

OUTCOMES OF SIGMA AND PRESENTATION OF SIGMA2

*TWO RESEARCH PROJECTS LED
BY EDF ON SEISMIC HAZARD
ASSESSMENT*

Pierre Labbé

2nd “DAMS & SEISMS” EWG WORKSHOP

Hosted by ITCOLD,
Roma, 6-7 February 2017



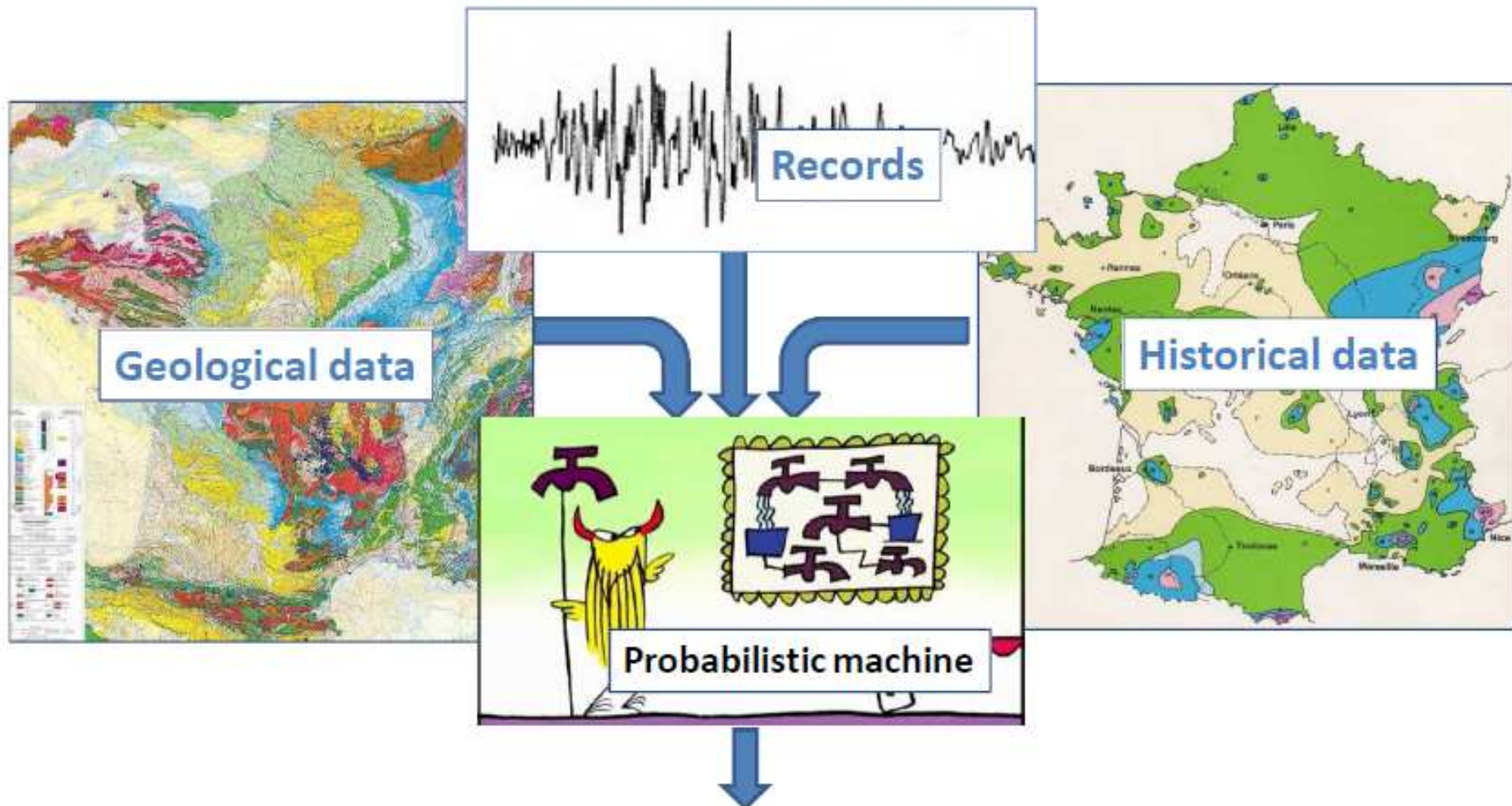
Why SIGMA ?

