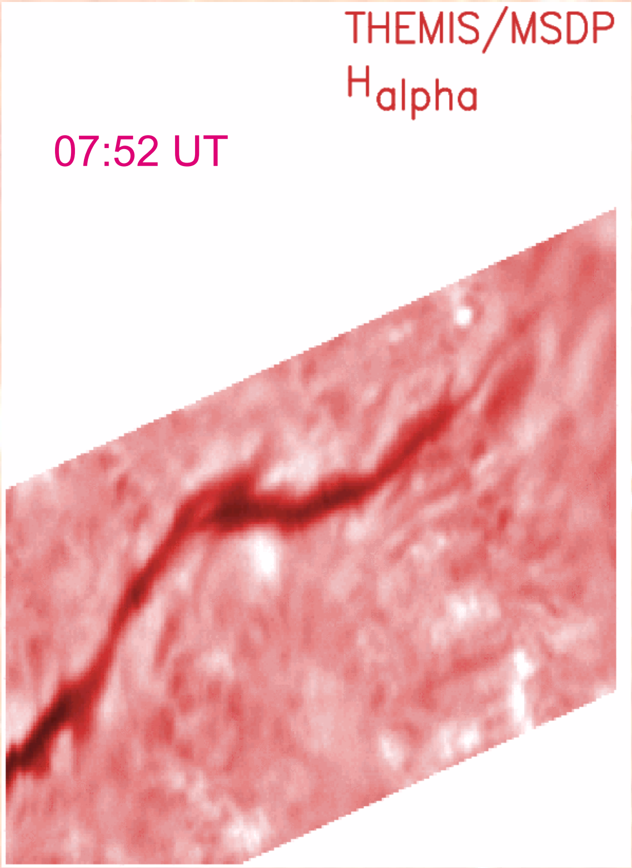
  ⇨ *EUV shows more mass than Hα*

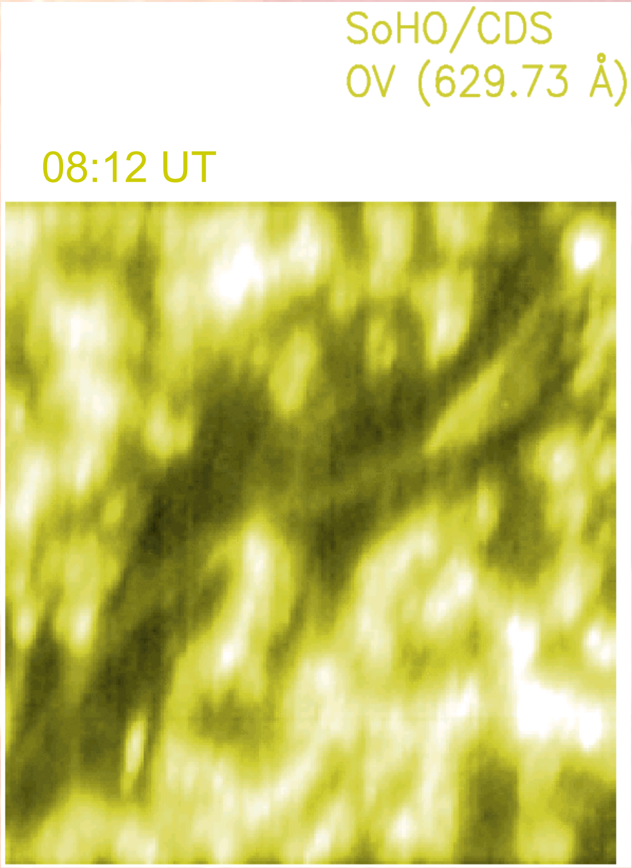
- distribution of cool material ?
- magnetic topology ?
- extra mass loading of CMEs ?

