An overview the ASTRID2 storage ring and its RF system

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ASTRID2

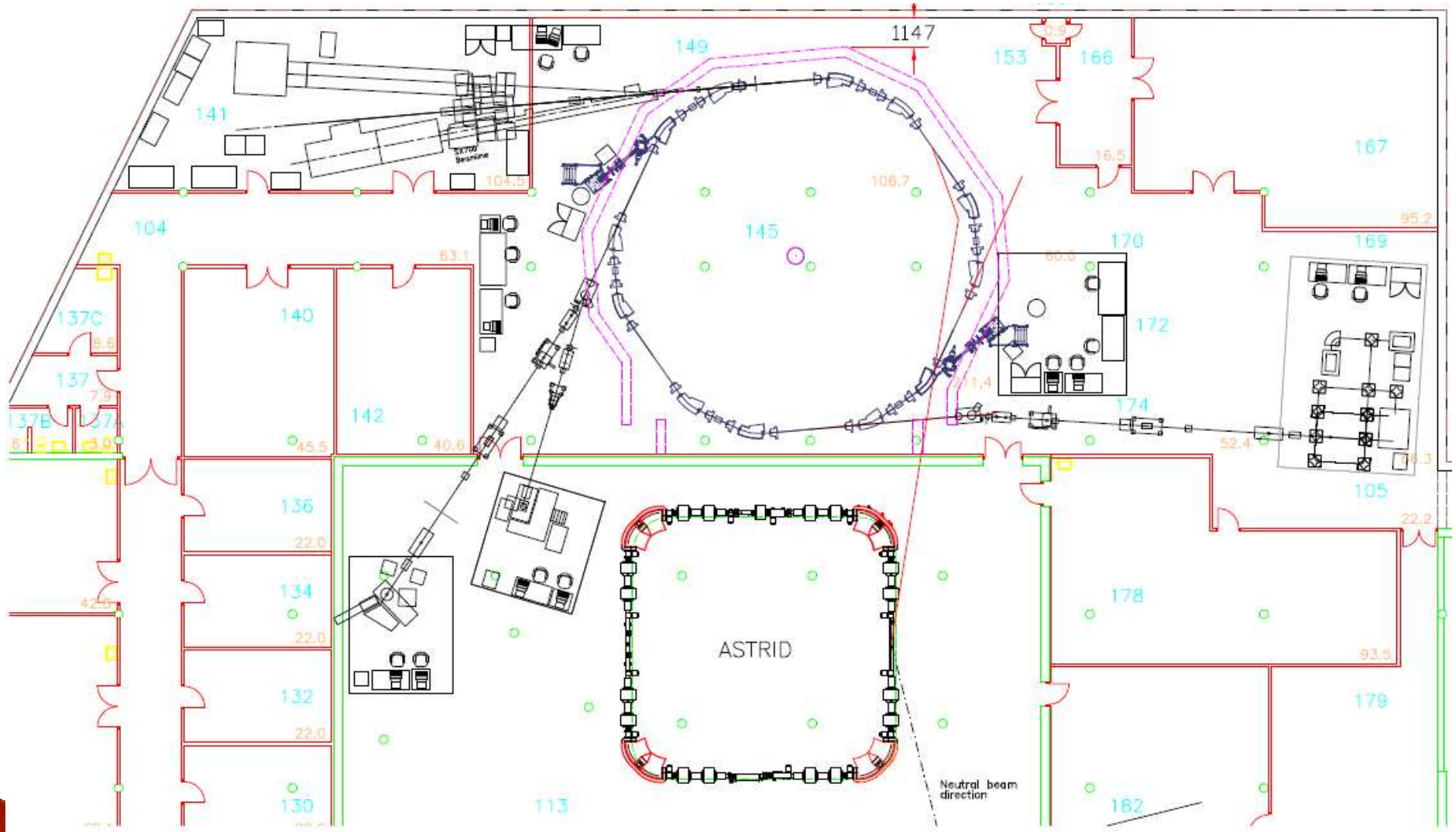
- ASTRID2 is the new synchrotron light source to be built in Århus, Denmark
- Dec 2008: Awarded 5.0 M€ for
  - Construction of the synchrotron
  - Transfer of beamlines from ASTRID1 to ASTRID2
  - New multipole wiggler

