Objectives:

The objectives of this WP are: to capitalize on the improved techniques in X-ray and gamma-ray data analysis and diagnostics; to develop the background theory of particle acceleration; to improve the efficiency of X-ray diagnostics by integration with appropriate datasets.

Deliverables in year 2:

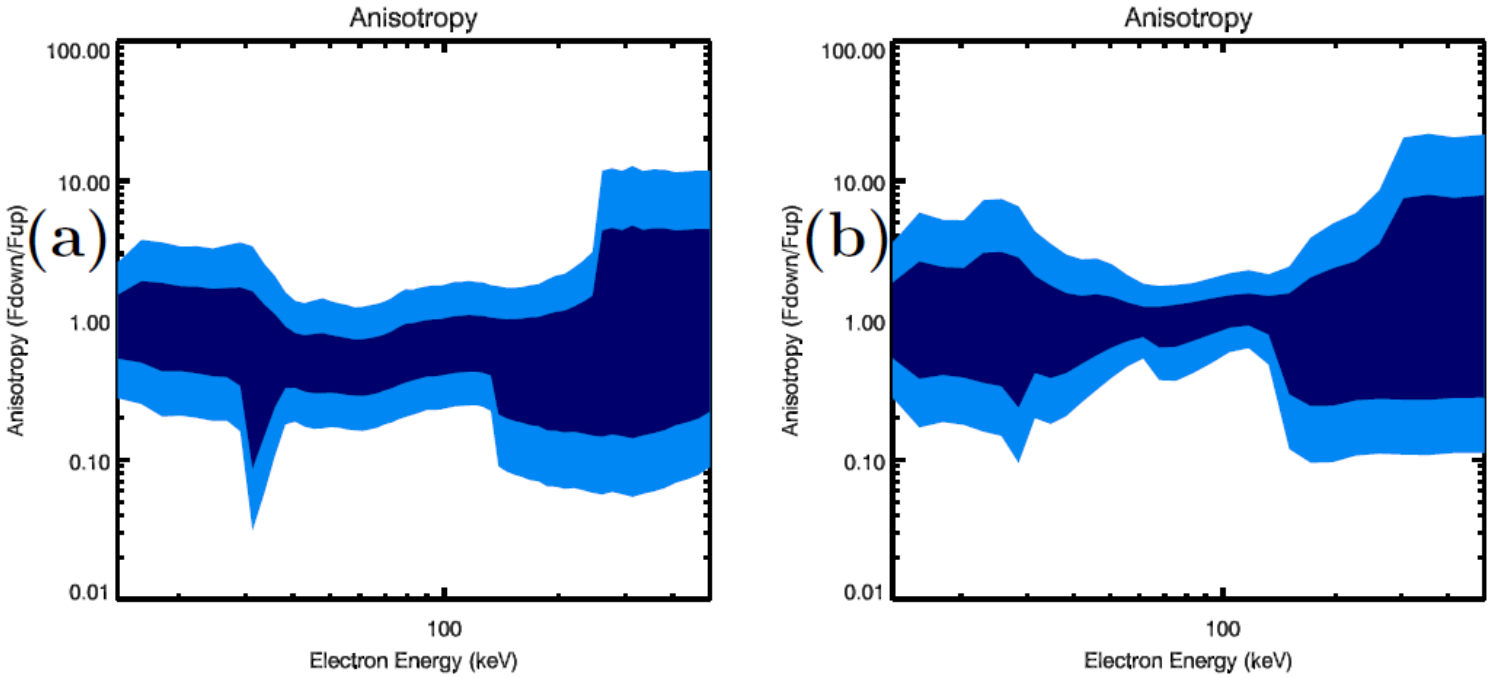
D3.1 Specification of models for particle acceleration mechanisms for selected events (Month 24)
D3. 2 Specification of models for energy release for selected events (Month 24)
D3.3 Specification of paradigms for simulation of synthetic data (Month 24)

Task 1: Parameters of accelerated particles

Derivation of the *characteristic parameters* of the accelerated particle populations in solar flares and use X-ray and gamma-ray diagnostics *to measure the electron angular distributions* and *X-ray source structures*. *Combination of the analysis of SEP events at the Earth and at the Sun using X-ray and gamma-ray data, to identify the propagation properties of energetic particles* in turbulent plasma media of the solar corona and interplanetary space.