3D is missing

3D magnetic field extrapolation for one observed filament

Joint THEMIS/SoHO campaign, 05/05/2000 *(conducted at MEDOC)*





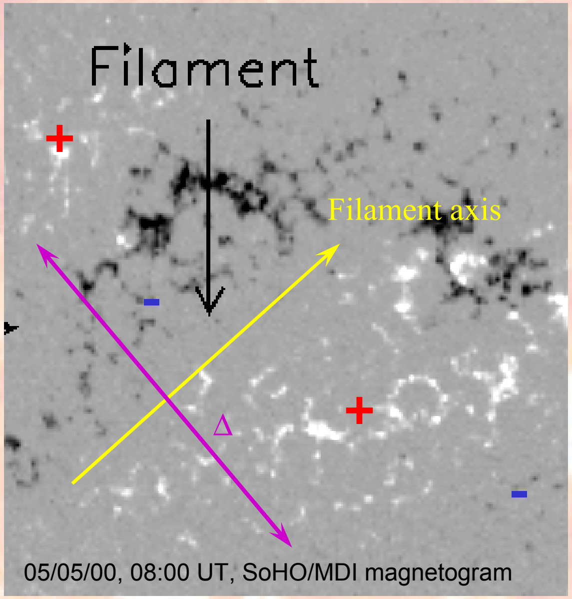
located at E17 S21

linear magneto-hydrostatic method

$$\nabla \times \boldsymbol{B} = \alpha \boldsymbol{B} + \zeta\, e^{-z/H}\, \nabla B_z \times \boldsymbol{u}_z$$ (Low 1992)

$$= \boldsymbol{j}\,(\text{force free}) + \boldsymbol{j}\,(\nabla p;\boldsymbol{g})$$

Departure from the force free approximation



- Lower boundary : $-\Delta/2 < x;y < \Delta/2$; periodic
  - $B_z\,(z=0) = B_{//}\,(MDI_{deproj})\,/\cos\theta$
  - Δ = observed *quasi-periodicity* in x
  - y axis = filament axis
- Upper boundary : $0 < z < \Delta_z$ *arbitrary*

$$\lim B\,(z \mapsto +\infty) = 0$$

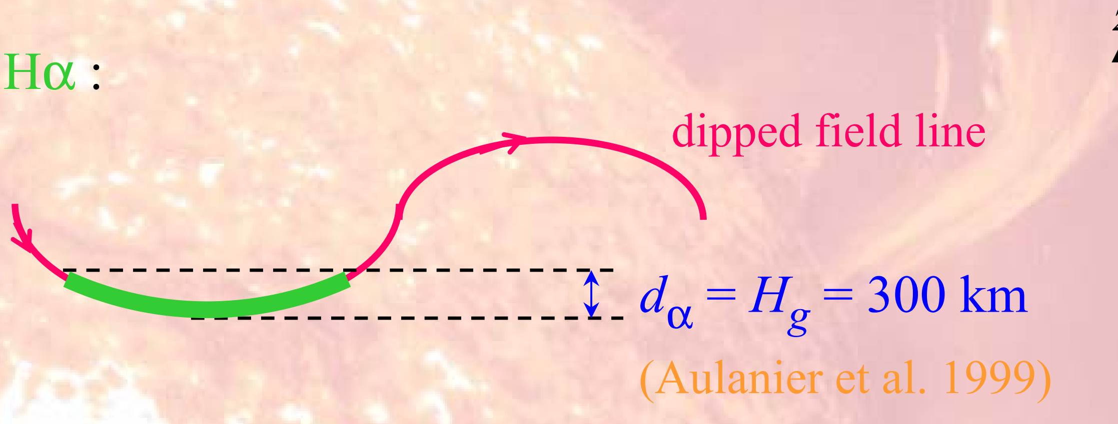
(α ; H) cannot be fixed ⇨ grid of 35 LMHS models

Selection of the best LMHS model

- For each 3D model, compute & plot magnetic dips :

  - Locus of dips : $(\boldsymbol{B} \,.\, \nabla)\, \boldsymbol{B} \Big|_{B_z = 0} > 0$

  - Portion visible in Hα :

