Underwater Particle Holography and Grid Middleware

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Objectives of HoloMar

- **Develop, construct & evaluate a fully-functioning prototype underwater holographic camera**
  - Holographically record large volumes of the upper water column containing marine plankton & seston
- **Design, develop & construct a fully-functioning hologram replay facility**
  - Replay holograms in the real image mode for high resolution inspection & measurement
- **Record, analyse & interpret holograms using specially developed image processing algorithms**
  - Identification of species, size, relative location & distribution of marine organisms without operator intervention

HoloCam launch from the *R.V. Calanus*

Data extraction & image processing

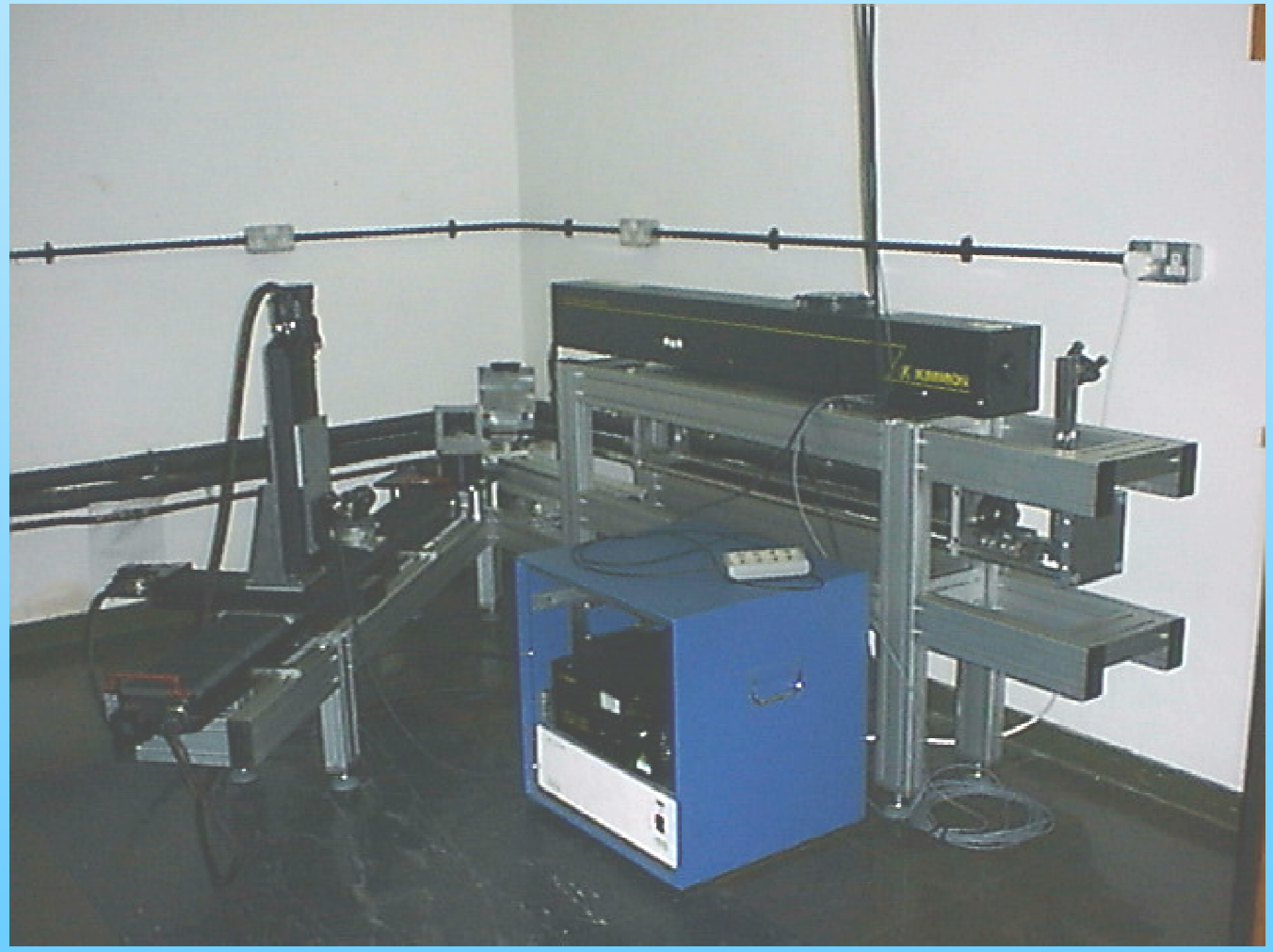
Steps:

- **Global adjustment of hologram for brightest and sharpest image**
  - orientation of plate holder and angle of reference beam
- **Scan videocamera through depth; capture successive images**
- **Digital processing for image enhancement**
  - cleaning and background removal
  - object tracking
  - best focus
  - image enhancement
  - segmentation
- **Species identification**
  - based on neural networks recognition

Results:

- **Size measurement & relative position**
- **Measurement of local concentration and distribution by category**

HoloScan replay facility



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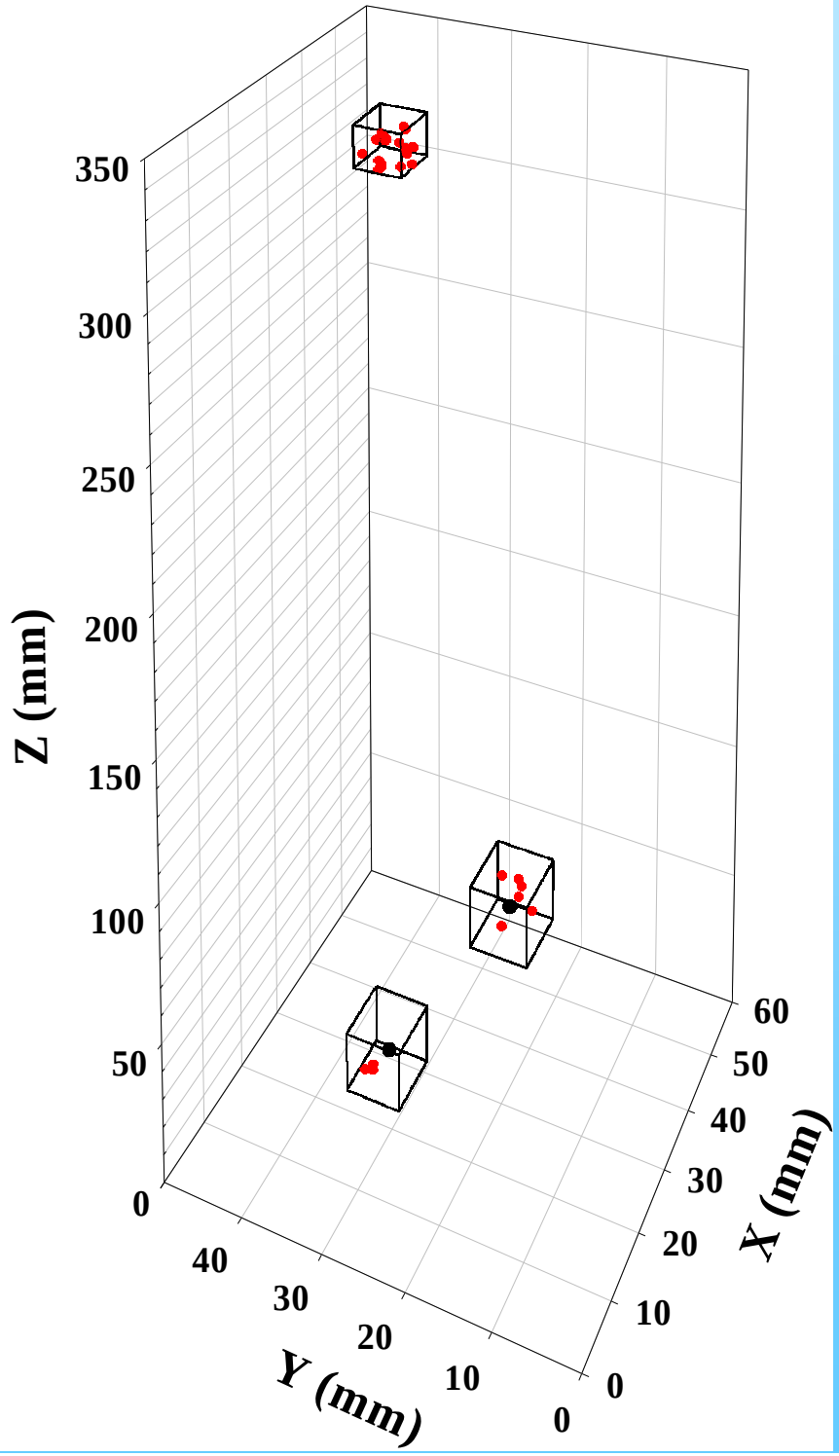
Denizens of Loch Etive

Calanus finmarchicus from holograms at 70 m; 2 mm long and located several tens of centimetres from the exit window.



