CAM Glitches

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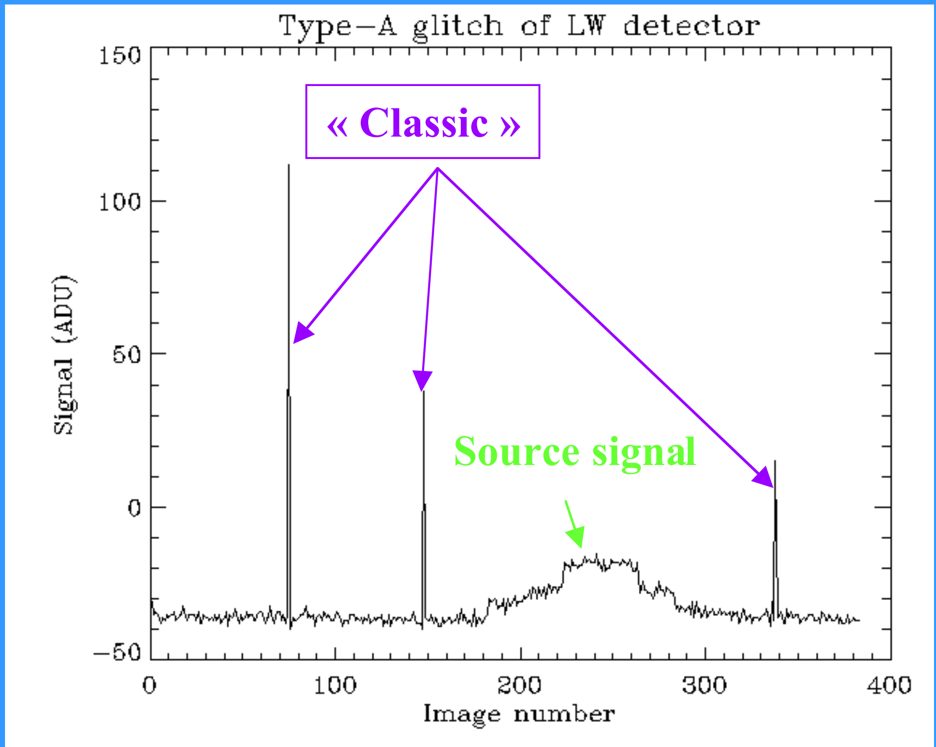
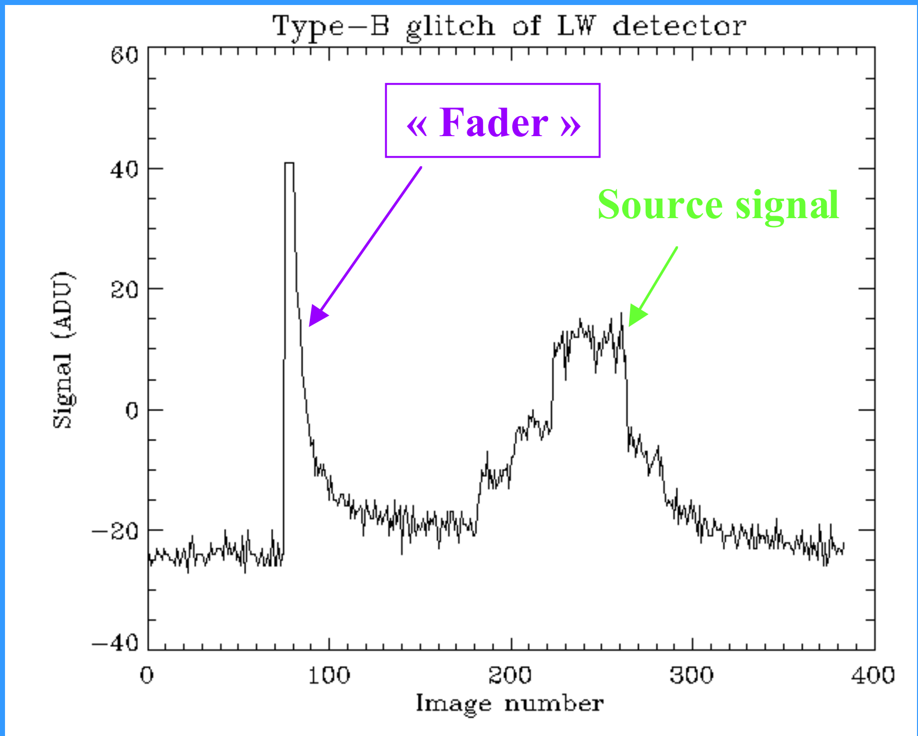
- Glitch characteristics
  - Spatial properties
  - Temporal properties
  - Key numbers
- Glitch Working Group
  - Objectives
  - Glitch rate prediction
  - Photo-conductor behaviour
- Conclusion & future work