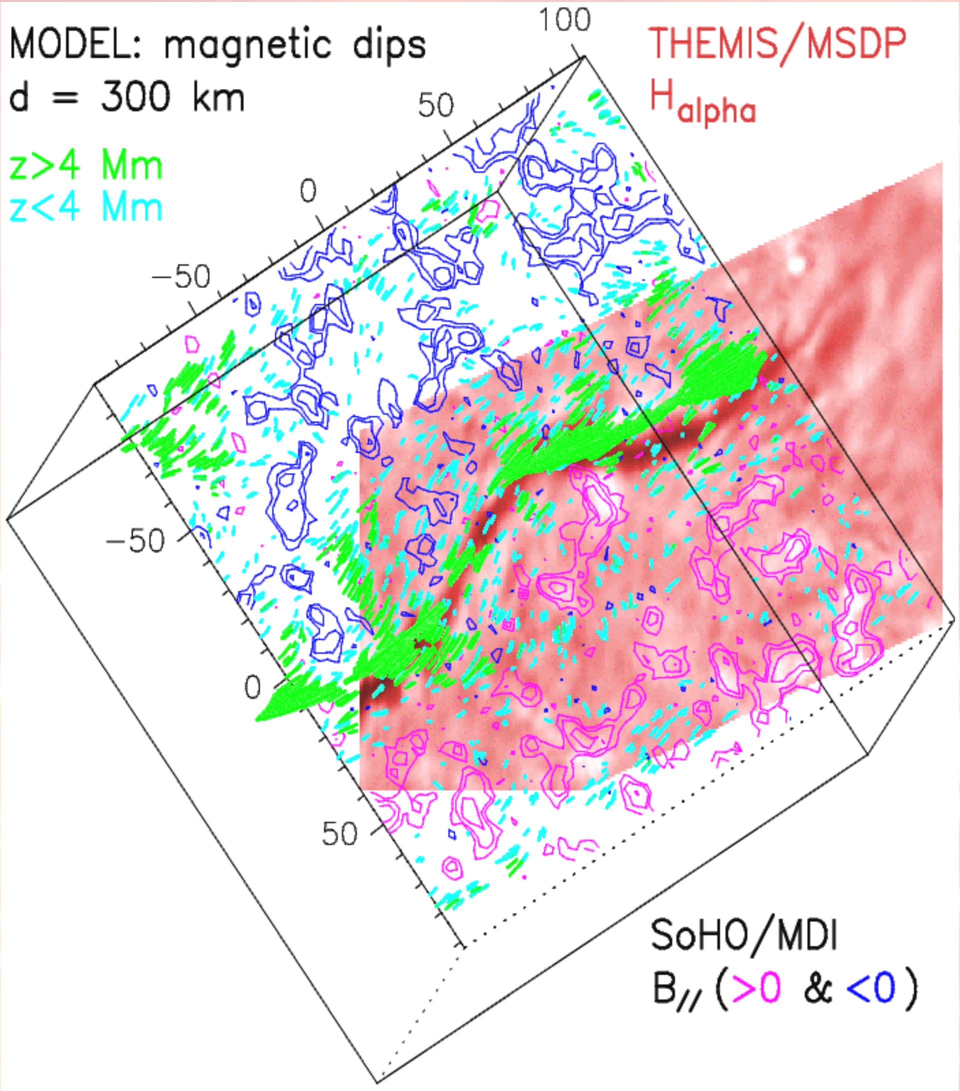


- Compare dips with Hα observations only:

  - dips to be matched with : **filament curved body & elbow**

  - Physical parameters : $\begin{cases} \alpha / \alpha_{res} = 0.94 \quad ; \quad \alpha = 3.08 \times 10^{-8}\ \mathrm{m}^{-1} \\ H = 25\ \mathrm{Mm} \end{cases}$

LMHS model of the Hα filament



- Calculation of dips on a 64^3 mesh :