Task 1a: … *The electron angular distributions*

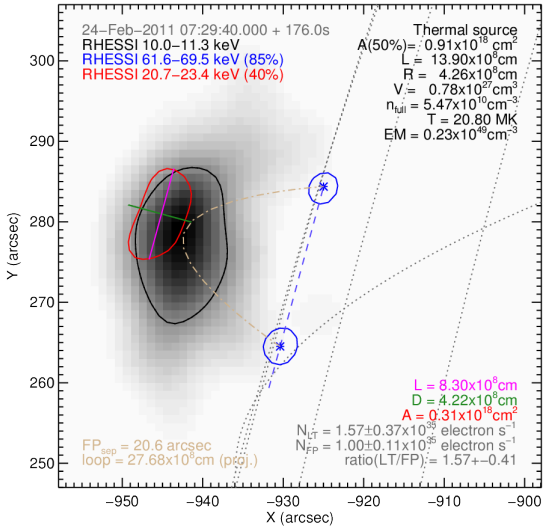
Dickson & Kontar, *Measurements of Solar Flare Anisotropy Using albedo with RHESSI, 9 flares analysed.*

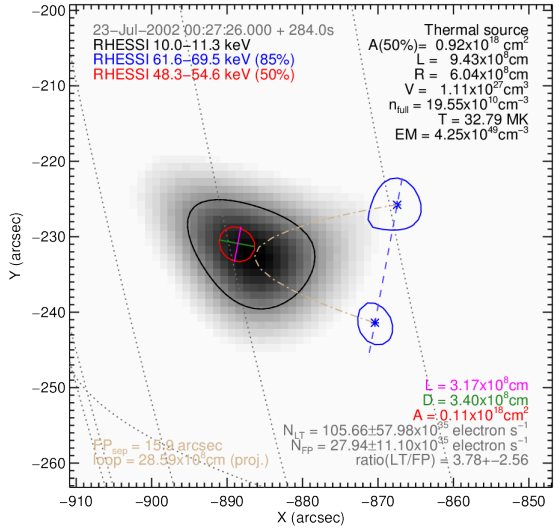


Status: *Rather positive referee report, revised version re-submitted to Solar Physics*

Task 1a: *The electron angular distributions (acceleration)*

Pitch-angle electron evolution – the work by Dr Paulo Simoes (UGLAS) started in October, 2011





Electron rate $\dot{N}$:

Flare	*2002-Jul-23*	*2003-Nov-02*	*2011-Feb-24*
ratio $\dot{N}_{LT}/\dot{N}_{FP}$	**3.8**	**2.2**	**1.6**

Magnetic trapping? Pitch-angle scattering (collisions, waves) ? *Pile-up effect?*

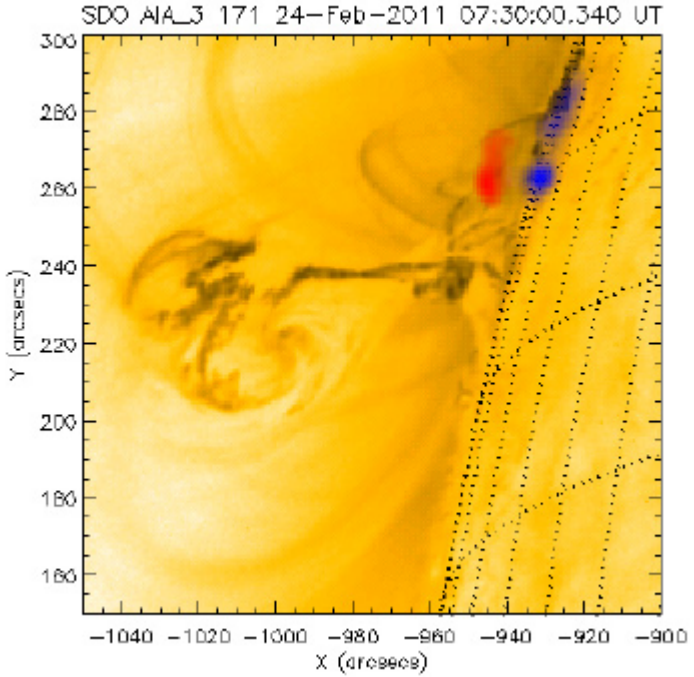
Task 1b: … *X-ray source structures (spatial and energy)*

