UNIVERSITE D'ORLEANS

l'Observatoire de Paris | LERMA

cnrs

Station de Radioastronomie de Nançay

RFI database R&D at Nançay Observatory

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Radio Interference in Large Bandwidth Observations

Bonn

RadioNet

SEVENTH FRAMEWORK PROGRAMME

Content

- Context and goal
- RFI-driven receiver characteristics
- Static RFI database
- Test-bench
- SDM
- Dynamic RFI database

Context

- Next generation of radio telescopes will need automatic RFI mitigation
  - Data-rates to big for manual edition
  - Automatic reduction of signal dynamics to fit into data-links

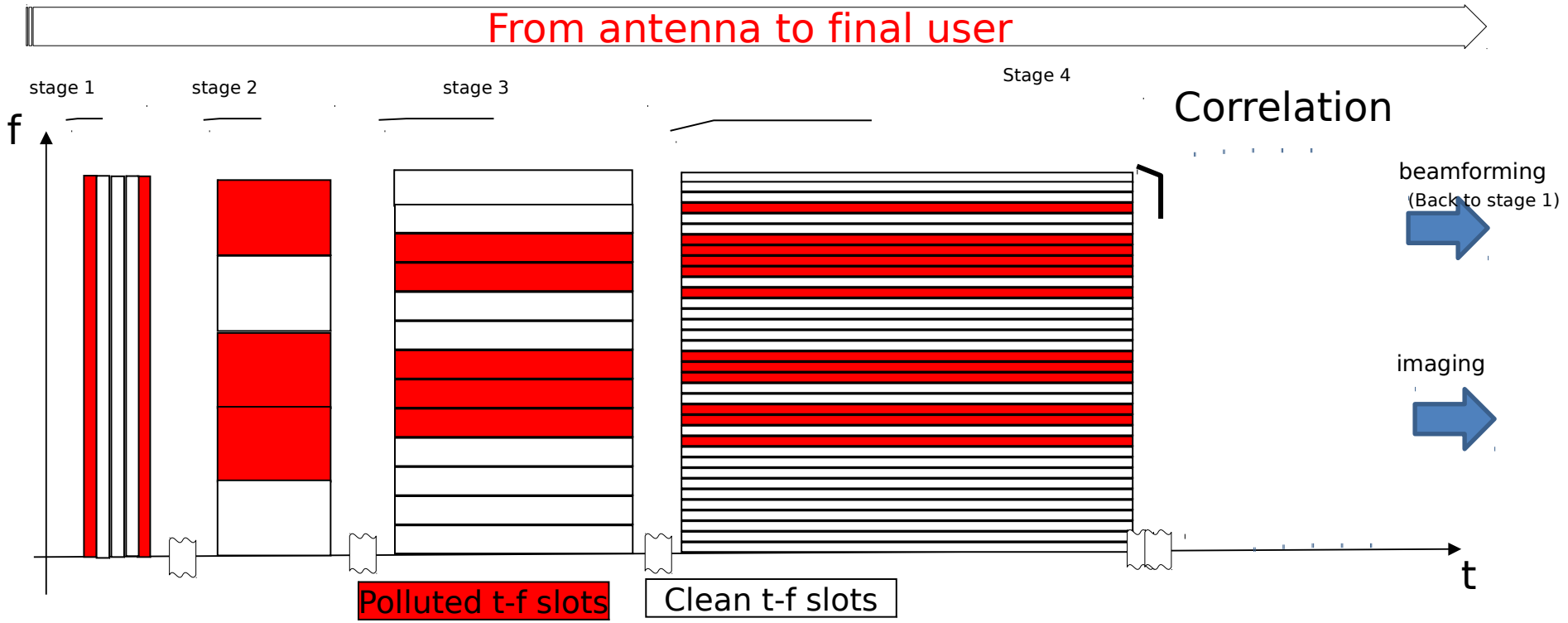
- Science data end-user (radioastronomer) wants to know the processing
  - For calibration issue
  - To understand what went wrong during an observation
  - To understand what process his data has faced

