HESPE
High Energy Solar Physics Data in Europe

2nd FP7 Space Conference

Larnaca, Cyprus, 15-16 November 2012

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HESPE's rationale

- to formulate and implement computational methods for hard X-ray spectroscopy, imaging and imaging spectroscopy

- to utilize Information and Communication Technology tools to provide solar physics, heliophysics and space weather scientists with algorithms and science ready products

description - 1

- framework programme: FP7
- theme: SPA.2010.2.1-03
  SPACE: exploitation of space science and exploration data
- specific program: cooperation
- funding scheme: collaborative project
- starting date: 01/12/2010
- duration: 36 months
- status: second year almost finished

description - 2

crew:

- università di genova, italy (unige) (coordinator)
- fachhochschule nordwestschweiz, switzerland (fhnw)
- university of glasgow, uk (unigla)
- universitaet graz, austria (unigra)
- cnrs, observatoire de paris, france (cnrs)
- university of california at berkeley (ucb)

third parties:

- cnr, italy (in unige, no cost)
- nasa goddard space flight center (in unige, no cost)

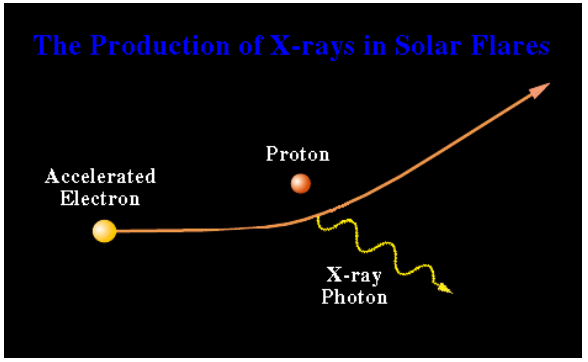
description - 3

work packages:

- wp1: management
- wp2: other activities (dissemination)
- wp3: theory
- wp4: computation
- wp5: technology
- wp6: future

physics, mathematics and computer science

models for energy transport, particle acceleration and x-ray emission aims to explain solar fares and their impact on the heliosphere



x-ray telescopes work by modulation rather than focusing; raw data (visibilities) reveal the image just after mathematical computation

ICT methods allow fast and intelligent retrieval of data and science products

two satellites

reuven ramaty high energy solar spectroscopic imager (RHESSI)

