Get a copy

EGU2015
14813

UMTS rapid response real-time seismic networks: implementation and strategies at INGV

Aladino Govoni, Lucia Margheriti, Milena Moretti, Valentino Lauciani, Gianpaolo Sensale, Augusto Bucci & Fabio Criscuoli

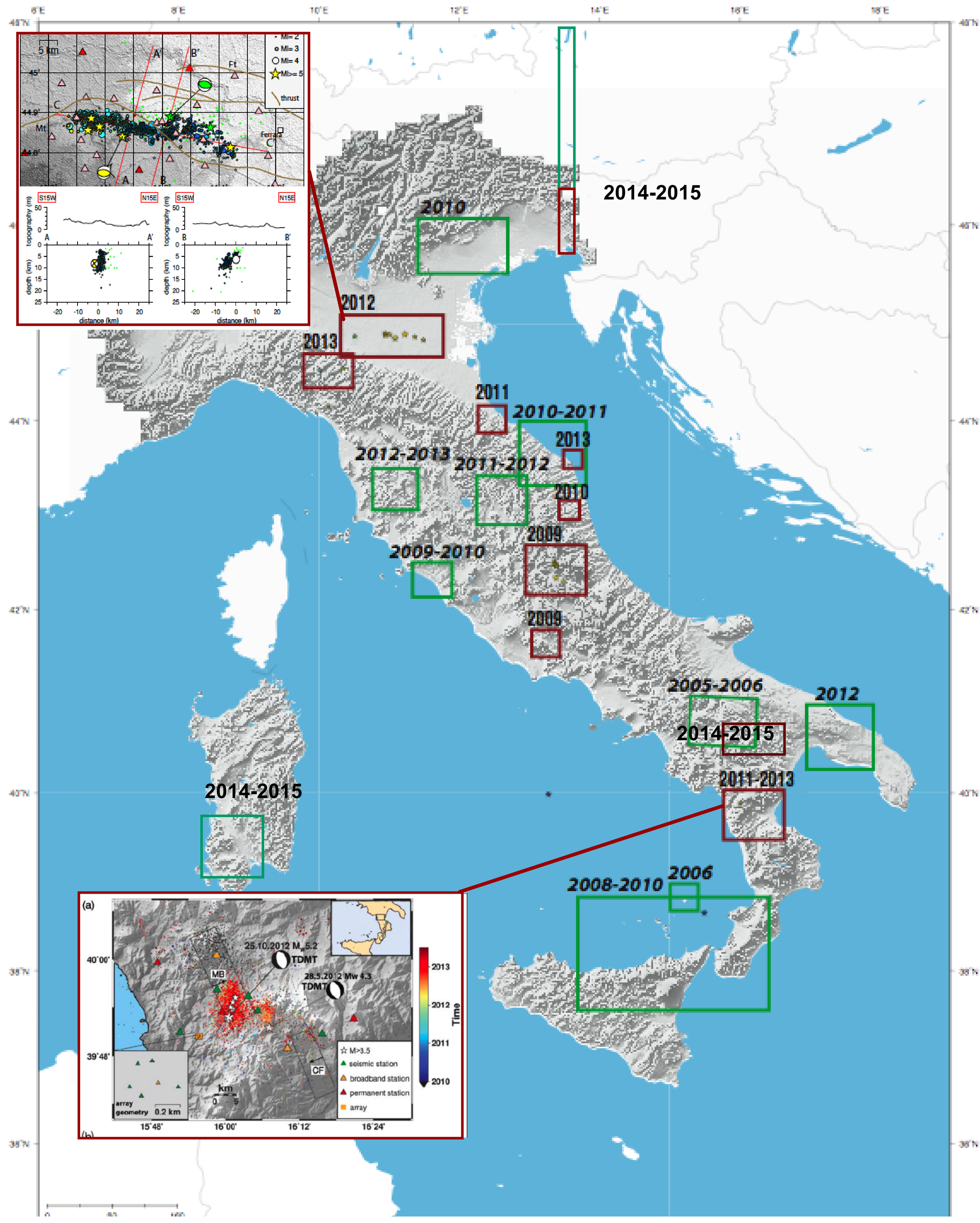
Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy (aladino.govoni@ingv.it)

European Geosciences Union
General Assembly 2015
Vienna, Austria
12 – 17 April, 2015

