A new LLRF system for ASTRID and the proposed ASTRID2

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Why a new LLRF?

- The present ASTRID LLRF is
  - Old, Analog
    - Risk of failure, not easy to repair/maintain
    - Not much diagnostics build in
  - Not stable (experience drifts)
- We may need a new LLRF for ASTRID2, if we get the money for ASTRID2

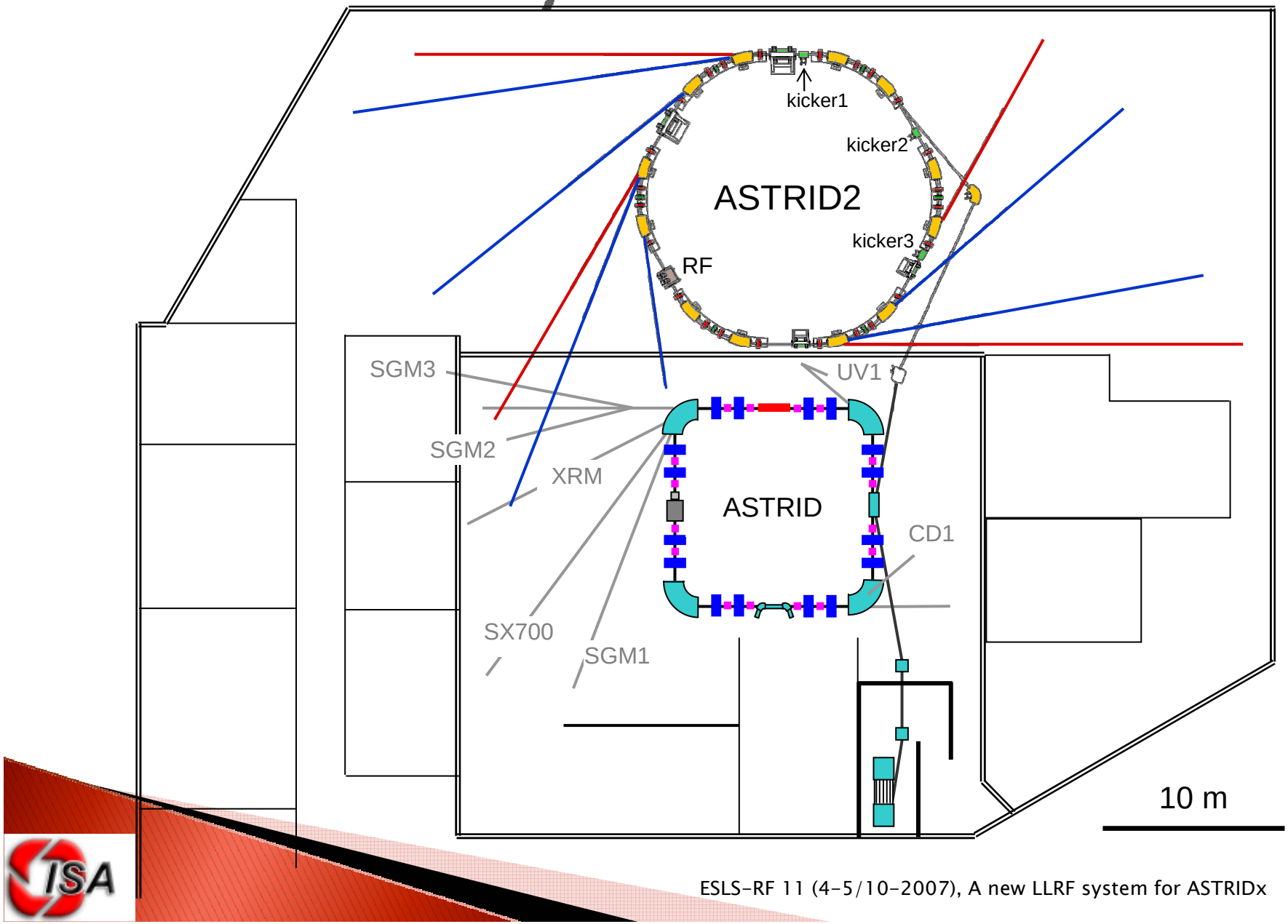
ASTRID2

- ASTRID2 is a proposed new synchrotron light source in Århus
  - Electron energy: 580 MeV
  - Emittance: 4-10 nm
  - Beam Current: 200 mA
  - Circumference: 45.7 m
  - 6-fold symmetry
  - 4 straight sections for insertion devices
  - Will use ASTRID as booster (full energy injection)
    - Allows top-up operation

