



Instrumentation  
Technologies

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**Fast Orbit Feedback  
using Libera  
Brilliance and Libera  
Photon**

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Libera **WORKSHOP**  
2009

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# Motivation

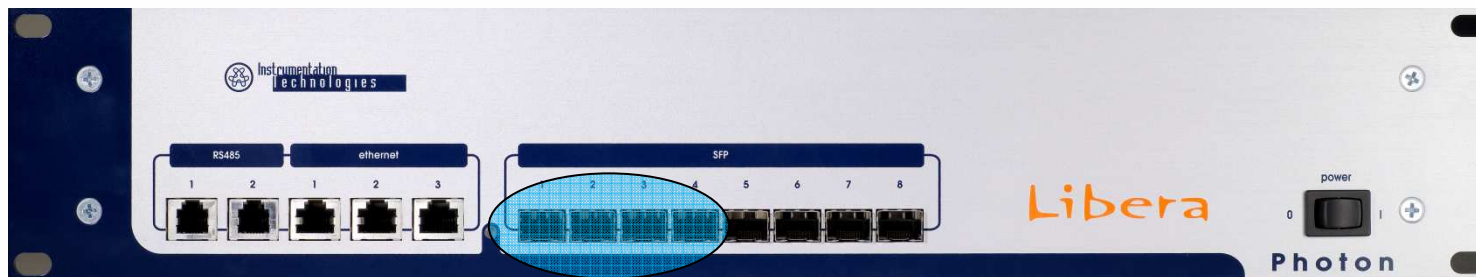
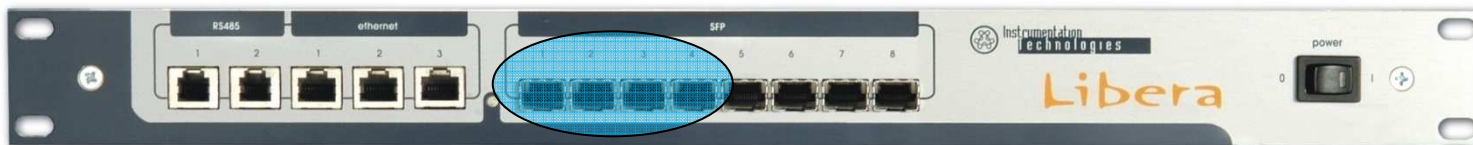
- **Target is to stabilize photon beam**
- **Suppression of beam disturbances**
- **Use Fast data input for Fast Orbit Feedback Loop**
- **Simple and efficient data collect**
- **Feedback loop can include both: electron and photon beam position monitors**

# Objectives

- **Libera Brilliance and Libera Photon as data source**
- **Both units are connected to the machine revolution frequency and fully synchronized**
- **Fast, low latency communication system**
- **Computational engines**
- **Interfaces to the PS and corrector magnets**

# Hardware

- **Libera Brilliance & Libera Photon**
- **SFP transceivers**
- **SFP ports 1 – 4**



# Libera Brilliance

## Fast acquisition data stream:

- **10 kHz data rate, ~ 2 kHz bandwidth**
- **Continuous data stream**
  - **amplitudes:  $V_a, V_b, V_c, V_d$**
  - **positions:  $X, Y (Z)$**
  - **other data:  $SUM, Q$**
  - **status: timestamp, Interlock, ADC overflow,**

## Libera ID

# Libera Photon

## Fast acquisition data stream:

- **10 kHz data rate, ~ 2 kHz bandwidth**
- **Continuous data stream**
  - **amplitudes: Ia, Ib, Ic, Id**
  - **positions: X (Y1), Y (Y2)**
  - **other data: SUM, Q (not defined)**
  - **counter, status**