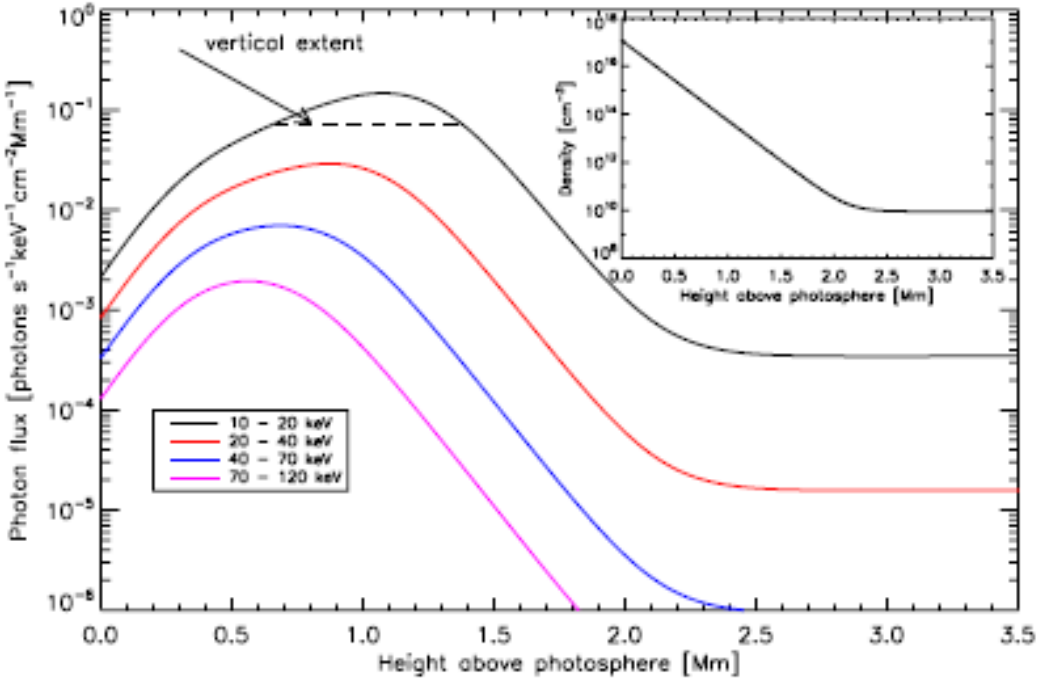
Battaglia M and Kontar E P 2011 Height structure of X-ray, EUV, and white-light emission in a solar flare *Astronomy and Astrophysics* **533** L2

Battaglia M and Kontar E P 2011 Hard X-Ray Footpoint Sizes and Positions as Diagnostics of Flare Accelerated Energetic Electrons in the Low Solar Atmosphere *Astrophysical Journal* **735** 42