ASTRID2 application

- Århus University has applied for 41 Mkr (5.5 M€) under the national program *Establishment of major national research infrastructure*
  - The 41 Mkr will cover a new storage ring, necessary upgrades to ASTRID and relocation of beam lines.
  - Buildings are not included
- We have passed the prequalification (60 applications), and have been invited, together with 10 other projects, to make a second application
  - The 11 projects have applied for 3 times the available money (200 Mkr this year)
- Decision around Christmas

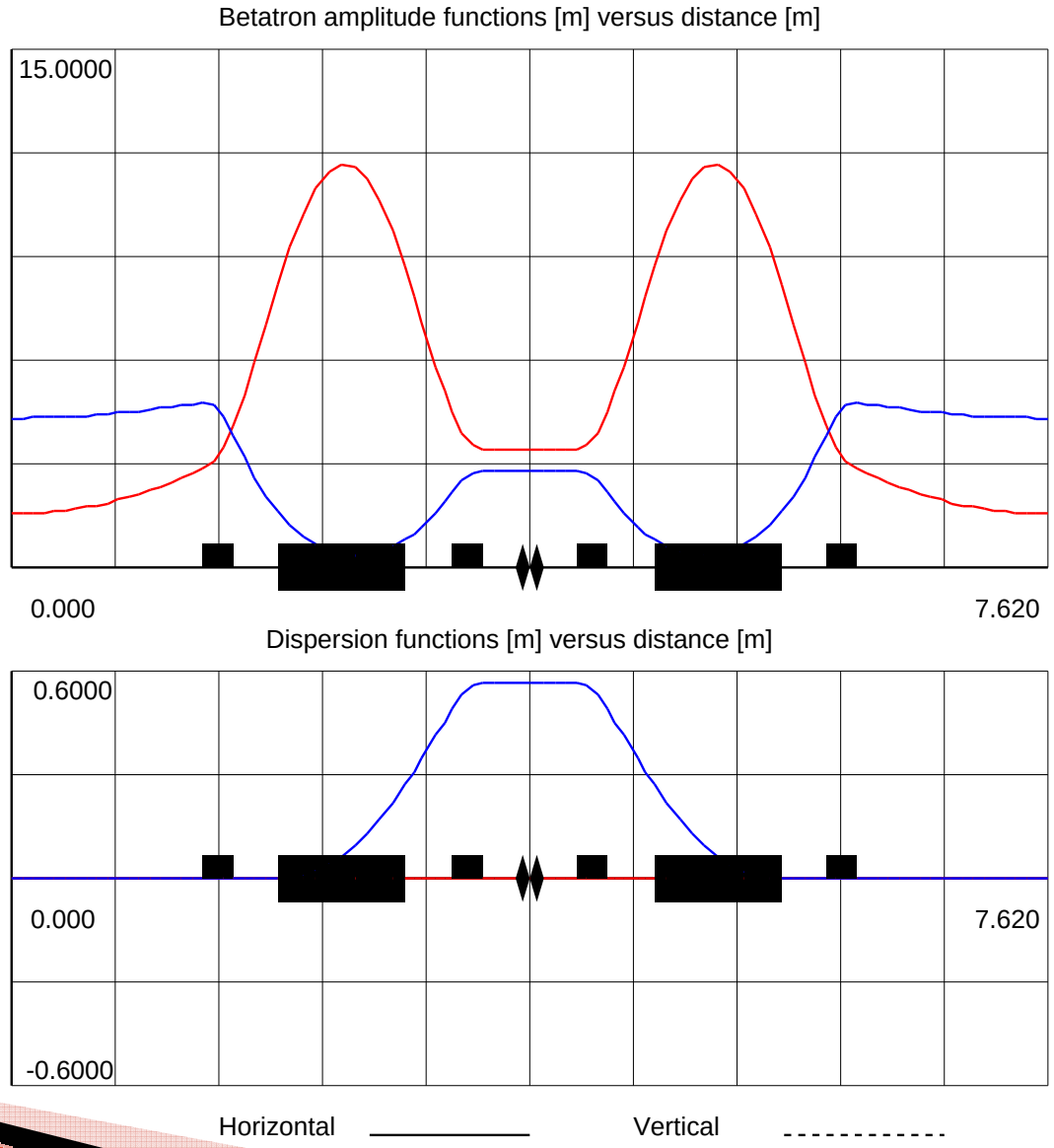
ASTRID2 Layout



ASTRID2 details

General parameters		**ASTRID2**	**ASTRID**
Energy	E [GeV]	0.58	0.58
Dipole field	B [T]	1.066	1.6
Circumference	L [m]	45.713	40.00
Current	I [mA]	200	200
Revolution time	T [ns]	143.51	133.43
Length straight sections	[m]	2.82	
Number of insertion devices		4	1
Lattice parameters			
Horizontal tune	Q_x	5.23	2.29
Vertical tune	Q_y	2.23	2.69
Horizontal chromaticity	$dQ_x/d(\Delta p/p)$	-6.47	-4.25