launch: 5 febbraio 2002

two more years support

high spectral resolution

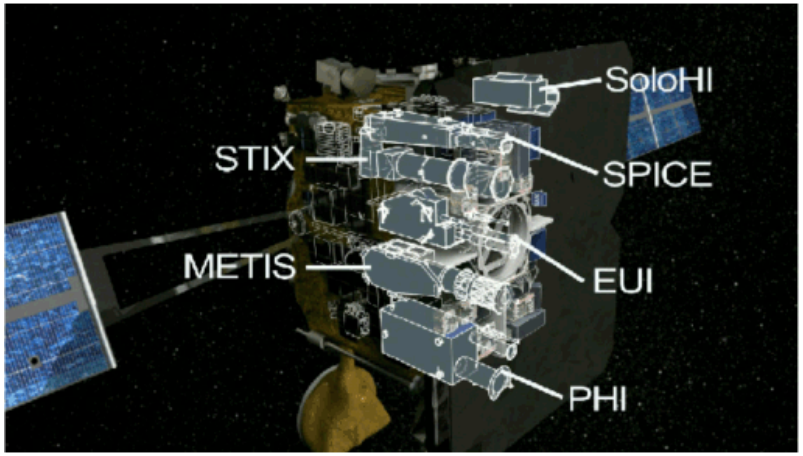
good spatial resolution

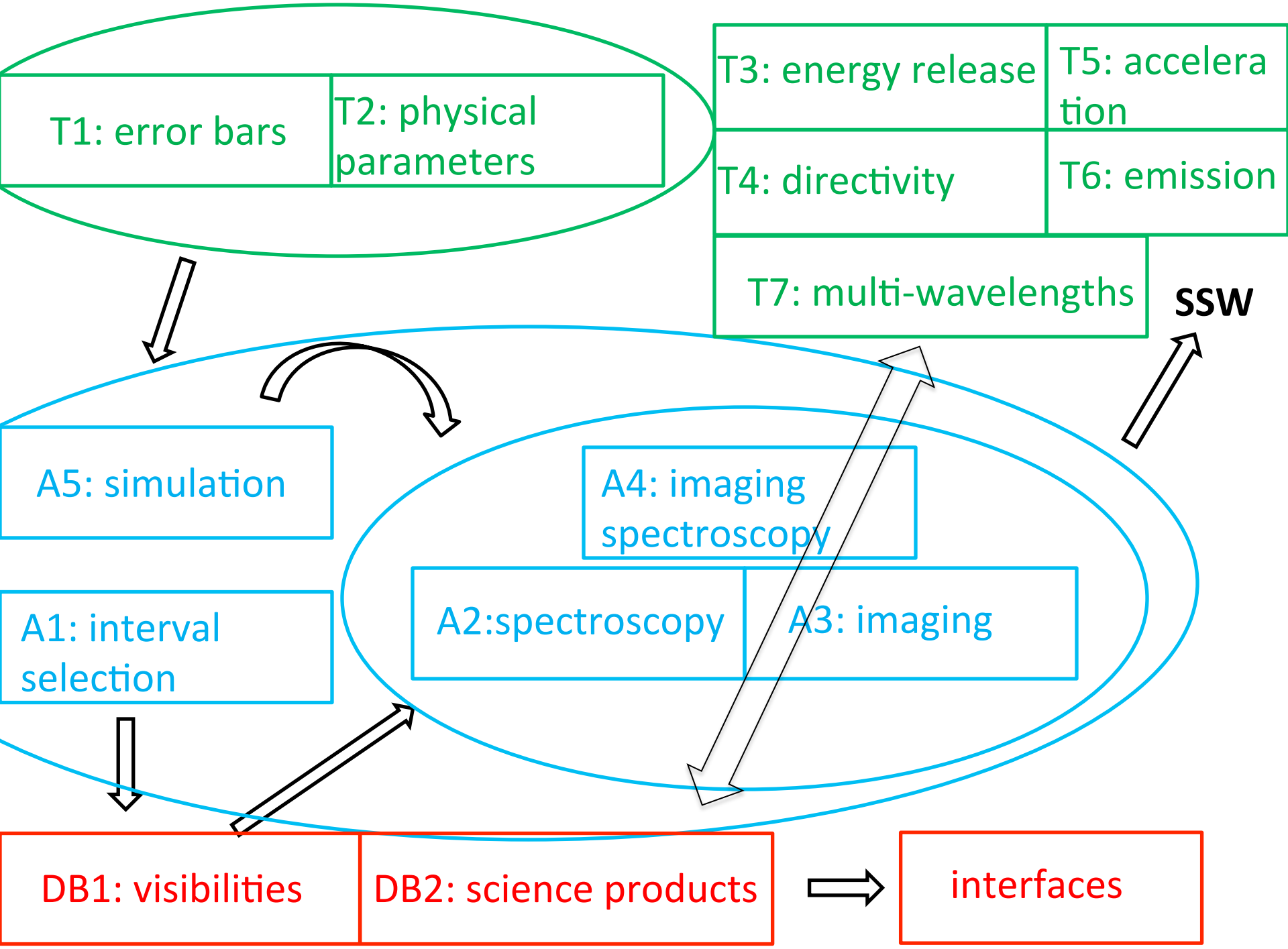
spectrometer/telescope for imaging hard x-rays (stix)