Distribution of “targets” around copepods

Interactions Between Meso- and Micro-Plankton: Deductions From Fine Scale Distributions in Three Dimensions Obtained Using In Situ Holography.

R.S. Lampitt, P.R. Hobson, X. Irigoien, M.A. Player, K. Saw, K. Tipping, J.Watson and J.J. Nebrensky.

EOS Transactions, American Geophysical Union. Vol **83** No 4 . 22 January 2002. p 84

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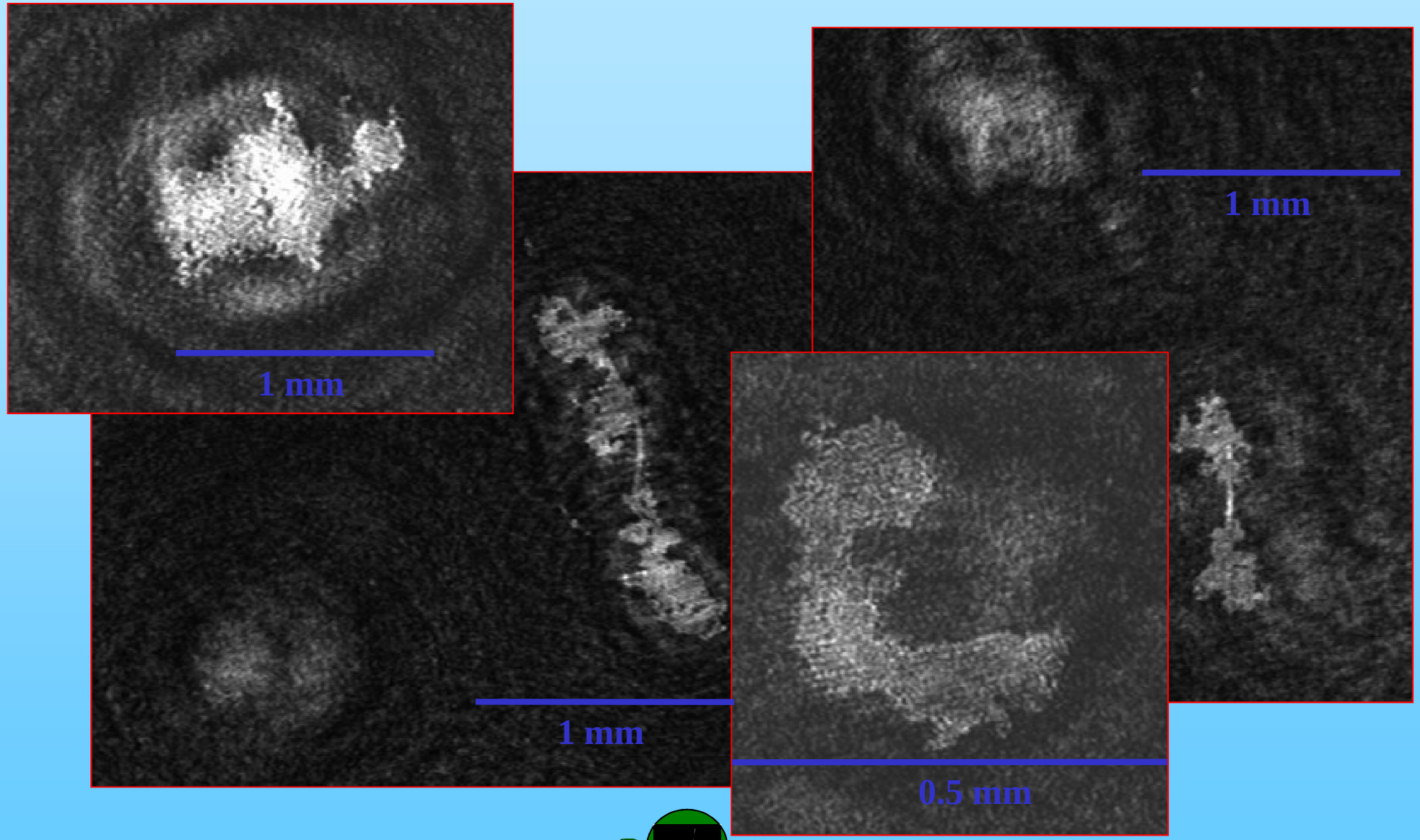
In-line Holograms of Flocs



