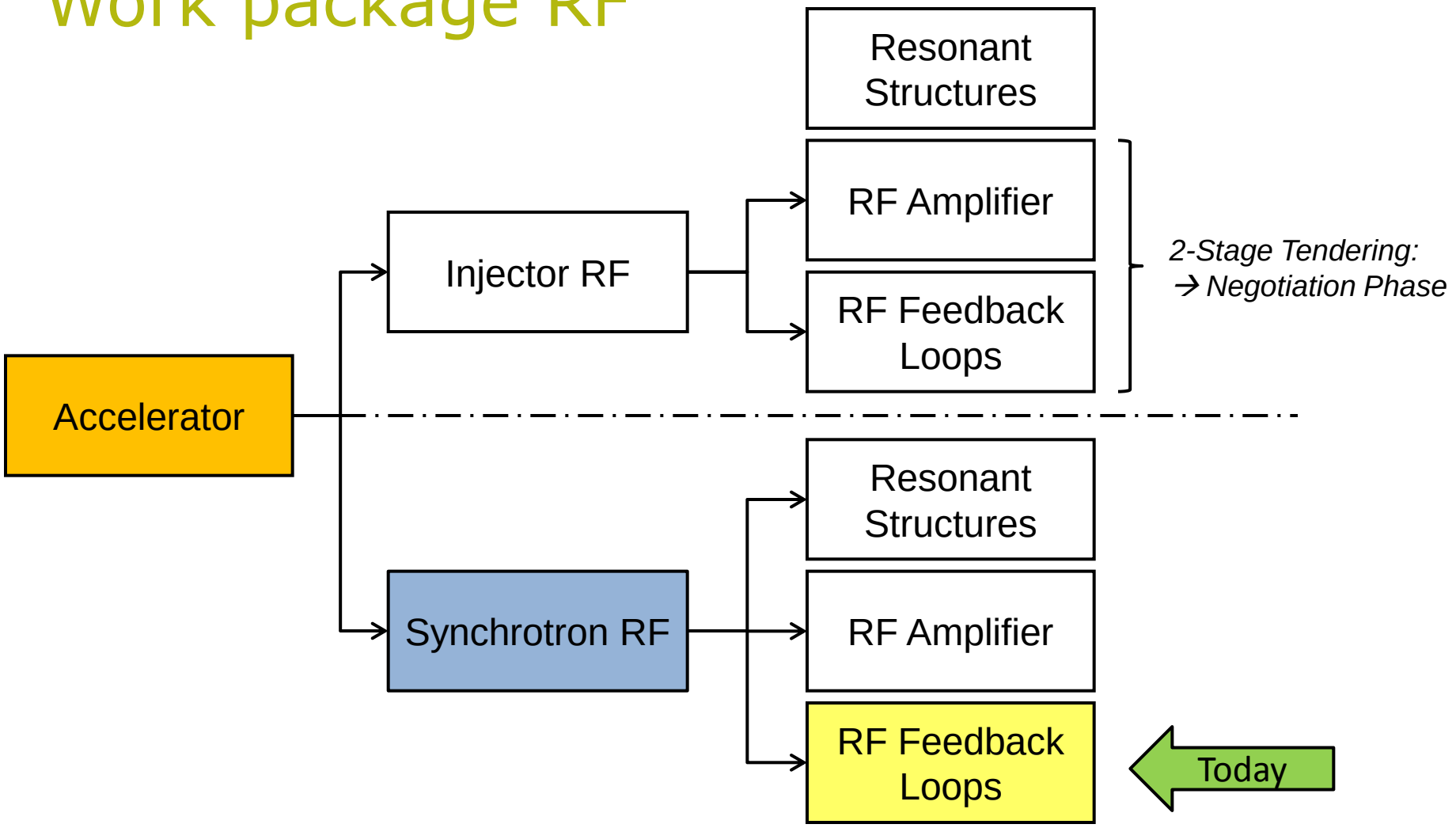
Synchrotron Low-Level RF

Present Status

complete presentation: **PP-100630-a-GKO**
MATM in June 2010, Synchrotron LLRF – Available options and possible solutions

Work package RF



Types of RF feedback

to counteract imperfections and drifts in the hardware (=linearization)

The Hardware loop(s)

regulate hardware performance of cavity + amplifier

- cavity gap voltage
- cavity tuning (if needed)