Goal

- Provide some data-quality analysis
  - No modification of the data, only flagging
- Provide some RFI mitigation tools
  - For cases where flagging is too weak
- Protect “clean” data
  - From “enhanced” data
  - From corrupted data
- Save the instrument observing states for (semi-) automatic data-reduction

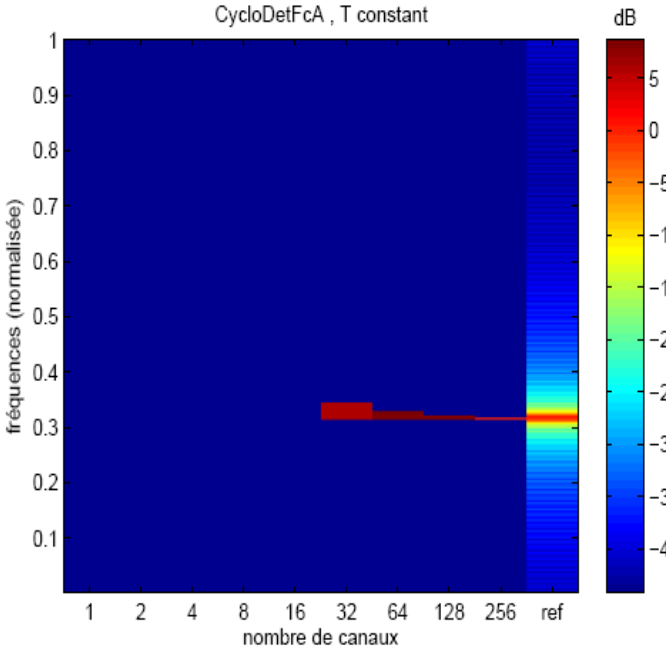
RFI-driven receiver characteristics

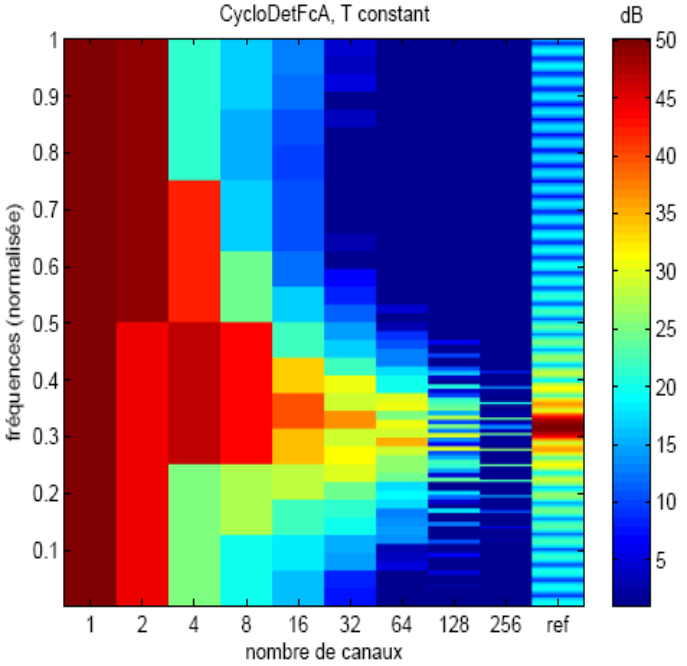
- Receivers are now designed first to handle RFI...
  still keeping in mind that they are used for science...
- Protect clean data areas from corrupted slots