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The Holographic Data Problem

At *high* magnification (a 1 mm by 0.7 mm view), one plate can generate **30 *Tera*Bytes** of raw data

- **Need to extract / visualise information, not data**
- **How does one characterise the 3-d, projected real image ?**
  - **e.g. brightness and contrast: how to find the brightest and darkest voxels in that 30 Tb?**
  - **Real image properties both fixed in plate and depend on replay laser and viewing camera**

Digital Holography

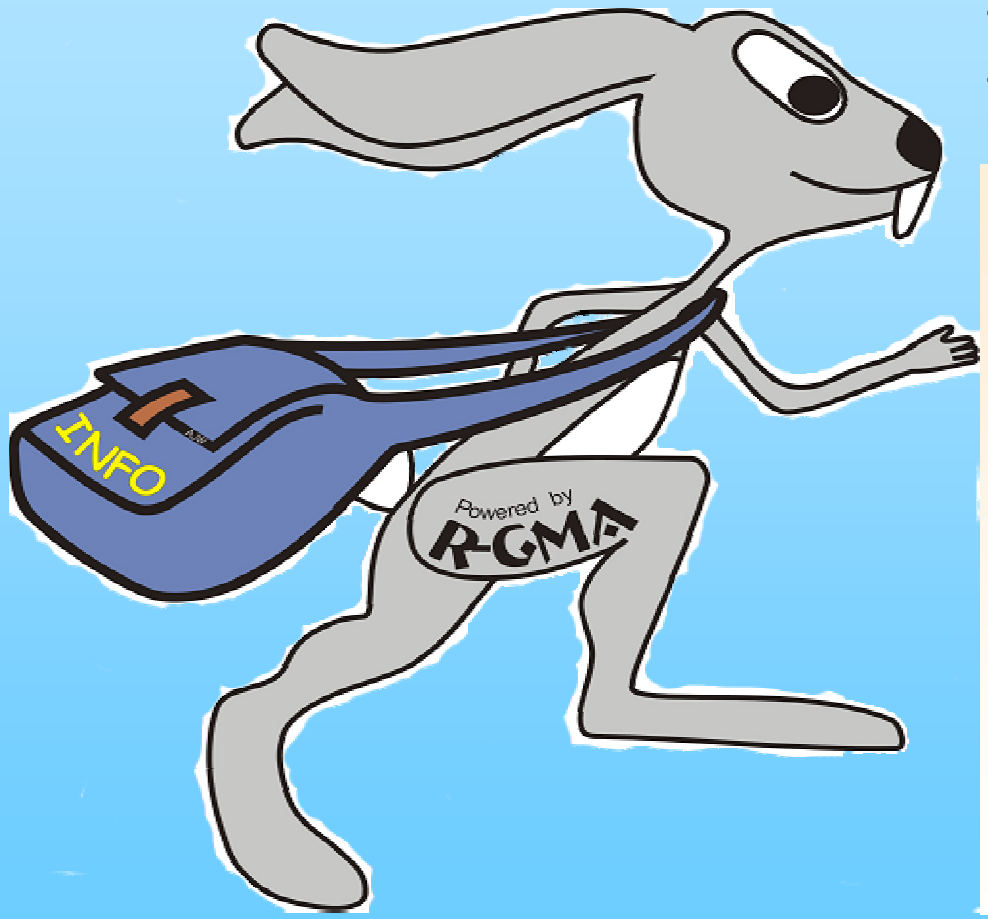
Instead of using photographic film, it is possible to capture the hologram directly on to the CCD, and then reconstruct numerically within a computer.
This avoids the need to handle glass plates within the holocamera, and eliminates chemical development.

Numerical reconstruction is computationally heavy - multiple FFTs.