Introduction

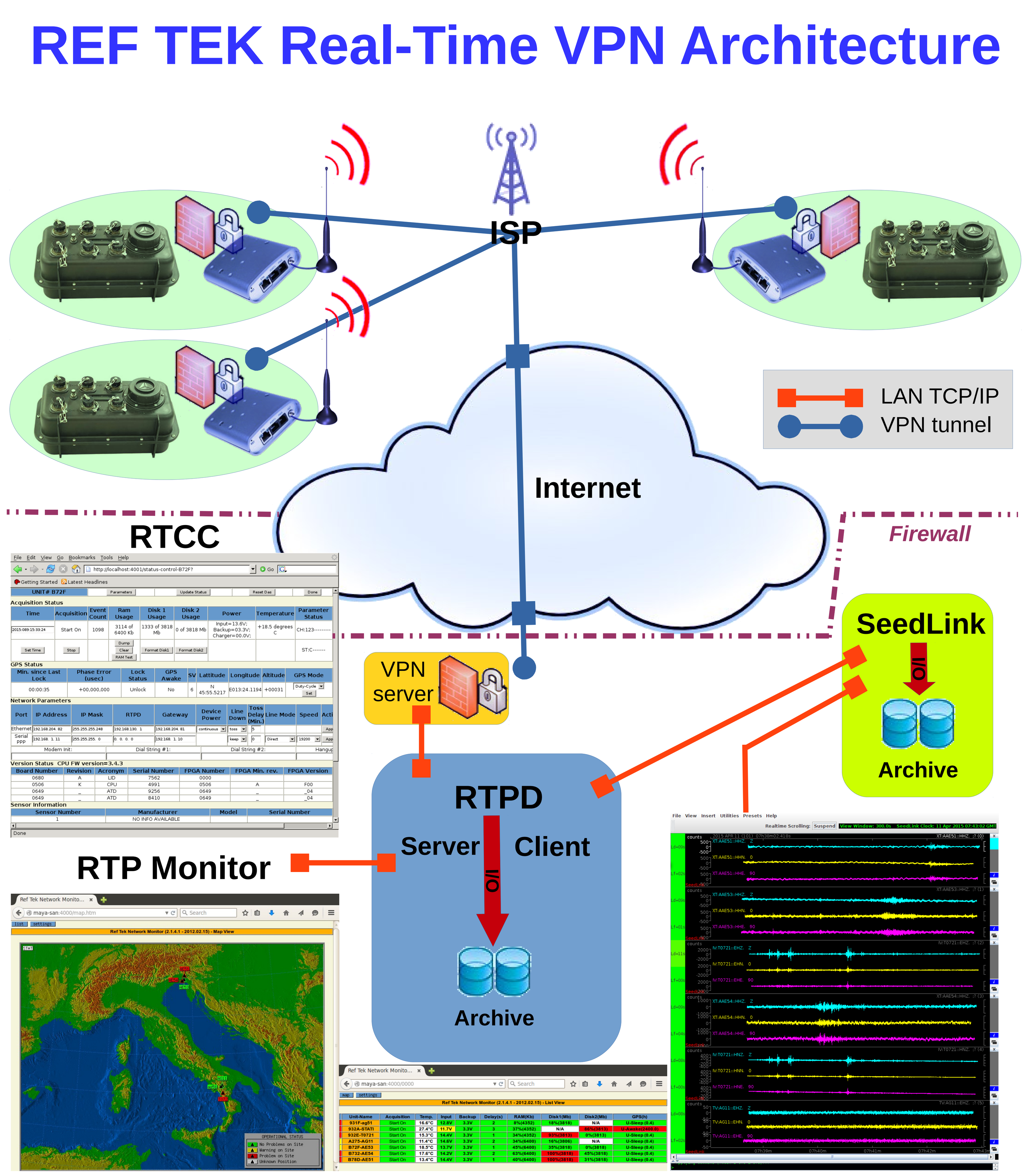
The benefits of portable real-time seismic networks are several and well known. During the management of a temporary experiment from the real-time data it is possible to detect and fix rapidly problems with power supply, time synchronization, disk failures and, most important, seismic signal quality degradation due to unexpected noise sources or sensor alignment/tampering. This usually minimizes field maintenance trips and maximizes both the quantity and the quality of the acquired data. When the area of the temporary experiment is not well monitored by the local permanent network, the real-time data from the temporary experiment can be fed to the permanent network monitoring system improving greatly both the real-time hypocentral locations and the final revised bulletin.
All these benefits apply also in case of seismic crises when rapid deployment stations can significantly contribute to the aftershock analysis.
Nowadays data transmission using meshed radio networks or satellite systems is not a big technological problem for a permanent seismic network where each site is optimized for the device power consumption and is usually installed by properly specialized technicians that can configure transmission devices and align antennas. This is not usually practical for temporary networks and especially for rapid response networks where the installation time is the main concern.
These difficulties are substantially lowered using the now widespread UMTS technology for data transmission. A small (but sometimes power hungry) properly configured device with an omnidirectional antenna must be added to the station assembly. All setups are usually configured before deployment and this allows for an easy installation also by untrained personnel.