  - We did apply for 5.5 M€
    - Cut away an undulator for a new beamline
      - Has to be financed together with a new beamline
    - Saved some money by changing the multipole wiggler to better match our need

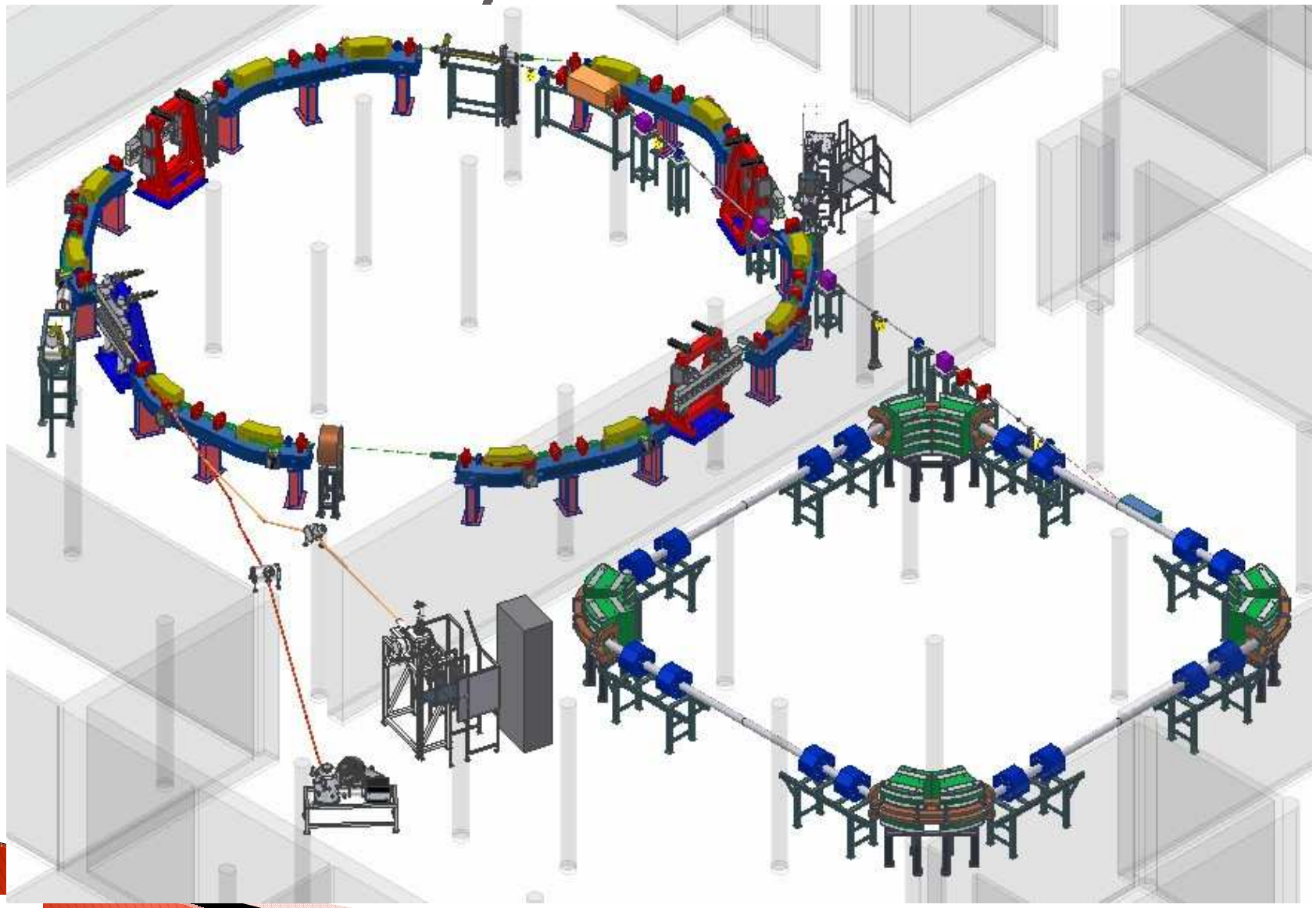
ASTRID2 main parameters

- Electron energy: 580 MeV
- Emittance: 12 nm
- Beam Current: 200 mA
- Circumference: 45.7 m
- 6-fold symmetry
  - lattice: DBA with 12 combined function dipole magnets
    - Integrated quadrupole gradient
- 4 straight sections for insertion devices
- Will use ASTRID as booster (full energy injection)
  - Allows top-up operation