Type-A or « Classic »



- ☞ Short duration :
  - similar to a δ function
  - lower than integration time
- ☞ Can be removed easily :
  - sigma clipping
  - multi-resolution method
- ☞ Mainly produced by :
  - trapped protons and electrons
  - galactic protons and electrons

Type-B or « Fader »



☞ Longer duration :
- strong increase of signal
- exponential decreasing tail

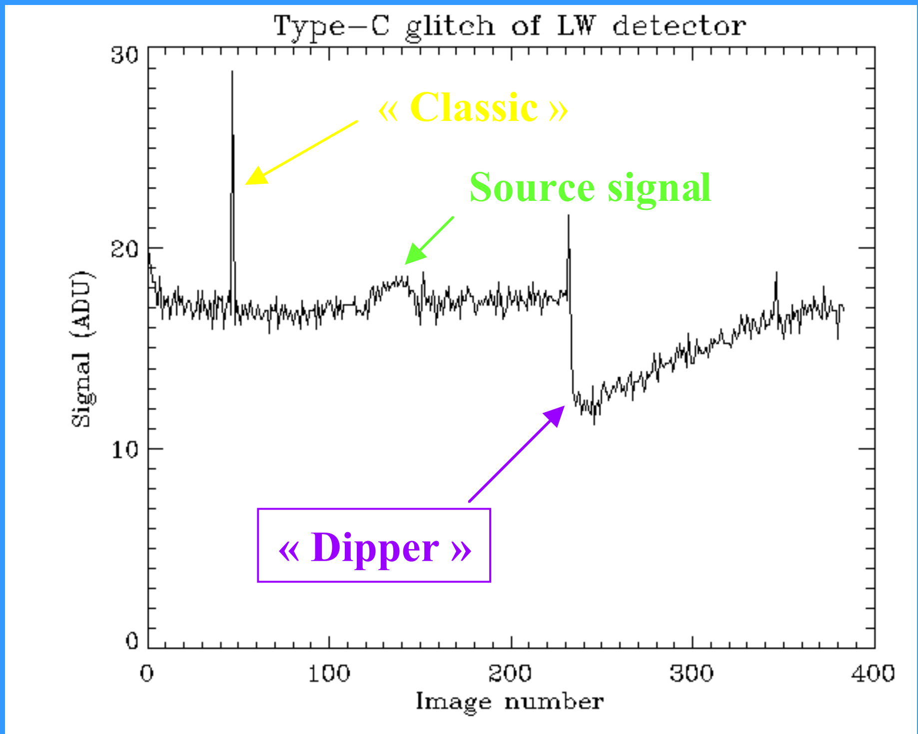
☞ CANNOT be removed easily :

tail residual often remains

➘ similarity with transient behaviour

☞ Mainly produced by :
- energetic protons and electrons
- galactic ions

Type-C or « Dipper »



☞ Long or short duration :
- similar to a δ function
- negative exponential increasing tail

☞ CANNOT be removed easily :

tail residual often remains

➘ similarity with transient behaviour

☞ Mainly produced by :
- high energetic protons and electrons
- galactic heavy ions

Key numbers for LW detector

- Rate ~ 1 glitch / sec
- Affected pixels ~ 8 pixels / glitch

- No clear variation along one orbit
  except just after/before radiation belts
- Possible variation from one orbit to another
  due to solar activity
- Sensitivity loss
  - ✓ 2% for 2.1 sec, 5% for 5.04 sec, 10% for 10.08 sec
  - ✓ BUT glitch tails, gain variation, heavy particles, … induce more sensitivity loss