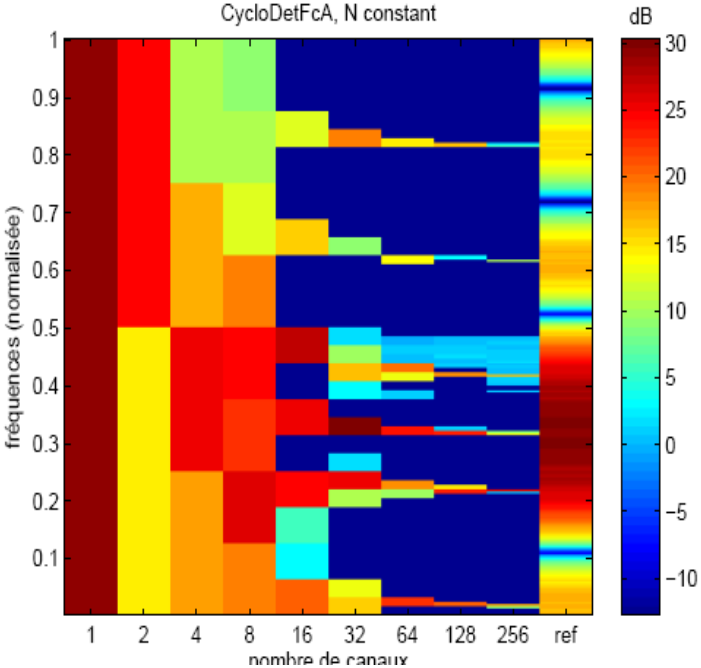


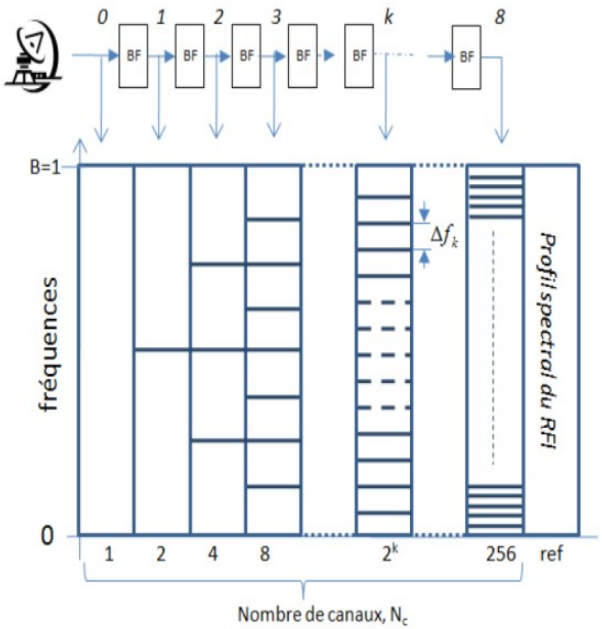
RFI-driven receiver characteristics

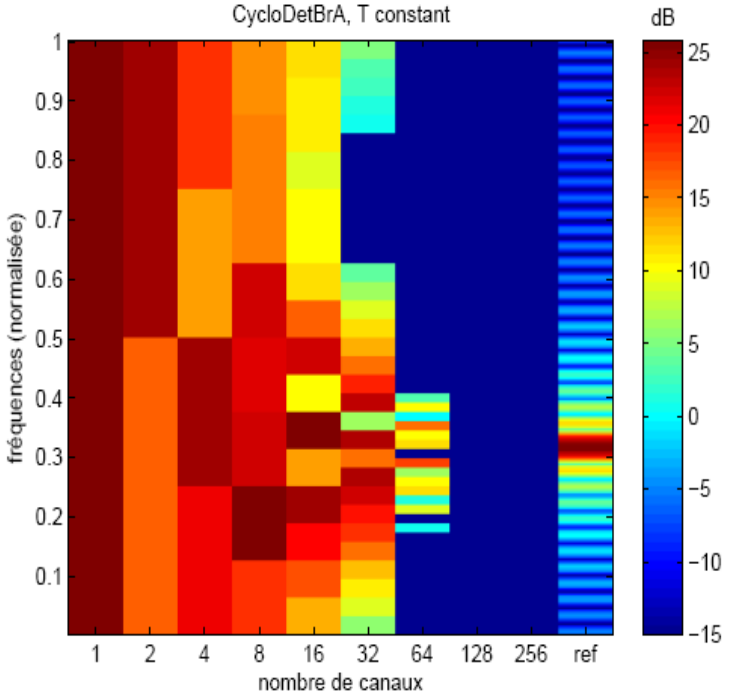
- But some RFI are better detected at high time resolution and some other at high frequency resolution.
- Need for a multi-stages data-quality analysis
- Need to combine those informations
- And to record them for post-processing

