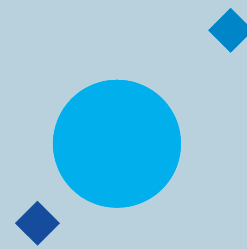




Osservatorio
Astronomico
di Cagliari



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Ministero dell'Istruzione,
dell'Università e della Ricerca



PON
RICERCA
E INNOVAZIONE
2014 - 2020

PULSAR MINER: una pipeline per la ricerca accelerata di pulsar

Alessandro Ridolfi

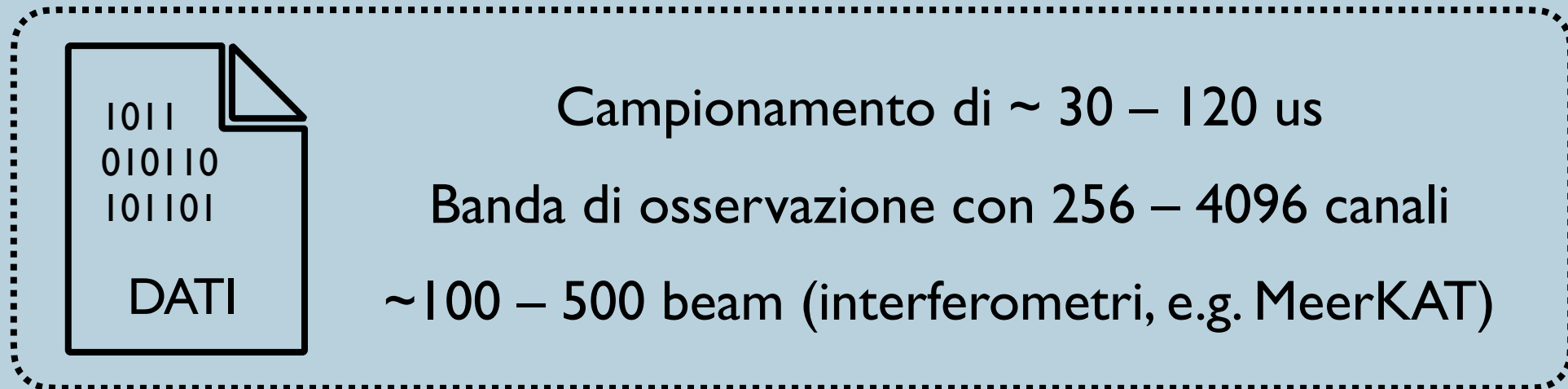
INAF - Osservatorio Astronomico di Cagliari
Max-Planck-Institut für Radioastronomie

Forum della Tecnologia Sperimentale e Tecnologica in INAF

Bologna, 23/06/2022

Sfide Computazionali

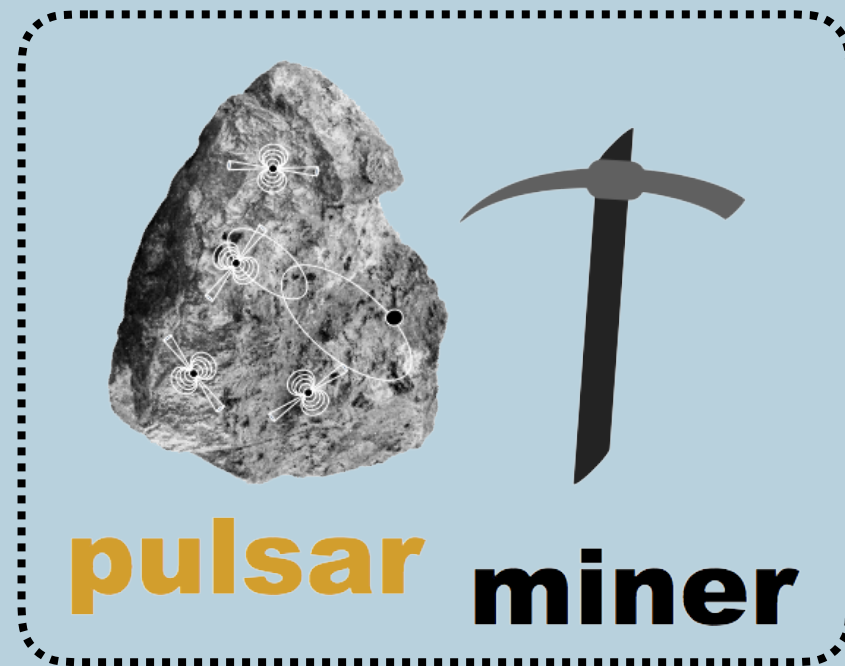
La ricerca di pulsar è uno tra i campi di ricerca più esigenti in termini di capacità computazionale.