Glitch Working Group

☞ Main objectives

- ✓ Build statistics of glitches from <u>in-flight data</u>
- ✓ Improvement of removal methods
  - ➘ post operation work for ISO = preliminary study for future experiments

☞ Results for CAM

- ✓ Review of glitch properties and removal methods
  - ➘ A. Claret et al., Experimental Astronomy, 1999
- ✓ New calculation of glitch rate
  - ➘ H. Dzitko et al., Experimental Astronomy, 1999
- ✓ Physics of glitches
- ✓ Monte-Carlo simulations

☞ Results for other instruments

- ✓ Comparison between ISO detectors
  - ➘ A. Heras et al., ESA workshop on space weather, Nov. 1998

Glitch rate of CAM

☞ Last estimations

- ✓ primary particles : GCR fluxes from ULYSSES/KET
- ✓ secondary particles and δ-rays : ~80% of primary contribution

☞ NOT taken into account

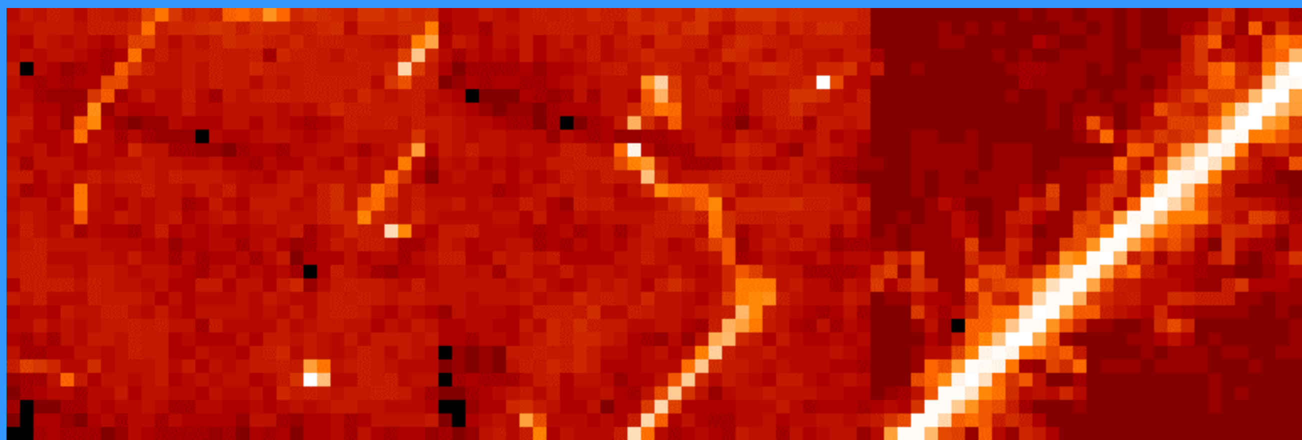
- ✓ electromagnetic showers
- ✓ secondary and δ-rays from the body of the spacecraft
  - ➘ possible 10-30% additional contribution

PFOV	1.5"	3"	**6"**	12"
Primary GCRs			**0.36 s^{-1}**	
Secondary particles and δ-rays			**0.29 s^{-1}**	
α-particles from $^{232}Th^{*}$	0.002 s^{-1}	0.02 s^{-1}	**0.16 s^{-1}**	0.35 s^{-1}
TOTAL	0.65 s^{-1}	0.67 s^{-1}	**0.81 s^{-1}**	1.0 s^{-1}