launch: 2017

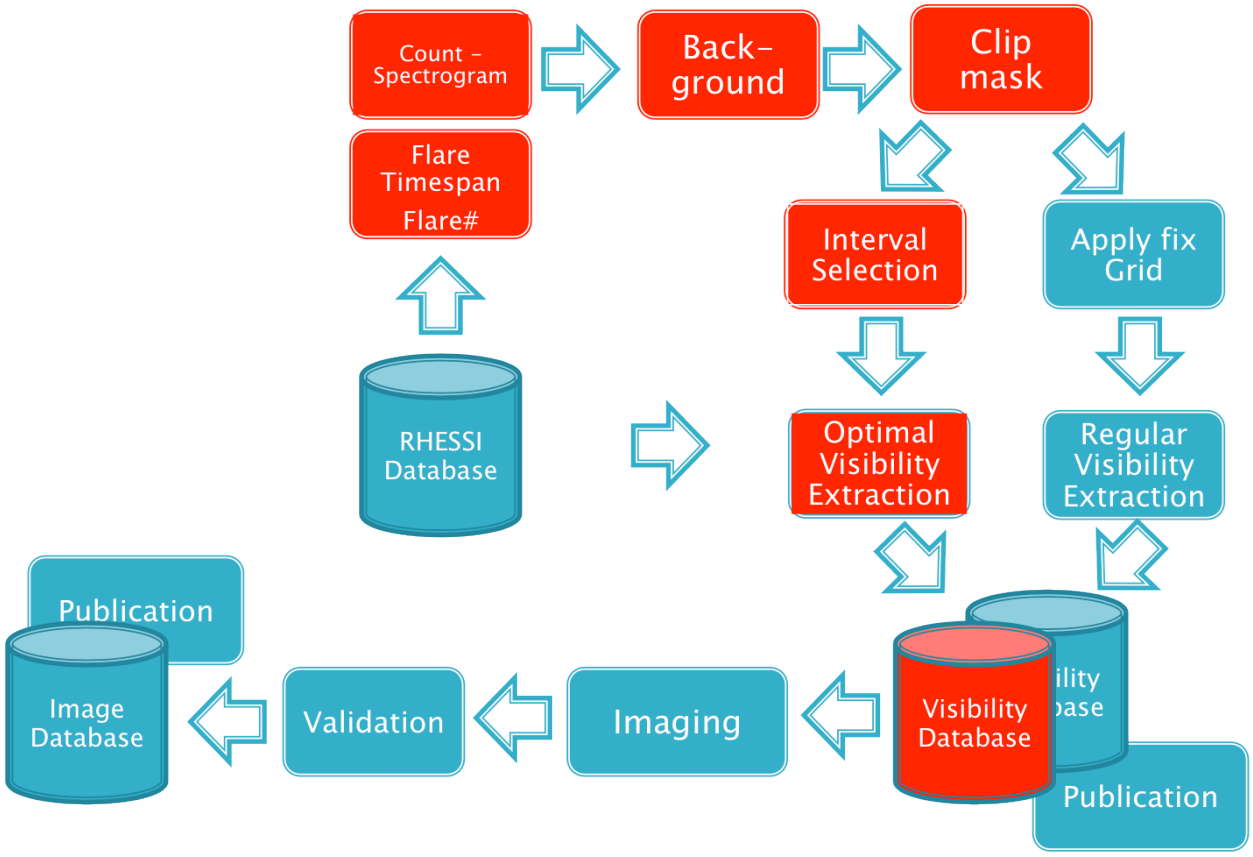
‘in situ’ measurements

integration with other kinds of data

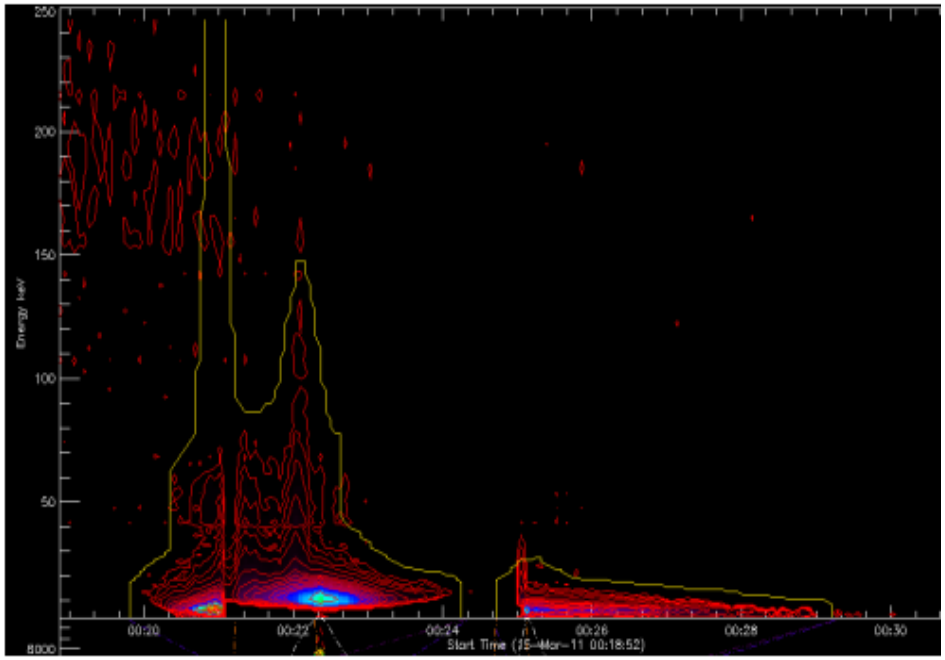


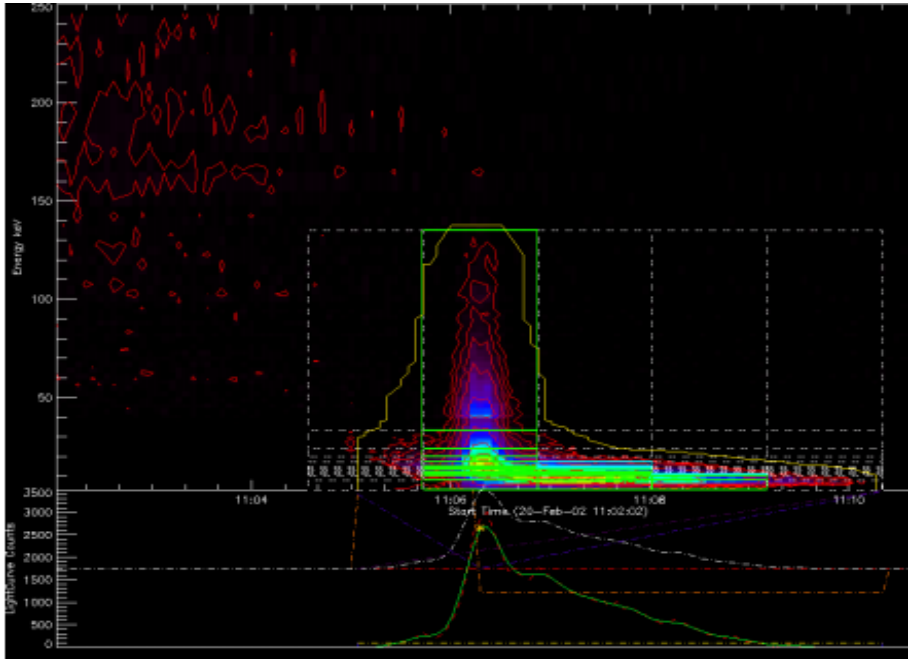

T1: error bars
T2: physical parameters
T3: energy release
T5: accelera tion
T4: directivity
T6: emission
T7: multi-wavelengths
SSW
A5: simulation
A4: imaging spectroscopy
A1: interval selection
A2:spectroscopy
A3: imaging
DB1: visibilities
DB2: science products
interfaces