INGV temporary networks in the last 10 years:
real-time UMTS stations and standalone stations.



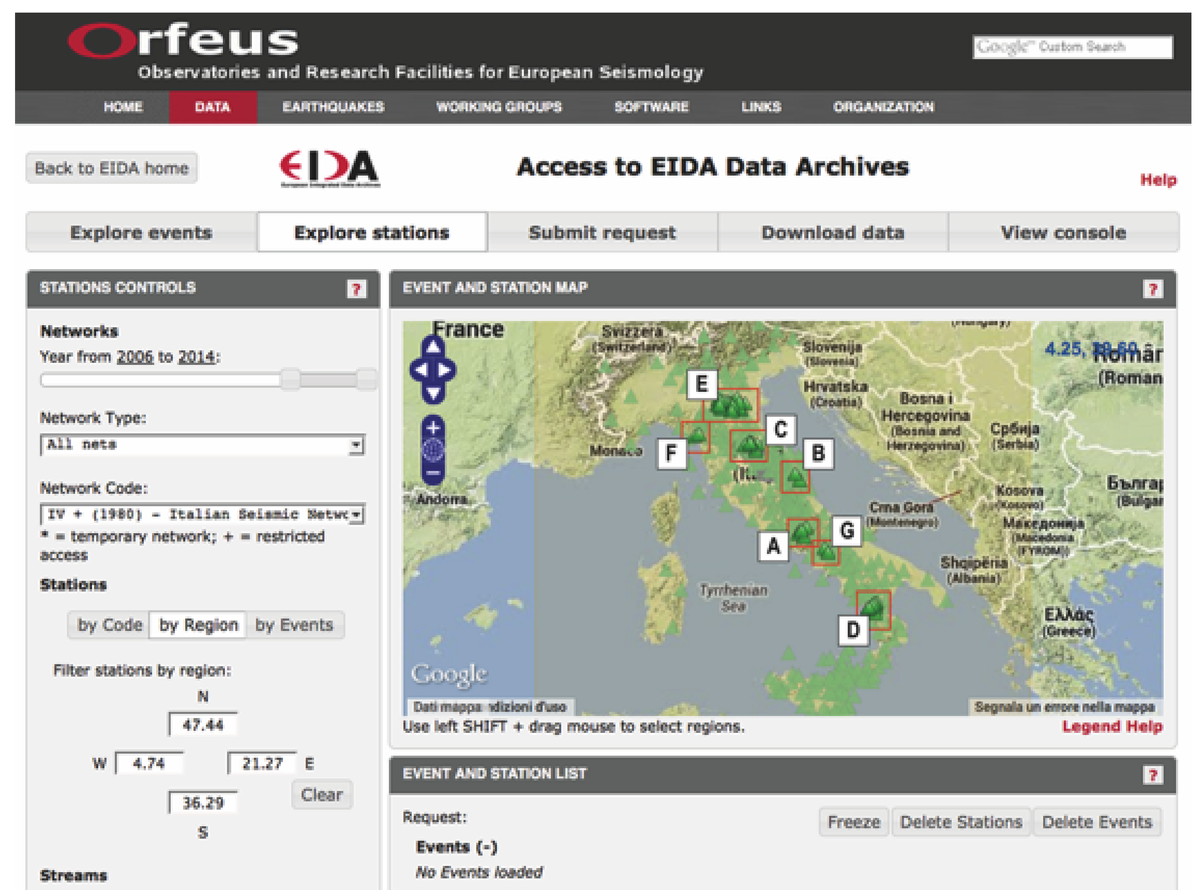
OpenVPN based real-time data acquisition scheme

UMTS is not very different from a home DSL connection, so the most difficult thing to do is really to reach a client behind a provider. Most provider's firewalls shield connections not initiated by the client (that in this case is the seismic station), 'strange' port/protocols (like seedlink 18000) and usually will change frequently the connection IP address.
This situation is not really the best for seedlink systems in which is the data server that looks for the client data, when the data link is initiated by the station (like RefTek 130) there are usually no big problems. You just 'plug and acquire'.
To overcome these problems you must use a UMTS router (not a simple modem) that can face more complex network situations and can do several tricks if needed.
A very 'quick&dirty' approach is to use a UMTS router with DynaDNS support, a m2m (machine to machine) UMTS contract with a local provider and a DynaDNS subscription (there are also open-source/free solutions). This gives to the remote station a valid internet address (something like mystation.dynadns.org) that is resolved to your current IP address and updated at any change. The router NAT can be configured to forward connections to the data service port directly to the seismic data logger behind the router.
This is basically all, but this setup is somewhat unreliable and insecure: all used ports are exposed to the Internet and the address lookups and the DynaDNS updates usually contribute to the overall latency of the station.
A much better solution consists in setting up a Virtual Private Network (VPN) supported by the UMTS router (basically all devices have at least one and any VPN type is good enough for seismological services - we choose OpenVPN).
The benefit is that all the stations now belong to a private network that you directly manage. All real world problems (reconnections, IP changes, etc., etc.) are handled automatically by the VPN server and there are no service ports exposed except of course the VPN one (that is usually strong enough).
This approach is much more secure and robust and you get an extra benefit in terms of bandwidth because the VPN tunnels are encrypted and compressed. The data acquisition scheme implemented at INGV is shown in the figure.