ASTRID2 Layout



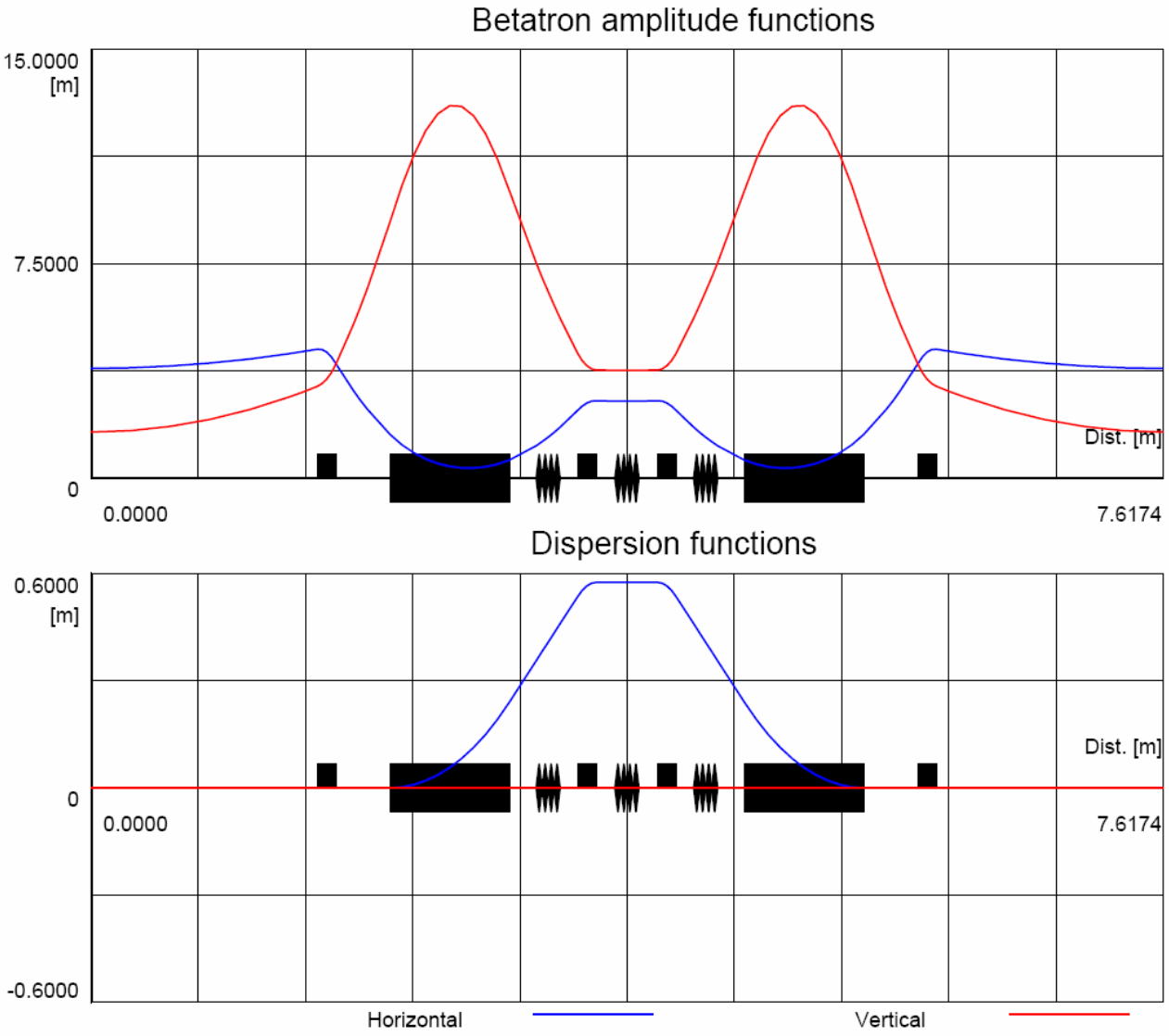
ASTRID2 Layout



ASTRID2 details

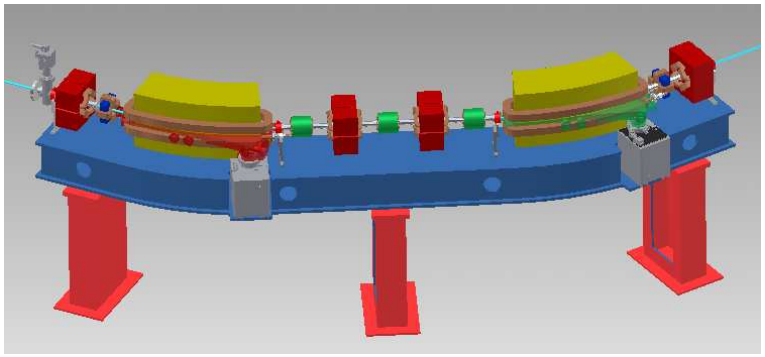
General parameters		**ASTRID2**	**ASTRID**
Energy	E [GeV]	0.58	0.58
Dipole field	B [T]	1.192	1.6
Circumference	L [m]	45.704	40.00
Current	I [mA]	200	200
Revolution time	T [ns]	152.45	133.43
Length straight sections	[m]	~3	
Number of insertion devices		4	1
Lattice parameters			
Straight section dispersion	[m]	0	2.7
Horizontal tune	Q_x	5.23	2.29
Vertical tune	Q_y	2.14	2.69
Horizontal chromaticity	$dQ_x/d(\Delta p/p)$	-6.4	-4.0
Vertical chromaticity	$dQ_y/d(\Delta p/p)$	-11.2	-7.1
Momentum compaction	α_p	0.0107	0.068
Coupling factor		5 %	5 %
Synchrotron Radiation parameters			
Synchrotron radiation integrals	I_1 [m]	0.488182	2.7164
	I_2 [m^{-1}]	3.870433	5.2016
	I_3 [m^{-2}]	2.384181	4.3060
	I_4 [m^{-2}]	-1.457685	1.8615
	I_5 [m^{-1}]	0.130774	0.9363
Energy loss per turn	U_0 [keV/turn]	6.2	8.3
Synchrotron radiation power	P_0 [kW]	1.2	1.6
Natural emittance	ε_H [nm]	12.1	140
Diffraction limit	λ [nm]	38-101	1759
Characteristic wavelength	λ_c [nm]	4.6	3.5
Characteristic energy	ε_c [eV]	267	358
Horizontal damping time	τ_h [ms]	20.7	29.1
Vertical damping time	τ_v [ms]	28.6	18.7
Longitudinal damping time	τ_s [ms]	17.6	7.9
RF parameters			
Damped energy spread	σ_E/E [0/00]	0.433	0.416
Damped bunch length	[cm]	2.2	6.5
RF frequency	[MHz]	104.950	104.950
Revolution frequency	[MHz]	6.56	7.5
Harmonic number	h	16	14
RF voltage	[kV]	50	30
Overvoltage factor	q	8.1	4
Quantum lifetime		∞	∞
Synchrotron frequency	$\upsilon=\Omega/2\pi$ [kHz]	10	20.6