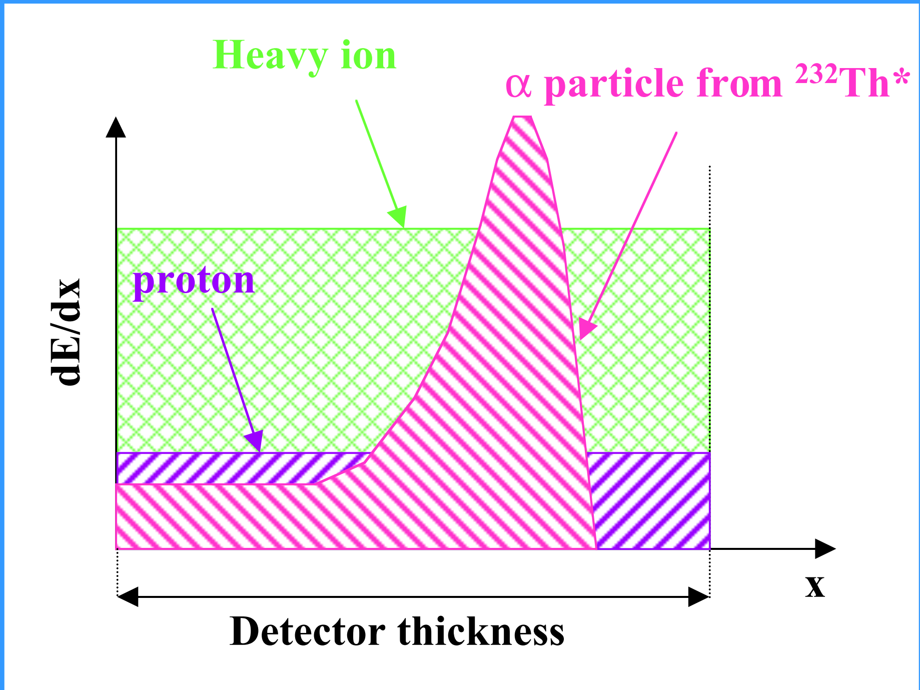
Spatial properties of glitches

☞ Spatial size of glitches depends of the incidence of ionising particles :

- galactic cosmic rays (isotropic) → ~ 8 pixels / glitch
- α-particles from $^{232}Th^*$ (normal incidence) → ~ 1-2 pixels / glitch
- secondary particles, heavy ions → variable

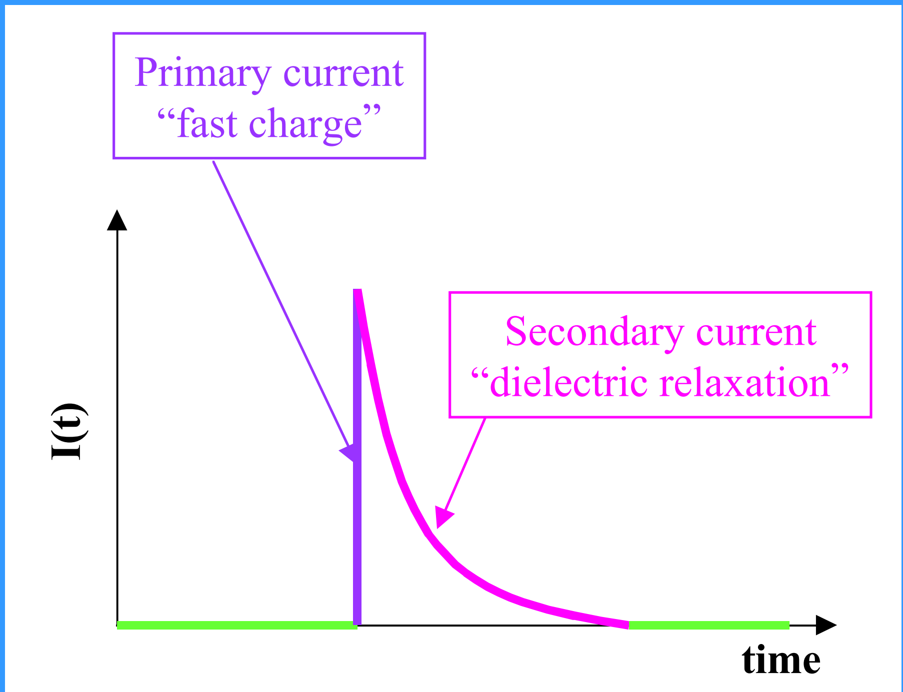


Temporal properties of glitches



- Ionisation depends of the Lineic Energy Transfer
  L.E.T. = $\int \frac{dE}{dx}\,dx$
- L.E.T. $\alpha\ Z_i^2$
  - 36 times higher for Carbon ion (Z=6)
  - 676 times higher for Iron ion (Z=26)
- L.E.T. = $f^{\underline{n}}(E_i)$
  - ↗ L.E.T. if the particle stops in the detector