$\sim 1-10$ TB/h !



**Necessità di una pipeline
efficiente e robusta
per l'analisi sistematica dei dati**



Basata sulla suite di
ricerca pulsar
PRESTO

www.cv.nrao.edu/~sransom/presto/

Supporto GPU
per la ricerca
accelerata

Scritta in
Python 2.7



Nessuna
procedura di
installazione
richiesta

Semplicità
d'uso

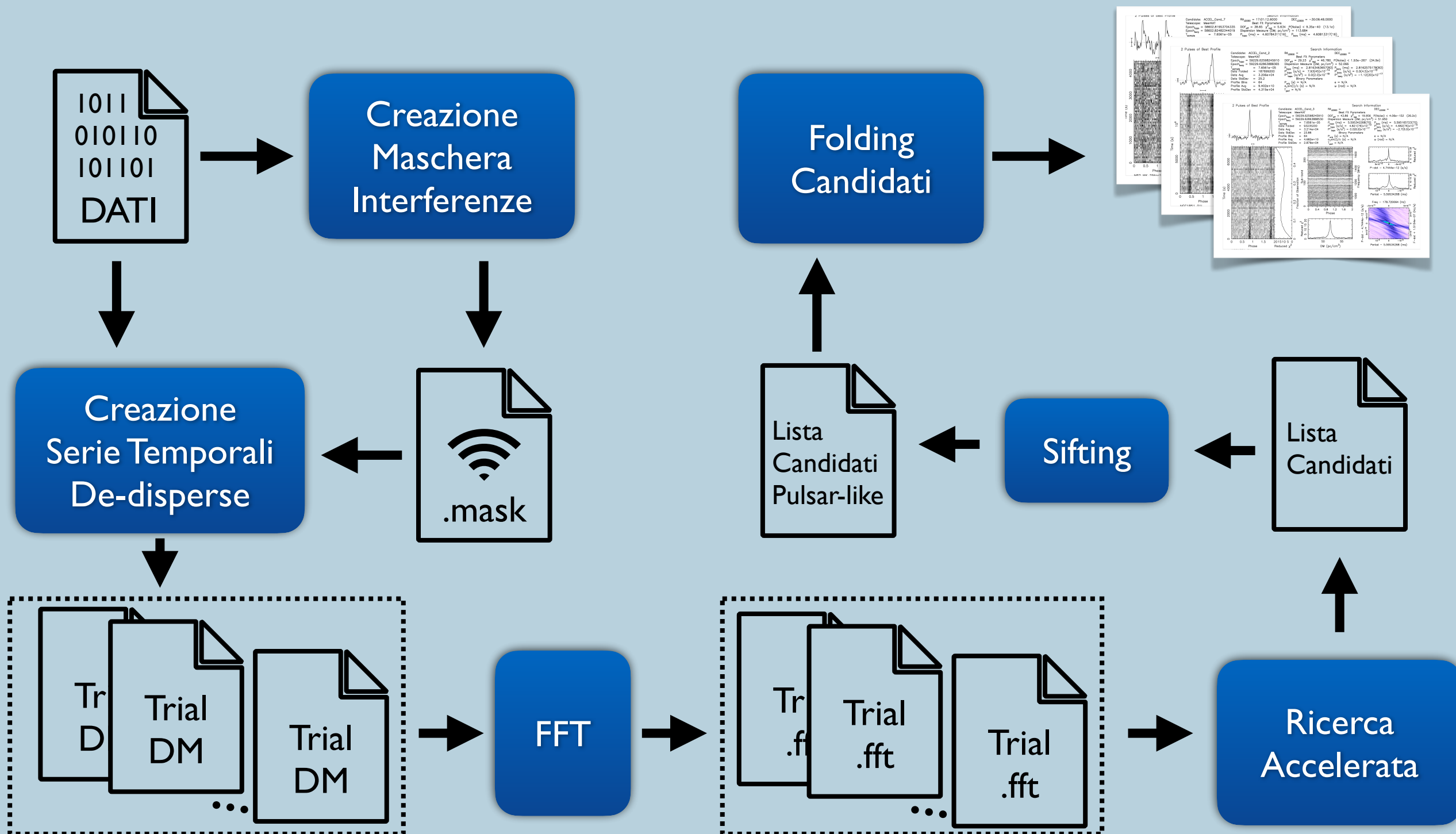
Capacità di
ripristino
esecuzione
interrotta