⇨ 2100 dips for $z =]\,4 ; 96\,]$

⇨ 3500 dips for $z = [\,0 ; 4\,]$

Hα filament body + feet

=

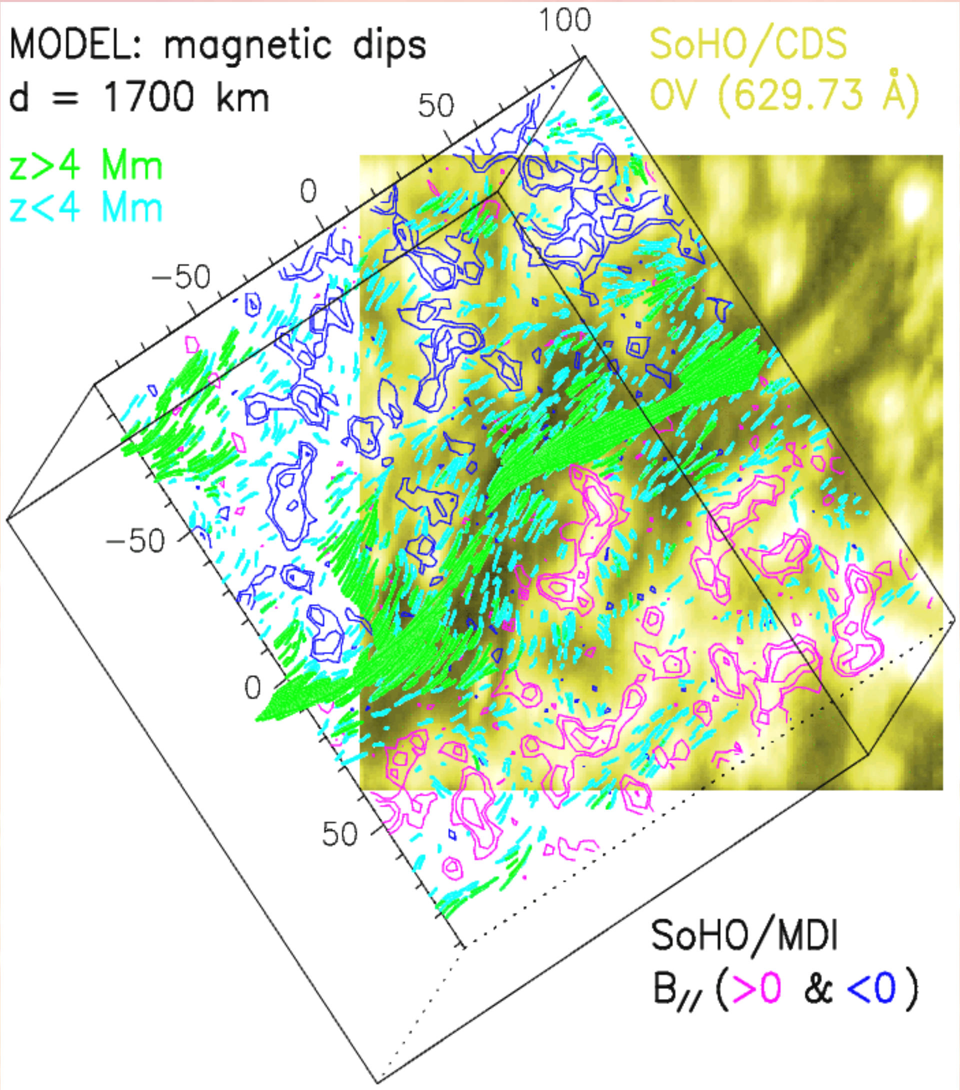
Sheet of dips in high altitude flux tube

+

Side dips on the edge of photospheric parasitic polarities

(Aulanier & Démoulin 1998)

LMHS model of the EUV filament



- Plot onto the EUV image the SAME dips from the SAME model built so as to match the Hα filament :

  ⇨ 2100 dips for $z =]\,4\,;\,96\,]$
  ⇨ 3500 dips for $z = [\,0\,;\,4\,]$

- Magnetic dips computed up to :