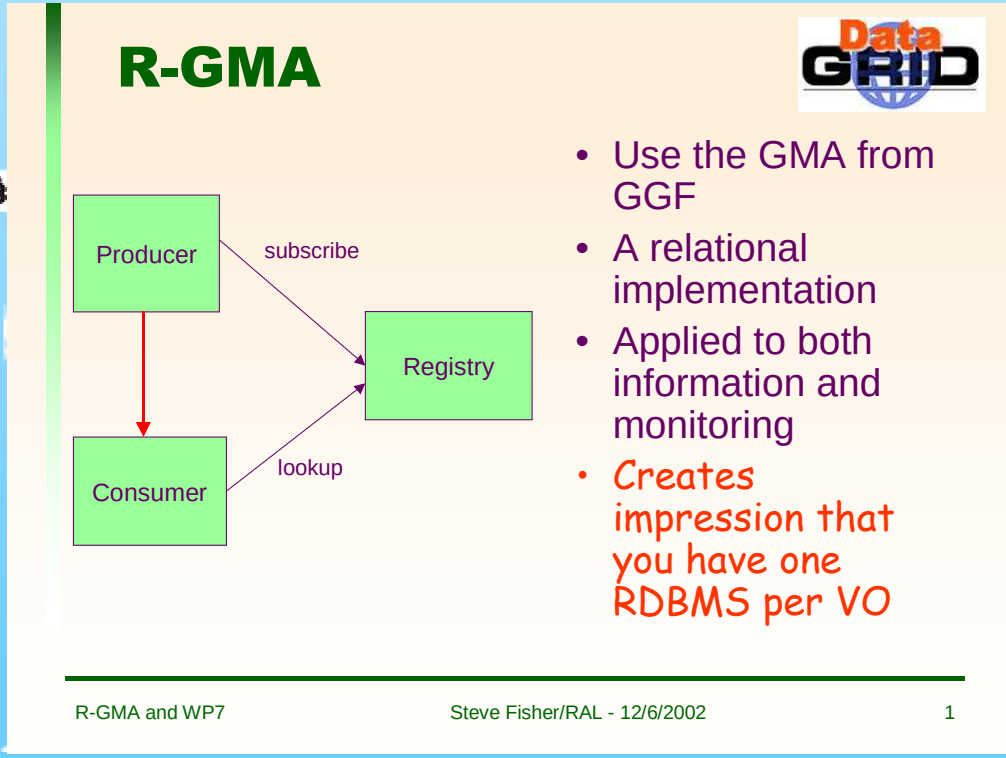
Marc Fournier-Carrié, a Socrates student, has implemented reconstruction software for single image planes from in-line holograms for his lab project.

The system is written in C++ on Linux.

Use of R-GMA in BOSS



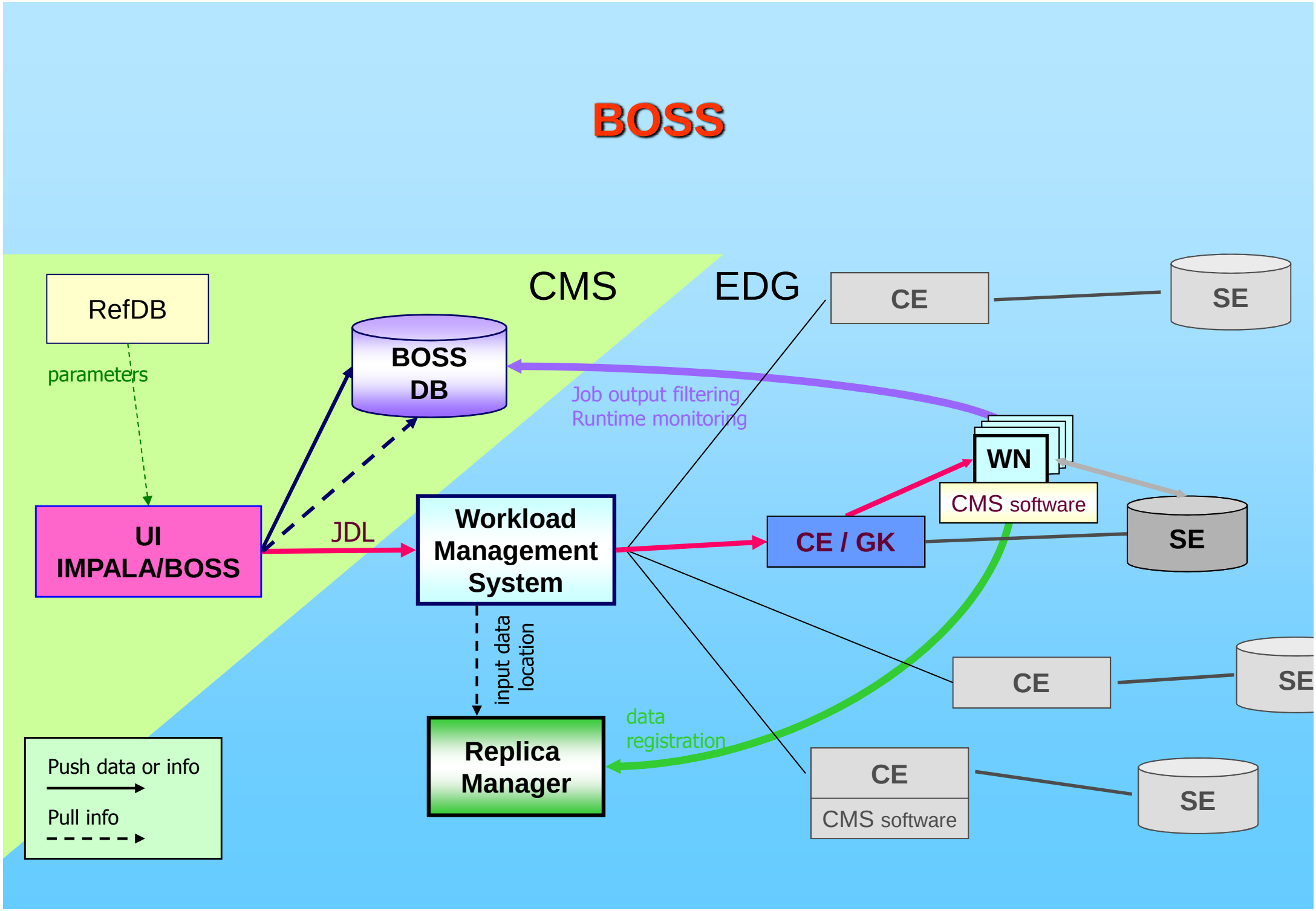
- Grid monitoring infrastructure
- Based on GGF GMA
- Discrete consumers and producers
- Registry acts as matchmaker