➤ **To address issues that control seismic hazard assessment outputs:**

- **uncertainties**
 - **Probabilistic approach**
 - **Deterministic approach**
- **some related scientific issues**
 - **Two examples**

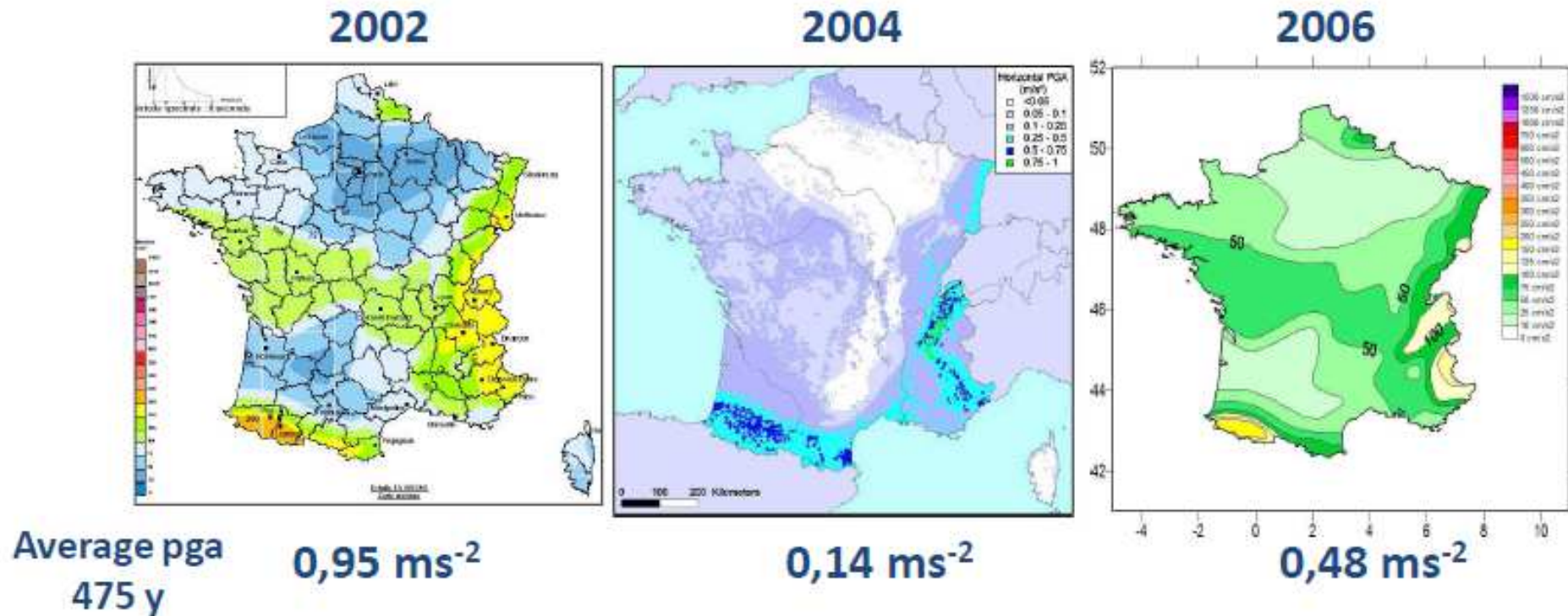
Why SIGMA ?

Uncertainties



Why SIGMA ?

Uncertainties

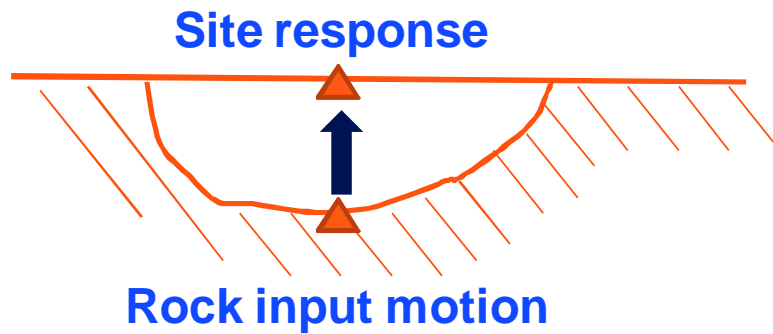


What is behind uncertainties ? How to stem them ?
What is aleatory, what is epistemic ?