Photo-conductor behaviour



☞ Primary current

• directly associated with the transport of the carriers (free electron-hole pairs)

• instantaneously generated

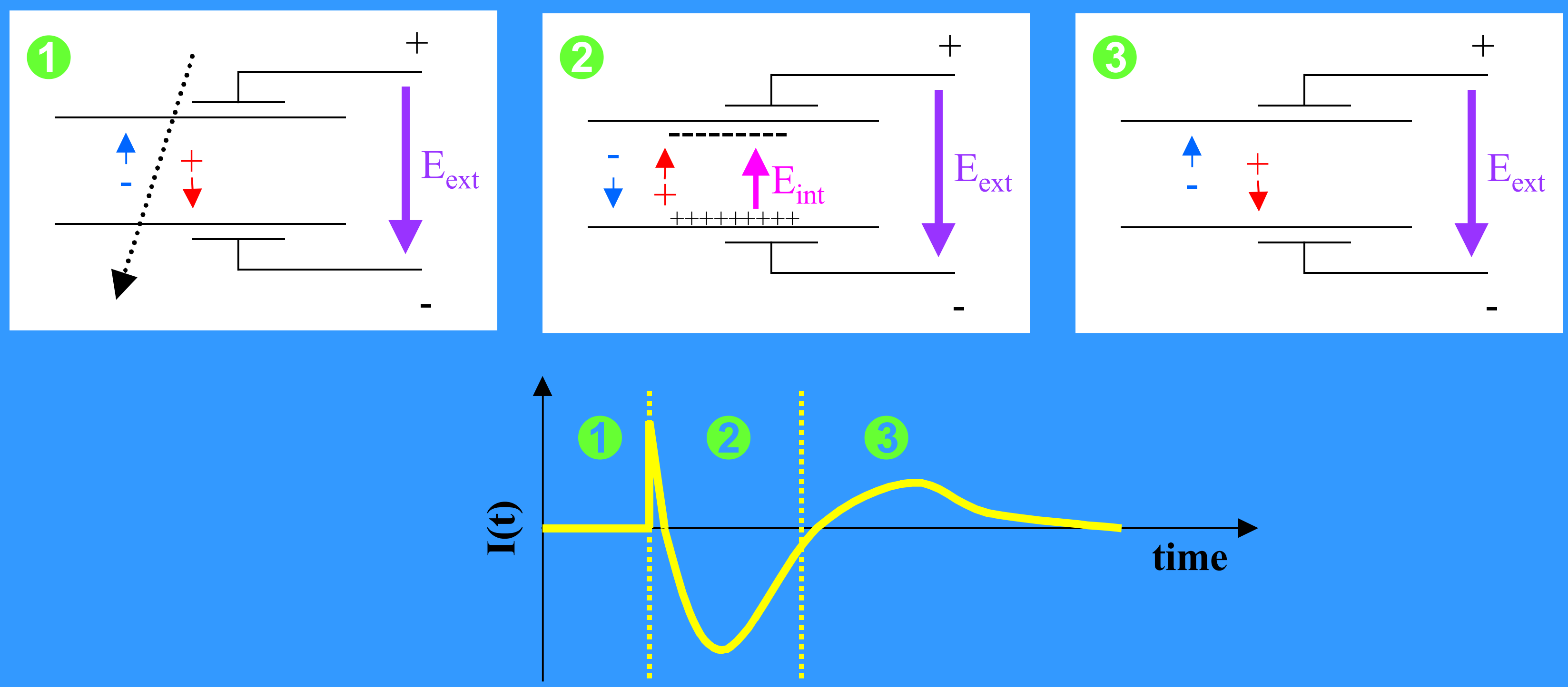
☞ Secondary current

• some of the carriers are trapped before they are swept out ⇒ the detector retain a net positive or negative charge after the primary current is over

• return of the detector to its initial state of neutrality which requires secondary current (dielectric relaxation)

What happens with heavy particles ?