# Communication System

- **Fast**

**100 Liberas \* 40 bytes \* 10 kHz = 40 MB/s**

**(Not including protocol overhead)**

- **Low latency**

**1Gb/s: 40  $\mu$ s on one cable** (with 100 Liberas at 40 bytes per Libera)



# Libera Based FOFB

- **Centralized**
- **Fully distributed**
- **Hybrid approach**



# Fully Distributed

**Libera is used as:**

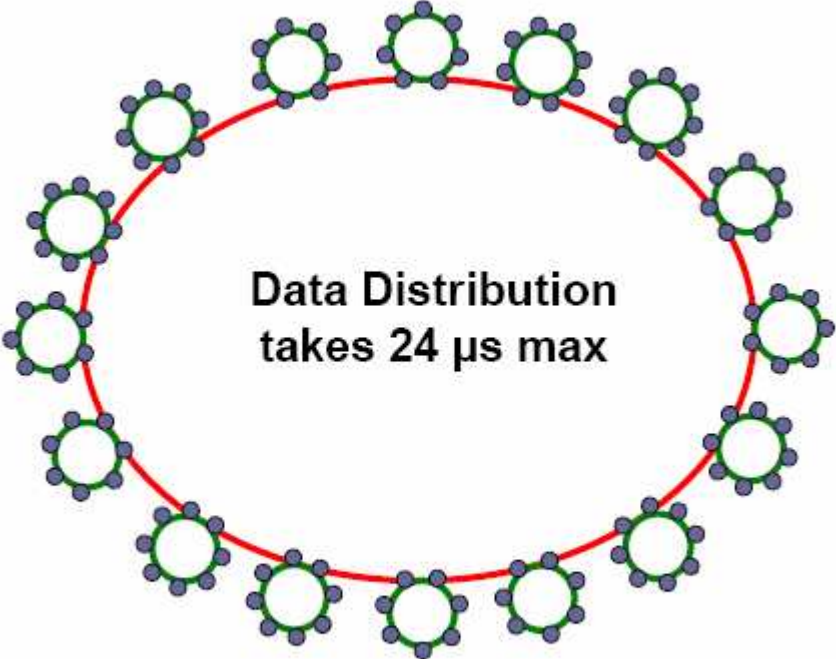
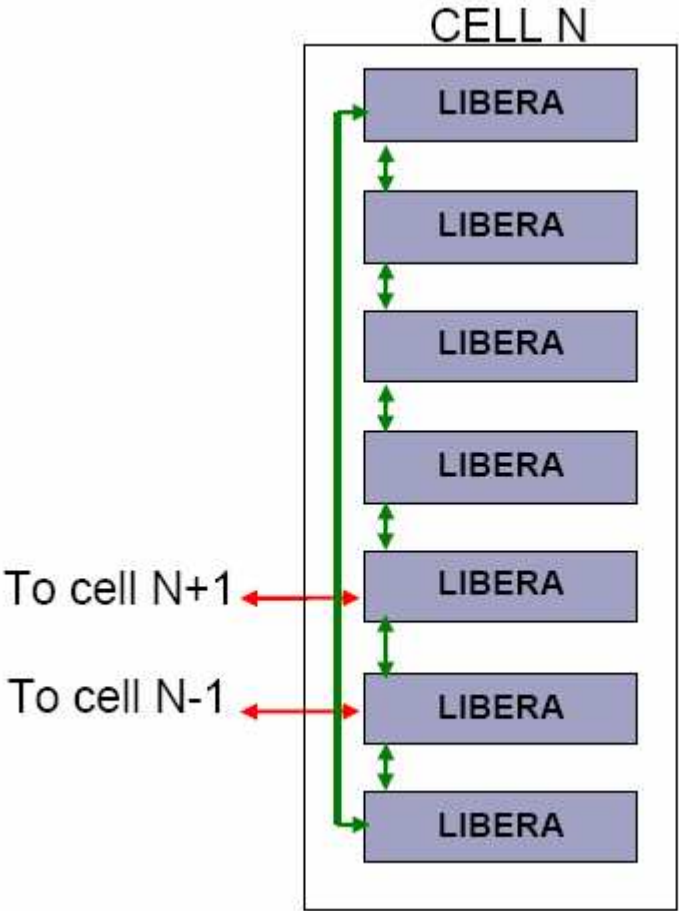
- **FA data source**
- **Router**
- **Computational engine**
- **PS driver**