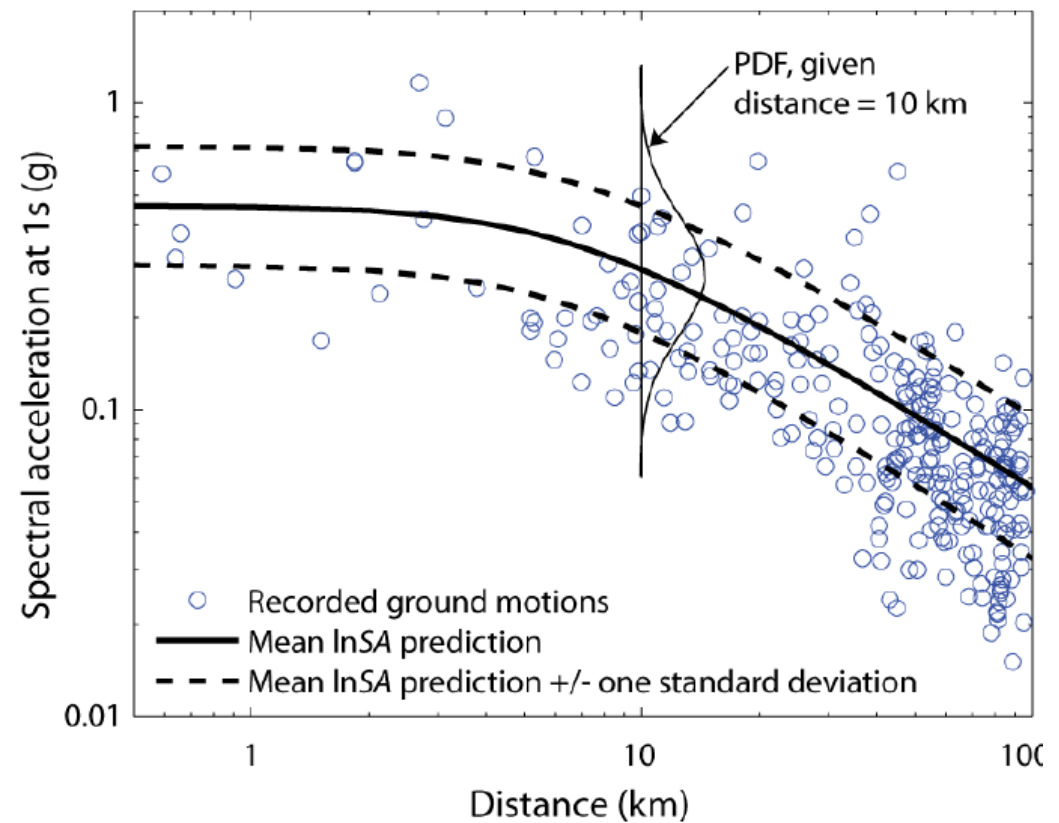
Why SIGMA ?