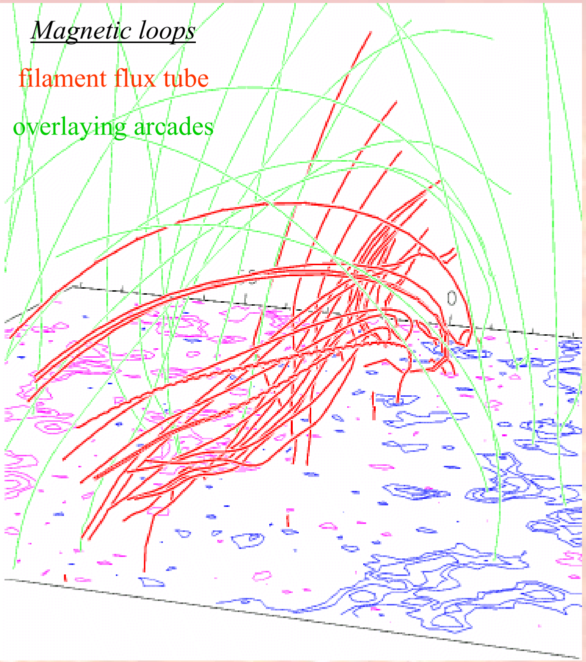
  ⇨ $d_{\mathrm{Lyman}} = 1700$ km

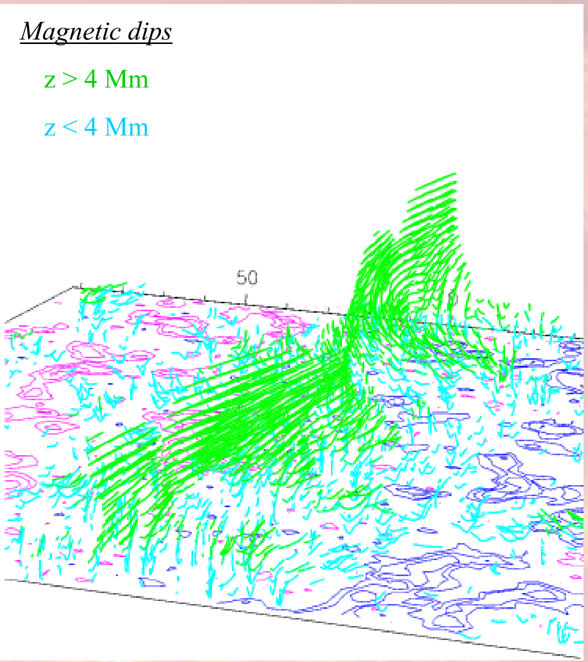
  (calculated with approximated RT)

- For hydrostatic-isothermal dips :

  ⇨ M (each dip) ~ 1.5 x M (Hα)