**User specific FPGA modules in Libera unit:**

- **Communication controller**
- **PID controller**
- **PS interface**

# Example: Soleil

Courtesy of  
Nicolas Hubert



↔ Copper link    ↔ Optic link

# Centralized

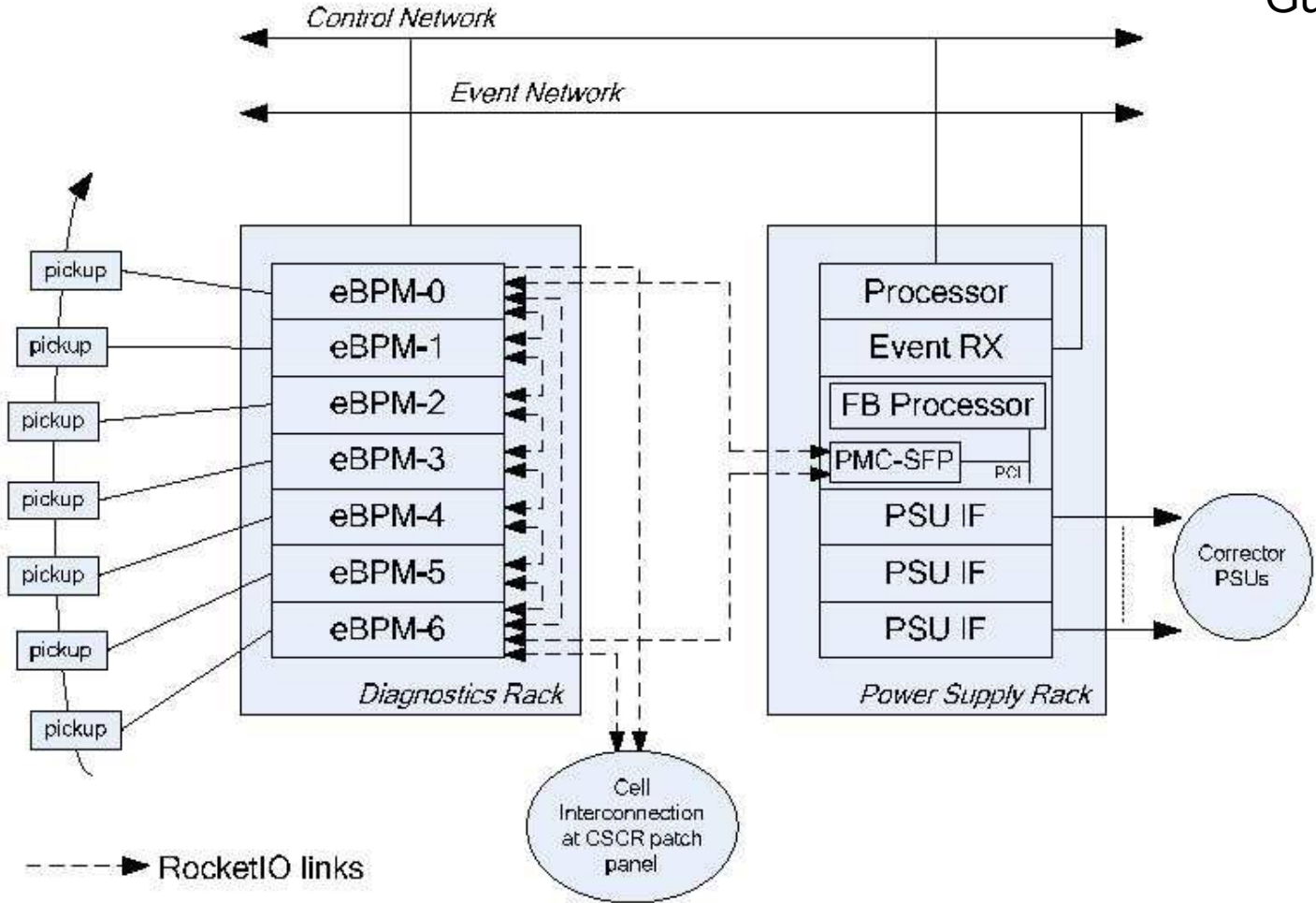
**Libera is used as or provides:**

- **FA data source**
- **Gigabit Ethernet data stream (standard UDP/IP)**
- **Communication network based**
- **Specific FPGA modules**