Battaglia M, Kontar E P, Fletcher L, MacKinnon A.L. – Simulations

Status: Accepted for publication in ApJ

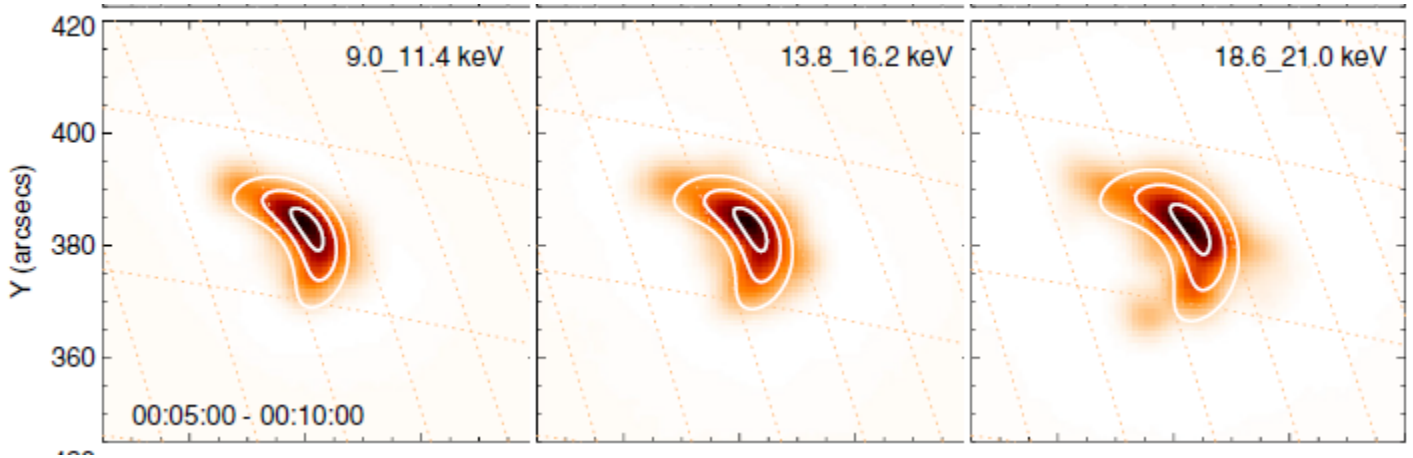




Task 1b: … *X-ray source structures*

Acceleration region and particle transport

Kontar, E. P.; Hannah, I. G.; Bian, N. H., Acceleration, Magnetic Fluctuations, and Cross-field Transport of Energetic Electrons in a Solar Flare Loop, 2011, ApJL,