technology: the HESPE framework



technology: interval selection algorithm



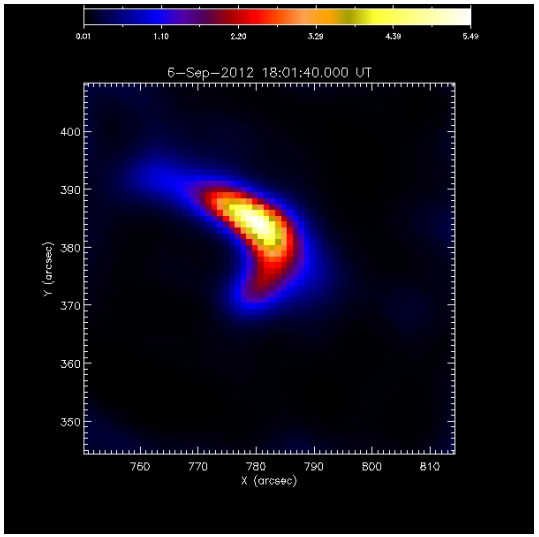


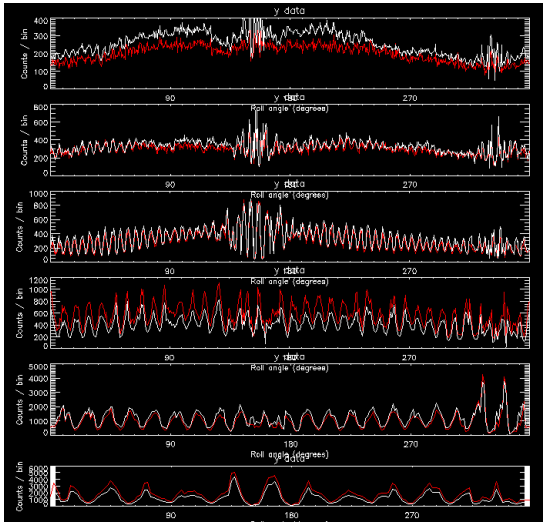
technology: the visibility database

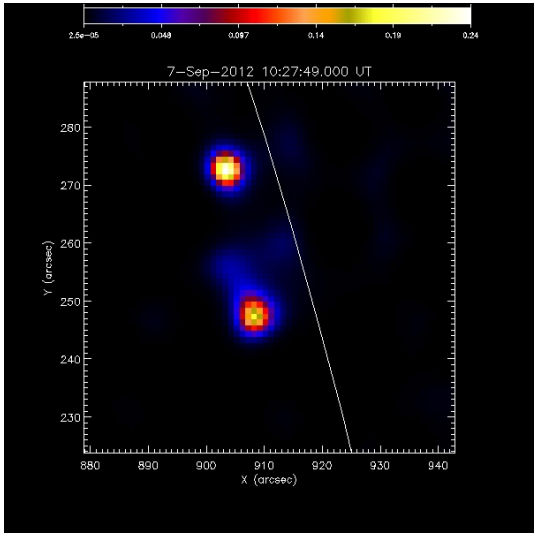
- link laszlo con demo

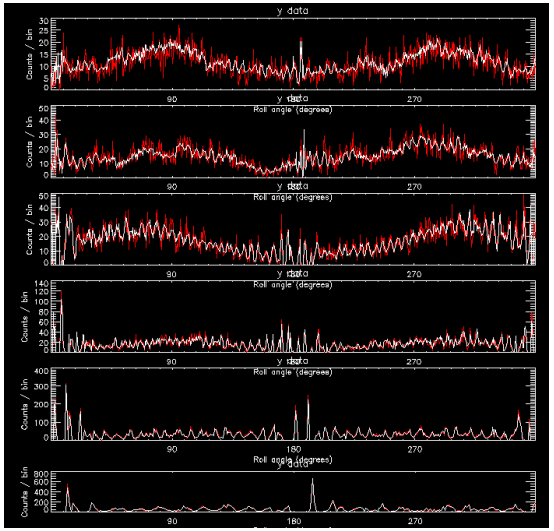
- oppure snapshot della webpage

computation: maximum-likelihood approach to imaging

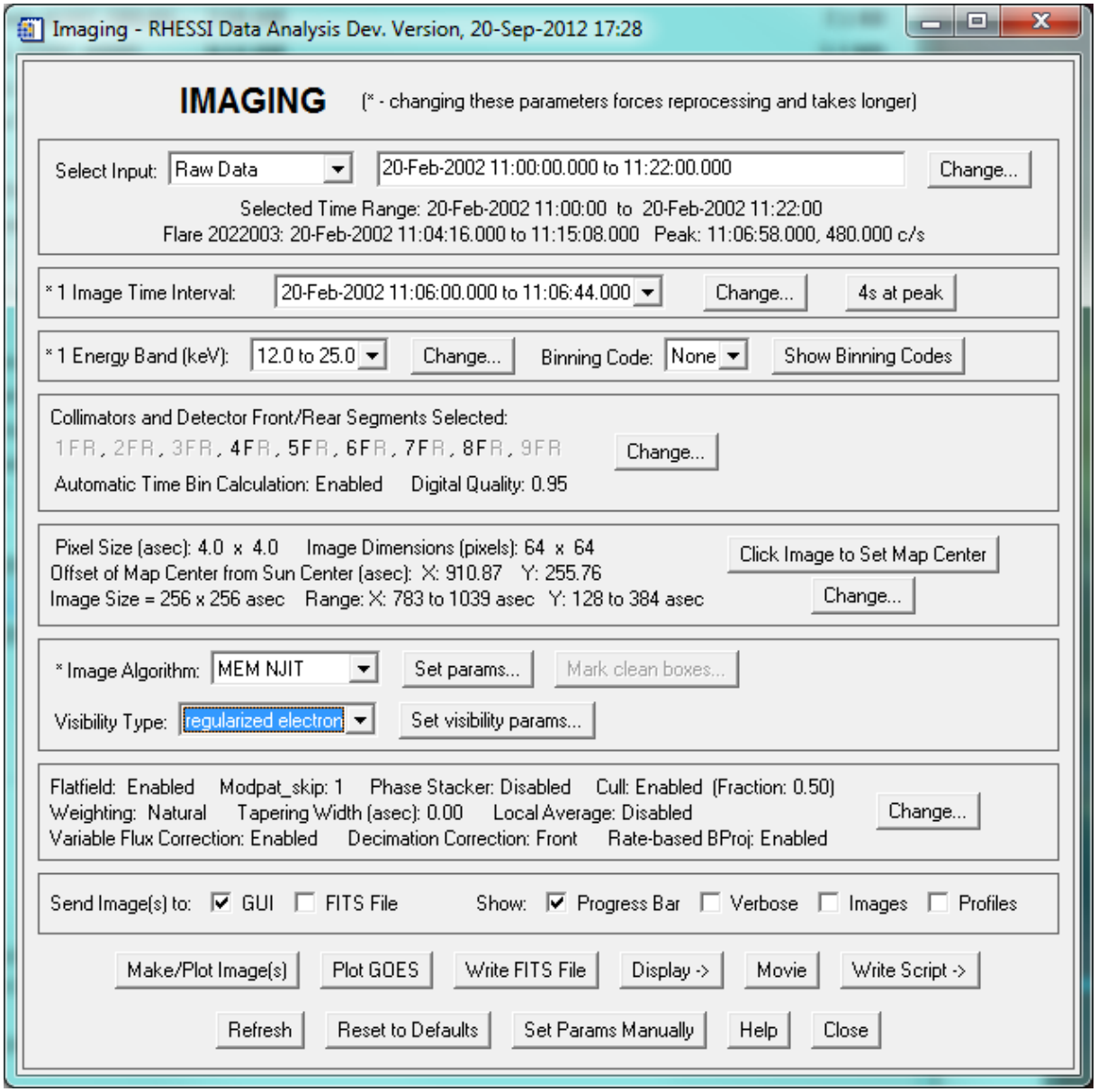