Vertical chromaticity	$dQ_y/d(\Delta p/p)$	-11.26	-7.11
Momentum compaction	α_p	0.0120	0.068
Coupling factor		5 %	5 %
Synchrotron Radiation parameters			
Synchrotron radiation integrals	I_1 [m]	0.546702	2.7164
	I_2 [m^{-1}]	3.463019	5.2016
	I_3 [m^{-2}]	1.908666	4.3060
	I_4 [m^{-2}]	-1.602292	1.8615
	I_5 [m^{-1}]	0.101072	0.9363
Energy loss per turn	U_0 [keV/turn]	5.5	8.3
Synchrotron radiation power	P_0 [kW]	1.1	1.6
Natural emittance	ε_H [nm]	(4-)10	140
Diffraction limit	λ [nm]	38-101	1759
Characteristic wavelength	λ_c [nm]	5.2	3.5
Characteristic energy	ε_c [eV]	238	358
Horizontal damping time	τ_h [ms]	21.8	29.1
Vertical damping time	τ_v [ms]	32.0	18.7
Longitudinal damping time	τ_s [ms]	20.8	7.9
RF parameters			
Damped energy spread	σ_E/E [0/00]	0.421	0.416
Damped bunch length	[cm]	2.2	6.5
RF frequency		105	105
Revolution frequency	[MHz]	6.18	7.5
Harmonic number	h	16	14
RF voltage	[kV]	50	30
Overvoltage factor	q	9.0	4
Quantum lifetime		∞	∞
Synchrotron frequency	$\upsilon=\Omega/2\pi$ [kHz]	1.6	20.6