Scientific Issues

The hard rock input motion issue



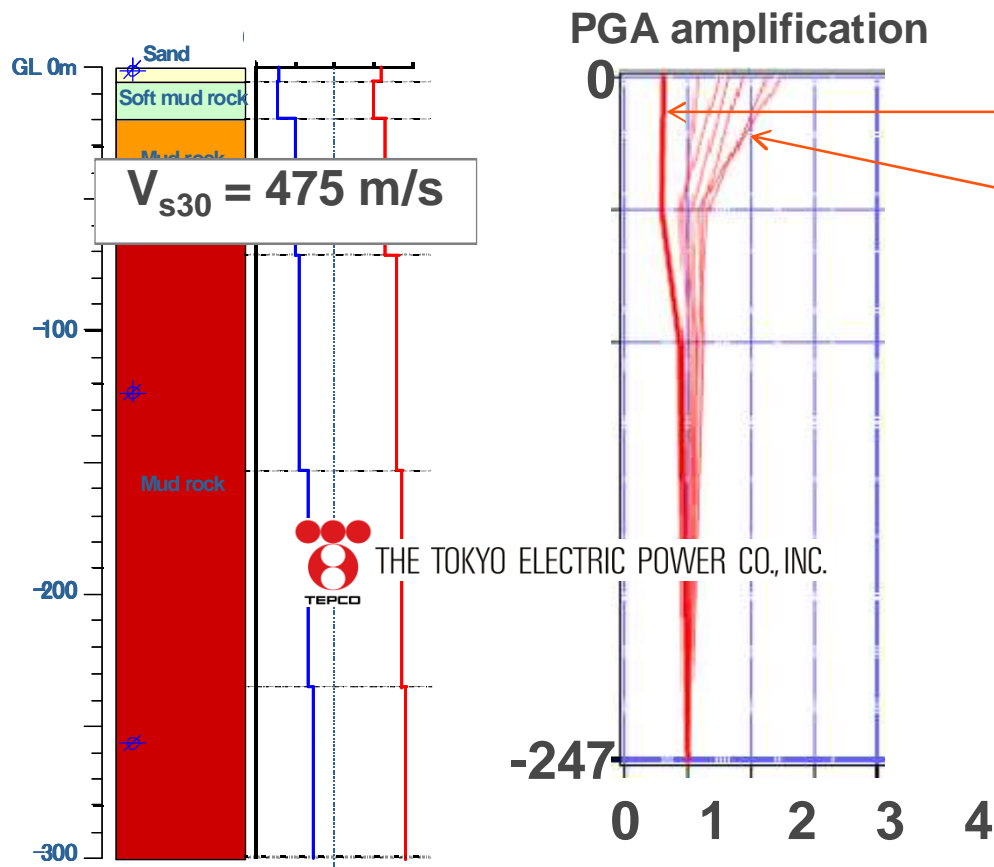
*How to screen/process
strong motion data to get
“true” hard rock signals ?*



Why SIGMA ?

Scientific Issues

The non-linear site response issue