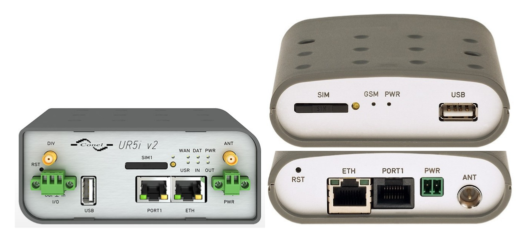
INGV staff learning how to deploy and configure a real-time station.

The data availability of temporary real-time station on EIDA.



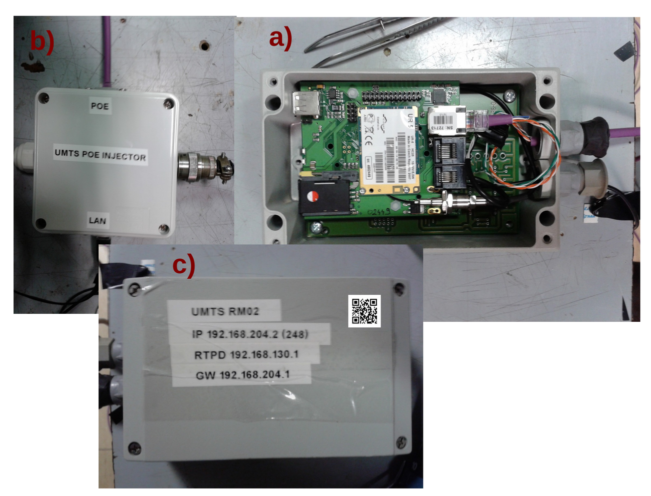
Implementation

The Conel UR5 (right) and UR5i v2 (left) UMTS router currently used.



We are currently using the Conel UR5 and UR5i v2 UMTS routers. These devices have reasonable power consumption ranging from 2W in continuos data trasmission with good UMTS signal up to 5W when the signal is poor and reconnections to the provider are frequent. These devices have all sort of nice features: 12 V power supply, an Ethernet 10/100 port, VPN support (IPsec, OpenVPN and L2TP), DHCP, NAT, NAT-T, DynDNS, NTP, VRRP. They have proved be rock solid in harsh conditions and they can also be telecontrolled using SMS.

The device packaged for installation on site.



The standard packaging is ruggerized inside a waterproof box with only two external connectors: one for the antenna (either omni or directional) and one for the POE Ethernet cable. The router box has a label with an ID and all the network parameters needed to configure the datalogger and also a QR code that let the operator access all site info using a smartphone.
An external switchbox takes power and ethernet from the data logger connectors and provides a POE connection to the router. The Ethernet port on the switchbox can be used to connect to the router for maintenance.

Conclusions

We describe here the implementation of a UMTS based portable seismic network for both temporary experiments and rapid response applications developed at INGV.
The first field experimentation of this approach dates back to the 2009 L'Aquila aftershock sequence and since then it has been customized and refined to overcome most reliability and security issues using an industry standard VPN architecture that allows to avoid UMTS provider firewall problems and does not expose to the Internet the usually weak and attack prone data acquisition ports. With this approach all the devices are protected inside a local network and the only exposed port is the VPN server one. This solution improves both the security and the bandwidth available to data transmission.
While most of the experimentation has been carried out using the RefTek units of the INGV Mobile Network this solution applies equally well to most seismic data loggers available on the market.
Overall the UMTS data transmission has been used in most temporary seismic experiments and in all seismic emergencies happened in Italy since 2010 and has proved to be a very cost effective approach with real-time data acquisition rates usually greater than 97% and all the benefits that result from the fast integration of the temporary data in the National Network monitoring system and in the EIDA data bank.

Acknoledgments

We wish to thank all INGV staff that in the last years have helped setting up, configure and install real-time UMTS stations.
We also thank L. Falco, E. D'Alema, W. Thorossian, S. Mazza and A. Rietbrock for valuable discussions and exchange of ideas.
This poster was typeset using LaTeX and the beamerposter package.