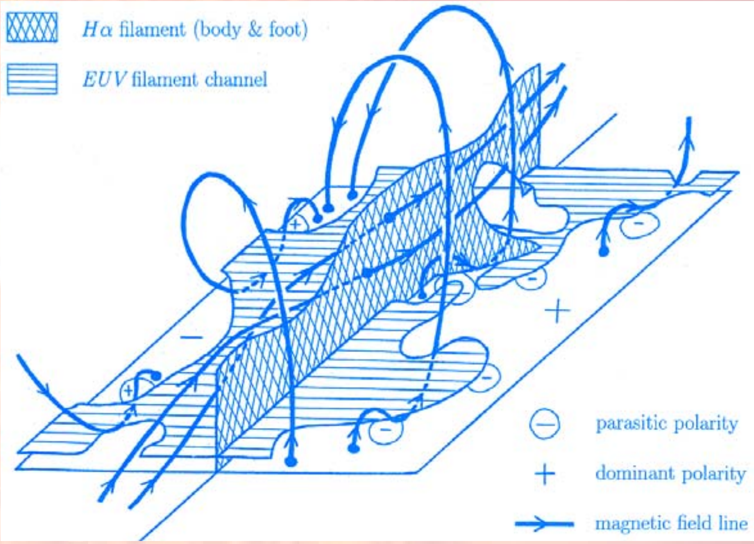
Magnetic topology of filament channels



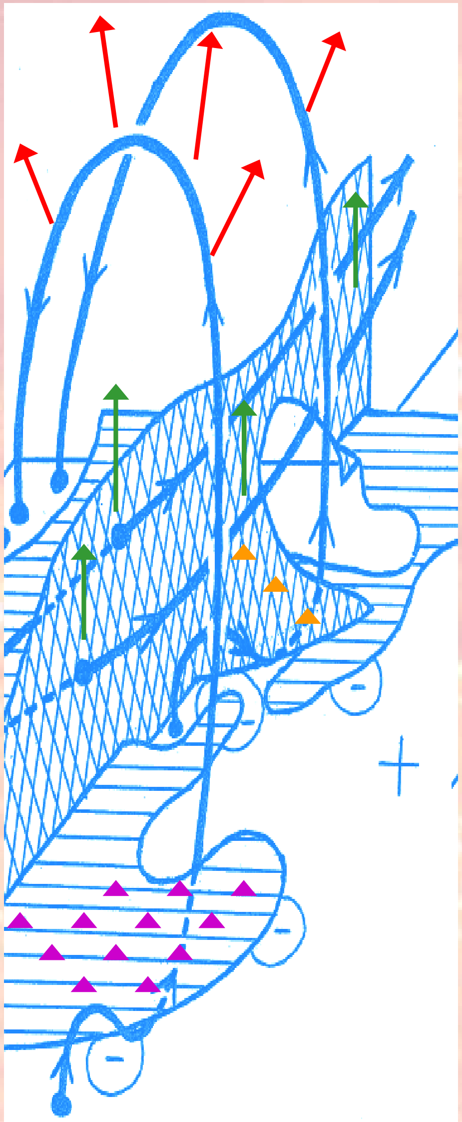


Filament body :
magnetic dips in weakly twisted (0.6 turns) and discontinuous flux tube

Hα & EUV extensions :
low-lying dips due to parasitic polarities located near the footpoints of some long overlaying sheared loops



Estimate for the mass loading of CMEs



Overlaying arcades → *CME front & cavity*

Filament flux tube → ***M (CME core) x 1.5***

M (each dip) ~ 1.5 x *M* (observable in Hα)