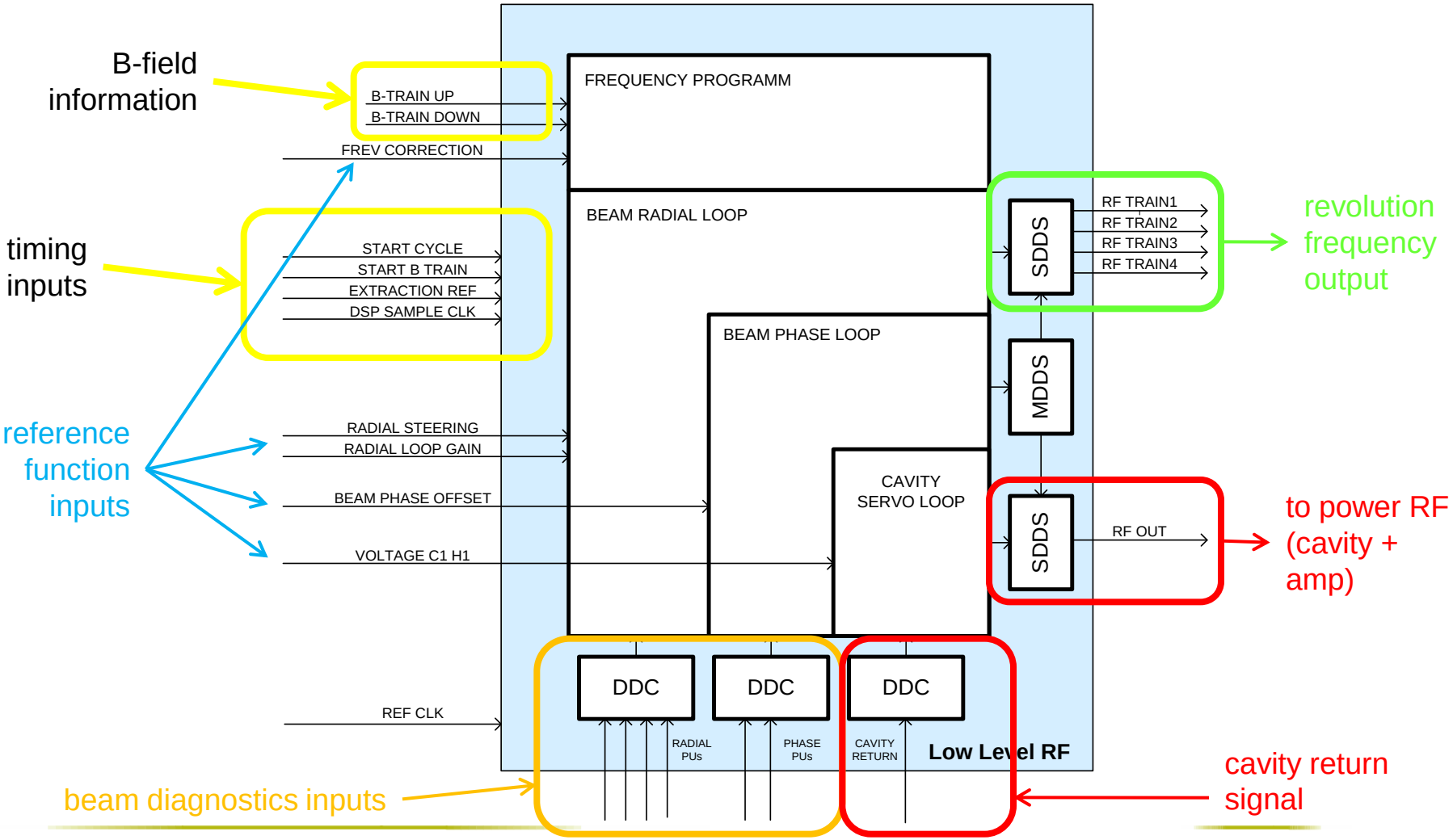
to reach the accuracy and stability required for reproducible beam performance

The Beam Control loops

use beam signals to directly stabilize beam performance

- beam phase loop
- radial loop
- frequency control
- “RF gymnastics”
  - adiabatic capture
  - dephasing
  - extraction