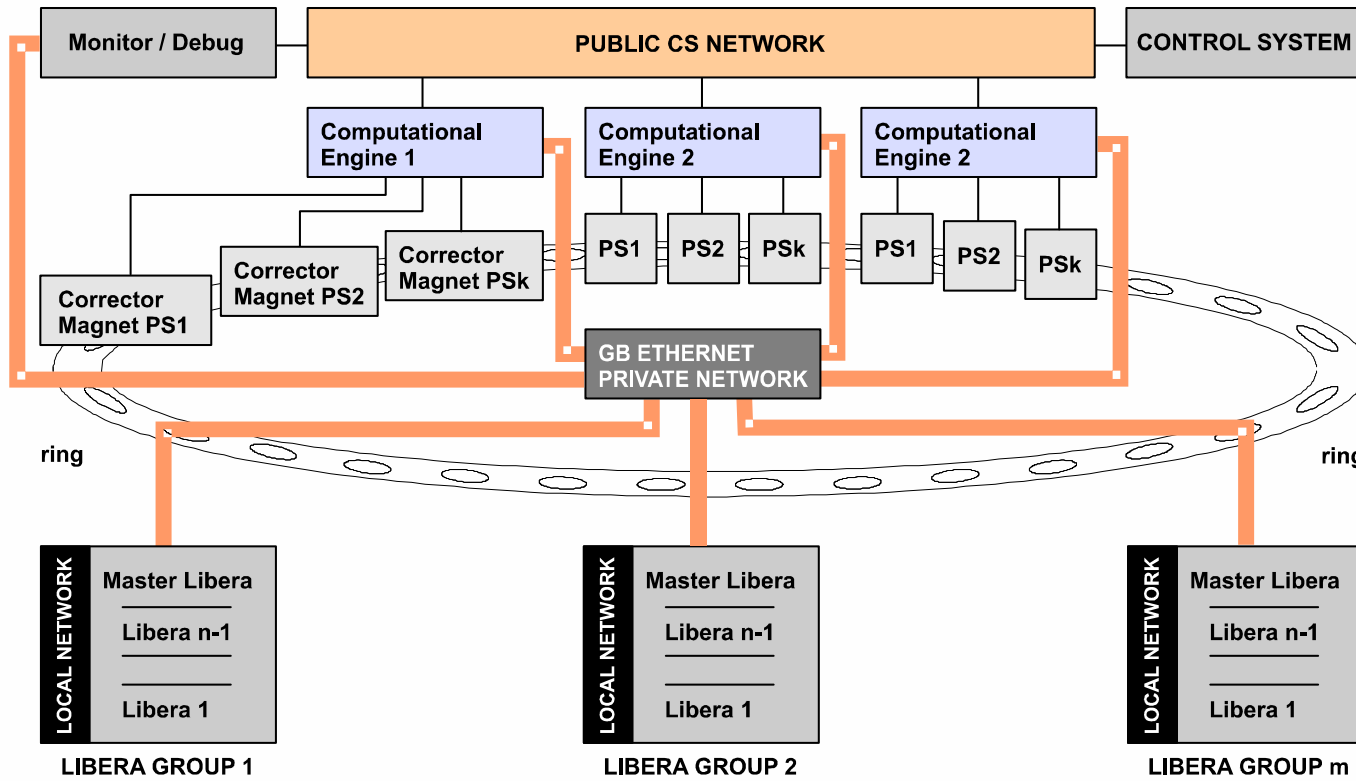
**For smaller machines, testing, ...**

# Hybrid Example: Diamond

Courtesy of  
Guenther Rehm

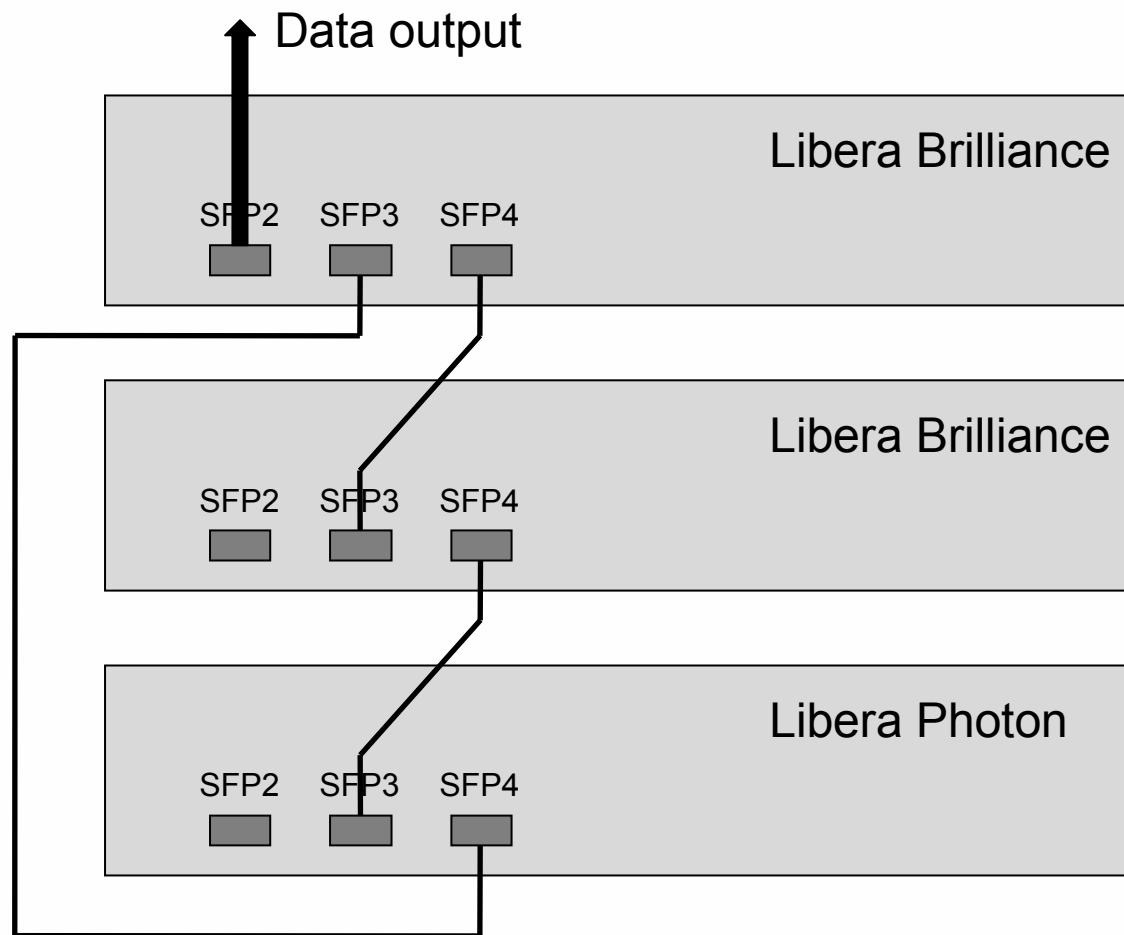


# FOFB Setup



— GB Ethernet  