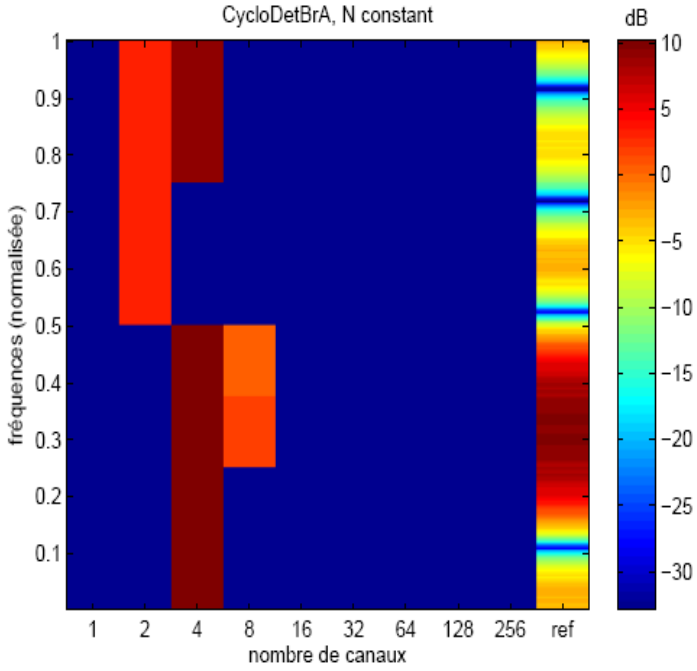

CycloDetFcA , T constant
dB
fréquences (normalisée)
nombre de canaux
1 2 4 8 16 32 64 128 256 ref


CycloDetFcA, T constant
dB
fréquences (normalisée)
nombre de canaux
1 2 4 8 16 32 64 128 256 ref


CycloDetFcA, N constant
dB
fréquences (normalisée)
nombre de canaux
1 2 4 8 16 32 64 128 256 ref


0 1 2 3 k 8
BF
B=1
0
fréquences
Δf_k
Profil spectral du RFI
1 2 4 8 2^k 256 ref
Nombre de canaux, N_c


CycloDetBrA, T constant
dB
fréquences (normalisée)
nombre de canaux
1 2 4 8 16 32 64 128 256 ref


CycloDetBrA, N constant
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Static RFI database

- What to store?
- What format?
- What performances?
- Which reuse?

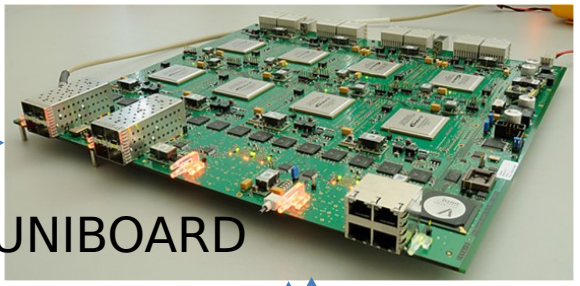
=> Conduct a real-life experiment

Test-Bench

waveforms

$$S_1(t,f,\mathbf{A}) \in C$$

Fs=200kHz
248 x (fo,**A**)