ASTRID2 lattice



ASTRID2 Status

- Sep. 2009: Order of
  - Magnets on girders for the synchrotron
    - Dipoles, Q-poles, Sextupoles, correctors
  - Fast magnets with power supplies
    - Extr. Kicker, fast bumpers, inj. Septum



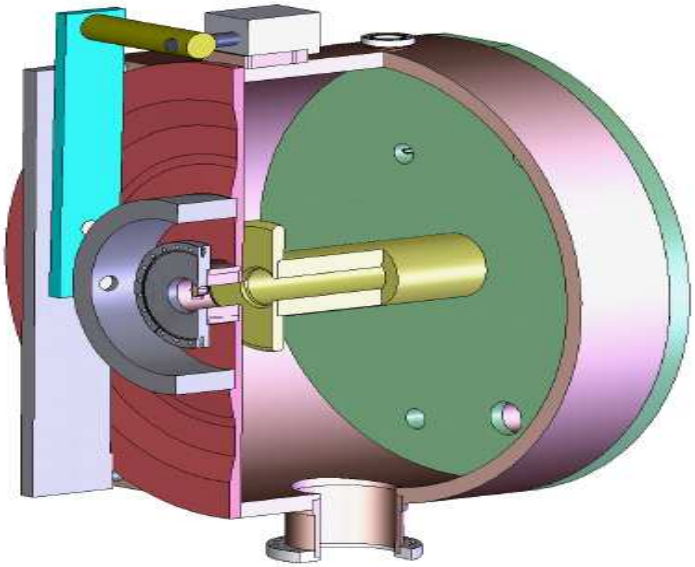
- Timeline
  - -2010: Design and order remaining items
  - 2011: Build and commission synchrotron
  - 2012: First beamlines on ASTRID2
  - 2013: All beamlines transferred to ASTRID2

ASTRID2 RF

- 105 MHz (like ASTRID)
- Main RF parameters
  - Harmonic: 16
  - RF voltage: 50–150 kV
  - Synchrotron frequency: 10–17 kHz
  - Synchrotron radiation power: ~1.4 kW
  - Cavity power: 0.8–7 kW
- 10 kW tube-based FM transmitter (triode)
  - Tube-based FM transmitters are
    - Cheaper
    - More robust

ASTRID2 Cavity

- Collaboration with MAX-lab
  - MAX-lab needs 8 cavities (100 MHz) for MAX IV
    - We need 2 cavities (105 MHz) (a spare for ASTRID1)
  - New MAX-lab cavity
    - Based on MAX II cavity
    - Use Electron Beam Welding instead of vacuum brazing
    - Proposal: Have industry build after MAX-lab RF design
  - MAX-lab will also build a 300 MHz Landau cavity