Hα feet

Wide EUV feet

unchanged

fall down to chromosphere

Not ejected

MOST of the mass observed in EUV filament channels will NOT be loaded into CMEs

Toward STEREO observations

EUV filament channels
=
optically thick enough

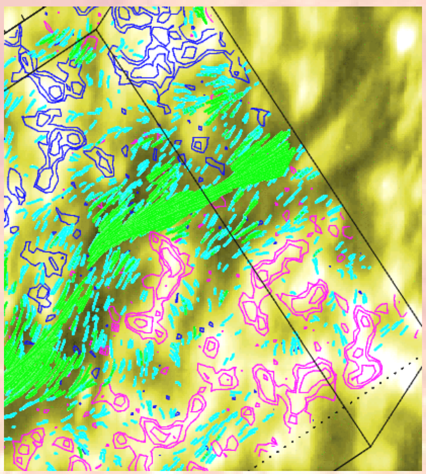
→ stereo reconstruction

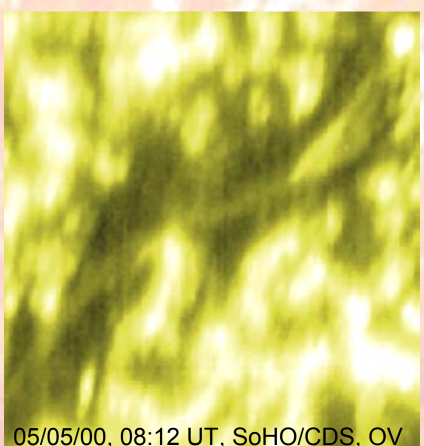
SECCHI / EUVI

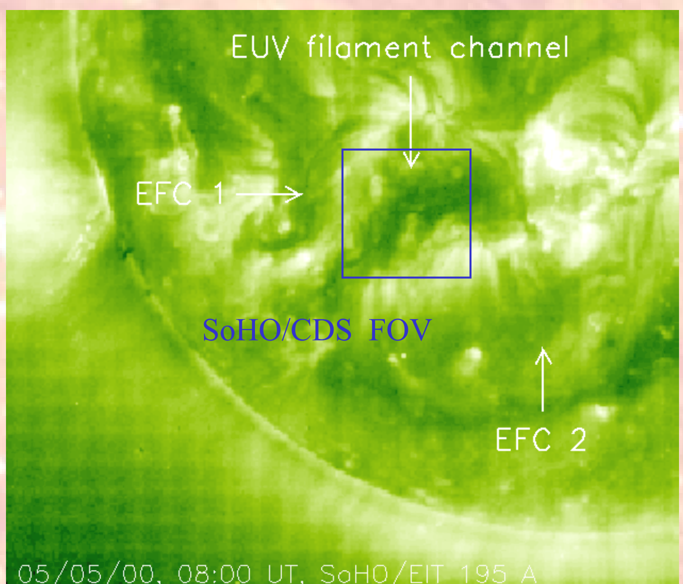
↑

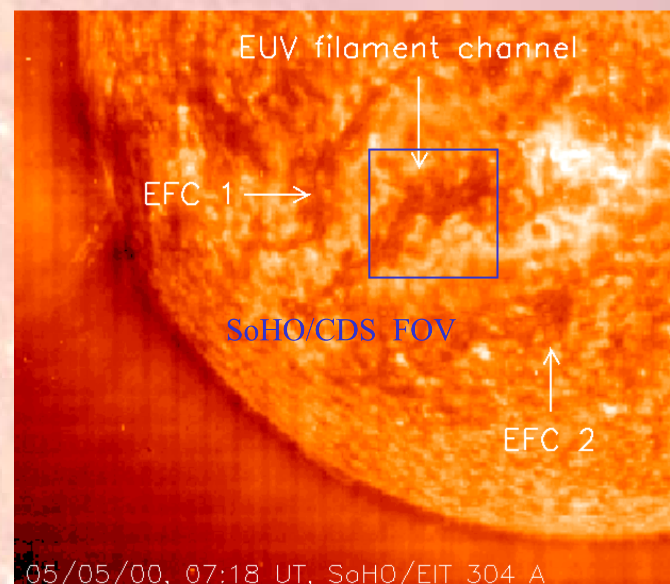
same shape as observed
in the 4 EIT wavelengths