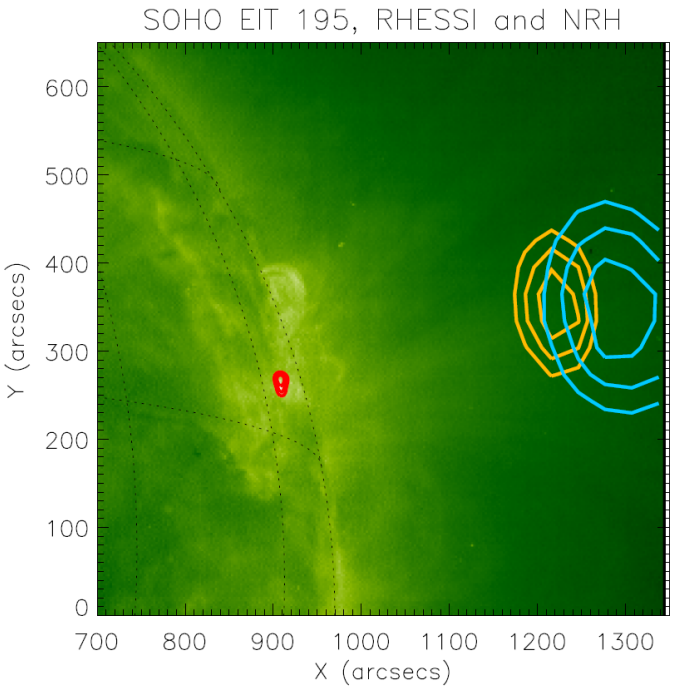


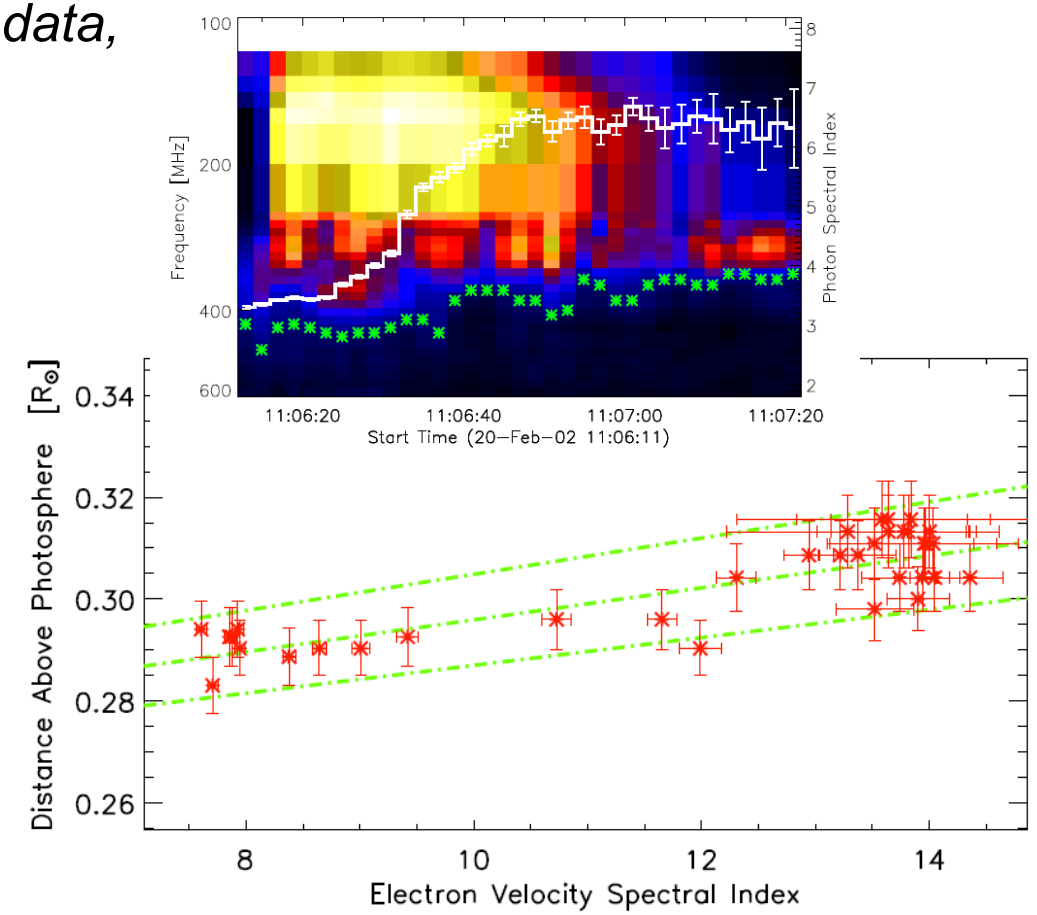
Unique diagnostic potential of acceleration size and magnetic fluctuations… Poses new questions – electron visibilities (Jingnan work) and finite temperature effects on transport (Michele work)

Status: Positive referee report for publication in A&A

Task 1c: … combination of the analysis of SEP events at the Earth and at the Sun using X-ray … (in collaboration with Meudon)

Reid, Vilmer, and Kontar, *Analysis of escaping and HXR producing electrons using X-ray and radio data,*