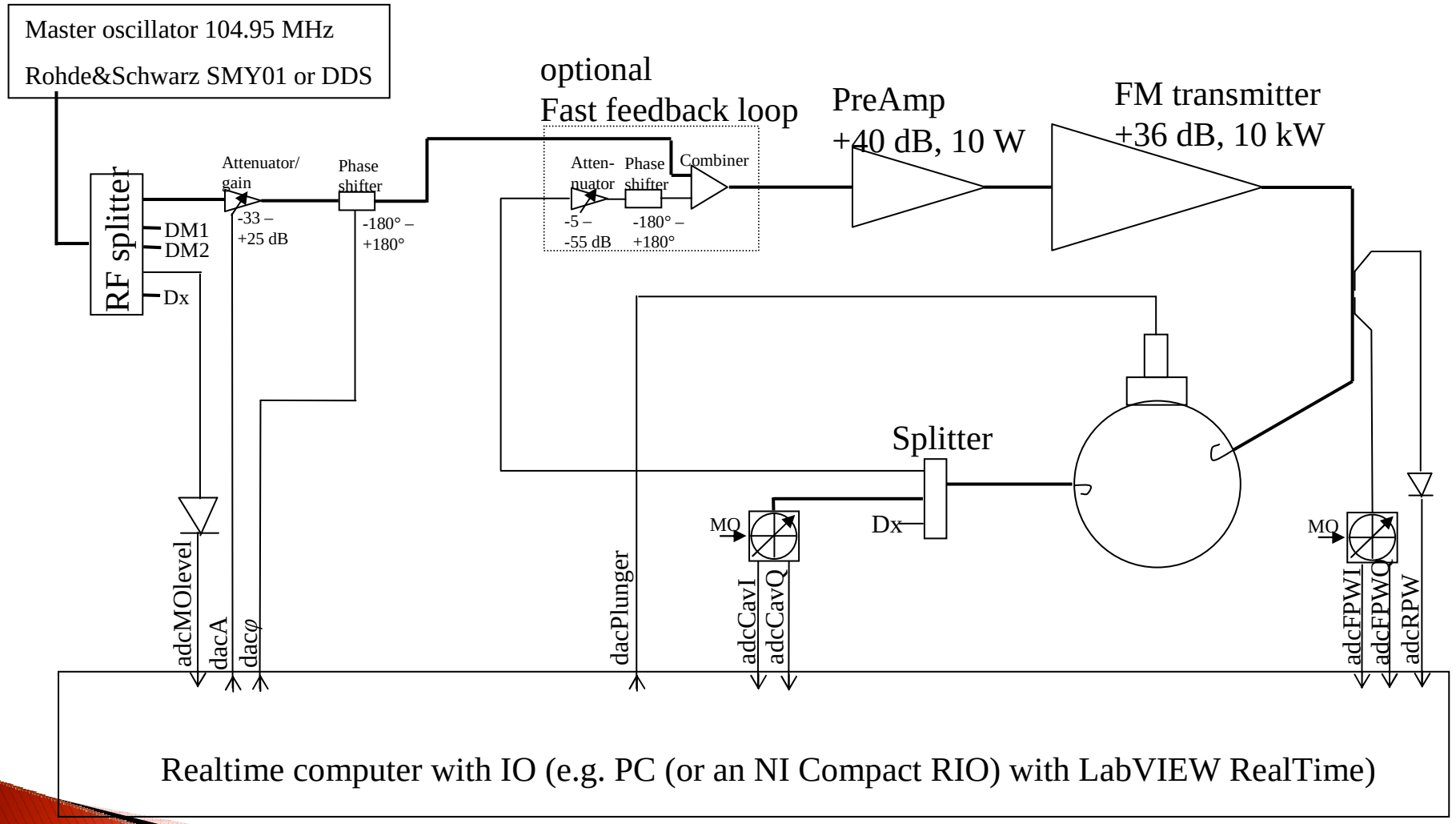
New ASTRIDx LLRF

- We will need a new LLRF for ASTRID2
- The present ASTRID LLRF is
  - Old, Analog
    - Risk of failure, not easy to repair/maintain
- We are seeking a solution which is
  - Simple (we have limited resources)
  - Adequate
- Two possibilities
  - Fully digital:
    - Direct digital sampling of down converted signals
      - Others achieve 0.1% stability
  - Analog down conversion to baseband
    - Digital control of baseband signals
      - Stability: ~1%

ASTRIDx LLRF (proposal)

- Digital control of baseband signal
  - Either with IQ modulators and demodulators or with amplitude and phase
  - A computer (PC) running LabVIEW Real-Time with FPGA equipped multifunction card to measure and control the baseband signals
    - NI PCIe-7851R/7852R:
      - Virtex 5 FPGA, 8 AI, 750 kS/s/ch, 8 AO, 1 MS/s/ch, 16 bit
      - PID Loop rates in excess of 100 kHz
        - Cavity fill time has a 3 dB point at 6 kHz
- We believe this solution is
  - Simple, but adequate
  - Flexible
  - Allows easily integrated diagnostics

ASTRIDx LLRF proposal



Conclusions

- Have shown you
  - The new ASTRID2 SR source
  - The RF system for ASTRID2
  - Proposal for new ASTRIDx LLRF
- Would appreciate feedback on our ideas
  - Analog system (digital control of baseband signals)?
  - Fully digital system with fast sampling of down converted signal?
    - Do we need the higher stability?