highly ionising ⇒ change of the electric field



Glitch removal methods

☞ IA algorithms give good results for classic glitches

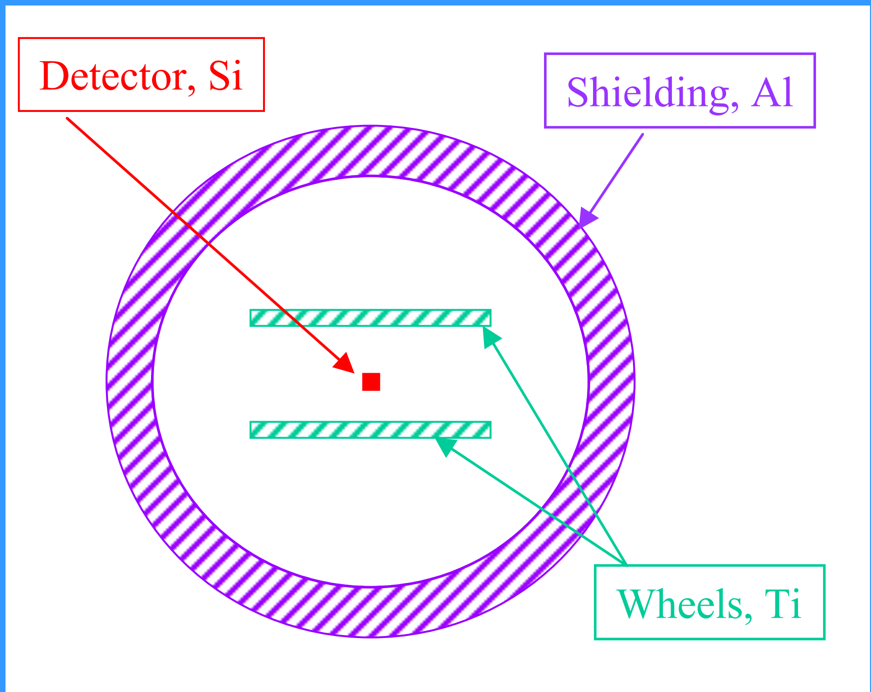
- ✓ Sigma-clipping
- ✓ Multi-resolution median transform (J-L Starck, CEA-Saclay)
  - ➘ Long tail glitches still NOT well removed

☞ What about methods based on particle identification ?

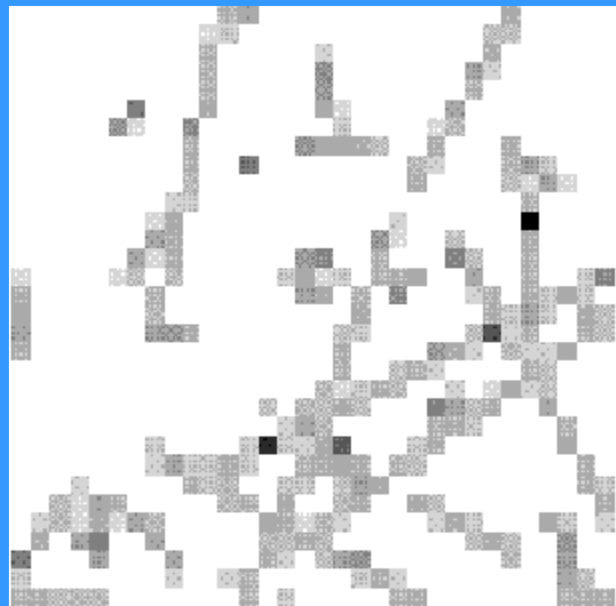
- ✓ Pattern recognition in 3D space is necessary but NOT trivial
- ✓ A given particle is likely to induce “classic” or “fader” or “dipper” depending of its energy, atomic number, incidence, …
  - ➘ Too many free parameters !

Monte-Carlo simulation

Simple CAM model used with GEANT code



CAM synthetic glitches



Conclusion & future work

☞ Conclusion

- ✓ Last estimation of glitch rate is in good agreement with in-flight data
- ✓ Study of glitch physics will NOT lead to major improvement of removal methods

☞ Future work

- ✓ Fitting of glitch tails may be improved
- ✓ Monte-Carlo simulations are useful to test some ideas about secondaries
- ✓ The GWG will provide predictions of glitch rate and effects for FIRST