→ 3D structure & evolution
of EUV channels

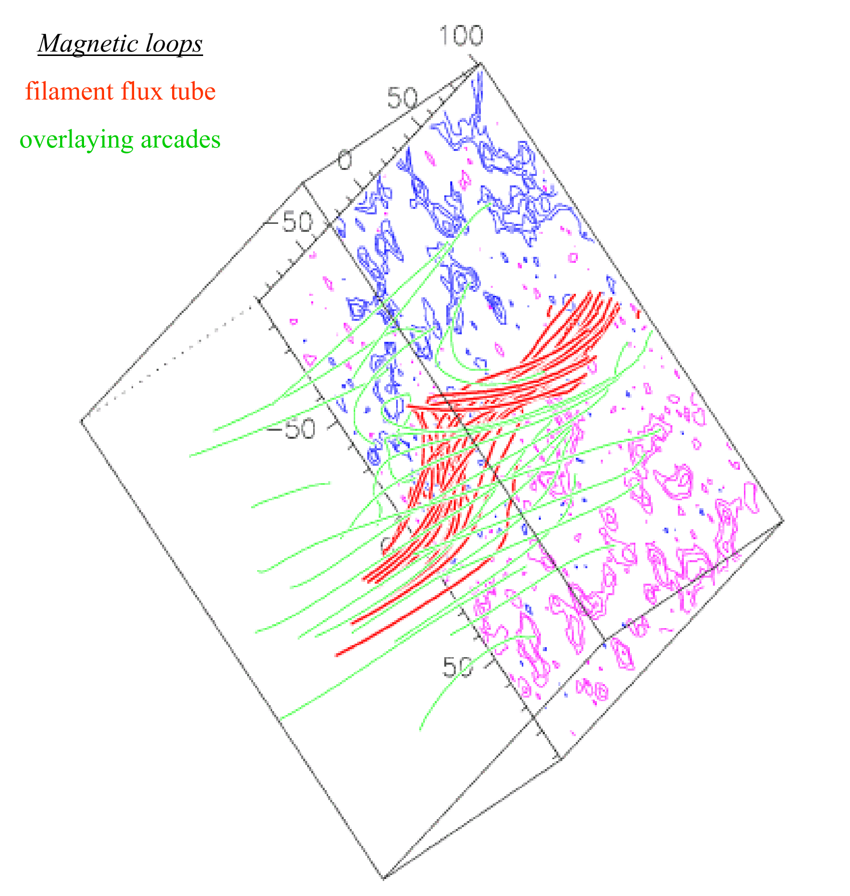


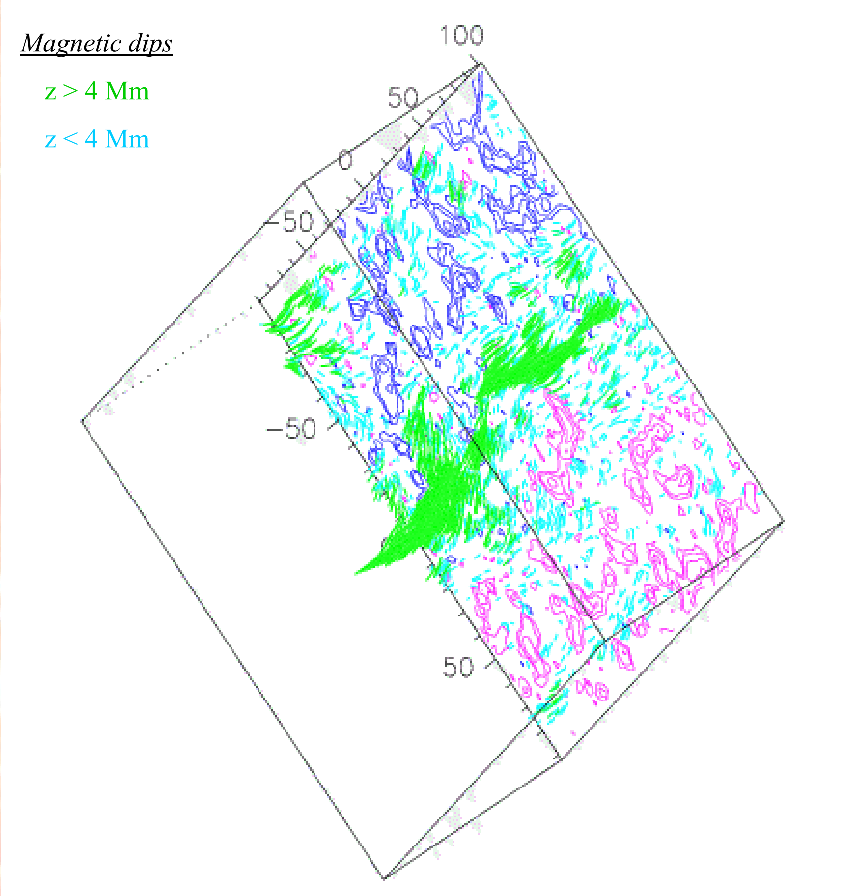






Compare LMHS model with observed transit on the disc





Several projections of one model :
LMHS extrapolation of the 05/05/00, 8:00 UT, SoHO/MDI magnetogram