Kashiwasaki-Kariwa 2007

Main shock: deamplification

Aftershocks: amplifications

Extrapolation from low PGA to high PGA is not possible !

Which appropriate models for site non-linear response?

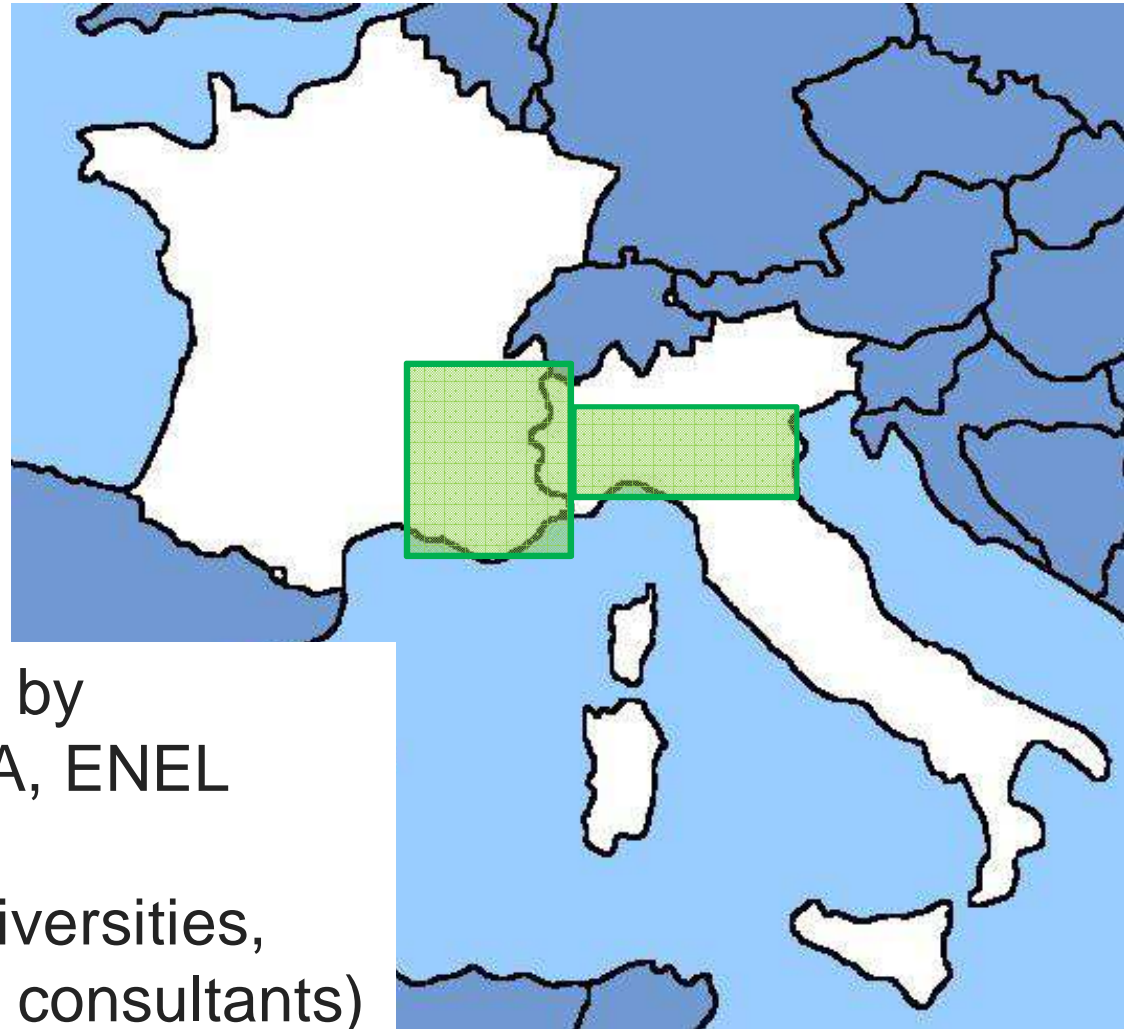
Why SIGMA ?