RFI statistics

Astro data

$$\mathbf{R}_{1s}(t,f) \in C$$

Crosslet dim 96 x96
B=200kHz
Every second

Power
B=100MHz

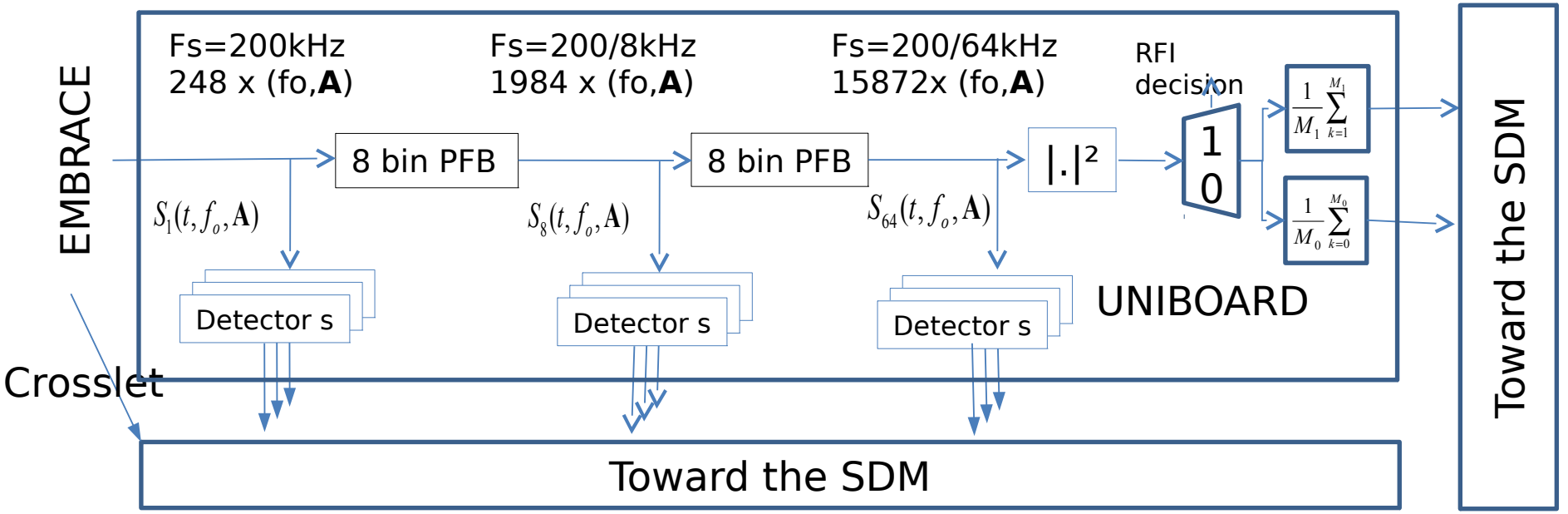
CPU or GPU

RFI statistics

Science Data Model
Database

- EMBRACE as a telescope
- Uniboard as a spectrometer and data-qualifier
- SDM as a database designer

Test-Bench



- Multi-TF resolution analysis
- Multi-criteria analysis
  - Power
  - Cyclic
  - Kurtosis

- Multi-buffer for data-accumulation
  - Clean
  - “Enhanced”
  - Corrupted

Science Data Model (SDMv2) for Radioastronomy

1997	Cornwell	Premices MeasurementSet (AIPS++)	Offline
2000	Kemball & Wieringa	MeasurementSet (MSv2) (AIPS++/CASA)	Core
2005	Viallefond & Lucas	AlmaScienceDataModel (CIPT ALMA)	Online & offline
2008	Viallefond	Premices SDMv2 (CIPT ALMA)	Phys. Quantities Static Representation
2010	Viallefond	SDMv2, multi-beam: Aperture Phased Arrays	Generic formalism
2012	Viallefond	Mathematical foundations	Algebraic structure
2013	Viallefond	From models to the theory	