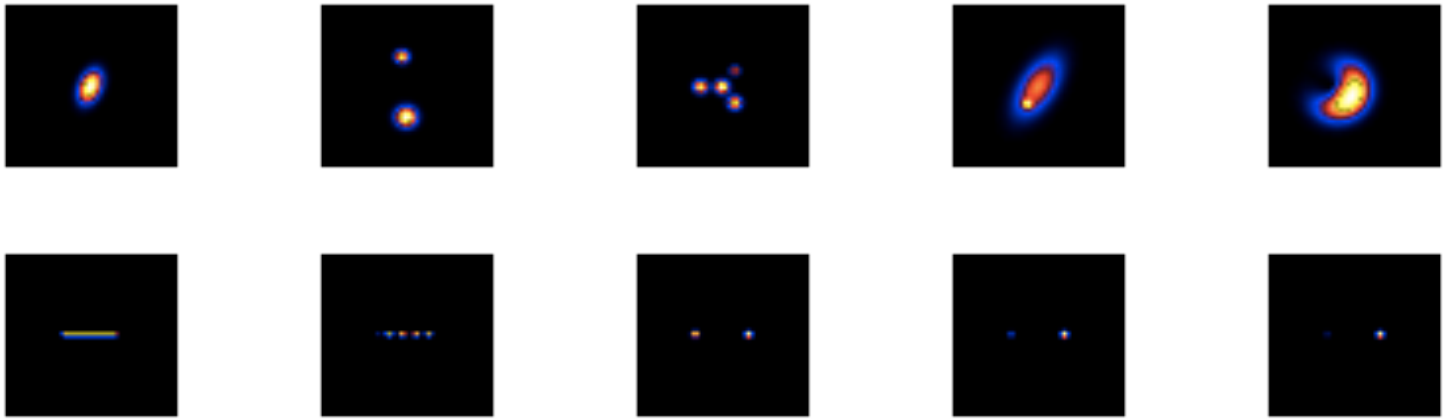




computation: electron maps from visibilities in SSW



validation: imaging test



RHESSI Imaging Algorithm Evaluation Framework

Criteria		Back projection	CLEAN	PIXON	MEM-NJIT	VIS_FWDFIT	UV_SMOOTH
General Characteristics							
Robustness				slower	can crash		
Need for parameter optimization							
Error estimation		Only for single sources					
Relative Speed							