Enhancing the seismic hazard assessment QA **on a strong scientific background**

- Eliminating obsolete, ill-documented or inappropriate data
- Improving database metadata quality
- Getting more realistic models
- Replacing experts' judgment by objective criteria
- ...

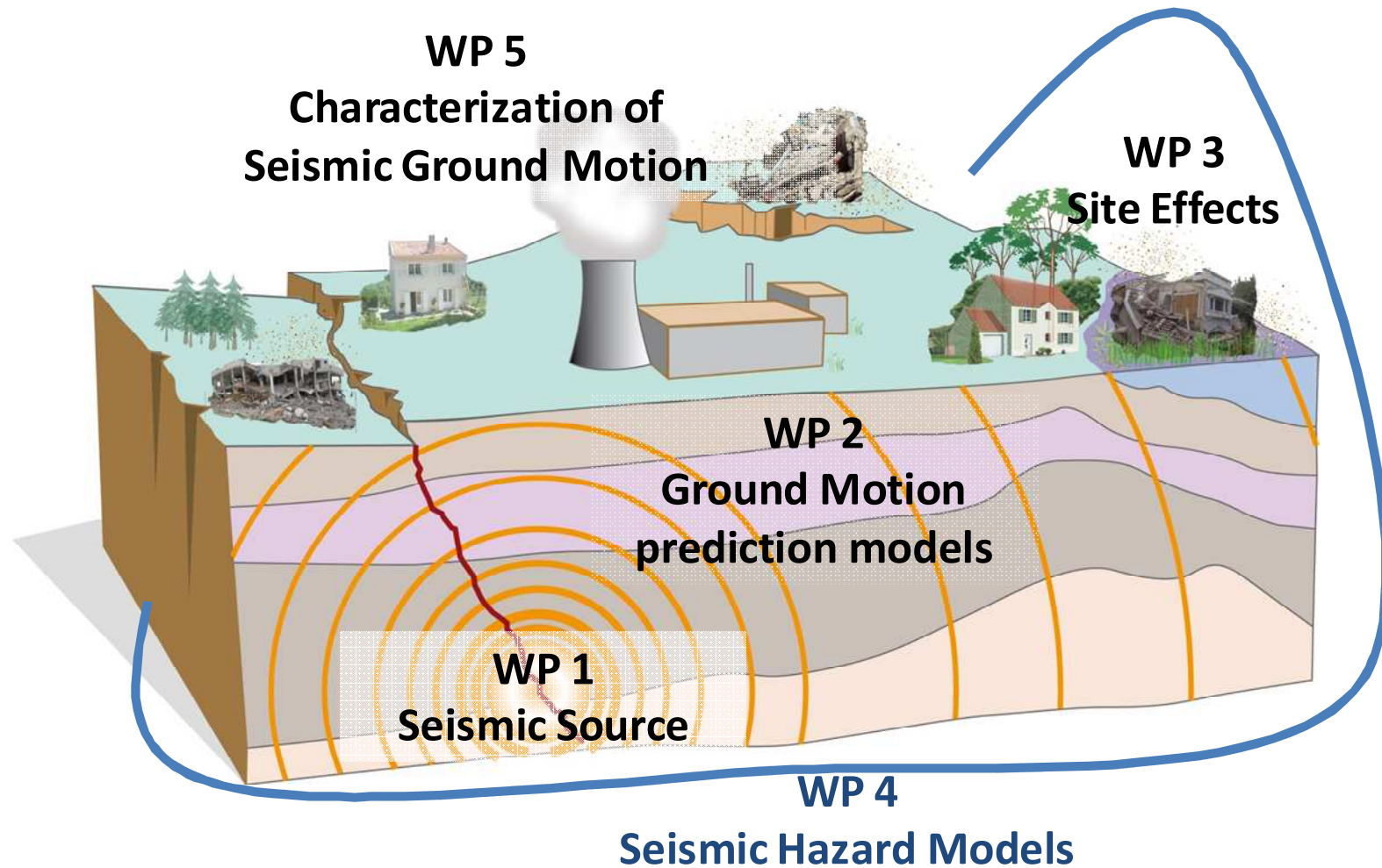


How SIGMA ?



- ❖ ~ 7.5 M€ ; funded by
EDF, Areva, CEA, ENEL
- ❖ 30 institutions (universities,
research centres, consultants)

How SIGMA ?



SIGMA Outputs

➤ **Results with immediate operational application**

- Homogenous Seismic Catalogue in M_w for France
- Seismic ground-motion database: **R**ESORCE
- Ground Motion Prediction Equations
- Best practices guideline for site characterisation
- Recommendations for non-linear site response analysis
- Operational guide to account for site effects
- Intensity Measures for Seismic PRA

*Final report to be published by Springer :
**Overview & lessons learnt from a probabilistic
seismic hazard assessment for France and Italy***