Funzioni di
logging
avanzate



Schema Semplificato della Pipeline

Pulsar!



Repository e Documentazione


GitHub: https://github.com/alex88ridolfi/PULSAR_MINER

Documentazione: http://alex88ridolfi.altervista.org/pagine/pulsar_software_PULSAR_MINER.html

Pagina Principale

Alessandro Ridolfi's home page

About	Research	Pulsars	Auroras
Résumé	Publications	Research Interests	Software
PSRALEX	PYSOLATOR	BINARY_GAZER SPIDER_TWISTER ugmrt2fil	SPLICE_DADA PULSAR_MINER



pulsar miner

PULSAR_MINER on GitHub

Latest version: 1.1.5 (08Jun2020)

```
git clone https://github.com/alex88ridolfi/PULSAR_MINER.git
```

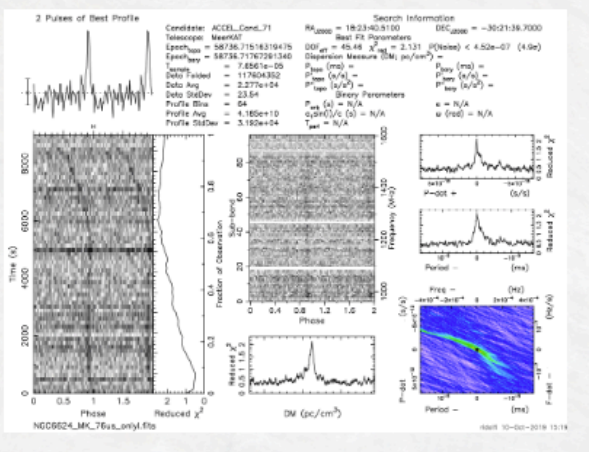
PULSAR_MINER

PULSAR_MINER is a simple, easy-to-use, PRESTO-based pulsar searching pipeline.

Requirements:

- Python 2.7
- Numpy
- PRESTO 2.1 or PRESTO 3
- PSRCHIVE

Edit the configuration file, input your observation to search, and you are ready to go!



Guida veloce how-to

2) Basic usage

To successfully use PULSAR_MINER, you need:

1. A search-mode observation file in a format compatible with PRESTO (typically a ".fil" filterbank file or a ".fits"/".sf" psrfits file).
2. A ".cfg" configuration file containing all the relevant search parameters. A template of such a file can be generated using the `-init_default` option.