ASTRID2 lattice



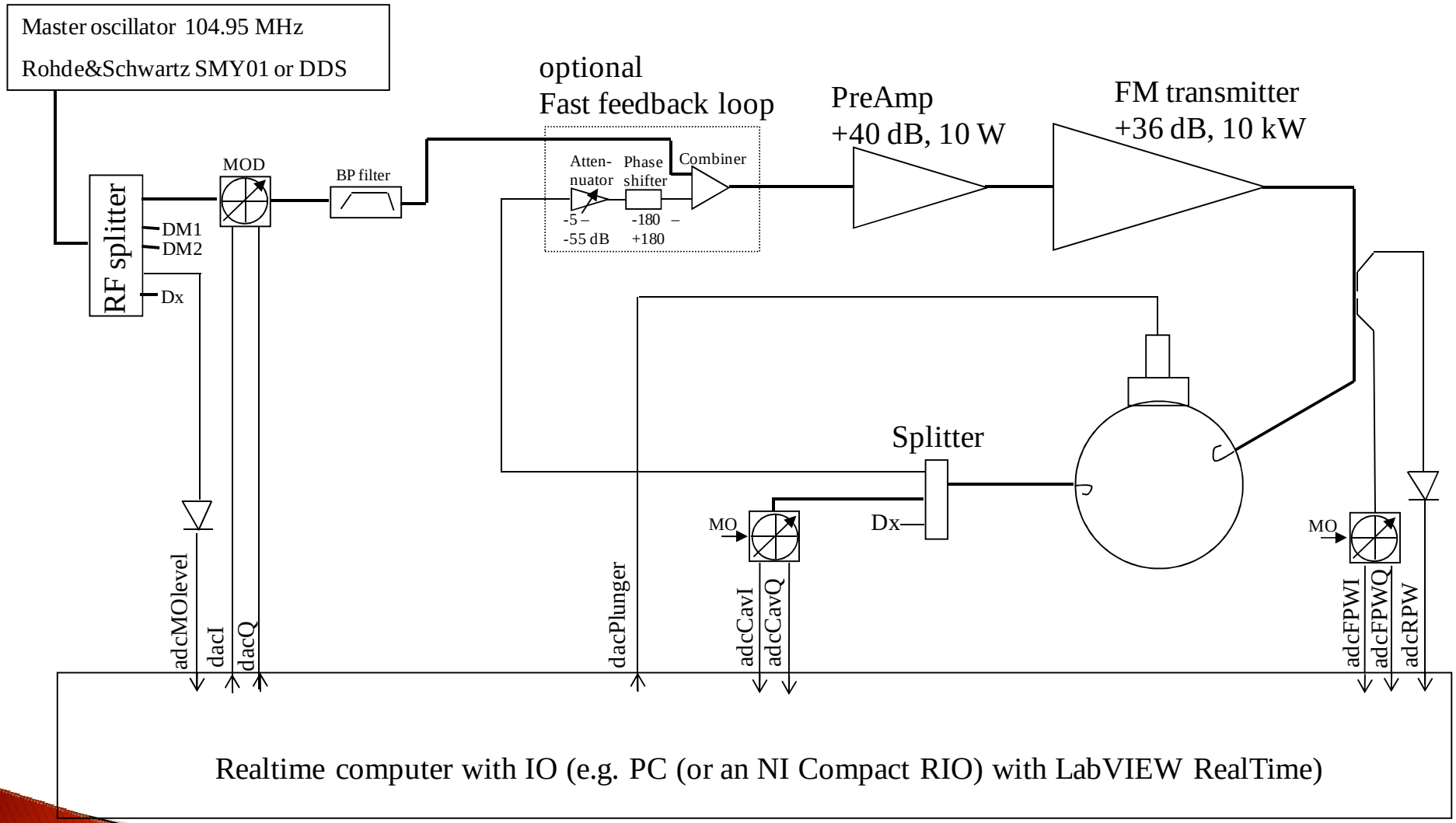
ASTRID2 RF

- 105 MHz (like ASTRID)
- The cavity could by like the new Max-II and -III cavities (which are similar in type to the ASTRID one)
- 10-20 kW tube-based FM transmitter (triode)
  - Tube-based FM transmitters are
    - Cheaper
    - More robust
- Main RF parameters
  - RF voltage (minimum): 50 kV
  - Harmonic: 16
  - Synchrotron frequency: 1.6 kHz
  - Synchrotron radiation power: 1.1 kW

The new LLRF for ASTRIDx

- Mixed analog/digital system
- Analog IQ modulators and demodulators for controlling and measuring the RF signals
- A computer (PC) running LabVIEW Real-Time with multifunction card to control and measure the baseband signals
- We believe this solution is
  - Simple, but adequate
  - Flexible
  - Allows easily integrated diagnostics

New ASTRID LLRF



A PC with LabVIEW Realtime

- With single points, multiple channels you can achieve loop rates of tens of kHz
  - Analog in – calculation (PID) – Analog out
- Need at maximum a bandwidth of some kHz
  - Cavity fill time has a 3 dB point at 6 kHz

Conclusions

- Have shown you
  - The new proposed ASTRID2 SR source
  - A new LLRF system for ASTRID and ASTRID2
- Would appreciate feedback on our ideas