science ready products: information on the target

Event No.	L_0 (arcsec)	W (arcsec)	V_0 (100 arcsec^3)	n (10^{11} cm^{-3})	$\mathcal{N}$ (10^{37})	η (20 keV) (10^{-3} s^{-1})	f
1	18.6	7.0	7.2	1.5	4.1	6.5	0.45
2	16.3	6.9	6.2	1.4	3.2	14.5	0.83
3	16.7	7.3	7.0	4.4	11.7	4.0	0.04
4	16.6	7.3	7.0	4.8	12.8	7.3	0.11
5	16.6	8.2	8.7	10.5	34.9	3.3	0.03
6	11.9	5.9	3.3	4.9	6.0	0.6	0.02
7	10.4	6.0	3.0	1.8	2.0	12.1	0.44
8	17.8	6.9	6.4	2.6	7.1	24.1	0.90
9	18.8	6.6	6.5	2.9	7.7	23.1	1.05
10	15.1	6.0	4.2	2.9	5.4	13.8	0.72
11	16.0	5.7	4.1	1.9	3.1	27.8	1.95
12	10.3	6.6	3.5	5.1	6.7	4.9	0.08
13	9.9	6.5	3.3	4.6	5.7	4.1	0.18
14	21.5	5.3	4.8	1.5	2.8	1.4	0.13
15	17.4	6.3	5.4	0.8	1.7	1.7	1.03
16	17.8	6.4	5.8	2.3	5.1	0.3	0.18
17	11.0	6.2	3.3	3.9	5.0	2.9	0.05
18	9.9	6.3	3.1	3.2	3.8	7.0	0.22
19	19.9	6.2	6.1	11.1	25.7	13.6	0.02
20	14.5	6.1	4.2	5.2	8.3	23.4	0.10
21	9.9	6.1	2.9	2.2	2.4	16.5	0.53
22	12.4	6.0	3.6	1.7	2.3	5.2	0.26
Geometric Mean	14.5	6.4	4.7	2.9	5.4	6.0	0.20
$\times/\div$	1.3	1.1	1.4	1.9	2.2	3.4	3.9

HESPE papers - 1

Su Y, Dennis B R, Holman G D et al 2012 Observations of a Two-stage Solar Eruptive Event (SEE): Evidence for Secondary Heating *The Astrophysical Journal Letters* **746** L5

Su Y, Wang T J, Veronig A et al 2012 Solar Magnetized "Tornadoes:" Relation to Filaments *The Astrophysical Journal Letters* **756** L41

Giménez de Castro C G, Cristiani G D, Simões P J A, Mandrini C H, Correia E, Kaufmann P 2012 A burst with double radio spectrum observed up to 212 GHz *Solar Physics* (in press)

Simões P J A and Kontar E P 2012 Implications for electron acceleration and transport from non-thermal electron rates at loop-top and foot-point sources in solar flares *Astronomy and Astrophysics* (submitted)

Csillaghy A, Etesi L and Hochmuth N 2012 Mainstreaming High-Energy Solar Data *Proc. Astronomical Data Analysis Software and Systems* XXI ASP Conference Series (in press)

Allavena S, Piana M, Benvenuto F and Massone A M 2011 An interpolation/extrapolation approach to X-ray imaging of solar flares *Inverse Problems and Imaging* **6** 1

HESPE papers - 2

Emslie A G and Massone A M 2012 Bayesian confidence limit of electron spectra obtained through regularized inversion of solar hard X-ray spectra *The Astrophysical Journal* (in press)

Massone A M and Piana M 2011 The use of electron maps to constrain some physical properties of solar flares *Solar Physics* (in press)

Schwartz R, Kontar E P, Jeffrey N and Massone A M 2011 Accounting for the albedo flux in RHESSI image reconstructions SPD *Meeting 2011*, Las Cruces, NM USA, June 12-16 2011

Guo J, Emslie A G, Massone A M and Piana M 2012 properties of the acceleration regions in several loop-structured solar flares *The Astrophysical Journal* **751** 129

Guo J, Emslie A G, Kontar E P, Benvenuto F, Massone A M and Piana M 2012 Determination of the acceleration region size in a loop-structured solar flare *Astronomy and Astrophysics* **543** A43

Torre G, Pinamonti N, Emslie A G, Guo J, Massone A M and Piana M 2012 Empirical determination of the energy loss rate of accelerated electrons in a well-observed solar flare *The Astrophysical Journal* **751** 129

HESPE papers - 3

Vilmer N 2012 Solar flares and energetic particles *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* **370** 3241-3268

Reid H, Vilmer N, Aulanier G and Pariat E 2012 X-ray and UV investigation into the magnetic connectivity of a solar flare *Astronomy and Astrophysics* (in press)

Reid H A S and Kontar E P 2012 Evolution of the solar flare energetic electrons in the inhomogeneous inner heliosphere Reid H A S, Kontar E P *Solar Physics* (in press)

Battaglia M, Kontar E P, Fletcher L and MacKinnon A L 2012 Numerical simulations of chromospheric hard X-ray source sizes in solar flares *The Astrophysical Journal* **752** 4B