 — 100MB Ethernet

# Connection Topology

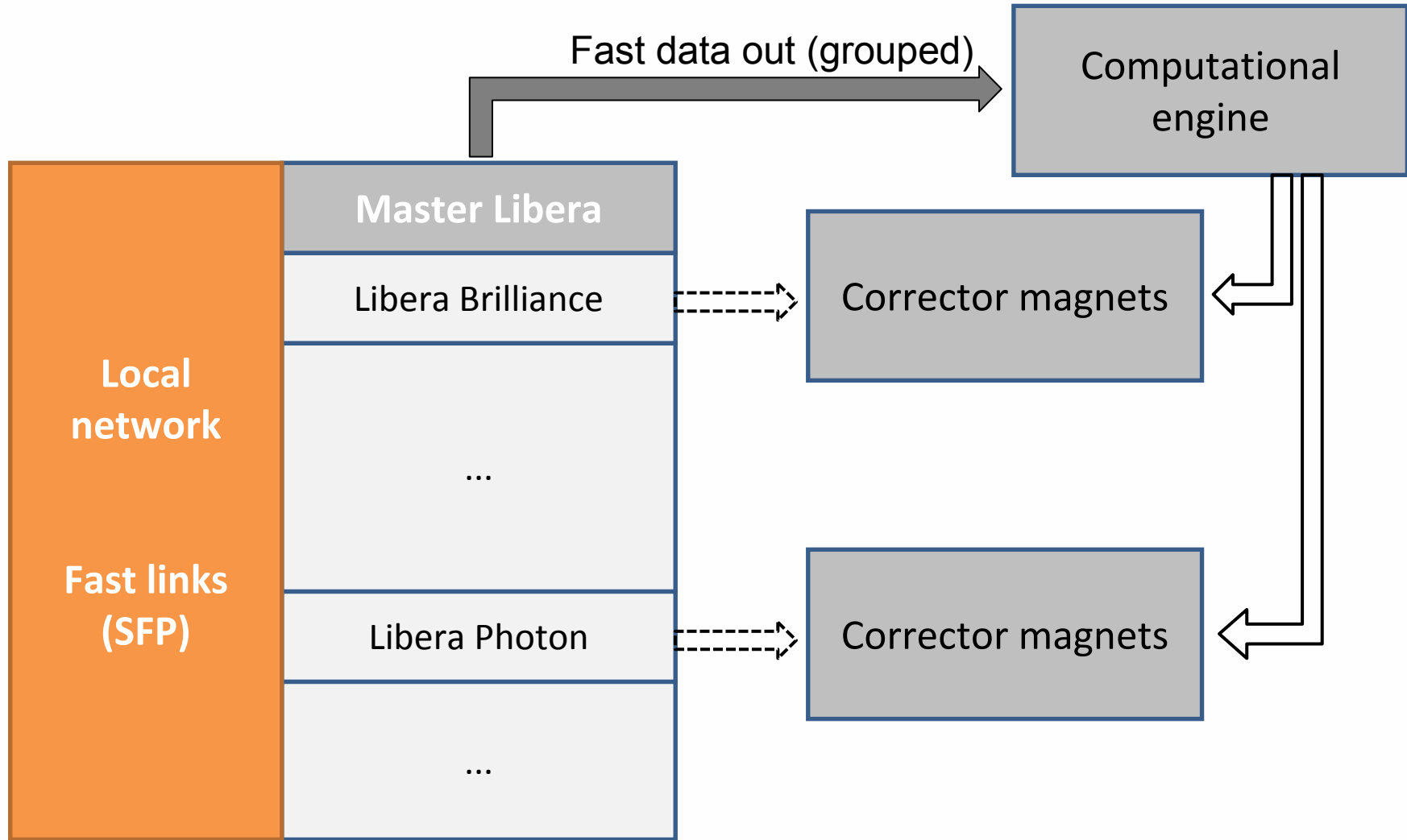


# Connection Topology

- Libera Grouping
  - Up to 64 units connected to the same loop
  - Simple connection topology (SFP3 → SFP4)
  - Data can be collected with any PC
- Communication Controller
  - Up to 1023 units connected to the same loop
  - “No” connection topology
  - Requires external receiver board