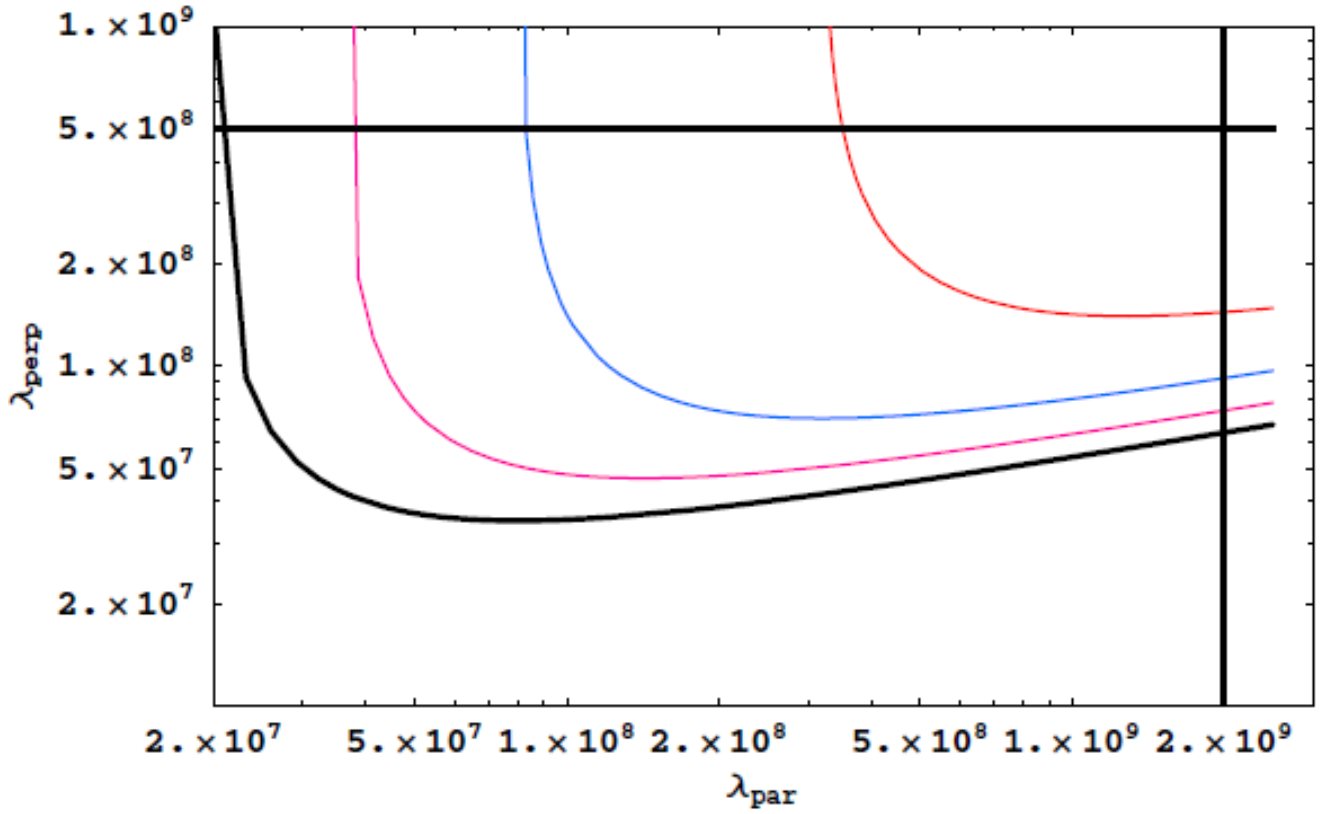
Status: In preparation …

Task 2 Study of the energy release sites and particle acceleration mechanisms
Combination of X-rays and other wavelengths to derive the physical conditions of the energy release sites and to better understand particle acceleration mechanisms: with radio observations related to geo-effective factors (space weather); optical, SXR and EUV (SDO mission).