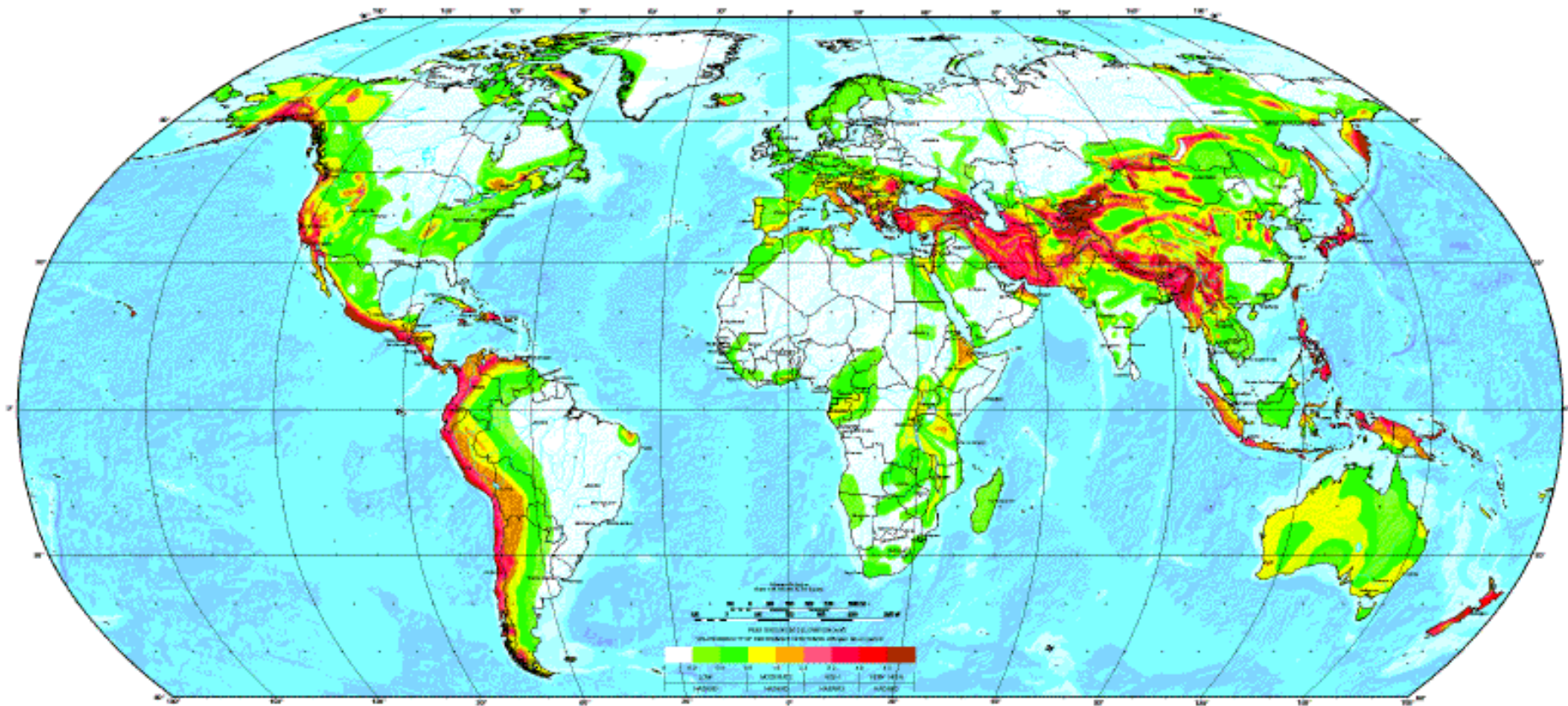
SIGMA Outputs

➤ Some significant scientific outputs

- Host to target correction of ground motion.
- Example of a site specific PSHA in the Po Plain, with single-station sigma and related uncertainties.
- Testing and Bayesian updating of PSHA
Conclusion of the OECD/NEA Pavia Workshop (Feb. 2015) :
“A state-of-the-art PSHA should include a testing (or scoring) phase against any available observation (including any kind of observation and any period of observation)”
- New damage indicator for nuclear installations.

40 papers in peer-reviewed journals; 14 PhD

SIGMA 2





Why SIGMA 2 ?

An EDF initiative, with the objective of

Grouping industrial partners sharing common concerns, in particular willing

- **to stabilize seismic hazard assessment outputs,**
- **to promote realistic PSHAs** (best estimate).

We consider that the SHARE map is not best-estimated. We propose to issue an updated version.

Our vision is that we should go towards hazard calculated at (a possibly hypothetical) rock outcrop, and site response calculated afterwards.



SIGMA 2 Scientific Program

➤ Enrich Data (Work Package 1/3)

Historical Data

- Collect new information on historical earthquakes
- Improve magnitude and depth estimate of historical earthquakes
- Identify site effects in historical databases

Instrumental Data

- Improve depth determination of instrumental earthquakes
- Produce a 3D crust velocity model to improve events location

Strong motions

- Enrich **R**esource : new signals, better metadata

Seismotectonic features

- Improve fault movements dating



SIGMA 2 Scientific Program

➤ Develop Models (Work Package 2/3)

Seismic Source, earthquake recurrence

- Develop recurrence models low seismicity areas
- Compare PSHA from high/low activity areas (data, uncertainties, outputs)
- Compare PSHA model by zones and models by fault

Ground Motion Prediction

- Develop new GMPEs for the European context, including site parameters
- Develop “Host to Target” methodologies
- Test the feasibility of ground motion simulations based on fault rupture modeling, in European context

Site Response and Geotechnics

- Improve modeling of non linear soil behavior
- Develop topographic site effects modeling
- Improve prediction, probability assessment and mitigation of liquefaction



SIGMA 2 Scientific Program

➤ Improve PSHA / DSHA practice (Work Package 3/3)

Testing

- Develop methods of "PSHA Testing" and "Bayesian updating" .
- Perform exercises, in particular propose an evolution of the SHARE hazard maps, based on new data and methods, including testing and updating.
- Issue a guide on PSHA testing, with examples.

Extreme events

- Compare and test methods to determine and deal with extreme events in hazard studies (Mmax in PSHA, maximum credible earthquakes).

Interfaces

- Identify hazard studies outputs (damage capacity indicators, such as CAV) that pertain to structural/safety analysis
- Develop attenuation models for those indicators