# Setups



# Configuration Files – Libera Grouping

```
/etc/default/fai_header
```

```
00:0d:9d:9c:9c:77
```

Destination

MAC address

```
00:00:00:00:00:01
```

Source MAC

address

```
1
```

Number of units in loop

```
10.0.3.33
```

Source IP address

```
10.0.1.249
```

Destination IP address

```
2048
```

```
2048
```

```
0
```

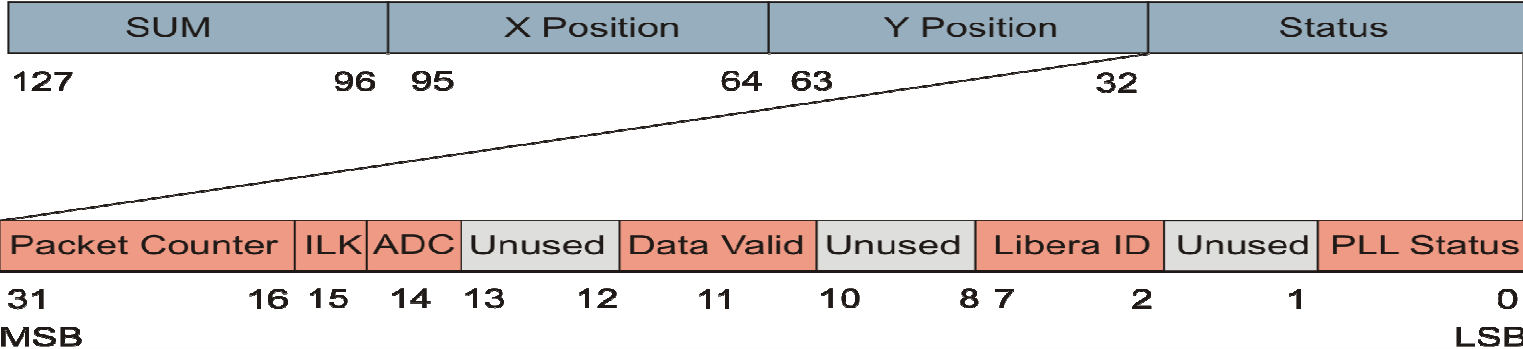
# Libera Grouping Data Packet

## Libera Grouping FA data contents

LIBERA ID=0                      LIBERA ID=1                      LIBERA ID=2

**UDP** | SUM, X, Y,... | SUM, X, Y,... | SUM, X, Y,...

128 Bit Data Structure



# Configuration files – Communication Controller

```
/etc/default/fai_dcc  
1  
    Unit ID number  
7500  
    Timeout (equals 75  $\mu$ s)
```