Assuming to have an observation file called "NGC6752_MeerKAT_0001.fits" you can generate a configuration file template with the command:

```
pulsar_miner -init_default NGC6752_MeerKAT_0001.fits
```

```
ridolfi@fortalesa: ~ — ssh — 112x12
ridolfi@alnitak:/pulsar1/DEMOS/PULSAR_MINER/NGC6752$ pulsar_miner -init_default NGC6752_MeerKAT_0001.fits
Input file 'NGC6752_MeerKAT_0001.fits' seems to be PSRFITS. Setting default file format to 'psrfits'.

Default configuration written onto 'NGC6752.cfg'.
Some common birdies written on 'common_birdies.txt'.

Now edit the config file, adjust the parameters and run the pipeline with:
pulsar_miner -config NGC6752.cfg -obs <myobservation>

ridolfi@alnitak:/pulsar1/DEMOS/PULSAR_MINER/NGC6752$
```

The code creates a template configuration file named after the current working directory ("NGC6752.cfg" in this example).

The configuration file sets all the relevant parameters for the search itself. The code also tries to fill a few entries autonomously (e.g. your PRESTO installation directory, the number of CPU cores available etc.) by reading some environment variables and getting some system information. It also sets the data file format by reading the input observation file. However, it is highly recommended that you cross-check these values.

Also, the majority of the parameters (such as the DM range to search, the acceleration search parameters etc.) are set to some generic default values. Obviously you may want to change them, since they will likely not be the optimal ones for your own search.

The parameters in the configuration file can be changed using a simple text editor, such as emacs.

```
emacs NGC6752.cfg
```

```
ridolfi@fortalesa: ~ — ssh — 138x40
File Edit Options Buffers Tools Conf Help
SEARCH_LABEL NGC6752 # Label of this search project
ROOT_WORKDIR /pulsar1/DEMOS/PULSAR_MINER/NGC6752 # Path of the working directory
DATA_TYPE psrfits # Options: filterbank, psrfits

# PRESTO installations and GPU acceleration
PRESTO /home/ridolfi/soft/presto2.1_24Mar2019 # Path of the main PRESTO installation
PRESTO_GPU /home/ridolfi/soft/presto2_on_gpu # Path of the PRESTO_ON_GPU installation (if present)
USE_CUDA 1 # Use GPU-acceleration? (1=yes, 0=no)
CUDA_IDS 0 # Comma-separated ids of NVIDIA GPUs to use (e.g. "0,1,2,3" - check with 'nvidia-smi')
```


Applicazioni e Risultati

PULSAR MINER è la principale pipeline usata per la ricerca di pulsar in ammassi globulari con MeerKAT

47 Tuc

Terzan 5



Installata e usata anche in HPC internazionali

- "Galahad" cluster (Manchester)
- "Hercules" cluster (MPCDF)



Credit: MPCDF



50+ pulsar scoperte in 3 anni

 <http://www.trapum.org/discoveries/>
Transients and Pulsars with MeerKAT

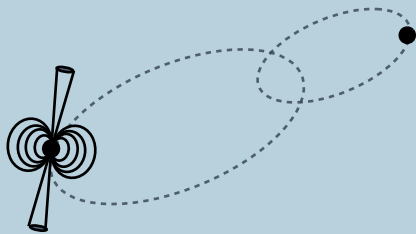
TOTAL DISCOVERIES: 143
EXGAL: 4 FERMI: 18 **GC: 54** MGPS-L: 66 TEV/SNR/PWNE: 1

Highlights

- 3 pulsar binarie (di cui due massicce) in orbite fortemente eccentriche

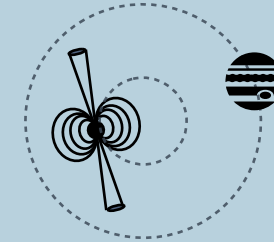
Ridolfi et al. 2021, MNRAS, 504, 1407

Ridolfi et al. 2022, arXiv:2203.12302



- 1 pulsar con compagna ultra-leggera

Vleeschower et al. 2022, MNRAS, 513, 1, 1386



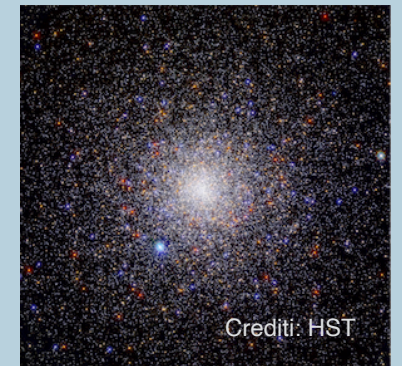
- La pulsar radio più luminosa conosciuta (nella Grande Nube di Magellano)