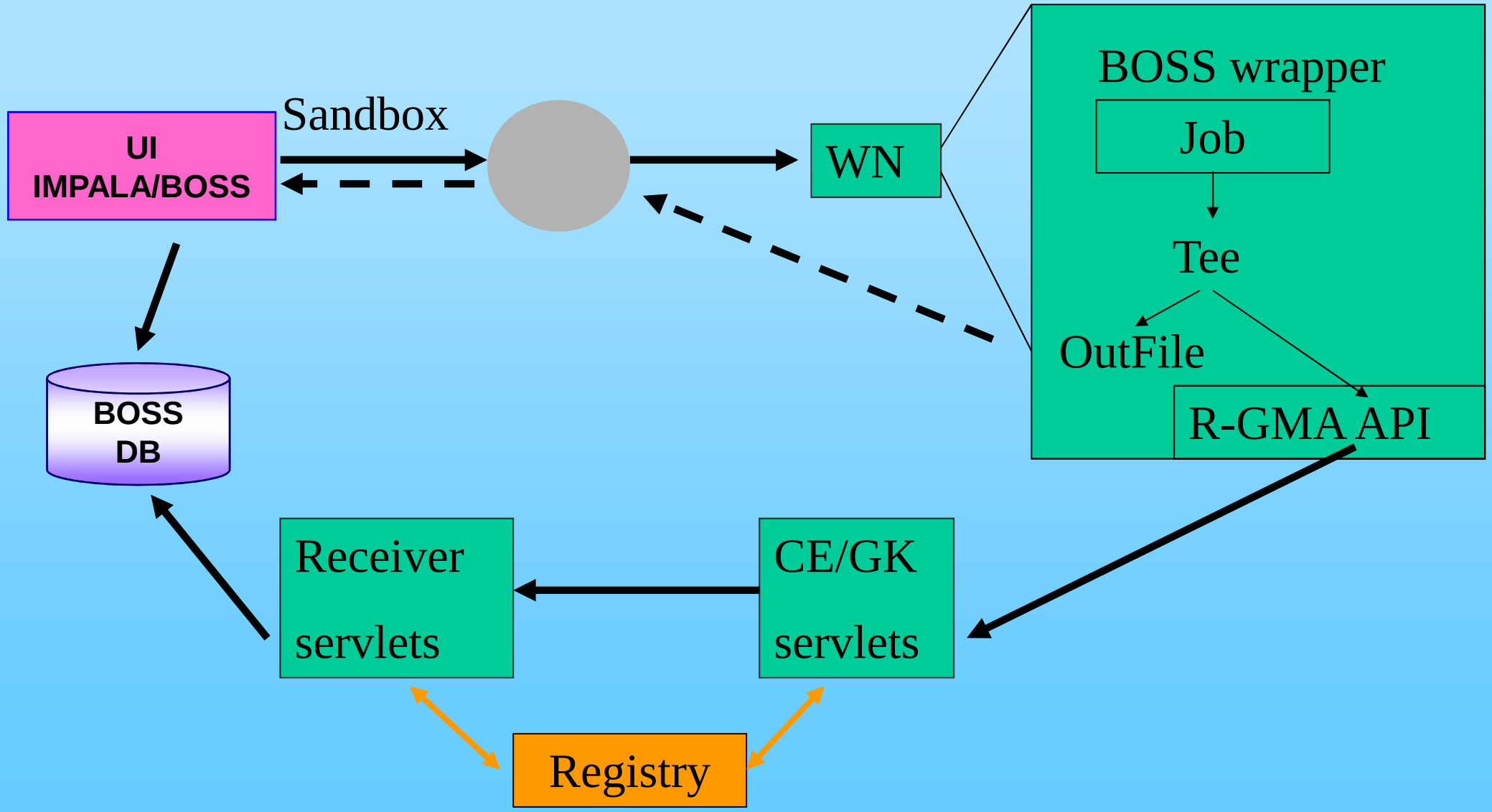
More on R-GMA see e.g.“**RGMA: today and tomorrow**” at