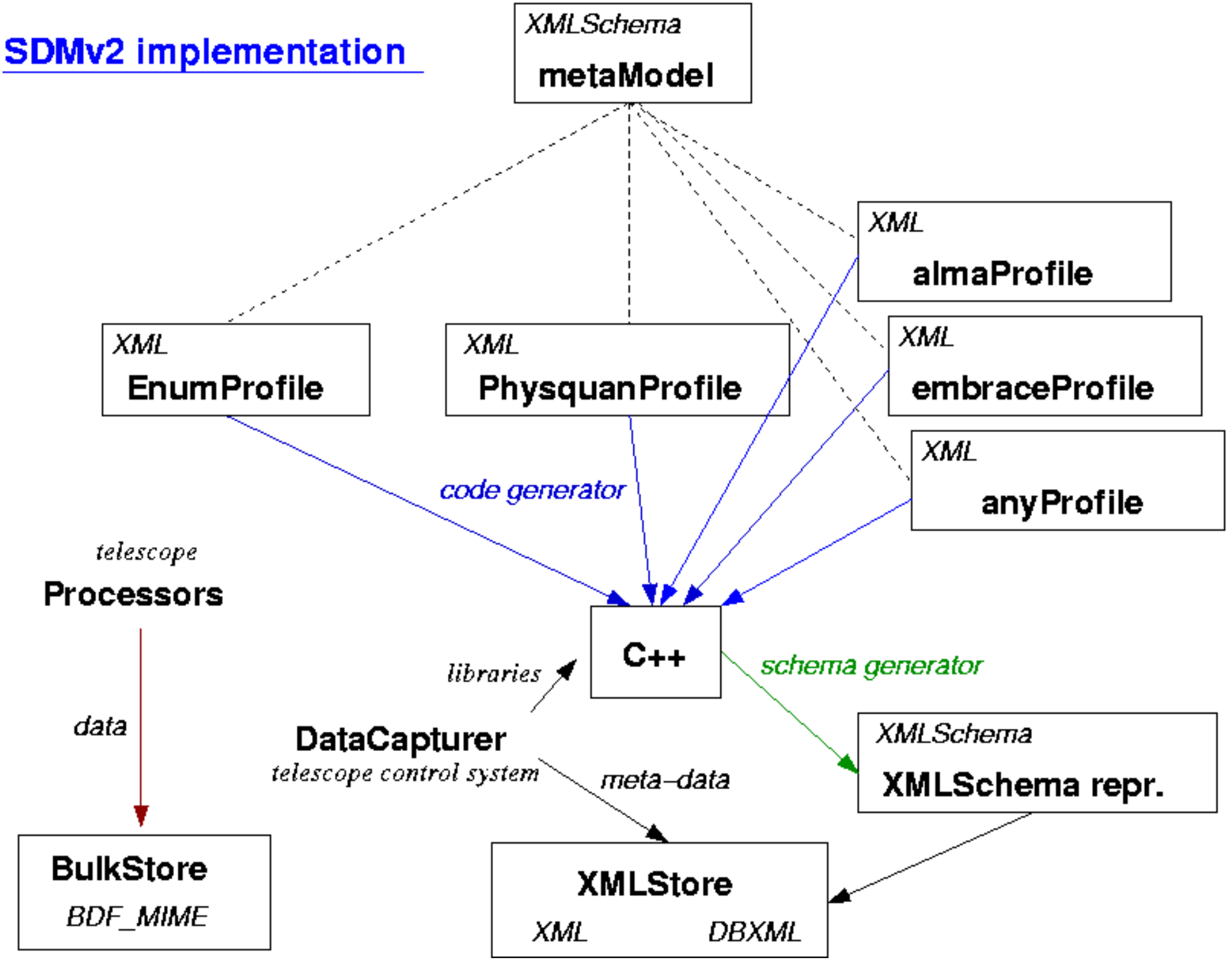
ASDM currently used by ALMA and JVLA, SDMv2 prototyped with EMBRACE

SDMv2

- General idea and goals
  - Transform concepts described using our human language into mathematical objects for effective use in information systems
  - Generic implementation using parametric polymorphism
  - Robustness & efficiency: type algebra with coherence rules assessed by the compiler
  - Evaluate this implementation (robustness, efficiency & expressiveness)

- Modules composing the SDMv2 package:
  - ENUM: Enumerations, sub-enumerations (partitioning), set-based algebra
  - PHYSQUAN: Physical quantities & measures (eg position, direction), algebra
  - SDM: Containers, local and global keys: semantics from constraints

SDMv2 implementation



Post-processing

- Manual editing:
  - Visualize RFI detections over scientific data
  - Accept or reject multi-buffer accumulations
- Automatic editing
  - Remove flagged data before data-reduction
- Band quality statistics

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Dynamic RFI database

- Possible for the SDM (records instrument state anyway)
- Allow near real-time resource reallocation
  - Remove RFI mitigation processing from clean bands
  - Assign those resources to occupied bands

- Reaction time?
- CPU resources?