Complete picture: Nested loops



Summary of I/O-Functionalities

- Analog I/O
  - DDC – Digital Down Conversion
  - DDS – Direct Digital Synthesis
- Timing and triggers
  - hard timing – electrical signal received
  - soft timing – derived from internal reference
- Static configuration data
  - set-points, loop parameters
- Reference functions
  - "soft GFAS" – downloaded table (timestamp + value)
- Signal acquisition
  - records of internal observation points or "probes" (offline)

Systems considered

A. LEIR LLRF (CERN)
B. new PS-Booster (CERN)
C. CNAO system
D. Redesign & tailored for MA
E. COTS HW + in-house firmware

All systems shall provide functionality for:

- ✓ Hardware feedback loops
- ✓ Beam control loops
- ✓ Digital signal processing
- ✓ Remote configurable

Interesting aspects (summary)

Solution A – LEIR LLRF

- hardware readily available
- successfully operated and proven to work

Solution B – new PS-Booster LLRF

- improved version of LEIR LLRF (i.e. Solution A)
- collaboration with CERN for completion (?)

Solution C – CNAO system

- compatible with MedAustron requirements
- single board

Solution D – redesign, tailored version for MA

- compatible with MedAustron Power Converter Controller

Solution E – COTS HW, in-house firmware

- no HW design or production required
- spare parts are “on the market”

Comparison	Solution A LEIR LLRF	Solution B new PSB	Solution C CNAO	Solution D re-design	Solution E COTS HW
HW board design available	☺ ☺	☺	??	⊘ ----> ☺	☺
firmware available	☺ ☺	☺	☺ ☺ ---->	☺	⊘ ⊘
HW complexity	⊘ ⊘	⊘	☺ ☺	☺ ☺	☺
MACS integration	☺	☺	??	☺ ☺	☺ ☺
loop performance	??	☺	☺ ☺	☺ ☺	??
operational / proven to work	☺ ☺	2011	2010 (?)	??	??
spare parts policy	⊘	⊘	☺	☺	☺ ☺
compatible with MA	??	??	☺	☺ ☺	??
auxiliary HW requirements	⊘	⊘	⊘ ⊘	⊘ ⊘	☺
maintainability	☺	☺	☺ ☺	☺ ☺	☺
effort for implementation	☺ ☺	☺ ☺	⊘	⊘ ⊘ ⊘	⊘ ⊘

Comparison	Relevance [min 0, max 3]	Solution A LEIR LLRF [min -2, max 2]	Solution B new PSB [min -2, max 2]	Solution C CNAO [min -2, max 2]	Solution D re-design [min -3, max 2]	Solution E COTS HW [min -2, max 2]
HW board design available	2 (normal)	2(*) (excellent)	2(*) (excellent)	-1 (difficult)	-1 (difficult)	1 (good)
firmware available	2 (normal)	2(*) (excellent)	2(*) (excellent)	2 (excellent)	1 (good)	-2 (challenging)
HW complexity	1 (nice2have)	-2 (challenging)	-1 (difficult)	2 (excellent)	2 (excellent)	1 (good)
MACS integration	3 (important)	1 (good)	1 (good)	0	2 (excellent)	2 (excellent)
loop performance	2 (normal)	0	1 (good)	2 (excellent)	2 (excellent)	2(+) (excellent)
operational / proven to work	1 (nice2have)	2	1 (good)	1 (good)	0	0
spare parts policy	2 (normal)	-1 (difficult)	-1 (difficult)	1 (good)	1 (good)	2 (excellent)
compatible with MA	3 (important)	0	0	1	2 (excellent)	2(+) (excellent)
auxiliary HW requirements	1 (nice2have)	-1 (difficult)	-1 (difficult)	-2 (challenging)	-2 (challenging)	1 (good)
maintainability	1 (nice2have)	1 (good)	1 (good)	2 (excellent)	2 (excellent)	1 (good)
effort for implementation	3 (important)	2 (excellent)	2 (excellent)	-1 (difficult)	-3 (nightmare)	-2 (challenging)
SCORE		**5.00**	**5.67**	**3.67**	**3.67**	**5.00**

(*) collaboration with CERN RF-team assumed

(+) assuming adequate HW found

Course of action

- The solutions are being evaluated in more detail with the aim to finally opt for one strategy to be implemented.

- Next steps:
  - evaluate feasibility
  - work out interfaces with other groups (MACS, BDI, special magnets)
  - prepare a design concept (→ Fall 2010)

THANK YOU!