http://documents.cern.ch/AGE/current/fullAgenda.php?ida=a022043

BOSS


CMS
EDG
RefDB
parameters
BOSS DB
Job output filtering
Runtime monitoring
CE
SE
WN
CMS software
UI IMPALA/BOSS
JDL
Workload Management System
CE / GK
SE
input data location
CE
SE
Replica Manager
data registration
CE
CMS software
SE
Push data or info
Pull info

Use of R-GMA in BOSS



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gw30.hep.ph.ic.ac.uk:0	boss_v3_3	72	counterdemo	majorcount	204	1043425943
gw30.hep.ph.ic.ac.uk:0	boss_v3_3	72	counterdemo	tick	15	1043425943
young.brunel.ac.uk:0	boss_v3_3_young	112	JOB	E_HOST	young	1043426585
young.brunel.ac.uk:0	boss_v3_3_young	112	JOB	E_PATH	/home/boss/boss-v3_3_pre5/CounterDemo	1043426585
young.brunel.ac.uk:0	boss_v3_3_young	112	JOB	E_USR	eesrjjn	1043426585
young.brunel.ac.uk:0	boss_v3_3_young	112	JOB	T_START	1043426579	1043426585
young.brunel.ac.uk:0	boss_v3_3_young	112	counterdemo	comment	START...	1043426585
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young.brunel.ac.uk:0	boss_v3_3_young	112	counterdemo	majorcount	0	1043426590
young.brunel.ac.uk:0	boss_v3_3_young	112	counterdemo	tick	1	1043426590
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young.brunel.ac.uk:0	boss_v3_3_young	112	counterdemo	majorcount	2	1043426595
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young.brunel.ac.uk:0	boss_v3_3_young	112	JOB	RET_CODE	0	1043426600
young.brunel.ac.uk:0	boss_v3_3_young	112	JOB	T_STAT	0.07s user 0.01s sys	1043426600
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Use of R-GMA in BOSS

- **R-GMA smoothes “firewall” issues**
- **Consumer can watch many producers; producers can feed multiple consumers.**
- **Provides uniform access to range of monitoring data (WP7 network, etc.)**
- **Doesn’t depend on other EDG components**

- **Scalability not proven**
  - GK a bottleneck?
  - Need separate CMS-specific R-GMA infrastructure?
- **Starting large-scale testing now - “J”**

Coming soon (“J+27”):

- **Registry replication**
- **On-fly schema definition**
- **Security – HTTPS**

Further Work

- **Effects of humidity on holographic emulsions**
- **Digital holography: recording of holograms**
  - Sensors / Optics / Integration
  - **BITLab holography facility**
- **Digital holography: numerical reconstruction**
  - Use of DC and Grid for number crunching
  - Tracking the images associated with a given hologram
- **Visualisation**
  - **BITLab**

- **Scalability of BOSS2RGMA – testing “now”**
- **R-GMA as a transport layer for application meta-data**

- **Open-source release of HoloBatch code**

The End