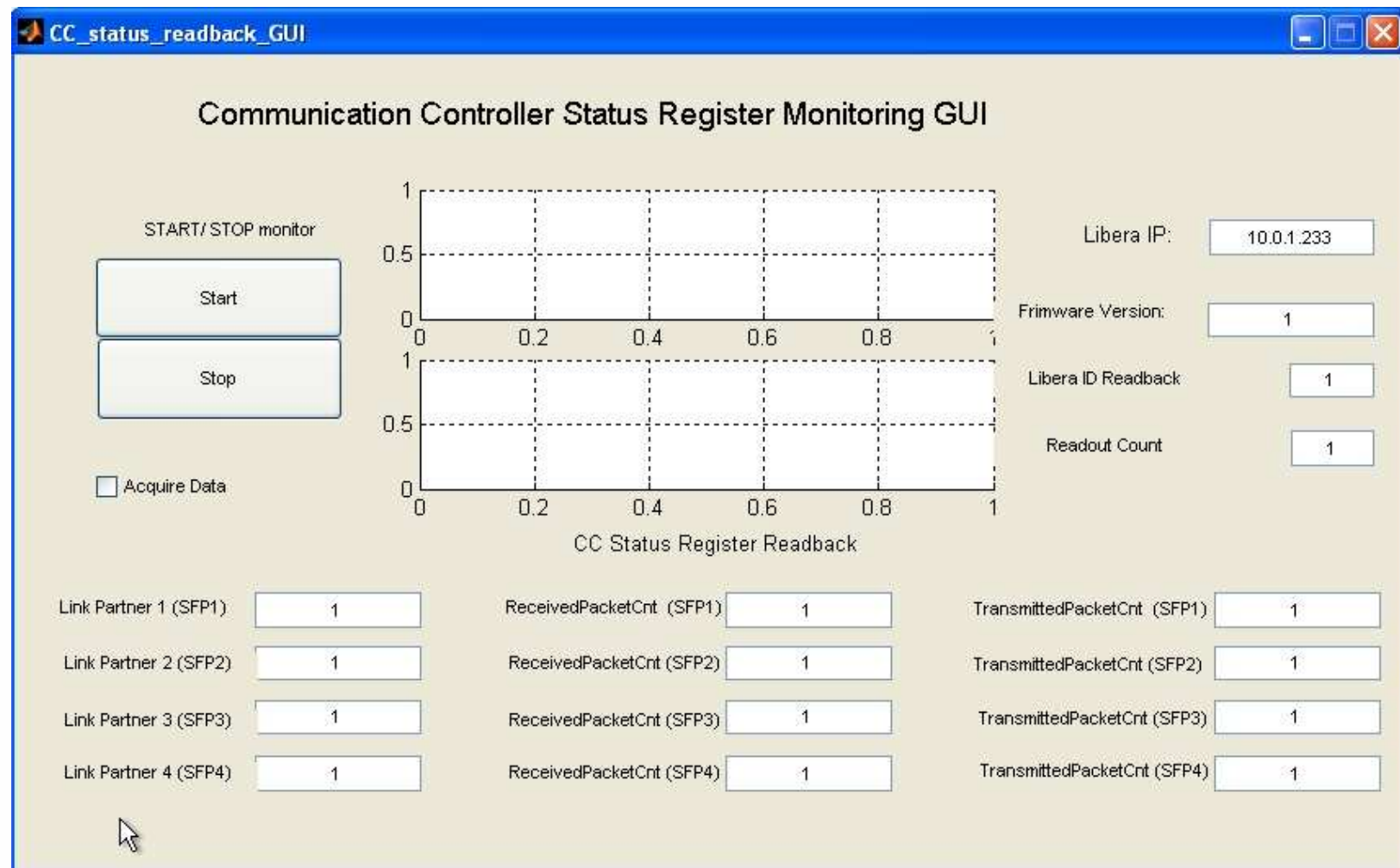


# Checking Status

- Libera Grouping: no checking available, all seen in data.
- Communication Controller:
  - libera -l -D

```
/******  
root@xcep:~# libera -l -D  
    LiberaID: 2  
    LinkPartner1: 1  
    LinkPartner2: 3  
    LinkPartner3: 1023  
    LinkPartner4: 1023  
    BPM count: 5  
*****
```

# Matlab GUI for Communication Controller



# Synchronization and Starting

Synchronization of all units in the feedback loop:

- Trigger disconnected.
- Issue “set\_time” command.
- Connect trigger to all units at the same time.
- Check the timestamp of Turn-by-Turn acquisitions.
- In case of Communication Controller, additional trigger is required for starting the data transfer.

# Conclusion

- Major benefit is compatibility of Libera Electron/Brilliance/Photon
- First tests of both units working together will be done at Soleil in the next months
- Libera Photon will be connected to the FOFB network to distribute the position of photon beam



**Thank you for your  
attention.**



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Libera Workshop 2009