Task 2a: … *X-ray source structures -> parameters of acceleration site*

Acceleration region and particle transport – turbulent diffusion

Bian, Kontar, & MacKinnon, *Turbulent cross-field transport of non-thermal electrons in coronal loops: theory and observations,* A&A, 2011, 535, id.A18



Task 2b: … *better understanding of acceleration…*

Nicolas Bian, A. Gordon Emslie & Eduard P. Kontar, *A Classification of Stochastic Acceleration Processes, ApJ, in preparation*

Classification of stochastic acceleration models
for particle transport
a) free streaming
b) diffusion
c) free streaming + diffusion

$$\frac{\partial f(p,t)}{\partial t} = \frac{\partial}{\partial p}\left[D_0 p^{\alpha} \frac{\partial f(p,t)}{\partial p}\right]$$

for fields
a) general case
b) plasma modes [specific case with omega=omega(k)]
c) resonance broadened growth/damping of waves

Task 2b: … *better understanding of acceleration…*

Nicolas Bian, A. Gordon Emslie & Eduard P. Kontar, *A Classification of Stochastic Acceleration Processes, ApJ, in preparation*

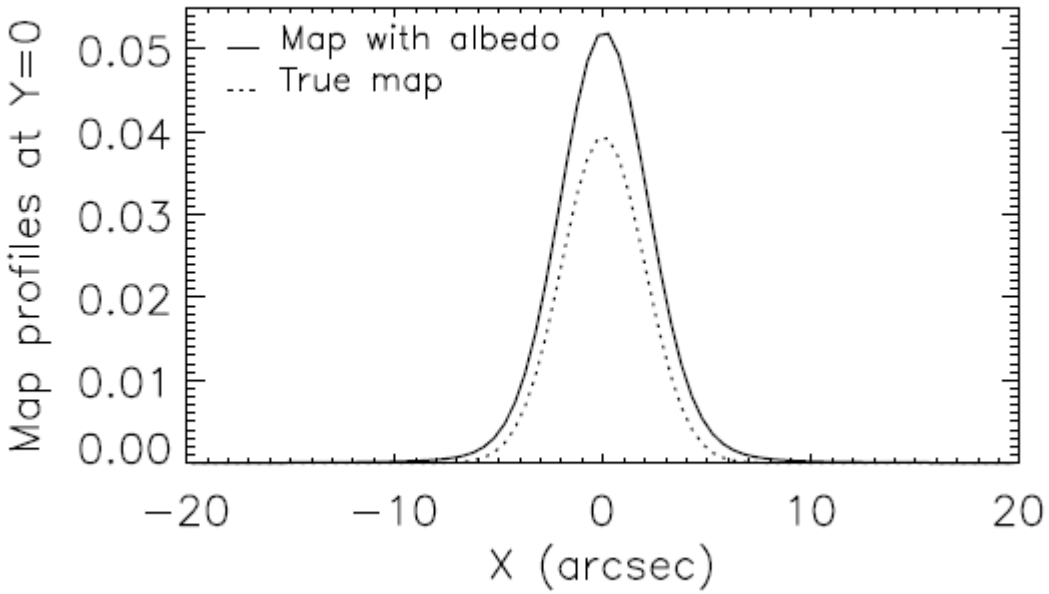
$$D(p) = \int_0^\infty dt \int_{-\infty}^\infty dx\, C(x,t)\, P(x,t)$$

$$D(p) = \int\int dk\, d\omega\, S(k,\omega)\, G(k,\omega) \quad ,$$

Task 3 Development of paradigms for generating synthetic data Design of physical/geometric configurations for flaring events; formulation of simulation paradigms for producing calibrated event lists, hard X-ray visibilities, count spectra and images.