Battaglia M and Kontar E P 2012 RHESSI and SDO/AIA observations of the chromospheric coronal plasma parameters during a solar flare *The Astrophysical Journal* (submitted)

Berkebile-Stoiser S, Veronig A M, Bein B and Temmer M 2012 Relation between the Coronal Mass Ejection acceleration and the non-thermal flare characteristics *Astrophys. Journal* **753** 88

HESPE papers - 4

Hudson H S, Fletcher L, Fisher G, Abbett W and Russell A 2012 Momentum distribution in solar flare processes *Solar Physics* **277** 77

Hudson H S, Fletcher L, MacKinnon A L and Woods T N 2012 Charge-exchange limits on low-energy alpha particle fluxes in solar flares *The Astrophysical Journal* **742** 84

Milligan R O, Chamberlin P C, Hudson H S, Woods T N, Mathioudakis M, Fletcher L, Kowalski A F and Keenan F P 2012 Observations of enhanced EUV continua during an X-class solar flare using SDO/EVE *The Astrophysical Journal* **748** 14

Battaglia M, Kontar E P, Fletcher L, MacKinnon A L 2012 Numerical simulations of chromospheric HXR source sizes in solar flares *The Astrophysical Journal* **752** 4

Fischer C E, Keller C U, Snik F, Fletcher L and Socas-Navarro H 2012 Numerical simulations of chromospheric HXR source sizes in solar flares *Astronomy and Astrophysics* (accepted)

Fletcher L, Innes D E, Hannah I G and Hudson H S 2012 SDO observations of the early phase of a solar flare *Astrophysical Journal* (submitted)

HESPE papers - 5

Russell A J B and Fletcher L 2012 Propagation of Alfvenic waves from corona to chromosphere and consequences for solar flares *The Astrophysical Journal* (submitted)

Fletcher L 2012 Solar chromospheric flares: energy release, transport and radiation Proceedings of the Fifth Hinode Science Meeting. ASP Conference Series, Vol. 456, 10-14 October 2011, Cambridge, Massachusetts. Edited by Leon Golub, Ineke De Moortel and Toshifumi Shimizu. San Francisco: Astronomical Society of the Pacific

current HESPE people

Federico Benvenuto, post-doc (UNIGE)
Gabriele Torre, PhD student (UNIGE)
Alberto Sorrentino, post-doc (UNIGE)
Laszlo Etesi, post-doc (FHNW)
Nicky Hochmuth, post-doc (FHNW)
Marina Battaglia, post-doc (FHNW)
Hanna Sathiapal, public outreach (FHNW)
Lyndsay Fletcher, professor (UNIGLA)
Eduard Kontar, professor (UNIGLA)
Paulo Simoes, post-doc (UNIGLA)
Ewan Dicson, post-doc (UNIGLA)
Yang Su, post-doc (UNIGRAZ)
Relindis Rott, PhD student (UNIGRAZ)
Hamish Reid, post-doc (CNRS)

dissemination initiatives - 1

- SIMAI, Turin, Italy, June 2012
- SIPWORK VI, Montana State, USA, August 2012
- Solar in Sonoma, Petaluma, USA, November 2012
- AGU Meeting, San Francisco, USA, December 2012
- COSPAR, Mysore, India, July 2012
- NAM UK, Manchester, March 2012
- Solar Orbiter V, Bruges, September 2012
- PNST, La Londre, France, March 2012
- French Reconnection, Paris, September 2012
- June 29th 2012, Cool Stars 17, Barcelona
- August 20th 2012, IAU XXVIII general assembly, Joint Discussion 3, Beijing, China
- 8th October 2012, 'Rocks'n'Stars', Goettingen, Germany
- 19th November 2012, Solar Physics with Radio Observations: 20 years of Nobeyama Radioheliograph and Beyond, Nagoya Japan
- 7th December 2011 Colloquium, Royal Observatory Belgium
- 23 May Queen's University Belfast
- 16th August 2012, Colloquium, Purple Mountain Observatory, Nanjing, China
- 16th October 2012, Seminar, MSSL

4th February 2012; Glasgow Science Centre

23 March 2012: Airdrie Astronomical Society

7th September 2012: Moray Astronomers Group

HESPE third year activity

it's time to provide more algorithms and more science products:

- HESPE directory in SSW
- publication of the database of science ready products

it's time to prepare the future:

- task 1: generation of synthetic data for future visibility-based instruments
- task 2: validation of algorithms against synthetic data
- task 3: generation of computational tools for processing generic visibility data