Wang et al. 2022, ApJ, 930, 1, 38



- 13 pulsar nell'ammasso NGC 1851

Ridolfi et al. 2022,
arXiv:2203.12302



- 14 pulsar nell'ammasso ω Centauri

Chen et al., in prep



Sviluppi e Prospettive



WORK IN
PROGRESS

Passaggio a
Python 3



Supporto a cluster
multi-nodo
(slurm)

Ottimizzazioni
multi-threading su
singolo nodo

Ottimizzazioni I/O
in presenza di
storage veloce
(RAID / SSD)

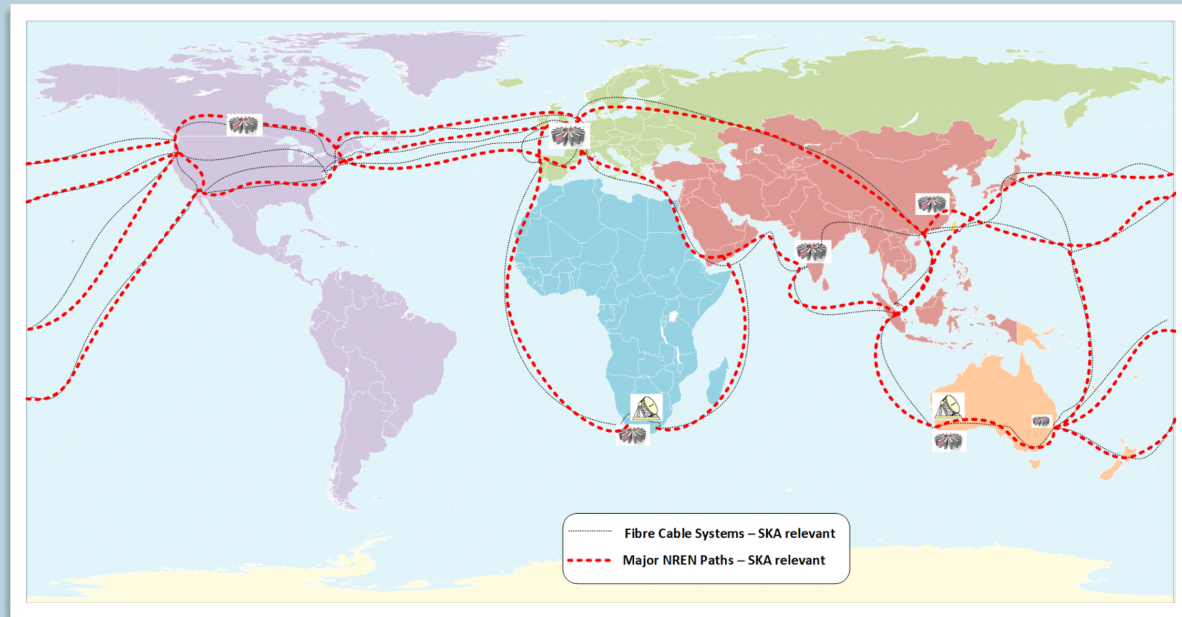
Ricerca di
single-pulses

Supporto a
software avanzati di
candidate viewing
(CandyJar)

Potenziamento
tool ausiliari

Sviluppi e Prospettive

Uso negli SKA Regional Centers per
analisi off-line di dati pulsar



Uso a INAF-OAC per analisi dati pulsar del
Sardinia Radio Telescope



<https://astronomers.skatelescope.org/the-ska-regional-centres/>

GRAZIE PER L'ATTENZIONE!