Task 3a: … Albedo and imaging…

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



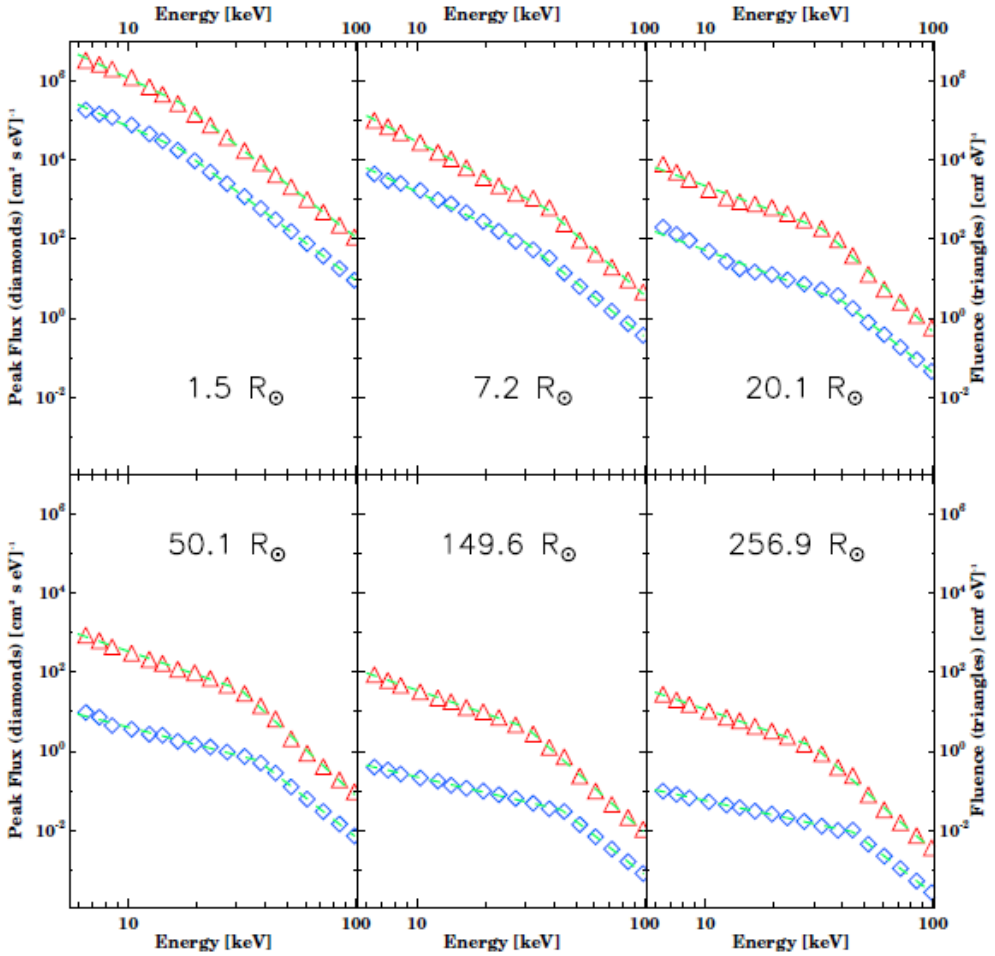
Task 4 Development of particle acceleration and propagation models
Based on the results obtained in tasks 2.1 and 2.2, we will undertake theoretical development of particle acceleration models, and particle propagation models.

Reid and Kontar, Evolution of the solar are energetic electrons in the inhomogeneous turbulent inner heliosphere, *in preparation*

Status: Almost accepted for publication in Solar Physics…

Task 4a …. propagation models …. See also Paulo's work and Jingnan/ Michele…

Reid and Kontar, Evolution of the solar are energetic electrons in the inhomogeneous turbulent inner heliosphere.



Task 4b …. *acceleration models …*

See also ….Nicolas Bian, A. Gordon Emslie & Eduard P. Kontar, *A Classification of Stochastic Acceleration Processes, ApJ, in preparation*

A) Further work to compare the list of parameters with the data inferred

B) New stochastic acceleration models in collisional plasma – effects on velocity diffusion

Conclusions

Deliverables (brief description) and month of delivery:
D3.1 Specification of models for particle acceleration mechanisms for selected events (Month 24)
D3. 2 Specification of models for energy release for selected events (Month 24)
D3.3 Specification of paradigms for simulation of synthetic data (Month 24)
D3.4 Specification of paradigms for multiwavelength interpretation (X-rays, EUV, radio) (Month 36)
D3.5 Part of the Project Report (first year) concerning the Theory Work Package (Month 12)
D3.6 Part of the Project Report (second year) concerning the Theory Work Package (Month 24)
D3.7 Part of the final Project Report concerning the Theory Work Package (Month 36)