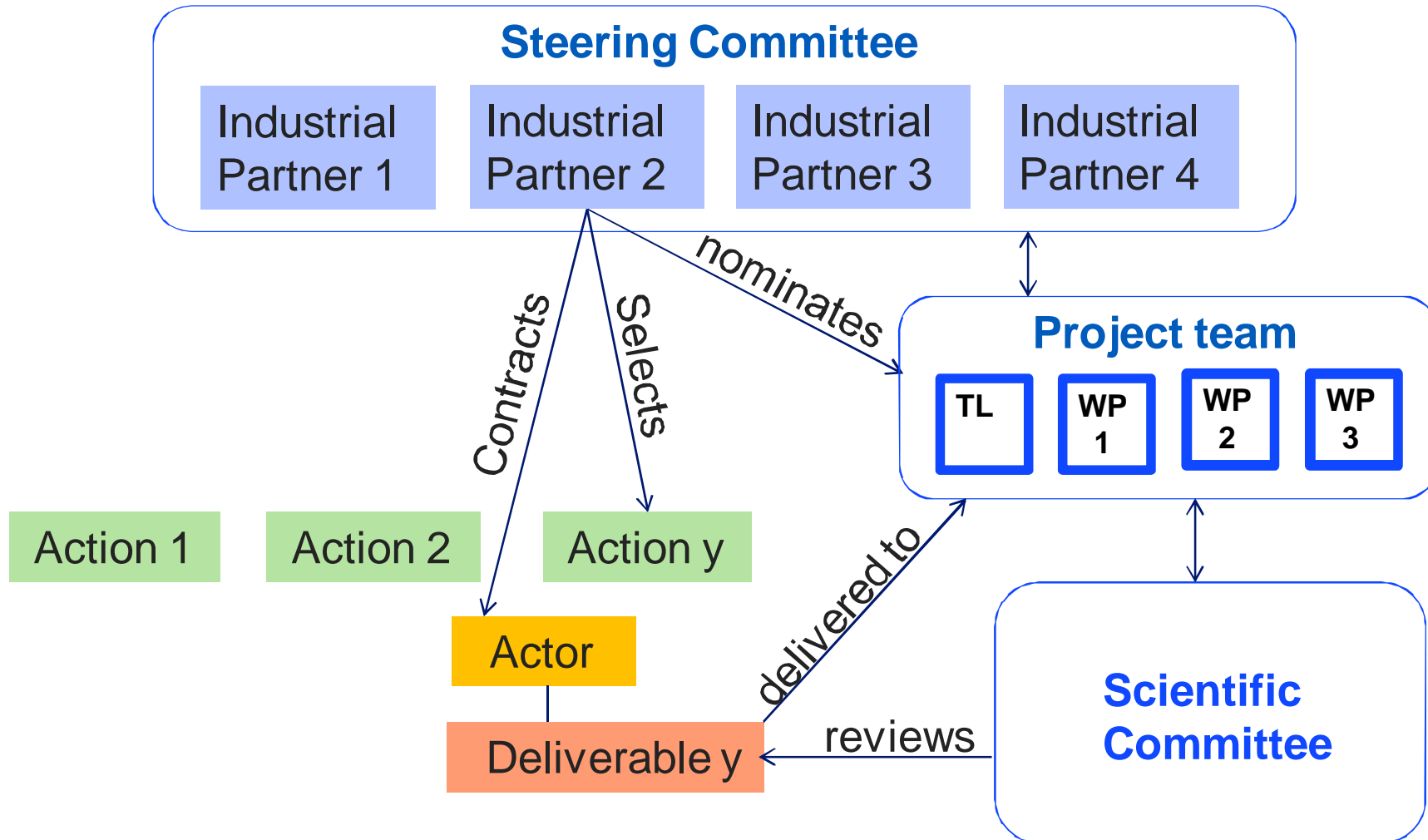


How SIGMA 2 ?

➤ Managerial outlines

- ***Proposed schedule : 5 years (2017-2022)***
 - Kick-off meeting: 6 February 2017,
- ***Financial contributions***
 - Open to different kinds of contributions : in cash, or in kind; expected participation around 50 k€/y
 - No subsidies.
 - Each Partner supports and funds a set of scientific actions.
- ***A Steering Committee*** validates/approves the workplan.
Each donor institution nominates a representative.
- ***Scientific Actors***
 - Academic Institutions selected by Partners

How SIGMA 2 ?



Two StC and ScC meetings per year



How SIGMA 2 ?

➤ **Partnership**

- ***Confirmed contributors***
 - ***Swissnuclear***
 - ***Pacific Gas & Electric (USA)***
 - ***CEZ (Czech Republic)***
 - ***CRIEPI (Japan)***
 - ***CEA (France)***
- ***A Memorandum of Understanding has been circulated to possible participants.***
- ***Gate open until the end of 2017.***



**Thank you for
your attention**

